PATENT SPECIFICATION (11) 1 567 909

1 567 909

(21) Application No's 9665/76 (22) Filed 11 Mar. 1976
37909/76 13 Sep. 1976

(23) Complete Specification Filed 10 Jun. 1977

(44) Complete Specification Published 21 May 1980

(51) INT. CL. [3] F27B 15/00

(52) Index at Acceptance
F4B A13C

(72) Inventors: BRIAN HARDING
ROY WILLIAM REYNOLDSON

(19)

(54) HEAT TREATMENT APPARATUS

(71) We, APOLLO HEAT LIMITED, formerly SHACKLEBEST LIMITED, a British Company, of Leewood House, Clows Top, Nr. Kidderminster, Worcestershire, do hereby declare the invention for which we pray that a Patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:-

This invention relates to heat treatment apparatus of the kind which comprises a fluidised bed which is intended for use in carrying out heat treatment processes on a component or components immersed in the fluidised bed. To this end, it is known to provide a bed which is formed of refractory particles and a gas, or gas/air mixture, which not only provides a sufficient velocity of gas or gas/air flow for fluidising the bed but which also provides within the bed in use the desired atmosphere for the required heat treatment process, it being understood that heat will also be applied to the bed in any convenient manner. Such heat treatment processes may comprise incidentally carbo-nitriding, oxy-carbo-nitriding, carburizing neutral annealing, neutral stress relieving and neutral hardening, the gas or gas/air mixture admitted to the bed having an appropriate composition to provide the correct atmosphere for the desired treatment.

The object of the present invention is to provide an improved heat treatment apparatus.

In accordance with the present invention there is provided heat treatment apparatus comprising a container for containing a mass of refractory particles, said container having a porous bottom through which in use a gas can be blown for the purpose of fluidising said refractory particles and for the purpose of providing a treatment atmosphere within said refractory particles, wherein there is provided at the upper end of said container a removable hood which incorporates baffle means which in use extends at least partially across the top of the container so as to assist in retaining said mass of refractory particles within the container, and air nozzle means disposed above said baffle means for supplying air to the hood when required, the hood having a wall which encompasses said baffle means and said air nozzle means, the top of said hood having an aperture through which in use gases ascending through the heat treatment apparatus can escape, there being also permitted means for heating said mass of refractory particles when disired.

The aforementioned heating means may comprise further nozzle means which may be disposed either just above or just below the upper surface of the mass of refractory particles in said container when said particles are in the fluidised condition. Third nozzle means may also be provided for cooling the exterior of the container when desired. The ways in which said air nozzle means, said further nozzle means, said third nozzle means can be used will be more particularly described hereinafter.

In an alternative construction, said heating means comprise a fluidised bed or beds which partially or wholly surrounds or surround said container for the purpose of heating the latter and the mass of refracting particles therein.

The invention will now be more particularly described with reference to the accompanying drawing wherein:-

Figure 1 is a schematic sectional view of one example of heat treatment apparatus in accordance with the invention,

Figure 2 is also a schematic sectional view of the apparatus seen in Figure 1 but illustrating an alternative mode of use.

Figure 3 is a schematic sectional view of another example of heat treatment apparatus in accordance with the invention, and

Figure 4 is a schematic sectional view

showing a variation of the apparatus seen in Figures 1 and 2.

Referring to the example of heat treatment apparatus shown in Figures 1 and 2 there is provided a container for containing a mass of rectractory particles. Said container has a wall 10 which may be of any convenient configuration in plan and which may be formed around its circumference with a plurality of corrugations which extend in generally vertical directions, said wall being provided with insulation 11. The bottom of said wall is supported on any suitable form of base frame (not shown) and is sealingly connected thereto and the bottom of said container is closed by a porous tile 12 which is also sealingly connected to the base frame. Disposed within said container thus formed is a mass of refractory particles 13 and in use a gas or gaseous mixture will be blown through said porous tile from the underside thereof through a conduit 14 for the purpose of fluidising said refractory particles and also for the purpose of providing a treatment atmosphere therein so that components which are to be treated will, in use, be inserted into the fluidised particles through the upper end of said container.

There is also provided at the upper end of said container a removable hood 15 which is mounted in any convenient way for movement between an open position in which access is permitted to the upper end of said container 10 and a closed position in which such access is not permitted. Said hood comprises a hood wall which is formed of any convenient material such as a refractory material and said wall is of generally inverted cup-shaped configuration so as to have a base portion 15*a* from which depends a skirt portion 15*b*, the base portion being formed in its centre with an aperture through which in use gases ascending through the heat treatment apparatus can pass.

Mounted within said skirt portion of the hood are air nozzle means which may be in the form of an annular pipe 16 formed with apertures at intervals around its inner periphery, said annular pipe being adapted to be connected to a source of air (not shown) which may be pressurised or which may be induced to flow through said pipe apertures by the draught in the apparatus. Furthermore, within the hood and somewhat below the aforesaid air nozzle means there is provided baffle means 17 which may be in the form of wire mesh or which may comprise one or more baffle plates which when the hood is in its closed position will extend at least partially across the upper end of said container so as to assist the retention of the refractory particles within said container. Subsidiary baffle means 18 may also be provided above said pipe 16. The hood 15 together with the air nozzle means 16 and the baffle means 17 and 18 are all arranged to move together when the hood is moved between its open and closed positions.

There is also provided within said container beneath said baffle means 17 (considering the hood to be in its operative or closed position), a further nozzle means which is conviently in the form of a second annular pipe 19 also formed around its inner periphery with a plurality of spaced apertures. Said second annular pipe may be disposed just above the upper surface of the mass of refractory particles when the latter are in the fluidised condition but in the embodiment shown in Figures 1 and 2 it is disposed just above said upper surface of the mass of refractory particles in the container when said particles are in the non-fluidised condition and just below said upper surface when the particles are fluidised. Furthermore, there is provided third nozzle means in the form of a third annular pipe 20 which surrounds the exterior of said container wall at or adjacent to the bottom thereof, said third annular pipe being formed in its upper surface with a plurality of spaced apertures. Said second and third annular pipes in the embodiment shown in Figures 1 and 2 are each connected to means for supplying pressurised air. Means are also provided for blowing gas beneath the aforesaid porous tile 12 as above-mentioned so that such gas will in use pass through the porous tile into the mass of refractory particles and suitable valve means (not shown) are provided for varying the composition of such gas and for adding, if desired further pressurised or secondary air which can enter the container 10 above the porous tile 12 via pipes 21.

Heat treatment apparatus as above described can be operated in various modes. Thus to begin with when it is desired to heat the refractory particles 13 within the container 10 a stoichiometric composition of a fluid fuel and air is blown through said porous tile 12 or, if a fuel rich mixture is used, secondary air can be supplied through the pipes 21, the combustible mixture then being ignited within the container so that combustion takes place largely in the lower part of the container. Such combustion will heat up the refractory particles and when the desired temperature has been obtained the hood 15 is opened to permit insertion of components (not shown) which are to be treated (such components being contained for example in any suitable basket) through the upper end of the container. The introduction of such components will initially lower the temperature in the fluidised bed and the composition of the gas passing through the bed is also altered so as to reduce the proportion of air (either by turning off the secondary air through pipes 21 or by varying the composition of the mixture passing through the tile)

and thereby provide a sub-stoichiometric proportion which will provide the desired treatment atmosphere within the fluidised bed. At the same time pressurised air will be admitted to the aforesaid second annular pipe 19 forming the further nozzle means and accordingly the fuel rich gas flowing to the top of the fluidised bed will be ignited to form a hot combustion zone (as shown in Figure 1) beneath baffle means 17 and adjacent to the upper surface of the refractory particles which will have the effect of quickly restoring the fluidised bed to the desired temperature whilst treatment is carried out on the components immersed in the desired treatment atmosphere in said bed. After combustion of the gases immediately above the top of the fluidised bed as aforesaid such gases will pass through the aforesaid baffle means 17 into the interior of the hood where they may be diluted, if desired, with further air which is admitted via the first-mentioned annular pipe 16. If however during the treatment operation the temperature of the fluidised bed becomes too high then the supply of air to the annular pipe 19 is cut off and air is supplied to the annular pipe 20 forming the third air nozzle means. Air from such pipe will then be able to flow upwardly around the exterior of the container wall through the channels formed by the corrugations thereof and such cooling air will then pass into the atmosphere.

In an alternative construction (shown in Figure 3), instead of providing heat for said fluidised bed by combustion either within the fluidised bed or just above the upper surface of the fluidised bed one or more further fluidised beds 22 and 23 are provided which partially or wholly surround the treatment bed. In this case the hood 24 is formed so as to cover the upper end or ends of the further fluidised bed or beds and as well as the container 25 and baffle means 17 further baffle means 26 are provided above said beds 22 and 23 to help retain the refractory particles of said further bed or beds. In use a separate supply of a fuel/air mixture will be blown through a porous tile or tiles 27 and 28 forming the bottom of said further fluidised bed or beds 22 and 23 and will be burn therein to provide heat for the treatment bed in the container 25 or alternatively pressurised air alone can be blown through said tiles 27 and 28 or through the annular pipe 20 when it is desired to cool the bed in the container 25 and in either case such air will pass into the hood. In both the embodiments shown in Figures 2 and 3, any combustible gases arriving in the hood may be burnt (with the aid of air flowing through the pipe 16) below the subsidiary baffle 18 before being exhausted.

In the modification shown in Figure 4, the further nozzle means comprising the pipe 19*a* is arranged in use to direct into the fluidised refractory particles a gaseous heating medium instead of air as is the case in the embodiment shown in Figures 1 and 2. Said annular pipe 19*a* is positioned at a level which is somewhat above the top of the bed of refractory particles 13 when said particles are in their slumped or non-activated position but below the level of said refractory particles when they are fluidised as seen in Figure 4. Furthermore a row of apertures is formed around the bottom of said annular pipe and a further row of apertures may be formed around its inner periphery. In addition there is provided a deflector plate 29 which is of annular form in plan and of generally U-shaped configuration in vertical cross-section. The annular pipe 19*a* is thus positioned within said deflector plate and the upper and lower parts of said plate 29 will extend above and below the annular pipe respectively. In use and when the treatment gas is being blown through the refractory mass a combustible gas or gas/air mixture would be admitted into said annular pipe 19*a* and ignition would be effected in any convenient manner so that plurality of flames would issue from the aforesaid apertures formed in the annular pipe, the deflector plate 29 having the effect of directing these flames radially inwardly whereby the refractory particles in the container would then be heated to maintain the temperature thereof instead by utilising a "fireball" below the baffle means 17 as seen in Figure 1.

As a modification to the structure as above described the aforesaid annular pipe 19*a* through which a combustible gas or gas/air mixture will be passed can be concentrically mounted within a further annular pipe which is also formed with a series of apertures and which in use will form between its inner surface and the exterior of the first-mentioned annular pipe an annular space through which air can be blown in order to prevent overheating of the first-mentioned annular pipe. A deflector plate would be provided as before and the two concentric annular pipes would be mounted within said deflector plate.

As a further alternative the further nozzle means comprises an annular pipe which is disposed just above the level of the top of the refractory bed and in this case a row of apertures would be formed in the underside of said annular pipe so that flames arising from combustion of a combustible gas or gaseous mixture flowing through said pipe would be directed downwardly through the apertures and into the fluidised bed from the top thereof. There is however also provided guide means in the form of an annular inverted trough arranged so that said annular pipe nests within the upper part of the inverted annular trough and in this case the latter helps to direct the flames and products

of combustion vertically downwards into the fluidised bed.

In the above described constructions the annular pipe through which the combustible gas or gaseous mixture is to be passed can be correctly set up within said deflector plate or inverted trough so that the flame apertures in the annular pipe are positioned correctly by utilizing one or more locating pins which are arranged to be inserted into one or more aligned apertures in the annular pipe and deflector plate or inverted trough as the case may be.

Heat treatment apparatus as shown in Figure 4 thus provides for heating of the fluidised bed by means of submerged combustion in which a gaseous heating medium is arranged to issue within the fluidised bed and which is separate from the gas or gaseous mixture which is used both to fluidise the bed and to provide the treatment atmosphere therein. This means that treatment can be carried out at a relatively low temperature since the temperature itself can be separately controlled by use of the aforesaid annular pipe 19*a* through which the combustible gas will be passed, it being understood that if the heating of the refractory bed is also to be effected by the gas blown upwardly through the porous tile then the requirements of rate of flow are such that it is difficult to maintain a temperature within the fluidised bed of less than approximately 750° - 800°C. Furthermore a fluidising gas can be used which is non-combustible and this may be desirable for certain treatments that are required.

Initially however a combustible mixture may be blown through said porous tile at the base of the container 10 to provide for a rapid heating up of the apparatus. Thereafter a neutral or non-combustible gas providing the desired atmosphere may be blown through said porous tile and the desired heat maintained by blowing the appropriate combustible gas through the aforesaid annular pipe which directs the flames and products of combustion into the fluidised bed. After treatment has finished the apparatus can be cooled by stopping the supply of combustible gas to said annular pipe 19*a* whilst cooling air can then be supplied to the third nozzle means 20 adapted to blow cooling air over the exterior of the container 10. The air nozzle means 16 that is disposed within the hood can be used to ensure that any unburned combustible gases are consumed before they are discharged to atmosphere through the aforesaid hood 15.

WHAT WE CLAIM IS:-

1. Heat treatment apparatus comprising a container for containing a mass of refractory particles, said container having a porous bottom through which in use a gas can be blown for the purpose of fluidising said refractory particles and for the purpose of providing a treatment atmosphere within said refractory particles, wherein there is provided at the upper end of said container a removable hood which incorporates baffle means which in use extends at least partially across the top of the container so as to assist in retaining said mass of refractory particles within the container, and air nozzle means disposed above said baffle means for supplying air to the hood when required, the hood having a wall which encompasses said baffle means and said air nozzle means, the top of said hood having an aperture through which in use gases ascending through the heat treatment apparatus can escape, there being also permitted means for heating said mass of refactory particles when desired.

2. Heat treatment apparatus as claimed in Claim 1 wherein said heating means comprises further nozzle means which are disposed beneath said baffle means and either just above or just below the upper surface of said refractory particles when the latter are in a fluidised condition.

3. Heat treatment apparatus as claimed in Claim 2 wherein there is provided a third nozzle means for cooling the exterior of said container when desired.

4. Heat treatment apparatus as claimed in Claim 2 wherein said further nozzle means is disposed below the surface of said refractory particles when the latter are fluidised and is used for introducing air for burning a fuel rich treatment gas above the bed of refractory particles.

5. Heat treatment apparatus as claimed in Claim 2 wherein said further nozzle means is disposed below the surface of said refractory particles when the latter are fluidised and is used for introducing a combustible gaseous mixture into the top of the bed of refractory particles.

6. Heat treatment apparatus as claimed in claim 1 wherein said means for heating the mass of refractory particles when required comprise a fluidised bed or beds which partially or wholly surrounds or surround said container.

7. Heat treatment apparatus substantially as hereinbefore described with reference to and as shown in Figures 1 and 2, or Figure 3 or Figure 4 of the accompanying drawings.

MARKS & CLERK,
Chartered Patent Agents,
Alpha Tower,
ATV Centre
Birmingham B1 1TT
Agents for the Applicants

Printed for Her Majesty's Stationery Office,
by Croydon Printing Company Limited, Croydon, Surrey, 1980.
Published by The Patent Office, 25 Southampton Buildings,
London, WC2A 1AY, from which copies may be obtained.

1567909 COMPLETE SPECIFICATION

1 SHEET This drawing is a reproduction of the Original on a reduced scale

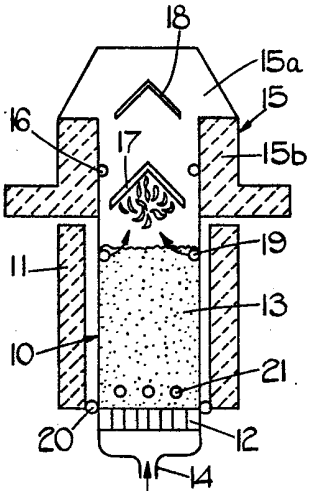

FIG. 1.

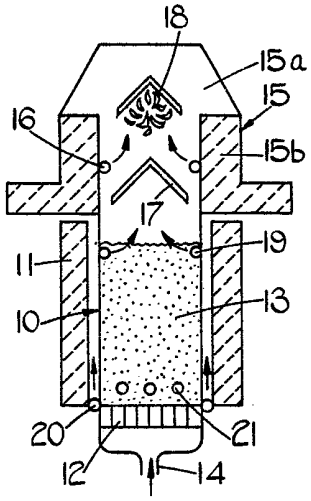

FIG. 2.

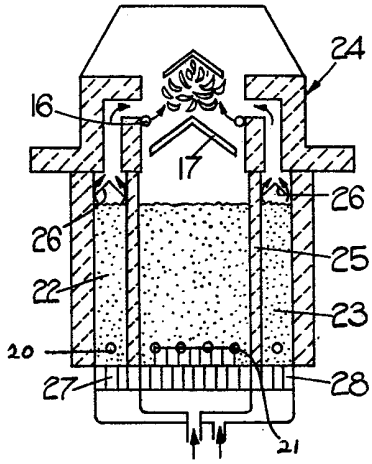

FIG. 3.

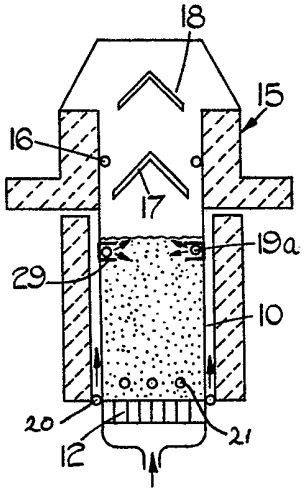

FIG. 4.