Patented Apr. 11, 1939 2,153,977

UNITED STATES PATENT OFFICE

2,153,977

CONDENSER TUBE

Richard A. Wilkins, Rome, N. Y., assignor to Revere Copper and Brass Incorporated, Rome, N. Y., a corporation of Maryland

No Drawing. Application December 24, 1936, Serial No. 117,563

5 Claims. (Cl. 138—47)

My invention relates to condenser tubes.

The invention has among its objects the provision of a condenser tube of improved physical characteristics that may be readily fabricated, worked and welded, and which has an improved resistance to the corrosive action of industrial waters and reagents.

Condenser tubes formed of 70:30 cupro-nickel have long been recognized as highly suitable for use in condensers subject to corrosion. Applicant has found that if small amounts of vanadium are added to the cupro-nickel its resistance to corrosion and the facility with which the tube may be welded, flanged or otherwise worked to secure it to the tube plate or the like are much increased. Further, this addition of a small amount of vanadium markedly increases the tensile strength and hardness of the tube, as compared to one made of binary cupro-nickel of the same nickel content. This increase in tensile strength and hardness, aside from being in themselves desirable in respect to increasing the durability of the tube, is desirable in that it tends to inhibit the type of corrosion termed "stress corrosion".

It has been found that the liability of a condenser tube to corrosion is increased by the presence in the metal of the tube of oxide particles. These particles tend to form nuclei about which corrosion is initiated. Vanadium applicant has found has the effect of eliminating the presence of such oxides.

Condenser tubes are particularly subject to failure by a combination of chemical corrosion and mechanical erosion loosely termed "impingement corrosion". Impingement corrosion commonly occurs near the entrance of the tube. Water, for example, conducted by the condenser tube commonly enters it from a chamber with which the end of the tube directly communicates. The end of the tube thus constitutes an orifice from the chamber, and although the tube is of uniform diameter causes the water to enter the tube in the form of a jet of contracted cross-section. This jet inwardly from the end of the tube expands to the inside dimensions of the tube followed by a region of turbulence extending along the tube until the flow becomes quiescent. The space about the jet is filled with air and other gases liberated from the water because the jet tends to create a reduced pressure in that space. This air tends to mix into the water at the region of turbulence. Because the inner walls of the tube at the space surrounding the jet are wet with the medium being conducted, and because there is a mechanical scouring of the tube at the region of turbulence, and in both instances the medium is rendered of an oxidizing nature on account of the air and other gases, a most noticeable corrosion tends to occur at these portions of the tube. Applicant however has found that the introduction of vanadium into the tube alloy acts to inhibit this type of corrosion. Further, he has found that if in addition to vanadium small amounts of chromium are added the resistance of the tube to this type of corrosion is further increased. The vanadium apparently imparts to the metal of the tube the property of forming a tenacious corrosion resisting film on the surface of the tube when initially subjected to the action of an oxidizing medium, the facility with which this film is formed and its tenacity apparently being increased by the presence of chromium.

Preferably the amount of vanadium added to 70:30 cupro-nickel should not exceed 1%, best results being secured with a range of vanadium from about 0.1 to 0.9%, and maximum effects with about 0.5% vanadium. Satisfactory results are secured with amounts of chromium up to about 1%, although amounts up to 2% are not particularly objectionable. With above 2% chromium the alloy is difficult to work into tubes. The preferred alloy consists of 70:30 cupro-nickel containing 0.5% each of vanadium and chromium.

The amount of nickel may be varied between 20 and 40%, the amount of vanadium being not less than 0.15% for values of nickel under 26%. Otherwise the amounts of vanadium and chromium may be as specified in connection with 70:30 cupro-nickel.

It has been found that sulphur, if present in the alloy of which the tube is made, has a deleterious effect on account of the formation of nickel sulphide. To eliminate this effect preferably manganese is added to the melt. Manganese has a greater affinity for sulphur than has nickel. The manganese sulphide and small amounts of residual manganese have no deleterious effect on the properties of the tube. Preferably the amount of manganese present in the tube should not exceed 0.5%, although amounts up to 1% are not particularly objectionable. If no sulphur is present in the materials entered into the melt of course manganese need not be employed. However, preferably it is employed to insure against any possible deleterious effects that may be caused by the possible presence of sulphur. It will therefore be understood, that although in the appended claims manganese is not specified, the tubes defined by those claims may within the

scope of the latter contain amounts of manganese up to 1% of the alloy, it being understood that manganese in the sense that it imparts no direct beneficial effect may be considered as an impurity.

Tubes made of the alloys described, besides having an increased resistance to corrosion, greater strength and hardness, and greater adaptability in respect to being worked and welded, may be fabricated more easily than cupro-nickel of the same nickel content. The tubes may be formed by drawing and extruding processes, and require lighter equipment to produce them than the cupro-nickel tubes of the same nickel content. In the sense that the tubes are formed by working the alloy as distinguished from casting them they are in the appended claims termed "wrought" tubes.

Although not precluded, the presence of metals such as aluminum, iron and zinc preferably is avoided, as these metals tend to have a deleterious effect on the resistance of the tube to corrosion, and further tend to reduce the strength and toughness of the tubes and, in some instances, to make them brittle. Aluminum has a marked tendency to decrease the ease with which the tubes may be welded.

It will further be understood that within the scope of the appended claims other metals may be present as impurities, or may be deliberately added for imparting special characteristics, so long as they do not substantially destroy valuable properties tended to be imparted by the vanadium or vanadium and chromium.

I claim:

1. Wrought tubes of cold workable cupro-nickel alloy containing chromium and vanadium, and capable of forming on their surfaces exposed to the media conducted thereby a tenacious protective film the presence of which is indicated by a resistance to impingement corrosion greater than that of a tube of binary cupro-nickel of the same copper and nickel content, which alloy contains, approximately, 20 to 40% nickel, appreciable amounts up to 1% vanadium, but at least 0.15% vanadium for all amounts of nickel up to 26%, appreciable amounts up to 2% chromium, balance substantially copper.

2. Wrought tubes according to claim 1 containing, approximately, 26 to 40% nickel and 0.15 to 1% vanadium.

3. Wrought tubes according to claim 1 containing, approximately, 0.5% each of vanadium and chromium.

4. Wrought tubes according to claim 1 containing, approximately, 30% nickel.

5. Wrought tubes according to claim 1 containing, approximately, 30% nickel and 0.5% each of vanadium and chromium.

RICHARD A. WILKINS.