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APPARATUS FOR BURNING OF POWDERED FUEL

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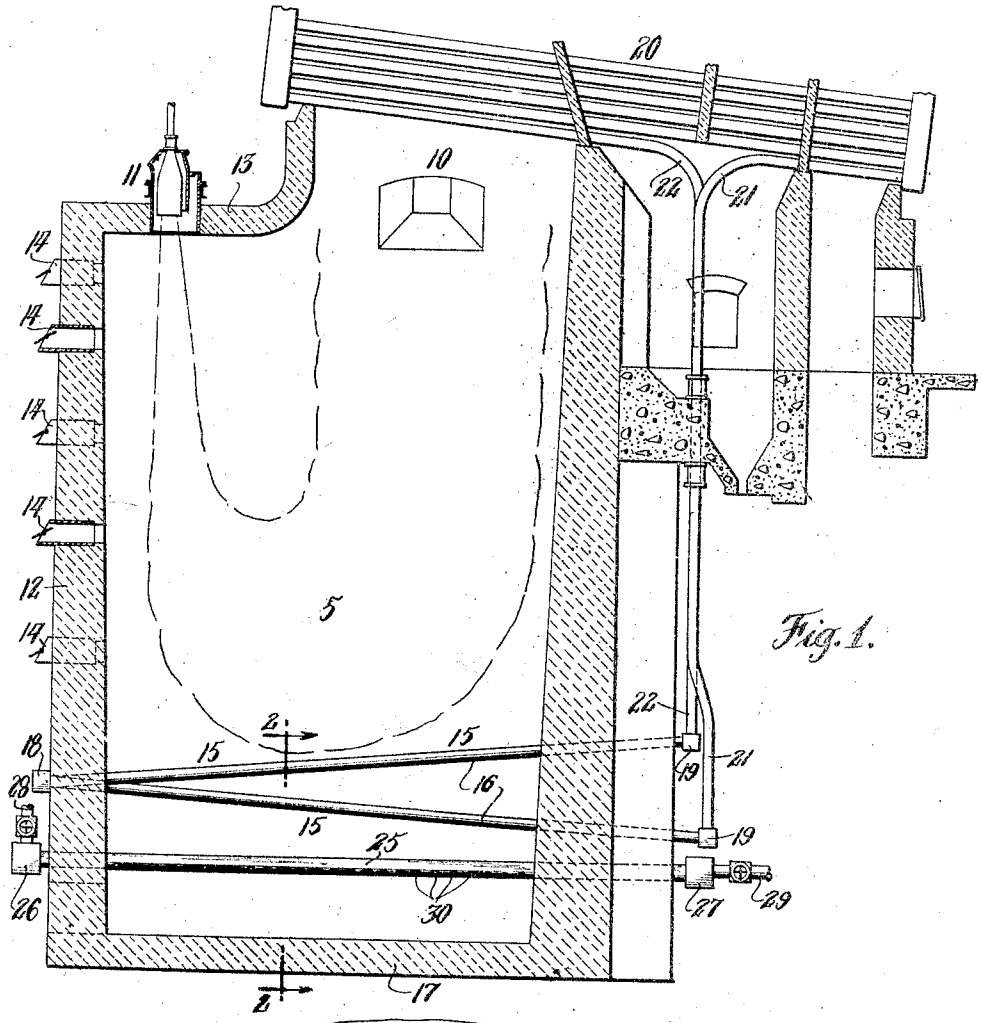


Fig. 1.

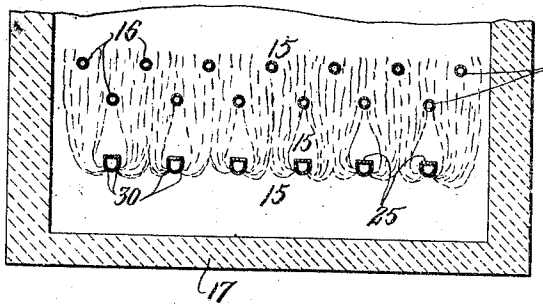


Fig. 2.

WITNESS

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APPARATUS FOR BURNING OF POWDERED FUEL.

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My invention relates to the burning of fuel in suspension, such as pulverized or powdered coal, and even oil, and to furnaces therefor. I aim to provide, in a novel way, against troublesome slag formation or deposits on the furnace bottom; to render means of obviating such deposits that have heretofore been employed more effective and to protect such means from injury by overheating; and, also, to improve the conditions of combustion and increase the fuel-burning capacity. I have discovered that material improvement in these respects can be achieved by suitable introduction or injection of a cooling medium in the lower region of a furnace of the character above indicated.

For the sake of greater clearness, I have hereinafter explained my invention in connection with an illustrative form of powdered fuel furnace provided with threefold means for obviating slagging difficulties such as above indicated, including one embodiment of my present invention. It will be understood, however, that the invention itself is not limited to this particular application and embodiment, but can be carried out and applied in various other ways.

In the drawing, Fig. 1 shows a vertical section through a steam boiler furnace such as just indicated.

Fig. 2 shows a fragmentary cross section through the furnace combustion chamber, taken as indicated by the line 2—2 in Fig. 1.

As shown in Fig. 1, the furnace combustion chamber 5 is a large, deep, unobstructed chamber inclosed by upright walls that slope outward slightly, so that the chamber as a whole expands upward. It has an outlet 10 for products of combustion from its upper region, at the rear. For reasons that will hereinafter appear, the chamber 5 may preferably be somewhat deeper, proportionately, than in present practice, so as to realize fully the possible advantages of my invention and to assure complete combustion therein. One or more powdered fuel burners 11 are directed downward into the combustion space or chamber 5 near its front wall 12, through the roof 13. As shown, such a burner 11 comprises an inner fuel pipe or nozzle with circumjacent damper-controlled air intakes. Powdered fuel with somewhat more than carrying air (say 30% or 40% of the total air required for proper combustion, more or less) is fed in or admitted through the burner 11, and is continually ignited by the heat of the front wall 12 and of the furnace generally. Air additional to that entering at the burner 11 is (or may be) supplied through damper-controlled inlet openings 14 at various heights in the front wall 12, to support combustion and prolong the burning of the fuel stream to a greater distance from the point of ignition. This results in a relatively long, soft flame which is not so hot as a short, white flame, and has less tendency to produce rapid wastage of the refractory furnace wall lining, or deposition of refuse from the fuel thereon in troublesome forms.

The air thus admitted at the intakes 14 may even be sufficient to form and maintain a cooling zone in the lower region 15 of the chamber 5.

In the present instance, there is also a "water screen" consisting of a series or bank of water tubes 16, extending "fore and aft" across the chamber 5 at a suitable height above the furnace floor 17, and sloping oppositely in alternation. As shown, the front ends of the oppositely sloping tubes 16 are interconnected by a common header 18, and their rear ends are connected into separate headers 19, 19. These headers 19, 19 are connected into the general circulation of the boiler 20 by means of piping or tubing 21, 22, so that the water makes a forward pass through the lower screen tubes 16 and returns rearward thru the upper ones. (Here and elsewhere, I have used the terms "front" and "rear" in reference to the regions where the furnace is fired and whence the products of combustion make their exit from the main combustion chamber 5, respectively.) The water screen 16 is adapted (in conjunction with air admitted at the intakes 14 and as hereinafter described, or even by itself) to maintain a cooling zone in the lower region 15 of the chamber 5.

As thus far described, the furnace illustrated is already known in the art. Its operation is, briefly, as follows:

The burning stream from the burner 11 (comprising mingled air, powdered fuel, combustible gases from the fuel, and products of combustion) descends in the front of the chamber 5 until its momentum is overcome by the upward draft through the boiler

20. It then bends upward and ascends through the rear of the chamber 5, and the products of combustion finally pass upward through the outlet 10 to the boiler heating surfaces. (The course of the flames is about as indicated by the dash lines.) The size and depth of the chamber 5, the contiguity of the downward and upward air and fuel streams, their change of direction as described, and the other conditions in the chamber assure rapid and complete combustion of "stream-line" character therein. High temperatures are developed, and large amounts of fuel can be burned rapidly and efficiently.

The relatively heavy incombustible residue from the fuel falling toward the floor 17 in a finely divided, molten state encounters and passes through the cooling zone in the lower region 15 of the chamber 5. In this cooling zone 15 (however it be maintained), the falling refuse particles are effectually cooled below fusion or slag-forming temperature, so that they do not run together or coalesce into a solid mass on the floor 17, but simply collect as dust that can easily be sucked out (or otherwise removed) at clean-out doors 23. When utilized, the water-screen 16 tends to absorb radiant heat from the subjacent deposit on the floor 17, and prevents refusion thereof by such heat from the region of combustion above the screen and the cooling zone 15.

In applying my present invention to such a furnace, I make provision for introducing a cooling agent or fluid into its lower region 15, where the cooling zone is ordinarily maintained as described above. As one means of doing this, I have shown a screen-like series of perforated pipes or ducts 25 extending across the lower region 15 of the chamber 5, in the present instance below and approximately paralleling the waterscreen tubes 16 with which this particular furnace is provided. The ends of the ducts 25 are connected into front and rear headers 26, 27 that have valve-controlled supply connections 28, 29 for cooling fluid. Preferably, the discharge holes 30 are in the rounded bottoms of the ducts 25, about at a 45° position, so as to be protected against clogging up by the falling refuse particles, and to direct the fluid diagonally downward toward the floor 17. The ducts 25 may be of cast-iron, if preferred, and may be cast with flat upper surfaces that will accumulate a protective covering of deposit, or support a refractory cover of firebrick or the like. Through the ducts 25 or other suitable means, the cooling fluid can be continually introduced in the form of a substantially (or more or less nearly) horizontal blanket, at any rate of input desired.

Such introduction of cooling fluid performs several functions. In the first place, it is a means of maintaining the cooling zone at 15 to prevent slagging on the furnace floor 17, and of supplementing other means such as described above in maintaining the desired low temperature of this zone. It is very effectual for preventing encroachment of the superjacent flame stream on the desired cooling zone, and as a means of regulating and varying the "flame level" in the chamber 5,—especially when a cooling fluid that does not support combustion is employed, as hereinafter explained. In this waterscreen-equipped furnace, in the second place, it is also a means of protecting the screen tubes against "blistering", by tempering the heat when the furnace is being "forced" in order to carry a heavy overload. (Such blistering is due to the fact that under extreme heat the tubes are partly filled with steam and thereby thermo-insulated from the cooling action of the water in them.) It may also tend to keep the flames from coming in contact with the tubes of the water screen when the furnace is operating at very high ratings. In the third place, when the cooling fluid introduced is of suitable character, it is a means of supporting the combustion of the fuel and may take the place of at least some of the inlets 14.

From every point of view, this continual and definite supply of cooling fluid at the critical lower region 15 is of advantage in obviating the tendency that would otherwise exist for this region to become a mere "dead" pocket of hot air and gas. Its introduction low down, underneath the water screen 16 here employed, tends to make it the more effective in every way,—besides insuring its contact with the screen as it rises therethrough.

The character of the cooling fluid to be preferred naturally depends on the effect particularly desired. If the cooling medium is to play an important part in combustion of the fuel as well as have the other features of advantage, then a cool supporter of combustion will be used, such as cold air from out of doors blown through the pipe 29. If maintenance of the cooling zone, prevention of flame encroachment, and protection of the waterscreen, are the real need, and it is not desired to affect the combustion to any great extent, then an inert medium may be preferred, such as water, steam of low pressure and temperature supplied from any suitable source through the pipe 28, or flue gases similarly supplied,—i. e., products of combustion that have been sufficiently cooled for my purpose by contact with boiler tubes, or with other heat-absorbing agencies. Such gases may be taken from the stack or chimney of a power plant, from uptakes or flues leading to the stack, or even from some point within a boiler itself where the gases have become

sufficiently cool. Under some conditions, where intermediate or combined effects are wanted, air and an inert medium may be supplied together through one of the pipes 28 or 29: e. g., in such proportions that the initial mixture itself will not support combustion, and that its air will become effective for that purpose only after mingling with the superjacent flame stream, where the inert medium will become too small a proportion of the whole to inhibit combustion any longer.

The quantity of cooling fluid to be introduced at 15 will depend both on its character and on the other conditions. If it be wholly inert, the desired flame level and the amount of anti-slagging and protective cooling required will govern. As to air (with or without a mingled inert medium), the amount will largely depend on the extent to which it may be admitted at the burner 11 or at the front intakes 14,—since any excess over what is necessary to secure proper combustion reduces efficiency. Moreover, the admission of fluid at 15 tends to raise the flame level, and in the case of air, to lengthen the flame; so that even though the combustion chamber 5 be extra deep (as mentioned above) to allow for such effects to a reasonable extent, admission at 15 of an excessive proportion of the total air is liable to bring the flame stream amongst the boiler tubes before combustion is complete, thus lowering efficiency and producing trouble-some deposits of refuse on the tubes.

It will thus be seen that the air (or other cooling medium) may be employed primarily for the protection of a water screen, or as an adjunct cooperating with the screen to create a cooling zone, or as a means for creating the zone.

I claim:

1. The combination of a pulverized fuel combustion chamber with a waterscreen in its lower region for maintenance of a cooling zone for falling refuse from fuel burned thereabove, so as to prevent slagging of such refuse; and means for discharging a fluid blanket in said lower region, to aid in maintaining the cooling zone.

2. The combination of a pulverized fuel combustion chamber with a waterscreen in its lower region for maintenance of a cooling zone for falling refuse from fuel burned thereabove so as to prevent slagging of such refuse; and means for discharging a horizontal air blanket underneath said screen.

3. The combination of a pulverized fuel combustion chamber with a waterscreen in its lower region for maintenance of a cooling zone for falling refuse from fuel burned thereabove, so as to prevent slagging of such refuse; and ducts under said screen for discharging cooling fluid therebeneath, to aid in maintaining the cooling zone and to rise to and protect the screen.

4. The combination of a pulverized fuel combustion chamber with a screen of water-tubes across its lower region for maintaining therein a cooling zone for falling refuse from fuel burned thereabove, and a series of ducts substantially below the screen tubes, for discharging cooling fluid in said zone.

5. The combination of a pulverized fuel combustion chamber with a screen of water-tubes across its lower region for maintaining therein a cooling zone for falling refuse from fuel burned thereabove, and a series of air ducts below and substantially paralleling the screen tubes, and discharging cooling fluid downward toward the bottom of the furnace.

6. A furnace of the character described comprising a combustion chamber with outlet for products of combustion from its upper region, means for admitting a downward stream of fuel and air for combustion at one side of the chamber, to descend burning therein until its momentum is overcome by the draft and then rise to said outlet, and a water screen in its lower region to maintain a cooling zone for falling refuse from fuel burned thereabove, so as to prevent slagging of such refuse; and means for discharging cooling fluid in said lower region, to aid in maintaining the low temperature of the cooling zone and protect the screen from the superjacent flame stream.

7. A furnace of the character described comprising a combustion chamber with outlet for products of combustion from its upper region, means for admitting a downward stream of fuel and air for combustion at one side of the chamber, to descend burning therein until its momentum is overcome by the draft and then rise to said outlet, and a water screen in its lower region to maintain a cooling zone for falling refuse from fuel burned thereabove, so as to prevent slagging of such refuse; and means for discharging a horizontal blanket of cool air underneath said screen.

In testimony whereof, I have hereunto signed my name.

CARL SCHWARTZ.