Patented Nov. 24, 1936 2,061,921

UNITED STATES PATENT OFFICE

2,061,921

CORROSION RESISTANT TUBES

Edward W. Roath, Waterbury, Conn., assignor to The Chase Companies, Incorporated, New Haven, Conn., a corporation of Connecticut

No Drawing. Application March 20, 1936, Serial No. 69,885

15 Claims. (Cl. 138—47)

This invention relates to improvements in corrosion-resistant tubes, and more particularly, dezincification-resistant wrought-brass tubes for use in contact with dezincifying liquids.

Condenser tubes, heat-exchange tubes, plumbing pipes and the like, generally designated herein as tubes, when made of certain brasses and used in contact with saline liquids, tend to dezincify at a greater or less rate, depending on various factors, one of which factors is the structure of the brass.

Ordinary straight or plain brasses consisting solely of copper and zinc are subject to dezincification when the actual copper content ranges between about 57% and about 85%. When one or more other elements are added to straight brasses, the actual copper content dezincification range is usually different.

Straight brasses subject to dezincification and having an actual copper content from about 64% to about 85% consist entirely of alpha solid solution, while those from about 64% down to about 57% consist of both alpha and beta solid solutions. Special brasses containing one or more additional elements, such, for example, as silicon, aluminum, tin, manganese, etc., in addition to the copper and zinc, and having approximately the same degree of saturation of the alpha solid solution or approximately equal relative proportions of the alpha and beta solid solutions as the straight brasses having an actual copper content from about 57% to about 85%, generally dezincify similarly to the straight brasses having equivalent structures.

But when one or more of the foregoing mentioned additional elements are incorporated in a straight brass, it changes the structural nature of the brass. If, for example, a special brass be made of 76% copper, 2% aluminum and the balance zinc, it is found that this brass has a structure equivalent to a straight brass of about 69% copper, that is, the 76% aluminum-containing brass has a degree of saturation of the alpha solid solution approximately equal to that which occurs in 69% straight brass. Therefore, the aluminum brass containing an actual copper content of 76% may be said to have an apparent copper content or structurally equivalent copper content of 69%.

Investigation of various special brasses containing additional elements such as silicon, aluminum and other elements, shows that the effect of these additional elements follows a law which can be represented approximately by the following mathematical equation:

$$A'=\frac{100.A}{100+x.m+y.n+z.o+etc.}$$

In the above equation:

A'=the per cent of apparent copper content

A=the percent of actual copper content

x, y, z, etc.=constants for the various added elements

m, n, o, etc.=the per cents of the corresponding added elements.

The following elements and their constants are given:

Silicon	=9	Lead	= 0
Aluminum	=5	Iron	=—0.1
Magnesium	=1	Manganese	=—0.5
Tin	=1	Nickel	=—2.2
Cadmium	=0		

To find, for example, the structurally equivalent or apparent copper content of a special brass having an actual copper content of 80%, aluminum 2%, tin 1% and balance zinc:

$$A'=\frac{100\times 80}{100+5\times 2+1\times 1}=\frac{8000}{111}=72\left\{\begin{matrix}\text{per cent of apparent}\\ \text{copper content}\end{matrix}\right.$$

In other words, the above aluminum brass having an actual copper content of 80% has approximately the same degree of saturation of the alpha solid solution as occurs in straight brass of 72% actual copper content. Therefore, we may say, that the aluminum brass having an actual copper content of 80% has an apparent copper content of about 72%.

Generally speaking, the question as to whether or not a given brass, whether straight or special, will be subject to dezincification, depends upon the structure of the brass, that is, upon whether its apparent copper content ranges between about 57% and about 85%.

Sea water and other salt waters, and so-called fresh water such as domestic water supplies and all surface and ground water supplies, whether of shallow or deep origin, all are dezincifying liquids which tend to induce dezincification, and all of them are included by the term saline liquid.

I have found that the addition of antimony to straight or special, normally dezincifiable brasses, distinctly improves the dezincification resistance of the brass. An addition of as little as 0.007% antimony substantially increases the dezincification resistance of brass alloys. The addition of 0.02% antimony to brass alloys further increases the resistance to corrosion and largely changes the type of corrosion from dezincification to the less harmful general thinning. The addition of 0.09% antimony to brass alloys still further increases the resistance to dezincification and in the case of some brasses, completely overcomes dezincification, such small corrosion as occurs being general thinning, a comparatively innocuous form of corrosion compared to dezincification,

particularly "plug-type" or localized dezincification. Ordinarily, about 0.15%, that is from 0.1% to 0.2% antimony is sufficient to incorporate in brass alloys to satisfactorily improve their dezincification resistance and generally completely overcome their tendency to "plug-type" dezincification which is the most serious type. Still higher amounts of antimony when added to brasses, are effective to improve their dezincification resistance, but when the amount passes above 0.35% antimony, increasing difficulty is encountered in manufacturing wrought-brass tubes, pipes, etc., owing to the inferior working properties of the brasses.

If from ¼% to 2% of tin is added to brasses containing antimony, the tin aids the antimony in still further improving the dezincification resistance.

If arsenic is used in brasses in place of antimony, it improves the dezincification resistance, but tends to bring about a different type of corrosion, namely, intercrystalline attack, which is more severe when small amounts of both arsenic and tin are present.

The addition of small amounts of antimony and arsenic, or antimony, arsenic and tin, greatly improves the dezincification resistance without producing any intercrystalline attack.

The following represent some satisfactory dezincification resistant brass alloys having an apparent copper content within a range of from 57% to 75% (by calculation in accordance with the previously given equation), for use in making wrought-brass tubes, pipes, etc.:

Alloy	Actual copper	Aluminum	Silicon	Tin	Nickel	Manganese	Lead	Antimony	Zinc
A	67						.1	.15	Bal.
B	60			.75			0.5	.15	Bal.
C	62						3.5	.15	Bal.
D	65							.15	Bal.
E	41				13	.5	1.25	.15	Bal.
F	70			1				.15	Bal.
G	60			0–1				.15	Bal.
H	76	2						.15	Bal.
I	83		1.2					.1	Bal.
J	78.2		.95					.15	Bal.

The following represent some additional dezincification resistant brass alloys:

Alloy	Actual copper	Aluminum	Silicon	Tin	Nickel	Manganese	Lead	Antimony	Arsenic	Zinc
K	76	2						.1		Bal.
L	76	2						.05	.05	Bal.
M	80	2		1				.05		Bal.
N	80	2		1				.33		Bal.
O	80	2		1	1			.02		Bal.
P	82	1.5				.75		.05		Bal.
Q	82	1.5		1	.5	.5		.05	.05	Bal.
R	65							.007		Bal.
S	65							.02		Bal.
T	65							.09		Bal.
U	70							.06		Bal.
V	75							.06		Bal.
W	68		1					.09		Bal.

The invention may be carried out in other specific ways than those herein set forth without departing from the spirit and essential characteristics of the invention, and the present embodiments are therefore to be considered in all respects as illustrative and not restrictive, and all changes coming within the meaning and equivalency range of the appended claims are intended to be embraced therein.

I claim:

1. A dezincification-resistant dezincifying-liquid-contact wrought-brass tube formed from brass containing: an apparent copper content from about 57% to about 85%; an actual zinc content less than the apparent copper content and which if alone with the copper would form a tube which would dezincify; an actual tin content from about ¼% to about 2%; an actual aluminum content from about ½% to about 4%; and an actual antimony content small enough to permit the tube to be wrought but sufficient to substantially improve the dezincification resistance of the tube.

2. A dezincification-resistant dezincifying-liquid-contact wrought-brass tube formed from brass containing: an apparent copper content from about 57% to about 85%; an actual zinc content less than the apparent copper content and which if alone with the copper would form a tube which would dezincify; an actual aluminum content from about ½% to about 4%; and an actual antimony content small enough to permit the tube to be wrought but sufficient to substantially improve the dezincification resistance of the tube.

3. A dezincification-resistant dezincifying-liquid-contact wrought-brass tube formed from brass containing: an apparent copper content from about 57% to about 85%; an actual zinc content less than the apparent copper content and which if alone with the copper would form a tube which would dezincify; an actual tin content from about ¼% to about 2%; and an actual antimony content small enough to permit the tube to be wrought but sufficient to substantially improve the dezincification resistance of the tube.

4. A dezincification-resistant dezincifying-liquid-contact wrought-brass tube formed from brass containing: an apparent copper content from about 57% to about 85%; an actual zinc content less than the apparent copper content and which if alone with the copper would form a tube which would dezincify; and an actual antimony content small enough to permit the tube to be wrought but sufficient to substantially improve the dezincification resistance of the tube.

5. A dezincification-resistant dezincifying-liquid-contact wrought-brass tube formed from brass containing: an apparent copper content from about 57% to about 85%; an actual zinc content less than the apparent copper content and which if alone with the copper would form a tube which would dezincify; an actual tin content from about ¼% to about 2%; an actual aluminum content from about ½% to about 4%; and an actual antimony content from about 0.01% to about 0.35% to substantially improve the dezincification resistance of the tube.

6. A dezincification-resistant dezincifying-liquid-contact wrought-brass tube formed from brass containing: an apparent copper content from about 57% to about 85%; an actual zinc content less than the apparent copper content and which if alone with the copper would form a tube which would dezincify; an actual aluminum content from about ½% to about 4%; and an actual antimony content from about 0.01% to about 0.35% to substantially improve the dezincification resistance of the tube.

7. A dezincification-resistant dezincifying-

liquid-contact wrought-brass tube formed from brass containing: an apparent copper content from about 57% to about 85%; an actual zinc content less than the apparent copper content and which if alone with the copper would form a tube which would dezincify; an actual tin content from about ¼% to about 2%; and an actual antimony content from about 0.01% to about 0.35% to substantially improve the dezincification resistance of the tube.

8. A dezincification-resistant dezincifying-liquid-contact wrought-brass tube formed from brass containing: an apparent copper content from about 57% to about 85%; an actual zinc content less than the apparent copper content and which if alone with the copper would form a tube which would dezincify; and an actual antimony content from about 0.01% to about 0.35% to substantially improve the dezincification resistance of the tube.

9. A dezincification-resistant dezincifying-liquid-contact wrought-brass tube formed from brass containing: an apparent copper content from about 57% to about 75%; an actual zinc content less than the apparent copper content and which if alone with the copper would form a tube which would dezincify; an actual tin content from about ½% to about 1½%; an actual aluminum content from about 1% to about 2½%; and an actual antimony content small enough to permit the tube to be wrought but sufficient to substantially improve the dezincification resistance of the tube.

10. A dezincification-resistant dezincifying-liquid-contact wrought-brass tube formed from brass containing: an apparent copper content from about 57% to about 75%; an actual zinc content less than the apparent copper content and which if alone with the copper would form a tube which would dezincify; an actual aluminum content from about 1% to about 2½%; and an actual antimony content small enough to permit the tube to be wrought but sufficient to substantially improve the dezincification resistance of the tube.

11. A dezincification-resistant dezincifying-liquid-contact wrought-brass tube formed from brass containing: an apparent copper content from about 57% to about 75%; an actual zinc content less than the apparent copper content and which if alone with the copper would form a tube which would dezincify; an actual tin content from about ½% to about 1½%; and an actual antimony content small enough to permit the tube to be wrought but sufficient to substantially improve the dezincification resistance of the tube.

12. A dezincification-resistant dezincifying-liquid-contact wrought-brass tube formed from brass containing: an apparent copper content from about 57% to about 75%; an actual zinc content less than the apparent copper content and which if alone with the copper would form a tube which would dezincify; and an actual antimony content small enough to permit the tube to be wrought but sufficient to substantially improve the dezincification resistance of the tube.

13. A dezincification-resistant dezincifying-liquid-contact wrought-brass tube formed from brass containing: an apparent copper content from about 57% to about 75%; an actual zinc content less than the apparent copper content and which if alone with the copper would form a tube which would dezincify; an actual tin content from about ½% to about 1½%; and an actual antimony content from about 0.03% to about 0.25% to substantially improve the dezincification resistance of the tube.

14. A dezincification-resistant dezincifying-liquid-contact wrought-brass tube formed from brass containing: an apparent copper content from about 57% to about 75%; an actual zinc content less than the apparent copper content, and which if alone with the copper would form a tube which would dezincify; an actual aluminum content from about 1% to about 2½%; and an actual antimony content from about 0.03% to about 0.25% to substantially improve the dezincification resistance of the tube.

15. A dezincification-resistant dezincifying-liquid-contact wrought-brass tube formed from brass containing: an apparent copper content from about 57% to about 75%; an actual zinc content less than the apparent copper content and which if alone with the copper would form a tube which would dezincify; an actual tin content from about ½% to about 1½%; an actual aluminum content from about 1% to about 2½%; and an actual antimony content from about 0.03% to about 0.25% to substantially improve the dezincification resistance of the tube.

EDWARD W. ROATH.