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BRASS PIPE AND TUBE

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1 Claim. (Cl. 138—47)

My invention relates to wrought brass pipes and tubes hereinafter for convenience of terminology called tubes, and has among its objects the provision of brass tubes which are practically immune under ordinary conditions to so-called "dezincification" and so-called "erosion corrosion."

Brass tubes as commercially constructed contain about 57 to 85% copper, with the balance zinc. It is also common to add small amounts of other elements, such as tin and aluminum, to brass tubes, and although these tend to reduce dezincification and make the metal more resistant to corrosion they do not by any means eliminate dezincification or prevent failure of the tubes by erosion corrosion.

The common compositions of brasses from which brass tubes are made are the following:

"Red brass," which contains approximately 80 to 85% copper, with the balance zinc;

"Seventy-thirty brass," which nominally contains 70% copper and 30% zinc;

"Yellow brass," which nominally contains 65% copper and 35% zinc, but commonly contains 64 to 66% copper with the balance zinc;

"Muntz metal," which nominally contains 60% copper and 40% zinc, but commonly contains 58 to 61% copper with the balance zinc;

Miscellaneous brasses, which contain 61 to 64% copper, with the balance zinc;

"Aluminum brass," which is a ternary alloy containing about 74 to 78% copper, with 1 to 3% aluminum substituted for an equal part of the zinc;

"Admiralty brass," which is a ternary alloy containing about 69 to 71% copper, with 0.5 to 1.5% tin substituted for an equal part of the zinc; and

"Naval brass," which is nominally a ternary alloy containing about 59 to 61% copper, with 0.6 to 1.2% tin substituted for an equal part of the zinc, although it commonly also contains about 0.05 to 0.5% lead substituted for an equal part of the zinc.

Applicant has found that in the above described alloys dezincification can be somewhat reduced by additions of either arsenic or antimony. He has however found that by adding small amounts of both arsenic and antimony, and having the amount of arsenic at least twice the amount of antimony, dezincification will be practically eliminated under all ordinary conditions. The addition of these substances it has been found causes to be formed on the surface of the brass tube exposed to the corrosive water a strongly adhering, impervious, tenacious, corrosion resistant film which is of hard glass-like consistency, and most remarkably acts to prevent erosion corrosion under all ordinary conditions. This film is also self-healing, and if its continuity is locally interrupted the film will immediately reform when subjected to the corrosive medium.

Apparently when the brass contains 0.02 to 0.2% arsenic and 0.01 to 0.1% antimony, with the amount of arsenic at least twice that of the antimony, there is initially formed on the exposed surface of the brass a mixture of metallic arsenic and antimony which is immediately converted to a complex oxide of arsenic and antimony when the brass is exposed to a corrosive medium, and apparently this same action occurs if the film so formed is scratched or its continuity otherwise locally interrupted so that the film will be substantially immediately self-healing.

It will be understood by those skilled in the art that dezincification and erosion corrosion are two entirely different phenomena, both in respect to conditions causing them and the effects of such conditions. Dezincification occurs under stagnant or very low velocity flow conditions in a brass pipe or tube and never under high velocity flow conditions, while erosion corrosion occurs only under very high velocity flow conditions and never under stagnant or low velocity flow conditions.

In respect to dezincification, it is well known that salt and brackish waters and many industrial and domestic fresh waters conducted by a brass tube act to dissolve the brass by chemical action. When the conditions are such that the dissolved copper is in the cupric condition it will by electro-chemical action redeposit on the same localized surface of the tube from which it was dissolved, the zinc remaining in solution. The apparent result of this action from a quantitative standpoint is that the brass at the point where the action occurs loses its zinc, hence the reason for the term "dezincification." This redeposition of the copper can occur only under stagnant or very low velocity flow conditions, because when the velocity is appreciable the dissolved copper will be swept away from the area of the tube from which it was dissolved before it can be redeposited.

The practical objection to dezincification, that is to say, redeposition of dissolved copper, is that the corrosion from which it results cannot be readily detected by inspection of the tube, for the

redeposited copper causes the localized area of the surface of the tube where the corrosion occurs to have dimensionally and otherwise about the same appearance as the other portions of its surface. However, this redeposited copper structurally is spongy and weak, and tubes which upon inspection after a period of use may be passed as satisfactory are liable to fail shortly as a result of corrosion at the point of dezincification which existed at the time they were inspected.

The action of arsenic or antimony additions to brass tubes in respect to preventing dezincification is, as is well known, not to prevent the chemical solution of the brass by corrosive action, but to diminish in so far as possible redeposition of the dissolved copper, which the arsenic or antimony does by altering the electric potential conditions upon which such redeposition depends. Hence, when arsenic or antimony alone is added to the brass, the corrosion causing solution of the brass results in the formation of pits or cavities which are not wholly obscured by redeposited copper and are readily discernible upon inspection of the tube.

On the other hand, as well understood by those skilled in the art, erosion corrosion is, generally speaking, the combined result of scouring of a tube under oxidizing and high velocity flow conditions, that is to say, under flow conditions at which dezincification cannot occur. A common type of this is the species of erosion corrosion known as "impingement corrosion" which occurs adjacent that end of a tube, such as a condenser tube, which communicates with a header or the like supplying water to the tube. At the entrance portion of the tube the water moving at high velocity enters in the form of a jet which is of reduced cross-section several inches beyond the inlet end of the tube, this jet gradually reexpanding to the inner dimensions of the tube a few inches beyond where is created a region of turbulence before the flow becomes quiescent still farther along the tube. On account of the reduced pressure which tends to exist in the space surrounding this jet, air and other gases which may be in solution in the water are liberated, the air mixing with the water at the point of turbulence, at which point the water strongly scours the tube and causes a clean surface of the brass to be constantly in contact with the water and entrained air. As is well known, corrosion is strongly accelerated when a corrosive medium acts on brass in the presence of an oxidizing gas such as air, and at this point of turbulence and scouring of the tube failure of the tube by erosion corrosion commonly occurs. As above pointed out, the addition of arsenic or antimony to brass will not prevent its chemical solution by the water, and hence such addition will not prevent erosion corrosion.

The above described corrosion resistant film, produced on the brass when both arsenic and antimony are added within the ranges and proportions specified, acts to prevent dezincification under stagnant and low velocity flow conditions, because the film constantly and effectively protects the underlying brass from contact with the water in the tube and thus prevents solution of the brass by corrosive action, as distinguished from permitting solution of the brass by corrosive action and minimizing redeposition of dissolved copper as is the case when arsenic or antimony alone is added to the brass. The film prevents erosion corrosion, because it effectively resists the scouring action of the high velocity water and thus prevents the underlying brass from being subjected to the corrosive action of the water and entrained air, so that again corrosion cannot occur under these conditions. Thus the action of the film is twofold: it not only protects the brass from the type of corrosion commonly called dezincification, but because of its hard glass-like consistency offers very great resistance to erosion corrosion by waters carrying entrained air passing through a brass tube at high velocity. Under many conditions of service a satisfactory film will be formed with as little as 0.03% arsenic plus 0.015% antimony. Under more severe conditions of service the amounts of arsenic and antimony should be increased.

It will be understood that, within the scope of the appended claims, wide deviations may be made from the compositions of the brasses herein described without departing from the spirit of the invention.

I claim:

A wrought brass tube, in which the brass contains arsenic and antimony, characterized by the property of forming on its surfaces subjected to corrosive waters an adhering, self-healing, corrosion resistant film protecting said surfaces against both dezincification and erosion corrosion, the amount of arsenic being approximately 0.02 to 0.2% and the amount of antimony 0.01 to 0.1% of the total constituents of the brass, the amount of antimony in each instance being not greater than one-half that of the arsenic, the amount of copper being approximately 57 to 85% of the total constituents of the brass, and the balance of the brass in respect to the copper, arsenic and antimony being all or mostly zinc.

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