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Segmented Plate for Assembly within a Confined Area having Limited Access

BACKGROUND OF THE INVENTION

Field of the Invention

In general, the present invention relates to original equipment manufacturer (OEM) components/parts/assemblies, new and replacement, which are located or built within a volume or chamber where access is limited; such as is the case with deaerator tanks within which plate assemblies are initially built, and at some point in time typically need replacing due to caustic conditions, extreme temperature fluctuations and low pressure(s) to which the plate assembly is exposed.

Background of the Invention

More-particularly, applicants' invention is directed to a unique segmented plate and associated plate assembly technique, adapted for use where access is limited to an area/chamber within which the plate is to be secured and employed for use in connection with an enclosure. While focus of the embodiments depicted and described herein is within the context of power plant boiler systems, and more-particularly, this discussion is directed towards use of applicants' segmented plate in deaerator tanks where water treatment takes place to mechanically reduce dissolved oxygen levels from the water before it flows into the boiler system, the plate assembly of the invention may be used in a wide variety of contexts in connection with a equipment having areas/chambers to which access is limited.

As is well known, deaerator tanks have chambers with limited access: the tray enclosure within which the deaerating process takes place typically has a nozzle-vent body assembly through which steam passes and non condensable gases (*e.g.*, oxygen, carbon dioxide) may pass. In many cases, the geometric size of internal assemblies make it difficult, if not impossible, to build or repair a damaged assembly having an exterior perimeter larger than will fit through the limited access. Not only does the segmented plate of the invention provide a unique solution for those responsible for regular power plant deaerator maintenance, by providing a replacement for those unitary plates currently built into a new OEM deaerator tank around a nozzle-vent body assembly of the tray enclosure, but applicants' new segmented plate may be initially installed by the OEM when a new tank

product is manufactured to make the disassembly and removal of a cracked, fractured, or otherwise damaged tray box's plate, less difficult. Again, and as one will appreciate, the segmented plate and associated plate assembly technique of the invention may be employed in a variety of other contexts where access to an area/chamber within which the plate is to operate, is limited.

It is preferable to keep maintenance downtime associated with tearing-down and rebuilding sub-assemblies of any system to a minimum; this is typically true, whether or not the reason for requiring a repair/rebuild is critical to overall system performance and operation. In the case of power plants, taking a plant 'off-line', or shutting down a major component of the plant for repair, can become very costly. Operating a power plant at less than optimal efficiency can likewise be very costly. One widely used treatment of water in power plants, known as deaerating, is done to remove oxygen from the water flowing into and through the boiler. The removal of oxygen using a deaerator assembly is important, as dissolved oxygen that remains in boiler water interacts with boiler component surfaces. Feedwater with dissolved oxygen leads to carbon doioxide dissolved in water. This lowers the feedwater pH levels and produces corrosive carbonic acid. Typically, a deaerator tank encloses some type of deaerating assembly; the deaerating assembly may be a tray type assembly enclosed to carry out the process of deaeration. Currently, as depicted schematically in FIG. 1 hereof, certain deaerator unit designs incorporate a unitary stainless steel plate bolted to the tray enclosure; this unitary rectangular plate 10 acts as a support for a centrally located nozzle body-vent assembly 14 through which steam is passed and unwanted/excess oxygen gas is vented to carry out deaeration.

When a unitary plate assembly such as that shown in FIG. 1 at 10 in operation secured to a tray enclosure within a deaerator tank 20 to which access 22 is limited, cracks or is otherwise damaged due to the caustic conditions to which the plate is exposed under normal, continuous use, unless the tank 20 may be disassembled (typically an onerous job) to provide more access, the damaged plate may only be replaced after it has been destroyed—for example, by using a torch or other metal cutting tool—and removed, piece-by-piece. Where a deaerator tank 20 is cumbersome to disassemble, or if the tank has no mechanism for disassembly except to torch (or otherwise) open a larger access so that replacement of a damaged plate may be made with another unitary plate, replacement of the new unitary plate may take an extraordinary amount of downtime, effort, and expense. Applicants have developed a unique segmented plate structure and associated assembly technique that attends

to this problem in the context of deaerator tank fabrication and maintenance, as well as provides further alternatives to assembling plate structures in a host of other environments.

General Background Discussion, provided by way of reference only

I. ***Oxygen Attack to Power Plant Assemblies***. Dissolved oxygen interacts with boiler component surfaces, forming "pits" on the metal surface. These pits may eventually grow large enough to penetrate the metal, forcing a boiler shutdown. Oxygen presents in boiler feedwater becomes very aggressive when heated, causing corrosive damage to preheaters and economizers. Oxygen that enters the boiler, whether dissolved in water or as oxygen gas, may also cause further damage to steam drums, mud drums, boiler tubes and headers. Damage can also occur to condensers and condensate piping from oxygen still present in the steam.

II. ***Boiler water treatment: Oxygen Removal with a Deaerator*** Controlling the oxygen content in the feedwater may be done through deaeration and chemical treatment. The boiler water treatment that involves the removal of dissolved oxygen in the water employs a deaerator (sometimes called a deaerating heater). Since the solubility of oxygen in water decreases as the water temperature rises, oxygen gas is removed by spraying the untreated boiler water onto trays located within a deaerator enclosure, where it makes direct contact with steam rising through the tray. The steam heats the water while stripping the oxygen. Proper functioning of the deaerator requires that both oxygen and nitrogen gases be vented away from the water being treated. One goal is that the deaerated water should have an oxygen concentration of less than 15ppb (ug/l). As mentioned, deaerators in steam generating systems, located upstream of heaters and the boiler, use steam to strip oxygen from the feedwater. A properly designed and maintained deaerator can effectively remove nearly all dissolved oxygen, O_2, from the feedwater, target is < 15ug/lppb (parts per billion). Final traces of oxygen can be removed from the feedwater with an oxygen scavenger. Deaerators are found in a multitude of types and combination of power plants, power/water cogeneration plants, that incorporate a steam generator, turbine(s), distillers, one or more deaerators, feed water heaters, and so on.

SUMMARY OF THE INVENTION

It is a primary object of this invention to provide an assembly technique and associated segmented plate adapted for assembly within a confined area or volume having a limited access thereto. The unique segmented plate and assembly technique characterized,

disclosed and supported herein, include a plurality of generally rigid plate-sections, made of a wide variety of materials, assembled with a flexible barrier interposed between and along adjacent boundaries of the plate-sections. The unique nature of applicants' invention permits plate-sections of an assembled plate to expand and contract in connection with changes in chamber environment due to temperature and/or pressure fluctuations, and caustic conditions, to which the plate is exposed—aiding to prolong useful life of a plate by tending to decrease opportunity for cracking, fracture, and other failure(s) within a plate in operation. Furthermore, the unique nature of applicants' segmented plate design facilitates an assembly technique that can become routine rather than onerous, by aiding in tear-down and replacement of worn, cracked, or otherwise damaged plates during maintenance.

As one will appreciate, certain of the several unique features, and further unique combinations of features, as supported and contemplated hereby may provide a variety of advantages including: versatility in application (*e.g.*, within power plant assemblies, heavy equipment and machinery, and so on); providing additional useful functionalities and maintenance solutions; reduction in downtime; flexibility and efficiency in plant operation; permitting on-site maintenance; and so on. These and other advantages of providing the new segmented plate and associated method of assembly, will be appreciated by perusing the instant technical discussion, including the drawings, claims, and abstract, in light of drawbacks to any existing technology that have been identified, or may be uncovered.

Once again, the invention includes a segmented plate adapted for assembly within a confined area or volume having limited access thereto, and a method of assembly, that incorporate many patentably distinguishing features, as described and supported herein. The plate, as assembled, has an exterior perimeter that includes exterior edge-boundaries of a plurality of generally rigid plate-sections, each of the plate-sections are sized smaller than the access to permit passage therethrough for the assembly. Interposed between and along adjacent boundaries of plate-sections that have been adjacently arranged, is a flexible barrier. An aperture or opening (*e.g.* 56, 116 or as defined by 131*i*) having an inner perimeter may be included so that the segmented plate may be assembled around an additional piece, sub-assembly or component that, also, is intended to operation within the confined area/volume. The inner perimeter of the aperture, may be of a variety of shapes (including having a curvature) and may be comprised of one or more inward-boundary of a first and second of the plate-sections. Adjacent boundaries may include an edge-boundary of a third plate-section adjacent a first edge-boundary of each of a first and second plate-section, and a fourth

edge-boundary of a fourth plate-section adjacent a second edge-boundary of each of the first and second plate-sections. The confined area may consist of a chamber of a deaerator tank or other volume to which access is limited. Due to extreme conditions under which the plate may operate, the generally rigid plate-sections will likely expand and contract upon exposure to the range of temperatures to which the confined area will be exposed; such materials for the plate-sections include a metal, an alloy (such as stainless steel), a ceramic, and so on. The flexible barrier may be made of a material having resiliency and adapted to produce a generally water-impermeable seal, selected from the group consisting of a gasket tape, a joint sealant, a plastic adhesive, a caulking compound, weather stripping, and a high temperature sealant. Preferably the barrier material is resilient to thermal fluctuations to which the segmented plate will be exposed in operation; selection of a thermally resistant material provides longevity to the seal such that it will not degrade to the point it is no longer effective. A wide variety of resilient barrier materials are currently available.

As one will appreciate, there are many further distinguishing features of the segmented plate and assembly technique of the invention. First and second collar pieces may be arranged, in water-impermeable fashion, adjacent the first and second inward-boundaries—which may be curved in full or in part. These first and second collar pieces may be further arranged around a periphery of a central sub-assembly, such as that having a spray nozzle and/or a vent passage therethrough. The first and second collar pieces and first and second top supports may all be arranged around the periphery of the sub-assembly. Furthermore, the following may be sandwiched between the first collar piece and a respective top support: a portion of the third edge-boundary, a portion of each of the adjacent first edge-boundaries of the first and second plate-sections, a portion of the first curved inward-boundary, and a portion of the second curved inward-boundary.

Rather than being centrally located within the segmented plate, the aperture can be an opening in the plate's exterior perimeter, for example, a first plate-section may be oriented so that its edge-boundary not only makes up part of the plate's exterior perimeter, but also makes up the inner perimeter of the aperture-opening.

In another characterization, the invention includes a segmented plate adapted for assembly within a chamber of a deaerator tank having a limited access; when assembled to enclose a tray assembly, the plate has an exterior perimeter, a plurality of generally rigid plate-sections, and interposed between and along adjacent boundaries of plate-sections that

have been adjacently arranged, is a flexible barrier. Once again, each of said plate-sections is sized smaller than the access to permit passage therethrough. The segmented plate, as assembled and secured to enclose a deaerating tray assembly, may have additional, or a combination of, the further distinguishing features identified above. The exterior perimeter of the plate is likely to be of a final geometric size larger than may pass through the limited access, and may be fabricated by suitable means into any of a number of shapes such as an oval, a circle, a polygon, and an irregular shape. An aperture added to accommodate a nozzle body/vent sub-assembly, whether centrally located or off-centered, will have an inner perimeter machined or otherwise suitably fabricated into a shape that will coincide with a periphery of the nozzle body sub-assembly, whether oval, circular, polygonal, or an irregular shape. Once again, first and second collar pieces may be arranged around a periphery of the sub-assembly. Further arranged atop the first and second collar pieces—and likewise arranged around the periphery—may be first and second top supports. The shape and size of the first and second collar pieces is preferably selected to match that of the sub-assembly periphery so that the collar pieces may be arranged adjacent the periphery to create a seam substantially impermeable to water under pressure (as a liquid or in the form of steam). While a flexible barrier material may be added to provide in a sealing capacity around the sub-assembly periphery and between the collar pieces, top supports, and/or plate-section edge boundaries, sufficiently fastening the components by suitable mechanical means (bolts, clips, nails, rivets, and so on) may be employed to produce a seam around the sub-assembly, without flexible barrier material.

Another characterization of the invention, as supported herein, focuses on a process for assembling a segmented plate within a confined area having a limited access. Steps include: passing each of a plurality of generally rigid plate-sections through the limited access; adjacently arranging at least two of the plate-sections, interposed between and along adjacent boundaries of said plate-sections is a flexible barrier; and constructing the segmented plate whereby a final geometric size of an exterior perimeter thereof is larger than may pass through the limited access. Further distinguishable method features, associated with those set forth above in connection with the segmented plate of the invention, include the following: arranging a third edge-boundary of a third of said plate-sections adjacent a first edge-boundary of each of a first and second of the plate-sections; arranging a fourth edge-boundary of a fourth of the plate-sections adjacent a second edge-boundary of each of the first and second plate-sections; arranging one or more collar pieces in water-impermeable fashion, adjacent a respective (first and second) inward-boundary of each of the first and

second plate-sections; arranging one or more top supports around the periphery of a central or off-centered sub-assembly and around the collar pieces; securing the top support(s), effecting a water-impermeable seam; sandwiching, between a first collar piece and a first top support, a portion of the third edge-boundary, a portion of each of the adjacent first edge-boundaries of the first and second plate-sections, a portion of the first curved inward-boundary, and a portion of the second curved inward-boundary; and securing the assembled sectioned plate to enclose a tray assembly adapted for use in carrying out deaerating.

The step of adjacently arranging at least two of the plate-sections may include, first, applying the flexible barrier to respective edge-boundaries, and then so arranging each of the plate-sections being employed, to produce a generally water-impermeable seal; or the step of adjacently arranging at least two of the plate-sections may include arranging a third edge-boundary of a third of the plate-sections adjacent a first edge-boundary of each of a first and second of the plate-sections, the first plate-section having been oriented with its first inward-edge-boundary in a manner that creates an opening in the exterior perimeter of the plate; or the step of adjacently arranging at least two of the plate-sections may include (1) arranging a third edge-boundary of a third of the plate-sections adjacent a first edge-boundary of each of a first and second of the plate-sections, (2) arranging a fourth edge-boundary of a fourth of the plate-sections adjacent a second edge-boundary of each of the first and second plate-sections, whereby the first and second plate-sections are oriented with a respective first and second curved inward-boundary such that an aperture within the segmented plate is created.