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METHOD OF MANUFACTURING A LINED IRON-BASE ARTICLE

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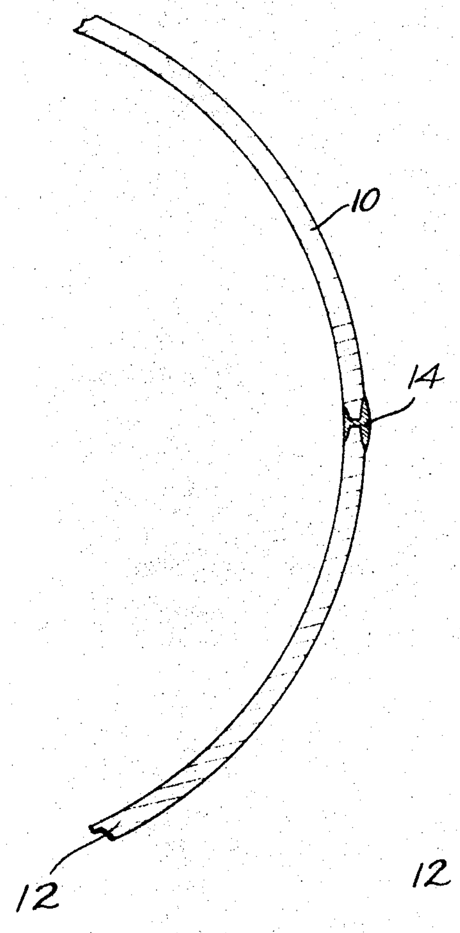

Fig. 1.

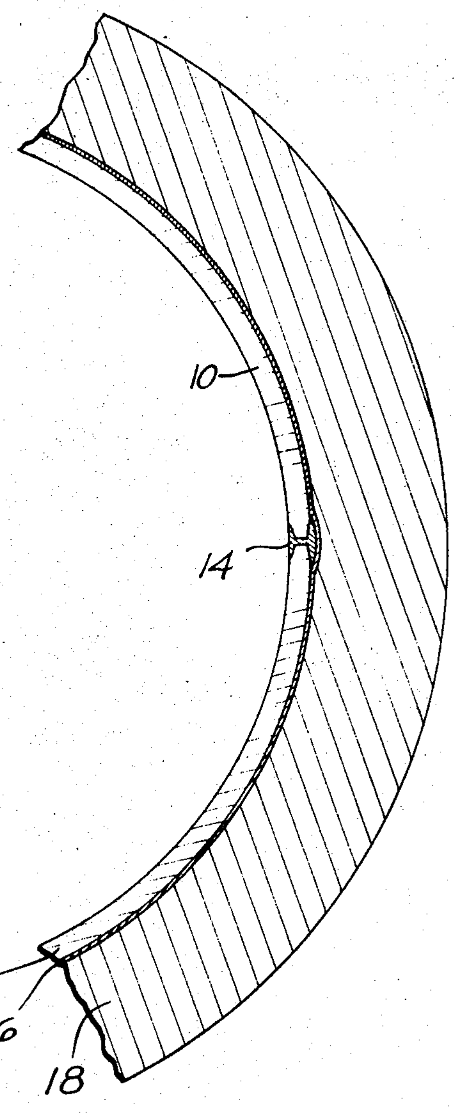

Fig. 2.

Herbert P. Kuebrich
INVENTOR

BY Kolisch & Hartwell
Attys.

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METHOD OF MANUFACTURING A LINED IRON-BASE ARTICLE

Herbert P. Kuebrich, Albany, Oreg., assignor, by mesne assignments, to Ti Line Corporation, Richland, Wash., a corporation of Washington

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ABSTRACT OF THE DISCLOSURE

A method of manufacturing comprising casting an iron-base metal about a refractory metal liner. A casting temperature is used which is below the melting point of the liner, so that the liner's integrity is maintained during casting. Prior to casting, an oxide is applied to the outer surface of the liner which inhibits chemical contamination of the liner during the casting.

This invention relates to the production of metal-lined products such as valves, pumps, fittings and similar articles.

In the handling of certain types of fluids, liquid and gaseous, corrosion problems are frequently encountered which require that those surfaces which come in contact with the fluid handled have a special corrosion-resistant composition if the surface is to remain serviceable for any useful period of time. Materials such as titanium and zirconium have desirable corrosion-resistant properties, and these materials therefore find important uses in the manufacture of certain types of fluid-handling equipment. Due to the relatively high cost of certain corrosion-resistant metals, it has proved advantageous to construct valves and like parts with a liner of metal having the desired corrosion-resistant properties, and a body of other metal surrounding the lining and providing the rigidity required.

Several procedures have been proposed for constructing a part such as a valve having a liner. A widely used method comprises casting a hollow body for the part forming a multiple piece liner for the cast body, and assembling the pieces inside the cast body by inserting them in proper position within the cast body and then welding the pieces together to form an integral liner. This procedure, of course, requires skilled labor and considerable time in fabricating the liner. Exact fits are difficult to obtain. Fatigue and corrosion failures are common. It has also been proposed that the liner first be prepared and used as a core in the manufacture of a cast body formed thereabout. While this procedure may be suitable in making certain products, problems are encountered with metals such as titanium and zirconium when these are employed as liners, due to contamination of the liner during the casting process through alloying of the liner with the metal of the casting, and reaction of the metal in the liner with such materials as carbon and oxygen, at the temperatures involved in making the casting, whereby embrittlement and other harm to the liner results.

Generally, an object of this invention is to provide an improved method for manufacturing parts such as valves and the like including corrosion-resistant liners, which process features casting a metal body about a liner with the liner first integrally formed and specially treated over the outer surface thereof whereby alloying and contamination at operating temperatures involved in producing the casting are prevented.

A related general object is to provide improved parts, such as valves, constructed according to the process contemplated.

More specifically, an object of the invention is the provision of a method for producing lined parts such as valves, wherein a liner is first prepared from a corrosion-resistant metal, and those surface portions of the liner which are to have cast metal bounding them are treated to have a coating thereover providing insulation and forming a barrier operable to prevent a reaction between the metal of the liner and the metal of the casting.

In a preferred embodiment of the invention, the coating which is selected for the liner comprises a refractory oxide disposed over the surface portions thereof which are to have metal cast as a body thereagainst, which refractory oxide remains on such surface portions as a solid and without fusing at those temperatures utilized in producing the cast body.

Valves, pump housing, fittings, etc. may be produced as contemplated herein with liners in the parts showing no evidence of hardening or embrittlement, or of alloying with the metal of the cast bodies of the parts. The parts, of course, are far more easily produce than when using a procedure wherein a liner is formed and then cut into segments thence to be assembled in the hollow interior of the part being constructed. The parts also are generally characterized by a true and exact fit of the liner within the cast body.

These and other objects and advantages are attained by the invention, and the same is described hereinbelow in conjunction with the acompanying drawings, and a specific example included for illustrative purposes.

FIG. 1 illustrates portions of a liner for a valve housing prior to having a cast body formed thereabout; and

FIG. 2 illustrates portions of a completed valve housing including a liner as contemplated herein.

The particular metal used in a liner is determined by the type of corrosion and wear resistance desired. Thus, and to specifically illustrate liner metals, they include such metals as titanium, zirconium, tantalum and niobium, as well as alloys of these materials. Thus, an alloy of titanium and palladium, containing from 0.1% to 2% palladium, finds extensive use in some applications. Illustrative of another alloy is a tantalum-tungsten alloy, containing up to about 10% tungsten, which tungsten is included to impart hardness to the alloy. These metals, while having desirable corrosion-resistant properties, tend easily to be contaminated at elevated temperatures with elements such as iron, nickel, chromium and similar metals commonly found in castings for valves and similar parts. Contamination also tends to result from the exposure of such metals at elevated temperatures to such elements as carbon and oxygen, present in casting metals, in the atmosphere, and in the sand utilized to form molds in which castings are prepared.

Before the cast body of a part is prepared, the liner is fabricated from the corrosion-resistant metal desired. Thus, two halves of a suitably shaped liner may be pressed from a sheet of the corrosion-resistant metal, and these halves then joined together as by welding. In FIG. 1 there is illustrated such portions of a typical liner made from liner sections indicated at **10** and **12** welded together as at weld regions **14**. In welding the sections together, it is convenient to use conventional tungsten, inert gas welding techniques. In such a welding procedure, tungsten is the material comprising the electrode, and the welding is done in an inert gas environment. Alternatively, electron beam welding is suitable.

After the liner is prepared, the exterior thereof (which normally is the surface which is surrounded by a cast body in a lined part) is treated to produce thereon a coating which forms a protective barrier preventing surface contamination of the liner. This coating, shown at **16** in FIG. 2, in the preferred embodiment of this invention comprises a refractory oxide, distributed as a thin film over the outer surface, which oxide has a melting point well above the temperature of the molten metal which is used in forming the cast body of a part. By way of example, if iron is to be employed to form the cast body, such having a melting point of approximately 2500° F., and usually being poured in a casting process while maintained at a temperature of some 200° higher than its melting point, then the refractory oxide should have a melting point in excess of 2700° F. Exemplary of oxides of this description, usable in the making of liners for cast bodies of iron, steel, stainless steel, or the usual nickel alloys, are such oxides as aluminum oxide, magnesium oxide, and titanium oxide.

According to one form of the invention, the refractory oxide may be applied to the surface of the liner by dipping or flame spraying techniques. The former process relies upon the application of a slurry of the refractory metal oxide to the surface of the liner, and subsequent removal of the liquid vehicle in the slurry, usually water. To produce better adhesion of a coating prepared by either of these methods to the surface of the liner, it is preferred that the surface first be roughened.

Roughing of the surface may be done by conventional sand blasting techniques. The roughing need not be extensive, and it has been found that roughing to produce a 60 to 100 microinch finish produces satisfactory results.

In preparing a coating of refractory oxide by a dipping process, a slurry of finely divided or powdered oxide in a vehicle such as water is prepared, and the liner is dipped in the slurry and when withdrawn, with a coating of oxide and water clinging to the liner. If the liner is warmed before dipping, to temperatures of 100–250° F., there is faster drying of the water in the slurry on removal of the liner. Drying can also be promoted by placing the coated liner in a current of hot air. With drying of the oxide coating, and if additional thickness in the coating is desired, the liner may be subjected to further dipping and drying steps.

When the refractory oxide is applied using flame spraying, a spray gun is employed, and an acetylene and air mixture utilized to produce a spray containing the oxide dispersed in the gas mixture. In flame spraying refractory oxides no water is used, as the process is a dry one. The refractory oxide is in the form of a fine powder which during spraying is picked up by the gas mixture and propelled out of the gun. The gas mixture on leaving the gun is ignited and the oxide material is carried to the part being sprayed by the gas flame with fusing of the oxide. On contacting the surface being sprayed the fused oxide adheres to the surface and a coating of oxide is built up on the surface.

Lined valves and other parts according to this invention in most instances employ liners having a wall thickness ranging from .015 inch to .25 inch. With the thinner liners, of course, not as much wear in the liner is permitted. Since the corrosion-resistant metals employed for the liners tend to be more expensive than the metals used in the cast bodies which surround the liners, the cost of a part increases with an increase in thickness in the wall of a liner.

With respect to the thickness of the oxide coatings used in the invention, in most instances such coatings will have a thickness when prepared as above ranging from a minimum of about .003 inch to about .02 inch. Coatings within this range of thickness are entirely satisfactory in carrying out the instant invention, and thus the indicated range embraces coating thicknesses preferred in the invention.

Protective coatings may also be prepared on the outer surface of a liner through oxidation of the metal which actually forms the liner. Thus, and considering a liner made of titanium, such may be heated in air for approximately 5–10 seconds, at temperatures in the neighborhood of 800–1200° F. and after such heating cooled rapidly with cool air, in a matter of minutes, to produce a titanium oxide coating over the liner having a thickness of about .0002 inch. With relatively thin coatings of this nature, it becomes more important to utilize liners having relatively thick walls, ranging upwardly from about .06 inch, as a thick wall in the liner promotes chilling of the casting metal when such is poured about the liner, with the drawing of heat from regions adjacent the casting metal. With rapid chilling, an oxide film as thin as the one indicated is effective to prevent alloying of the liner with the metal used in the casting.

Alternatively, an oxide coating about the liner may be prepared from the metal of the liner, utilizing an autoclave process. Thus, zirconium may be placed in an autoclave, and with heat and steam under pressure introduced to the autoclave, an oxide coating may be produced.

Having prepared the integrated lining, and the refractory oxide coating thereabout, whereby alloying and contamination are prevented, the body of the part being manufactured, shown at **18** in FIG. 2, may be cast directly about the liner with the liner functioning as a core. Casting may be performed in the usual maner, by pouring fused metal into a mold and about the liner which liner functions to outline the interior of the part being cast. With the casting completed, and on removal of the part from the mold, a lined part results with a snug fit existing between the liner and surrounding cast body and with the elimination of contamination problems. The coating prevents adhesion between the casting and the liner.

The following example has been included to illustrate the preparation of a part according to the method contemplated.

EXAMPLE I

A liner was formed for the housing of a 1 inch diaphragm valve, from titanium sheet .025 inch thick. This sheet was hot pressed at 600° F., in an air environment, to produce two halves of the liner. These were then welded together, using a tungsten arc in an argon atmosphere chamber, to produce a one piece liner.

The liner was then sand blasted, with the production of a 75 microinch finish around the outer surface thereof. The roughened liner then had a .010 inch thick aluminum oxide coating applied thereabout, using flame spraying techniques.

The completed liner together with its refractory oxide coating was then placed in a green sand mold, and utilized as a core in the production of a cast body of iron about the liner having a wall thickness of .375 inch. The iron before pouring was heated to a temperature approximately 200° F. in excess of its melting point. After pouring of the fused metal into the mold and about the core or liner, the casting was allowed to cool for 10 minutes, and then withdrawn from the sand mold. Thence, the casting was allowed to cool to room temperature in the air.

These were made of the hardness of the liner, before and after casting of the iron body, and these tests showed the hardness remained essentially unchanged. This lack of change in hardness indicated no contamination by oxygen, even though the casting was performed in an air environment. The valve was sectioned, to determine if there had been alloying of the liner with the iron. No metal-to-metal contact was noted.

Metallographic samples were prepared by polishing a cut section and etching the polished area, and these samples were then subjected to inspection under the microscope. No contamination of iron or carbon in the liner in the region bounded by the aluminum oxide was noted.

Similar procedures were followed in making valves having liners of tantalum, zirconium, niobium, and alloys of such metals, with coatings of the various oxides earlier listed.

The method contemplated is useful in preparing all types of parts used in the handling of fluids. The method, of course, is particularly useful where such parts have irregularly shaped interiors, making the insertion of a one piece liner difficult. The process enables the utilization of materials as liners which heretofore could not be used.

While there has been described some specific embodiments of the invention, it is appreciated that variations and modifications are possible. It is desired to cover all modifications and variations of the invention as would be apparent to one skilled in the art, and that come within the scope of the appended claims.

I claim:

1. A method of manufacturing articles comprising a cast body of an iron-base metal surrounding a metallic liner, said liner defining a passage extending through the cast body, the method comprising using a refractory metal in the liner which has a substantially higher melting point than the melting point of the iron-base metal which forms the cast body, casting the body about the outer surface of the liner using a casting temperature which is below the melting point of the liner, whereby the solid integrity of the liner is maintained during the casting step, and prior to casting of said body, applying an oxide selected from the group consisting of aluminum oxide, magnesium oxide, titanium oxide, and mixtures thereof to form a coating on the outer surface of the liner, such coating inhibiting chemical contamination of the liner during the casting step.

2. The method of claim 1 wherein the oxide is applied to form a coating by preparing a slurry of finely divided oxide in a liquid vehicle, and such slurry is applied over the surface of the liner and then dried.

3. The method of claim 1, wherein the oxide coating is applied with fusing of the oxide to the outer surface of the liner.

4. The method of claim 2, wherein the outer surface of the liner is roughened prior to the application of the coating.

5. The method of claim 1, wherein the liner is comprised of metal from the group consisting of titanium, zirconium, tantalum, niobium, and alloys thereof.

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WILLIAM J. STEPHENSON, Primary Examiner

EUGENE MAR, Assistant Examiner

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