Fig. 1
Fig. 7

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BURNER WITH STRUCTURE FOR MIXING COMBUSTIBLE GASES

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The present invention relates to burners.

More particularly, the present invention relates to burners which are required to burn a pair of combustible gases. For example, it is common in blast furnace installations to provide burners which are used to heat regenerators which, after they are heated, are used for the purpose of heating the air so as to provide a blast of the desired temperature before it is introduced into the blast furnace. Burners of this latter type are required to burn a mixture of blast furnace gas and air, and it is extremely important with such burners to provide a thorough and uniform mixing of the combustible gases before they are actually burned.

Although attempts have been made to achieve this objective, all of the known structures which are designed to accomplish this result do not operate in a fully satisfactory manner. Thus, the pair of combustible gases are separately introduced into the burner and while partial mixing takes place, there is inevitably separate pockets of different gases which do not become mixed and which provide combustion of a sudden explosive nature at an elevation which is far too high in the combustion chamber, often resulting in damage to the burner.

It is accordingly a primary object of the present invention to provide for a burner of the above type a structure which will reliably mix the combustible gases in such a way that they are thoroughly and uniformly mixed with each other just prior to reaching the combustion chamber.

Another object of the present invention is to provide a gas mixing structure which is capable of distributing the combustible gases, in thoroughly and uniformly mixed condition, over the entire combustion chamber.

Still another object of the present invention is to provide for a burner of the above type a gas mixing structure which can have components thereof easily exchanged so that it is possible to vary the manner in which the gases are handled in accordance with the particular nature of the gases themselves as well as in accordance with the particular outputs which are desired.

Still another object of the present invention is to provide a structure of the above type which is exceedingly rugged and reliable in operation.

With the above objects in view, the invention includes, in a burner, a burner housing defining in its interior a combustion chamber and formed at an elevation lower than the combustion chamber with a pair of inlets through which a pair of different combustible gases are adapted to enter into the interior of the burner housing beneath the combustion chamber thereof. In accordance with the present invention a wall means is located in the burner housing beneath the combustion chamber thereof, and this wall means defines a pair of gas chambers which do not communicate with each other but which do respectively communicate with the pair of inlets for receiving the pair of combustible gases therefrom, and this wall means is formed above the gas chambers with a plurality of elongated parallel passages which extend across the interior of the burner housing and which are divided into one set of alternate passages which communicate only with one of the gas chambers and a second set of alternate passages which alternate with the first-mentioned set of passages and which communicate only with the other of the gas chambers. Also, in accordance with the present invention, there is located directly over this wall a nozzle means which includes a plurality of individual nozzles each of which communicates with at least one pair of adjoining passages so as to receive the different gases therefrom, so that the different gases are necessarily mixed in each nozzle before reaching the combustion chamber which is located directly over the nozzle means.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings, in which:

FIG. 1 is a transpose sectional elevation of one possible embodiment of a burner construction according to the present invention, FIG. 1 being taken along line I—III of FIG. 2 in the direction of the arrows;

FIG. 2 is a longitudinal sectional view of the burner of FIG. 1, the section of FIG. 2 being taken along line II—II of FIG. 1 in the direction of the arrows;

FIG. 3 is a sectional plan view of the structure of FIGS. 1 and 2 taken through the combustion chamber just above the gas mixing structure shown in FIGS. 1 and 2;

FIG. 4 is a longitudinal sectional elevation of another embodiment of a burner construction according to the present invention, the section of FIG. 4 being taken along line IV—IV of FIG. 7 in the direction of arrows;

FIG. 5 is a fragmentary sectional elevation showing a different construction of a nozzle means of the invention;

FIG. 6 is a top plan view of the structure of FIG. 5; and

FIG. 7 is a sectional elevation of the embodiment of FIG. 4, on an enlarged scale as compared to FIG. 4, the section of FIG. 7 being taken along line VII—VII of FIG. 4 in the direction of the arrows.

The particular burner structure which is illustrated in the drawings is adapted to be used with regenerators of the type which are to be found in blast furnace installations. Such regenerators include a checkerbrick structure which is first heated to a desired temperature and which thereafter is air past therethrough to be heated before being introduced into the blast furnace. Such regenerators are heated by suitable burners, and these burners may be located directly in the regenerators themselves or they may form separate units which communicate through a suitable duct with the top of the regenerator. The particular burner structure shown in the drawings is of the type which is located directly in the interior of a regenerator, although it is to be understood that the invention is equally applicable to individual gas burners which communicate through a suitable conduit with the regenerator.
Referring to FIGS. 1–3, there is shown therein part of a wall 1 which forms the outer wall of a regenerator of the type referred to above. The wall 1 is formed of a wall 3 of channel-shaped configuration extends vertically from the bottom of the generator upwardly almost to the top thereof, and this wall 3 forms part with the outer wall 1 of the regenerator the burner which is provided with the structure of the invention. This burner wall 3 and part of the wall 1, as is indicated in FIG. 3. In this particular case it is apparent that the burner housing 4, 5, 6, and 7 define a chamber 10 and 11 thereof a nozzle means which is made up of a plurality of individual nozzles 13 each of which communicates with at least one pair of adjoining passages, as is apparent from FIG. 1, so that in this way the two gases necessarily mix in each nozzle 13 before reaching the combustion chamber 2.

The nozzle means includes a plurality of longitudinal bar means 12 which extend parallel to the passages 10 and 11 and which are located directly thereover with the several longitudinal bars 12 respectively aligned and substantially bisecting the several passages 10 and 11, respectively, as shown most clearly in FIG. 1. Moreover, it will be noted that the bottom edge portions of the bars 12 are of a wedge-shaped configuration with their tapered cross section directed oppositely to the tapered edges of the wall means forming the oval-shaped cross section of the bars 12 are located at the top ends of the passages 10 and 11 extending partly into these passages to an elevation somewhat lower than the top edges of the wall portions 8. As a result of this arrangement the gas flowing upwardly through any pair of the passages 10 and 11 will necessarily flow upwardly along opposite sides of the bar 12 located thereover. Therefore, the gases flowing upwardly through any pair of adjoining passages 10 and 11 will necessarily intermingle in the space between a pair of bars 12 before flowing upwardly beyond the bars 12.

The nozzle means includes in addition to the bars 12, which extend longitudinally of the passages 10 and 11, transverse bars 14 which are also tapered at their bottom edges, and these bars 14 in addition are notched at their bottom edges so as to receive the upper edge portions of the walls 8 in these notches, as is apparent from FIG. 1. The bars 14, in addition to being notched at their bottom edges, are formed with notches extending downwardly from their top edges and receiving the bars 12, so that the bars 14 of the nozzle means rest on the walls 8 while the bars 12 are carried by the bars 14 and, as is apparent from FIG. 3, the block which forms the wall means 9 is formed with notches receiving the ends of the bars 14.

Thus, these bars 12 and 14 cooperate to form the nozzles 13 which are of rectangular cross section and which are distributed over the wall means 9 in a substantially horizontal plane between the wall means 9 and the combustion chamber 2 and, as is apparent from FIG. 1, each nozzle 13 communicates with at least one pair of adjoining passages 10 and 11 so that the gases flowing upwardly therethrough necessarily enter into each nozzle 13 to mix therewith before reaching the combustion chamber 2, and in this way the structure of the invention provides a thorough and uniform mixing of the gases before they reach the combustion chamber, and uniform burning takes place in the combustion chamber 2 just above the nozzle means 13 with each other. Thus, the passage of the gases flowing upwardly along the combustion chamber 2.

As is apparent from FIG. 3, the bars 12 instead of being in the form of continuous members can be in the form of separate sections which join each other at their ends so that in this way it is possible to remove the sections which form the bar means 12 and replace with other sections having a different configuration so as to enable the shape and size of the several nozzles 13 to be changed so that the shape and size of the nozzles will provide the best possible operation for the particular gases which are to be burned and for the conditions of the gas flow.
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The wall 30 which is formed at its underside with a groove receiving the top edge portion of the wall 29a, and this horizontal wall 30 completely covers the gas chambers 6 and 7. This wall 30 is formed with a plurality of elongated parallel passages 10a and 11a which respectively correspond to the above-described passages 10 and 11, and the passages 10a and 11a also extend across the interior of the burner housing beneath the combustion chamber 2. The passages 10a respectively alternate with the passages 11a, and these passages are of course in the form of grooves extending across the horizontal wall 30 and terminating short of the underside thereof. At its portion which is located over the chamber 7 the horizontal wall 30 is pried with openings. In the passing completely therethrough only at the passages 11a, while at the portion of the wall 30 located over the gas chamber 6, this wall 30 is formed with openings which pass completely therethrough only at the passages 10a. As is apparent from FIG. 4 each of these openings extends completely across the chamber 5 or the chamber 6. Thus, the chamber 7 communicates through the openings on the right side of the wall 29a, as viewed in FIG. 4, only with the passages 11a, while the gas chamber 6 communicates through the openings on the left side of the wall 29a, as viewed in FIG. 4, only with the passages 10a, and thus with the embodiment of FIG. 4 in which different gases are again compelled to flow upwardly through alternating sets of horizontal elongated passages. The individual wall portions which are situated between each pair of adjoining passages 10a and 11a are tapered so as to have a wedge-shaped cross section at their upper edge portions, of substantially the same configuration as the upper edge portions of the walls 8 described above, and the several transverse bars 14a are substantially identical with the above-described bars 14 and are notched at their lower edges to receive the upper edges of the wall portions between the passages 10a and 11a. In the same way, the longitudinal bars 12 extend into notches of the transverse bars 14a and have bottom tapered edges of substantially wedge-shaped cross section which substantially bisect the passages 10a and 11a and which extend into the latter to an elevation slightly lower than the top edges of the wall portions between the passages 10a and 11a, so that in this way the longitudinal bar means 12a and the transverse bar means 14a cooperate to form nozzles 13a substantially identical with the nozzles 13 and cooperating in the same way with the longitudinal passages 12a so that the two gases will always be within each of the nozzles 13a before reaching the combustion chamber 2. FIG. 4 shows with the solid arrows the flow of the gas from the gas chamber 7 and with the dotted arrows the flow of gas from the gas chamber 6. Of course, the bars 12a may also be subdivided into separate sections as to be easily replaceable as described above in connection with the bars 12.

In addition to the structure described above, the structure of the invention includes means carried by the wall means beneath the longitudinal horizontal passages to influence the flow of gas upwardly into these passages. Thus, FIGS. 1 and 2 illustrate circular members or bars 15 which extend across the passages 10 and 11 to an elevation lower than the upper portions thereof. These bars 15 will provide a turbulence in the upwardly flowing gases so that a better mixture thereof is provided in the nozzles 13. In the embodiment of FIG. 4 elongated parallel members 16 and 17 extend across the upper portion of the chambers 6 and 7 beneath the horizontal wall 30 in a direction transverse to the passages 10a and 11a so that these walls 16 also will enhance the mixing of the gases as well as direct the upward flow thereof into the passages 10a and 11a. The lower edges 16c of the walls 16 are gas tight over the chambers 6 and 7 and are also rounded, as is apparent from FIGS. 4 and 7.

Another embodiment of a nozzle means which can be used either with the embodiment of FIGS. 1-3 or with the embodiment of FIGS. 4 and 7 is illustrated in FIGS. 5 and 6. Thus, as may be seen from FIGS. 5 and 6, the nozzle means of this embodiment is made up of a plurality of blocks 17 which are of rectangular or square cross section, in a horizontal plane, but which are formed with cylindrical openings 18 passing upwardly through the interior of the burner housing. At their bottom edges the walls 17 are notched so as to receive the top edges of the wall portions 8, as indicated in FIG. 5, and in addition the bottom edges of the walls of the block 17 are tapered as illustrated in FIG. 5 so that with this construction also each nozzle 17 communicates with a pair of adjoining passages to receive the two gases which necessarily mix while flowing up through the cylindrical openings 18. The nozzles 17 are simply arranged, as indicated in FIG. 6, one next to the other over the wall means across the interior of the burner housing just beneath the combustion chamber. If desired the inner surfaces of the blocks 17 may be formed with helical grooves which will enhance the mixing of the gases. Of course, with this construction it is an extremely simple matter to remove one set of blocks 17 and replace them with another set having openings 18 of a different size and/or configuration so that here again it is a simple matter to adapt the particular burner housing which is to be used. Again, the particular gases, particular output, and particular operating conditions. Thus, if the burner is not to be used with blast furnace gas, but with a different gas which is easier to burn, then the nozzles would be changed for other nozzles which would perform better with a different gas mixture which is more easily combustible, and it should be noted that in addition, with the structure of the invention it is possible to easily change the particular location of the nozzles with respect to the passages 10 and 11 or 10a and 11a. Of course, the cross sectional area of the nozzle will be at least partly according to the cross sectional area of the interior of the burner housing so that where the structure of the invention is used with a burner housing of relatively small horizontal cross sectional area the size of the nozzles will be different from an arrangement where the structure of the invention is used in a burner housing of relatively large horizontal cross sectional area.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of burners differing from the types described above.

While the invention has been illustrated and described as embodied in gas burners, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be secured by Letters Patent is:

1. In a burner, in combination, a burner housing defining a combustion chamber with inlets through which a pair of different combustible gases are adapted to enter into the burner housing; wall means located in said burner housing beneath said combustion chamber and having upper edges defining a bottom of said combustion chamber and lower portions spaced from said upper edges and defining a pair of gas chambers respectively communicating with said inlets and separate from each other for respectively receiving the gases which

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are introduced into the burner housing through said inlets, said wall means also defining above said gas chambers a plurality of elongated parallel passages which extend across the burner housing beneath said combustion chamber and which are divided into a first set of alternate passages all of which communicate with one of said gas chambers and a second set of alternate passages respectively alternating with the passages of said first set and all communicating with the other of said gas chambers; and nozzle means located in said housing at said upper edges of said wall means between the latter and said combustion chamber and including a plurality of elongated bars extending in a direction transverse to the direction of said elongated passages and forming a plurality of elongated channels located substantially in a common plane and partly downwardly of said upper edges of said wall means, distributed across the interior of said housing, and each communicating downwardly of said upper edges with said plurality of passages so that the gases which rise upwardly through said elongated passages will mix in said channels formed by said elongated bars extending transversely of said elongated passages before entering into said combustion chamber.

2. In a burner, in combination, a burner housing defining in its interior a combustion chamber and being formed beneath said housing with a pair of inlets through which a pair of different combustible gases are adapted to enter into said housing beneath said combustion chamber thereof; wall means located in said housing beneath said combustion chamber and having upper edges defining a bottom of said combustion chamber and lower portions spaced from said upper edges defining a pair of separate gas chambers which do not communicate with each other and which respectively communicate with said pair of inlets for respectively receiving the gases which are introduced therethrough, said wall means defining over said gas chambers beneath said combustion chamber a plurality of elongated parallel passages extending across the interior of said burner housing and including a first set of alternate elongated passages which communicate with one of said gas chambers and a second set of alternate elongated passages which respectively communicate with the other of said gas chambers; a plurality of transverse bar means distributed across the interior of said housing and extending transversely of said set of passages and defining with the latter a plurality of elongated channels into each of which gases from said set of passages flow to at least partially mix therein; and a plurality of longitudinal bar means extending across the interior of said housing at the upper edges of said plurality of transverse bar means between the latter and said combustion chamber, said longitudinal bar means being parallel to said passages and respectively aligned therewith, with each of said longitudinal bar means substantially bisecting the passage over which it is located, and said longitudinal bar means subdividing said elongated channels and defining with said transverse bar means a plurality of individual nozzles through which partially mixed gases from said elongated channels flow for intimate admixture before entering the combustion chamber.

3. In a burner, in combination, a burner housing defining in its interior a combustion chamber and formed with a pair of inlets located beneath said combustion chamber for respectively introducing a pair of different combustible gases into the interior of said housing; wall means located in said housing beneath said combustion chamber and defining a pair of gas chambers separate from and directly beneath said combustion chamber; said gas chambers being disposed at least partly downwardly of said upper edges and each being formed with an opening passing therethrough and communicating with at least one pair of adjoining passages so that the two gases will mix in said openings of said blocks, whereby one set of blocks may be exchanged for another set of blocks having openings of different sizes.

4. In a burner, in combination, a burner housing defining in its interior a combustion chamber and formed with a pair of inlets located at an elevation lower than said combustion chamber and through which a pair of different gases are adapted respectively to enter into the interior of said housing beneath said combustion chamber thereof; wall means located in said housing beneath said combustion chamber and having upper edges defining a bottom of said combustion chamber and lower portions spaced from said upper edges and defining a pair of separate gas chambers which do not communicate with each other and which respectively communicate with said pair of inlets for respectively receiving the gases which are introduced therethrough, said wall means defining over said gas chambers beneath said combustion chamber a plurality of elongated parallel passages extending across the interior of said burner housing and including a first set of alternate elongated passages all of which communicate with one of said gas chambers and a second set of alternate elongated passages which respectively communicate with the other of said gas chambers; a plurality of transverse bar means distributed across the interior of said housing and extending transversely of said set of passages and defining with the latter a plurality of elongated channels into each of which gases from said set of passages flow to at least partially mix therein; and a plurality of longitudinal bar means extending across the interior of said housing at the upper edges of said plurality of transverse bar means between the latter and said combustion chamber, said longitudinal bar means being parallel to said passages and respectively aligned therewith, with each of said longitudinal bar means substantially bisecting the passage over which it is located, and said longitudinal bar means subdividing said elongated channels and defining with said transverse bar means a plurality of individual nozzles through which partially mixed gases from said elongated channels flow for intimate admixture before entering the combustion chamber.
sages and all communicating only with the other of said gas chambers; nozzle means located at said upper edges of said wall means between the latter and said combustion chamber, said nozzle means including a plurality of individual nozzles each of which communicates with at least one pair of adjoining passages to receive the two gases which mix in each nozzle before reaching the combustion chamber, said nozzle means being formed by two sets of elongated bars one of which extends transversely to said sets of passages and forms a plurality of elongated channels each communicating with all of said passages, and the other of which extends across said one set of elongated bars parallel to said passages and intersects said channels so as to form with the one set of elongated bars a plurality of individual nozzles, the bars of at least one of said sets being formed of individual, replaceable sections so that by replacing said sections the sizes and shapes of the individual nozzles can be changed.

6. In a burner, in combustion, a burner housing defining in its interior a combustion chamber and formed with a pair of inlets located at an elevation lower than said combustion chamber and through which a pair of different gases are adapted respectively to enter into the interior of said burner housing beneath said combustion chamber; wall means located in said burner housing beneath said combustion chamber having upper edges defining a bottom of said chamber and lower portions spaced from said upper edges and defining a pair of gas chambers which are out of communication with each other and which respectively communicate with said pair of inlets for respectively receiving the gases therein, said wall means being formed above said gas chambers with a plurality of elongated parallel passages extending across the interior of said burner housing and dividing into one set of alternate passages all of which communicate with only one of said gas chambers; nozzle means located directly at said upper edges of said wall means between the latter and said combustion chamber and having at least portions located downwardly of said upper edges, said nozzle means including a plurality of elongated channels having upper edge portions and extending transversely of said passages for preliminary admixture of the gases flowing upwardly thereto, and a plurality of individual nozzles at said upper edge portions of said channels, said individual nozzles each communicating at least with one pair of adjoining passages so that the two gases are finally admixed in each of said nozzles before reaching said combustion chamber; and means carried by said wall means and communicating with said gas chambers for influencing the flow of gas from said gas chambers upwardly through said passages including members extending transversely of said passages.

8. In a burner, in combustion, a burner housing defining in its interior a combustion chamber and formed with a pair of inlets located at an elevation lower than said combustion chamber and through which a pair of different combustible gases are adapted to enter into the interior of said burner housing beneath said combustion chamber thereof, a block located in and substantially filling the lower portion of said burner housing beneath said combustion chamber thereof, said block being formed with a pair of spaces which are out of communication with each other and which respectively communicate with said inlets so that said spaces respectively form a pair of gas chambers for respectively receiving gases introduced through said inlets, and said block being formed with a first set of substantially vertical cutouts extending from the top of said block into the latter into communication with only one of said spaces, said first set of cutouts extending from said one space over the other of said spaces in the interior of said block, and said block being formed with a second set of substantially vertical cutouts respectively alternating with said first set of cutouts and communicating with the other of said spaces, said second set of cutouts extending from said other space over said one space without communicating with the latter, whereby said cutouts form two sets of elongated parallel passages one set of which alternates with the other and respectively communicating with said gas chambers; and nozzle means located at the top of said block and including a plurality of individual nozzles each of which communicates with at least one pair of adjoining cutouts to receive the two gases which are mixed in each nozzle before reaching said combustion chamber.

9. In a burner, in combustion, a burner housing defining in its interior a combustion chamber and being formed at an elevation lower than said combustion chamber with a pair of inlets through which a pair of different combustible gases are adapted to be introduced into the interior of said housing beneath said combustion chamber thereof; a partition located between said pair of inlets and extending completely across the interior of said burner housing to divide the latter into a pair of gas chambers respectively communicating with said inlets to receive the gases therefrom; a horizontal wall also extending across the interior of said combustion chamber and engaging the top of said partition, said horizontal wall being formed just above said partition with a plurality of elongated passages which extend across the interior of said burner housing and which are parallel to each other, said horizontal wall being formed with a plurality of elongated parallel passages each communicating with only one of said gas chambers and with every other one of said passages, so that the gas from said one gas chamber can only flow into the latter passages.
and said horizontal wall being formed with additional slots which communicate only with the other of said gas chambers and with the remaining passages which alternate with those passages which receive gas from said one gas chamber, whereby the two different gases will respectively flow to alternating sets of the passages in said horizontal wall; and nozzle means located at an upper surface of said horizontal wall and including a plurality of individual nozzles each which communicates with at least one pair of adjoining passages to receive the two gases therefrom whereby the two gases mix in each of the nozzles before reaching the combustion chamber.