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METHOD FOR HEAT TREATMENT OF FINELY DIVIDED SOLID MEDIA

Filed April 18, 1951

2 Sheets-Sheet 1

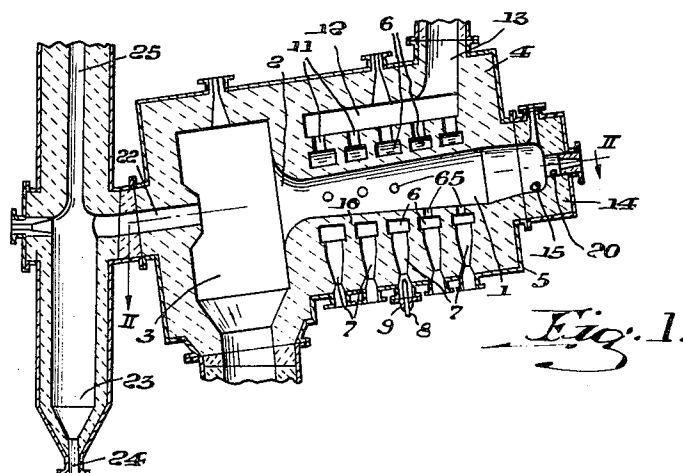


Fig. 1.

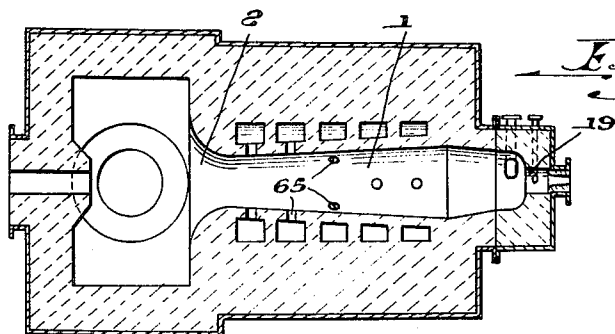


Fig. 2.

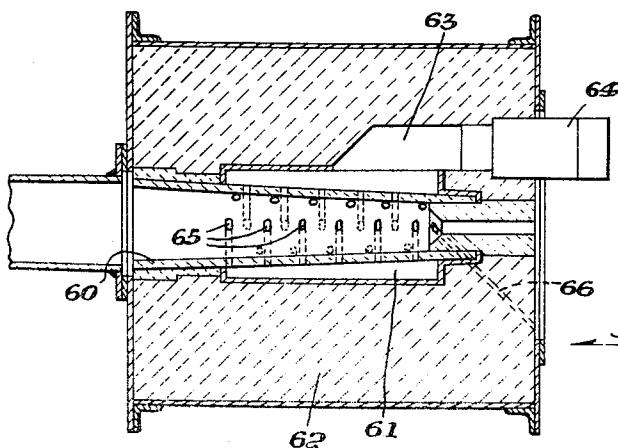


Fig. 6.

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Fig. 5

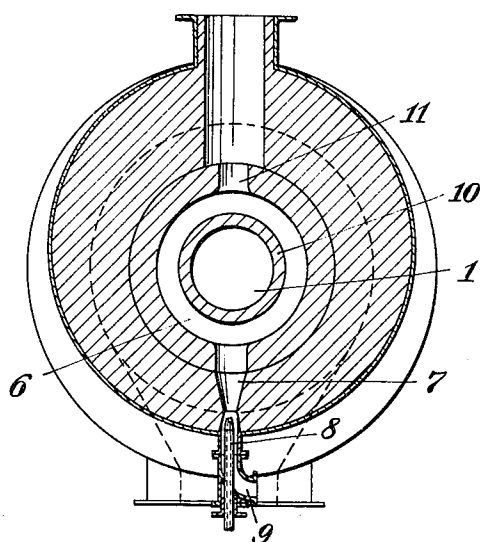


Fig. 3

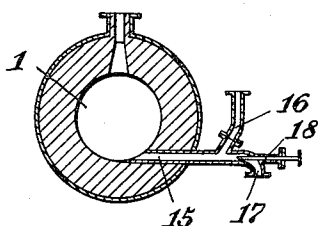
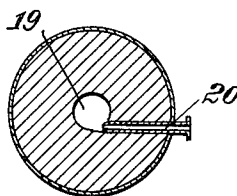


Fig. 4



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METHOD FOR HEAT TREATMENT OF FINELY DIVIDED SOLID MEDIA

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4 Claims. (Cl. 202—108)

This invention relates to the treatment of pulverised or finely granular materials with gaseous or vaporised media, and in particular to the heat treatment of such materials with hot gases for the purpose of creating reactions of any kind within the solid material being treated or heated, especially reactions such as endothermic reactions between the solid material and the gases.

An example of a heat treatment for which the present invention is particularly suited is the low temperature carbonisation or de-gasification of bituminous coal with the recovery of the volatile constituents of the coal in the form of valuable fuel gas and tar.

A similar heat treatment is for example called for in the firing of limestone for the production of lime (calcium oxide).

As an example of carrying out reactions between solid and gaseous media there may be mentioned the reduction of iron oxides (ore) with reducing gases for the production of elementary iron (spongy iron).

The invention will be explained in greater detail hereafter with reference to the low temperature carbonisation of coal.

The de-gasification or carbonisation of coal is frequently employed in order to recover the valuable volatile constituents of the coal before it is used for firing boilers or like purposes, or to produce a diluent which is admixed with highly bituminous or swelling coal prior to coking in order to produce a hard coke.

Various kinds of devices have already been proposed for the carbonisation and de-gasification of pulverised or granular coal. Most of the known processes employ a rotary oven in the form of a long cylinder which is slightly inclined so that the raw coal received at the higher end is gradually moved towards the lower end, on rotation of the tube drum, in contra-flow to the hot gases. The same apparatus has also been suggested for the so-called oxidation of bituminous fuels in which the coal is heated in a stream of oxygen or air, so that the coal takes up oxygen with decomposition of the coal bitumen. In this way there is produced a diluent material which does not cake and can be added to swelling coals prior to coking for the production of hard coke.

The usual rotary tube oven, even if provided with additional installations has the disadvantage that the contact surface between the coal and the gaseous phase is relatively small. On account of this the transmission of heat by the hot gases to the coal is bad. Another disadvantage is that it is practically impossible to heat rotary ovens externally. The heat required for the heat treatment must instead be transferred exclusively to the solid material by the hot gases.

The invention provides a new way for treating or heat-treating pulverised or finely granular solids.

The idea underlying the invention consists essentially in that the solid material to be treated is injected tangentially or approximately tangentially and if necessary with a slight inclination to the longitudinal axis, into a stationary substantially cylindrical oven heated by hot gases in

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an external heating chamber, for example by means of hot gases introduced from the heating chamber into the oven at a plurality of points along the oven, so that the mixture of finely divided coal and gas moves along the wall of the oven in a substantially helical direction of flow.

The considerable advance which is obtained by means of this fundamental method of operation is explained in the following:

In order to transfer heat from the hot gases to the finely divided material a definite relative movement over a large surface between the two media is of decisive importance. Whilst the mixture of finely divided solid material and hot gases is moved along a fixed wall the movement of the solid bodies in the mixture is more strongly retarded than the movement of the carrier gas and therefore relative movement in a considerable degree takes place between the solid bodies and the gas atmosphere.

The employment of a stationary drum oven has in addition the advantage that the treatment chamber can be externally heated. This provides a substantially quicker and more extensive heating of the finely divided coal than with the usual rotary tube ovens operating with interior heating.

By means of a suitable composition of the carrier gas it is easy to ensure that the coal entering into the reaction chamber operating at a higher temperature stage is readily oxidised on the surface of the separate particles of coal. In this way the caking together of the coal particles is counteracted in the initial zone of the oven.

The reaction chamber may be in the form of a vertical, horizontal or inclined cylinder or the like. The desired substantially helical movement of the solid bodies may also be obtained even when the reaction chamber is constructed with a horizontal axis.

At the discharge end of the oven there is provided a container preferably water-cooled, in which collects a part at least of the material coming from the heat treatment. The finer particles of the treatment material escape with the gaseous constituents approximately in the centre of the oven cover. On this account the reaction chamber can with advantage be shaped substantially in the form of the known dust separators (cyclones).

From the gas-dust mixture which is being withdrawn the solid material is separated in a dry state, at a temperature of about 500° by electric discharge. The gas is then led into the usual type of condensation plant in order to recover tar and other hydrocarbon oils. According to the amount of air introduced with the coal into the reaction chamber, there may be produced a gas which after cleaning and cooling is ready for immediate use for lighting or heating in town gas systems.

The walls of the cylindrical reaction chamber which also may be referred to as a stationary tube oven, may be made of heat resistant steel, but are preferably made from ceramic material.

A further important characteristic of the invention provides that the hot gases are introduced into the reaction chamber serving for the treatment of the solid material, tangentially or approximately tangentially, at a plurality of points over the length of the reaction chamber. By means of this feature in longer reaction chambers, the desired helical movement is assured and correspondingly the course of the desired reactions, or the heat exchange, is improved.

According to the invention heating flues for the indirect heating of the reaction chamber may be provided in the walls of the tube oven.

Further important characteristics and applications of the invention will be evident from the following description of two forms of construction of a device constructed

according to the subject invention for the heat treatment of pulverised materials, particularly for the carbonisation of pulverised or fine coal, which is illustrated in the drawing and in which:

Fig. 1 is a vertical section through one form of construction of the apparatus,

Fig. 2 is a longitudinal section on the line II—II of Fig. 1,

Fig. 3 is a cross section on the line III—III of Fig. 1,

Fig. 4 is a section on the line IV—IV of Fig. 1,

Fig. 5 is a section on the line V—V of Fig. 1 and finally

Fig. 6 shows a section through another form of construction of the subject of the invention.

The apparatus illustrated in the drawing has a tube-like reaction chamber 1, the longitudinal axis of which is slightly inclined, for example at about 8–10°. The reaction chamber 1 is closed at one end and open at the other end 2, whilst gradually widening, into a chamber 3.

The reaction chamber 1 and the chamber 3 are formed of refractory brickwork 4 which is arranged, with the employment of suitable bad heat conducting material in a housing 5 of sheet steel or the like, which is preferably gas-tight. In the walls of the reaction chamber 1 there are provided peripherally extending heating flues 6 which are provided underneath with burners 7 into which open the nozzles 8 and the pipes 9 for the combustion air. The heating media burn in the flues 7 and the resulting hot waste gases pass upwardly through the waste gas flues 6 whereby they meet the wall 10 of the reaction chamber 1 and give up a considerable amount of their sensible heat to the same. The waste gases then pass through means in the form of a series of openings 65 for passing hot combustion gases from the flues 6 into chamber 1, and through the openings 11 into a waste gas collecting passage 12 which is connected to the flue gas outlet 13.

The reaction chamber 1 is, as can be seen in particular from Fig. 1, constructed in the form of a double truncated cone. Into its closed end, which lies in a reduced part 14 of the housing, there opens the supply pipe 15 for the solid material to be treated, for example finely granular or pulverised bituminous coal.

The supply pipe 15 extends, as can be seen from Fig. 3, substantially tangentially to the reaction chamber 1. It is, however, preferably placed slightly oblique to the axis of the oven so that the gases flowing into the reaction chamber 1 through the passage 15 pass through the reaction chamber with a helical movement to its open end 2.

The solid material to be treated is introduced into the supply pipe 15 through the pipe 16, for example from a bunker, not shown. In the pipe 15 the finely divided solid material is engaged by a stream of gas which is delivered for example through the pipe 17 and is injected in the form of a jet into the reaction chamber 1.

Preferably air is delivered through the pipe 17, if necessary preheated air, whilst a suitable fuel gas, for example town gas is introduced through the nozzle pipe 18 which opens into the pipe 15. The temperature in the pipe 15 is maintained in such a way that the gas and air burn either in the pipe 15 or immediately after leaving the same. If combustion or partial combustion is permitted in the pipe 15 certain advantages are obtained. For example, in the treatment of bituminous coals these may be superficially oxidised by bringing them into contact with highly heated oxygen. Through this the bituminous coal completely or partly loses its coking properties, thus simplifying in some cases the subsequent treatment in the reaction chamber 1.

The helical movement of the finely divided solid material and the carrier gas which is introduced together with the solid material, or even separately therefrom, is characteristic of the invention. The effect is that the solid material is gradually conveyed along the heated wall of the reaction chamber 1 from closed end of the

reaction chamber to the open end 2 and that a considerable relative movement takes place between the solid material and the carrier gas, which substantially improves the transmission of heat from the latter to the solid material.

In order to support the formation of a helical movement and, correspondingly of a hollow cylindrical gas mass in the reaction chamber 1, there may be formed in the central neutral zone of the reaction chamber in some cases a second waste gas column for which purpose nozzle 20 likewise opens tangentially into a narrow backward projection 19 of the reaction chamber 1, fuel gas or other suitable gas being introduced through said nozzle.

The finely divided solid material passes, after being heated to the desired temperature in the reaction chamber 1, into the separating chamber 3 in which the greatest part of the finely divided solid material separates from the carrier gas and collects at 21. The solid material outlet 21 is provided with suitable closure members, not shown in the drawing.

The carrier gas freed from a substantial part of the solid material passes out through the passage 22 and then passes into the cyclone 23 in the lower part of which the separated dust accumulates, and is withdrawn through the opening 24 whilst the hot gas, substantially freed from dust, escapes at 25.

If the apparatus is employed for the low temperature carbonisation of coal, there escapes from the gas outlet 25 a valuable fuel gas which contains tarry constituents. This fuel gas is conveyed to a plant, not shown on the drawing, for the recovery of the hydrocarbon oils and the like contained therein.

The fuel gas can be used then for heating the reaction chamber 1 or used in circulation as the carrier gas.

The apparatus illustrated in addition to being applicable to the carbonisation of bituminous coal may also be employed with advantage, for example, in the so-called decarbonising of calcium carbonate or for other purposes.

In the apparatus shown in Fig. 6 which is, as aforesaid, another form of construction of the subject invention, the arrangement shown in Figures 1 to 5 is modified as follows so as to have the hot heating gas pass into the reaction chamber from the heating chamber. Otherwise the operation is substantially the same as that described as above in connection with Figures 1 to 5, as shown, the reaction chamber formed for example from a slightly conical tubular member 60 is arranged in a heating chamber 61 which is formed of refractory brickwork 62. A gas-air burner 64 opens into a lateral extension 63 of the heating chamber. The hot waste gases of the burner 64 can enter into the reaction chamber by means of openings 65 in the wall 60 of the reaction chamber, and at a substantially tangential direction. As can be seen from Fig. 6 a series of openings 65 is distributed over the length of the reaction pipe 60. The solid material to be treated is injected through the passage 66 which opens obliquely and tangentially into the narrower end of the reaction chamber.

The apparatus shown in Fig. 6 provides a particularly intensive helical movement of the media in the reaction chamber.

Having now described our invention and in what manner the same is to be performed we state that any other form of realisation not departing from the scope of the invention should be included within the following claims.

What we claim is:

1. Apparatus for the heat treatment of finely-divided solid material comprising a metallic shell having a heat-resistant inner lining, an elongated substantially cylindrical reaction chamber located within said lining, a nozzle disposed tangentially to said reaction chamber said nozzle being located adjacent one end thereof and so positioned that material passing therethrough will follow a helical path through said reaction chamber, means

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for feeding finely-divided solid material to said nozzle, a heating chamber located within said lining intermediate the reaction chamber and said shell means for supplying hot combustion gases to said heating chamber and means for passing hot gases from said heating chamber to said reaction chamber.

2. The apparatus of claim 1 in which the longitudinal axis of said reaction chamber is inclined 8-10° from horizontal.

3. The apparatus of claim 1 in which said means for passing hot gases from said heating chamber to said reaction chamber comprises a plurality of passageways spaced along and tangentially disposed to the periphery of said reaction chamber.

4. The apparatus of claim 1 in which the reaction chamber is in the form of double truncated cones the bases of which are located facing each other.

References Cited in the file of this patent

UNITED STATES PATENTS

Re. 4,457	King	July 4, 1871
885,766	De Laval	Apr. 28, 1908
901,232	Eldred	Oct. 13, 1908
1,026,724	Trump et al.	May 21, 1912
1,213,887	Krause	Jan. 30, 1917
1,256,703	Landers	Feb. 19, 1918
1,432,170	Fenton	Oct. 17, 1922
1,478,526	Merrell	Dec. 25, 1923

20

25

1,618,808
1,781,614
1,893,913
1,913,391
1,944,872
2,020,431
2,032,827
2,257,907
2,316,207
2,319,836
2,344,007
2,350,204
2,351,091
2,367,694
2,441,613
2,464,812
2,519,481
2,548,875

6

Burg Feb. 22, 1927
Trent Nov. 11, 1930
Saint-Jacques Jan. 10, 1933
Hutchinson June 13, 1933
Andrews et al. Jan. 30, 1934
Osborne Nov. 12, 1935
Andrews Mar. 3, 1936
Griswold Oct. 7, 1941
Winter Apr. 13, 1943
Woerner May 25, 1943
Totzek Mar. 14, 1944
Wagner May 30, 1944
Barr June 13, 1944
Smuggs Jan. 23, 1945
Balassa May 18, 1948
Johnson Mar. 22, 1949
Kubie et al. Aug. 22, 1950
Degnen Apr. 17, 1951

FOREIGN PATENTS

Great Britain Apr. 12, 1928

OTHER REFERENCES

Kalbach: "Fluidization in Chemical Reactions," pp. 105-108, Chemical Engineering, January 1947.
"Fluidizing Processes," by Parent, Yagol and Steiner, Chemical Engineering Processes, pp. 429, 430, 435, vol. 43, No. 8.