H. R. BARNHURST.

APPARATUS FOR BURNING POWDERED FUEL.

APPLICATION FILED JAN. 21, 1910.

961,671. Patented June 14, 1910.

Fig. 1.

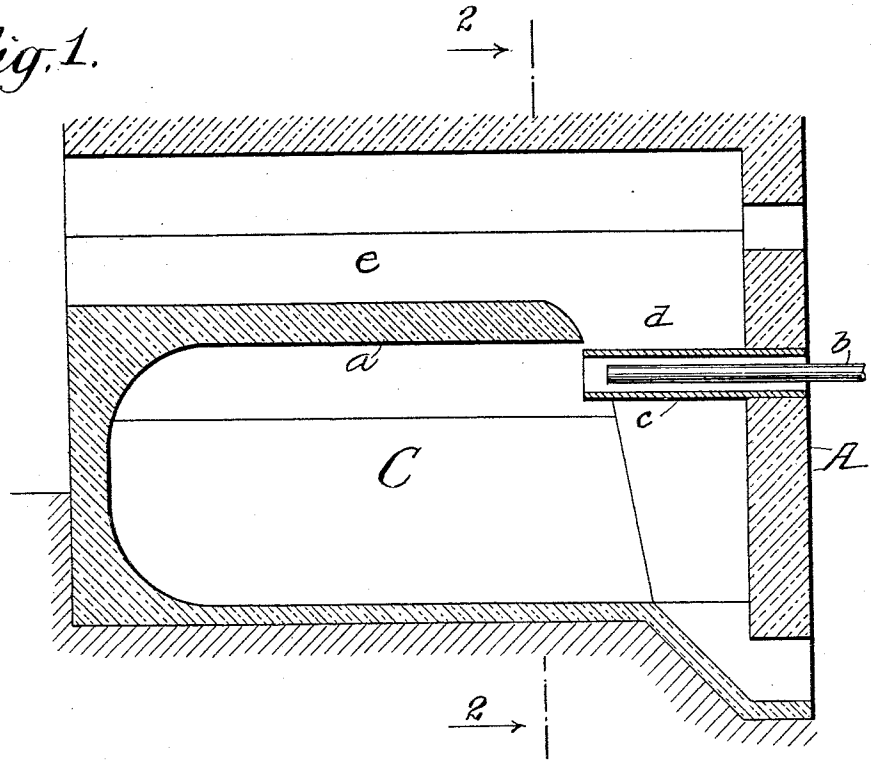
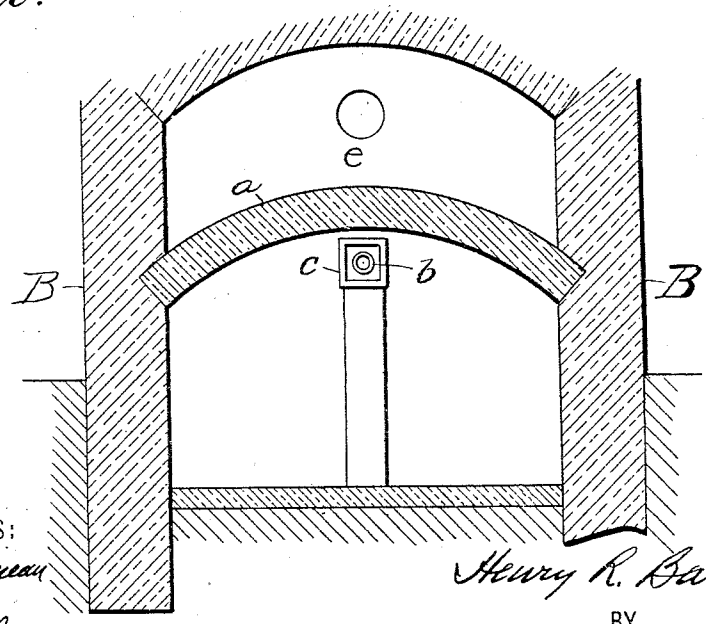


Fig. 2.



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APPARATUS FOR BURNING POWDERED FUEL.

961,671. Specification of Letters Patent. **Patented June 14, 1910.**

Application filed January 21, 1910. Serial No. 539,401.

To all whom it may concern:

Be it known that I, HENRY R. BARNHURST, a citizen of the United States, residing at Allentown, county of Lehigh, State of Pennsylvania, have invented certain new and useful Improvements in Apparatus for Burning Powdered Fuel; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

In an application for Letters Patent of the United States, filed of even date herewith, I have described a method of effecting the combustion, for industrial purposes, of fuel of such a character that ordinary expedients for burning it are attended with but indifferent results. One of the materials for whose combustion the method referred to is particularly intended is anthracite culm, reduced, by mechanical means, to a fine powder. This fine powder, ground for example to such a degree of subdivision that 85 per cent. of it will pass through a screen of No. 200 mesh, is not self-ignitible when mixed, in the ordinary way, with a carrying body of air and projected into a combustion chamber in the usual manner familiar to the art of burning pulverized fuel. In this respect, the finely divided anthracite culm is similar to many other difficultly ignitible fuels and waste materials, such as low grade bituminous dusts of difficult ignitibility, containing high percentages of ash, tank mud from coal washeries, coke breeze and charcoal breeze, wherein the amount of volatile hydrocarbon present is not sufficient of itself to sustain free ignition when reduced to a like fine powder.

By the practice of the method set forth in my companion application I am enabled to effect the combustion of these difficultly ignitible fuels, by establishing and maintaining appropriate conditions in the combustion chamber. To this end I first bring the combustion chamber to such a heat, by the combustion therein of fuel appropriate to the purpose, that upon the subsequent admission of the body of air and anthracite culm or its equivalent, ignition thereof will take place, and I continuously maintain this ignition and the effective combustion of the otherwise non-ignitible mixture by conducting the incoming current in close proximity to a highly heated inner surface of the combustion chamber (as, for instance, the arch thereof) and maintain this inner surface at the ignition point as against the cooling effect of the incoming mixture by the expedient of conveying the products of combustion after they leave the combustion chamber into a flue extending along the reverse side of the ignition wall or arch, which is made sufficiently thin to readily transmit from the passing products of combustion an amount of heat sufficient for the purpose. The heat thus transmitted to the incoming current of air and difficultly ignitible fuel is supplemented by heat radiated directly thereto from a return current of the products of combustion within the combustion chamber itself, this return current forming with the incoming current a return bend or loop and preferably making its exit at or near the point at which the injecting devices for the fuel enter the combustion chamber. This particular location of the injector devices also permits them to be exposed to the heat of the outgoing products of combustion and likewise causes a minor portion of the products of combustion to be entrained with the entering mixture thereby adding their sensible heat thereto.

The present application relates to apparatus for carrying the method into effect, the accompanying drawing illustrating the form which I prefer and have found to operate well in practice.

In the drawing, Figure 1 represents a longitudinal sectional view of my said preferred form of apparatus; Fig. 2 represents a cross sectional view thereof taken on a plane indicated by the line 2—2 of Fig. 1.

Similar letters of reference indicate similar parts in both views.

Referring to the drawing, A indicates the front outer wall of the furnace structure, B the outer side walls thereof, and C the combustion chamber. One of the walls of the combustion chamber (preferably the arch *a* thereof) is made quite thin, say nine inches in thickness or thereabout, and of refractory material conducive to heat, (the more conducive, the better) and is intended to serve as the "ignition" wall or arch hereinbefore referred to. Accordingly, the pipe *b* through which the mixture of air and pulverized culm or other difficultly-ignitible fuel is projected, and the surrounding conduit or twyer *c* through which an addi-

tional amount of atmospheric air is drawn in, are located just out of line with the inner surface of the wall or arch *a*, so as to direct the incoming fuel cloud along and in close proximity thereto.

At its furthermost or rear end, the combustion chamber C is curved, as shown, and its walls are preferably made smooth throughout so as to minimize the production of interfering eddy currents. The exit port *d* for the products of combustion is located in proximity to the entrance conduit for the fuel cloud, and the said exit port leads into a wide and large flue *e* on the reverse or upper side of the wall or arch *a*. In this flue of large dimensions, the products of combustion are slowed down to a velocity of say 20 to 22 feet per second, and have the opportunity to impart a sufficient portion of their heat to the wall or arch *a* and therethrough to the entering fuel cloud to raise the temperature of the latter and thus to assist in continuously maintaining it at the full ignition point.

Before injecting into the combustion chamber the mixture of air and pulverized culm or the like, I heat the combustion chamber to such a degree and in such manner as will bring it to the temperature necessary to initiate the ignition and combustion of the otherwise non-ignitible mixture. While this preliminary heating of the combustion chamber may be effected in various ways, such as by building therein a wood fire, I find that it may be quickly and conveniently brought to a high temperature by introducing through the pipe *b*, after the wood fire has been burning for a time, the usual mixture of air and finely pulverized ordinary bituminous coal, which then readily ignites because of the large proportion of rich hydrocarbons present in that fuel.

As soon as the combustion chamber has been sufficiently heated, and particularly as soon as the inner surface of the wall or arch *a* has been raised to the temperature necessary for insuring and maintaining ignition of the mixture of air and difficultly-ignitible fuel, the supply of pulverized bituminous coal is cut off and the pulverized difficultly-ignitible fuel is substituted therefor. The regular operation then proceeds continuously. The mixture of air and pulverized difficultly-ignitible fuel projected into the combustion chamber through the pipe *b* draws in an additional supply of air through the conduit *c* and is at once ignited by the heat radiated upon it from the ignition wall or arch *a*. The ignited fuel cloud traveling rapidly along the wall or arch *a* constitutes the entrance branch of the loop. The ignition progresses from the periphery toward the center of the fuel cloud, and increasing in volume as it advances, it is finally deflected by the curved or filleted rear wall of the combustion chamber and merges into the return branch of the loop, which takes its way toward the exit port *d*, in the form of a flame cloud burning fiercely by the time it reaches the front part of the combustion chamber. The heat of the flame cloud constituting the return bend of the loop is thus radiated, as the operation proceeds, upon the entering branch of the loop consisting of the continuously supplied and ignited fuel cloud. A portion of the products of combustion from the flame cloud is drawn into the entering fuel cloud at the point where the latter issues from the injector into the combustion chamber, thereby imparting to the fuel cloud the sensible heat of the portion of the products of combustion thus entrained. Coincident with the intense inflaming of the return bend or current of the loop, the accompanying air and products of combustion have experienced an enormous expansion, so that the flame cloud rises through the uptake in strong volume and with a velocity which is greatest at the middle of the arch *a*. Accordingly, I have selected this point as the preferable point of location for the fuel injector, although it will be understood that I do not limit myself to such location, as in some instances, especially, for large furnaces, it may be found desirable to use more than one fuel injector. Finally, the main body portion of the products of combustion, issuing and passing along the wide and spacious flue *e* on the reverse side of the highly conducting thin wall or arch *a* keeps said wall or arch continuously at the high temperature necessary for the maintenance of ignition of the entering cloud of air and pulverized difficultly-ignitible fuel. After subserving the functions described, the products of combustion pass on to place of use for which they are intended, as, for instance, a steam boiler, a kiln, the laboratory of a metallurgical or heating furnace, or the like.

While I have described in particular the specific application of my apparatus to the combustion of the waste material known as anthracite culm, yet it will be quite evident that the apparatus described is equally applicable to other fuels of difficult ignitibility, which are usually, for this very reason, regarded as waste fuels, and exist at present, in enormous quantities. Such materials form at the present time a large item in the waste of our natural resources, and their efficient utilization is of great economic and national importance. Among such materials I would enumerate coke breeze, charcoal breeze, tank mud from coal washeries, and low grade bituminous dusts of difficult ignitibility, containing high percentages of ash. Furthermore, it is quite within the range of practicability to pulverize the

smaller sizes of anthracite coal and burn them as dust by my invention.

Having thus described my invention, what I claim is:—

1. Apparatus for burning powdered fuel, consisting of a combustion chamber having an exit flue for the passage of the products of combustion on leaving the combustion chamber, and having a wall common to the combustion chamber and said exit flue, said wall being sufficiently thin to transmit therethrough to the point of discharge of the fuel, along the inner surface of the wall, the amount of heat necessary to maintain ignition thereat, and means for projecting into the combustion chamber and along the inner surface of said wall a body of air mixed with fuel; substantially as described.

2. Apparatus for burning powdered fuel, consisting of a combustion chamber having an exit flue for the passage of the products of combustion on leaving the combustion chamber, and having a wall common to the combustion chamber and said exit flue, said wall being sufficiently thin to transmit therethrough to the point of discharge of the fuel, along the inner surface of the wall, the amount of heat necessary to maintain ignition thereat, and an injector for projecting into the combustion chamber along the inner surface of said wall, a body of air mixed with fuel powder, said injector being located in proximity to the port leading from the combustion chamber into the exit flue for the products of combustion, whereby the mixture of air and fuel and products of combustion thereof will traverse the combustion chamber in the form of a loop; substantially as described.

3. Apparatus for burning powdered fuel, consisting of a combustion chamber having an exit flue for the passage of the products of combustion on leaving the combustion chamber, and having a wall common to the combustion chamber and said exit flue, said wall being sufficiently thin to transmit therethrough to the point of discharge of the fuel, along the inner surface of the wall, the amount of heat necessary to maintain ignition thereat, and an injector for injecting into the combustion chamber along the inner surface of said wall a body of air mixed with fuel powder, said injector being located in proximity to the port leading from the combustion chamber into the exit flue for the products of combustion, and extending across said port so as to lie in the path of the outgoing products of combustion, whereby the mixture of air and fuel, and products of combustion thereof, will traverse the combustion chamber in the form of a loop, and whereby the incoming body of air and fuel will be preheated by heat from the products of combustion and a portion of the products of combustion will be entrained with the said entering mixture; substantially as described.

4. Apparatus for burning powdered fuel, comprising a combustion chamber provided at its top with a thin arch constituting one of the walls of said chamber, a second arch above the first and forming therewith a wide and spacious flue into which the products of combustion enter from the combustion chamber, and an injector for injecting into the combustion chamber along the inner surface of the thin arch from front to rear thereof a body of air mixed with powdered fuel, said injector being located in proximity to the port leading from the combustion chamber into said exit flue for the products of combustion; substantially as described.

5. Apparatus for burning powdered fuel, comprising a combustion chamber provided at its top with a thin arch constituting one of the walls of said chamber, a second arch above the first and forming therewith a wide and spacious flue into which the products of combustion enter from the combustion chamber, and an injector for injecting into the combustion chamber along the inner surface of the thin arch from front to rear thereof a body of air mixed with powdered fuel, said injector being located in proximity to the port leading from the combustion chamber into said exit flue for the products of combustion, and extending across said port so as to lie in the path of the outgoing products of combustion; substantially as described.

In testimony whereof I affix my signature, in presence of two witnesses.

HENRY R. BARNHURST.

Witnesses:
SHIRLEY H. KING,
RAYMOND W. LENTZ.