

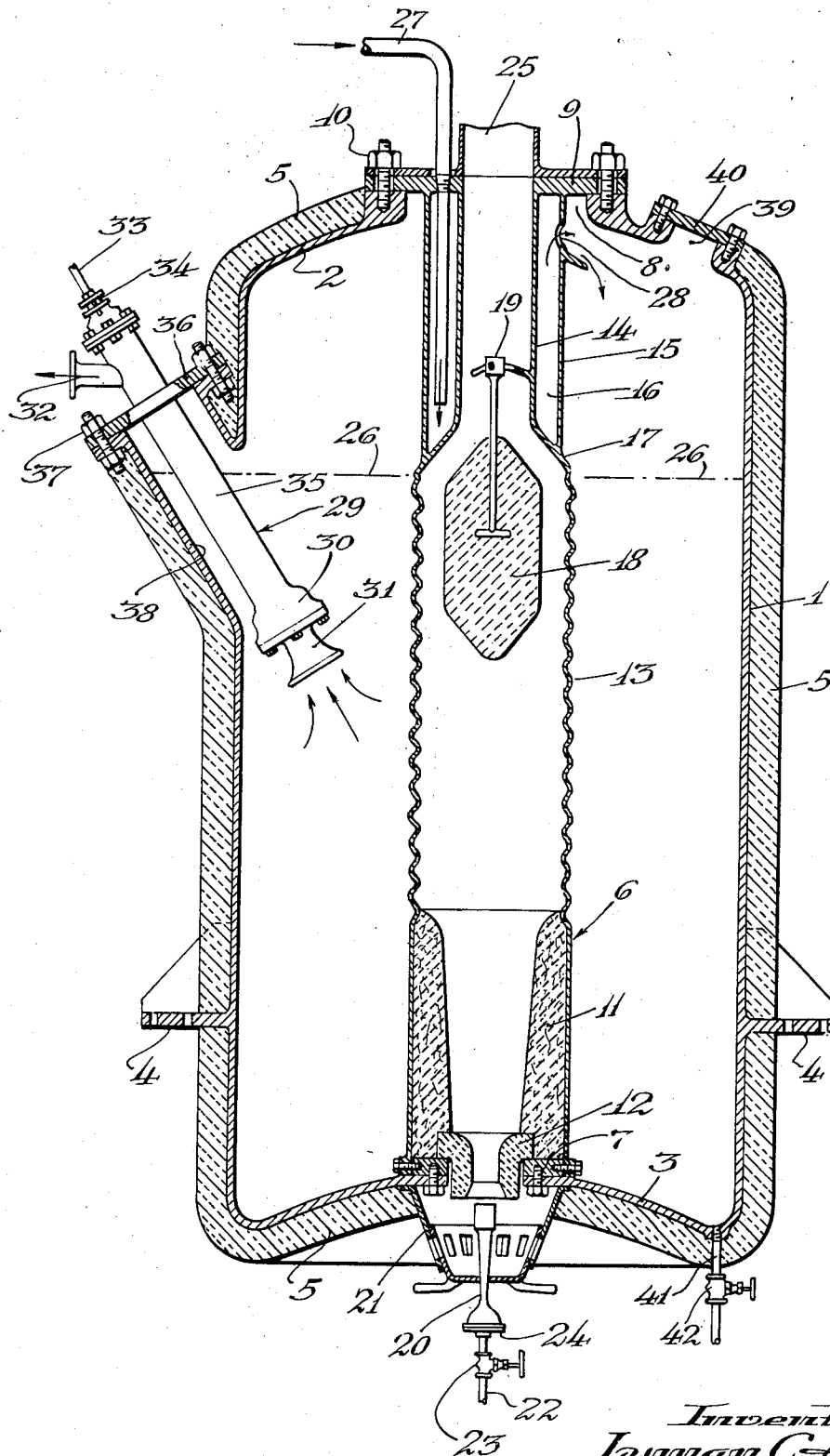
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HEATING AND CIRCULATING DEVICE

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HEATING AND CIRCULATING DEVICE

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5 Claims. (Cl. 126—343.5)

The invention relates to a heating and circulating device which, although adaptable to many other uses, is particularly intended for reducing normally solid materials, such as salt mixtures, for example, to molten or fluid state, heating the fluid to the desired temperature and circulating the same through suitable equipment wherein it is employed as a convective medium.

Numerous chemical processes, including many of the catalytically promoted hydrocarbon conversion processes now being rapidly adopted by the refining industry, must be conducted at carefully regulated, relatively high temperatures. It is often convenient to control the reaction temperature by circulating a convective fluid through the reaction zone in indirect contact and heat exchange relation with the reactants undergoing conversion therein, the temperature of the circulating convective fluid being maintained at a level which will keep the reaction temperature within the desired limits.

Certain materials which are solid at atmospheric temperature and molten or fluid at the temperature required for controlling the particular reaction to be conducted have been found particularly useful for this purpose. They include such materials as low melting point metals and alloys, eutectic and non-eutectic mixtures of two or more metal salts, mixtures of diphenyl and diphenyl oxide, mixtures of metal nitrates and nitrites and the like. The physical and chemical characteristics of many such materials have been determined and the material to be employed may be selected to suit requirements. Its specific composition does not constitute a part of the present invention.

The invention is directed to an apparatus suitable for use as a storage reservoir for such material for reducing the same to molten or fluid state, for maintaining it at the required temperature and for circulating the same from the storage reservoir through the equipment wherein it serves as convective fluid back to the storage reservoir.

The features and advantages of the invention will be apparent to those familiar with the art from an inspection of the accompanying diagrammatic drawing and the following description thereof.

The drawing is an elevational view, shown principally in section, of one specific form of the apparatus provided by the invention.

Referring to the drawing, the vessel here illustrated comprises a vertically disposed, substantially cylindrical outer metal shell 1 provided

with substantially elliptical upper and lower heads 2 and 3, respectively, and provided with supporting lugs 4 for mounting the same on a steel framework or other supporting structure, not illustrated. Heat-insulating material, of any desired form, indicated at 5, is preferably provided about the outer walls of the vessel to prevent the excessive loss of heat therefrom to the atmosphere.

A duct 6 of suitable metal or alloy is provided within the vessel and extends from the lower head 3, to which it is bolted, as indicated at 7, upwardly to an opening 8 provided through the upper head of the vessel. The duct 6 is provided at its upper end with a flange 9 which is bolted to the upper head 2, as indicated at 10, and serves as a closure plate for opening 8. The duct is preferably so constructed that it may be removed from the vessel through opening 8 when flange 9 is detached from head 2 and the bolts at 7 are removed.

The lower portion of duct 6, in the case illustrated, is lined as indicated at 11, with a substantial thickness of refractory and heat insulating material, such as a mixture of fire-clay and exfoliated vermiculite or other insulation with a suitable binder, such as high alumina cement for example, and a refractory burner block 12 is provided at the lower end of the duct.

Circumferential corrugations are provided, as indicated at 13, in the wall of duct 6 throughout a substantial portion of its length, and the upper portion of the duct comprises the concentrically disposed inner and outer walls 14 and 15, respectively, these walls being spaced apart to provide a confined annular zone 16 therebetween, the purpose of which will be later described. A substantially conical section 17 of duct 6 joins its corrugated portion with its walls 14 and 15 and a member 18, preferably formed of suitable refractory material, such as fire-clay or the like, is suspended, as indicated at 19, within the duct immediately beneath the conical section 17.

A suitable burner 20 for fluid fuel, such as gas or oil, is provided beneath the vessel adjacent burner block 12, the mouth of the burner being enclosed by a suitable air-regulating device, such as indicated, for example, at 21. Fuel is supplied to the burner through line 22, controlled by valve 23, and air for mixing with the fuel in the burner may be supplied thereto through the conventional air-regulating device 24 at the outer end of the burner.

The upper end of duct 6 communicates through flue 25 with a suitable stack, not shown, and in

the case illustrated duct 25 is secured to the upper head of the vessel by the same bolts which hold flange 9 in place.

A body of the material to be heated and circulated is maintained within the vessel in the annular space between duct 6 and shell 1, the approximate normal level of this material being indicated in the drawing by the broken line 26. Heat is supplied to this material from duct 6 when burner 20 is fired, the lined lower portion of the duct serving as a combustion zone. Since the lining 11 preferably comprises both heat-insulating and refractory material the lower portion of the duct is protected from the hottest flames and the transmission of heat through the duct to the lower portion of the body of material undergoing heating is restricted.

The corrugations 13 in the wall of duct 6 serve to increase the transfer of heat therethrough to the surrounding body of material in the vessel, and member 18 assists in maintaining a high heat transfer rate through the duct to the upper portion of said body both by restricting the cross-sectional area of the duct at this point, so that the velocity of the combustion gases flowing around member 18 over the corrugated wall of the duct is increased, and by acting as a heat-radiating body. Thus, both the radiant and convection components are increased in the corrugated portion of the duct most remote from the burner and at the approximate level of the upper portion of the body of material to be heated.

Combustion gases after their passage around member 18 flow through the space defined by the inner wall 14 of the upper portion of the duct and thence through flue 25 and from the system. To recover useful heat from the combustion gases in that portion of the duct extending above the normal level 26, above mentioned, and to reduce the stack temperature, fluid from the main body of material being heated in the vessel is returned, after its circulation through the reactor or other equipment, not illustrated, wherein it serves as convective fluid, through line 27 into the space 16 between the walls 14 and 15 wherein it is preheated prior to its return to the main body within the vessel. The preheated fluid from the confined space 16 flows from the upper portion of this zone through a port 28 provided therein into the annular space between the duct and the shell of the vessel, to commingle therein with the main body of fluid undergoing heating in this space.

For effecting circulation of the heated fluid from the main body thereof within the vessel, through the equipment wherein it serves as a convective fluid, back to the vessel, a pump 29 is provided. Although the specific form and construction of this pump is not a limiting feature of the invention, I prefer to employ a pump such as disclosed in my co-pending application Serial No. 444,327 filed May 25, 1942, which is particularly designed for this class of service. The pump 29 is of the centrifugal or rotary type with an impeller, not shown, disposed in the lower portion 30 of the pump case which is immersed in the body of the material undergoing heating within the vessel, the pump taking suction from this body at its lower end through member 31 and discharging the heated fluid through outlet connection 32 on that portion of discharge duct 35 which extends outside the vessel. The pump impeller is driven through shaft 33 by any suitable means, such as an electric motor or a turbine, not illustrated, and the shaft is packed at the outer end of the case as indicated at 34. The

case of the pump comprises an elongated discharge duct 35 connecting the discharge side of impeller chamber 30 with the discharge nozzle 32. Member 35 is connected to and extends through a flange 36 which is bolted, as indicated at 37, to a flanged member 38 provided on the shell of the vessel. Preferably, member 38 extends from beneath level 26 to above the same so that by unbolting flange 36, the entire pump assembly may be removed from the vessel without drawing down the liquid level in the vessel.

It will be understood, of course, that when a normally solid material is to be heated within the vessel and used as convective fluid, the vessel is initially charged with the solid material in subdivided form by dumping it into the vessel through a suitable charging port, such as indicated at 39, which is normally closed by the bolted flange or coverplate 40. After the vessel is thus charged and port 39 is closed, the material is melted and reduced to a molten or fluid state by regulated firing of burner 20 before pump 29 is started. After it has reached the desired temperature the pump may be started and circulation of the convective fluid established.

During operation, while the apparatus is being fired, member 6 will normally be at a substantially higher temperature than the shell of the vessel and will tend to expand a greater amount than the shell. The difference in longitudinal expansion and contraction between the shell of the vessel and member 6 is accommodated in the corrugated section 13 of member 6. Thus, the corrugated section 13 not only serves to increase the heat dissipating surface of member 6 and thereby increase the heat transmitted to the surrounding body of material undergoing heating within the vessel, but it also serves as an expansion device to prevent the development of excessive stress, as a result of differential expansion and contraction between the member 6 and the shell of the vessel.

The substantially vertical disposition of member 6 within the body of material undergoing heating is also advantageous in operations wherein the material employed as convective fluid is solid under conditions which prevail within the vessel when it is not in operation. When it becomes necessary to shut down the process for any reason and firing of the device is discontinued, the convective fluid stored within the vessel and drained back thereto from the reactor or other device through which it is normally circulated will solidify upon cooling. This material may be drained from the vessel while hot, through drain line 41 and valve 42, but it is desirable to retain it therein to avoid the necessity for grinding or pulverizing the same and recharging the vessel prior to subsequent operation thereof. Difficulties would be encountered in melting or liquefying the solid mass except for the disposition of member 6 in a substantially vertical position or in a position such that it extends from the lower portion of the vessel to or above the level of solid material. Otherwise, material melted or liquefied in the lower portion of the mass before its upper portion becomes molten will be trapped beneath the solid mass and, upon expansion due to its increased temperature, may cause serious damage to the apparatus. With member 6 disposed and constructed in the manner provided, the material immediately adjacent this member will be quickly liquefied and the hot liquid will flow along the wall of member 6 to the upper

portion of the mass regardless of which section of member 6 is the hottest.

The disposition of refractory insulating material, as indicated at 11, at the lower end of member 6 also assists in preventing the aforementioned difficulties upon starting the device by reducing the heat input to the lower portion of the mass of solid material. Member 18 is also of assistance in this respect since it serves to increase the heat transmitted to the upper portion of the mass.

I claim as my invention:

1. An apparatus of the class described comprising, in combination, a substantially cylindrical and vertically disposed closed vessel, a heating duct extending within the vessel from the lower end to the upper end thereof, means adjacent the lower end of the duct for projecting hot combustion gases upwardly therethrough, means for removing combustion gases from the upper end of the duct, an annular space being provided between said duct and the wall of the vessel for the reception of a mass of material to be heated, means for admitting material to be heated to said annular space and means for discharging heated fluid from said annular space and from the vessel, walls forming a confined

zone about the upper portion of said duct, means for admitting material to be heated to said confined zone, and means for directing material from said confined zone into said annular space.

2. An apparatus such as defined in claim 1, wherein said duct is lined adjacent its lower end with refractory and heat-insulating material.

3. An apparatus such as defined in claim 1, wherein said duct is secured adjacent its opposite ends to opposite ends of the vessel and is provided with circumferential corrugations in its wall intermediate its points of attachment to the vessel.

4. An apparatus such as defined in claim 1, wherein insulation is provided on the lower portion of said duct, and wherein corrugations are provided in the wall of the duct above the insulation.

5. An apparatus such as defined in claim 1, wherein insulation is provided on the lower portion of said duct and wherein a refractory member is positioned within the upper portion of the duct, said refractory member being spaced from the wall of the duct to provide a zone of restricted flow therebetween for the combustion gases.

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