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NOZZLE FOR GAS BURNERS AND THE LIKE HAVING
CIRCUMFERENTIAL SLOTS.

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2 Sheets-Sheet 1

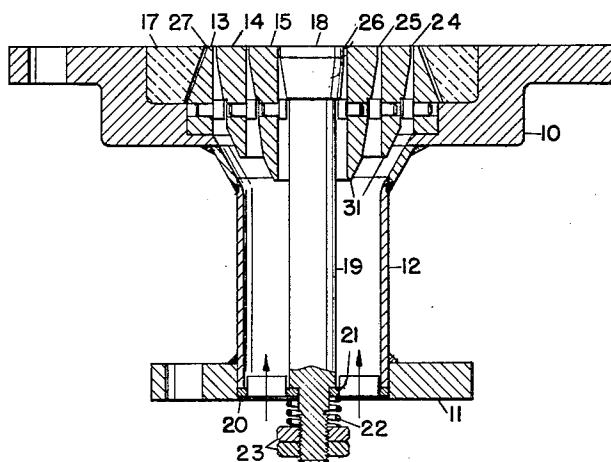


FIG. 1

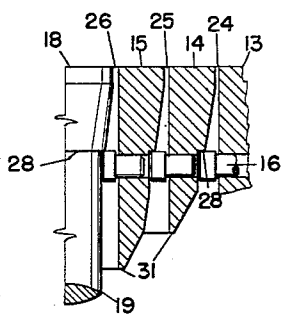


FIG. 2

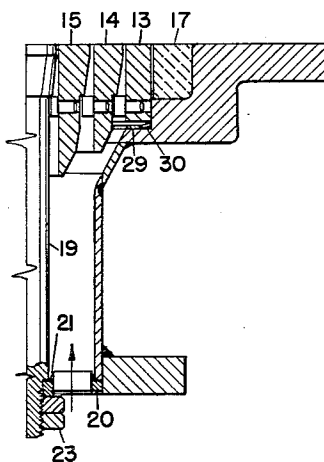


FIG. 3

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2 Sheets-Sheet 2

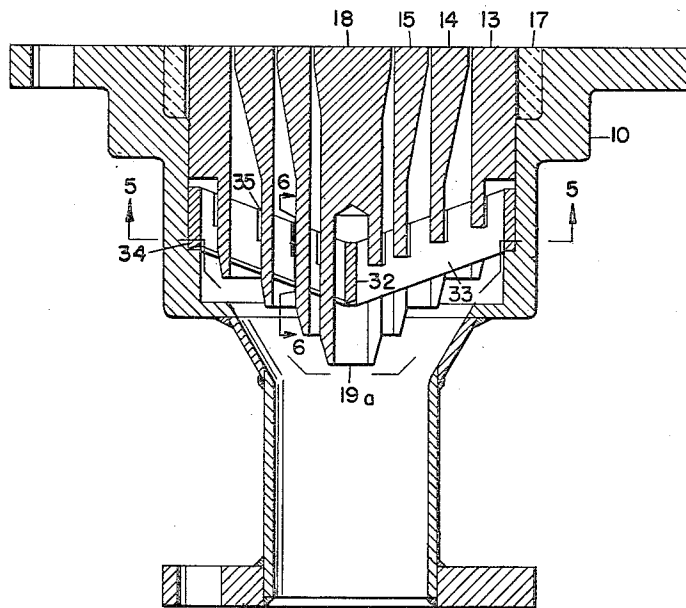


FIG. 4

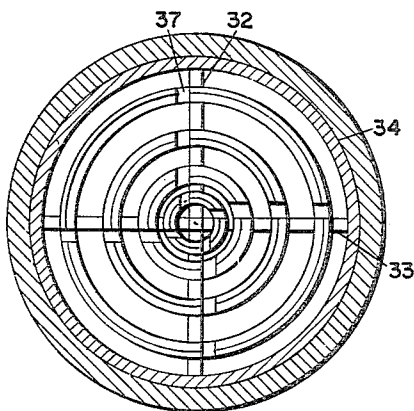


FIG. 5

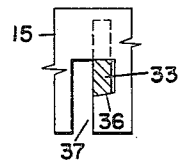


FIG. 6

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NOZZLE FOR GAS BURNERS AND THE LIKE HAVING CIRCUMFERENTIAL SLOTS

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3 Claims. (Cl. 158—116)

This invention relates to nozzles providing a plurality of circumferential slots for the discharge of a combustible mixture of gaseous fuel and air, or, in general, any gaseous mixture capable of undergoing reaction at elevated temperatures, including suspensions of solid fuel in air, all herein referred to as gaseous streams. The invention finds especial although not exclusive application in burning installations and the disclosure will relate to such an application; however, it may also be applied in the chemical industry, for instance, for hydrogen-chlorine reactions. Wherever terms are employed herein which refer to the combustion of a gas, they should be construed to include such other cases as the afore-mentioned.

When gas-burning nozzles are used for heavy loads it may happen that the flame is blown off as a result of the high velocity at which the gas mixture flows through the nozzle orifices. This drawback has been overcome by promoting the formation of stabilizing whirls at the burner nozzle; an example thereof is described in the U. S. Patent No. 2,515,845, in which the combustible mixture is fed into the combustion chamber through an annular hole.

If burners of very high capacity are required, the size of the annular discharge opening may be increased, but this possibility is very restricted. Starting, for example, from a given difference in pressure between the front and back of the nozzle plate containing the said opening, the capacity of the burner may be increased by increasing the product of the slot width and the diameter, to which the capacity is directly proportional. In increasing the slot width as well as the diameter of the slot, however, there are certain restrictions if it is required to retain the required shape of flame in the combustion chamber to avoid local thermal overloading of the chamber wall.

Burners with more than one annular slot have been proposed in order to obtain greater capacities; a burner of this type is known, for example, from the Germany Patent No. 433,484, in which the burner tip is formed by a plurality of slots situated between concentric rings.

In this type of burner the flow of gas is divided up into a number of concentric annular streams which mainly flow out in an axial direction. Small toroidal whirls can thus be formed between each pair of adjoining streams, which give the required stabilizing effect if the mutual relation between slot and ring width is suitably chosen.

It has been found in practice that in burners with concentric annular slots the flame in the combustion chamber is drawn towards the interior in a somewhat radial direction, i. e., from the peripheral wall of the combustion chamber, thus completely or almost completely avoiding the danger of local thermal overloading. In this type of burner with several concentric rings the temperature will generally be greater at the center of the burner tip than at the outside, where the annular burner openings are situated, as the transfer of heat, for example, towards the wall of the combustion chamber, can take

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place more easily on the outside. If the rings form a continuous grid, as in the abovementioned German patent, this will cause thermal stresses in the burner plate in consequence of irregular expansion, with the result that there is at least a danger of undesirable deformations occurring in the rings which may adversely affect the passage and distribution of the combustible mixture and, hence, the combustion.

It is the primary object of this invention to overcome the above-noted drawbacks in gas burners relating to deformation of the concentric rings and slots caused by thermal effects.

In summary, the burner according to the invention comprises a plurality of concentric rings that are radially spaced from one another to provide a plurality of intervening, concentric annular discharge slots by which the gaseous stream flows from the back side of the set of rings to the front, the said rings being supported from a burner housing in such a manner that they can undergo individual deformation as a result of variations in temperature and relative differences in temperature.

According to one embodiment this may be achieved by providing lugs on each ring, preferably set back from the front face, each lug extending to an adjoining ring with play in a radial direction, the outermost ring being supported from the burner housing, either rigidly or resiliently to permit axial movement; the lugs may extend radially outwardly from the rings to which they are secured or radially inwardly therefrom, as desired. Within the innermost ring is a circular plate, similarly spaced from and supported by lugs with respect to the adjacent ring, and further connected to the housing by an axial spindle that advantageously has a resilient connection to the said plate or to the housing, although the resilient connection is not necessary when the outermost ring is mounted resiliently. The plate thereby retains the entire assemblage of rings. This enables each ring to expand freely in a radial as well as in an axial direction.

According to another embodiment the housing contains a framework, e. g., a grid or spider, set back from the front of the set of rings and the rings are mounted individually on the bars of the grid by any suitable means, such as a bayonet-type connection or the like. The grid is set back sufficiently far not to be significantly affected by thermal stresses. The rings, being separated from one another, are individually free to deform radially and axially.

To form whirls that stabilize the flame against being blown off the widths of the rings are advantageously at least four times the widths of the slots.

The shape of the rings is preferably so chosen that the heat is suitably transferred to the cold combustible gas stream in a manner that the temperature of the latter, during the time that it is in the burner housing or the annular slots prior to discharge, remains below the ignition temperature, so that no self-ignition can occur in advance of the burner openings. Since higher temperatures prevail at the center of the burner than at the periphery, the rings are made progressively longer in an axial direction, the outermost ring being the shortest. Further, the rings are tapered or bevelled at the rear ends and all parts are shaped so that no pockets are formed in which whirls may occur; such whirls are impossible to control and, in view of the greater residence time of the combustible mixture in such whirls, the danger of excessive temperature rise and self-ignition of the gas within the housing would be increased if this precaution were not taken. To prevent flash-back it is recommended that even when operating at minimum load the gas should pass through the annular slots at a

velocity greater than that of the propagation of the flame-front.

The invention will be further described with reference to the accompanying drawings forming a part of this specification and illustrating certain preferred embodiments thereof, wherein:

Figure 1 is a central sectional view through the burner;

Figure 2 is a detail view, on an enlarged scale, of a portion of Figure 1;

Figure 3 is a fragmentary central sectional view showing a modification;

Figure 4 is a central sectional view of a further modified embodiment of the burner; and

Figures 5 and 6 are sectional views taken on the correspondingly numbered section lines indicated on Figure 4.

Referring to Figures 1 and 2 of the drawings, the burner consists of a housing that is essentially cylindrical and includes front and rear flange plates 10 and 11, respectively, and a connecting tubular part 12; a plurality of rings 13, 14 and 15 that are radially spaced and positioned by radial lugs 16 (Fig. 2); a seal ring 17, advantageously of ceramic material; a central circular plate 18 spaced radially from the innermost ring 15 and having a spindle 19 integral therewith and extending rearwardly therefrom; and attachment means securing the back end of the spindle to the housing, including an open grid or spider 20 having a central hub 21 pressed into the housing, a compression spring 22, and nuts 23. Annular discharge slots 24, 25 and 26 are formed adjoining the rings, between each pair of adjacent rings and between the innermost ring and the central circular plate, for the passage of the combustible gaseous stream toward the front of the burner, shown at the top of the drawing. These slots are of any suitable width, preferably 1-2 mm. at the front, and uniform for all slots. The front face is advantageously substantially flat, as shown.

The central circular plate 18 and the several rings 13-15 are free for individual limited radial movements, whereby limited expansion is possible as a result of an increase in temperature. The outermost ring 13 is advantageously afforded space for expansion by making the seal ring 17 slightly larger; a preferred way of achieving this is to form the ring 17 by applying a ceramic material in a plastic state into the annular gap between the ring 13 and flange plate 10. Expansion of the ring 13 upon being heated pushes this material outward, so that when the burner has been in operation for some time a small expansion gap will occur between the ring 13 and the ceramic ring 17, which has by now hardened. This gap is shown in Figure 1 at 27, necessarily exaggerated. The lugs 16 on each ring are circumferentially distributed and extend radially inwards; they are fixed, e. g., by pressing into radial holes in the rings. The central plate 18 and each ring inside of the outermost ring 13 has a rearwardly-directed shoulder or abutment 28 on the outer side thereof for coaction with the front sides of the lugs of the next outer ring. The radially outwardly directed surface of the plate and the specified rings immediately to the rear of the abutments are accurately dimensioned to be spaced by small clearances from the inner ends of the supporting lugs. In this way each series of lugs, provided on one of the rings, forms a support with radial play for the adjoining smaller ring or the circular central plate. This manner of supporting the rings permits movement, although slight, in a radial direction. The rings are held in position in an axial direction by means of the central plate 18 and the spindle 19, the rear end of which is threaded extends through the central hub 21, and has axial sliding movement therein. Rearward movement may, if desired, be restricted by providing a shoulder on the spindle for abutment against the hub 21, as shown. Forward movement is opposed by the spring 22, which urges the spindle rearwardly, thereby applying pressure between each abut-

ment 28 and the lugs coacting therewith. This provides flexibility in that each ring can expand in an axial direction due to an increase in temperature.

It will be noted that the spring 22 provides a resilient connection for the spindle. While not in every case essential, some resilient connection between the housing and the rings is highly desirable because it loads the lugs 16 with a constant pressure, substantially independent of the expansion of the rings. Without provision for axial movement of either the central circular plate or the outermost ring, the only possible axial movement of the rings upon expansion thereof would be by elastic stretching of the spindle, which would place high stresses on the lugs. If the connection is too firm the spindle may break on account of contraction, for example, or the lugs may be bent out of shape. A loose connection, e. g., by not tightening the nuts 23 firmly against the spindle, could prevent this; but this permits the spindle to assume an entirely free position as a result of expansion due to an increase in temperature and presents the possibility of too great an axial movement in consequence, so that the positions of the rings on the lugs may be disturbed, and chatter, sporadic variations in the shapes of the annular discharge channels, and damage through jamming may occur.

Figure 3 shows an alternative construction, wherein resiliency is provided between the ring 13 and the flange plate 10 by an annular metal spacer 29 having resilient upwardly inclined teeth 30. The connection for the spindle 19 to the spider hub 21 may in this case be modified by omitting the spring and tightening the nuts 23 against the hub, the deflection of the teeth 30 being sufficient to accommodate axial movement due to thermal expansion.

The shape of the rings is preferably so chosen that the heat is suitably transferred to the gaseous stream, since care must be taken that the temperature of the combustible mixture, during the time that it is in the burner housing or the annular discharge slots, remains below the ignition temperature, so that no self-ignition can occur in advance of the discharge ends of these slots. If care is now taken that the temperature of the rear sides of rings (directed away from the flame) does not exceed a certain value, for example, approximately 390° F. when burning butane, propane, propylene, etc., there will be no danger of self-ignition. This is effected by making the height of the rings situated more towards the center greater than that of the rings situated more towards the outside. As shown, the rings 13, 14 and 15 have progressively greater lengths, measured in the axial direction. In the operation of the burner higher temperatures prevail at the center than towards the outside, hence the temperature drop in the rings near the center must be greater than in the rings situated toward the outside in order to attain uniform temperatures at the backs of the rings. By the arrangement shown the temperature of each ring at the points indicated at 31, i. e., just before the gaseous streams branch off into the various annular channels, is held below a desired value, e. g., 390° F. in the case of the fuels mentioned above, and self-ignition is avoided.

Not only is the profile of the rings such as to be adapted to transfer heat to the gaseous stream in accordance with the heat flow through metal of the rings, as described above, but the profile is further such as to promote uniform distribution of the gaseous stream among the various annular channels. The lengths and shapes of the channels are chosen so as to prevent, for example, disproportionately more gas from flowing through the innermost slot than through the outer slots, which is a normal tendency in the case of identically shaped passages. As the resistance encountered by the gas flowing through the slots is chiefly due to wall friction, an increase in the height of the center rings, resulting in longer inner channels, satisfies this requirement.

Finally, the rings are shaped so that on the rear sides no pockets are formed in which whirls may occur, such whirls being impossible to control and causing increased residence time of the gas whereby the possibility of self-ignition of the gas in the housing is increased. As shown in the drawings, the rings are bevelled, presenting a cross section that is tapered toward the rear; this and the arrangement of the housing, which serves as a common fuel supply line for the several annular slots, without obstructions are effective in meeting this requirement.

The play allowed between the various rings or central plate and the lugs is preferably between about 2 and 10% of the slot widths, e. g., in the order of 0.1 mm. for a slot width of 1 to 2 mm., so that no special centering means is required. The burner can then be used in the horizontal as well as in the vertical position. In determining the amount of play at the ends of the lugs the expansion of the rings which may be expected should, of course, be taken into account.

The material of the rings is chosen in accordance with various operational factors; an iron-nickel-chrome alloy is often very suitable for such cast rings.

For effective flame stabilization against blow-off at the discharge openings of the slots, it is desirable to insure the formation of stabilizing whirls at the discharge side of the nozzle plate. This effect depends on a correct choice of the ratio of the width of the rings to the width of the discharge slots, which should be at least four. When this ratio is correctly chosen toroidal whirls are formed between each successive pair of annular slots to give such a degree of stabilization to the flames that the annular ceramic wall or cup, as used according to the aforesaid U. S. Patent No. 2,515,845, may be dispensed with. When the said ratio is less than four the rings are too narrow for stabilizing whirls to occur. The burner may be used in conjunction with an additional, larger annular slot surrounding the outer ring through which only air is supplied, the air then forming an air screen or curtain which, if required, may then serve as secondary combustion air. This is possible because the stabilizing whirls obviate the danger of having the flame blown off; in contrast, in prior installations wherein it was desired to cool the combustion gases by dilution with secondary air, the latter had to be fed into the combustion chamber at a point some distance downstream from the point of fuel admission. In prior ring-type burners having fixed grids, such as that described in German Patent No. 433,484, this manner of supplying additional air is also not feasible for the reason that the cold air at the edge of the burner grid produces great temperature differences between the center and the edge of the burner, which increases the risk of excessive thermal stress—a difficulty that is avoided by the burner according to this invention.

Referring to Figures 4-6, wherein like reference numbers denote like parts, there is shown a modified arrangement of mounting the concentric rings in spaced relation employing a grid including narrow transverse support ribs 32 and 33 fixed to a ring 34 that is pressed into the housing. The grid is mounted back from the front of the burner by a sufficient distance to be not materially affected by the flame heat, and the bars are advantageously inclined with respect to the transverse plane so that the center is set back farther than the peripheral part to conform to the relatively greater lengths of the inner rings.

The bars have notches 35 at the upper edges and their lower edges 36 are inclined. Each ring has four notches 37, shaped as indicated in Figure 6, by which the rings may be attached to the grid by a movement toward the rear of the burner followed by a rotation of the ring to lock it into place. The angle of the edges 36 is such that friction retains the rings in locked position after rotation. It is evident that these rings are again individually mounted in radially spaced relation, so that they are free for individual deformation in radial and axial directions. The spindle 19a is in this embodiment formed with a ring-shaped base having similar notches 37 and being similarly attached to the grid.

It is evident that the number of rings and their size will be chosen in accordance with the desired burner capacity required and that the construction is not limited to the examples described above.

We claim as our invention:

1. A burner for the external combustion of gaseous mixtures comprising: a burner housing having an open substantially planar front face, a central plate member located in and arranged along the plane of said front face and having downwardly facing abutments, concentric rings having downwardly facing abutments located between said central plate and said housing and arranged to form narrow slits for the emission of combustible gas mixture therebetween, said rings and said plate extending over the whole area of the front face of said housing except for the area of said slots, said rings extending in a rearward axial direction increasing in length toward the center of the burner to effect cooling of the rings by the gaseous mixture so that self-ignition of the gaseous mixture is avoided, and means holding the outer one of said rings in the housing and spaced lugs projecting radially from the rings and slidably contacting said abutments on the adjacent rings and on said central plate member whereby the rings may undergo individual deformation as a result of temperature difference.

2. A burner for the external combustion of gaseous mixtures according to claim 1 in which each lug has a small clearance between each said lug and the next adjacent concentric ring located closer to the axis of the burner housing.

3. A burner for the external combustion of gaseous mixtures according to claim 1 wherein a central spindle extends rearward from said central plate and is resiliently supported at the back from said housing for limited axial movement.

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