Dec. 18, 1956 W. JUNKERMANN 2,774,339

FLUID HEATER FURNACE

Filed March 31, 1953 2 Sheets-Sheet 1

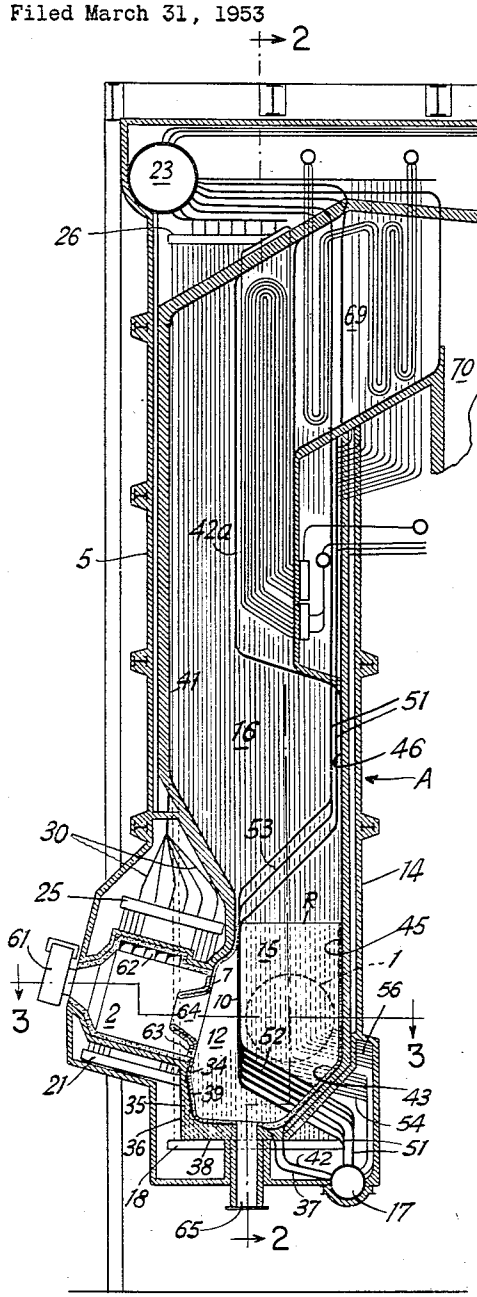


FIG. 1

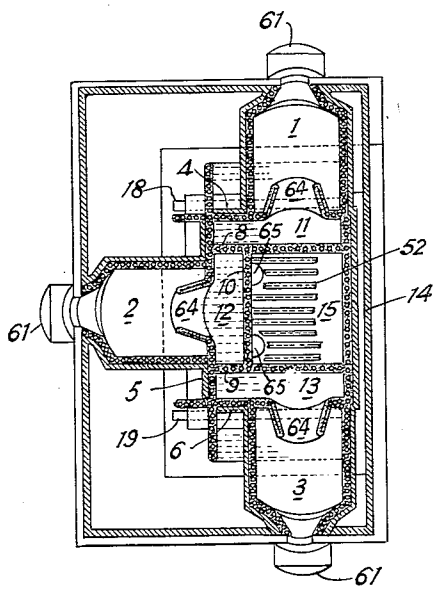


FIG. 3

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FLUID HEATER FURNACE

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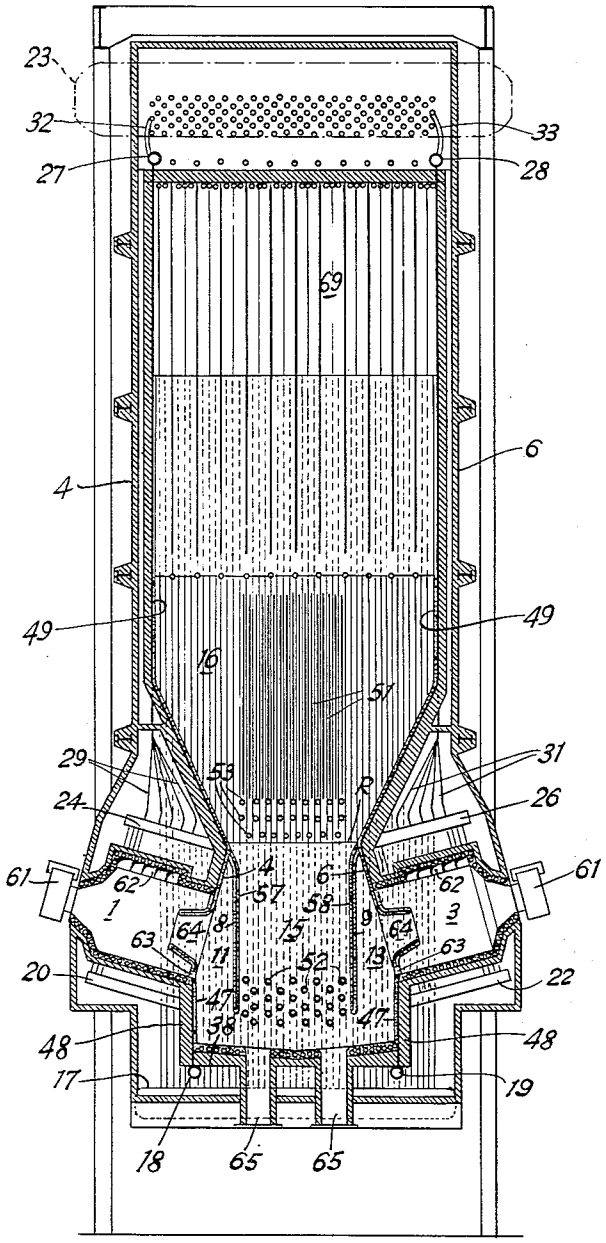


FIG. 2

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FLUID HEATER FURNACE

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6 Claims. (Cl. 122—240)

The present invention relates to a fluid heater furnace having as its firing means a plurality of cyclone furnaces each of which is generally of the type disclosed, for example, in U. S. patent Kerr et al. 2,594,312, April 29, 1952. In one form, the cyclone furnaces may be arranged at a common elevation, in separate upright outer walls of a fluid heater furnace having its internal space divided by upright fluid cooled walls inwardly spaced from the discharge ends of the cyclone furnaces; the latter walls defining at their outer sides separate gas receiving chambers or wells into which the respective cyclone furnaces discharge, and at their inner sides, a gas flow chamber or well through which the gases are directed into an upper radiation chamber, of upwardly increasing flow area, in which a substantial proportion of the total fluid heating surface is disposed.

Heretofore, in multiple cyclone furnace-fired units, the cyclone furnaces are usually mounted in the front wall of a secondary furnace, for example, in a single horizontal row for a small number of cyclone furnaces, whereas for accommodation of a larger number in a wall of the same width, the cyclone furnaces are necessarily arranged in successive rows at separate elevations. However, with the latter arrangement, it is necessary to provide a secondary chamber space of comparatively large volume which ordinarily is not favorable to the maintenance of slag fluidity within such a chamber.

The present inventive arrangement results in the flame being continuously directed over a slag discharge opening provided in the bottom of the secondary chamber, even when only one cyclone furnace is in operation for a partial load condition. This arrangement also enables each cyclone furnace outlet to be brought close to a gas reflecting arch in the secondary furnace chamber without undue reduction in the size of that chamber. In determining the size of secondary chamber to be provided, there are two major factors to be considered, namely, the total interior space must not exceed a certain maximum value in order that the slag will remain liquid and, on the other hand, it must provide a sufficient surface area so that with the hot combustion gases impinging thereon, and being deflected thereby, the liquid slag particles contained therein will still become separated therefrom.

The foregoing relationships have usually been estimated on the basis of total heat input per hour per unit of furnace volume, suitably according to the formula Q/V, wherein Q denotes the traversing heat quantity in 10^6 kilogram calories per hour (10^6 kcal./hr.), and V, the volume of the secondary furnace space in cubic meters ($m.^3$). However, it is necessary to regard the two components Q and V separately, so that with "A" denoting the wall area of the space in square meters ($m.^2$),

$$\frac{Q}{A}=\frac{10^6 \text{ kcal.}}{(m.^2)(hr.)}$$

and

$$\frac{V}{A}, \text{ in meters,}=\frac{m.^3}{m.^2}$$

Accordingly, certain optimal operating values have been determined as follows:

$$\frac{Q}{A}=\frac{1.65\ (10^6 \text{ kcal})}{(m.^2)(hr.)}$$

and

$$\frac{V}{A}=0.135 \text{ m.}$$

With the customary multiple arrangement of cyclone furnaces, all discharging into a common chamber, the foregoing values can only be realized with difficulty. From the foregoing rule, therefore, it follows that in order to obtain favorable relationships also at partial loads, the secondary furnace chamber must be divided into separate gas inlet compartments corresponding to the number of cyclone furnaces.

The various features of novelty which characterize my invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, its operating advantages and specific objects attained by its use, reference should be had to the accompanying drawings and descriptive matter in which I have illustrated and described a specific embodiment of my invention.

Of the drawings:

Fig. 1 is a vertical section of a fluid heater furnace constructed as an embodiment of the invention;

Fig. 2 is a vertical section of Fig. 1, taken along line 2—2; and

Fig. 3 is a horizontal section of Fig. 2, taken along line 3—3.

The drawings show a fluid heater furnace arranged for use in a vapor generating unit, for example, as an integral component of the total assembly. Included therefore is a vertically elongated furnace section A of substantially rectangular formation in a horizontal plane, and having as its firing means a plurality of cyclone furnaces **1**, **2**, **3** which are mounted in upright outer walls **4**, **5**, **6** toward the bottom, each of which walls is formed with a reentrant wall section having its lower portion **7** inclined downwardly and outwardly for assembly of a cyclone furnace therein, in right-angled relation thereto. Interiorly of furnace section A, at a common level with primary furnaces **1**, **2**, **3**, upright walls or partitions **8**, **9**, **10** serve to divide the furnace section A into three secondary furnace compartments **11**, **12**, **13**, into which the respective cyclone furnaces separately discharge; walls **8**, **9** being arranged parallel to one another and perpendicular to wall **5**, and wall **10** being arranged perpendicular to walls **8** and **9**, and parallel to the upright rear furnace wall **14**. The partitions **8**, **9**, **10** thus define an interior well or gas flow region **15** of rectangular cross-section which opens upwardly through progressively increasing flow areas into a radiation chamber **16** extending throughout the remaining height of the setting. All walls of the cyclone furnaces **1**, **2**, **3**, of the well **15**, and of the radiation chamber **16**, are fluid cooled and formed with fluid heating tubes of the associated vapor generator. Such tubes, for example, are arranged and connected so as to be supplied with liquid from lower headers **17**, **18**, **19**, **20**, **21**, **22** and to discharge into the elevated boiler drum **23**, either by direct connections, or through intermediate headers **24**, **25**, **26**, **27**, **28**, and riser tubes **29**, **30**, **31**, **32**, **33**, the majority of which conductors and connections are diagrammatically indicated. The arrangement of the necessary down-

comers and their connections is omitted for simplification of the graphic disclosure.

In the wall areas of cyclone furnaces **1**, **2**, **3**, of the secondary furnace space **12**, and of the well **15**, to an elevation indicated by line R, above the cyclone furnaces, the wall tubes are provided on the fire side, in known manner, with metallic studs, not shown, which studs are embedded within a covering layer of refractory material **34**, and surrounded outwardly by a heat insulating jacket **35** and a sheet metal casing **36**.

A row of tubes **37**, starting at the lowermost fluid distributing header **17**, extends along the bottom **38** of the secondary chamber **12** and its front wall **39**, and continues upwardly along the inclined inner end wall of cyclone furnace **2**, thence along the front wall **41** of radiation chamber **16**. An additional tube row **42** extends from header **17** upwardly and rearwardly along an inclined bottom wall portion **43** of chamber **12** and thence along the upright rear wall **45** of well **15**, with portions continuing upwardly along the rear wall **46** of radiation chamber **16**, and other portions **42***a* extending forwardly of superheater surface, as indicated. From the lower side wall inlet headers **18** and **19**, rows of wall tubes **47**, **47** extend upwardly along opposing side walls **48**, **48** of the secondary chamber, together with the inner end walls of cyclone furnaces **1** and **3** and, in their continuation, along opposing lateral walls **49**, **49** of the radiation chamber **16**.

Tubes **51**, in another group, having lower ends connected in rows to header **17**, extend upwardly through the inclined furnace floor portion **43**, between rear wall tubes **42**, to form an inclined tubular slag screen **52**, and then the front partition **10** between well **15** and the secondary furnace compartment **12**. The tubes **51** are then inclined upwardly toward the rear of the furnace to form a tubular slag screen **53** disposed across the lower, gas inlet end of radiation chamber **16**. The tubes **51** are then continued upwardly in front of rear wall **46** for suitable riser connections to upper drum **23**. Other groups of tubes **54**, **56** also extend upwardly from header **17** to form the two opposing walls **57**, **58** of well **15**, whence they are continued upwardly along the opposing side wall portions **49**, **49**.

In the embodiment disclosed, each of the cyclone furnaces **1**, **2** and **3** respectively, is of cylindrical formation about a central axis which is inclined downwardly toward a separate one of the outer wells or compartments **11**, **12**, **13**. A fluent mixture of solid fuel particles suspended in a high velocity stream of preheated primary air is introduced tangentially into a fuel inlet chamber or primary burner **61** at the outer end. The burning fuel-and-air mixture is caused to move in a substantially helical path along the circumferential wall of the cyclone furnace, while a major portion of the combustion air is introduced in one or more streams through a tangentially arranged secondary air inlet **62** extending lengthwise of the cyclone chamber. Combustion of the fuel takes place at a rapid rate and at temperatures above the ash fusing temperature, whereby slag formed on the inner wall surfaces continuously drains along inner wall surfaces for discharge in molten condition through a bottom outlet **63** from the lowermost part of the chamber. The hot gases of combustion discharge through a central gas outlet **64** which is suitably defined by a reentrant annular throat section of the inner end wall. In the bottom wall **38**, vertically below the partition **10**, and adjacent partitions **8**, **9** there are provided two slag outlets **65**, **65** through which slag is discharged to the exterior of the setting for ultimate disposal. The hot gases flowing through the cyclone outlets **64** enter the respective secondary chamber compartments **11**, **12**, **13** where they are caused to impinge on the upright depending walls **8**, **10**, **9**, by which the gases are deflected downwardly and thus caused to flow along the furnace bottom **38** in passing through slag screen **52** into the well **15**. It is not until the combustion gases enter the well that their temperatures fall below the melting temperature of the slag whereupon, in passing through the upper slag screen **53**, the gases are further cooled to insure that the gases will have temperatures which lie below the melting point of the slag when the gases enter the radiation space **16**.

The heating gases flow upwardly through the radiation space **16**, in contact with a tubular superheater component as shown, and then through succeeding flues **69** and **70** in each of which flues other heating surface may be disposed, as herein indicated only in part.

While in accordance with the provisions of the statutes I have illustrated and described herein a specific form of the invention now known to me, those skilled in the art will understand that changes may be made in the form of the apparatus disclosed without departing from the spirit of the invention covered by my claims, and that certain features of the invention may sometimes be used to advantage without a corresponding use of other features.

1. A furnace unit having a pair of upright outer walls forming opposing lateral boundaries of a furnace chamber, upright partitions inwardly spaced from said lateral boundaries and respectively defining therewith separate gas receiving compartments, said partitions defining an interior well space arranged to receive heating gases from said compartments, and through which space said gases are directed, said furnace chamber having a bottom wall common to said compartments and said well space, and furnaces in which the combustion of slag-forming solid fuel particles is effected, said furnaces having outlets through which gases of combustion from separate furnaces are discharged into the separate compartments against the respective partitions and deflected downwardly thereby toward said bottom wall, said partitions having lower ends upwardly spaced from said bottom wall at elevations lower than said furnace outlets and defining therewith areas through which said gases flow into a lower portion of said well space.

2. A furnace unit according to claim 1 and further comprising fluid conducting tubes forming a slag screen inclined across said well space in the path of the gases entering from each of said combustion furnaces.

3. A furnace unit according to claim 2 and further comprising header means from which fluid is supplied to the lower ends of tubes forming said slag screen, and other fluid conducting tubes extending from said header means and providing fluid cooling means for at least one of said partitions.

4. A furnace unit according to claim 1 wherein said furnaces are respectively formed as cyclone furnaces of substantially circular cross-section about axes of substantially horizontal arrangement, said furnaces respectively having said gas outlets axially arranged and having slag outlets opening into said compartments at elevations below said gas outlets, and a slag discharge outlet in said bottom chamber wall at a location vertically below one of said partitions.

5. A furnace unit having opposing upright walls arranged in two sets and forming the lateral boundaries of a furnace chamber of substantially rectangular horizontal cross section, upright partitions inwardly spaced from three of said lateral boundaries and defining therewith an equal number of separate gas receiving compartments, one of said partitions extending between the remaining two partitions and arranged in abutting relation thereto said partitions defining with the remaining lateral boundary of said chamber an inner well space, said chamber having a bottom wall along which heating gases are directed from said compartments into said well space, and cyclone furnaces mounted respectively in said three lateral boundaries and each adapted to effect the combustion of slag forming solid fuel particles, said furnaces having separate outlets through which com-

bustion gases and slag are separately discharged at different elevations into the respective compartments, said bottom wall being formed with a slag-discharge area having portions respectively arranged in the vicinity of the lower ends of said partitions.

6. A furnace unit as defined in claim 5 and further comprising tubes extending in slag screen formation across the lower end of said well and continuing upwardly within the structure of one of said partitions, other tubes incorporated in the structures of the remaining partitions, and header means from which fluid is supplied to all of said tubes, said header means being arranged exteriorly of said furnace unit at an elevation lower than said bottom wall.

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