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L. CONANT
FURNACE

2,773,750

Filed June 14, 1951

2 Sheets-Sheet 1

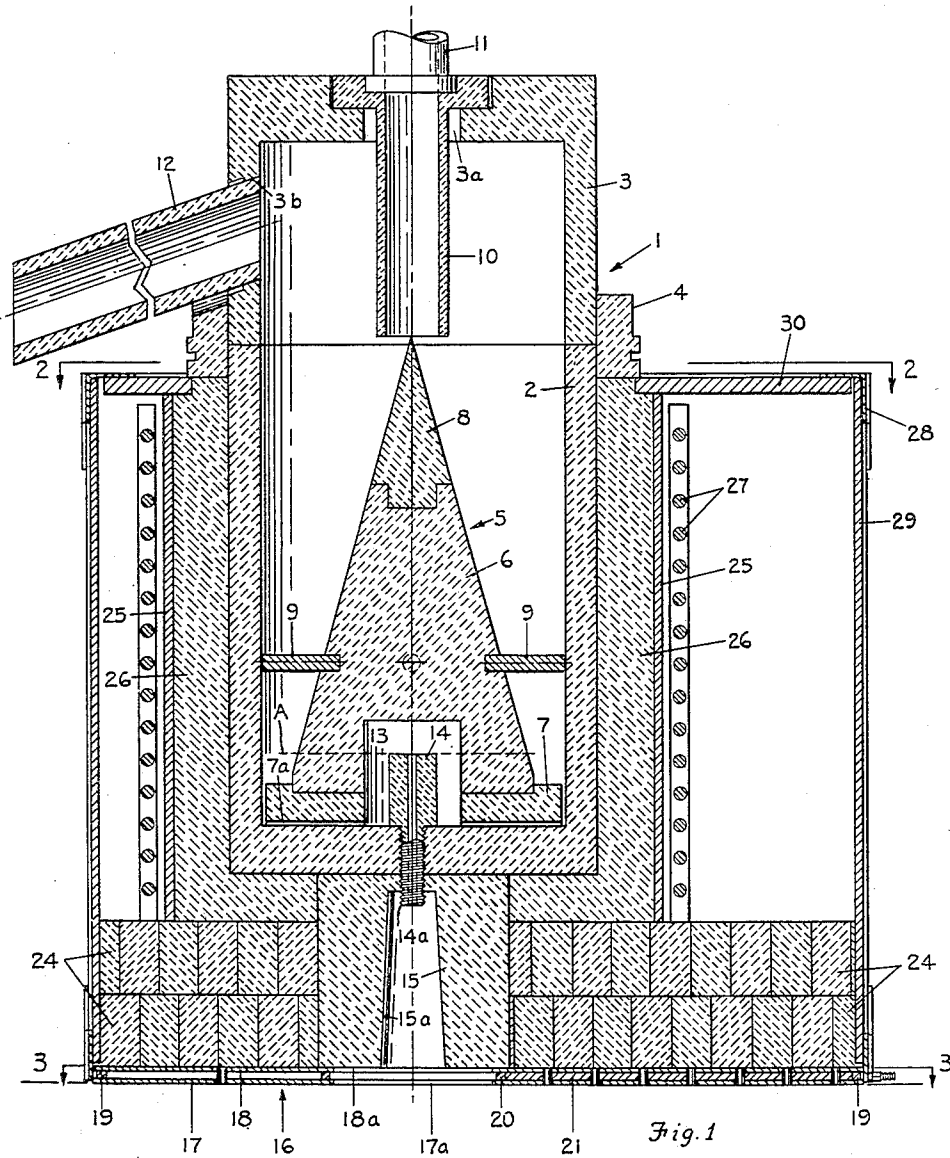


Fig. 1

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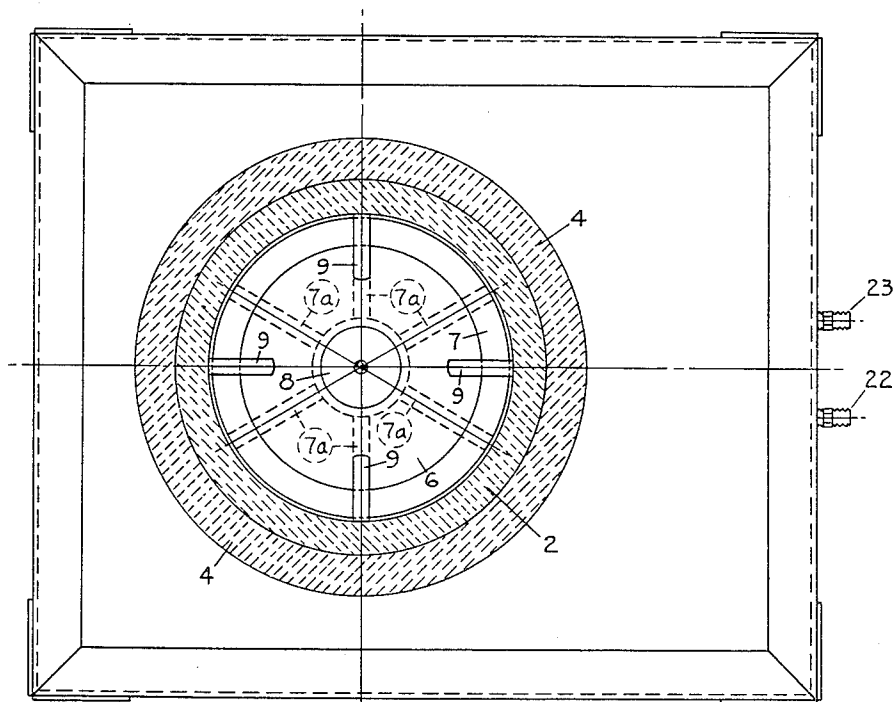


Fig. 2

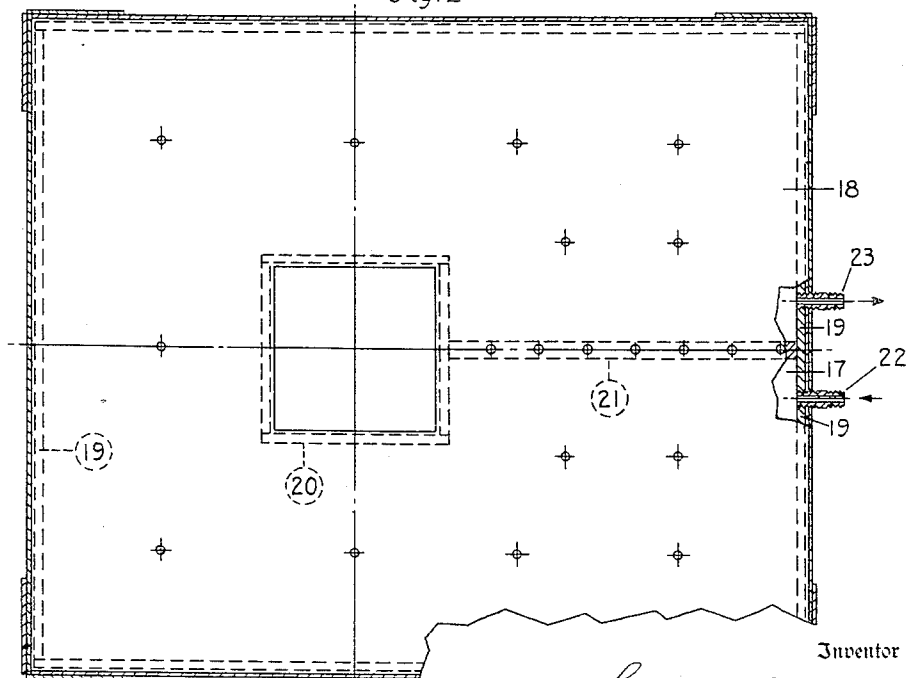


Fig. 3

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6 Claims. (Cl. 23—277)

The invention relates to furnaces of the type having a treating chamber into which materials are charged for thermal treatment, and the invention relates more particularly to an improved heating chamber structure for such furnaces.

It is an object of the invention to provide a furnace having a treating chamber structure of improved thermal efficiency and capable of rapidly applying heat from an external source to a charge under treatment.

It is also an object of the invention to provide a furnace having an externally heated treating chamber structure of high thermal efficiency and adapted for treatment of materials that are highly corrosive when heated.

The invention has for another object the provision of a furnace having a treating chamber structure especially adapted for the treatment of materials which cause or is accompanied by the presence of gases or vapors within the charge under treatment, the construction being such as to insure the discharge of such gases or vapors from the treating chamber without undue or dangerous accumulation of pressure in the chamber.

A further object of the invention is to provide a furnace for simultaneously treating materials in solid, molten and vapor states and adapted to effect separation from the solid material of the materials in the molten and vapor states and effect separate discharge of the two latter materials from the treating chamber of the furnace.

With the foregoing and other incidental or ancillary objects in view, the invention consists in certain forms, arrangements, and combinations of structural parts hereinafter described and particularly defined in appended claims, the description of an exemplary form of construction being set forth in connection with the accompanying drawings.

In the drawings,

Fig. 1 is an axial vertical section of the furnace.

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

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

Referring in detail to the furnace shown in the drawings, 1 designates as an entirety a furnace treating chamber structure which is designed to be heated by external means hereinafter described and comprises a crucible 2 having a flat bottom wall and cylindrical side walls, a cover or dome 3, which rests upon the top of the crucible 2 with a closely fitting joint and a sealing ring 4 which is disposed to cover the said joint.

The treating chamber structure further comprises an interior crucible core designated as an entirety by the numeral 5 and comprising a conical body part 6, a circular base 7 which is formed with a top recess to receive the bottom of the body 6, and a pointed top piece 8. The core base 7 rests directly on the bottom wall of the crucible 2 with the major parts of the lower surface of the base and of the upper surface of the bottom wall of the crucible in good heat-conducting mutual engagement. The body 6 of the core is fitted

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with four graphite pins 9, the ends of which engage the inner side wall surface of the crucible 2 and serve to center the entire core structure in the crucible.

The cover 3 has a central aperture 3a in which is fitted a depending flanged feed tube 10 through which solid material to be treated may be charged into the crucible 2, the material being delivered to tube 10 from any conventional feed mechanism (not shown) through a conduit 11 which is preferably made of stainless steel. The cover 3 is formed also with an opening 3b in its side wall to receive the downwardly inclined discharge conduit 12 through which vaporous products may be discharged from the treating chamber.

The body 6 of the core structure has its bottom formed with a downwardly opening recess and base 7 is formed with a central aperture registering with the recess so as to form in the bottom of the core structure a chamber 13 in which is arranged a circular weir piece or conduit 14 which also constitutes a part of the treating chamber structure of the furnace and has a lower reduced section formed with screw threads 14a which engage mating threads formed in the bottom wall of the crucible 2 and the top of a supporting block 15 which has a downwardly opening recess 15a into which the lower end of the weir 14 projects. Thus constructed and mounted, the weir piece 14 has good heat-conducting engagement with the bottom wall of the crucible and with the block 15.

The bottom of the core base 7 is formed with a plurality of radially extending shallow grooves 7a which form restricted communicating passages leading from an annular space between the inner side wall of the crucible 2 and the outer surface of base 7 to the chamber 13. Thus molten material that settles in the bottom of the treating chamber may find its way through passages 7a into the chamber 13 and thence over the top of the weir member 14 to be discharged through the weir opening from the bottom of the furnace. The elevated weir thus maintains in the bottom of the furnace a bath of hot molten material up to the level of line A. This body of molten material forms an effective liquid seal for all of the passages (7a) leading from the main charge space of the crucible to the molten material outlet conduit through the weir. Should solid lumps of the charge material find their way to the outer ends of passages 7a they are held back by the restricted size of the passages until the material is molten. Thus both vapors and molten material are separated from solid material under treatment and are separately discharged from the furnace.

All parts of the treating chamber structure of the furnace, are formed of nonmetallic refractory material. The material of at least the crucible 2 and the core structure 5 should also have good thermal conductivity, that is to say, not substantially lower than that of graphite; and at least the side walls of the crucible of the structure should preferably have sufficient electric conductivity to permit satisfactory induction heating of the furnace. For at least some uses graphite is a preferred material for all parts of the treating chamber structure, including inlet conduit 10 and outlet conduit 12, because graphite is highly refractory, both chemically and thermally, and has good thermal and electrical conductivity. However, in its broader aspects the invention is not limited to the use of graphite alone. The supporting block 15 also is preferably formed of graphite and its upper part is heated by coil 27 both directly and indirectly through the bottom of crucible 2 which tightly engages it. This heating helps to insure the maintenance of the weir conduit at a sufficiently high temperature to prevent freezing of the molten material therein.

The block 15 rests upon a water-cooled support structure designated as an entirety by 16 and comprising metal

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plates 17 and 18 between which are interposed an outer rectangular metal frame 19 and an inner frame 20 which surrounds plate apertures 17a and 18a beneath the recess 15a of block 15. Support 16 is also provided with a partition 21 extending from frame 19 to frame 20 on one side of the plate apertures. The various parts of the support structure 16 are suitably welded together to form a water tight chamber therein. Adjacent the partition 21 frame 19 is fitted with a water inlet conduit 22 and a discharge conduit 23 so that cooling water entering the chamber of the support 16 may be suitably distributed therethrough before issuing through the discharge conduit.

Two layers of blocks 24 of fire brick or other refractory structural material of low thermal conductivity rest upon the cooling plate 16, and upon the top layer is disposed an upright wall 25 of refractory material, such as "Transite," which encloses a space surrounding the side walls and part of the bottom wall of the crucible which is filled with tamped loose refractory material 26 of low thermal conductivity. Outside the wall 25 and relatively close thereto is arranged a high frequency electrical coil conventionally indicated at 27 by which the treating chamber structure can be inductively heated in well known manner.

An outer enclosing structure for the furnace is provided in the form of a top rectangular frame and corner uprights, all formed of angle members 28, 28, preferably made of aluminum alloy, the lower ends of the upright angles being attached to the supporting base 16. To the angle frame structure are attached side walls 29 and a top wall 30 both of which may be formed of a material such as Transite. The enclosed space to the right of the coil 27 in Fig. 1 is made large enough to accommodate electrical control apparatus (not shown) for the furnace.

In order to indicate the advantages of the furnace construction which is shown in the drawings it will be convenient to describe the use and operation of the furnace for the decomposition of ammonium beryllium fluoride which is a highly corrosive substance when heated. The solid double salt on being charged into the treating chamber of the heated furnace up to a suitable level near the top of the core structure 5 is subjected to the heat of the hot side walls of the crucible 2 both by conduction and by radiation from the side walls. However the salt is not a good conductor of heat and for that reason the temperature of the charge tends to rise relatively slowly as the material of the charge moves slowly downward toward the bottom of the crucible. With the present furnace this undesirable condition is to a very substantial extent overcome by the fact that heat is transmitted from the bottom wall of the hot crucible upward into the core structure 5 so that the temperature of the core is raised above the temperature of the charge immediately surrounding it. For this reason the charge is brought to the decomposition temperature in a shorter time than would be possible without the use of the core structure. As the charge progresses downward in the treating chamber of the furnace the double fluoride salt is decomposed into beryllium fluoride and ammonium fluoride, the former settling in a molten state in the bottom of the furnace while the ammonium fluoride in a vapor state is drawn off through the outlet conduit 12. The elevation of the outlet weir 14 above the bottom of the crucible maintains a molten bath of the beryllium fluoride up to the level of line A and this highly heated bath, surrounding the lower part of the core structure, facilitates the heating of the latter.

Notwithstanding the more efficient heating of the charge attended by the use of the core structure the solid double salt may progress downward in the crucible to a considerable extent before decomposition occurs and since decomposition is accompanied by the evolution of rather large volumes of vapor there is danger of the building up of dangerously high vapor pressures within

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the charge. Indeed such pressures might easily reach an intensity that would result in blowing the dome off the furnace with resultant damage of the apparatus and endangering of attendants. By the tapered form of the core structure 5 such danger is avoided since even a relatively small lifting of the charge by the pressure of gases or vapors therein results in the formation of a clearance between the charge material and the converging sides of the core so that the gas or vapor generated in the body of the charge is afforded relatively free passage to the furnace outlet conduit 12. In the manner previously explained both the vapors (ammonium fluoride) and the still solid parts of the charge are prevented from having access to the discharge passage for molten material. Furthermore, the provision for effective heating of the weir member prevents freezing of the molten material in the discharge conduit.

It will be apparent that the improved furnace is designed to effect a continuous discharge of molten material through the elevated weir and by providing apparatus capable of continuously charging the furnace the latter may be operated continuously with high efficiency for prolonged periods of time.

It will be understood that the description of the operation of the furnace for the decomposition of the double fluoride salt is intended entirely for the purpose of explanation and is in no way to be considered as limiting the use of the furnace. On the contrary, one or more of the advantages incident to the improved construction of the furnace may be had in the treatment of a wide variety of materials. It will also be apparent that the novel form of the treating chamber structure and more particularly of the crucible with core, may be embodied in apparatus of various types and forms and with the use of various forms of heating means, the scope of the invention being indicated by the appended claims.

What is claimed is:

1. In a furnace, the combination of a closed chamber structure comprising a crucible with bottom and side walls formed of refractory material of good thermal conductivity, a cover closing the top of the crucible, and a solid core structure of considerable mass formed of refractory material of good thermal conductivity and supported directly on the bottom wall of the crucible with the major part of its bottom surface in good heat-conducting engagement with the major part of the upper surface of the bottom wall of the crucible, the core structure extending upward from the crucible bottom wall to form for the furnace an annular charge-treating space between the core structure and the side wall of the crucible and the chamber structure having in the upper part thereof a charging opening for delivery of solid material into the annular charge-treating space and a separate discharge opening for vapors and having in the bottom thereof a discharge passage for molten material; and means wholly outside the charge-treating space for heating the side and bottom walls of the crucible and causing effective heating of the core by the conduction of heat thereto from the bottom wall of the crucible.

2. A furnace as claimed in claim 1 in which the horizontal cross-sectional area of the annular charge-treating space is substantially smaller in the lower part of the space than it is in its upper part.

3. A furnace as claimed in claim 1 in which there is a lateral clearance space between the bottom part of the core structure and the inner surface of the crucible side wall, in which the bottom of the core structure is formed with a central downwardly-opening recess, in which the bottom surface of the core is grooved to form a plurality of radial passages for molten material between the said lateral clearance space and the said bottom recess of the core, and in which the bottom discharge passage for molten material is provided by an upright conduit extending through the bottom wall of the crucible with good heat-conducting engagement there-

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with and upward in the bottom recess of the core with its upper open end at a level above the level of the said radial grooves in the bottom surface of the core.

4. A furnace as claimed in claim 1 in which the horizontal cross-sectional area of the annular charge-treating space between the core structure and the side wall of the crucible increases progressively from the bottom to the top of the charge space.

5. A furnace as claimed in claim 4 in which the crucible is cylindrical and the core is conical with an upward taper.

6. In a furnace, the combination of a closed chamber structure comprising a crucible with bottom and side walls formed of refractory material of good thermal conductivity, a cover closing the top of the crucible, and a solid core structure of considerable mass formed of refractory material of good thermal conductivity and supported directly on the bottom wall of the crucible with the major part of its bottom surface in good heat-conducting engagement with the upper surface of the bottom wall of the crucible, the core structure extending upward from the crucible bottom wall to form for the furnace an annular charge-treating space between the core structure and the side wall of the crucible and the chamber structure having in the upper part thereof a charging opening for delivery of solid material into the annular charge-treating space and a separate discharge opening for vapors and the closed chamber structure being further characterized by a lateral clearance space between the bottom part of the core structure and the inner surface of the crucible side wall, by the formation of the core with a central downwardly opening recess and a plurality of radial grooves in its bottom surface

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forming passages for molten material between the said lateral clearance space and the bottom recess of the core, by an upright conduit extending through the bottom wall of the crucible with good heat-conducting engagement therewith and upward in the bottom recess of the core with its upper open end at a level above the level of the said radial grooves in the bottom surface of the core, the conduit constituting a discharge passage from the chamber structure for molten material; and means wholly outside the charge-treating space for heating the side and bottom walls of the crucible and thereby effectively heating the core and the molten material discharge conduit by conduction of heat to them from the bottom wall of the crucible.

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