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**DE-A-1 950 077  
DE-A-2 448 977  
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FR-A-2 403 518  
JP-A-57 043 110  
US-A-4 401 099**

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## Description

This invention relates to a single-ended radiant tube which is heated by a gas burner.

A problem with known single-ended radiant tubes, particularly those of small diameters, has been that their flame tubes have tended to fail after a relatively short working life. The flame tubes have failed primarily as a result of the burner flame's impinging on them too close to the burner after combustion and causing excessive heating of the flame tube in front of the burner.

Usually, see for instance the JP—A—57043110, the combustible air and gas mixture has been caused to swirl in front of the burner to enhance the mixing of the air and gas for improved combustion. However, the swirling action has encouraged the mixture to spread outwardly away from the central axis of the burner and flame tube so that on combustion the flame impinges on the inside surface of the flame tube close to the burner and causes the undesirable excessive heating of the flame tube.

The present invention seeks to overcome, or at least reduce, the problem.

According to one aspect the present invention consists in a method of extending the working life of a flame tube in a single-ended radiant tube of the kind in which the flame produced by ignition of a gas/air mixture burns along the flame tube, combustion air for the mixture passes over a tubular air shroud behind a burner from which the gas from the mixture issues and swirling of the combustion air about the central longitudinal axis of the flame tube is caused at the burner, characterised in that swirling of the air is induced before it mixes with the gas, in that the distance between the air shroud and the burner is set such that the air is converging towards said central longitudinal axis as it approaches the swirl inducing position and the swirling air then continues close to said central longitudinal axis and causes a vortex to be produced in front of the burner which encourages the gas issuing from the burner to flow, and the flame resulting from ignition of the swirling air and gas mixture to extend, centrally of the flame tube in the region adjacent to the burner, and in that in said region the flame is caused to be surrounded by some of the combustion air still to be used for combustion thereby to reduce heat transfer from the flame to the flame tube in said region.

According to a second aspect the present invention consists in a single-ended radiant tube comprising an outer tube closed at a first end and connected, or adapted to be connected, at a second end to exhaust means, a gas burner adjacent to the second end connected to gas supply means, combustion air supply means at the second end by which air is supplied to be mixed with gas issuing from the burner for combustion, a flame tube in and spaced from the outer tube extending from the burner towards the first end, in which flame tube burns the flame produced by ignition of the gas/air mixture, a

tubular air shroud positioned behind the burner over which the combustion air passes to the burner, swirl inducing means at the burner whereby swirling of the combustion air about the central longitudinal axis of the flame tube is induced before it passes in front of the burner, and an annular exhaust gases passage defined between the flame tube and the outer tube which communicates with the interior of the flame tube at the first end and along which exhaust gases pass to the exhaust means, characterised in that the swirl inducing means is positioned to cause the air to be swirled before it mixes with the gas, the distance between the air shroud and the burner is set such that the combustion air is converging towards the central longitudinal axis of the flame tube as it approaches the swirl inducing means, the swirl inducing means causes the air to continue closely about said central longitudinal axis and produce a vortex in front of the burner which encourages the gas to flow, and the flame resulting from ignition of the swirling air and gas mixture to extend, centrally of the flame tube in the region adjacent to the burner, and in that air which has still to be used for combustion is caused to surround the flame in the region adjacent to the burner, thereby to reduce heat transfer from the flame to the flame tube in said region.

By encouraging the flame to burn centrally of the flame tube in the region adjacent to the burner, impingement of the flame on the flame tube adjacent to the burner where the combustion is most violent is prevented or reduced, and hence the extent to which that part of the flame tube is heated is reduced. This together with the surrounding of the flame adjacent to the burner with combustion air to reduce heat transfer from the flame to the flame tube can extend appreciably the working life of the flame tube.

The swirl inducing means preferably comprises vanes disposed about the burner which cause the air to swirl as it flows past the burner. The vanes may be on the burner. They may extend fully across the entry for the combustion air into the flame tube. They may be contained within a tubular cowl which extends over and is spaced from the burner and around which an annular passage for air is defined opening into the flame tube. The cowl divides the air supply to the flame tube into a primary air stream which passes through the cowl between the vanes, and so is caused to swirl, and a secondary air stream which passes through the annular passage to provide an envelope of air which surrounds the flame immediately in front of the burner. In both arrangements the swirling air encourages the flame to burn centrally of the flame tube adjacent to the burner and adjacent to the burner the flame is surrounded by air which reduces the heat transfer to the flame tube, but the cowl provides a more accurate division of the air supply to perform these functions.

The extent of the mixing of the air with the gas immediately in front of the burner can be adjusted

by varying the distance between the burner and the air shroud. This enables the length of the flame to be adjusted. It is desirable to arrange it such that combustion takes place over the length of the flame tube to its discharge end, but not beyond the discharge end.

When the radiant tube is relatively long and is to have a high input the distance of the burner from the air shroud may be shortened with the result that the air, whilst converging towards the central axis of the flame tube, passes through the swirl inducing means further away from the central axis. In consequence there will be reduced initial mixing of the air with the gas, and the flame length is increased. Conversely when the radiant tube is relatively short and is to have a low input the distance of the burner from the air shroud is increased so that the air passes through the swirl inducing means closer to the central axis of the flame tube, and hence passes the gas port or ports of the burner at higher velocity, thereby inducing faster mixing of the air and gas and producing a shorter flame.

This method of varying the flame length differs from the normal method which is to increase the air in a supply of pre-mixed air and gas to the burner to shorten the flame, and to reduce the air in the supply of pre-mixed air and gas to lengthen the flame. A radiant tube in accordance with the present invention may be operated without a pre-mixed supply of air and gas to the burner. Shortening the flame length with the air and gas swirling radially outwards in the previously known radiant tubes has generally resulted in serious overheating of the flame tubes adjacent to the burners in use and early failure of the flame tubes.

The most suitable position of the burner relative to the air shroud for a particular length and diameter of flame tube and gas flow can be ascertained empirically without undue difficulty, and once ascertained can be fixed for production. It is possible that the radiant tube may be produced incorporating adjustment means for varying the distance between the air shroud and burner as required by the user, but it is envisaged that normally the desirable distance will be ascertained empirically by workshop or laboratory testing or prototypes and then be fixed accordingly during production.

The radiant tube may include a recuperator. Thus there may be an air passage by way of which the combustion air passes from the air supply means to the flame tube, and to which heat is imparted to pre-heat the air for combustion from exhaust gases passing through an exhaust gas passage which is connected to the annular exhaust gases passage defined between the flame tube and the outer tube. In the preferred embodiment the flame tube extends rearwards past the burner and serves as part of the recuperator to separate the exhaust gases passage from the air passage. The air shroud may be disposed in and spaced from the rearward extension of the flame tube such that the air passage is

defined at least in part by the space between the air shroud and the rearward extension of the flame tube. The air passage may be defined by other parts.

The present invention is applicable to radiant tubes having flame tubes of a range of diameters. The advantages of the invention are especially noteworthy, however, when the flame tube is of small outside diameter for example 4.5" (11.43 cm) or less.

An embodiment of the invention will now be described by way of example with reference to the accompanying drawings in which:

*Figure 1* is a longitudinal axial section through a single-ended recuperative radiant tube in accordance with the invention;

*Figure 2* is a similar section showing a modification, and

*Figures 3 and 4* are enlarged views respectively of a burner and associated cowl.

Referring to *Figure 1* of the drawings, the radiant tube comprises an outer tube 1, a co-axial flame tube 2 inside and extending for a substantial part of the length of the outer tube 1, a tubular air shroud 3 extending co-axially within a rear section of the flame tube 2, and a burner tube 4 extending co-axially through the air shroud 3 to a burner 5 spaced in front of the air shroud within the flame tube.

The outer tube 1 has a closed forward end 6 and an externally flanged rearward end 7 by which an exhaust housing 8 is fixed co-axially at one end, at an external annular flange 9, to the outer tube. An exhaust gas outlet 10 opens radially from the exhaust housing 8. At an opposite end the exhaust housing 8 has fixed to it, at a further external annular flange 11, a burner inlet housing 12 having a corresponding external annular flange 13 at one end. The opposite end of the burner inlet housing 12 is closed by a radial end wall 14 axially through which extends, and to which is fixed, the burner tube 4. The air shroud 3 is also fixed, at its rear end, to the end wall 14 of the burner inlet housing. A combustion air inlet 15 opens radially into the burner inlet housing 12. At its rear end the flame tube has an external annular flange 16 which is clamped between the adjacent annular flanges 11 and 13 of the exhaust housing 8 and the burner inlet housing respectively, thereby to secure the flame tube in position with respect to the exhaust housing and the outer tube 1. The forward, discharge, end of the flame tube is open.

An air passage 17 defined by the annular space between the air shroud and the rear section of the flame tube extends forwards from the burner inlet housing 12 towards the burner 5. An exhaust gas passage 18 is defined by the annular space between the outer tube and the flame tube and extends rearwards from the forward end of the outer tube to the exhaust housing 8. The annular flange 16 of the flame tube separates the exhaust gas passage from the interior of the burner inlet housing. The part of the radiant tube from the rearward end of the exhaust housing 8 to the

burner 5 constitutes a recuperator in which combustion air passing along the passage 17 to the burner is heated by the exhaust gases passing along the exhaust gas passage 18 to the exhaust gas outlet 10.

The burner 5 has a cylindrical body from the circumferential surface of which project several, equi-angularly spaced, vanes 19 of air screw form designed to induce swirling movement of air passing between them about the axis of the flame tube. The vanes 19 extend to the internal surface of the flame tube. In front of the vanes 19 the burner has a ring of gas ports 20 which communicate with the bore of the burner tube 4 and open radially through the circumferential surface of the burner's body.

A spark rod 27 of known kind provides the means of ignition for the burner. The spark rod is secured to the end wall 14 of the burner inlet housing, extends through the air shroud 3, through one of the vanes 19 of the burner, which supports the forward end of the spark rod, and terminates just in front of the gas ports 20.

In use of the radiant tube gas supplied to the burner by the burner tube 4 is discharged radially into the flame tube from the gas ports 20. Combustion air supplied to the burner inlet housing 12 at the air inlet 15 flows forwards through the air passage 17 and then between the vanes 19 of the burner which cause the air to swirl before it meets the gas discharging from the gas ports. The distance of the burner from the forward end of the air shroud is set to suit the length and diameter of the flame tube and the gas flow to the burner, and is such that when the air meets the vanes it is converging towards the axis of the flame tube. The swirling of the air caused by the vanes produces a vortex in front of the burner which encourages the gas to flow centrally along the flame tube at least next to the burner. In consequence on combustion of the gas/air mixture the flame is contained centrally of the flame tube adjacent to the burner and so impingement of the flame on the part of the flame tube adjacent to the burner, where combustion is most violent, is prevented or substantially reduced. Heat transfer to the flame tube is also reduced by the envelope of air still to be used for combustion surrounding the flame adjacent to the burner. Impingement of the flame on the flame tube further along the flame tube is acceptable.

Reference will now be made to Figures 2, 3 and 4 of the drawings in which parts similar to those of the radiant tube described above are identified by the same reference numerals. Except for the modification which relates to the burner 5, the radiant tube is in accordance with that described above.

The burner 5 has equi-angularly spaced vanes 19 of air screw form projecting from its cylindrical body behind a ring of radial gas ports 20, Figure 3, communicating with an axial blind bore 21 with which the bore of the burner tube 4 connects. However, the vanes 19 are radially shorter than before and do not extend to the internal surface of

the flame tube 2. Instead they extend to the internal surface of the bore 22 of a tubular, circular section, cowl 23 which extends co-axially over the burner. A reduced diameter portion 24 of the bore 22, Figure 4, presents a shoulder 25 against which the vanes 19 abut at their rear edges adjacent their outer ends to locate the burner correctly in the cowl. The outer end of the vanes are secured to the cowl. The external diameter of the cowl 23 is smaller than the internal diameter of the flame tube, and the cowl is positioned co-axially with the flame tube so that an annular passage 26 is defined between the cowl and the wall of the flame tube. As shown in Figure 2 the external diameter of the cowl is similar to that of the air shroud, but that is not essential. The cowl is longer than the burner which is positioned so that it is fully contained within the cowl.

The vanes could possibly be formed integrally with the cowl, rather than with the burner, and extend to the burner.

The cowl is spaced axially from the discharge end of the air shroud 3. It serves to separate the air issuing from the air shroud in use of the radiant tube into two streams. One, primary, stream passes through the cowl and is caused by the vanes to swirl before it meets and mixes with the gas discharging from the gas ports 20 for primary combustion, and the other, secondary, stream passes through the annular passage 26. The swirling movement imparted by the primary stream to the gas/air mixture emerging from the cowl, contains the flame centrally of the flame tube adjacent to the burner. The secondary stream of air forms an envelope around the flame adjacent to the burner which, as before, reduces the heat transfer to the flame tube in that region. It will be appreciated that in this case the envelope is more clearly defined than in the above-described embodiment. Further along the flame tube secondary stream provides secondary air for combustion.

As in the above-described embodiment, the distance of the burner, with the cowl, from the discharge end of the air shroud can be adjusted to suit the gas flow and to vary the length of the flame according to the length of the flame tube.

In a typical example of the modification the cowl 2 projects forwards from the burner by a distance of about 0.375" (9.5 mm).

Typically with and without the modification the flame tube of the radiant tube has an outside diameter of 3.25" (8.255 cm).

## Claims

1. A method of extending the working life of a flame tube (2) in a single-ended radiant tube of the kind in which the flame produced by ignition of a gas/air mixture burns along the flame tube, combustion air for the mixture passes over a tubular air shroud (3) behind a burner (5) from which the gas for the mixture issues and swirling of the combustion air about the central longi-

tudinal axis of the flame tube is caused at the burner (5), characterised in that swirling of the air is induced before it mixes with the gas, in that the distance between the air shroud (3) and the burner (5) is set such that the air is converging towards said central longitudinal axis as it approaches the swirl inducing position and the swirling air then continues close to said central longitudinal axis and causes a vortex to be produced in front of the burner (5) which encourages the gas issuing from the burner to flow, and the flame resulting from ignition of the swirling air and gas mixture to extend, centrally of the flame tube in the region adjacent to the burner (5), and in that in said region the flame is caused to be surrounded by some of the combustion air still to be used for combustion thereby to reduce heat transfer from the flame to the flame tube in said region.

2. A method according to claim 1 characterised in that the length of the flame is varied by adjustment of the distance between the air shroud (3) and the burner (5), the air being caused to converge more closely towards said central longitudinal axis as it approaches the swirl inducing position as said distance is increased and the velocity at which the swirling air meets the gas issuing from the burner (5) being increased so that faster mixing of the air and gas is induced and the length of the resultant flame is reduced.

3. A single-ended radiant tube comprising an outer tube (1) closed at a first end and connected, or adapted to be connected, at a second end to exhaust means (10), a gas burner (5) adjacent to the second end connected to gas supply means (4), combustion air supply means (12) at the second end by which air is supplied to be mixed with gas issuing from the burner (5) for combustion, a flame tube (2) in and spaced from the outer tube (1) extending from the burner (5) towards the first end, in which flame tube (2) burns the flame produced by ignition of the gas/air mixture, a tubular air shroud (3) positioned behind the burner (5) over which the combustion air passes to the burner (5), swirl inducing means (19) at the burner (5) whereby swirling of the combustion air about the central longitudinal axis of the flame tube (2) is induced before it passes in front of the burner, and an annular exhaust gases passage (18) defined between the flame tube (2) and the outer tube (1) which communicates with the interior of the flame tube (2) at the first end and along which exhaust gases pass to the exhaust means (10), characterised in that the swirl inducing means (19) is positioned to cause the air to be swirled before it mixes with the gas, the distance between the air shroud (3) and the burner (5) is set such that the combustion air is converging towards the central longitudinal axis of the flame tube (2) as it approaches the swirl inducing means (19), the swirl inducing means (19) causes the air to continue closely about said central longitudinal axis and produce a vortex in front of the burner which encourages the gas to flow, and the flame resulting from ignition of the swirling air and gas

mixture to extend, centrally of the flame tube (2) in the region adjacent to the burner (5), and in that air which has still to be used for combustion is caused to surround the flame in the region adjacent to the burner, thereby to reduce heat transfer from the flame to the flame tube (2) in said region.

4. A single-ended radiant tube according to claim 3 characterised in that the air shroud (3) and the burner (5) are relatively adjustable longitudinally of the flame tube (2) to vary the distance between them, and thereby vary the closeness of the converging air to the said central longitudinal axis as it approaches the swirl inducing means (19) and the extent of the initial mixing of the air with the gas, the combustion air being caused to converge more closely towards said central longitudinal axis as said distance is increased and the velocity at which the swirling air meets the gas issuing from the burner thereby being increased so that faster mixing of the air and gas is induced and the length of the resultant flame is reduced.

5. A single-ended radiant tube according to claim 3 or claim 4 characterised in that the swirl inducing means (19) comprises vanes (10) disposed about the burner (5), and in that the burner (5) has a ring of gas ports (20) disposed forwardly of the vanes (19) and directed away from the central longitudinal axis of the flame tube (2) into the flow paths of combustion air passing between the vanes (19).

6. A single-ended radiant tube according to claim 5 characterised in that the vanes (19) extend fully across an entry for the combustion air into the flame tube (2).

7. A single-ended radiant tube according to claim 5 characterised in that the vanes (19) are contained within a tubular cowl (23) which extends over and is spaced from the burner (5) and around which an annular passage (26) for air is defined opening into the flame tube (2), the arrangement being such that the cowl (23) divides air which has passed over the air shroud (3) into a primary air stream which passes through the cowl (23) between the vanes (19) and is caused to swirl and mixes with the gas issuing from the burner (5) for combustion, and a secondary air stream which passes through the annular passage (26) into the flame tube (2) to provide an envelope of air which surrounds the flame adjacent to the burner (5).

8. A single-ended radiant tube according to any of claims 3 to 7 characterised in that the flame tube (2) extends rearwards past the burner (5) and forms part of a recuperator, the air shroud (3) is disposed in and spaced from the rearward extension of the flame tube (2), an air passage (17) is defined at least in part by the space between the air shroud (3) and the rearward extension, by way of which air passage (17) the combustion air passes from the air supply means (12) to the flame tube (2), and an exhaust gases passage is defined around the rearward extension and connects with the annular passage (18) to receive exhaust gases whereby heat is imparted to the air passage (17) to pre-heat the air for combustion.

9. A single-ended radiant tube according to claim 8 characterised in that the exhaust means comprises an exhaust housing (8) having an exhaust outlet (10) and to which the second end of the outer tube (1) and a rear end of the flame tube (2) are connected and into which the annular exhaust gases passage (18) opens, and the combustion air supply means comprises a housing (12) which has an air inlet (15), is connected to the rear end of the flame tube (2) and to the air shroud (3), and with which the air passage (17) communicates.

10. A single-ended radiant tube according to any of claims 3 to 9 characterised in that the flame tube (2) has an outside diameter of up to 4.5'' (11.43 cm).

11. A single-ended radiant tube according to claim 10 characterised in that the flame tube (2) has an outside diameter of 3.25'' (8.255 cm).

#### Patentansprüche

1. Verfahren zur Erhöhung der Betriebs-Lebensdauer eines Flammrohrs (2) in einem einfach endenden Strahlungsheizrohr, in dem die durch Zünden eines Gas/Luft-Gemisches erzeugte Flamme entlang dem Flammrohr brennt, Verbrennungsluft für das Gemisch über einen rohrförmigen Luftmantel (3) hinter einen Brenner (5) gelangt, aus dem das Gas für das Gemisch austritt und an dem Brenner ein Verwirbeln der Verbrennungsluft um die Mittel-Längsachse des Flammrohrs herum bewirkt wird, dadurch gekennzeichnet, daß das Verwirbeln der Luft hervorgerufen wird, bevor die Luft sich mit dem Gas vermischt, daß der Abstand zwischen dem Luftmantel (3) und dem Brenner (5) derart gewählt ist, daß die Luft zur Mittel-Längsachse hin konvergiert, wenn die sich der Verwirbelungsstelle nähert, und die wirbelnde Luft dann in der Nähe der Mittel-Längsachse weiterströmt und veranlaßt, daß vor dem Brenner (5) ein Luftwirbel erzeugt wird, der das Ausströmen des Gases aus dem Brenner unterstützt und dazu beiträgt, daß die durch die Zündung des Gemisches aus verwirbelter Luft und Gas resultierende Flamme sich in der Mitte des Flammrohrs im Bereich neben dem Brenner (5) erstreckt, und daß in dem Bereich die Flamme veranlaßt wird, von einem Teil der Verbrennungsluft, die noch für die Verbrennung benötigt wird, umhüllt zu werden, damit die Wärmeübertragung von der Flamme auf das Flammrohr in diesem Bereich reduziert wird.

2. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß die Länge der Flamme dadurch variiert wird, daß die Entfernung zwischen dem Luftmantel (3) und dem Brenner (5) eingestellt wird, wobei die Luft, wenn der Abstand vergrößert wird, noch mehr gegen die Mittel-Längsachse konvergiert, wenn sie sich der Verwirbelungsstelle nähert, und die Geschwindigkeit, mit der die verwirbelte Luft auf das von dem Brenner (5) ausgestoßene Gas auftrifft, vergrößert wird, so daß eine raschere Mischung von Luft und Gas erfolgt und die Länge der sich ergebenden Flamme verringert wird.

3. Einfach endendes Strahlungsheizrohr, umfassend: ein Außenrohr (1), das an einem ersten Ende geschlossen ist und an einem zweiten Ende an eine Abgasvorrichtung (10) angeschlossen ist oder anschließbar ist, einen Gasbrenner (5), der in der Nachbarschaft des zweiten Endes an eine Gasquelle (4) angeschlossen ist, eine Verbrennungsluft-Zuführeinrichtung (12), an dem zweiten Ende, durch welche mit dem von dem Brenner ausgestoßenen Gas zu mischende Luft für die Verbrennung zugeführt wird, ein Flammrohr (2), das mit Abstand innerhalb des Außenrohres (1) angeordnet ist und sich von dem Brenner (5) aus in Richtung auf das erste Ende hin erstreckt, und in welchem die durch Zünden des Gas/Luftgemisches erzeugte Flamme brennt, einen rohrförmigen Luftmantel (3), der hinter dem Brenner (5) angeordnet ist und über den die Verbrennungsluft zu dem Brenner (5) gelangt, eine Verwirbelungseinrichtung (19) an dem Brenner (5), durch welche die Verbrennungsluft um die Mittel-Längsachse des Flammrohrs (2) verwirbelt wird, bevor sie vor den Brenner gelangt, und einen ringförmigen Abgaskanal (18) der zwischen dem Flammrohr (2) und dem Außenrohr (1) gebildet ist, der mit dem Inneren des Flammrohrs (2) an dem ersten Ende in Verbindung steht, und entlang dessen Abgase zu der Abgasvorrichtung (10) gelangen, dadurch gekennzeichnet, daß die Verwirbelungseinrichtung (19) derart positioniert ist, daß sie eine Verwirbelung der Luft vor dem Vermischen mit dem Gas verursacht, daß der Abstand zwischen dem Luftmantel (3) und dem Brenner (5) derart gewählt ist, daß die Verbrennungsluft in Richtung auf die Mittel-Längsachse des Flammrohrs (2) konvergiert, wenn sie sich der Verwirbelungseinrichtung (19) nähert, daß die Verwirbelungseinrichtung (19) veranlaßt, daß die Luft in dichter Nachbarschaft zu und um die Mittel-Längsachse herum weiterströmt und vor dem Brenner einen Luftwirbel erzeugt, der den Gasstrom fördert und dazu beiträgt, daß die aus der Zündung des Gemisches aus verwirbelter Luft und Gas entstehende Flamme sich in der Mitte des Flammrohrs (2) in dem Bereich neben dem Brenner (5) erstreckt, und daß die Luft, die noch für die Verbrennung benötigt wird, veranlaßt wird, die Flamme in dem Bereich neben dem Brenner zu umgeben, um dadurch die Wärmeübertragung von der Flamme auf das Flammrohr (2) in dem Bereich zu reduzieren.

4. Strahlungsheizrohr nach Anspruch 3, dadurch gekennzeichnet, daß der Luftmantel (3) und der Brenner (5) in Längsrichtung des Flammrohrs (2) relativ zueinander verstellbar sind, um den Abstand zwischen ihnen und damit die Nähe der mit Annäherung an die Verwirbelungseinrichtung (19) zu der Mittel-Längsachse konvergierenden Luft bezüglich der Längsachse und außerdem das Ausmaß der Anfangsvermischung von Luft und Gas zu variieren, wobei die Verbrennungsluft veranlaßt wird, noch näher in Richtung der Mittel-Längsachse zu konvergieren, wenn der Abstand erhöht wird, und die Geschwindigkeit, mit der die verwirbelte Luft auf das von dem Brenner ausgestoßene

Gas trifft, erhöht wird, so daß eine raschere Vermischung von Luft und Gas bewirkt und die Länge der sich ergebenden Flamme reduziert wird.

5. Strahlungsheizrohr nach Anspruch 3 oder 4, dadurch gekennzeichnet, daß die Verwirbelungseinrichtung (19) um den Brenner (5) herum angeordnete Leitbleche (10) aufweist, und daß der Brenner (5) einen Ring von Gasaustrittsöffnungen (20) aufweist, die vor den Leitblechen (19) angeordnet sind und von der Mittel-Längsachse des Flammrohrs (2) wegweisen in die Strömungswege der zwischen den Leitblechen (19) hindurchströmenden Verbrennungsluft.

6. Strahlungsheizrohr nach Anspruch 5, dadurch gekennzeichnet, daß sich die Leitbleche (19) vollständig über einen Einlaß für die Verbrennungsluft für das Flammrohr (2) erstrecken.

7. Strahlungsheizrohr nach Anspruch 5, dadurch gekennzeichnet, daß die Leitbleche (19) innerhalb einer Rohrhülse (23) enthalten sind, die sich über den Brenner (5) erstreckt und von diesem beabstandet ist, und um die herum ein ringförmiger Kanal (26) definiert ist, der sich in das Flammrohr (2) öffnet, wobei die Anordnung derart ausgebildet ist, daß die Hülse (23) die über den Luftmantel (3) gelangte Luft unterteilt in einen Primär-Luftstrom, der durch die Hülse (23) hindurch zwischen den Leitblechen (19) strömt und veranlaßt wird, zu verwirbeln und sich mit dem von dem Brenner (5) ausgestoßenen Gas für die Verbrennung zu vermischen, und einen Sekundär-Luftstrom, der durch den Ringkanal (26) in das Flammrohr (3) gelangt, um eine Luft-Umhüllung zu bilden, welche die Flamme in der Nachbarschaft des Brenners (5) umgibt.

8. Strahlungsheizrohr nach einem der Ansprüche 3—7, dadurch gekennzeichnet, daß sich das Flammrohr (2) rückwärts an dem Brenner (5) vorbei erstreckt und einen Teil eines Rekuperators bildet, daß der Luftmantel (3) innerhalb und mit Abstand von der rückwärtigen Verlängerung des Flammrohrs (2) angeordnet ist, daß zumindest teilweise durch den Raum zwischen dem Luftmantel (3) und der rückwärtigen Verlängerung ein Luftkanal (17) definiert ist, durch den die Verbrennungsluft von der Luftquelle (12) zu dem Flammrohr (2) gelangt, und daß um die rückwärtige Verlängerung herum ein Abgaskanal definiert ist, der mit dem Ringkanal (18) zur Aufnahme von Abgasen in Verbindung steht, wodurch zum Vorheizen der Verbrennungsluft Wärme zu dem Luftkanal (17) übertragen wird.

9. Strahlungsheizrohr nach Anspruch 8, dadurch gekennzeichnet, daß die Abgasvorrichtung ein Abgasgehäuse (8) aufweist, der einen Abgas-Auslaß (10) besitzt, und mit dem das zweite Ende des Außenrohrs (1) und das rückwärtige Ende des Flammrohrs (2) verbunden sind, und in den der ringförmige Abgaskanal (18) mündet, und daß die Verbrennungsluft-Zuführeinrichtung ein Gehäuse (12) aufweist, welches einen Luft-Einlaß (15) besitzt, an das hintere Ende des Flammrohrs (2) und den Luftmantel (3) angeschlossen ist, und mit dem der Luftkanal (17) in Verbindung steht.

10. Strahlungsheizrohr nach einem der Ansprüche 3—9, dadurch gekennzeichnet, daß das Flammrohr (2) einen Außendurchmesser von bis zu 4,5" (11,43 cm) aufweist.

11. Strahlungsheizrohr nach Anspruch 10, dadurch gekennzeichnet, daß das Flammrohr einen Außendurchmesser von 3,25" (8,255 cm) aufweist.

## Revendications

1. Procédé de prolongement de la durée d'utilisation d'un tube de flamme (2) dans un tube radiant de type plongeant, du type dans lequel la flamme produite par l'allumage d'un mélange de gaz et d'air brûle le long du tube de flamme, de l'air de combustion destiné au mélange s'écoule sur un capot tubulaire (3) placé derrière un brûleur (5) dont provient le gaz destiné au mélange, et un tourbillonnement de l'air de combustion autour de l'axe longitudinal central du tube de flamme est provoqué au niveau du brûleur (5), caractérisé en ce que le tourbillonnement de l'air est provoqué avant qu'il ne se mélange au gaz, en ce que la distance comprise entre le capot (3) et le brûleur (5) est réglée de manière que l'air converge vers l'axe central longitudinal lorsqu'il se rapproche de la position qui provoque le tourbillonnement et l'air qui tourbillonne continue alors à proximité de l'axe longitudinal central et provoque la formation d'un tourbillon en avant du brûleur (5), ce tourbillon favorisant la circulation du gaz sortant du brûleur et la disposition de la flamme résultant de l'allumage du mélange d'air et de gaz qui tourbillonne au centre du tube de flamme dans la région adjacente au brûleur (5), et en ce que, dans cette région, la flamme est entourée par une partie d'air de combustion qui doit encore être utilisée pour la combustion si bien que le transfert de chaleur de la flamme au tube de flamme est réduit dans ladite région.

2. Procédé selon la revendication 1, caractérisé en ce que la longueur de la flamme est modifiée par réglage de la distance comprise entre le capot (3) et le brûleur (5), l'air étant obligé de converger plus près de l'axe longitudinal central lorsqu'il se rapproche de la position provoquant un tourbillonnement lorsque ladite distance augmente et la vitesse à laquelle l'air tourbillonnant rencontre le gaz sortant du brûleur (5) augmentant si bien qu'un mélange rapide de l'air et du gaz est provoqué et que la longueur de la flamme résultante est réduite.

3. Tube radiant de type plongeant, comprenant un tube externe (1) fermé à une première extrémité et raccordé ou destiné à être raccordé à la seconde extrémité à un dispositif d'échappement (10), un brûleur (5) à gaz adjacent à la seconde extrémité, relié à un dispositif (4) d'alimentation en gaz, un dispositif (12) d'alimentation en air de combustion, placé à la seconde extrémité et transmettant de l'air qui doit être mélangé au gaz provenant du brûleur (5) afin que le gaz brûle, un tube de flamme (2) placé dans le tube externe (1) distant de ce tube externe et dirigé à partir du



brûleur (5) vers la première extrémité, dans lequel le tube de flamme (2) assure la combustion de la flamme produite par allumage du mélange gaz-air, un capot tubulaire (3) d'air placé derrière le brûleur (5) et sur lequel circule l'air de combustion dirigé vers le brûleur (5), un dispositif (19) destiné à provoquer un tourbillonnement au niveau du brûleur (5), si bien que le tourbillonnement de l'air de combustion autour de l'axe longitudinal central du tube de flamme (2) est provoqué avant son passage en avant du brûleur, et un passage annulaire (18) de gaz d'échappement délimité entre le tube de flamme (2) et le tube externe (1), ce passage communiquant avec l'intérieur du tube de flamme (2) à la première extrémité et les gaz d'échappement circulant dans ce passage vers le dispositif d'échappement (10), caractérisé en ce que le dispositif (19) destiné à provoquer un tourbillonnement est disposé de manière qu'il provoque le tourbillonnement de l'air avant son mélange avec le gaz, la distance comprise entre le capot (3) et le brûleur (5) est réglée de manière que l'air de combustion converge vers l'axe longitudinal central du tube de flamme (2) en se rapprochant du dispositif (19) destiné à provoquer le tourbillonnement, le dispositif (19) destiné à provoquer le tourbillonnement provoque la circulation continue de l'air près de l'axe longitudinal central, autour de celui-ci, et la formation d'un tourbillon en avant du brûleur, ce tourbillon facilitant la circulation du gaz et la disposition de la flamme résultant de l'allumage du mélange tourbillonnant d'air et de gaz au centre du tube de flamme (2) dans la région adjacente au brûleur (5), et en ce que l'air qui doit encore être utilisé pour la combustion est disposé autour de la flamme dans la région adjacente au brûleur, si bien que le transfert de chaleur de la flamme au tube de flamme (2) est réduit dans ladite région.

4. Tube radiant de type plongeant selon la revendication 3, caractérisé en ce que le capot (3) et le brûleur (5) sont réglables l'un par rapport à l'autre suivant la longueur du tube de flamme (2) afin que la distance les séparant puisse être modifiée et fasse ainsi varier la proximité de l'air convergeant par rapport à l'axe longitudinale central, lorsque l'air se rapproche du dispositif (19) provoquant un tourbillonnement, et l'importance du mélange initial de l'air avec le gaz, l'air de combustion convergeant plus vers l'axe central longitudinal lorsque ladite distance augmente et la vitesse à laquelle l'air tourbillonnant rencontre le gaz sortant du brûleur étant ainsi accrue si bien qu'un mélange rapide de l'air et du gaz est provoqué et la longueur de la flamme résultante est réduite.

5. Tube radiant de type plongeant selon l'une des revendications 3 et 4, caractérisé en ce que le dispositif (19) destiné à provoquer un tourbillonnement comporte des ailettes (10) placées autour du brûleur (5), et en ce que le brûleur (5) a un anneau de lumière (20) de sortie de gaz disposé en avant des ailettes (19) et dirigé du côté

opposé à l'axe longitudinal central du tube de flamme (2) vers le trajets de circulation de l'air de combustion circulant entre les ailettes (19).

6. Tube radiant de type plongeant selon la revendication 5, caractérisé en ce que les ailettes (19) sont disposées transversalement à la totalité de l'entrée d'air de combustion dans le tube de flamme (2).

7. Tube radiant de type plongeant selon la revendication 5, caractérisé en ce que les ailettes (19) sont contenues dans un capuchon tubulaire (23) disposé autour du brûleur (5) et à distance de celui-ci, un passage annulaire (26) d'air débouchant dans le tube de flamme (2) étant délimité autour du capuchon, la disposition étant telle que le capuchon (23) divise l'air qui a circulé sur le capot (3) en un courant d'air primaire qui s'écoule dans le capot (23) entre les ailettes (19) et tourbillonne et se mélange au gaz sortant du brûleur (5) avant sa combustion, et un courant d'air secondaire qui s'écoule dans le passage annulaire (26) et pénètre dans le tube de flamme (2) afin qu'il forme une enveloppe d'air qui entoure la flamme près du brûleur (5).

8. Tube radiant de type plongeant selon l'une quelconque des revendications 3 à 7, caractérisé en ce que le tube de flamme (2) est dirigé vers l'arrière au-delà du brûleur (5) et fait partie d'un récupérateur, le capot (3) est disposé dans le prolongement vers l'arrière du tube de flamme (2) et à distance de ce prolongement, un passage (17) de circulation d'air est délimité au moins en partie par l'espace compris entre le capot (3) et le prolongement formé vers l'arrière, l'air de combustion s'écoulant par l'intermédiaire de ce passage (17) du dispositif (12) d'alimentation en air vers le tube de flamme (2), et au passage de gaz d'échappement est délimité autour du prolongement tourné vers l'arrière et est raccordé au passage annulaire (18) afin qu'il reçoive les gaz d'échappement, si bien que de la chaleur est transmise au passage (17) d'air afin que l'air de combustion soit préchauffé.

9. Tube radiant de type plongeant selon la revendication 8, caractérisé en ce que le dispositif d'échappement comporte un boîtier (8) d'échappement ayant une sortie (10) d'échappement et auquel sont raccordées la seconde extrémité du tube externe (1) et une extrémité arrière du tube de flamme (2) et dans lequel débouche le passage annulaire (18) de gaz d'échappement, et le dispositif d'alimentation en air de combustion comporte un boîtier (12) qui a une entrée d'air (15), qui est raccordée à l'extrémité arrière du tube de flamme (2) et au capot (3) et avec lequel communique le passage (17) de circulation d'air.

10. Tube radiant de type plongeant selon l'une quelconque des revendications 3 à 9, caractérisé en ce que le tube de flamme (2) a un diamètre externe inférieur ou égal à 11,43 cm.

11. Tube radiant de type plongeant selon la revendication 10, caractérisé en ce que le tube de flamme (2) a un diamètre externe de 8,255 cm.



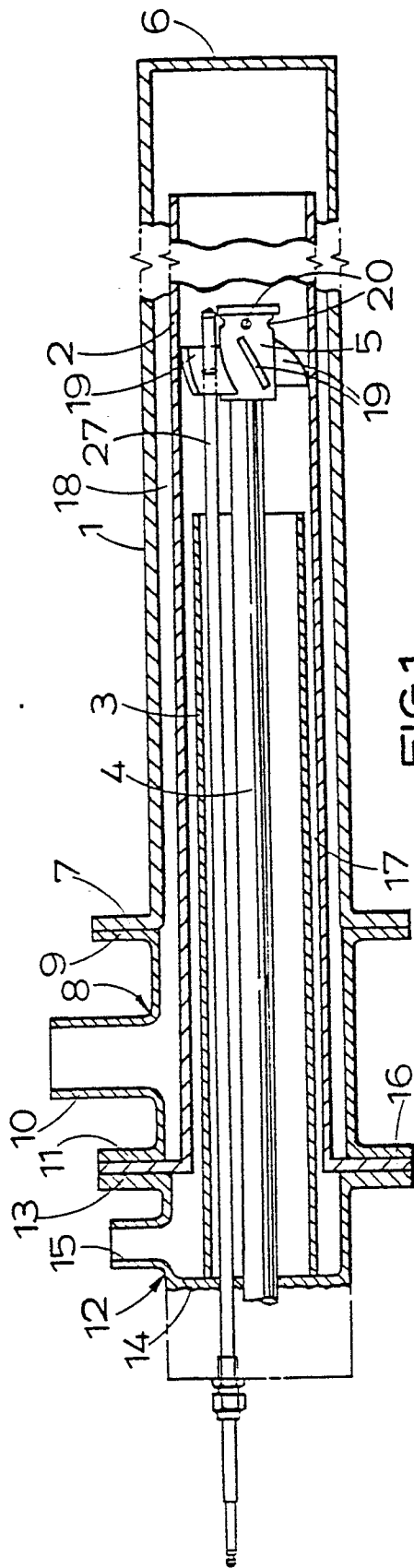


FIG. 1.

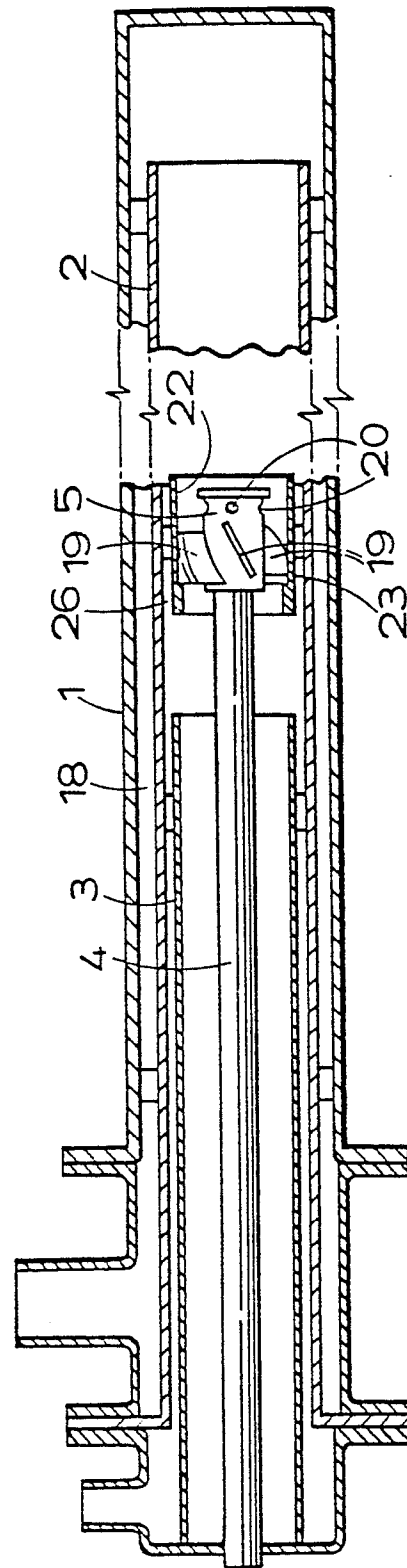


FIG. 2.

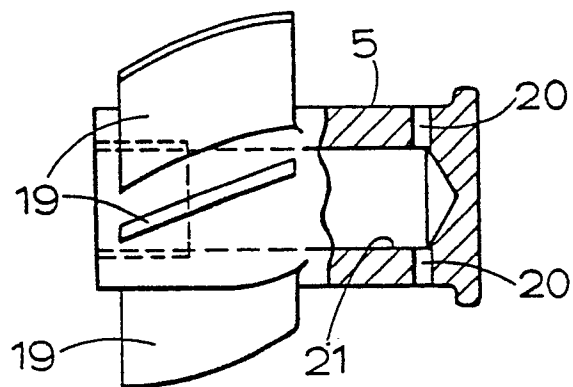


FIG. 3.

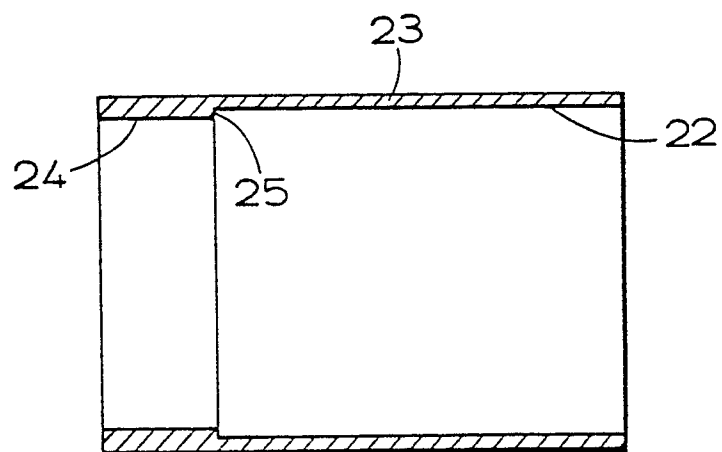


FIG. 4.