Jan. 9, 1951 G. C. KIEFER 2,537,466

LINING FOR VESSELS

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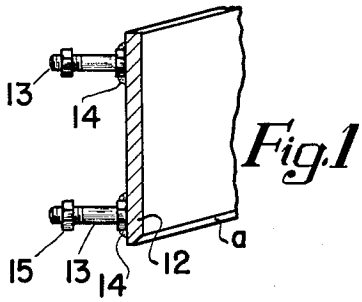


Fig.1

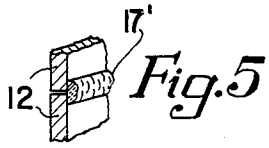


Fig.5

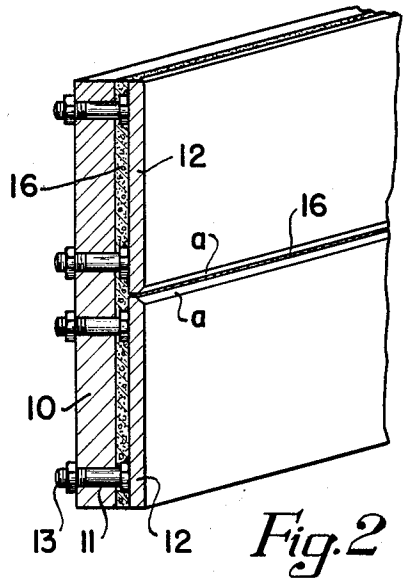


Fig.2

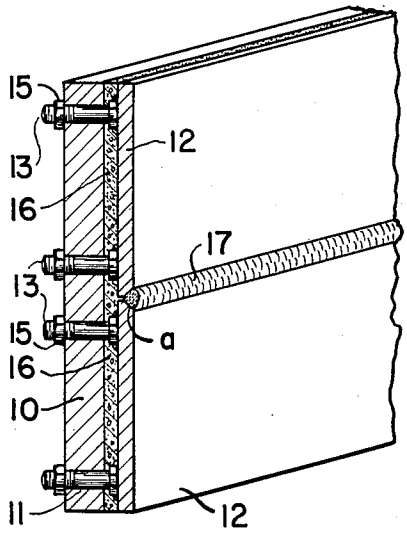


Fig.3

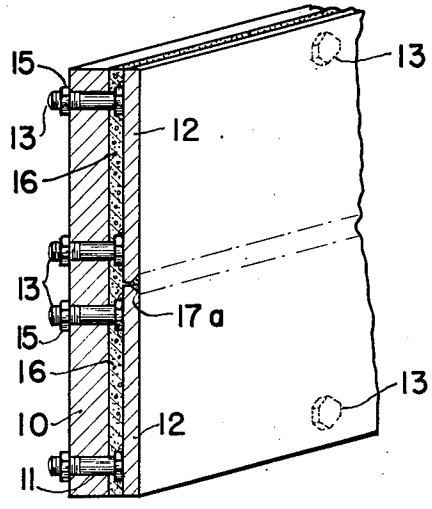


Fig.4

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LINING FOR VESSELS

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2 Claims. (Cl. 220—63)

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This invention pertains to linings such as are suitable for vessels and particularly to vessels having corrosion-resistant linings. One phase of the invention pertains to pressure vessel applications.

Previous to the present invention, the lining of ordinary steel (ferrous base metal) vessels with corrosion-resistant materials has been widely practiced. In this connection sheets or sections of a corrosion-resisting metal, such as stainless steel, nickel, etc., are welded to a common steel shell. Where the outside shell is new and its surface relatively smooth, such practice is fairly satisfactory, but where vessels have been in service for some time or the common steel surface is rough and uneven, it is, from a practical standpoint, impossible to place the thin gauge liner in intimate contact with the shell. This results in failures due to stress corrosion, fatigue, and other causes of a physical nature, due in part at least to the fact that the liner of lesser thickness is not supported at the voids and tends to flex or breathe with changes in temperature or pressure within the vessel.

Thus, it has been an object of my invention to provide a new and improved lining for vessels.

Another object has been to devise new or improved procedure for applying a relatively thin layer of corrosion-resisting metal to a common metal vessel body in such a manner as to eliminate voids between the liner and the body or shell and prevent failures.

Another object has been to provide a new and improved method of assembling a liner with respect to a vessel.

A further object has been to provide a lining for a vessel that will have generally improved characteristics and will meet the problems involved in the art.

A still further object has been to provide a liner and procedure for mounting the same such that a substantially uniform corrosion-resistant surface will be presented of such a nature that it will be free from distortion and localized stresses resulting from fabrication, etc.

These and many other objects of my invention will appear to those skilled in the art from the description and exemplary disclosures thereof.

In accordance with a preferred procedure of my invention, I first apply a smooth coat of a suitable type of cement over the entire surface (usually inner) of the vessel to be lined and a corrosion-resistant lining over the cement. The lining is, in effect, pressed upon the coating to provide a substantially uniform coating layer.

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Such cement will be selected on the basis of its ability to non-objectionably withstand any temperatures involved in the utilization of the vessel and to avoid harm to either the base metal, for example, common steel, or to the corrosion-resistant lining of the vessel. Since the cement is not directly subjected to the corrosive fluids, liquids or gases (acids, alkalis, etc.) in the vessel, it does not have to have corrosion-resisting properties. The cement serves as a cushion and, therefore, should preferably not become brittle or crumble at temperatures involved in the particular application. In a lining of a paper pulp digester, a cement mixture of litharge and glycerine has successfully been employed. In other cases, rubber-like cements or putty have served. The intermediate lining also serves as an insulator between the liner and the base metal portions.

In the exemplary embodiment shown, small diameter rods or bolts are spot welded at right angles to the back face of the corrosion-resistant liner sections of any suitable contour and size and these rods are inserted through holes drilled in the base metal shell in such a manner that the liner may be drawn up tightly by threaded bolts to press out or compress the cementitious or intermediate layer of material. The number of tightening or positioning rods will, of course, depend on the size or contour of the section of the lining, for example, where the lining is to be applied in relatively small sections, rods at four corners of each section will suffice, but for larger sections, rods may be spaced along the four edges and the center of the lining, for example.

After the lining sections are drawn up tight against the coating intermediate layer, the coating, if of cementitious material, is scraped away where the sections meet (at their interstices) and a continuous lining is provided by welding adjacent edges of adjacent sections thereof together. Where smooth surfaces are desirable, the weld areas may be ground flush with the plane of the corrosion-resistant or tertiary layer and the entire line polished without difficulty.

Various advantages of the invention will be obvious to those skilled in the art, for example, a uniform surface is insured which is free from distortion and localized stresses resulting from fabrication, and means is provided for avoiding objectional flexes in the lining wherein regular surface conditions exist in the original shell. It provides a continuous lining that facilitates cleaning and lowers maintenance cost. Also, the relative uniformity of the lining results in equal pressure over each square inch of the surface

that, of course, changes with changes in temperature and/or pressure in the vessel.

In exemplified embodiments of my invention shown in the drawings:

Figure 1 is a perspective detail in vertical section of a lining constructed or utilized in accordance with my invention.

Figure 2 is a perspective sectional view in vertical elevation of a liner, such as shown in Figure 1, in an assembled relationship with respect to a base metal portion of a vessel.

Figure 3 is similar to Figure 2 except that it shows the completion of welding of adjacent liner sections.

Figure 4 is a view similar to Figure 3, but shows an additional set of tightening or positioning bolts; and, also illustrates a further step of a procedure of my invention wherein the weld metal is ground away and the inside of the corrosion-resistant liner is polished, if desired.

Figure 5 is a perspective elevational detail of another form of joint between liner sections.

Referring particularly to Figures 1 and 2, I have shown a base metal shell or body portion 10 of a vessel, such as a pressure vessel, which may be of common steel, for example, which is drilled out at 11 to receive bolts or stems 13 that extend backwardly from inside surface portions of a suitable lining material 12, for example, of corrosion-resistant stainless steel, etc., see column 1. The heads of bolts 13 are shown as secured or welded at 14 to form a unitary extension from back faces of the liner portions or layers 12. It will be apparent that the bolts may be secured to the liner members in any suitable manner, and, if desired, their heads may be positioned within depressed portions in the back of the liner. The coating material or intermediate layer is represented by the numeral 16.

In Figures 1 to 4, inclusive, I have slightly beveled off the edges *a* of the liner sections or members 12 to receive a bead of weld metal 17, although, if desired, resistance or any other suitable type of welding may be employed.

In Figure 5, I have shown a weld bead 17' which is applied to the adjoining edges of the liner sections 12. This type of weld may be employed where it is not necessary or desirable to grind the inner surface of the weld down to the plane of the liner sections.

In Figure 4, the weld bead 17*a* represents the weld 17 after its exposed surface portions have been ground down and, if desired, polished. The weld metal, of course, will preferably be of a type corresponding in characteristics to that of the corrosion-resistant layer.

As previously pointed out, in carrying out a preferred procedure of my invention, the base metal vessel portions 10 are drilled out, a suitable cement or other material is positioned as a layer over a surface portion of the base metal layer, and the corrosion-resistant lining section 12 is secured in place by tightening up the nuts 15. The tightening up may be effected in such a manner as to provide substantially uniform thickness of intermediate material. Any surplus cement will be squeezed out between the edges of the liner sections 12, etc., and it is stripped or cleaned away before the welding operation is effected.

After the welding operation has been completed, the bolts may be again or further tightened up so that welded lining will be tightly supported on the intermediate layer and secured to the shell.

The intermediate layer may also comprise a suitable flexible insulator material instead of a cementitious material. I prefer to use a material that is temperature-resistant (will not become brittle where the vessel is used for hot or very cold fluids), that may be compressed or is capable of flow to provide a substantially uniform thickness layer, and that will, in effect, flexibly support the liner layer, permitting it to expand and contract with variations in temperature of the fluid being treated in the vessel. Although I prefer to use non-metallic materials, suitable relatively soft metals or alloys or aggregates may be employed in this connection. The adjustable bolt mounting of the liner at spaced locations therealong also provides a flexible construction which permits the liner to substantially uniformly expand and contract on the intermediate layer.

It will be apparent to those skilled in the art that, although I have illustrated specific embodiments of my invention, the principles thereof may be applied to other embodiments and various modifications, revisions, additions and subtractions may be made to such specific exemplary embodiments without departing from the spirit and scope of the invention as indicated by the appended claims.

What I claim is:

1. A pressure vessel for corrosive materials which comprises, a shaped unitary relatively thick outer shell of ferrous base metal, a temperature-resistant cushioning layer of flowable cementitious material on an inner surface area of said shell, a plurality of corrosion-resistant shaped sections of relatively lesser thickness than said outer shell in an adjacent edge-to-edge relationship with respect to each other, weld metal along the adjacent edges of said sections and with said sections defining a unitary sealed-off liner for the vessel, said liner having its inner surface area in close abutment with said cushioning layer, a plurality of spaced-apart tension bolts welded to and extending from the inner surface of each of said sections through the cushioning layer and the outer shell and having threaded ends projecting from an outer surface area of said outer shell, nuts substantially uniformly tightened down on the threaded ends of said bolts, and said bolts being under sufficient tension such that the material of the layer is in tight compression between opposed inner surface areas of said outer shell and said liner and voids therebetween are essentially completely filled up by the material.

2. A pressure vessel for corrosive materials which comprises, a shaped relatively thick outer shell of ferrous base metal, a temperature-resistant cushioning layer of flowable insulating material on an inner surface area of said shell, a plurality of corrosion-resistant shaped sections of relatively lesser thickness than said outer shell in an adjacent edge-to-edge relationship with respect to each other, weld metal along the adjacent edges of said sections and with said sections defining a unitary sealed-off liner for the vessel, said liner having its inner surface area in close abutment with said cushioning layer, a plurality of spaced-apart tension stems secured to and extending from the inner surface of each of said sections through the cushioning layer and having end portions extending through said outer shell, securing means mounted on the projecting end portion of each of said stems, said means on said stems being substantially uniformly tightened down thereon and with respect to said outer shell, and said stems being under sufficient tension

such that the material of said layer is in tight compression between opposed inner surface areas of said outer shell and said liner and voids therebetween are substantially completely filled up by the material.

GEORGE C. KIEFER.

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