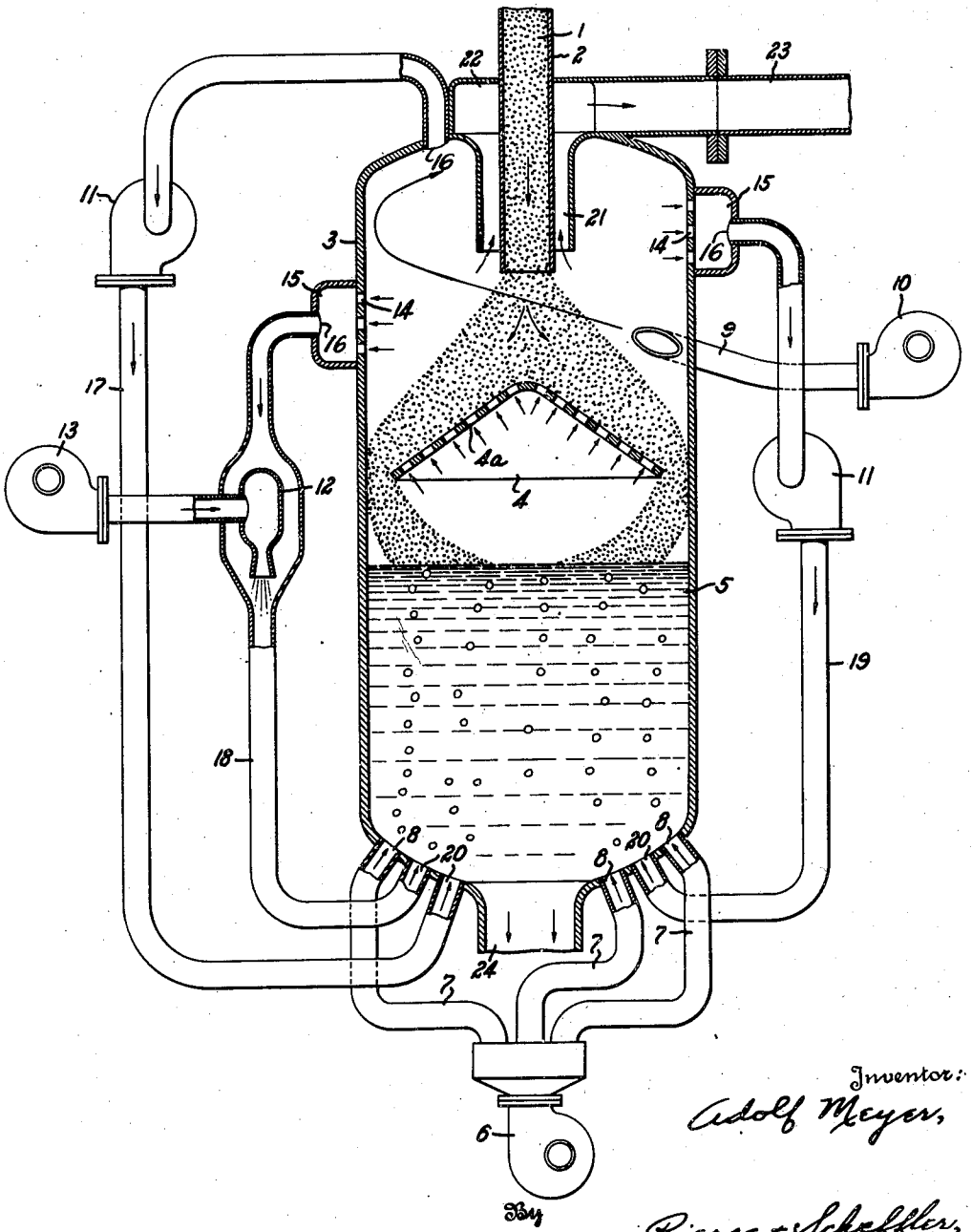
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APPARATUS FOR PRODUCING HOT GASES

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APPARATUS FOR PRODUCING HOT GASES

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This invention relates to a novel apparatus for producing combustion gases at high pressure that are used for driving gas turbines and the like.

One method already proposed for the production of driving gases for gas turbines has been to reduce solid fuel such as coal to gas in a gas producer and to burn this gas in the combustion chamber associated with the turbine. In order to avoid these separate steps of first a reduction to gas and then a combustion of the produced gas, which requires both a gas producer and a combustion chamber, another method already proposed has been to subject solid fuels in powdered or dust form to combustion in a shaft-furnace under such a pressure and with such an excess of air that the products of combustion, when leaving the shaft-furnace, have both the requisite pressure for driving purposes, and also a high temperature favourable for the efficiency of the turbine, but still safe for the blading. The combustion at the high pressure required for driving the gas turbine has this advantage over the combustion at atmospheric pressure or only slightly above it, such as is usually employed for shaft-furnaces and boilers, that the combustion is far more intense and the dimensions of the furnace become far smaller. Should the combustion be carried through only with the amount of excess air usually employed in boilers, the final temperature of the gases would be far too high for operating the gas turbine.

Now, in the method of producing hot gases, more particularly for the operation of gas turbines, by the combustion of solid fuels in powdered or dust form in a shaft-furnace under such a pressure and with such an excess of air that the products of combustion have both the requisite pressure for driving the turbine, driving the producer and the like and also a high temperature which is nevertheless safe for the blading of the turbine, for pipes and other elements, one portion of the compressed air serving for the combustion of the fuel and the cooling of the combustion gases being introduced directly into a layer of fuel, it is recommended, according to the invention, to utilize other portions of the compressed air as cooling air and for ejecting any residues of the combustion, which have been swept along, and any particles carried along from the fuel layer and thereupon to return both to the furnace bed.

With such a method at least a portion of the great excess of fresh air required for bringing the final temperature of the combustion products down to a suitable value may be introduced into the burning layer of fuel of suitable height in such quantity and in such a manner that this layer is loosened up by the air, the separate fuel particles become surrounded by air and are partially carried by it. By this means the intensive combustion, already caused by the height of the air pressure employed, is still further substantially increased, so that the dimensions of the furnace for a given output may be still further reduced.

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This result is aided by the circumstance, that with the high air pressure and the available pressure drop the fuel layer may occupy a considerable height. With this mode of operation, however, it is not possible, owing to the considerable tractive force of the pressure air and its great quantity, to prevent some of the smaller parts of the fuel from being carried away with the products of combustion. For this reason there should be placed beyond the burning layer an arrangement which separates out these solid residues, in order that they will not pass into the gas turbine and there cause erosion of the blades, pipes and so forth. Hence, it is of advantage to use a portion of the compressed air which serves the purpose of cooling the products of combustion for creating in the upper part of the shaft-furnace a vortex which is adapted to throw out these solid residues. With this object in view, the portion of the compressed air intended for this purpose may be caused to enter the separating chamber through tangential nozzles. For this purpose one or more separators of known types may be used.

At the same time, and this is even more important, the combustion of the rising combustible gas is first of all by means of the secondary air and then with the excess air blown in tangentially and acting as cooling air, very favourably affected. A very intense reduction of the combustion gases occurs because the fuel layer is heated from above by radiation from the flame (dependence of CO-CO_2 equilibrium on the temperature of the reducing zone).

The fuel may be fed from below to the combustion zone, in the manner of an underfed furnace. It is, however, preferable to do this from above, so as to have the still unburnt larger pieces on the surface of the burning layer, as these are less likely to be carried along than the pieces which have already become smaller or quite small through the combustion. The fuel will thus travel from above downwards.

An arrangement for carrying out the method according to the invention thus consists, for instance, in a shaft-furnace with a feed opening for the solid fuel and an eduction pipe for the produced gases in the upper part, a cone for spreading the fuel falling down on it and nozzles above and below the cone, of which the former are tangentially directed and serve the purpose of creating a vortex in the outflowing gas by means of the cooling air introduced through them, with the object of throwing out slag and

fuel, whilst the lower nozzles are intended in part for the introduction of compressed air into the bed of the fire for loosening up and causing intensive combustion of the fuel layer and in part for reintroducing the slag and fuel particles which are entrained in air that is withdrawn from the upper part of the shaft furnace and returned to the furnace below the fuel bed.

A suitable procedure has been found to be one in which the slag is made fluid and kept fluid by suitable regulation of the fire, as the slag can thus be removed from the pressure chamber in a far simpler manner than is the case where solid slag is to be removed. By making certain additions to the fuel, the melting temperature of the slag can be regulated.

The accompanying drawing shows by way of example an arrangement for carrying out the method according to the invention. The fuel such as finely pulverized coal 1 which is fed in by a means of a feed regulating device not shown, enters downwardly through a pipe 2 into the shaft-furnace 3 and spreads on the cone 4 flowing down at the periphery of the furnace into the bed 5 of the furnace in accordance with its natural slope. There air compressed by compressor 6 is introduced via pipes 7 through nozzles 8 into the furnace bed from the bottom, the amount of air being such that the desired loosening of the layer of fuel and a corresponding intensity of combustion results. The combustion gases escape through the layer of fuel at the periphery of the cone 4 and through holes 4a in the latter, sweeping everywhere through freshly arriving fuel. Through one or more tangentially disposed nozzles 9 air from the output of compressor 10 is also introduced, which acts as secondary air for the combustion of the gas and the excess portion of which serves as cooling air, this air creating a waste gas vortex, the centrifugal action of which throws out the solid residues of the combustion and any particles carried along from the layer of fuel. As, owing to the peculiarity of the proposed mode of combustion, the solid residues may still contain a considerable quantity of unburnt parts, it is of advantage to return these residues along with the conveying air which removes them from the separator back into the fire bed of the shaft-furnace. In order to reintroduce them, it is necessary somewhat to raise the pressure of the conveying air, as, in consequence of the losses in the centrifugal separator, it has a lower pressure than that prevailing in the combustion chamber. This raising of the pressure may be affected by means of separate fans 11, and by jet apparatus 12, operated by freshly arriving compressed air from compressor 13 which subsequently is used for the combustion. Thus, the residues are drawn away by suction from furnace 3 through holes 14 into chamber 15 and through openings 16 together with any gases which have been generated, and by means of the fans 11, or the jet apparatus 12, the pipes 17, 18, 19, and the nozzles 20 are returned to the furnace bed, where the combustible residues are completely burnt. This subjection of the unburnt pulverized fuel to suction may be repeated. The gases, thus purified, pass through the pipe 21 which is concentric with the fuel inlet pipe 2 into the header chamber 22 and from there are conveyed through the pipe 23 for their ultimate use in a gas turbine, a superheater, a steam, hot water or hot air producer.

The heavier slag particles settle downwardly to the bottom of the furnace 3 and are drawn off through pipe 24.

In order to assist the action of the fuel dust separator, the fuel streaming in from above may also be so guided that the combustion products are forced to sweep through a layer of fuel heating the latter and themselves being cooled down, when a great part of the solid residues carried along by the products of combustion will be kept back in the layer of fuel. As, with this arrangement, light particles of fuel produced by the crushing of the fuel may be carried away by the gases and, on the other hand, the hot products of combustion may cause a certain degasification of the fresh incoming fuel, it is yet advisable to place after this kind of separator centrifugal separators or the like, with the object of returning with conveying air the separated out fuel dust and any gases produced from the fuel back into the furnace bed.

In a furnace bed which as in this case is heated by radiation from the flame, it is natural that there will be a very intense reduction of the combustion gases.

While in order to simplify illustration, separate blowers 6, 10 and 13 have been shown for supplying pressure air, it will be obvious, of course, that all of the pressure air could be delivered from a single blower with suitable piping.

I claim:

1. In a furnace for producing hot gases, an upright casing, an inlet for pulverized fuel at the top of said casing, a gas eduction pipe at the top of said casing, a perforated cone disposed transversely in said casing beneath said fuel inlet for spreading fuel falling upon it to form a layer of fuel underneath, nozzle means projecting through the wall of said furnace tangentially thereof above said cone, means delivering pressure air through said nozzle means to create a vortex in the combustion gas to separate residue and unburnt fuel particles therefrom, pipe means connecting the upper part of said furnace with the lower part thereof below said layer of fuel for reintroducing said residue and particles, an inlet to said furnace below said layer of fuel, and means delivering pressure air to said inlet for loosening said layer of fuel and effecting intensive combustion thereof.

2. A furnace as defined in claim 1 and further including means in said pipe means for raising the pressure of the air flowing therethrough.

3. A furnace as defined in claim 1 and further including a jet device in said pipe means facing in the direction of air flow therethrough, and means delivering pressure air to said jet.

4. A furnace as defined in claim 1 wherein said cone is provided with a plurality of openings therethrough.

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