Jan. 28, 1969 E. E. HIRSCHBERG ET AL 3,424,542

RADIANT SPIRAL FLAME GAS BURNER

Filed Feb. 27, 1967 Sheet 1 of 2

FIG. 1

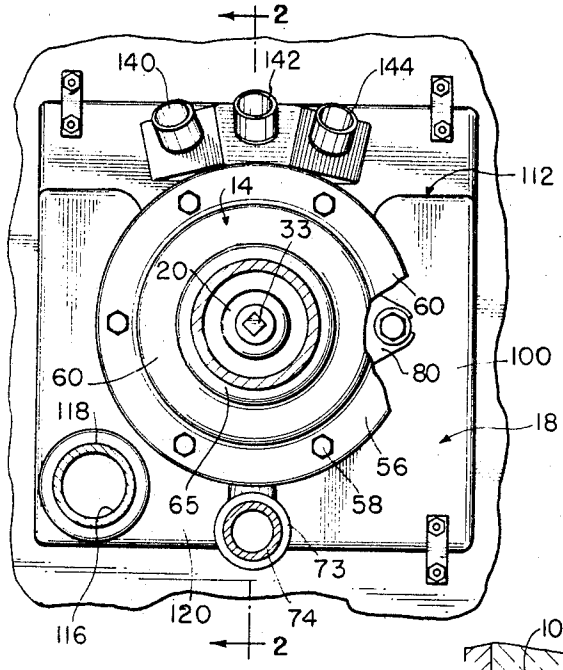
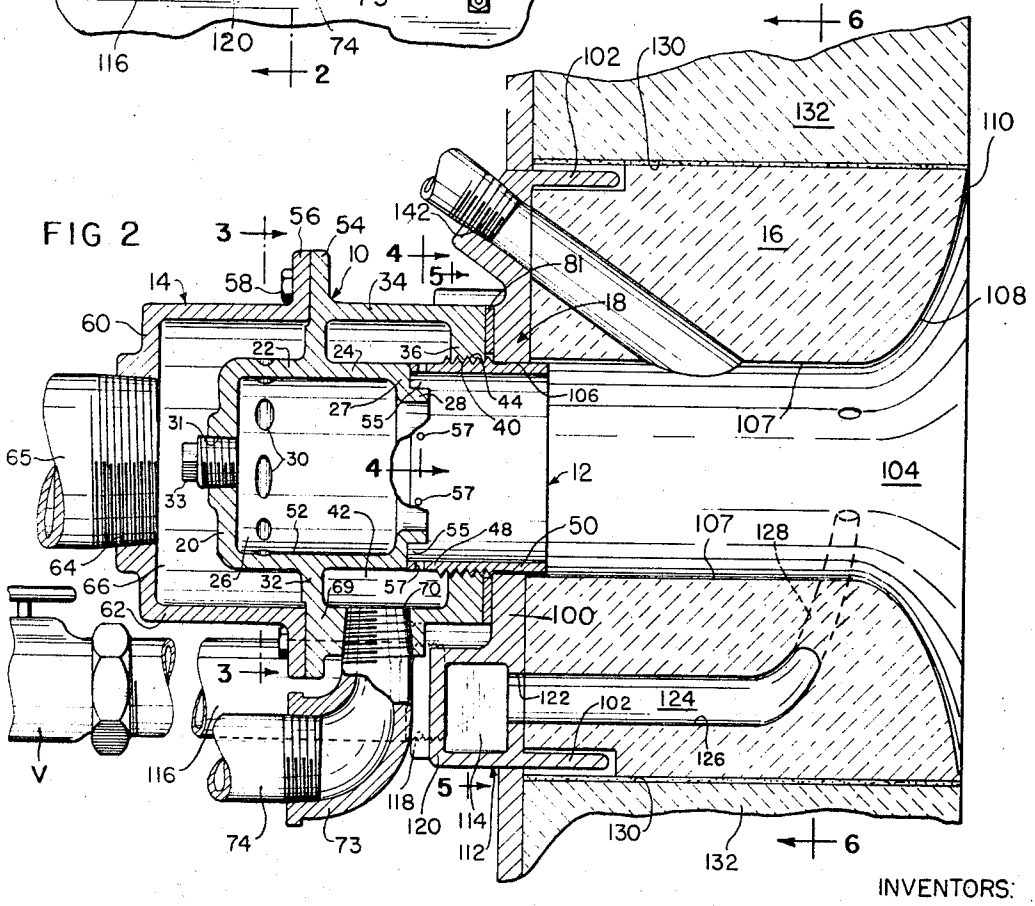


FIG 2



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RADIANT SPIRAL FLAME GAS BURNER

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FIG. 3

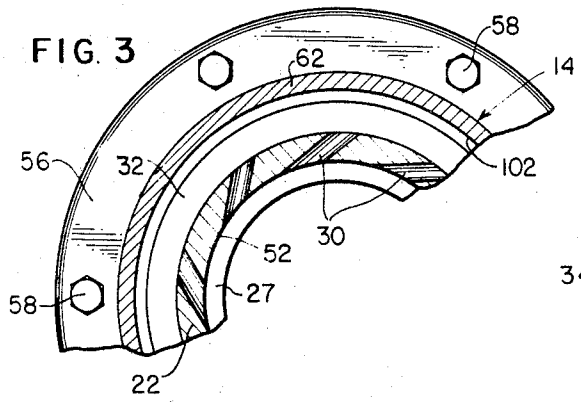
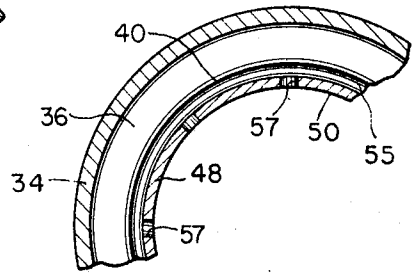


FIG. 4



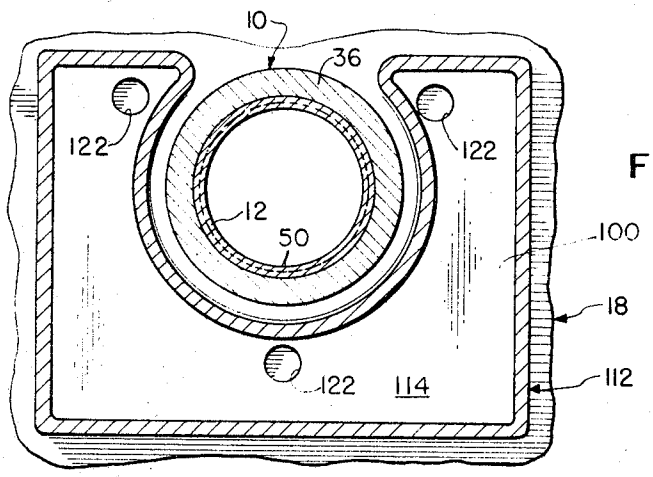


FIG. 5

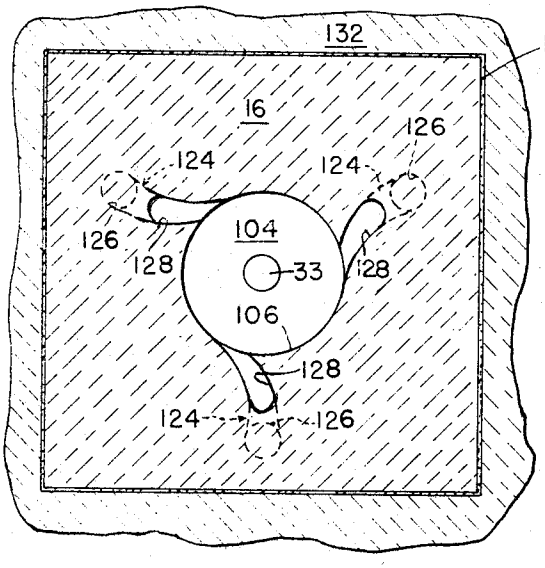


FIG. 6

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RADIANT SPIRAL FLAME GAS BURNER

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Filed Feb. 27, 1967, Ser. No. 618,756
U.S. Cl. 431—348 4 Claims
Int. Cl. F23d 13/12; B05b 7/10

ABSTRACT OF THE DISCLOSURE

A radiant gas burner having special means for accommodating large quantities of excess air or gas. A series of passages formed in the combustion block to which the burner proper is applied conduct the excess air or gas to a region of well established combustion where such air or gas may be assimilated without danger of flame extinction.

The present invention relates generally to a spiral flame gas burner and has particular reference to a radiant spiral flame gas burner of the general type which is shown and described in detail in U.S. Patent No. 3,050,112, granted on Aug. 21, 1962, and entitled "Radiant Gas Burner." The particular burner of the present patent application is an improvement upon and over the burner of such patent.

Briefly, the burner of the aforementioned Patent No. 3,050,112 is one which is capable of developing a large expanse of heat radiation which may be directed toward an object to be heated with the flow of gases proceeding at a relatively low velocity. To accomplish this, the burner is in the form of a composite burner assembly and a cooperating refractory combustion block, the arrangement being such as to provide in the central portion of the assembly a cylindrical inner swirl chamber into which air is admitted through a series of tangentially arranged ports which give to the air a swirling motion within the chamber. The chamber is provided with a restricted forward exit opening having associated therewith a forwardly projecting lip. The air within the chamber picks up a considerable amount of circumferential velocity, thus causing it to hug the cylindrical wall of the chamber as it moves forwardly toward the lip. As it leaves the lip, this swirling mass of air has injected into it gas which is introduced through a series of circumferentially arranged ports. The air and its injected gas continue to move forwardly with a swirling motion which causes the same to be thrown outwardly by centrifugal force so as to hug the surrounding cylindrical wall and become sufficiently intermixed that effective combustion may then be supported. Combustion is initiated at this point and due to the high velocity spin of the gas-air mixture, the forward motion of the same is materially reduced and is, in fact, maintained at a rate which is dependent only upon the crowding action of the oncoming gaseous constituents. The swirling mixture then enters the combustion block and, in this region of extremely low forward velocity, the surface of the combustion block spreads outwardly in radial fashion so that the flame which is still affected strongly by centrifugal force tends to follow the radial or curved surface of the block with very little forward velocity. The net result of this phenomenon is the provision of a wide flat expanse of flame with the necessary turbulence for intimate mixing of air and gas and consequent complete combustion, the latter taking place in a circumferential path rather than in an axial path so that an extremely short flame characteristic is attained for heat application over a wide area. During such combustion, the radial or curved faces of the combustion block become

incandescent and offer a large amount of substantially residual radiant heat.

The purpose and object of the present invention is to provide a novel means whereby either excess air or excess gas may be applied to a burner of the aforementioned character without affecting the normal operation of the burner, i.e., while still maintaining a combustible mixture. Heretofore, a burner like that of said Patent No. 3,050,112 or any other low velocity radiant heat burner was somewhat limited in the extent to which the gas-air ratio could be varied inasmuch as the addition of excess air through the regular air channels and ports over and above the limited maximum gas-air ratio for which the burner was designed would result in quenching of the flame at or near its point of inception. Similar flame quenching or, at least, poor flame characteristics were obtained when attempts were made to supply excess gas through the regular gas channels and ports.

According to the present invention, in order materially to extend the variation of the gas-air ratio of which the burner is capable, separate excess air openings which supply air to the throat of the burner are provided, the passages by means of which this is accomplished being formed in the refractory or other combustion block itself. The present burner is designed primarily to accommodate the application of excess air, but under the more limited circumstances where it is desired to supply excess gas to the burner, the passages in the refractory combustion block may be employed for the introduction of excess gas. In either event, whether the present burner be employed as an excess air burner or as an excess gas burner, the addition of the excess air or gas in the particular manner disclosed herein and at a region on the face of the burner block beyond the point where stoichiometric combustion conditions normally prevail, insures that the combustion process will not be interrupted by the forced addition of either air or gas in the initial combustion region and ample time will be afforded in this region for thorough intermixing of the air and gas and consequent stabilized combustion which will not be destroyed by the introduction of air or gas into the then stable swirling flame region. Still further, according to the present invention, the introduction of the excess gas or air into the stabilized flame region as outlined above, is made in tangential fashion so that the swirling gas-air mixture will not be obstructed in its swirling motion but rather will be enhanced in its motion, thus preserving and even prolonging the swirl action and maintaining the desired flat flame characteristic. In the case of excess gas, such introduction of the gas results in a cracking or break-down thereof so as to produce a readily combustible union of the products of combustion at the burner tuyere.

The provision of a radiant spiral flame gas burner of the character briefly outlined above, and possessing the stated advantages constitutes the principal object of the present invention. Other objects and advantages, not at this time enumerated, will readily suggest themselves as the nature of the invention is better understood from a consideration of the following detailed description.

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

In these drawings:

FIG. 1 is a front elevational view of a burner embodying the principles of the present invention;

FIG. 2 is a vertical longitudinal sectional view taken on the line 2—2 of FIG. 1;

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

FIG. 4 is a fragmentary transverse sectional view taken on the line 4—4 of FIG. 2;

FIG. 5 is a fragmentary transverse sectional view taken on the line 5—5 of FIG. 2; and

FIG. 6 is a fragmentary transverse sectional view taken substantially along the line 6—6 of FIG. 2.

Referring now to the drawings in detail, the radiant spiral flame gas burner of the present invention involves in its general organization a main burner casting **10**, a cylindrical front tube **12** which, in effect, constitutes a forward extension of the casting **10**, a rearcover casting **14** which constitutes an air connection for the main casting, a refractory combustion block **16**, and a combined block holder and excess air manifold **18** (hereinafter referred to for brevity as "the block holder"). The main burner casting **10**, its cover casting **14**, and the front tube **12** consistute a three-part burner assembly which is substantially identical with the similar three-part burner assembly which is shown and described in aforementioned U.S. Patent No. 3,050,112. The combustion block **16** and the block holder **18** correspond in a general way to the similar combustion block and the similar block holder of said patent, but according to the present invention, the combustion block **16** and the block holder **18** are of modified construction and embody means whereby excess air or gas may be supplied to the burner as a whole in order thereby materially to increase the latitude of the gas-air ratio of the present burner over that of the patented burner. To facilitate description herein, the present burner will be described and discussed on the basis of its being an excess air burner, and it will be understood that by simply supplying excess gas to the various passages and ports which are associated with the combustion block **16** and the block holder **18** and have been designated herein as air passages and air ports, the desired conversion may be made without substantial modification except possibly by varying the areas of such passages and ports in accordance with acceptable engineering expediencies.

The main burner casting **10** is of generally cylindrical design and is also of cup-shaped or dished configuration. As best shown in FIG. 1, the casting **10** is provided with a substantially flat circular rear wall **20** and a forwardly extending cylindrical side wall **22** having a forward cylindrical extension **24**. The side wall **22** of the main burner casting and its forward extension, in combination with the circular rear wall **20**, define together a substantially cylindrical inner air chamber **26** which, because of the peculiar motion of air flowing through this chamber, will hereinafter be referred to as the swirl chamber of the burner. The forward end of the swirl chamber is open and embodies an inwardly directed circular rib **27** which defines a gradual restriction and terminates in a relatively thin circular lip **28**, the nature and function of which will be set forth presently. Air is adapted to be admitted to the interior of the swirl chamber **26** through an annular series of circumferentially spaced and tangentially directed air ports **30**, the nature and function of which also will be explained presently. Said air ports are formed in the rear end region of the side wall **22** of the casting **10**. The rear wall **20** of the main burner casting may be formed with a threaded hole **31** for a conversion plug **33**. The hole and plug have no significance in connection with the present invention other than to provide a convenient means whereby the burner may, if desired, be converted to oil operation.

At its juncture with the extension **24**, the side wall **22** is formed with a radial and outwardly extending circular web **32** which is joined to and formed integrally with the front end of a forwardly extending outer cylindrical wall **34** in spaced and concentric relation with the cylindrical extension **24**. The outer cylindrical wall **34** projects a short distance forwardly of the cylindrical extension **24** and has a thickened inturned rim **36** which is interiorly threaded as at **40**. The outer cylindrical wall **34**, in combination with the cylindrical extension **24**, the web **32** and the inturned rim **36**, provides or defines a jacket-like gas chamber **42** which surrounds the swirl chamber **26**.

The cylindrical front tube **12** is externally threaded at **44** in the medial region or central portion thereof for threaded reception with the internally threaded inturned rim **36** so that, in effect, it constitutes a further extension of the cylindrical side wall **22** of the main burner casting **10**. Forwardly of its threaded central portion, the tube **12** projects through a circular hole in the block holder **18** and extends into the combustion block **16** for a short distance. Rearwardly of the threaded central portion **44**, the tube **12** has an integral lip portion **48** which spans the distance between the inturned rib **36** and the inwardly directed rim **27** and closes the otherwise open annulus between these two parts. The cylindrical front tube **12** is provided with an inner cylindrical wall surface **50** which, except for the interruption resulting from the lip **28**, affords a cylindrical continuation of the inner cylindrical wall surface **52** of the cylindrical side wall **22** of the main burner casting. The lip **48** is spaced outwards a small distance from the lip **28** so that the two lips define therebetween a small annular pocket **55** immediately forwards of the circular rib **27**. The lip **48** is provided with an annular series of circumferentially spaced gas ports **57** which function to admit gas from the gas chamber **42** to the annular pocket **55**.

At its outer periphery, the circular web **32** terminates in a radial bolting flange **54** which is designed for attachment to a similar bolting flange **56** on the cover casting **14**, suitable clamping bolts **58** being provided for securing the two castings **10** and **14** together.

The cover casting **14** is of cup-shape design and comprises a circular rear wall **60** and a forwardly extending cylindrical side wall **62** the front end of which embodies as an integral part thereof the previously mentioned bolting flange **56**. The rear wall **60** of the cover casting **14** is provided with a relatively large centrally disposed opening **64** which is designed for threaded reception of a horizontal air supply pipe **65**. It will be seen, therefore, that the cover casting **14**, in effect, constitutes a manifold casing which, in combination with the rear portion of the main burner casting **10**, provides a preliminary or manifold-type air chamber **66** from which air is passed through the aforementioned air ports **30** into the swirl chamber **26**. The lower region of the outer cylindrical wall **34** of the main burner casting **10** is thickened as at **69** and is provided with a threaded opening **70** therethrough for reception of an elbow fitting **73** which receives one end of a gas supply pipe **74**. As shown in FIG. 1, the inturned rim **36** at the front end of the outer cylindrical wall **34** is provided with a plurality of radially extending integral attachment ears **80** (only one of which is shown—see FIG. 1) by means of which the entire three-part assembly (**10**, **12**, **14**) may be secured to the block holder **18**. A ring-shaped gasket **81** is interposed between the rim **36** and the adjacent portion of the block holder **18**.

The arrangement of parts thus far described is purely conventional, which is to say that it constitutes the burner proper of the burner as a whole. No claim is made herein to any novelty of such arrangement per se, the function of which is to premix and conduct the gaseous constituents of combustion through the block holder **18** and deliver the same as an ignited and swirling mass to the refractory combustion block **16** for further combustion and flame pattern control. The novelty of the present invention resides rather in the novel construction of the combustion block **16** and the block holder **18** whereby facilities are provided for supplying excess air to the burner as a whole and for insuring that the burner will accommodate this excess air without flame extinguishment and without destroying the flat flame characteristic which is essential to proper operation of the burner for the purposes intended.

As shown in FIG. 3, the various air ports **30** in the side wall **22** of the main burner casting **10** have their axes arranged tangentially with respect to a circle which

is concentric with the longitudinal axis of the main burner casting **10**, the circle having a diameter equal to the diameter substantially of the inner cylindrical wall surface **52** of said side wall. The gas ports **57** in the rear end of its front tube **12** are truly radial. It will be understood that the size, inclination and the number of the ports of either series may be varied at will to accommodate the requirements of varying burner installations.

Referring now specifically to FIGS. 2, 5 and 6, the block holder **18** is in the form of a casting and comprises a rectangular plate-like portion **100** having an integral forwardly extending marginal flange **102** which encompasses the extreme rear portion of the combustion block **16**. The latter is conformably shaped to the block holder **18** and may be formed of various materials which are capable of heat absorption and radiation as, for example, a refractory or ceramic material, asbestos block, metal alloy, etc. The block **16** is generally rectangular and it is formed with a relatively large central horn-shaped opening **104** which is flared forwardly and outwardly as best seen in FIG. 2. The opening **104** registers at its rear end with a circular opening **106** in the central portion of the block holder **18** and the rear end of the opening **104** encompasses the extreme forward end region of the front tube **12**. The rear region of the opening **104** is generally cylindrical as indicated at **107**, but the medial regions of the opening flare forwardly and outwardly as at **108** and causes the opening to terminate in a radial face **110** which constitutes the front face of the combustion block **16**.

As shown in FIGS. 1, 2 and 5, the block holder **18** further comprises a generally U-shaped chamber-forming housing part **112** which is generally rectangular in transverse cross section, partially encompasses the outer cylindrical wall **34** of the gas chamber, and establishes an excess air manifold chamber **114**. Excess air under pressure is supplied to this manifold chamber **114** from a horizontal conduit **116** (see FIGS. 1 and 2), the forward end of which is threadedly received in an inlet opening **118** which leads to said manifold chamber and is formed in the rear wall **120** of the chamber-forming housing part **112** of the block holder **18**. The supply of excess air through the supply conduit **116** is controlled by a valve V (see FIG. 2). The plate-like portion **110** of said block holder is provided with a series of three holes **122** and these establish outlet ports for the excess air manifold chamber **114**. Each of the port-forming holes communicates with the rear end of an excess air by-pass passage **124** in the combustion block **16**, there being three such passages.

The three excess air by-pass passages **124** are equally spaced around the central opening **104** in the combustion block **16** and they are similar in their disposition or orientation, as well as in their contour. Each passage **124** is formed with a linearly straight portion **126**, the rear end of which registers with one of the port-forming holes **122** leading from the excess air manifold chamber. The forward region of each passage **124** is turned inwardly of the combustion block **16** on a curved bias as shown at **128**, extends in a generally tangential fashion toward the central opening **104**, and communicates with this opening at a region which is spaced only slightly rearwardly from the transverse plane of juncture between the cylindrical surface **107** of the opening **104** and the flared region **108** of said opening. The direction of extent of each of the three passages **124** is such that excess air entering the opening **104** from the passages **124** is introduced tangentially and in such direction as to slide into the swirling mass of ignited combustible constituents and join them in their path of swirling movement, thus augmenting the swirling action.

The block holder **18** and its attached combustion block **16** are adapted to be projected in the usual manner through a suitable opening **130** in a furnace wall, a fragment of which is shown at **132** (see FIG. 2). The essential and operative elements of the improved burner of the present invention have been described above and certain alternative or auxiliary instrumentalities, including peep sight, piloting and electrode devices **140**, **142** and **144**, respectively, disclosed as incidental features and are believed to require no detailed description.

The present burner may, if desired, be operated without supplying excess air thereto. In such an instance, the supply of air under pressure through the conduit **116** to the egress air manifold chamber **114** is cut off by closing the aforementioned valve V. Under such circumstances, air entering the air chamber **66** from the air supply pipe **65** causes an appreciable pressure to be built up within said air chamber so that it will pass in jet form through the tangentially disposed air ports **30** and enter the swirl chamber **26** in a generally circumferential direction. The various jets will thus be forced against the cylindrical wall surface **52** so as to pick up considerable circumferential velocity. The rear wall **20** of the main burner casting **10** provides a reaction surface for the forward impelling of the swirling mass of air under the influence of oncoming air issuing from the ports **30**. The swirling mass will thus move forwardly while at the same time hugging the cylindrical wall surface **52**. At the lip **28**, sufficient air pressure is built up to draw gas inwardly through the ports **57** by a modified venturi action which relies for its venturi effect upon the relatively high velocity component of the circumferential sweep around the rim of the lip **28** and in front of the pocket **55**. The gas is picked up at this region and is constrained to follow the swirling motion of the air and move forwardly with the latter and hug the cylindrical wall surface **50** of the front tube **12**.

At this initial region of gas entrainment, intermixture of the air and gas is incomplete so that there will be little or no combustion. However, as the two fluids move forwardly in the swirl chamber **26** and along the inside of the front tube **12**, the mixture improves gradually until the same reaches the forward rim of the front tube **12**, at which time the gas and air are thoroughly mixed and will support combustion. At a region just forwardly of the tube **12** excellent combustible conditions are prevalent and because there is a tendency for the gas and air to hug the cylindrical wall surface **50** of the tube, an ignition ring is created immediately forwardly of the front rim of the tube **12** where the mixture first contacts the front end of the central horn-shaped opening **104** in the combustion block **16**. The front tube **12** thus constitutes and it also provides an initial combustion space where combustion is first initiated. The now burning mixture retains a high velocity spin and, as the diameter of the opening **104** becomes larger, the forward velocity of these products of combustion is reduced practicaly to nothingness so that the flame hugs the outwardly flared wall of said opening and spreads out, so to speak, across the radial face **110** and travels radially outwardly considerably beyond the forward rim of the combustion block and into the interior of the furnace chamber.

It has been found that the burner assembly of the present invention is able to tolerate as much as 1600% excess air without destroying the desired flat characteristic of the flame. The desired amount of excess air is supplied to the burner assembly by regulating the flow of air through the valve V in the conduit **116**. Upon opening of the valve V, this excess air is supplied to the excess air manifold **114** from the conduit **116** and then from said manifold **114** it flows forwardly through the three excess air passages **124** in the combustion block **16** and enters the central opening **104**, i.e., the burner throat, at a region where the combustible mixture is fully ignited and after it has had sufficient time to attain stability so that the introduction of large quantities of air thereto will not quench the flame. Since the excess air is introduced tangentially into the swirling mixture

in the direction of swirl, there will be no bucking of the swirling action and, in fact, this swirling action will be enhanced, depending upon the velocity of the air entering said throat.

The present burner may, if desired, be used as an excess gas burner, in which case it is merely necessary to supply gas through the valve V and the conduit **116** to the excess manifold chamber **114** instead of air. By supplying gas and air to the burner through the regular gas and air supply conduits **74** and **65**, respectively, at a relatively low rate, and adding excess gas at a region beyond that where the combustible mixture normally burns, the resultant mixture is a useable one and will support combustion at a gas-air ratio which is far in excess of that which the burner will tolerate when attempts are made to supply the excess gas solely through the conduit **116**.

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 or scope of the invention. For example, although the burner selected for exemplary illustration herein is of the general type that is shown and described in aforementioned Patent No. 3,050,112, the principles of the invention are readily applicable to a wide variety of radiant burners which supply a large area flat flame within a comparatively short combustion zone, whether the flame be spiral or otherwise. Therefore, only insofar as the invention is particulraly pointed out in the accompanying claims is the same to be limited.

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

1. A gas burner adapted to produce a low forward velocity flame of wide expanse and comprising a burner casing presenting a forwardly extending cylindrical discharge nozzle having a forward circular rim, means for supplying gas and air to said burner casing for admixture therein and discharge from said nozzle, a combustion block having a forward flat face, a rear flat face, and a central opening therethrough in register with the forward end of the nozzle and into which the nozzle projects axially, said bore presenting an internal surface of circular cross section throughout, the rear region of which is substantially cylindrical and constitutes, in effect, a cylindrical continuation of said discharge nozzle, and the forward region of which is flared gradually outwardly and forwardly so as to merge with the forward flat face of the combustion block, there being a series of excess gaseous fluid passages in said combustion block leading from an outer surface of the block inwardly toward said central opening at a region closely adjacent to the juncture region between the cylindrical and flared regions thereof, a manifold common to said excess gaseous fluid passages, and a supply conduit for regularly supplying gaseous fluid to said manifold.

2. A gas burner as set forth in claim **1** and wherein said excess gaseous fluid passages are equally and circumferentially spaced around said central opening in the combustion block, have linearly straight rear portions which extend longitudinally through the block, and inwardly directed forward portions which communicate with said central opening in said juncture region.

3. A gas burner as set forth in claim **2** and wherein said burner casing is of the type which produces a low forward velocity swirling flame which is of wide expanse and closely hugs the wall of the burner nozzle and continues forwardly into said central opening in the combustion block, and said inwardly directed portions of the excess gaseous fluid passages communicate with said central opening in tangential fashion so as to direct excess fluid into said opening in the general direction of swirl.

4. A gas burner construction as set forth in claim **3** and wherein the linearly straight rear portions of the excess gaseous fluid passages lead from the rear face of the combustion block, the burner including, additionally, a combustion block holder in the form of a flat plate which fits against said flat rear face of the combustion block and through which the nozzle projects, said manifold being integrally formed with the block holder and, at least in part, encompassing said nozzle.

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U.S. Cl. X.R.

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