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DEPARTMENT OF MINES AND RESOURCES

BUREAU OF MINES

CANADA

Ottawa, July 19, 1946.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 2079.

Pressure Testing of Silver-Brazed Locomotive Fittings.

(Copy No. 4.)

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Introduction:

On June 8, 1946, Mr. J.S. Fullerton, of Handy & Harman of Canada Limited, Toronto, Ontario, requested the assistance of these Laboratories with regard to the pressure testing of silver-brazed locomotive fittings made by T. McAvity & Sons, Limited, Montreal, Quebec. On June 24, Mr. F. W. Blanchard, Development Engineer, of T. McAvity & Sons, Limited, by letter, advised of the shipment of a test assembly consisting of fittings with pre-placed rings of silver brazing alloy, a length of copper pipe, and a locomotive bronze valve. This assembly was received on July 3.

Mr. Fullerton's letter referred to a conversation with the writer (H.J.N.), in Ottawa in the early part of June, in

(Introduction, cont'd) -

which the following information was obtained:

> "Similar fittings are now in use on some American railways but have not as yet been approved by the A.R.A. Such approval is being sought and a committee of this organization has the matter under consideration. Manufacturers of such fittings restrict the use of such silver-brazed fittings to service conditions where pressures and temperatures do not exceed 300 pounds and 550° F. respectively. It is understood that the Canadian manufacturer (T. McAvity & Sons, Ltd.) intends to submit these fittings, for approval in locomotive construction, to the Canadian railways. To this end it was desired to test the fittings at 550° F. to pressures well in excess of 300 pounds; pressures of 750 and 1,000 pounds being suggested, in order to demonstrate that a wide margin of safety existed."

Object of Investigation:

(1) To pressure-test silver-brazed locomotive fittings at a temperature of 550° F. and pressures of 750 pounds and 1000 pounds.

(2) To section and examine the fittings after testing, to determine the quality of the bond secured.

PROCEDURE:

(1) The test assembly was photographed "as received". It consisted of two brass unions, shoulder fittings fitted with pre-placed rings, which were stated to be Easy-Flo,* a length of ¾" copper tubing to which the shoulder fittings were to be brazed, and a bronze locomotive valve.

(2) The shoulder fittings were brazed to the copper tube,

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* Made by Handy & Harman of Canada Limited. - Copper, 16 per cent; silver, 50 per cent; zinc, 16 per cent; cadmium, 18 per cent.

(Procedure, cont'd) -

using an oxyacetylene welding torch and a standard brazing technique. Excess flux was removed by washing in hot water.

(3) The assembly was assembled for testing as shown in Figure 2. Pressure was applied by means of a cylinder of nitrogen connected to a junction block and thence to the assembly. An accurate gauge was attached to the junction box and controlling valves applied at the delivery side of the junction block. Unfortunately, the valve could not be made airtight and therefore was not used nor tested. The open end of the assembly was closed by means of a standard malleable iron pipe cap.

(4) The whole assembly was put into a furnace and slowly brought to 550° F. When this temperature was attained, pressure was applied. The valve was used to bleed off nitrogen as expansion of the gas took place in the assembly. When equilibrium conditions had been established at 750 pounds pressure, timing was begun. The test was continued for 4 hours and the assembly removed and examined for any traces of creep at the end of each hour. No leakage was detected.

(5) The above procedure was repeated for a pressure of 1000 pounds at 550° F. No leakage was detected.

(6) At the conclusion of the pressure tests the brazed joint was sectioned and a macro photo taken to show the penetration of the brazing alloy (Figure 3). A microscopic examination of the bond revealed the formation of an intermetallic compound between the brazing alloy and the copper and brass (Figure 4).

Discussion:

Pressure tests reveal that the design of the joint provides a large margin of safety in that a pressure of 1000 pounds was successfully endured for four hours without sign

(Discussion, cont'd) -

of failure. A macroscopic examination reveals that clearances were sufficient to permit easy complete penetration of the brazing alloy along the entire interface. A microscopic examination of the joint reveals the formation of a complex intermetallic compound which would provide good mechanical properties to the joint.

In view of the above tests, it would appear that such fittings have ample strength to provide a comfortable margin of safety for service at 300 pounds pressure at 550° F.

Conclusions:

1. The silver-brazed locomotive fittings withstood a 4-hour test at 750 pounds pressure at 550° F. without sign of failure, and a similar length of time at 1,000 pounds pressure at the same temperature.

2. Complete penetration of the brazing alloy was obtained along the entire interface.

3. An intermetallic compound is formed between the brazing alloy and the copper and brass which would be expected to provide a joint of good mechanical properties.

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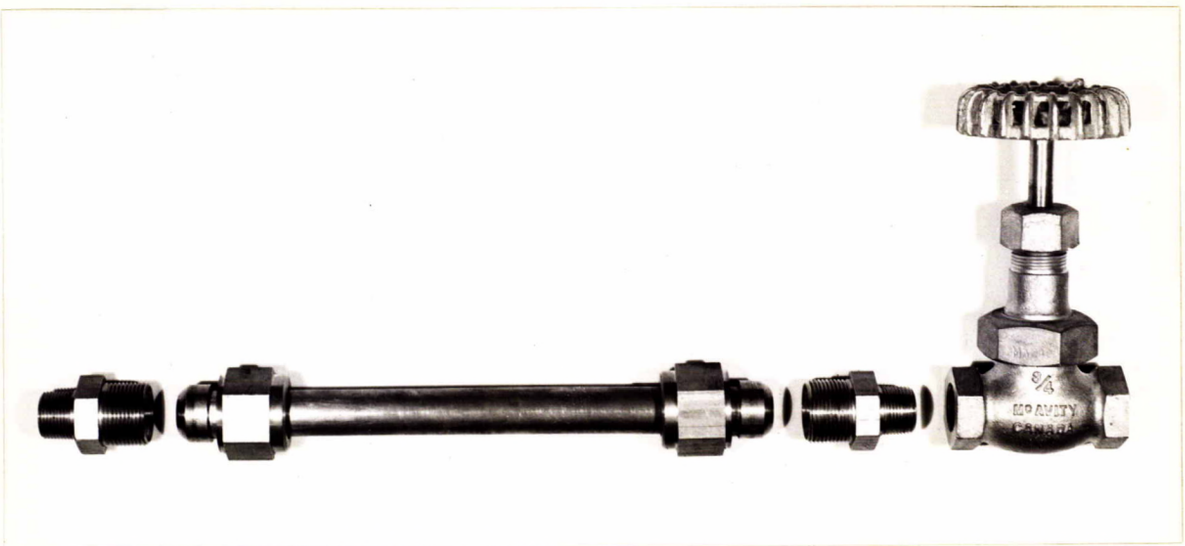
(Figures 1 to 4 follow,
on Pages 4 to 6.)

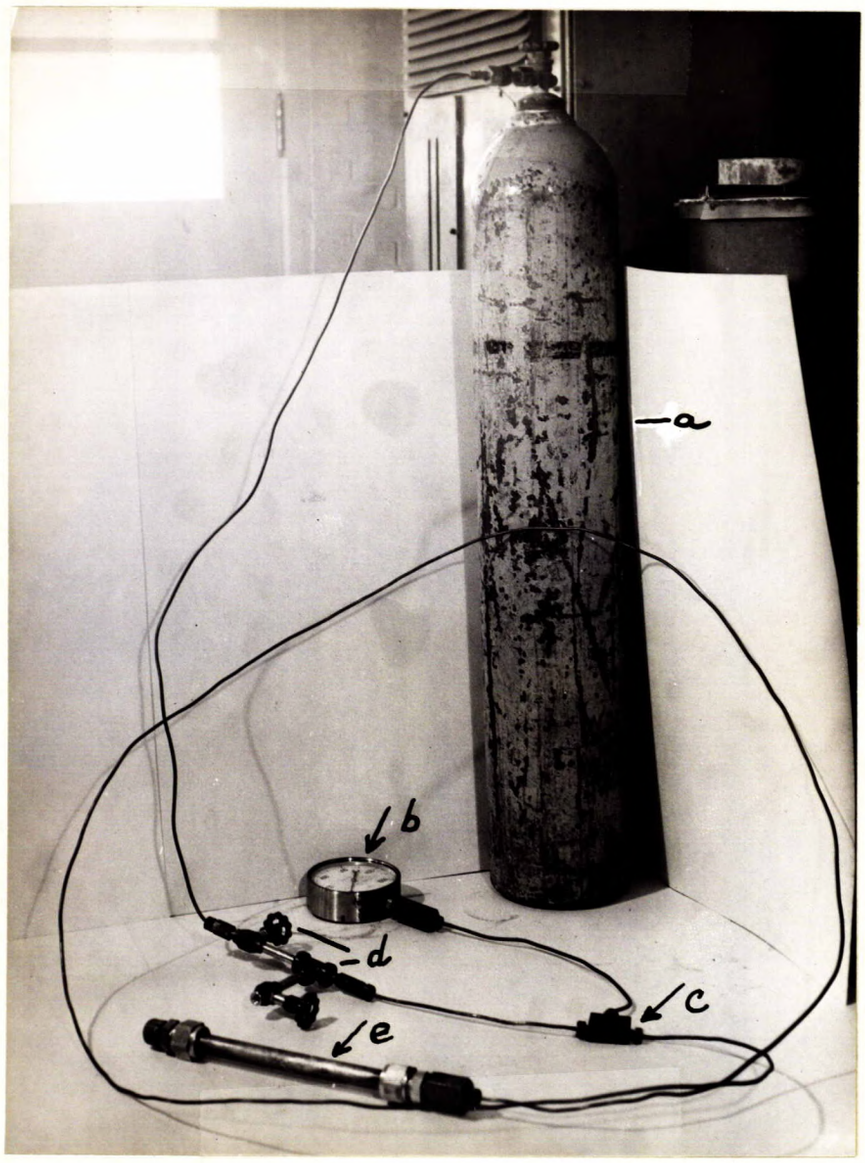
HJN:PES.

Figure 1.



COMPONENTS OF ASSEMBLY
"AS RECEIVED".

Figure 2.



ASSEMBLY READY FOR TESTING.

Nitrogen under tank pressure of 2,200 pounds fed through a controlling valve to a junction block. Pressure gauge attached to junction block. Assembly pressure could be dropped to zero by a valve at one side of the junction block. Note malleable iron pipe sealing the end of the assembly.

Legend:

a - cylinder of nitrogen.
b - gauge, 0-1,000 pounds.
c - junction block.
d - controlling valves.
e - assembly being tested.

Figure 3.

MACRO PHOTOGRAPH OF BRAZED JOINT.

Note complete penetration of brazing alloy.

(Approximately 2½ times actual size.)

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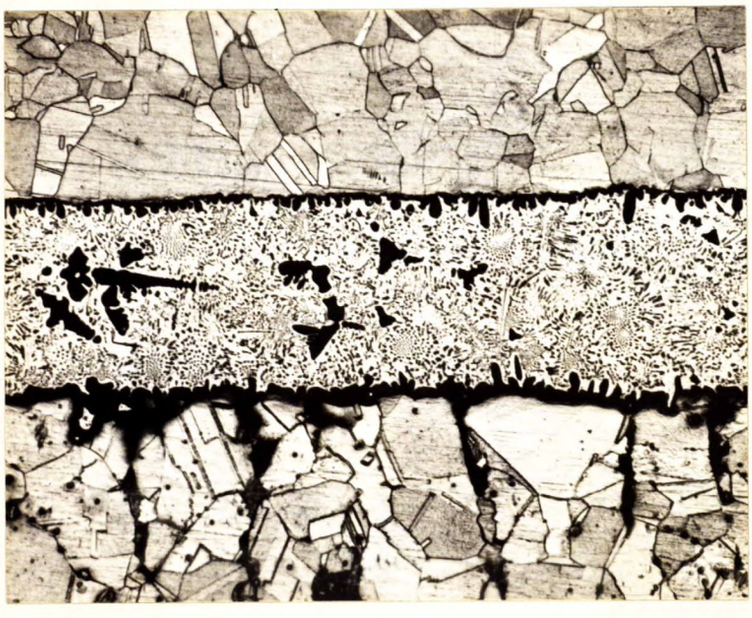
Figure 4.



X250, etched in $FeCl_2$ and alcohol.

PHOTOMICROGRAPH OF JOINT. COPPER AT TOP, BRASS AT BOTTOM.

Note formation of intermetallic compound between brazing alloy and copper and brass.

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HJN:PES.