My invention relates to large reaction vessels such as vertical chambers or towers employed in industrial processing, as for example coking towers for accumulation of coke products of petroleum refining, sponge-iron reactors, and the like.

Reactors of the character indicated may be in the order of 20 to 30 feet in diameter and extend on a vertical axis fifty, eighty or one hundred feet high. From time to time they must be cleaned of the accumulated solid matter (e.g., a de-coking operation, in the case of a coking tower), and this operation is performed by first removing a bottom door to expose a central opening in the tower, and by then boring out the solid matter, using a large rotating drill rig having an elongated stem or Kelly shaft sunk and journalled below grade level.

In the past, the closure door for such reactors or towers has been generally flat, and there have been numerous flat surfaces presented not only to the accumulating solid matter but also to the solid matter being removed. Furthermore, the means for securing the door have been subject to numerous inconveniences, so that not only is excessive time wasted in opening the door, but parts are damaged and must be replaced before the reactor can be returned to service.

It is, accordingly, an object of the invention to provide an improved door construction for a reaction chamber or tower of the character indicated. Another object is to meet the above object with a structure in which no horizontal surfaces are presented either to the accumulating solid matter or to solid matter being removed.

A further object is to provide a door construction which can be manipulated with relative ease, and without fouling other parts. It is also an object to provide an improved door construction which will inherently aid in centering the boring tool used to clean out the accumulated solid matter. It is a general object to meet the above objects with a structure of relative simplicity, and yet rugged, sealed and insulated in such manner as to assure increased life and utility as compared with prior constructions.

Other objects and various further features of novelty and invention will be pointed out or will occur to those skilled in the art from a reading of the following specification in conjunction with the accompanying drawings.

In said drawings, which show, for illustrative purposes only, a preferred form of the invention:

FIG. 1 is a fragmentary simplified view in elevation of a reactor vessel, coking tower or the like embodying a bottom-closure means of my invention;

FIG. 2 is an enlarged sectional view taken in the plane 2—2 of FIG. 1;

FIG. 3 is a still further enlarged, fragmentary sectional view of clamping means and of the fit of the bottom-closure means of FIG. 1, taken in the plane 3—3 of FIG. 5;

FIG. 4 is a side view in partial section of the clamping means of FIG. 3, taken along the line 4—4 of FIG. 3 but on a scale reduced from that of FIG. 3;

FIG. 5 is a fragmentary view, from beneath the closed vessel of FIG. 1, and showing features of the closure means, clamping means, and release mechanism of the invention;

FIG. 6 is an enlarged fragmentary view of the release mechanism of FIG. 5, parts being sectioned in the plane 6—6 of FIG. 5.

Briefly, the invention contemplates closure of the bottom opening in a reactor or the like embodied by employment of a dished circular door presented in a domed or generally conical convex surface projecting into the inner volume of the reactor. The interfit of this door to the body of the reactor is such as to present only downwardly sloping smooth surfaces to the accumulating solid matter and to the solid matter being removed. The configuration is such as to have molded the accumulated solid mass with a concave conical shape, centered on the reactor axis and uniquely adapted to align a de-coking or the like boring or drill bit for accurate self-centered boring into the solid mass.

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Referring to Figs. 1 and 2 of the drawings, the invention is shown in application to a cylindrical vessel, reactor or tower having a body 10 extending on an upward or vertical axis and provided with a central circular opening at the lower end. Generally, the bottom end is of funnel shape, as defined by converging walls of a conical portion 11, and the diameter of the opening is essentially one-half the bore diameter of the main body 10 of the chamber. The chamber itself rests on legs 12 supporting the entire structure above grade level, so that to dislodge accumulated solid matter access may be had through a removable closure or door 13 sealing off the bottom opening of the vessel. Conventional means, such as a Kelly shaft (not shown), is employed for boring out the accumulated solid matter so that it may be dislodged merely by dropping onto a suitable conveyor belt for remote transport.

In my copending patent application Ser. No. 361,122, filed Apr. 20, 1964, now Patent No. 3,280,416, I describe an improved drilling mechanism of the general character to which I allude, and therefore reference may be had to such description and disclosure for a better understanding of the reference to a Kelly shaft.

As will be seen in FIG. 2, the shape of the closure or door 13 is circular and dished upwardly, thus presenting a convex surface of generally conical dome shape projecting up into the volume of the chamber 10. Preferably, the flare or downward slope of the conical surface of the door 13 conforms with the shape of the drill used to bore out the accumulated solid matter. Also preferably, the central or nose end of the door 13 is rounded and tangentially merged to the overall generally conical configuration of the door surface.

As other features matter, in fabricating a door such as that of FIG. 2, several separable parts may be involved; these are shown welded to each other. Thus, the rounded nose piece 14 may be a separate steel casting, that is, separate and apart from the generally conical main body 15 to which it fits and to which it may be secured by
welding, as indicated at 10'. Greater strength and cross-section are desired in the outer part of the door 13, namely, the skirt part 16, which may be another steel casting, secured by welds 17 to the main body 15. In spite of the number of parts making up the door 13, it will be appreciated that the overall convex surface thereof presents nothing but smooth and continuously related downward slopes, and that these slopes extend into substantial overlap with the adjacent edge of the reactor, at the bottom opening thereof.

To complete the description of the door 13, the outer edge of skirt 16 is provided with notches or radial slots 18 at angularly spaced locations, for securing purposes, as will later be clear. Also, for manipulative purposes, a flat circular plate or platform 19 bridges and reinforces the nose 14, being welded in place, as shown. A central hole 20 in plate 19 serves to locate the upwardly projecting lip end of the Kelly shaft 21 (or of a suitably shrouded fitting carried thereby), so that when released from the tower opening, door 13 may be lowered, removed, and replaced, using the elevating mechanism (not shown) of the Kelly-shaft assembly. Radial struts 23 and arcuate segments 22 between plate 19 and nose 14 are welded in place and serve to distribute the weight of door 13 at its connection to plate 19.

In reaction chambers involving materials corrosive to the described parts, it is desirable to provide stainless-steel cladding on all interior surfaces. For door 13 (FIG. 3), such cladding is indicated at 24 and at 24' for the skirt and body parts 16 and 15, respectively.

Basic construction of the reactor funnel 11 may be as described for door 13. Thus, a steel casting 11 is shown welded to the funnel body 11, and the interior surfaces of both parts are lined with stainless-steel cladding. Also, another steel casting 25 is welded at 26-26' to the member 11' of the reactor opening, presenting a generally concave conical surface for overlap and sealing engagement with the skirt 16 of door 13. To promote the seal, the lip casting 25 is provided with a circumferentially continuous groove 28, which, with the portion exposed to the inner volume of the reactor, is shown lined with stainless-steel cladding 27. The seal means carried in groove 28 contemplates heat and liquid barriers, provided by separate circumferentially continuous compressible rings 29-30, fitting the inner and outer corners of groove 28 and projecting downwardly for compressed sealing contact with skirt 16; the heat-barrier ring 29 may be made of asbestos material, and the liquid-barrier ring 30 may be of primarily rubber-like material. A clamp or wedge ring 31 is shown wedged between both barrier rings 29-30 in place and is itself removably secured by plural spaced screws, as at 32.

To removably retain door 13 in place, the invention provides plural swing bolts 35, mounted on the reactor at such locations outside the outer radial limits of door 13 that, when released and allowed to hang vertically (phantom outline in FIG. 3), the bolts 35 and the washers and nuts 36-37 carried thereby will be clear of door 13 as it is manipulated out of and back into closed position. Thus, the ring casting 11' forming part of the funnel structure is provided with slotted openings 18' corresponding with the openings 18 in door 13, to receive the shank of each bolt 35; and the pivot pin 34 for each bolt 35 is carried by two spaced uprighting walls or arms 33 welded to casting 11' at the side walls of each slot 18'. The door 13 is set in place when all nuts 37 have been secured, to uniformly compress seals 29-30 about the circumferential extent of skirt 16.

In order to remove door 13, the Kelly fitting 21 is positioned in supporting relation with plate 19, and door 13 is unfastened by loosening all nuts 37, allowing all bolts 35 to hang free. If a lowering of the Kelly shaft does not also lower the door 13, then the door is stuck, and resort may be had to prying techniques to dislodge it. In the form shown, this is accomplished by imparting incremental rotation to door 13 about its axis, and one or more rotary jacks of the type shown in FIGS. 5 and 6 may be employed. Each such jack involves a short arcuate segment 40 carried by the outer limit of door 13, and pinion means 41 meshes with rack 40. Pinion 41 is carried at one end of a pivot shaft 43, journalled in a suitable bracket or fitting welded at 45-46 to the funnel casting 11'. A crank 43 is removably or permanently fastened (as desired) to a boss or head 47 secured to the other end of shaft 42, thus vertically locating pinion 41.

It will be understood that with suitable extensions, crank 43 may be of such length as to provide sufficient mechanical advantage (amplified if desired by further rotary jacks 40-41 at locations angularly spaced from that shown in FIGS. 5 and 6) to incrementally rotate door 13 and thus crack the bond by which it is stuck in closed position. Door 13 is then free to be lowered by the Kelly fitting 21, and the desired contour of accumulated solid matter is presented at the bottom opening to provide optimum conditions for boring with a Kelly drill.

It will be appreciated that I have disclosed an improved reactor-vessel construction of the character indicated, offering important advantages over the flat doors of previous constructions. With my arrangement, manipulation is facilitated by having all securing bolts 35 swing clear, in non-fouling relation with a lowering door 13. Both the securing means 35-37 and the rotary-jack means 43-41 are to the greatest extent possible retained by the reactor vessel, clear of the door 13 and free from fouling by clinker or other solid matter dislodged during the cleanout operation. The same can also be said of the seal means 29-30, which therefore lend themselves to extended life. No flat horizontal surfaces are anywhere presented for accumulation of solid matter.

While the invention has been described in detail for the preferred form shown, it will be understood that modifications may be made within the scope of the invention as defined in the claims which follow.

I claim:

1. In a reaction vessel of the character indicated, a cylindrical body on an upstanding elongated axis and having on said axis a circular opening at the bottom end, a door for removably closing said opening and comprising a convex circular disk of larger diameter than said opening and adapted to close the opening when the convex portion faces upwardly and projects into the inner volume of said vessel, the convex surface of said door extending continuously to the convexly rounded and releasable clamp means including parts carried by said body and by said door for removably securing said door in closed position.

2. In a reaction vessel of the character indicated, a cylindrical body on an upstanding elongated axis and having on said axis a circular opening at the bottom end, a door for removably closing said opening and comprising a generally conical disk of larger diameter than said opening and adapted to close the opening when convex portion thereof faces upwardly and projects into the inner volume of said vessel, the bottom edge of said convex opening being generally conical and conforming with the local slope of the convex disk when said door is closed, and releasable clamp means including parts carried by said body and by said door for removably securing said door in closed position.

3. A vessel according to claim 2 in which the convex side of said door has a slope down from the horizontal in the range of 20° to 45°.

4. A vessel according to claim 2, in which the convex side of said door has a slope down from the horizontal in the amount of substantially 30°.

5. A vessel according to claim 2, in which the projecting tip of the convex side is rounded and is essentially tangentially formed with the generally conical remainder of the convex side.
6. A vessel according to claim 2, in which the other side of said door includes flat support means with a central opening on the door axis, whereby an upwardly projected lifting tool or jack may be centrally located for balanced handling of the door when said clamp means is released.

7. In a reaction vessel of the character indicated, a cylindrical body on an upstanding elongated axis and having on said axis a circular opening at the bottom end, a door for removably closing said opening and comprising a generally conical disc of larger diameter than said opening and adapted to close the opening when the convex side thereof faces upwardly and projects into the inner volume of said vessel, the rim of the opening of said vessel being formed with a truncated generally conical concave surface of slope matching that of the convex side of said door, whereby the closure effected by said door, is characterized by relatively wide circumferentially extending overlap of said concave surface with the convex side of said door, and releasable clamp means including parts carried by said body and by said door for removably securing said door in closed position.

8. A vessel according to claim 7, in which the fit of said door to said vessel includes a circumferentially extending yieldable seal means carried by and projecting downwardly from said concave surface and compressed into sealing relation with said convex surface upon setting said clamp means.

9. A vessel according to claim 8, in which said seal means comprises spaced inner and outer rings of different seal materials, the inner ring being of insulating material to constitute a heat-barrier seal, and the outer ring being of rubber-like material to constitute a pressure seal against liquid egress.

10. In a reaction vessel of the character indicated, a cylindrical body on an upstanding elongated axis and having on said axis a circular opening at the bottom end, a door for removably closing said opening and comprising a generally conical disc of larger diameter than said opening and adapted to close the opening when the convex side thereof faces upwardly and projects into the inner volume of said vessel, the rim of the opening of said vessel being formed with a truncated generally conical concave surface of slope matching that of the convex side of said door, whereby the closure effected by said door is characterized by relatively wide circumferentially extending overlap of said concave surface with the convex side of said door, and releasable clamp means including parts carried by said body and by said door for removably securing said door in closed position, said mechanism comprising release parts carried by both said door and said body, and acting means reacting between said release parts for applying a unidirectional torque to said door about the door axis.

11. In a reaction vessel of the character indicated, a cylindrical body on an upstanding elongated axis and having on said axis a circular opening at the bottom end, a door for removably closing said opening and comprising a convex circular dish of larger diameter than said opening and adapted to close the opening when the convex portion faces upwardly and projects into the inner volume of said vessel, the convex surface of said door extending continuously to the peripheral limits of the reaction-vessel opening, said door being fully removable from said opening, and releasable clamp means consisting of parts carried by said body and by said door for removably securing said door in closed position, said parts carried by said body comprising plural bolts spaced about the periphery of said opening, each said bolt being pivotally suspended from a point outside of but adjacent the radially outer limit of said door, whereby when released said bolts may hang clear of said door to permit non fouling handling of said door, each bolt being swingable radially inwardly into clamping engagement with the adjacent clamp part carried by said door.

12. The vessel according to claim 11, in which the clamp parts carried by the door project radially outside the limit of said opening and define a radial slot for reception of each swing bolt, and a nut carried by each bolt for securing the door at the margins of each slot.

13. In a reaction vessel of the character indicated, a cylindrical body on an upstanding elongated axis and having on said axis a circular opening at the bottom end, a door for removably closing said opening and comprising a generally conical disc of larger diameter than said opening and adapted to close the opening when the convex side thereof faces upwardly and projects into the inner volume of said vessel, said generally conical disc having a substantial central body portion of relatively thin metal and a peripherally continuous circumferential integral rim of relatively thick metal, the rim of the opening of said vessel being formed with a truncated generally conical concave surface of slope matching that of the convex side of said door, whereby the closure effected by said door is characterized by relatively wide circumferentially extending overlap of said concave surface with the convex side of said door, and releasable clamp means including parts carried by said body and by the relatively thick part of said door for removably securing said door in closed position.

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