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(54) **Heating powdered material**

(57) An industrial furnace (1), for instance a heating and/or reducing furnace arranged to treat material in powder form or in small pieces, has an annular chamber with refractory walls which is charged with material to be treated. The charge is moved forward from an inlet orifice to a discharge orifice by a members (13) provided with hollow teeth (19) which are cooled by water, air or vapour circulation. In an alternative embodiment the chamber is rectilinear in shape and the hollow teeth are arranged to execute a reciprocating motion for stirring the charge and moving it towards the discharge orifice. A further passageway may be provided in the hollow members 13 and teeth 19 for the introduction of powdered charge material.

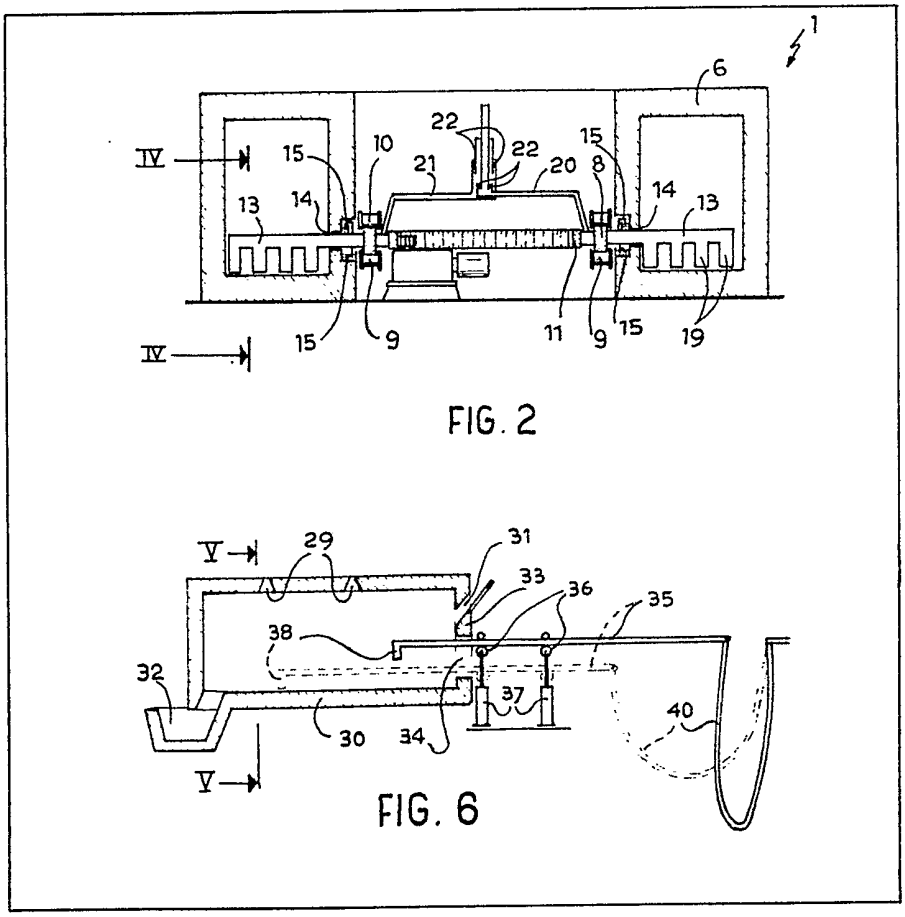

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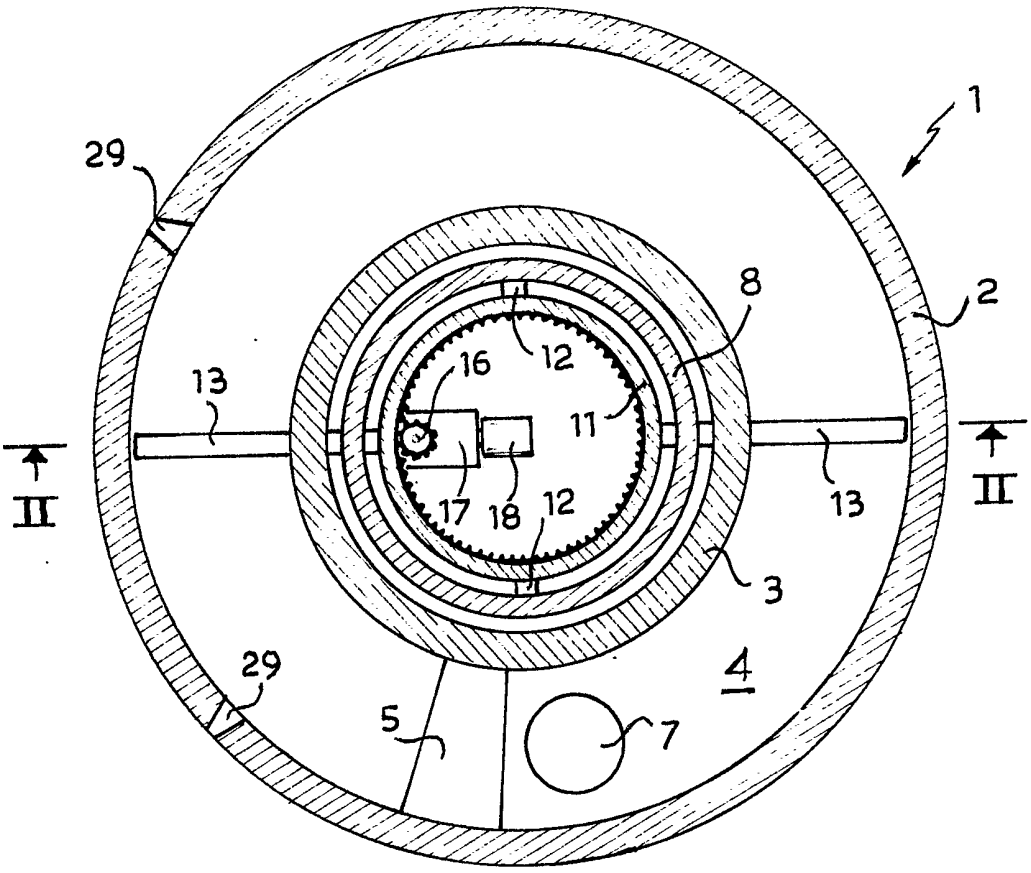
FIG. 1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2
8
13
16
12
11
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18
12
13
II
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3
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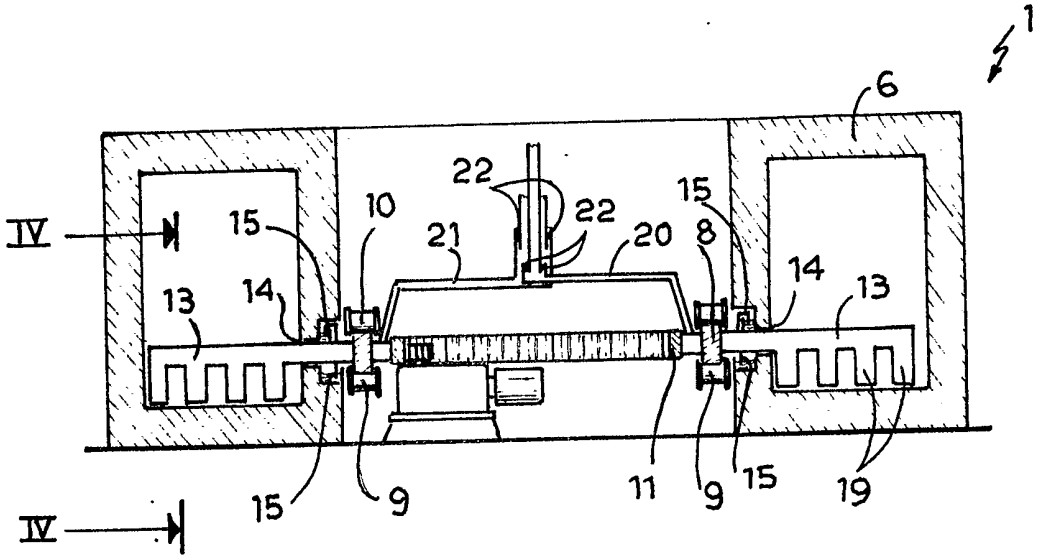
29
5
7


1
6
IV
15
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19
IV

FIG. 2

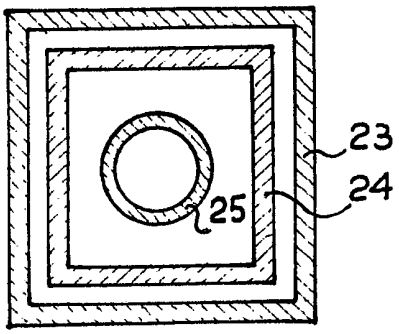

FIG. 3

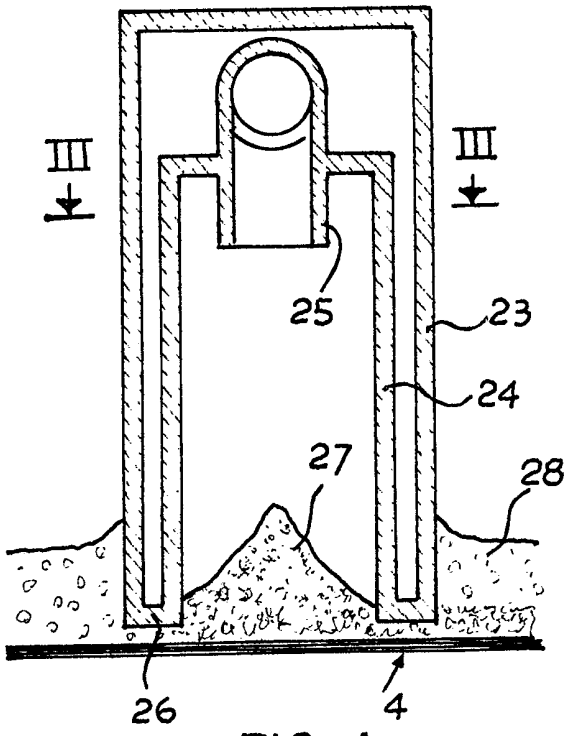

FIG. 4

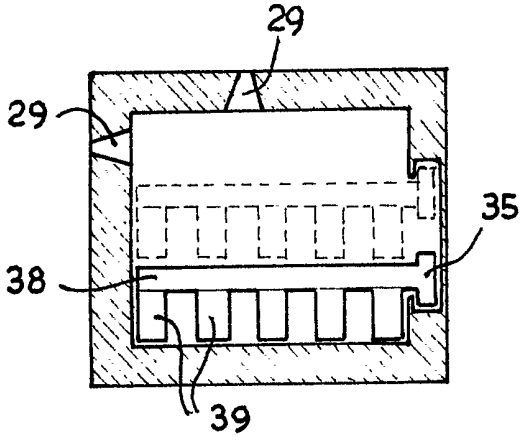

FIG. 5

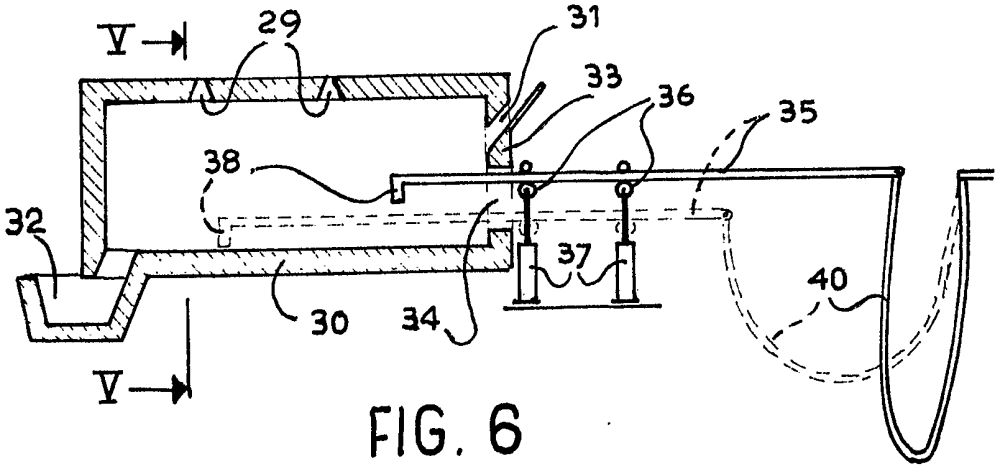

FIG. 6

SPECIFICATION

Industrial furnace

The present invention relates to an industrial furnace, and more particularly to a heating and/or reducing furnace for treating materials in powder and/or small pieces.

The furnaces intended for such operations have a small thermal efficiency as the material becomes strongly heated at the surface exposed to the heat source but badly transmits the heat to the interior of the bulk. Moreover these furnaces are complex and therefore expensive; in particular they use complex means to move the material from the charge to the discharge orifices and often the reducing furnaces cannot use the combustible gases, in particular the carbon oxide developing during the reduction.

The invention aims to obviate to the above mentioned drawbacks and to provide a furnace which is simple to construct and easy to operate, and which has a long life and allows a continuous operation.

In its more general aspect, the furnace comprises a chamber, which has refractory walls, is arranged to receive thermal energy from electric means and/or from a fuel, has inlet and discharge orifices and is equipped with means which stir the material inside the chamber and push it from the inlet zone to the discharge zone.

These stirring and pushing means comprise a movable rod ending in a cross-bar having downward projecting teeth.

In case the furnace is to operate at a relatively high temperature, above 1000°C, the movable rod, the cross-bar and the teeth are hollow elements in which a cooling fluid can flow.

The furnace according to the invention may have several different shapes; to achieve the above mentioned requirements of simplicity, the chamber can suitably have either a circular or a rectilinear plan.

The stirring and pushing means, consisting of said moving rod, cross-bar and teeth, may have cavities of relatively large sections, through which the whole furnace charge or a part thereof can also pass.

The invention will be better understood with reference to the accompanying drawings, in which:

— Figure 1 is a horizontal cross sectional view of a furnace according to the invention, of the annular type;

— Figure 2 is a vertical cross section through the annular furnace of Fig. 1;

— Fig. 3 is a horizontal cross section on enlarged scale of a tooth pushing the material;

— Fig. 4 is a vertical cross section of the tooth shown in Fig. 3;

— Fig. 5 is a vertical cross section of a furnace with rectilinear axis, and

— Fig. 6 is a vertical longitudinal section on a reduced scale of the furnace shown in Fig. 5.

If the material to be heated is also to be reduced, for instance with coal, so that carbon monoxide develops during the reaction phase, by introducing into the furnace air, possibly pre-heated, the combustion of CO to CO_2 can be exploited within the furnace. The furnace can have burning nozzles or even air supplying nozzles.

If coal in powder or in small pieces is introduced into the furnace, it can be gasified with air or even water, producing CO and H_2.

According to a first embodiment (Figs. 1 and 2) the furnace, when viewed in plan, has the shape of an annulus delimited by outer and inner refractory walls 2, 3, connected by a sole 4 having a discharge orifice 5 and by a crown 6 through which a charge duct 7 is realized. Wall 2 is pierced by burners 29.

Internally to wall 3 a metal gear 8 is supported by a set of rollers 9 and is kept in its position by a second set of upper rollers 10. Said gear is rigidly linked to another gear 11 internal to the first one and fastened thereto by spokes 12 and arms 13 which pass through inner wall 3 having an opening 14 (Fig. 2) with a gas-tight labyrinth seal 15. Gear 11 is an internal gear and meshes with pinion 16 driven by reduction gear 17 in turn driven by motor 18.

As shown in Fig. 2, arms 13 extend over almost the whole radial width of the furnace chamber and have downward projecting teeth 19.

In correspondence with the furnace centre, at a certain height above the gear 11, connecting members, for instance bars 20 and 21 linking arms 13, are provided.

According to a first embodiment such arms, as well as arms 13 and teeth 19, may be solid. In this case bars 20, 21 and the rotatable joint with seals 22, shown in Fig. 2, can be dispensed with. This solution is convenient when the furnace is intended for operation at relatively limited temperature, for instance up to 1000°C.

According to a second embodiment arms 20, 21, arms 13 and teeth 19 are hollow, and the respective cavities communicate with one another thereby allowing the circulation of a cooling fluid (for instance water, air, water vapour, gas, etc.) so that the furnace can operate at high temperature. In this case, as shown in Fig. 2, hollow bars 20, 21 are fed from the outside through a rotatable joint whose tightness is achieved through seals 22.

According to a third embodiment, besides said communicating cavities, other cavities are provided which communicate with the furnace interior, for instance through the tooth bottom. In this case the rotating seal joint comprises three coaxial tubular elements two of which serve for the inlet and outlet of the cooling fluid and the third is intended for the introduction of a material in powder or in small pieces, such as ore and/or fuel, which forms a part or the whole of the furnace charge.

A solution of this kind is shown in Figs. 3 and 4, which are cross sectional views of a tooth 19 with a first, outer pipe 23, a central pipe 24 and an inner pipe 25. Pipes 23 and 24 are connected at their lower end by a square ring 26.

Fig. 4 shows material 27 outgoing from the

tooth and material 28 lying on furnace sole 4.

The operation of the described furnace is as follows: through orifice 7 a first part of the material to be heated and/or treated is introduced; arm 13, driven by motor 18, rotate and through teeth 19 stir and push the material to be treated. After a run somewhat shorter than a complete turn, the material has been sufficiently heated for instance by burners 29 and has arrived in correspondence of orifice 5 through which it falls in an underlying container.

In the case of the high-temperature furnace the fluid arriving through the rotating joint with seals 22 cools arms 13 and teeth 19 and is upward discharged through the same rotating joint.

In the case of the third embodiment, the material is introduced through the cooled teeth (Figs. 3, 4).

Figs. 5 and 6 shown the realization of the invention by a furnace with rectilinear axis. In this case means are to be provided allowing reciprocation of the toothed arms, with means for lifting said arms and teeth to avoid that during the return stroke the teeth come into contact with the material thereby hindering the forward movement thereof. A chamber 30 of refractory material, preferably of parallelepipedal shape, with burners 29 in the crown and/or in the walls, has a charge opening 31 and a discharge opening 32. Vertical wall 33 has an opening 34 for passage of an arm 35 supported by rollers 36 driven by a motor, not shown. These rollers are in turn supported by jacks 37. Arm 35 ends within the furnace in a cross-bar 38 having teeth 39. At the opposite end arm 35, which is assumed to be hollow, is connected to at least a pipe 40 supplying the cooling fluid and/or the charge material.

The operation of the furnace is the same as that of the circular furnace, the only difference being that jacks 37, when arm 35 has ended its stroke to the left, allow it to be lifted to such an extent that the teeth are no longer in contact with the material, to move the arm back to the starting position. The crucible shown at output 32 can be heated by an electric arc or by a combustion torch thereby melting the material contained therein. The same arrangement may be provided for the container receiving the material from orifice 5 (Fig. 1).

The furnace according to the invention is very well suited to treat small material which in the conventional furnaces creates several difficulties.

It is self evident that in the practice variants and modifications are possible without departing from the scopes of the invention.

CLAIMS

1. An industrial furnace comprising a chamber having refractory walls and arranged to receive thermal energy from electric means and/or from a fuel, wherein the chamber is provided with an inlet orifice and a discharge orifice and is equipped with means for stirring the material within the chamber and pushing it from the inlet zone to the discharge zone.

2. A furnace according to claim 1, wherein the stirring and pushing means comprise at least a rod which supports, directly or through a cross-bar, downwardly projecting teeth.

3. A furnace according to claim 2, wherein the rod, the cross-bar if present, and the teeth are hollow, having internal cavities in communication with one another for the circulation of a cooling fluid such as water, water vapour, air, gas or the like, which fluid is discharged outside the furnace.

4. A furnace according to claim 2 or claim 3, wherein the rod, the cross-bar if present, and the teeth have also a set of communicating cavities which communicate also with the furnace interior for the introduction of charge materials into the furnace.

5. A furnace according to any preceding claim, having an annular plan, defined by outer and inner refractory walls which are connected by a floor having a discharge orifice and by an upper wall having a charge duct,

wherein the furnace further comprises a metal gear arranged internally to the inner wall and supported and located by rollers, and a second gear attached to the first gear by radial arms passing through an opening provided with a sealing labyrinth, the second gear being an internally toothed gear meshing with a pinion driven by a motor with a reduction gear.

6. A furnace according to claim 5, wherein the radial arms are connected by rods, preferably hollow, connected with the outside through a rotating joint with seals.

7. A furnace according to claim 6, wherein the radial arms are provided with hollow teeth having cavities for the circulation of cooling fluid and pipes ending within the furnace for the introduction of material.

8. A furnace according to any of claims 1 to 4, wherein the chamber has a charge orifice and a discharge orifice, and a side window for the passage of a hollow arm supported by motor driven rollers in turn supported by jacks, the arm being connected, outside the furnace, to a flexible pipe supplying cooling fluid and/or charge material, the arm being connected inside the furnace to a cross-bar provided with teeth, the jacks allowing a forward stroke of the arm within the furnace with the teeth in a lowered position and a return stroke with the teeth being raised.

9. An industrial furnace, constructed and arranged substantially as herein described and shown in the drawings.

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