An unheading device for removable attachment onto a lower flanged opening (11) of a vertically-oriented vessel such as a coking drum (10), the unheading device being controllably supported by multiple elongated vertically-extensible actuators (22) such as hydraulic cylinders which extend between a lifting frame unit (20) holding a head unit (14) and the vessel support structure (12). The multiple vertically-extensible actuators are each pivotally attached at their lower ends to the lifting frame unit, and are each pivotally attached at their upper ends to the stationary support structure for the vessel. The unheading device is adapted for lowering the head unit and moving it laterally aside to a parking position on a platform portion (12a) of the vessel support structure, then raising the lifting frame unit with its attached decoking chute (16) unit to contact the vessel lower flanged opening for coke removal therefrom.
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COKING VESSEL UNHEADING DEVICE AND SUPPORT STRUCTURE

Background of the Invention

This invention pertains to a vertical vessel unheading device and its associated support structure. It pertains particularly to such an unheading device for the lower flange and head assembly of a coking vessel, which device is movably supported directly from the vessel support structure by multiple elongated extensible actuators and is arranged for periodic removal and replacement during vessel operations.

Unheading devices provided at the lower end of large coking drums or vessels used in petroleum refinery operations and which are capable of remote operation are known, such as disclosed by U.S. Patent No. 4,726,109 to Malsbury et al and U.S. 4,960,358 to DiGiacomo et al. In past installations of such remotely operated unheading devices for coking vessels, the unheading device has been supported by four vertically oriented actuator cylinders pivotally attached to trunnions welded onto the coking vessel bottom cone section. However, these welded attachments require regularly scheduled inspection and testing to ensure load capacity of the attachment welds. Because any repairs could require undesired post weld heat treatment locally at the attachment welds and extending undesired vessel shutdowns, an improved support arrangement for such vertically-oriented actuator cylinders for unheading devices is needed.
Summary of the Invention

This invention provides an improved unheading device and associated support structure for a vertical vessel, and includes a head unit which is removably attachable to a lower flanged opening of the vertical vessel such as a coking vessel. The head unit is supported by multiple generally vertically-oriented actuators which extend between a lifting frame unit of the unheading device and the vessel support structure. With this arrangement, the loads applied by the unheading device multiple actuators to the lifting frame while supporting the head unit is transferred directly to the vessel support structure, rather than being undesirably carried by and transferred through the vessel bottom conical section to the vessel support structure. The loads are carried by the multiple actuators when the coking vessel bottom head unit is being held securely in place during the head unit detachment and reattachment steps. The multiple actuators exert an upward force capable of supporting an entire column of coke and water in the coking vessel, which force is transferred directly to the vessel support structure, which also includes a horizontal platform member for supporting the head unit in a lateral or offset position.

Accordingly, the unheading device according to this invention includes a head unit adapted for removable attachment to a lower flanged opening of a vertical vessel; clamping means for fastening and unfastening the head unit to the lower flanged opening so as to permit downward removal of the head unit; a vertically movable lifting frame adapted for supporting and lowering the head unit from the vessel lower flange, the lifting frame unit having an extendable decoking chute attached to its lower side; multiple actuators extending substantially vertically between the lifting frame and an external support structure for the vessel; and a cover/cradle skid unit including dual horizontal
actuators adapted for moving the head unit laterally to a side position on a stationary platform and return.

The improved unheading device of this invention is arranged to be supported directly from a coking vessel support structure, and provides for the head unit to be unfastened and lowered by the lifting frame unit from the coking vessel lower flanged opening, lateral movement of the head unit by the cover/cradle skid unit to a side position on a platform support member, while the extendable decoking chute is raised to connect with the vessel lower flanged opening for coke removal therefrom, and for subsequent return movement and reattachment of the head unit onto the vessel lower flange. More specifically, after the head unit cover plate is unfastened from the vessel lower flanged opening, the lifting frame lowers the head unit by operation of the multiple vertically-oriented actuators, and the cover/cradle skid unit moves the head unit laterally from beneath the coking vessel to a side location on an auxiliary platform by means of dual horizontal actuators. Because the lifting frame unit also includes the cylindrical-shaped decoking chute attached to the lower side of the lifting frame unit, the chute can be raised by the lifting frame unit upwardly to contact the coking vessel lower flanged opening after the head unit has been carried by the cover/cradle skid unit to its side position. The cover/cradle skid unit lateral movement permits the decoking chute to be raised by the lifting frame unit into contact with the vessel lower flanged opening such as for a vessel decoking step. The decoking chute is equipped with an upper end seal ring provided at the lower flanged opening of the coking vessel, and also has an annular lower seal ring provided between the chute and the stationary platform. When the decoking chute is in its fully raised position, the two seals prevent backflow and escape of vapors (steam) and hot water during the coke cutting operation in the vessel.
After a decoking operation for the coking vessel has been completed, the unheading device is adapted so as to lower the lifting frame unit and the decoking chute, and for the head unit to be returned laterally from its side position by the dual horizontal actuators so as to be repositioned on the lifting frame unit in accurate vertical alignment with the vessel lower flange. Then the head unit is lifted up by the lifting frame unit into accurate engagement with the vessel lower flange by the multiple substantially vertical actuators of the lifting frame unit. To ensure accurate engagement and installation of the head unit fastener bolts, the head unit is provided with two alignment pins which are circumferentially oriented one hundred eighty degrees apart and each fits into a tapered hole in the vessel lower flange. The head unit fastener bolts are then refastened pressure-tightly into place. The multiple vertical actuator mechanisms for the lifting frame unit and decoking chute is preferably provided by four equally-spaced hydraulic cylinders attached to the rectangular lifting frame unit at its four outer corners and operated by suitable remote control means such as a hydraulic fluid pressure source.

An advantage of this invention is that a lower head cover unit for a vertically-oriented vessel such as a coking vessel can be conveniently removed from the vessel by utilizing the remotely operated unheading device, which lowers the head unit and moves it laterally aside, after which it raises a decoking chute and seals it to the vessel lower flange and also to the stationary platform of the coking vessel structure, with all units being supported directly and reliably from the coking vessel support structure. Such an unheading device permits periodic rapid and reliable removal of coke deposited in the coking vessel, so as to increase the available operating time for the vessel, and also improves personal safety by avoiding undesirable exposure of personnel to hot hydrocarbons, steam and water during such unheading operations. This
unheading device can be advantageously used for either new or existing delayed coking vessels for decoking the vessel at desired intervals rapidly and safely.

**Brief Description of the Drawings**

This invention will be further described with reference to the following drawings, in which:

Fig. 1 shows an elevation view of a vertically-oriented vessel which has an unheading device and platform support means provided at the vessel lower end, the unheading device being supported by multiple actuators extending substantially vertically between the unheading device and the vessel support structure;

Fig. 2 shows an enlarged perspective view of the vessel unheading device including a head unit attached pressure-tightly to the lower flange of the vertical vessel, a lifting frame unit including multiple vertically-oriented actuators attached to the vessel support structure, and a cover/cradle skid unit for moving the head unit laterally aside;

Fig. 3 shows an enlarged elevation view of the attachment means for one of the vertically-oriented actuators onto both the lifting frame unit and the vessel support structure;

Fig. 4 shows a perspective view similar to Fig. 2 but with the head unit being detached from the vessel lower flange and moved laterally aside by the cover/cradle skid unit to a parking position on a platform portion of the vessel
support structure, and a decoking chute raised to contact and seal with the vessel lower flange;

Fig. 5 shows a plan view of the unheading device taken at line 5-5' of Fig. 4; and

Fig. 6 shows an elevation view of the decoking chute which includes a gasket seal means at its upper end for sealing the chute against the vessel lower flange, and an annular seal means at its lower end for sealing the chute to the support structure platform.

Description of the Invention

As generally shown by Fig. 1, a vertically-oriented coking vessel 10 is supported by a suitable support structure 12 provided beneath the vessel 10, the structure including a horizontal stationary platform portion 12a all constructed of reinforced concrete or steel. Such coking vessels 10 as used in petroleum refinery operations are usually between twenty and twenty-eight feet in diameter, between seventy-five and one hundred feet tall, and have a lower conical shaped portion 10a and a nozzle opening 11 connected to a lower flange 13, which is usually between five and six feet in diameter. A removable lower head unit 14 includes an upper cover plate 14a which is attached pressure-tightly to the flange 13 by a plurality of suitable fastener means 15 such as bolts or similar means. Coke deposited in the coking vessel 10 during its extended operations in a petroleum refinery is removed from the vessel periodically as needed by removing the lower head unit 14 and cutting the coke from within the vessel. The loosened coke falls through the nozzle opening 11 and flange 13 and then through a decoking chute 16 into a storage pit or rail car
(not shown) for removal, the decoking chute 16 being removably connectable to the flange 13.

As additionally shown by Figs. 2 and 3, the head unit 14 is attached rigidly by suitable structural members onto a lower cover/cradle skid 17. Head unit 14 also includes a feed pipe 18 which is connected to upper cover plate 14a and extends laterally therefrom for use in feeding fluids such as hydrocarbon liquid, steam and water into the coking vessel 10 and for draining fluids from it as needed.

The head unit 14 and its lower cover/cradle skid 17 are supported by a lifting frame unit 20, which is vertically movable. The lifting frame unit 20 is supported from the vessel main stationary support structure 12 by four elongated vertically-oriented hydraulic pressure actuators 22. These four hydraulic actuator cylinders 22 are equally spaced apart, and are each oriented at an angle of between fifteen and forty-five degrees relative to the vertical centerline of vessel 10 and head unit 14. Each actuator cylinder is pivotably attached at its lower end 23 onto the lifting frame unit 20 at its four corners. The four actuator cylinders 22 are also each pivotably attached at its upper end 24 to a suitable bracket or embedment plate 25, which is rigidly secured to a vertical member of the vessel support structure 12, as shown in greater detail in Figs. 2 and 3. Locations for the upper end attachments 24 for the four actuator cylinders 22 is determined by the geometry of the lifting frame unit 20 and the decoking chute 16, and the attachments 24 are usually on the flat face of an opening 12b in the support structure 12 through which the vessel conical-shaped portion 10a extends downwardly. Such attachment location 24, 25 minimizes undesired heat transfer from the hot coking vessel 10 to the hydraulic actuator cylinder 22. Alternatively, for incorporating the unheading device into
existing coking vessels, suitable auxiliary structural members (not shown) can be provided and the embedment plates 25 can be incorporated to the vessel support structure 12 at appropriate locations on the auxiliary members.

The four hydraulic actuator cylinders 22 include suitable control means (not shown) which provide for the actuator cylinders to be extended equally and evenly so that the lifting frame unit 20 supporting the head unit 14 is lowered and lifted evenly without any undesired tipping movements. Two alignment pins 19 equally spaced apart are provided attached rigidly onto the head unit 14 upper cover 14a to assure accurate alignment of head unit 14 with the lower flange 13 whenever the head unit is raised to contact the vessel lower flange 13. The fastener means 15 for head unit 14 onto the vessel lower flange 13 are individual bolts and nuts. The lifting frame 20 is provided with four guide tubes 27 located at the corners of the frame and which mate with four alignment pins 28 attached rigidly to the horizontal platform 12a, so as to assure accurate vertical alignment of the lifting frame unit 20 when it is lowered by actuator cylinders 22 onto the platform 12a.

As also shown in Figs. 2 and 4, a cover/cradle unit 30 having dual parallel guide surfaces 32 is interfitted within a central portion of the lifting frame unit 20. Dual horizontal extendable actuators 34 are each pivotally attached at their forward ends 34a to one side of the cover/cradle skid unit 30, and are each pivotally attached at their rearward ends 34b onto the horizontal platform portion 12a of the vessel support structure 12. These dual actuator attachments to the cover/cradle skid unit 30 provide for the head unit 14 to be moved laterally to a side position on the platform 12a by the dual actuators 34, as shown by Figs. 4 and 5. During the lateral movement of the cover/cradle skid unit 30 to its side position on platform structure 12a, it is supported on the
platform structure at its forward end 31 by dual moveable brackets 36 which are guided along dual tracks 38 provided in the platform structure 12a. The cover/cradle skid unit 17 is supported at its rearward end by dual support chairs 37 which are attached to and extended upwardly from the platform 12a. The lifting frame 20 is supported in its lowered position by the guide tubes 27 which are attached to and extend downward from the lifting frame 20 onto the alignment pins 28.

After the cover/cradle skid unit 30 and head unit 14 have been moved aside, the lifting frame unit 20 which has the decoking chute 16 attached onto its lower side, is moved upwardly by action of the four vertical actuators 22, so that the upper end of the decoking chute 16 is held firmly and sealed against the lower flanged opening 13 of the coking vessel 10. As shown by Fig. 6, the coking chute 16 extends through a circular opening 12b in the platform 12a. The upper end of the decoking chute 16 includes an annular outer sleeve portion 40 which extends upwardly adjacent to the outer periphery of the lower flange 13 of vessel 10, so as to provide a guide means for vertical alignment of the decoking chute 16 with the flange. A sealing ring 42 is provided between the upper flange 16a of the chute 16 and the vessel lower flange 13. The lower end of decoking chute 16 is also sealed to the opening 12b in platform 12a by a flexible sealing ring 44 which is positioned between an annular projection 16b of the chute 16 and the inner surface of circular opening 12b in the platform structure 12. These sealing means 40, 42 and 44 serve to effectively prevent the undesirable escape of steam and hot water from the vessel flange 13 and chute 16. The coke accumulated within the vessel 10 is removed through the chute 16 to a storage pit or rail car (not shown) for further handling and use, as generally shown by Fig. 4.
After removal of coke from the coking vessel 10 has been completed, the lifting frame unit 20 carrying the attached decoking chute 16 is lowered by the four vertically-oriented actuators 22 to its lower position onto the platform 12a. Next, the dual horizontal actuators 34 move the cover/cradle skid unit 17 back to its original position so as it interfits with the dual guide surfaces 26 of the lifting frame unit 20. Then the lifting frame unit 20 is lifted upwardly by the four vertical actuators 22, and head unit 14 is vertically guided by the dual alignment pins 19 and returned to its original position with the head unit 14 aligned with the lower flanged opening 13. Next, the fastener bolts 15 are replaced to attach the head unit 14 pressure-tightly onto the flange 13, as shown by Figs. 1-3.

Although this invention has been disclosed broadly and as a preferred embodiment, it will be understood that modifications and variations can be made within the scope of the invention as defined by the claims.
WE CLAIM:

1. An unheading device for a vertical vessel adapted for being removably supported from a support structure of the vessel and removably attached onto a lower flanged opening of the vessel, the device comprising:

   (a) a head unit including a head cover fixedly attached onto a cover/cradle skid, said head cover being adapted for removable attachment to the lower flanged opening of the vertical vessel;

   (b) a lifting frame unit adapted for supporting the cover/cradle skid of said head unit and for vertically moving the head unit, said lifting frame unit including an extendable chute unit attached to the lifting frame unit lower side;

   (c) multiple elongated vertically extendable actuator means with each actuator being attached at its lower end to a corner of said lifting frame unit, and each said actuator being attached at its upper end to a stationary support structure for the vessel; and

   (d) a cover/cradle skid unit including dual horizontal actuators adapted for moving said head unit laterally from the lifting frame unit to a side location on a stationary platform portion of the vessel support structure relative to said lower flanged opening, whereby the head unit can be controllably lowered by the multiple vertical-extendable
actuators and moved aside by the cover/cradle skid unit to permit removing accumulated material through the lower flanged opening of the vertical vessel and the decoking chute unit, after which the head unit can be returned laterally, lifted and reattached pressure-tightly to the vessel lower flanged opening.

2. The unheading device according to claim 1, wherein said head unit upper cover plate is attached pressure-tightly onto the lower flanged opening of a vertical coking vessel.

3. The unheading device according to claim 1, wherein each said multiple vertically-extendable actuator is oriented at an angle of between fifteen and forty-five degrees with the vertical centerline of said head unit and the vessel.

4. The unheading device according to claim 1, wherein said multiple vertically-extendable actuators consists of four hydraulic-actuated cylinders, each cylinder having its upper end pivotably attached to an embedment plate which is rigidly attached to the stationary support structure for the vessel.

5. The unheading device according to claim 1, wherein said head unit includes vertical alignment means for aligning the head unit cover plate with the lower flanged opening of the vessel during lifting of the head unit by the lifting frame unit.

6. The unheading device according to claim 1, wherein said stationary platform portion is rigidly attached to the stationary support structure for the vessel.
7. The unheading device according to claim 1, wherein said multiple vertically-extendable actuators include control means adapted for assuring uniform vertical movement of the actuators and said head unit.

8. The unheading device according to claim 1, wherein said extendable chute includes seal means for sealing means for sealing the chute upper end to the lower side of the vessel flanged opening.

9. The unheading device according to claim 1, wherein said extendable chute includes an annular seal means for sealing the chute to an opening in the support structure platform.

10. An unheading device for a vertical vessel and adapted for being removably supported from the vessel support structure and removably attached onto a lower flanged opening of the vessel, the device comprising:

   (a) a head unit including a head cover fixedly attached onto a cover/cradle skid, said head cover being adapted for removable attachment to the lower flanged opening of the vertical vessel;

   (b) a lifting frame unit adapted for contacting the cover/cradle skid of said head unit and for supporting and vertically moving the head unit, said lifting frame unit including an extendable chute unit attached to said lifting frame unit lower side;

   (c) four equally-spaced vertically extendable hydraulic-
operated actuator cylinders, each said actuator cylinder being attached at its lower end to a corner of said lifting frame unit, and each said actuator cylinder being attached at its upper end to an embedment plate of a stationary support structure for the vessel, said actuator cylinders each being aligned at an angle of between fifteen and forty-five degrees with the vertical centerline of the vessel; and

(d) a cover/cradle skid unit including dual horizontal actuator cylinders adapted for moving said head unit laterally from the lifting frame unit to a side location on a stationary platform portion of said vessel support structure relative to said lower flanged opening, whereby the lifting frame unit can be controllably raised and lowered by the four vertical extendable hydraulic actuator cylinders, and moved aside by the cover/cradle skid unit to permit removal of accumulated material through the lower flanged opening of the vertical vessel and the extendable chute unit, after which the head unit can be laterally returned, lifted and reattached to the vessel lower flanged opening.
FIG. 2
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
IPC(6) : C10B 33/14
US CL : 414/216; 202/241,252
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED
Minimum documentation searched (classification system followed by classification symbols)
U.S. : 414/216,292,589,609; 202/241,244,251,252

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic database consulted during the international search (name of database and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<td>US, 4,960,358 A (DiGiacomo et al) 02 October 1990</td>
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<td>US, 5,098,524 A (Antalfy et al) 24 March 1992 See Fig. 4.</td>
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<td>A, P</td>
<td>US 5,628,603 A (Antalfy et al) 13 May 1997</td>
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Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents:
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Date of the actual completion of the international search
12 SEPTEMBER 1997

Date of mailing of the international search report
29 OCT 1997

Name and mailing address of the ISA/US Commissioner of Patents and Trademarks
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Facsimile No. (703) 305-3230

Authorized officer
David A. Bucci
Telephone No. (703) 305-1113

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