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1,542,834

T. A. PEEBLES ET AL.

METHOD OF BURNING PULVERIZED FUEL AND BURNER FOR PULVERIZED FUEL

Filed Feb. 2, 1922

2 Sheets-Sheet 1

FIG. 1.

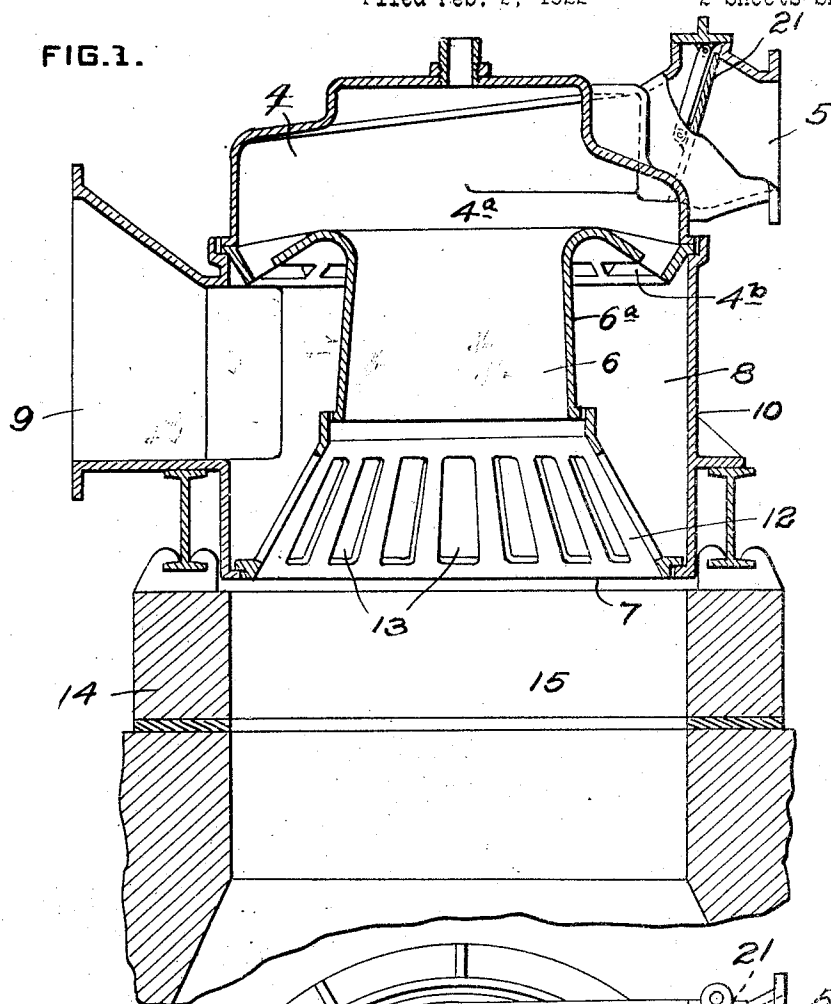
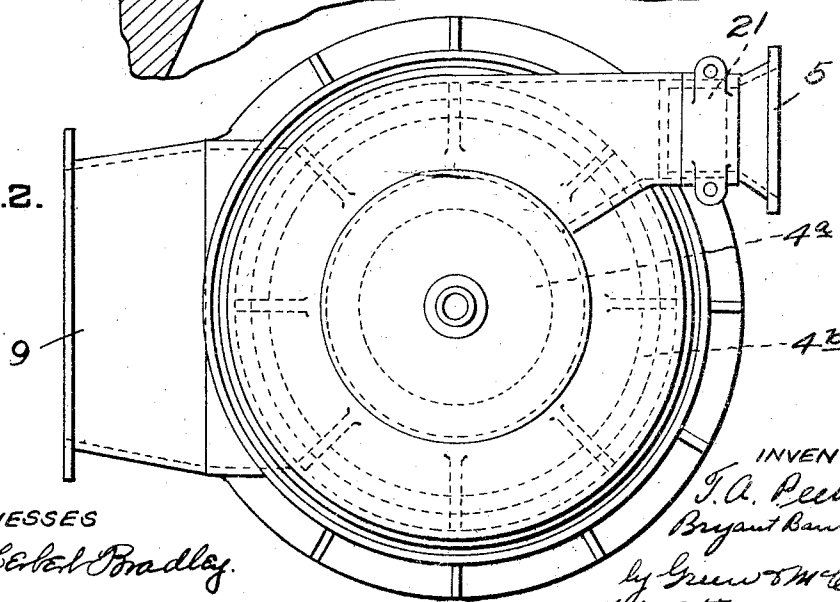


FIG. 2.



WITNESSES

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their Attorneys in fact

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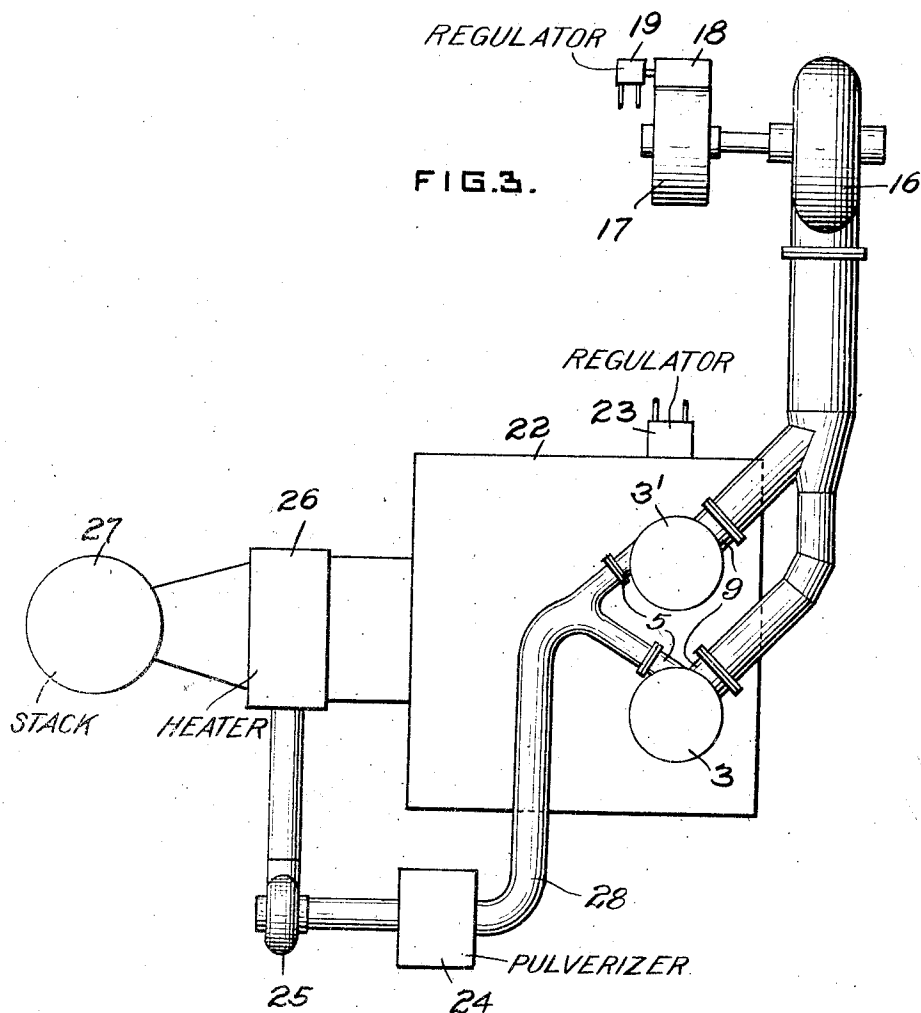
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WITNESSES

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UNITED STATES PATENT OFFICE.

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METHOD OF BURNING PULVERIZED FUEL AND BURNER FOR PULVERIZED FUEL.

Application filed February 2, 1922. Serial No. 533,563.

To all whom it may concern:

Be it known that we, THOMAS A. PEEBLES and BRYANT BANNISTER, citizens of the United States, and residents of Pittsburgh, in the county of Allegheny and State of Pennsylvania, have made a new and useful Improvement in Methods of Burning Pulverized Fuel and Burners for Pulverized Fuel, of which the following is a specification.

This invention relates to a method of burning fuel and to burners for pulverized fuel.

An object of the invention is to produce a burner in which all of the air for promoting combustion is delivered to the furnace or combustion chamber with the pulverized fuel.

A further object is to produce a burner for pulverized fuel in which means are employed for insuring complete combustion of the fuel by separating the heavier particles of the fuel from the lighter particles and so delivering the heavier particles that an adequate air supply is insured for their rapid and complete combustion.

A further object is to produce a burner for pulverized fuel in which means are employed for delivering the lighter particles of the fuel through the central portion of the discharge orifice of the burner and for delivering the heavier or coarser particles, together with a volume of air sufficient to promote rapid and complete combustion, through the outer or peripheral portion of the orifice and in the form of an annulus substantially surrounding but tending to intermingle with the central core of finer or lighter fuel particles.

A further object is to produce a burner for pulverized fuel in which the major portion of the air for combustion is delivered through the burner with the coarser or heavier particles of the fuel.

A further object is to produce a burner for pulverized fuel through which the fuel-impelling air, as well as the secondary air for completing combustion, is delivered and in which means are employed for preventing the secondary air from backing up into the fuel delivery passage to the burner.

A further object is to produce an improved method of burning pulverized fuel in which the heavier or coarser particles of fuel are separated from the lighter or finer particles and are delivered to the combustion

chamber under conditions which will promote their rapid and complete combustion.

These and other objects which will be made more apparent throughout the further description of the invention are attained by means of apparatus embodying the features herein described and illustrated in the drawings accompanying and forming a part hereof.

In the drawings, Figure 1 is a vertical sectional view of a burner embodying my invention, which is shown in connection with a fragmental sectional view of the walls of a furnace with which it is associated.

Figure 2 is a top plan view of the burner shown in Fig. 1.

Figure 3 is a diagrammatic plan view illustrating a combination of associated apparatus, also forming a part of our invention.

In burning pulverized fuel, it is desirable to burn the fuel as it moves through the combustion chamber of the furnace. While the pulverizing operation reduces the fuel to a fine powder, the mass of fuel delivered to the furnace is not absolutely homogeneous with relation to size of particles, some portions being coarser or heavier than other portions. It will, therefore, be apparent that, in order to produce uniform combustion of the heavier and lighter particles and complete combustion of the heavier particles, the heavier particles must be somewhat favored from the standpoint of air supply. In order to accomplish rapid and complete combustion of all of the fuel delivered by the burner, we so construct the burner that the heavier particles are separated from the lighter particles and are delivered with the main air supply in such a way that, as they enter and move through the combustion chamber of the furnace, they are surrounded by an adequate quantity of air to promote complete and rapid combustion. In order to accomplish this, we provide the burner with means for separating the heavier or coarser particles from the lighter or finer particles of fuel, and for delivering the heavier particles to the furnace with the air constituting the main air supply to the furnace.

In pulverizing fuel, the power necessary and consequently the cost of pulverizing increases directly with the fineness to which the fuel is pulverized. On the other hand,

any pulverizing process which reduces the bulk of the fuel to a relatively coarse powder, reduces a certain percentage of the fuel to an extremely fine dust or powder which is fine enough for rapid and complete combustion under ordinary conditions encountered in furnaces for burning pulverized fuel. By employing the method herein set forth as a part of our invention, we can effectively and efficiently burn pulverized fuel in which a relatively large percentage of the fuel delivered to the furnace is coarser than has heretofore been effectively burned in a pulverized fuel furnace, because we are able to advantageously and effectively utilize the extremely fine fuel particles in maintaining a zone of intense combustion and at the same time deliver the coarser particles in such a way that they are subjected to the sensible heat of this combustion while surrounded by an air supply adequate for their rapid and complete combustion. It will, therefore, be apparent that one of the results of our invention is to cheapen the process of burning fuel, since with it it is possible to effectively and efficiently burn coarser fuel than has heretofore been utilized in furnaces for pulverized fuel.

Referring to the drawings: As illustrated in Figs. 1 and 2, the burner includes a substantially circular separating chamber 4 to which the pulverized fuel is delivered substantially tangentially through a port or passage 5. It will be understood that the fuel so delivered is conveyed into the chamber 4 by a current of air as is usual. The chamber 4 is provided with a central port 4^a which is formed in the bottom thereof and communicates with a passage 6 extending downwardly toward the discharge orifice 7 of the burner. The chamber 4 is also provided in its bottom wall and adjacent to its outer peripheral wall with an annular series of ports 4^b which communicate with a passage 8 of the burner that surrounds the passage 6. An air delivery port 9 communicates with the passage 8 and is preferably of such size that it will deliver sufficient air to insure complete combustion of all the fuel delivered by the burner. As shown, the passage 6 is surrounded by a cylindrical wall 6^a which is so flanged at its upper end as to form the bottom and a portion of the peripheral wall of the separating chamber 4. The passage 8 is located between this wall and the outer wall 10 of the burner. In the drawings, the passage 6 is shown terminating at its lower end in a flaring or cone-shaped passage which is surrounded by a cone-shaped member 12 supported on a flange of the wall 10 and forming in effect a continuation of the wall 6^a. This member is provided with an annular series of ports 13 which establish communication between the passage 8 and the passage 6 and

are located immediately adjacent to the discharge orifice 7 of the burner.

A whirling motion is occasioned by the tangential delivery of the fuel and propelling air to the separating chamber 4 and this occasions a centrifugal separation of the heavier from the lighter particles of the fuel, the lighter particles moving downwardly through the central passage 6 with the major portion of the impelling air. The heavier particles of fuel are thrown outwardly against the outer wall of the chamber 4 by the centrifugal action and are delivered to the passage 8 through the ports 4^b. These ports are preferably so located that the fuel passing through them falls free in its passage through the annular chamber 8 so that the incoming air, admitted through the port 9, is capable of thoroughly mixing with it and carrying it through the ports 13.

The burner is preferably so constructed and so operated that substantially seventy-five per cent of the air necessary for complete combustion of the fuel delivered by the burner is delivered through this annular passage 8. All the remaining air is delivered with the fuel through the separating chamber. It will be apparent that the ports 13 are so positioned with relation to the passages 6 and 8 that the air from the passage 8, carrying the heavier or coarser particles of fuel, envelops but also mixes with the current of air issuing from the central portion of the separating chamber and carrying the lighter or finer particles of fuel. The inclination of the ports 13 tends to direct the air passing them inwardly toward the center of the discharge orifice, and the location of these ports around the entire circumference aids in obtaining a thorough mixing and in insuring complete combustion. This arrangement of the ports 13, and the delivery through them of the main air supply insures rapid and complete combustion of heavier particles; first, because the air is delivered most effectively to the combustion zone, and second, because the heavier particles are distributed throughout the outer portion of the jet of incoming air and consequently their combustion is not delayed nor hampered by the masking action of the products of combustion from the more readily combustible finer particles.

In Figure 1, we have shown the burner associated with a wall 14 of the furnace. The wall 14 is preferably so formed as to provide a relatively short downwardly extending passage 15 which, in effect, forms a continuation of the flared portion of the burner passage 6. One of the features of our invention is that the secondary air supply delivered through the passage 8 is controllable. This is best accomplished by employing mechanical means such as a motor driven fan or blower 16 for delivering the

air through the port 9. With such an arrangement of apparatus, the air supply may be readily controlled in accordance with the requirements. In Fig. 3, we have shown the blower 16 direct connected to a turbine 17 and we have also diagrammatically illustrated the turbine valve 18 associated with an automatic-control device 19 which may be, in turn, controlled by apparatus responsive to variations in steam pressure or steam flow or both.

The air delivered through the port 9 preferably enters the mixing passage of the burner at a higher velocity than the air delivered with the fuel through the separating chamber. This, together with the arrangement of the ports 13 around the entire circumference of the burner, insures a complete mixing action and complete combustion at the point of ignition. In order to prevent a back flow of the main air supply through the fuel inlet passage 5, we provide that passage with a check valve 21 so arranged that it will swing inwardly and open in response to a flow of fuel and its impelling air toward the chamber 4, but will close in case the supply of powdered fuel with the air for its conveyance is shut off and it will, therefore, prevent the backing up of the main air supply in the fuel delivery passages.

In Fig. 3, we have shown the blower 16 connected so as to deliver air to two burners 3 and 3', both of which are associated with a furnace 22. We have diagrammatically shown an automatic control device 23 associated with the furnace which may be connected with the valve-controlling apparatus 19 in the usual manner for the purpose of automatically controlling the delivery of the main air supply to the burners. The apparatus 23 may be a pressure-responsive device, capable of responding to variations in steam pressure or it may be a steam flow meter, or any other device responsive in operation to variations in operating conditions of the furnace associated with the burners, such as the control system described in Patent Number 1,338,927, granted May 4, 1920 to J. M. Hopwood. Powdered fuel is delivered to the burners 3 and 3' from a pulverizer 24 by means of a blower 25. As shown in Fig. 3 the intake of the blower 25 communicates with a heater 26 which is preferably arranged in the offtake passages of the furnace and receives heat from the gases passing to the stack 27; with this arrangement heated air is delivered to the pulverizer and the fuel is dried as it is pulverized. Pulverized fuel is conveyed to the burners 3 and 3' through the passage 28 which communicates at one end with the pulverizer and at the other with the two burners.

It will be apparent that by separating the heavier particles of the fuel from the lighter

particles, we are able to maintain more uniform combustion, since the heavier particles are delivered to the combustion zone under conditions that will favor their rapid and complete combustion. By delivering these particles with the main air supply to the outer portion of the stream of fuel and air entering the furnace, the heavier particles are surrounded by adequate air to complete their combustion and there is little or no tendency for the products of combustion, resulting from the combustion of the more combustible portions of the fuel, masking the heavier particles and thereby delaying or impeding their combustion.

In addition, the central portion of the jet receives adequate air to maintain complete and intense combustion, due to the mixing action at the junction of the passages 6 and 8.

While we have illustrated and described but one embodiment of the apparatus herein set forth as a part of our invention and while we have described but one method of burning pulverized fuel, it will be apparent that various changes, additions and omissions may be made both in the apparatus and in the method herein set forth without departing from the spirit and scope of the invention, as set forth by the appended claims.

The claims are as follows:

1. A process of burning pulverized fuel which consists in separating the heavier from the lighter particles of fuel, delivering the heavier particles to the combustion zone, with the main air supply and simultaneously delivering the lighter particles with an impelling current of air.

2. A process of burning pulverized fuel, which consists in separating the heavier particles from the lighter particles of fuel, delivering the lighter particles to the combustion chamber with a stream of air, and delivering the heavier particles to the combustion chamber with the main air supply in a stream adjacent to and intermingling with the stream of smaller particles.

3. A process of burning pulverized fuel, which consists in separating the heavier particles from the lighter particles of fuel, delivering the lighter particles with a stream of air to the ignition zone, and delivering the heavier particles to the ignition zone with the main air supply in a stream surrounding but intermingling with the stream of air and lighter particles.

4. A process of burning pulverized fuel, which consists in separating the heavier from the lighter particles of the fuel, and in delivering the heavier particles to the combustion zone with the main air supply for supporting combustion and delivering the lighter particles to the combustion zone through a separate path.

5. A process of burning pulverized fuel,

which consists in separating the heavier from the lighter particles of fuel, delivering the lighter particles to the combustion zone with a stream of impelling air, conveying the heavier particles in the main air supply, delivering the main air supply and the conveyed heavier particles to the combustion zone with the lighter particles.

6. A process of burning pulverized fuel, which consists in separating the heavier from the lighter particles of fuel, conveying the separated fuel in separate streams of air, and in delivering all the air for supporting combustion to the combustion zone with the fuel.

7. A process of burning pulverized fuel, which consists in separating the heavier from the lighter particles of the fuel, delivering the lighter particles of fuel to the combustion zone with sufficient air to maintain intense combustion, and delivering the main air supply and the heavier particles to the combustion zone so as to subject the heavier particles to the sensible heat of the combustion of the lighter particles.

8. A burner for pulverized fuel, comprising means for separating the heavier from the lighter particles of fuel, means for delivering the lighter particles from the separating means to the discharge orifice of the burner, and means for delivering the heavier particles from the separating means to the discharge orifice of the burner together with a stream of air for supporting combustion.

9. A burner for pulverized fuel comprising means for separating the heavier from the lighter particles of fuel, a passage communicating therewith receiving the lighter particles, and a passage communicating therewith receiving the heavier particles, provided with an air intake port, said passages communicating with each other at their delivery ends.

10. A burner for pulverized fuel, comprising a separating chamber for separating the heavier from the lighter particles of fuel, a downwardly extending passage extending therefrom receiving the lighter particles of fuel, a separate passage having an air inlet port formed therein and receiving the heavier particles from said chamber, and communicating at its outlet end with the outlet of said first mentioned passage.

11. A burner for pulverized fuel, comprising a separating chamber, to which pulverized fuel is delivered, having a port for the delivery of heavier particles of fuel, and a port for the delivery of lighter particles of fuel, a separate passage communicating with each of said ports, and communicating with each other at their outlets, one of said passages having a port for the admission of air for completing combustion of the fuel delivered by the burner.

12. In combination in a burner for pulverized fuel, a separating chamber to which fuel is delivered having an outlet for the lighter particles near the center thereof and an outlet for the heavier particles near the periphery thereof, a passage extending centrally through the burner and communicating with the first mentioned outlet, and with the discharge orifice of the burner, and a passage communicating with the second mentioned outlet and with the discharge orifice, and provided with an air inlet port.

13. In combination in a burner for pulverized fuel, a separating chamber having a tangentially located fuel inlet passage, a fuel delivery port located centrally thereof and a second fuel delivery port located adjacent the periphery thereof, separate coaxial passages communicating with said ports, one of which is provided with an air inlet port, and a one way valve located in said fuel inlet passage.

14. In combination in a burner for pulverized fuel, a separating chamber provided with a fuel inlet passage, a delivery port for the lighter particles of fuel, and a second delivery port for the heavier particles, separate passages communicating with said ports, one of which is provided with an air inlet port, and means associated with said fuel inlet passage for preventing a back flow therethrough.

15. In a burner for pulverized fuel comprising means for separating the heavier from the lighter particles of fuel, means for delivering the lighter particles of fuel to the outlet orifice of the burner, and means for delivering the heavier particles of fuel to the outlet orifice together with the main air supply for supporting combustion.

16. In a system for burning pulverized fuel, a furnace, a burner for pulverized fuel associated therewith and comprising a separating chamber for separating the heavier from the lighter particles of the pulverized fuel, separate passages communicating with said chamber, for delivering the fuel separated therein, and means for delivering the main air supply to the furnace through one of said passages.

17. In a system for burning pulverized fuel, a furnace, a separating chamber for separating the heavier from the lighter particles of the pulverized fuel, separate passages communicating with said chamber, for delivering the fuel separated therein to the furnace, means for delivering the main air supply to the furnace through one of said passages, and means responsive to variations in operating conditions within the furnace for controlling the operation of said air delivery means.

18. In a system for burning pulverized fuel, a furnace, a burner for the pulverized fuel associated therewith and comprising

a separating chamber, for separating the heavier from the lighter particles of pulverized fuel, separate passages for delivering the heavier and lighter fuel to the furnace, said passages communicating at their discharge ends, means for delivering the main air supply for completing combustion within the furnace through one of said passages and means for controlling the delivery of the air in response to variations in the demand on the furnace.

19. A process of burning pulverized fuel which consists in separating the heavier from the lighter particles of the pulverized fuel, and delivering the fuel so separated to the combustion zone with separate streams of air.

20. A process of burning pulverized fuel which consists in separating the heavier from the lighter particles of fuel, mixing the masses of fuel so separated with separate streams of air, and so delivering the fuel and air to the combustion chamber of a furnace that the heavier particles are provided with an adequate air supply and are subjected to the sensible heat of combustion of the lighter particles while traversing the combustion zone.

21. A process of burning pulverized fuel which consists in subjecting a stream of pulverized fuel to a separating action as it moves toward a combustion chamber for the purpose of separating the heavier from the lighter particles of fuel, and continuously delivering the heavier and lighter particles so separated to the combustion zone by means of separate streams of air.

22. A process of burning pulverized fuel, which consists in delivering a substantially constant stream of pulverized fuel, subjecting the fuel so delivered to a continuous separating action to separate the heavier from the lighter particles of fuel and continuously delivering the fuel so separated to a combustion chamber by means of separate streams of air, so that the heavier particles are subjected to the heat of combustion of the lighter particles while surrounded by an adequate air supply for their rapid and complete combustion.

In testimony whereof, we have hereunto subscribed our names this 1st day of February, 1922.

THOMAS A. PEEBLES.
BRYANT BANNISTER.