May 17, 1932. J. P. LEASK ET AL 1,858,674

METHOD OF AND APPARATUS FOR BURNING FINELY DIVIDED FUEL

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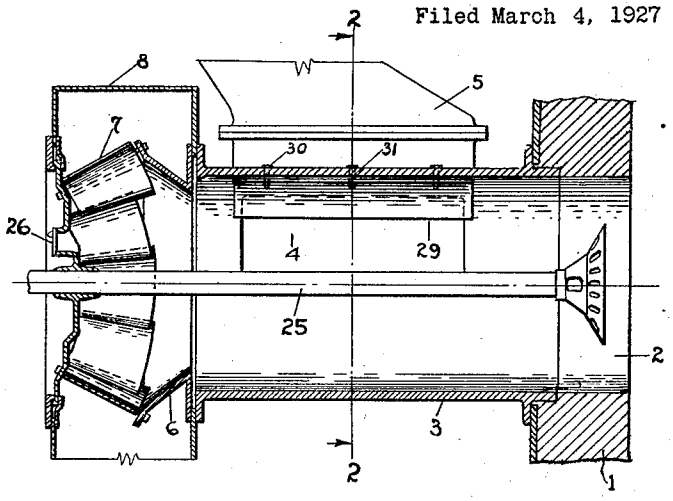


Fig. 1

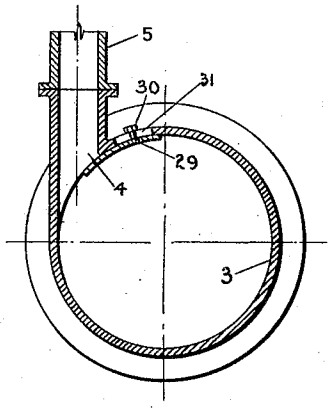


Fig. 2

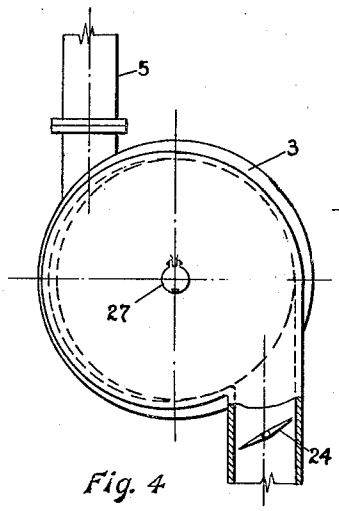


Fig. 4

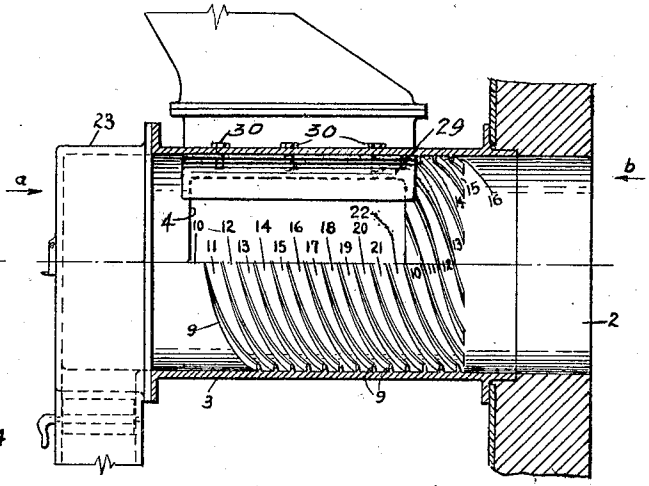


Fig. 3

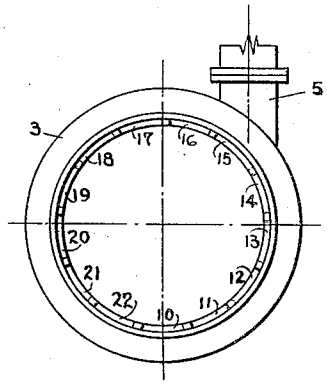


Fig. 5

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UNITED STATES PATENT OFFICE

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METHOD OF AND APPARATUS FOR BURNING FINELY DIVIDED FUEL

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Our invention relates to fuel burning apparatus and more particularly to a method and means for burning finely divided fuel. For the purpose of describing one application of our invention, we have selected the burning of pulverized coal. Various systems have been devised for the burning of pulverized coal, the general practice being to deliver this fuel to the furnace, supported in a column of air, by means of which it can be transmitted through pipes and conduits. The air so used is designated as the carrier air. While it is possible to supply sufficient carrier air for complete combustion of the fuel, the usual method is to use a more or less variable fraction of this amount and to supplement this by additional air, known in the art as secondary air.

Some means of creating turbulence of the gases in the furnace greatly promotes the complete combustion of the fuel and when means are provided for mixing the air for combustion intimately with the fuel at the point where it enters the furnace, the rapidity of combustion is further greatly increased. This results in shortening the flame and makes it possible to use furnaces of comparatively small volume. One method of imparting turbulence to the gases is to introduce the air for combustion with a gyrating or rotary motion. This rotary motion is in turn imparted to the gases in the furnace and has proved to be an effective means of creating the turbulent effect desired. In such systems it has also been proposed to deliver the finely divided coal to a rotating column of air from a point outside of the same.

If the entering column of carrier air and pulverized coal is also given a rotary motion, the turbulent effect is still further promoted. We have found that if open, unobstructed conduits are used, the resistance to the flow of the carrier air and pulverized coal is reduced and the power required for delivering this mixture to the furnace is lessened. The same thing applies to the method of delivering the secondary air to the furnace. High rates of combustion may, in this way, be secured with low draft pressures. This further implies that if the secondary air is delivered under pressure by means of fans, the power required to operate the fans is reduced.

The object of the present invention is to provide a burner for finely divided fuel, which may be used for high rates of combustion with comparatively low air pressures, both for the primary and secondary sources of supply, or for ordinary or reduced rates of combustion with less than the ordinary air pressure required.

In the accompanying drawings, Figure 1 is a central longitudinal section of one form of apparatus embodying our invention and by which the described method may be practised.

Figure 2 is a transverse section on the plane of the line 2—2 of Figure 1.

Figure 3 is a view similar to Figure 1 in which the burner tube is provided on its inner wall with a series of guide vanes.

Figure 4 is an end view, partly in section, looking in the direction of the arrow *a* on Figure 3, and

Figure 5 is an end view, looking in the direction of the arrow *b* on Figure 3.

Similar reference numerals indicate similar parts in the several views.

Referring to Figures 1 and 2, the numeral 1 indicates a portion of a furnace wall, an opening through which leads into the combustion chamber. Within the opening 2 in said wall is supported one end of an open-ended burner tube 3, which in the form shown is cylindrical, but may be of any other suitable form. The function of the burner tube is to receive and discharge the finely divided fuel through the opening 2 into the combustion chamber. No combustion takes place in the tube itself. In the side of the burner tube is an opening 4 through which the finely divided fuel is discharged from an intake duct 5 which duct may be integral with the burner tube, or made separate therefrom and secured thereto by any suitable means. As shown in the drawings the intake duct leads vertically downward. Any other direction may be used as desired. The area of the intake duct is dependent upon the amount of carrier air

and fuel to be delivered, and the velocity with which it is desired to deliver the mixture to the tube 3. In practice, the intake tube is so proportioned as to give as low a velocity as practicable to insure proper delivery of the fuel to the combustion chamber. In a commercial installation made by us the burner tube 3 was approximately 34″ in length and 23″ in diameter. The opening 4 was approximately 20″ in width, longitudinally of the tube, and 9″ in height measured circumferentially of the tube, the intake duct being 3½″ x 20″. This provides a relatively wide unobstructed opening for the fuel. These dimensions may vary over a wide range depending on conditions.

As shown in Figure 1 the bore of the burner tube 3 is a smooth surface, while in Figures 2 and 3 the surface is shown provided with guide vanes arranged spirally, for the purpose hereinafter described. At the end of the burner tube away from the furnace we may secure any well known form of air register for controlling the secondary air for combustion. Preferably this should be of the type whereby the entering air is given a rotary motion. The type shown in Figure 1 comprises a register 6 having adjustable doors 7, by which the desired rotary motion is imparted to the air in a manner well known in the art. The register may be supported in any desired manner in a wind-box 8, into which air for combustion may be forced under pressure. The particular means for admitting secondary air for combustion may be varied according to conditions, the types shown being merely for purposes of illustration. Other parts necessary for the proper crushing and feeding of the fuel will be used in commercial installations, such parts being well known and not requiring illustration in the drawings.

The operation of the apparatus illustrated in Figures 1 and 2 is as follows: The fuel, having been properly prepared for burning, is conducted by the carrier air through the intake duct 5 to opening 4 and discharged against the side of the burner tube in a stream line substantially tangential to the wall of the tube. Due to the velocity of the carrier air and the form of the inner surface of the burner tube, the fuel will be forced around said surface in a spiral path directed toward the open end of the tube connecting with the combustion chamber. The greater portion of the mass of fuel in its travel, due to centrifugal action, will hug the wall of the tube and remain in relatively close contact therewith. It will be obvious that the portion of the fuel entering through the intake duct farthest removed from the open end of the tube will travel a longer distance around the surface of the tube, and that the fuel entering the intake duct nearest the furnace will travel the shortest distance. The proportions of the tube, and the velocity of the entering fuel and carrier air, are so designed that the fuel entering at these points will approach closely together at the point where they enter the furnace. This will result in giving a substantially continuous and relatively thin stream of fuel entirely around the periphery of the end of the tube adjacent the opening of the furnace.

At times it may be desirable to vary the velocity of the carrier air and fuel. For such purpose we provide an adjustable plate 29, Figures 1, 2 and 3, which by means of the securing bolts 30 in slots 31 in the wall of the tube 3 permit varying the opening of the inlet 4.

The purpose of the guide vanes shown in Figures 3 and 5 is to further insure the above conditions being fulfilled. These vanes 9 may start from the lower edge of the intake duct as shown in Figure 3, or they may be extended up into the intake duct 4 or may be otherwise arranged as desired. They extend in the form of spirals around the inner surface of the tube, terminating in substantially the same transverse plane in proximity to the outlet end of the burner tube, as shown in Figure 3. The channels formed by the vanes and the surface of the cylinder are numbered from 10 to 22 both inclusive. They are, in the commercial installation above mentioned, approximately ¾″ in depth and 1″ in width. The number of channels may vary with the fuel used and other conditions. We have found thirteen to produce satisfactory results when burning pulverized coal in said commercial installation. The channel 10 connected with the side of the intake duct most remote from the furnace passes around the wall of the tube and terminates adjacent the channel 22 which connects with the side of the intake duct nearest the furnace. The intermediate channels filling the space between the end channels 10 and 22 terminate, as illustrated in Figures 3 and 5, in spaced relation to each other and discharge at the periphery in a series of adjacent outlets. The vanes thus serve to guide the fuel around the wall of the burner tube and effect a substantially even distribution of fuel around the periphery of the burner adjacent the furnace. While these guide vanes are not essential to the operation of the burner, they prevent any divergence of the fuel from the desired path, such as might be caused by too great a velocity of the secondary air, or other causes.

It will be noted that the first channel 10 has a wall on one side only until it reaches the vane forming channel 22. The portion of fuel entering channel 10 and flowing along same is held against the single wall by reason of the general movement of air toward the combustion chamber. It will be observed also that the fuel in channels 10 and 11 passes

over a small gap at the point where the intake duct enters tube 3.

In the drawings the channels 10 to 22 inclusive are shown with a constant pitch. This pitch may be either constant or variable as desired, it being necessary only to so arrange the guide vanes that substantially equal amounts of fuel are delivered around the periphery of the furnace end of the tube 3. It will be noted that the modification of the pitch of the vanes 9 and the control of the air register provides a means for increasing and decreasing the rotation of the finely divided fuel and the air in the tube 2, and that by this means the angle of the flame burst from the tube 2 may be controlled.

In Figures 3 and 4 we have shown over the end of the burner tube remote from the furnace a substantially cylindrical housing 23 instead of the wind-box and air register. Air under pressure, controlled by the damper 24, is forced into this housing through the inlet substantially tangentially to its inner wall, thus giving a rotary motion to the air as it passes into the tube 3. If desired a "snail shell" casing or one of involute form may be used. Peep holes 26 and 27 are provided for inspection and for the insertion of a torch for lighting.

The described burner may be used for burning finely divided solid fuel alone or, if desired, we may introduce a liquid fuel burner 25 of any well known type, as indicated in Figure 1 for use therewith.

By the term "finely divided fuel" we mean such fuels as pulverized coal, comminuted vegetable matter and the like.

We claim:

1. The method of burning finely divided fuel which consists in delivering such fuel with carrier air tangentially to the wall of a burner tube, causing the fuel to travel in a spiral path in a general direction transverse to the line of feed along the inner wall of said tube toward the end thereof, and discharging the fuel so carried into a combustion chamber.

2. The method of burning finely divided fuel which consists in delivering such fuel with carrier air tangentially to the wall of a burner tube, causing the fuel to travel in a spiral path in a general direction transverse to the line of feed toward one end of said tube, admitting at the other end of said tube a column of air for combustion within the spirally moving mass, and discharging the fuel and air into a combustion chamber.

3. The method of burning finely divided fuel which consists in delivering such fuel with carrier air tangentially to the wall of a burner tube, causing the fuel to travel in a spiral path in a general direction transverse to the line of feed toward one end of said tube, admitting at the other end of said tube a rotating column of air for combustion within the spirally moving mass, and discharging the fuel and air into a combustion chamber.

4. The method of burning finely divided fuel which consists in delivering such fuel with carrier air tangentially to the inner wall of a burner tube, causing the fuel to travel along said wall in a spiral path in a general direction transverse to the line of feed, and discharging the fuel into a combustion chamber in a substantially continuous and relatively thin stream around the periphery of the tube.

5. An apparatus for burning finely divided fuel comprising a tube, one end of which is open to a combustion chamber and a fuel intake duct arranged to discharge the fuel in a direction tangential to the inner wall of said tube to thereby impart to the fuel a movement around the wall of said tube in a spiral path toward the outlet end of the tube.

6. An apparatus for burning finely divided fuel comprising a tube, one end of which is open to a combustion chamber, a fuel intake duct arranged to discharge the fuel in a direction tangential to the inner wall of said tube to thereby impart to the fuel a movement around the wall of the tube in a spiral path toward the outlet end of the tube, and means for directing a column of air within the spirally moving mass.

7. An apparatus for burning finely divided fuel comprising a tube, one end of which opens into a combustion chamber, a fuel intake duct arranged to discharge the fuel in a direction tangential to the wall of said tube, and means secured to the inner wall of said tube to maintain the fuel in a spiral path and to guide it around the wall of the tube in its travel toward the outlet end thereof.

8. An apparatus for burning finely divided fuel comprising a tube, one end of which is open to a combustion chamber, a fuel intake duct arranged to discharge the fuel in a direction tangential to the inner wall of said tube, and spirally arranged vanes on the inner wall of the tube to form a series of channels extending from the intake opening toward the outlet of the tube, for the purpose described.

9. An apparatus for burning finely divided fuel comprising a tube, one end of which is open to a combustion chamber, a fuel intake duct arranged to discharge the fuel in a direction tangential to the inner wall of said tube, and spirally arranged vanes on the inner wall of the tube to form a series of channels extending from the intake toward the outlet of the tube, the outlet ends of said channels being in substantially the same transverse plane and spaced apart so as to discharge the fuel at the periphery of the tube in a relatively thin stream.

10. An apparatus for burning finely di-

vided fuel comprising a tube one end of which is open to a combustion chamber, a fuel intake duct arranged to discharge the fuel in a direction tangential to the inner wall of said tube to thereby impart to the fuel a movement around the wall of said tube in a spiral path toward the outlet end of the tube, and means for varying the area of the fuel intake.

11. An apparatus for burning finely divided fuel comprising a tube one end of which is open to a combustion chamber, a fuel intake duct arranged to discharge the fuel in a direction tangential to the inner wall of said tube to thereby impart to the fuel a movement around the wall of said tube in a spiral path toward the outlet end of the tube, a plate within the burner tube, and means for adjusting the same to vary the area of the fuel intake.

In testimony whereof, we have affixed our signatures to this specification.

JOHN P. LEASK.
HORACE T. DYER.