

Aug. 25, 1942.

L. W. HELLER

2,293,736

COMBUSTION APPARATUS

Filed Aug. 25, 1934

2 Sheets-Sheet 1

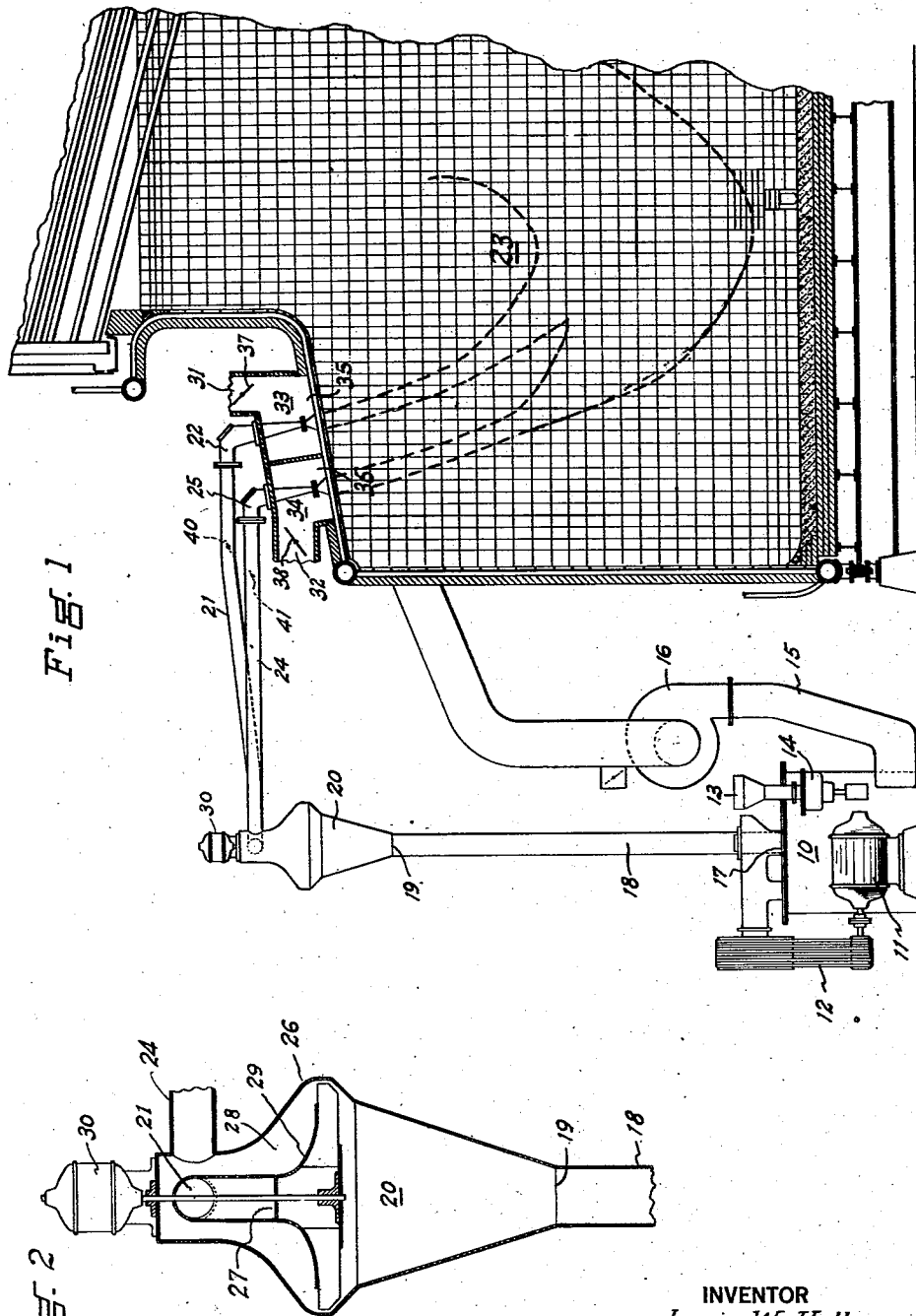


Fig. 2

Fig. 1

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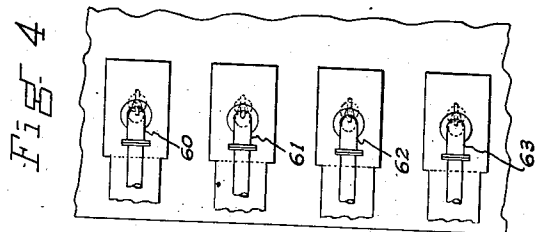
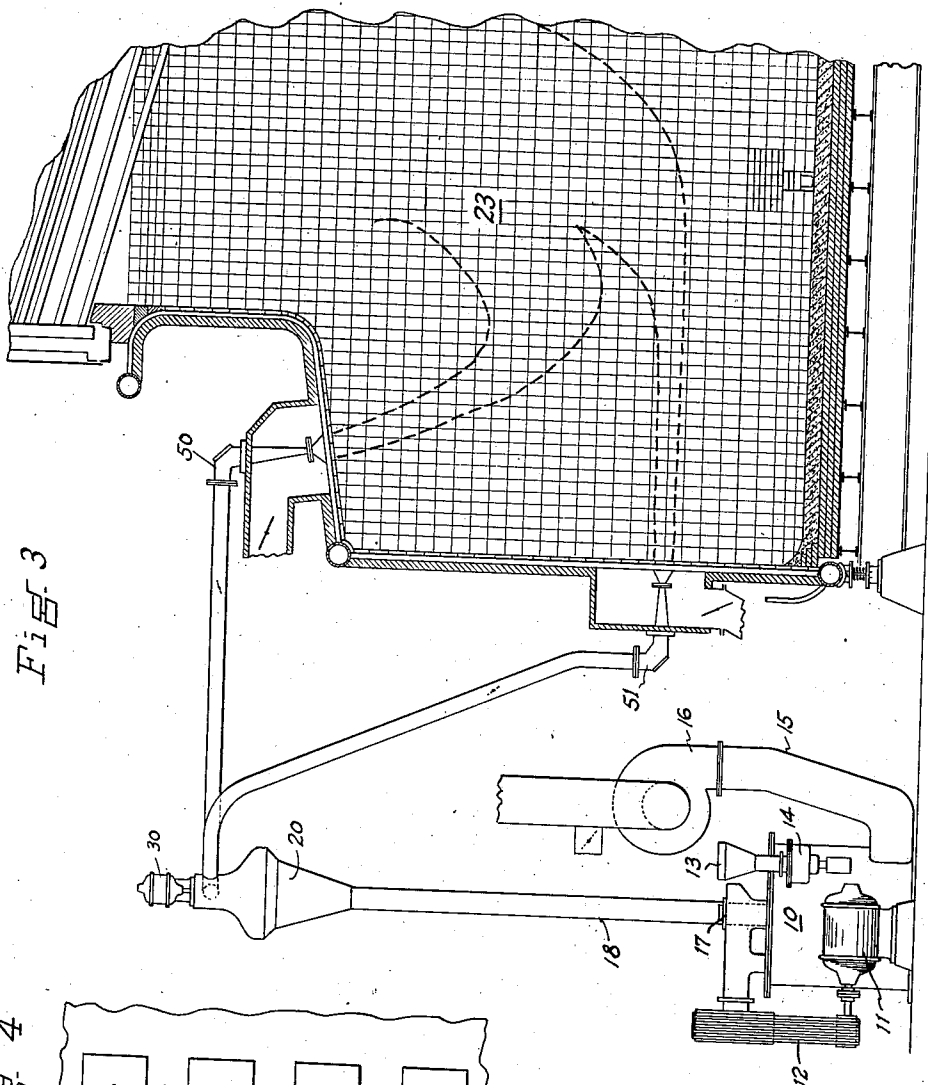
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2 Sheets-Sheet 2



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COMBUSTION APPARATUS

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19 Claims. (Cl. 110—28)

This invention relates to combustion apparatus and more particularly to methods and apparatus for burning pulverized fuel in suspension in furnace chambers.

It is an object of the present invention to provide an improved method and an improved apparatus for burning pulverized fuel in suspension in a furnace chamber, whereby ignition and the maintenance of a steady and stable flame is assured, and whereby a high degree of reliability of combustion is obtained over a wide range of combustion rates and of furnace temperatures.

A further object of my invention is to provide an improved method and apparatus for burning pulverized fuel whereby a relatively high degree of heat liberation may be obtained for the available furnace-chamber space.

These and other objects will be apparent from an examination of the following description taken in connection with the accompanying drawings in which:

Fig. 1 is a vertical sectional view illustrating my improvements as applied to a boiler furnace, the approximate path of flow of the entering fuel streams being indicated in broken lines;

Fig. 2 is a vertical sectional view through a power-driven classifier or separator used in connection with my invention;

Fig. 3 is a vertical sectional view illustrating a modified form of my invention, the approximate path of flow of the entering fuel streams being indicated in broken lines; and

Fig. 4 is a fragmentary plan view illustrating a further modified form of burner arrangement.

In prior methods and apparatus for burning pulverized fuel in suspension in a furnace chamber, the pulverized fuel is usually mixed with sufficient air to effect the transportation of the fuel and the stream of fuel and air conducted to a burner, through which it is introduced into the furnace chamber. In direct-firing systems the fuel is transported directly from a pulverizing mill to the burner by a stream of air passing through the mill. In other systems, the pulverized fuel is stored in a bin or the like, and is mixed with the carrying-air stream when it is to be introduced into the furnace.

In all systems of this character, after fuel has been initially ignited by some auxiliary means, such as a torch, gas flame, or the like, and after the furnace has been operating for a sufficient time, the entering fuel is brought to ignition temperature and ignited by the heat reflected from the furnace walls and by the heat from the flame of combustion of previously ignited fuel. Heat is

transmitted to the entering fuel in two ways, viz: by radiation from the flame and other hot bodies such as the furnace walls, and by conduction between adjacent fuel particles from the flame back through the stream toward the point of introduction. The transmission of heat from the flame and other hot bodies to the entering fuel is greater at high furnace ratings and when there is a relatively small air space between the fuel particles. The rate of flame propagation is dependent upon the rate at which the heat is transmitted to the entering fuel particles. If the rate of flame propagation is high, a steady and stable flame can be maintained. If the flame propagating rate is low, the stream velocity will tend to move the flame down-stream; and, if too low, will result in the flame being extinguished.

As the rate of heat transmission up-stream is dependent upon the air space between particles, a steady flame is hard to maintain in a furnace when the particles are too large or when excess air is present with the fuel, and this difficulty is more pronounced at low ratings when the flame is less intense and the surrounding furnace walls are at a lower temperature.

In accordance with my invention, I obviate the above difficulties and provide for the maintenance of a steady and stable flame throughout the range of furnace ratings by classifying the stream of fuel and air coming from the pulverizer or bin into two streams, and introducing the two streams into the furnace in separate paths, which paths are in heat-influencing relation to one another. The classification is such that the air and fuel in one of the streams are so proportioned as to provide for a rapid transmission of heat from one particle of fuel to another, whereby the stream ignites and burns rapidly with a stable flame. The arrangement may be such that the fuel in the other stream enters the already ignited stream after ignition, and the combustion of all the fuel is then completed; or, if desired, the arrangement may be such that the heat of combustion of the already ignited stream will provide a high furnace temperature adjacent the point of entrance of the other stream and thereby promote the combustion of the fuel in such other stream. In some cases, both operations may be desired.

Referring now in detail to the construction illustrated, and particularly to Fig. 1, it will be observed that I have shown a fuel pulverizing mill of the conventional type, which may be driven by any suitable means, for example, an electric

motor 11 mounted at the side thereof and operatively connected thereto by a flexible drive 12. The mill 10 is provided with a supply hopper 13 containing the fuel to be pulverized and connected at its lower end to the inlet of the mill, by a feeder 14. The hopper may be kept filled with fuel from any suitable source (not shown).

The mill 10 is provided with an inlet for air under pressure, to which is connected a discharge conduit 15 of a power-driven fan 16. Air under pressure from the fan 16 flows through the mill and through an outlet opening connected to the lower end of a conduit 18. As the air flows through the mill, the finer fuel particles are entrained therein and are carried away through the conduit 18.

The structure and operation thus far described is well known in the art and further detail showing, and description thereof, is believed to be unnecessary, it being sufficient to say that this apparatus provides a supply of pulverized fuel in suspension in air to the conduit 18.

As stated, the lower end of the conduit 18 is connected to the mill outlet. The upper end of this conduit 18 is connected to an inlet 19 of a power-driven centrifugal classifier 20, wherein the mixture is divided into two streams, one stream being conducted by a pipe 21 to one burner 22 located in the upper part of a furnace chamber 23, and the other stream being conducted by a pipe 24 to a second burner 25 also in the upper part of the furnace chamber.

The classifier 20 may be of any suitable design of either a rotary type, as shown, or of a stationary type. I have shown the separator as comprising a casing 26 having the inlet 19 in the lower portion thereof, which as stated, is connected to the conduit 18, and two outlets, 27 and 28 respectively, the outlet 27 being located adjacent the center of the casing 26 and the outlet 28 spaced radially from the outlet 27. A rotor 29 is disposed within the casing 26 and is mounted on a vertical shaft connected at its upper end to a variable speed electric motor 30. In operation, rotary motion is imparted to the rotor and as a result the fuel and air is moved in circular paths in the casing, thereby creating a centrifugal effect and causing the heavier constituents of the mixture to collect adjacent the walls of the casing. The outlet 27 is connected to the pipe 21 leading to the burner 22 and the outlet 28 to the pipe 24 leading to the burner 25.

The burners 22 and 25 are arranged to direct their respective streams vertically downward and in approximately parallel directions. The streams are turned by the bottom of the furnace and flow upward and into contact with the heat absorbing surfaces of the boiler located in the upper portion of the furnace. The reversal of direction of flow of the streams aids in mixing the streams and thereby promotes the final stages of combustion of the fuel. The furnace is of the conventional type and further description is, therefore, considered unnecessary.

In the construction illustrated, the air which is mixed with the fuel in the mill 10 is preferably the air necessary to effect the transportation of the fuel in suspension therein to the furnace, the amount representing in some cases between 25% and 35% of the total amount of air required for combustion. The remaining or secondary air for completing combustion may be supplied from any suitable source (not shown) by pipes 31 and 32 which are respectively connected to compartments 33 and 34, and the lat-

ter are provided with openings 35 and 36, which surround the discharge ends of the burners 22 and 25, respectively. Valves 37 and 38 are disposed in the pipes 31 and 32 respectively, for regulating the supply of secondary air to each burner. The streams of secondary air flowing through the openings 35 and 36 join respectively the streams discharged from the burners 22 and 25 and serve to support the combustion of fuel therein. However, any form of burner design or method of supplying the air may be used without departing from the spirit of my invention.

It is noted that, the apparatus thus far described provides for the pulverizing of the fuel in the mill 10; for the mixing with the fuel of air in sufficient quantities to effect its transportation from the mill and through the conduit 18, classifier 20 and pipes 21 and 24; for the separation of the mixture into two streams; and finally for the introduction of the two streams into the furnace chamber through separate burners.

According to the broader aspects of my invention, the fuel and air in the conduit 18 may be classified by the classifier 20 in any one of a number of ways, depending upon the particular conditions and the results desired. For example, if the fuel being used is bituminous coal which, of course, contains a substantial amount of combustible volatile matter, I have found that by designing the classifier 20 so that only the relatively heavier particles leave through the opening 28 and enter the furnace through the burner 25 and that the remaining lighter particles leave through the opening 27 and enter the furnace through the burner 22, easy ignition and rapid burning of the relatively fine particles introduced through the burner 22 can be effected and the heat from this burning stream will serve to promote the combustion of the heavy particles in the stream introduced through the burner 25. In the stream containing the finer particles there is less air space between particles and hence, the fuel therein ignites relatively easily and burns more rapidly to provide a steady and stable flame. With other factors being equal, the rate of flame propagation varies with the degree of fineness of the fuel.

According to the broader aspects of my invention, the burners 22 and 25 may be arranged in a number of ways, depending upon the particular conditions. In the embodiment shown in Fig. 1, the arrangement of the burners is such that the stream including the heavier particles, which is introduced through the burner 25, travels a greater distance than the stream containing the lighter particles introduced through the burner 22. By reason of this arrangement, ample time is provided for the gasification of the relatively heavier particles of fuel, and consequently for the liberation therefrom of the solid non-combustible constituents, before the stream from the burner 25 contacts with the heat absorbing surfaces of the boiler. If the solid non-combustibles are not separated out of the stream prior to contact with the boiler tubes, slagging of the tubes will likely result.

It is also within the intended scope of this invention to vary the velocities at which the different streams enter the furnace. Valves 40 and 41 disposed respectively in the pipes 21 and 24 and the valves 37 and 38 disposed respectively in the pipes 31 and 32 provide for varying the velocity of either or both streams in any desired way. As an example of how the stream velocities

may be varied, the stream carrying the finer particles of fuel may be introduced at a relatively low velocity so as to give a shorter path of flame travel. This is feasible because only a short path is necessary in order to complete combustion of this type of fuel. The remaining portions of the furnace chamber can be used for the combustion of the heavier particles. Also, the velocities of the streams may be varied to suit the flame propagating characteristics of the particular fuel and the desired fuel and air ratio of the fuel used. It is also to be noted that while I have shown the two burners as being in the same chamber, other arrangements may be resorted to; for example, the burners may be placed in separate chambers with the walls of each chamber cooled in proportion to the amount of heat liberated therein, whereby efficient utilization of the heat may be obtained and the proper temperature for combustion maintained in each chamber.

The proportions of fuel and air in the respective streams entering the furnace through the burners 22 and 25 may be varied to suit different conditions by changing the speed of the variable speed motor 30, driving the classifier 20. For example, it may be found desirable in starting up, in order to quickly heat up the furnace, to regulate the speed of the motor so that practically all of the fuel will enter the furnace through one of the burners. Or after starting up, the motor speed may be varied to change the flame characteristics of the two burners. The valves 40, 41, 37, and 38 also provide a means for varying the flame characteristics in the furnace.

By the arrangement shown in the drawings, I provide for the burning of pulverized bituminous coal in an effective and flexible manner and at high rates of heat liberation in the furnace and at low rates without unsteadiness and instability of flame. Furthermore, as the relatively fine particles are separated from the heavier particles, propagation of the flame is more rapid in the stream containing the fines for a given fuel air ratio and a resulting high temperature flame of great stability is produced close to the portion of the furnace where the fuel enters; and, as a consequence, ignition and completion of the combustion of the heavier particles is assured. Also, as the fines are separated from the heavier particles of fuel, the inert gases resulting from the combustion of the fines interfere to a minimum degree with the mixture of fresh oxygen-bearing air with the heavier particles. Therefore, the combustion of the relatively heavier particles is effected more quickly and with greater stability of the flame than would be the case if they were introduced into the furnace along with the relatively finer particles.

In some installations it may be found more desirable to provide an arrangement of burners, such as shown in Fig. 3. In this figure, a burner 50, through which the relatively fine particles are introduced into the furnace, is arranged to direct its stream downwardly from the upper portion of the furnace; and the burner 51, through which the relatively heavier particles are introduced, is disposed in the lower part of the furnace and arranged to direct its stream of relatively heavier particles of fuel and air in a more or less horizontal direction along the bottom of the furnace and on the outside of the stream carrying the relatively finer particles of fuel. By reason of this construction, a more

intimate mixture of the two streams is provided after their ignition has been effected, which in some instances will provide for more effective combustion. It is to be observed that, as was the case of the previously described modifications, heat from the more rapidly burning fine particle stream is transmitted to the heavy particle stream and thereby promotes ignition and combustion in the latter stream. The modified structure also provides for the stream containing the relatively heavier particles traveling a greater distance than the stream carrying the relatively lighter particles. Hence, the gasification of the fuel and the separation of the non-combustible solid constituents of the fuel is assured prior to contact with the heat absorbing surface of the boiler.

In Fig. 4, I have shown a further modified arrangement wherein burners 60, 61, 62 and 63 are disposed in side-by-side relation across the furnace instead of in the fore and aft relation shown in Fig. 1. Alternate burners 60 and 62 direct streams of relatively fine fuel and air vertically downward in a furnace, and the remaining burners 61 and 63 direct streams of relatively heavy particles of fuel and air also vertically downward and in paths approximately parallel to one another and to the streams introduced through burners 60 and 62. This alternate arrangement of streams of relatively fine and heavy fuel, provides for the effective transfer of heat from the rapidly burning fine particle streams to the heavy particle streams and hence promotes ignition and combustion of the fuel in the latter.

It is to be observed that my invention, in its broader aspects, is not limited to a method and apparatus for burning bituminous coal or any particular kind of fuel, because the steps of separating the mixture of fuel and air from the pulverizer into two streams and of admitting these streams into the furnace in separate paths and through separate burners may be used to advantage with any type of pulverulent fuel, wherein the mixture of fuel and air is classified to produce a stream more readily ignitable than the original mixture of fuel and air for effecting its translation in suspension therein. Furthermore, other arrangements and other degrees of separation may be found useful to suit the particular characteristics of the fuel to be used.

While I have shown my invention in a plurality of forms, it will be obvious to those skilled in the art that it is not so limited but is susceptible of various other changes and modifications without departing from the spirit thereof and I desire, therefore, that only such limitations shall be placed thereupon as are imposed by the prior art or as are specifically set forth in the appended claims.

What I claim is:

1. A method of preparing and burning pulverized fuel in suspension in a furnace chamber, which comprises pulverizing the fuel; mixing the pulverized fuel with air for effecting transportation of the fuel in suspension therein; classifying the mixture into two streams, one of which is composed of the relatively heavier fuel particles and air, and the other of which is composed of the relatively lighter fuel particles and air; and introducing the two streams into the furnace in separate paths and in such directions that the stream including the heavier particles travels a greater distance in the furnace than the stream including the lighter particles while in position to

receive sufficient heat radiation from combustion of the lighter fuel particle stream to promote combustion of the heavier fuel particles.

2. In combustion apparatus, the combination of means defining a combustion chamber for the burning of pulverized fuel in suspension therein; means providing a mixture of pulverized fuel and carrier air; a centrifugal separating device including means defining a separating chamber and means providing for the movement of fluid in said separating chamber about a central axis thereof; said separating chamber having an inlet, a first outlet adjacent the central axis thereof, and a second outlet spaced radially from the first outlet; conduit means for conveying the mixture of pulverized fuel and air from the means providing the mixture to the inlet of said separating chamber; first and second burners arranged to direct separate streams of fluid into the combustion chamber; conduit means connecting the first outlet of the separating device with the first burner; and conduit means connecting the second outlet with the second burner.

3. In combustion apparatus, the combination of means defining a combustion chamber for the burning of pulverized fuel in suspension therein; means providing a mixture of pulverized fuel and carrier air; a centrifugal separating device including means defining a separating chamber, means providing for the movement of fluid in said separating chamber about a central axis thereof, and means for varying the rate at which the fluid in said separating chamber flows about said central axis; said separating chamber having an inlet, a first outlet adjacent the central axis thereof, and a second outlet spaced radially from the first outlet; conduit means for conveying the mixture of pulverized fuel and air from the means providing the mixture to the inlet of the chamber; first and second burners arranged to direct separate streams of fluid into the combustion chamber; conduit means connecting the first outlet of the separating device with the first burner; and conduit means connecting the second outlet with the second burner.

4. In combustion apparatus, the combination of means defining a combustion chamber for the burning of pulverized fuel in suspension therein; means providing a mixture of pulverized fuel and carrier air; a centrifugal separating device including means defining a separating chamber and means providing for the movement of fluid in said separating chamber about a central axis thereof; said separating chamber having an inlet, a first outlet adjacent the central axis thereof, and a second outlet spaced radially from the first outlet; conduit means for conveying the mixture of pulverized fuel and air from the means providing the mixture to the inlet of said separating chamber; first and second burners arranged to direct separate streams of fluid into the combustion chamber in paths which are separated for a given distance and then merge into one another; conduit means connecting the first outlet of the separating device with the first burner; and conduit means for connecting the second outlet with the second burner.

5. In combustion apparatus; the combination of means defining a combustion chamber for the burning of pulverized fuel in suspension therein; means providing a mixture of pulverized fuel and carrier air; a centrifugal separating device including means defining a separating chamber and means providing for the movement of fluid in said separating chamber about a central axis

thereof; said separating chamber having an inlet, a first outlet adjacent the central axis thereof, and a second outlet spaced radially from the first outlet; conduit means for conveying the mixture of pulverized fuel and air from the means providing the mixture to the inlet of said separating chamber; first and second burners arranged to direct separate streams of fluid into the combustion chamber in paths which are approximately parallel and adjacent to one another for a substantial distance of the travel of the fluids; conduit means connecting the first outlet of the separating device with the first burner; and conduit means connecting the second outlet with the second burner.

6. In combustion apparatus, the combination of means defining a combustion chamber for the burning of pulverized fuel in suspension therein; means providing a mixture of pulverized fuel and carrier air; a centrifugal separating device including means defining a separating chamber and means providing for the movement of fluid in said separating chamber about a central axis thereof; said separating chamber having an inlet, a first outlet adjacent the central axis thereof, and a second outlet spaced radially from the first outlet; conduit means for conveying the mixture of pulverized fuel and air from the means providing the mixture to the inlet of said separating chamber; first and second burners arranged to direct separate streams into the combustion chamber which are approximately parallel for a substantial distance and then merge into one another; conduit means connecting the first outlet of the separating device with the first burner; and conduit means connecting the second outlet with the second burner.

7. The process of burning solid fuel which comprises pulverizing the fuel, classifying the pulverized fuel while in suspension in an air stream into separate streams, one containing a readily ignitable fuel-air mixture and another a less ignitable fuel-air mixture, delivering the less ignitable fuel-air stream to a combustion zone, separately delivering the readily ignitable fuel-air stream to the combustion zone at a point providing a path therein shorter than the path of travel therein of the less ignitable fuel-air stream from its point of introduction to the combustion zone gas exit and in sufficient radiant heat transmitting relation to the path of travel therein of the less ignitable fuel-air stream to promote combustion of the fuel particles in the less ignitable fuel-air stream.

8. The process of burning solid fuel which comprises pulverizing the fuel, classifying the pulverized fuel into separate portions, one containing the heavier fuel particles and another the relatively lighter fuel particles, delivering the portion containing the heavier fuel particles and combustion air to a combustion zone, and separately delivering the portion containing the lighter fuel particles and combustion air to the combustion zone at a point providing a path therein shorter than the path of travel therein of the less ignitable fuel-air stream from its point of introduction to the combustion zone gas exit and in sufficient radiant heat transmitting relation to the path of travel therein of the heavier fuel particle stream to promote combustion of the heavier fuel particles.

9. The process of burning solid fuel which comprises pulverizing the fuel, classifying the pulverized fuel while in suspension in an air stream into separate streams, one containing a readily

ignitable mixture of the lighter fuel particles and air and another a less ignitable mixture of the relatively heavier fuel particles and air, delivering the less ignitable stream containing the heavier fuel particles to a combustion zone, and separately delivering the readily ignitable stream containing the lighter fuel particles to the combustion zone at a point providing a path therein shorter than the path of travel therein of the less ignitable fuel-air stream from its point of introduction to the combustion zone gas exit and in sufficient radiant heat transmitting relation to the initial portion of the path of travel therein of the less ignitable heavier fuel particle stream to promote combustion of the heavier fuel particles.

10. The process of burning solid fuel which comprises pulverizing the fuel, classifying the pulverized fuel into separate portions, one containing the heavier fuel particles and another the relatively lighter fuel particles, delivering the portion containing the heavier fuel particles and combustion air to a combustion zone, and separately delivering the portion containing the lighter fuel particles and combustion air to the combustion zone at a point providing a path therein shorter than the path of travel therein of the less ignitable fuel-air stream from its point of introduction to the combustion zone gas exit and in sufficient radiant heat transmitting relation to the path of travel therein of the heavier fuel particle stream to promote combustion of the heavier fuel particles and at a lower velocity than the heavier fuel particle stream.

11. The process of burning solid fuel which comprises pulverizing the fuel, classifying the pulverized fuel while in suspension in an air stream into two separate streams, one containing a readily ignitable mixture of the lighter fuel particles and air and the other a less ignitable mixture of relatively heavier fuel particles and air, delivering the less ignitable stream containing the heavier fuel particles to a combustion zone, and separately delivering the readily ignitable stream containing the lighter fuel particles to the combustion zone at a point providing an initially parallel path therein shorter than the path of travel therein of the less ignitable fuel-air stream from its point of introduction to the combustion zone gas exit and in sufficient radiant heat transmitting relation to the initial portion of the path of travel therein of the less ignitable heavier fuel particle stream to promote combustion of the heavier fuel particles and at a lower velocity than the less ignitable heavier fuel particle stream.

12. Pulverized fuel burning apparatus comprising a fuel pulverizer of the air-swept type, a furnace having a plurality of pulverized fuel burners arranged to discharge fuel into said furnace in initially separate paths, conduit means for delivering pulverized fuel-laden air from said pulverizer to said furnace including a variable speed rotary classifier for regularly classifying the fuel-laden air from said pulverizer into separate streams, one containing mainly the heavier fuel particles and the other containing mainly the relatively lighter fuel particles, and means for separately delivering the classified streams to said fuel burners.

13. Pulverized fuel burning apparatus comprising a fuel pulverizer of the air swept type, a furnace having a horizontally-extending wall and a subjacent vertically-extending wall, separate fuel burners arranged to discharge fuel laden

air into said furnace through said walls, conduit means for conducting fuel laden air from said pulverizer to said burners, said conduit means including a centrifugal classifier constructed to classify the fuel laden air into separate streams for said separate burners, one of said streams consisting of a readily ignitable fuel-air mixture and the other consisting of a less ignitable fuel-air mixture, and conduit means for delivering the readily ignitable fuel-air mixture to the burner discharging through said horizontally extending wall and the less ignitable fuel-air mixture to the burner discharging through said vertically extending wall.

14. Pulverized fuel burning apparatus comprising a fuel pulverizer of the air-swept type, a furnace having a heating gas outlet, a pulverized fuel burner, a second pulverized fuel burner positioned intermediate said first fuel burner and said outlet, said fuel burners being directed relative to said outlet so as to discharge fuel into said furnace in initially separate paths having different lengths of travel in said furnace from said burners to said outlet, the discharge from said second fuel burner having a shorter length of travel than and in a path in substantial radiant heat transmitting relation with the discharge from said first fuel burner, conduit means for delivering pulverized fuel-laden air from said pulverizer to said furnace including a separate classifier spaced above the level of said pulverizer and arranged to classify the fuel into separate streams, one consisting of a readily ignitable fuel-air mixture and the other containing a less ignitable fuel-air mixture, means for delivering the stream containing the less ignitable fuel-air mixture to said first fuel burner, and means for delivering the stream containing the readily ignitable fuel-air mixture to said second fuel burner.

15. Pulverized fuel burning apparatus comprising a furnace having a heating gas outlet, a pulverized fuel burner, a second pulverized fuel burner positioned intermediate said first fuel burner and said outlet, said fuel burners being directed relative to said outlet so as to discharge fuel into said furnace in initially separate paths having different lengths of travel in said furnace from said burners to said outlet, the discharge from said second fuel burner having a shorter length of travel than and in a path in substantial radiant heat transmitting relation with the discharge from said first fuel burner, conduit means for delivering pulverized fuel-laden air to said furnace including a separate classifier arranged to classify the fuel into separate streams, one containing the heavier fuel particles and the other containing the relatively lighter fuel particles, means for delivering the stream containing the heavier fuel particles to said first fuel burner, and means for delivering the stream containing the lighter fuel particles to said second fuel burner.

16. Pulverized fuel burning apparatus comprising a fuel pulverizer of the air-swept type, a furnace having a heating gas outlet, a pulverized fuel burner, a second pulverized fuel burner positioned intermediate said first fuel burner and said outlet, said fuel burners being directed relative to said outlet so as to discharge fuel into said furnace in converging paths having different lengths of travel in said furnace from said burners to said outlet, the discharge from said second fuel burner having a shorter length of travel than and in a path in substantial radiant heat transmitting relation with the discharge from said

first fuel burner, conduit means for delivering pulverized fuel-laden air from said pulverizer to said furnace including a variable rotary classifier spaced above said pulverizer and arranged to classify the fuel into separate streams, one containing the heavier fuel particles and the other containing the relatively lighter fuel particles, means for delivering the stream containing the heavier fuel particles to said first fuel burner, and means for delivering the stream containing the lighter fuel particles to said second fuel burner.

17. The method of producing combustion of fuels which comprises entraining the fuel in a stream of air, delivering the fuel and air mixture to a separating zone, separating the mixture into separate streams, one containing a readily ignitable fuel-air mixture and another a less ignitable fuel-air mixture, delivering the readily ignitable stream to the upper portion of the furnace for combustion in an ignition zone and delivering the less ignitable stream to a lower portion of the furnace outside said ignition zone to rejoin the burning readily ignitable stream.

18. The method of supplying pulverized fuel to a furnace for combustion which comprises entraining the fuel in a stream of air, delivering

the fuel and air mixture to a separating zone, separating the mixture into separate streams, one containing a readily ignitable fuel-air mixture and another a less ignitable fuel-air mixture, delivering the readily ignitable stream to the upper portion of the furnace through one wall thereof for combustion in an ignition zone and delivering the less ignitable stream to the furnace through another wall thereof outside of said ignition zone and at a lower portion of the furnace to rejoin the burning readily ignitable stream.

19. Apparatus for producing combustion of fuel in a furnace comprising means for entraining the fuel in a stream of air, a separator for separating the fuel-air mixture into separate streams, one containing a readily ignitable fuel-air mixture and another a less ignitable fuel-air mixture, a burner nozzle disposed to deliver the readily ignitable stream to the upper portion of the furnace for combustion in an ignition section thereof, and means for delivering the less ignitable stream to a lower portion of the furnace outside said ignition section to rejoin the burning readily ignitable stream.

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