

[54] **BURNING LIQUID FUELS**
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Primary Examiner—Edward G. Favors

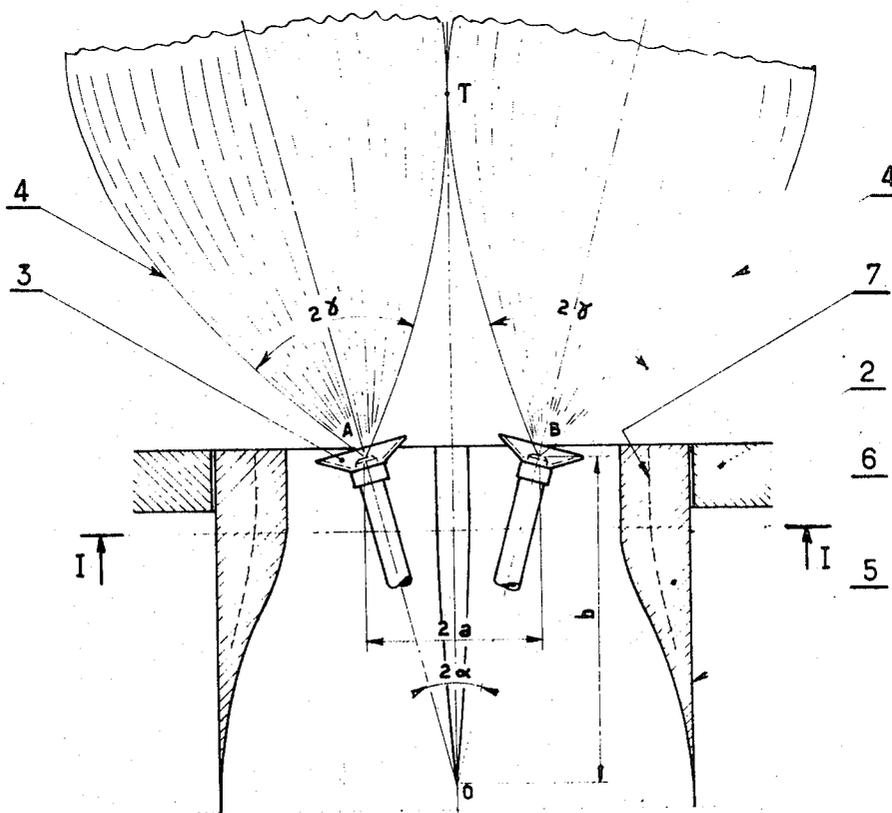
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 [51] Int. Cl. **F23c 5/08**
 [58] **Field of Search**..... 431/174, 175, 181-189, 431/278, 283, 285

[57] **ABSTRACT**

A system for burning liquid fuels comprising a plurality of burners disposed in a single opening and in a single distributor for air for combustion, the said burners diverging towards the interior of the furnace, their mutual orientations being such that the individual flames penetrate one another slightly or are tangential to one another, and the air distributor comprises longitudinally profiled air deflectors which define a contour inside the air distributor formed by arcs of a circle centred on the burner axes.

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11 Claims, 11 Drawing Figures



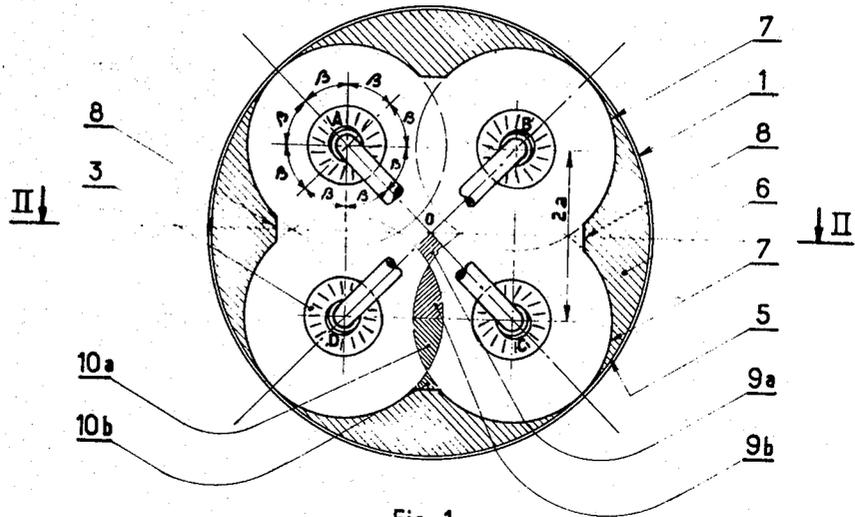


Fig. 1

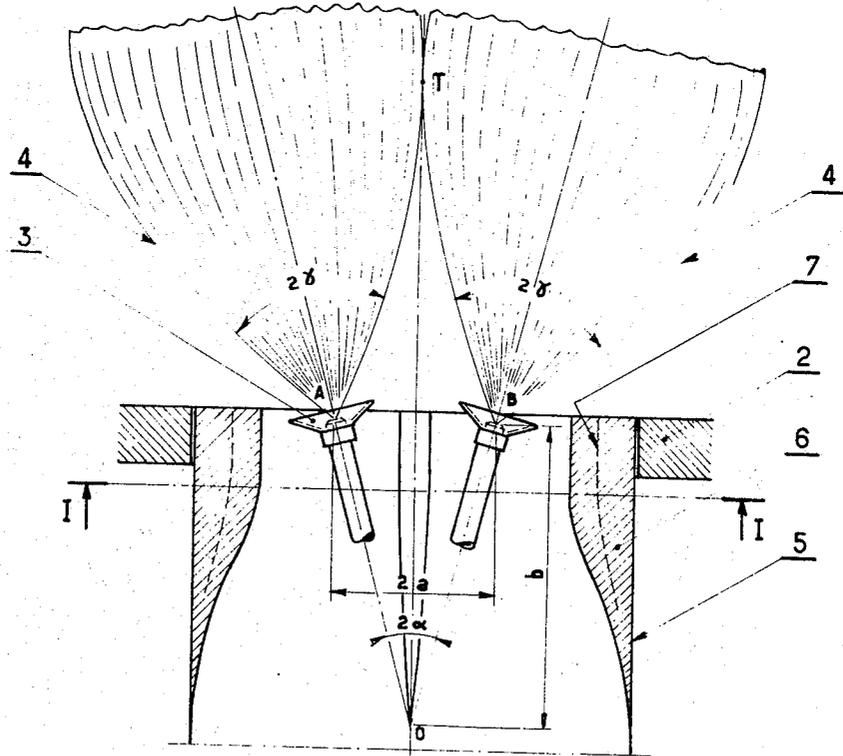


Fig. 2

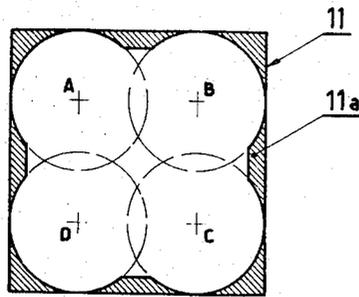


Fig. 3

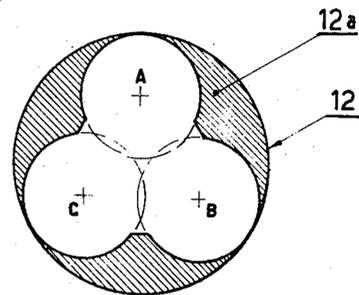


Fig. 4

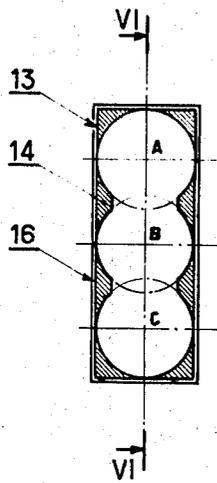


Fig. 5

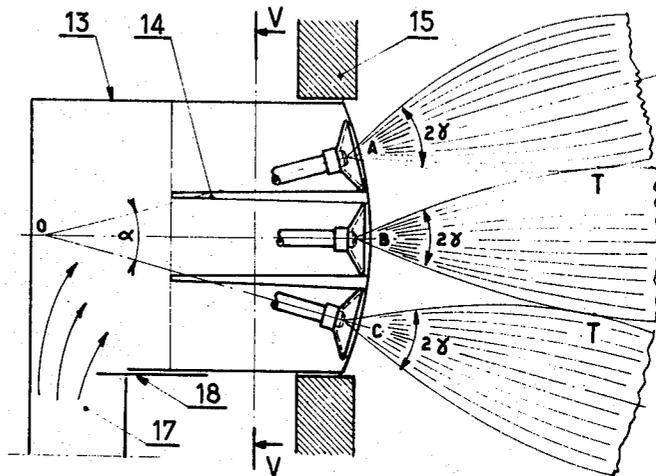


Fig. 6

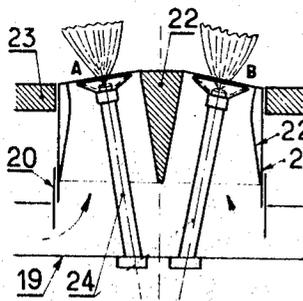


Fig. 7

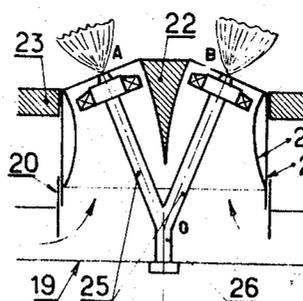


Fig. 8

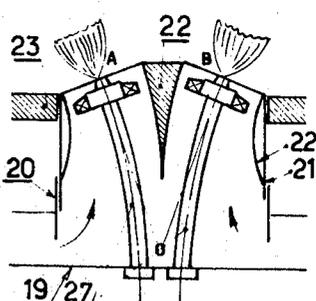


Fig. 9

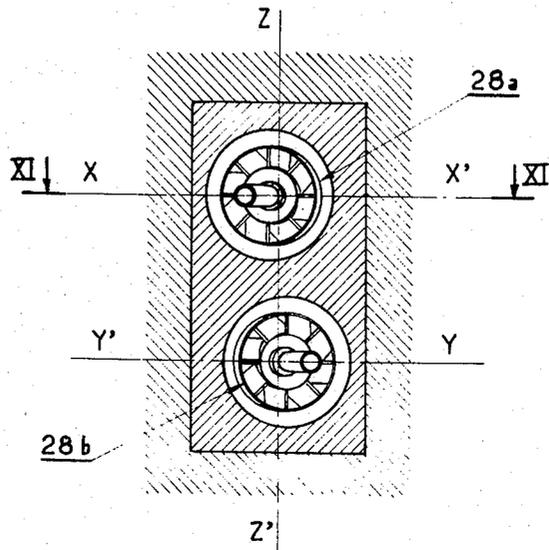


Fig. 10

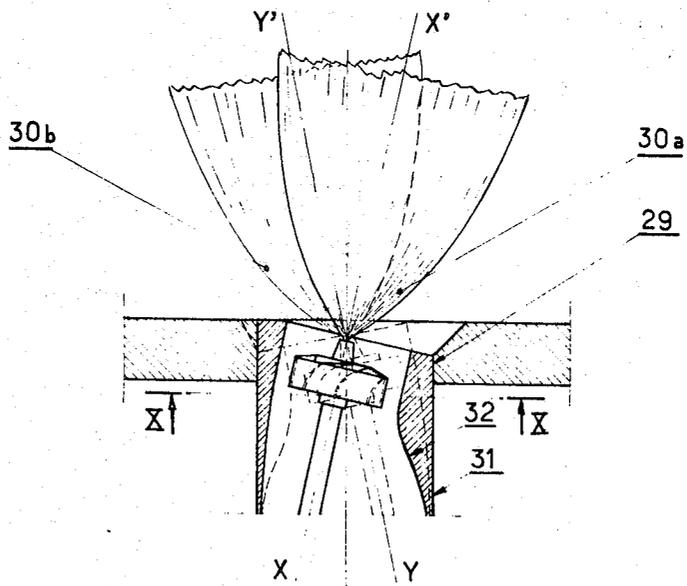


Fig. 11

BURNING LIQUID FUELS

This invention relates to systems for burning liquid fuels, intended for equipping industrial boilers, ovens and all furnaces.

These systems comprise a plurality of burners disposed in a single opening, i.e. a single opening in the furnace wall.

Systems are already known which comprise a plurality of burners disposed in a single opening at the corners of a regular polygon, but these burners have parallel axes so that the individual flames penetrate one another giving a very much longer single total flame than the individual flames, so that the dimensions of the furnace have to be increased.

Systems are also known which comprise a plurality of aligned burners arranged in an arc of a circle and together forming large angles, so that the flames emerging from the lateral burners are directed obliquely towards the side walls, so that very wide furnace design is required.

Furnaces are also known which comprise a plurality of parallel burners disposed in separate openings and so spaced that the individual flames are tangential, thus giving good combustion. This solution gives high heating capacities but has the disadvantage of increasing the number of openings and making it necessary to provide each of them with a conduit for the distribution for air for combustion.

The object of the present invention is to solve the problem of designing high-capacity furnaces without increasing their dimensions, without increasing the number of openings and distributors for air for combustions, and maintaining good combustion.

To this end, a single opening contains a plurality of burners which diverge in the inward direction of the furnace, their mutual orientations being so determined in dependence on their spacing and the angle of spread of the individual flames that the said flames penetrate one another slightly or are tangential to one another.

Generally, the opening has a circular or polygonal contour. In that case, the burners may be disposed at the corners of a regular polygon and converge rearwardly to form with one another angles which are determined in dependence on their spacing and the form of the individual flames.

The burners may also be disposed in one or more planes along radii of an arc of a circle. They may also be so disposed that the jets are situated in a single plane while the burner axes are oriented alternately on either side of said plane and form with the latter angles which are determined in dependence on the spacing of the burners and the shape of the individual flames.

The burner assembly is disposed inside a common conduit for the distribution of air for combustion, the external shape of which is adapted to that of the opening, which is generally circular.

On the inside, near the end adjacent the furnace, said conduit contains air deflectors which are longitudinally profiled to channel the air for combustion. These deflectors define a contour inside the said end containing arcs of a circle centred on the burner axes.

This contour may be formed, for example, by arcs of a circle and portions of a straight line interconnecting the said arcs of a circle, i.e. the deflectors are formed by intermediate plane surfaces between surfaces which are portions of cylinders.

Preferably, the radii of the said arcs of a circle are slightly greater than half the distance separating the two adjacent burners on whose axis they are centred.

The object of these deflectors is to provide good distribution of air for combustion to all the individual flames, more particularly by compelling the air for combustion to flow into the central zone which is completely or partly surrounded by the individual flames. If the space surrounding each burner is divided into a certain number of equal segments β , the shape of the deflectors is such that the air passage section corresponding to each of these segments is substantially the same, taking into account the fact that in the central zone the segments of the different flames overlap.

The invention enables small-dimension furnaces of high calorific capacity to be produced.

If an attempt is made to obtain the same result by using a plurality of burners, the individual flames must not penetrate one another. If they do penetrate one another, the particles of atomised liquid fuel projected by the different burners meet one another and combustion deteriorates as a result of the combination of these particles into larger droplets.

Also, if the flames merge into one, the gases produced in the central zone cannot expand, so that the total flame becomes elongated, and its length becomes almost the same as that given by a single burner discharging the full amount of the fuel.

Of course a plurality of burners can be used in separate openings spaced sufficiently from one another for the individual flames not to meet. This solution is complex because it increases the number of systems and the presence of a plurality of openings complicates the production of tubes which usually line the inner surface of the wall in which the openings are formed.

The inventor has also found that if a plurality of flames are produced very close to one another but without meeting, combustion is improved as a result of the turbulence produced in the zone at the centre of such flames, and this improves the mixture of air for combustion and fuel. According to the invention, therefore, a plurality of burners are disposed in a single opening, the burners diverging towards the furnace, so the individual flames penetrate one another very slightly or are tangential to one another, i.e. they are not spaced to a point such as to retain their individuality but on the other hand they are not brought so close together as to form a complete flame.

The following description of the accompanying drawings relates to a number of embodiments without limiting force.

FIG. 1 is a cross section of a system according to the invention,

FIG. 2 is a section of FIG. 1 on the horizontal plane II — II,

FIGS. 3 and 4 are diagrammatic cross sections of systems according to the invention,

FIGS. 5 and 6 are a cross section and a longitudinal section of a system according to the invention,

FIGS. 7, 8 and 9 are diagrammatic longitudinal sections of systems according to the invention, and

FIGS. 10 and 11 are a cross section of a longitudinal section of another system according to the invention;

FIG. 1 is a cross section on the line I — I in FIG. 2 and FIG. 2 is a section of FIG. 1 on the line II — II.

These two figures illustrate a circular opening 1 in the front panel 2 of a furnace and four burners A, B,

C, D disposed in the opening at the four corners of a square of side $2a$. Each burner is provided with an individual flame detector 3, which may be replaced by any other system providing a similar function, for example a flame box, a deflector washer, a finned rose, and so on.

Each combustion head considered separately produces a flame having an angle of spread of 2δ . The axes of the combustion heads A and B converge substantially at a point 0. In a diagonal plane passing through the point 0 and through the two heads A and B, the axes of the heads form an angle 2α . Since the four heads are disposed at the corners of a square in the case of the figure, then by reason of symmetry the same angle 2α is also found in a vertical diagonal plane passing through the two heads AD or BC.

If, however, the four heads were disposed in a rectangle in vertical diagonal planes passing through A D or B C, the heads would form an angle $2\alpha'$ different from 2α and the axes of the four heads would not converge at the same point 0.

The angles α and α' are so determined that the envelopes 4 of the individual flames are substantially tangential at their point of maximum spread T or penetrate one another very slightly at that point. The angles α and α' must not be excessive to a point such that the flames retain their individuality, but nor must they be too small to a point such that the individual flames tend to penetrate one another, with consequent condensation of the droplets of liquid fuel atomised by adjacent burners and an elongation of the total flame.

The value of the angles α and α' is completely determined as soon as the spacing $2a$ between adjacent burner tips and the apex angle 2δ of the individual flames are known, these parameters being fixed by the design.

The distance b between the point 0 and the burner tip is determined by the parameters a and α' .

FIGS. 1 and 2 also show the air distributor 5 common to all the heads.

In the case of a circular opening, as in the figure, the air distributor is formed by a cylinder, the outside diameter of which is adapted to that of the opening. On the inside it has air deflectors 6 longitudinally profiled according to aerodynamic shapes intended to channel the flow of air for combustion to the burners.

The open end of the air distributor 5 situated substantially in the transverse plane containing the burner tips has a contour defined by the air deflectors 6. This contour is so determined that if the space around each combustion head is divided into a given number of segments having the same angle β , for example eight 45° segments, the air passage sections corresponding to equal individual flame segments are substantially equal.

This result is obtained by selecting a contour formed by arcs of a circle 7 centred on the burner heads and interconnected by surfaces 8. The radius of these arcs is slightly greater than half the distance between two combustion heads, so that the continuations of these circles overlap as shown in broken lines.

If the radius of the circles 7 is so selected that the cross-hatched areas $9a$ and $9b$ are substantially equal as are the areas $10a$ and $10b$, the above condition is satisfied even in the space situated between the flames where the air for combustion has to be distributed amongst a plurality of flames.

This system produces a very divergent total flame, the length of which is substantially that of each unit flame and the performances of which benefit from the interaction of the unit flames on one another at high temperature.

The system is provided with known unit combustion heads which, considered separately, give excellent performances, which are improved by the twinning arrangement. It may be equipped, for example, with low-divergence burners without a gas recycling system, which produce torch-type flames having an angle of spread 2α of the order to 30° to 35° which, in the case of burner spacings compatible with the dimensions of the opening, give values of the order of 8° to 12° for the angle formed by the axis of the heads and the general axis of the system.

It may be provided with burners giving medium or high-divergence flames with combustion gas recycling, to produce ball-type flames having an angle of spread 2δ of the order of 60° to 70° . In that case, the value of the angle of divergence of the burners from the axis of the system is of the order of 20° to 25° .

Of course, if the opening is of a square or rectangular shape, the air distributor will have a similar external contour.

FIG. 3 diagrammatically illustrates four combustion heads A B C D disposed at the four corners of a square and inside an air distributor 11 having a square external contour.

FIG. 4 diagrammatically shows three combustion heads A B C disposed at the three corners of an equilateral triangle and encased in an air distributor 12 having a circular external contour. In both cases, longitudinally profiled air deflectors $11a$ and $12a$ allow the end section of the air distributor to be given an internal contour formed by slightly secant arcs of a circle.

FIG. 5 diagrammatically illustrates a cross section on the line V — V in FIG. 6. The system comprises three combustion heads A B C disposed in line inside an air distributor 13 having a rectangular external contour. As before, this distributor comprises longitudinally profiled deflectors 14 which, in the transverse plane of the combustion heads, define an internal contour formed by arcs of a circle centred on the heads A, B and C.

FIG. 6 is a longitudinal section of FIG. 5 on the line VI — VI. The three combustion heads converge at a point 0 and are disposed in an arc of a circle having the centre 0. Together they form an angle α which depends on the spacing between the heads and on the angle of spread 2δ of the unit flames. This angle α is determined at the design stage so that the unit flames very slightly penetrate one another or are tangential at T.

FIG. 6 also shows the front panel 15 of the furnace which is formed with a rectangular opening 16 which is elongated in the vertical direction, thus reducing the deflections of the tubes which line the front panel. FIG. 6 also shows the rear part of the air distributor connected to the inlet conduit 17 for the air for combustion. A damper of any known type, for example comprising a slide 18, allows the total quantity of air for combustion to be controlled.

FIG. 6 also shows the air deflectors 14 which are longitudinally profiled after a certain distance from the rear of the heads. This system gives a vertically elongate flat flame or a horizontally elongate flat flame if the latter is more suitable for the use for which the burner is intended.

FIGS. 7, 8 and 9 diagrammatically illustrate in horizontal longitudinal section through two combustion heads A and B the fuel supply conduits or injection pipes. The same system holds good for the fuel-oil return conduits or auxiliary fluid conduits.

These three figures diagrammatically illustrate the back plate 19 bounding the air distributor and forming the rear limit of the complete system supporting the combustion heads. Reference 20 denotes a damper, for example a slide, allowing the air flow to be controlled. Reference 21 denotes the air distributor which encases the burners and which is equipped on the inside with longitudinally profiled air deflectors 22. Reference 23 denotes the furnace front.

Referring to FIG. 7, the axes of the combustion heads converge at a point outside the system. In this case, the injection pipes 24 are rectilinear to outside the system and can be removed separately so that work can be carried out on one of the burners without stopping the equipment.

Referring to FIG. 8, the angle α is such that the point of convergence of the axes 0 is situated inside the equipment. The rectilinear burner pipes 25 are connected to a common header 26 but separate removal is no longer possible.

Like FIG. 8, FIG. 9 shows the case in which the point 0 is inside the system.

To allow independent removal of the injection pipes 27, the latter are curved so that each pipe intersects the plate 19 perpendicularly. Removal of each pipe is effected by a slightly circular movement.

The air guide conduits may be so oriented that their longitudinal axis coincides with that of the unit burners as, for example, in FIGS. 7, 8 and 9. Their axis may be different from that of the unit burners as, for example, in FIG. 2.

FIG. 7 shows burners provided with conical flame deflectors while FIGS. 8 and 9 show burners equipped with roses to give a rotary movement to the air.

FIG. 10 and 11 are sections on the lines X — X and XI — XI of another embodiment in which the heads of the two burners 28a and 28b are aligned in one opening 29 along a vertical axis z z'. The axes Y Y' and X X' of the burners are contained in parallel or substantially parallel horizontal planes but are inclined in relation to the plane of symmetry of the opening passing through Z Z', one of them, Y Y' being inclined to the left and the other X X', to the right so that the individual flames 30a and 30b are tangential or very slightly secant. There may be more than two burners.

Of course the burner heads may be aligned along a horizontal axis and oriented both above and below the horizontal plane passing through the burner heads.

The common air duct 31 contains longitudinally profiled air deflectors 32 which around each burner head bound circular passage sections for the air for combustion.

As an example, burners 28a and 28b are shown with rotating bladed roses.

The systems described allow higher quantities of fuel to be burned and the cross section of the flame to be adjusted to the shapes of the furnace and the uses of the latter without substantially elongating the general flame. More particularly, the invention allows very divergent or flat flames to be obtained. Very good combustion quality, even at the centre of the total flame to which the air for combustion penetrates, is obtained by

determining the divergence angles of the burners and by using air for combustion deflectors according to the invention.

The complete system is disposed in a single opening, thus avoiding complication to the furnace design, and each burner can be removed separately, thus facilitating maintenance.

Of course, those versed in the art may make various modifications — without departing from the scope of the invention, to the systems which have been described above solely by way of example, without any limiting force.

I claim:

1. A system for burning liquid fuels in a furnace, comprising a plurality of spaced burners disposed in a single opening, the burners diverging in the inward direction of said furnace, each burner being adapted to provide a flame having a predetermined angle of spread with respect to the portion of said burner at which the fuel for the flame is emitted from the burner and said burners being oriented at angles with respect to each other such that the flames produced thereby penetrate one another only slightly or are tangential to one another.

2. A system for burning liquid fuels in a furnace, comprising a plurality of spaced burners disposed in a single circular or polygonal opening, the said burners diverging in the inward direction of said furnace and being disposed at the corners of a polygon, each burner being adapted to provide a flame having a predetermined angle of spread with respect to the portion of said burner at which the fuel for the flame is emitted from the burner and said burners being oriented at angles with respect to each other such that the flames produced thereby penetrate one another only slightly or are tangential to one another.

3. A system for burning liquid fuels, comprising a plurality of burners disposed in a single opening and in the same longitudinal plane, wherein the burner axes converge substantially at a single point situated outside the furnace; the ends of the burners are disposed on an arc of a circle centred at said point; the axes of said burners together form identical angles and the radius of the said arc of a circle is determined in dependence on said angle and the angle of spread of the individual flames so that the latter penetrate one another slightly or are tangential to one another.

4. A system for burning liquid fuels, comprising a plurality of burners disposed in a single opening, wherein the ends of the said burners are disposed in spaced relation and in a single longitudinal plane, each burner being adapted to provide a flame having a predetermined angle of spread with respect to the portion of said burner at which the fuel for the flame is emitted from the burner and the axes of alternate ones of said burners being oriented oppositely with respect to said plane and forming with said plane angles such that the said individual flames emitted by each burner penetrate one another slightly or are tangential to one another.

5. A system for burning liquid fuels in a furnace, comprising a plurality of spaced burners disposed in a single opening, burners diverging in the inward direction of said furnace, each burner being adapted to provide a flame having a predetermined angle of spread with respect to the portion of said burner at which the fuel for the flame is emitted from the burner and said burners being oriented at angles with respect to each

other such that the flames produced thereby penetrate one another only slightly or are tangential to one another, said burners being disposed inside a single distributor conduit for the air for combustion, having an external shape adapted to that of the opening and comprising, on the inside, near the end adjacent the furnace, air deflectors profiled longitudinally to channel the air for combustion, said deflectors defining a contour inside the said end containing arcs of circles centred on the burner axes.

6. A system according to claim 5, wherein the internal contour of the said end adjacent the furnace is formed by arcs of a circle centred on the burner axes and portions of straight lines interconnecting the said arcs of a circle.

7. A system according to claim 6, wherein the radii of the said adjacent arcs are slightly greater than half the distance between the two adjacent burners on whose axis they are centred.

8. A system according to claim 5, disposed inside a single distributor for air for combustion bounded by a back plate, wherein the burner supply conduits are rec-

tilinear and their axes converge at a point situated rearwardly of the said plate so that each burner is removable separately.

9. A system according to claim 5, disposed inside a single distributor for air for combustion bounded by a back plate, wherein the burner supply conduits are rectilinear and converge at a point situated inside the said distributor where they are connected to a common header perpendicular to the said back plate.

10. A system according to claim 5, situated inside a single distributor for air for combustion bounded by a back plate, where the burner axes converge at a point situated inside the said air distributor and the burner supply conduits are curved and lead separately to the said back plate and perpendicularly to the latter so that they can be removed separately.

11. A system as set forth in claim 1, wherein said opening is in a wall of said furnace and wherein said portion of each burner lies substantially in the plane of the inner surface of said wall.

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