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O T T A W A July 19th, 1944.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1685.

Investigation of Silver Brazing Process.

(Copy No. 10.)

Bureau of Mines
Division of Metallic
Minerals

Physical Metallurgy
Research Laboratories

CANADA
DEPARTMENT
OF
MINES AND RESOURCES
Mines and Geology Branch

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Origin of Material:

In May, 1944, Mr. R. C. Blyth, Principal Steamship Inspector, Steamship Inspection Division, Department of Transport, Ottawa, Ontario, requested the assistance of these Laboratories in determining the suitability of the silver brazing process for use in steamship piping construction.

Handy & Harman of Canada, Limited, Toronto, Ontario, arranged the fabrication and testing of a pipe pressure test assembly. Also submitted was correspondence from Lloyd's Register of Shipping, The British Corporation Register of Shipping and Aircraft, and the Department of National Defence, Naval Service, as evidence of the acceptance of the silver brazing process where the service temperature does not exceed 425° F. and the pressure 200 pounds. The acceptance of the

(Origin of Material, cont'd) -

silver brazing process by the Department of National Defence for Air is indicated by a specification (C-28-22A) issued by the Aeronautical Engineering Division.

In addition, reports of tests performed by the U.S. Navy's Bureau of Engineering and the Bureau of Ships were submitted. These tests consisted of pressure tests on flanged assemblies silver-brazed together, the pressure being applied slowly, and also rapidly up to 400 pounds to simulate underwater explosion; shear resistance of the silver-brazed joints at normal and elevated temperatures (900° F.); tensile loading of silver-brazed joints while under pressure; static torsion with and without internal air pressure; resistance to torsional vibration; tension impact tests to determine tendency to brittleness; high temperature while under high pressure, to simulate fire at sea conditions; corrosion resistance of silver-brazed joints; long-time tension tests at temperatures up to 750° F.; alternating steam and cooling water tests. In the case of every test the performance of the silver-brazed joints was considered satisfactory.

Object of Investigation:

(1) To examine the silver brazing process with a view to determining its suitability in steamship copper pipe installations.

(2) To suggest imposition of limitations on its use as may be found desirable.

PROCEDURE:

1. A pressure test assembly, shown in Figure 1, was fabricated by means of silver brazing. This assembly consists of an 18-inch length of copper tubing, 3/16-inch wall thickness and 4-inch O.D., to the ends of which were brazed 11/16-inch brass flanges. The braze joining the ends of the copper pipe to the flanges was made with Sil-Fos silver brazing alloy. The

(Procedure, cont'd) -

ends of the pipe were then sealed by brazing cover plates to the flanges. The braze was made with Easy-Flo silver brazing alloy.

2. The assembly was subjected to a 1000-pound internal hydrostatic pressure test and the assembly hammered while under pressure, in an attempt to start leakage. No such leakage was observed. The pressure caused one cover plate to bulge and both ends of the copper tube to expand considerably. Figure 2 shows the bulged cover plate.

3. Sections of the joint between the cover plate and flange plates were subjected to tension tests. The table below lists the results secured:

Test	Dimensions, inches	Tension Causing Failure, in pounds
1	1.006 x 1.1875	4,560
2	1.008 x 1.250	4,660

On completion of tests it was noted that the brazing alloy had penetrated only to a maximum of $\frac{1}{4}$ inch into the joint, the average penetration being approximately 1/8 inch. This is due to a bend in the flange which, beyond this distance, prevents capillary action from drawing in the alloy. In closely fitting surfaces, complete penetration is easily secured. The results of these tests, however, show the high shearing strength of the Easy-Flo silver brazed joint.

4. A microscopic examination revealed that a good bond had been secured between the two brass components and also between the copper pipe and brass flange. Figures 3 and 4, respectively, show these two joints.

Discussion:

It is immediately apparent, from the reports submitted, that the U.S. Navy has subjected the silver brazing process to

(Discussion, cont'd) -

a comprehensive examination. It is understood that the U.S. Navy has approved the process for naval construction work for temperatures up to 425° F. and pressures up to 200 pounds. In view of the above facts there is little useful purpose to be served by these Laboratories duplicating tests already performed.

The widespread acceptance of the silver brazing process by the various shipping inspection services and the Canadian Navy, is also significant. It is not surprising, then, that the pressure test herein reported was quite successful.

The tension tests and macro-examination indicate the necessity for securing a close fit-up between the parts to be brazed. It is a characteristic of this process that the greatest strength of joint is developed when the silver alloy is from 0.0015 to 0.003 inch in thickness. Above and below this joint thickness, the strength falls off rapidly.

The microscopic examination shows that the silver alloy has bonded well with both brass and copper components to give a strong joint.

CONCLUSIONS:

1. From a review of the reports submitted and the widespread acceptance of the silver brazing processes, it would appear that its use in ship pipe construction is satisfactory.

2. The results of the pressure test, tension tests, and microscopic examination strengthen the above conclusion.

Recommendations:

1. The use of silver brazing alloys for joints where the temperature does not exceed 425° F. and the pressure

(Recommendations, cont'd) -

does not exceed 200 pounds, is recommended without reservations.

2. Where silver brazing is used, close attention should be paid to securing the necessary close fit-up of mating surfaces.

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Figure 1.

PIPE PRESSURE TEST ASSEMBLY AFTER TESTING.

Note expansion of copper pipe at both ends.

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Figure 2.

PIPE PRESSURE TEST ASSEMBLY AFTER TESTING.

Note pronounced outward expansion of end cover plate.

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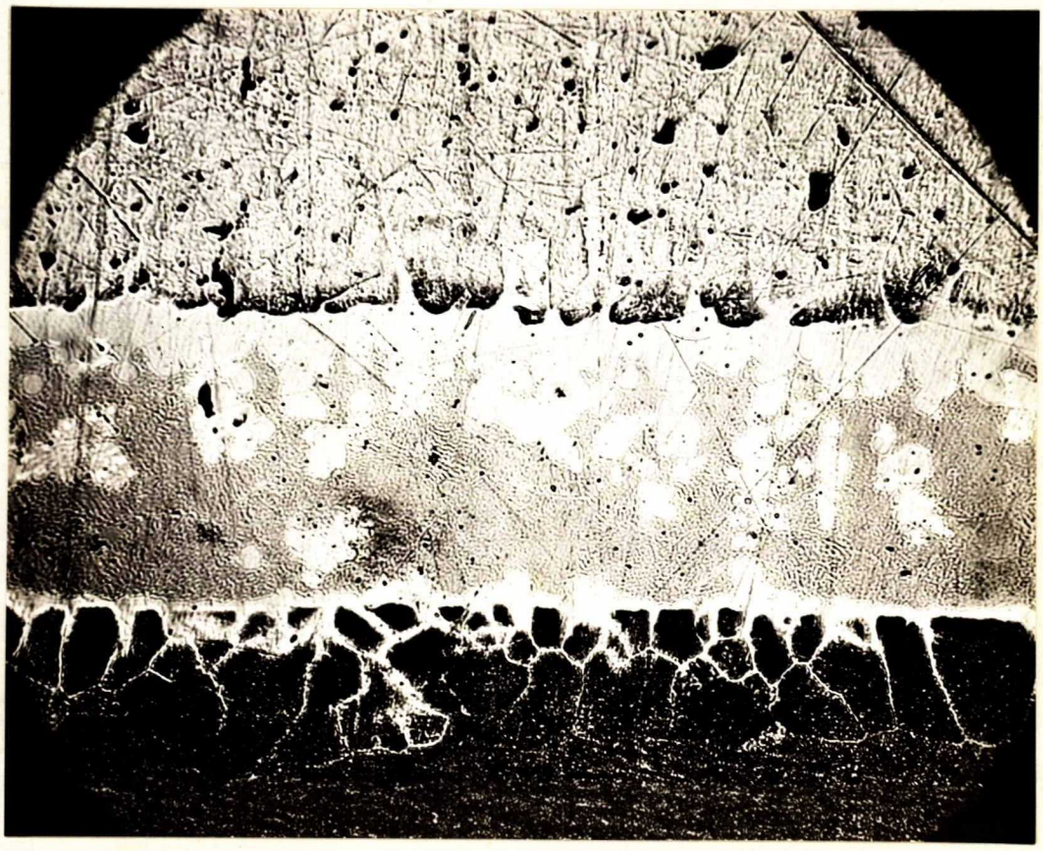
Figure 3.



X250, etched in ferric chloride and hydrochloric acid in water.

SIL-FOS JOINT BETWEEN COPPER PIPE (ABOVE) AND BRASS FLANGE (BELOW).

Note penetration of brazing alloy into both members.

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Figure 4.

X250, etched in ferric chloride
and hydrochloric acid in water.

EASY-FLO JOINT BETWEEN BRASS FLANGE
AND BRASS COVER PLATE.

Note penetration of brazing alloy
into both members.

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