THE FORERUNNER
IN SPECIALTY METALS

TECHNICAL INFORMATION

THE TORCH BRAZING OF ELKONITE® MATERIALS TO CMW® COPPER-BASE ALLOYS

INTRODUCTION:

There are numerous occasions when it is desirable to perform brazing operations on ELKONITE® materials or to replace ELKONITE® facings on electrodes or dies for resistance welding applications in the field.

The information outlined here is intended as a general guide to the accepted procedures for such operations. No attempt has been made to coverall possible conditions, so that some specific problems may require special engineering advice and aid. While the information below is a general guide for torch brazing, the information can be utilized in induction brazing, resistance brazing and furnace brazing.

Part A: THE BRAZING OF NEW PARTS

I. General Procedure

To obtain a satisfactory braze, the brazing surfaces of the ELKONITE® and the copper-base alloy to which it is to be joined must be close fitting and clean.

1. Cleaning of the ELKONITE®

The ELKONITE® surface to be brazed must be chemically clean. Heavy deposits of grease or surface soil may be removed by carbon tetrachloride, alcohol, approved vapor degreasing or by means of hot alkaline cleaning solutions.
The surface should be further ground or sanded to remove oxide film. Sanding may be done using such material as aluminum oxide abrasive cloth, 120 to 240 grit.

ELKONITE® should not be acid bright-dipped nor should any other chemical method of removing oxide be used. ELKONITE® should not be sand or grit blasted.

2. Cleaning of the Copper Alloy Backing Material

Grease, oil, and surface soil must be removed from the copper alloy in much the same manner as the ELKONITE®. Sanding or grinding of the surface to be brazed is recommended if the material is oxidized.

Chemical bright-dipping is permissible using acid solutions normally used to bright-dip copper parts

3. Fit of Parts to be Brazed

The surfaces of the ELKONITE® and copper alloy to be brazed should be close fitting and parallel, and any burrs on corners or edges which might hold the material apart should be removed.

II. Brazing Technique

1. Brazing Filler Metal

AWS A 5.8 BAg-9 and an appropriate flux may be used to join any of the following ELKONITE® and copper alloy combinations:

ELKONITE®		COPPER ALLOYS
ELKONITE® 1W3		Copper (C10200)
ELKONITE® 3W3	Brazed to	ELKALOY® A (C16200)
ELKONITE® 5W3	any of the	CMW® 3 (C1.8200)
ELKONITE® 10W3	materials to	CMW® 100 (C17500)
ELKONITE® 3W53	the right	CMW® 353 (C18000)
ELKONIT®10W53		CMW® 328 (C18150)
ELKONITE® TC-5		CMW® 73 (C17200)
ELKONITE® TC-10		CMW® 28 (C15000)
ELKONITE® TC-20		
ELKONITE® TC-53		

The melting point of BAg-9 is 692°C (1280°F) and it flows freely at 708°C (1310°F).

For brazing ELKON® 100-W or ELKON® 100-M to any of the backing materials BCuP-5 and flux are used to tin the ELKON® 100-W or ELKON® 100-M prior to brazing. The ELKON® is then joined to the backing with BAg-9.

The flux must be thinned with water so that it may be conveniently applied with a brush.

An alternate brazing material such as, BAg-7, BAg-1 or BAg-3 may be substituted for BAg-9.

2. Condition of Copper Base Alloy

The following backing materials should be brazed in the full hard condition:

ELKALOY® A	CMW® 3	CMW® 328
CMW® 100	CMW® 73	CMW® 28
COPPER		

CMW® 353 castings should be brazed in the "as cast" condition.

III. Brazing Procedure

After the materials have been cleaned and fitted, the brazing procedure should be as follows:

1. Coat all surfaces to be joined with a light coating of flux.

2. Tin the ELKONITE® as follows:
   Cut a piece of 0,005' to 0.006" thick sheet brazing filler metal approximately 2/3 of the full area of the ELKONITE®. Lightly flux both sides of the brazing filler metal and place it on the ELKONITE®. Using either oxy-hydrogen or oxyacetylene adjusted to give a soft reducing flame, heat the ELKONITE® until the brazing filler metal flows freely. The flame should be kept moving and should not be played directly on the brazing surface. In many cases the brazing filler metal will tend to "ball up" and must be spread or "puddled" using a 3/32" or 1/8" diameter steel rod with a 1" right angle bent on the end. The entire surface must be uniformly "tinned" to ensure a strong joint.

3. Place the tinned ELKONITE® on the already fluxed copper alloy backing material (an additional brazing filler metal coupon may be added) and reheat the assembly to brazing temperature. When the brazing filler metal is molten, maintain the temperature and move the ELKONITE® about, using a steel rod, to secure complete tinning of the copper alloy backing. Usually it is necessary to maintain the brazing temperature from 15 to 90 seconds, depending upon the mass of the metal being joined. Note: Gas burners may be used to heat large parts uniformly.

4. Immediately upon removal of the flame, apply sufficient pressure to squeeze out excess brazing filler metal and flux. A pressure of not less than 20 pounds per square inch is recommended and the pressure should be maintained until the braze sets. On large pieces being brazed, the pressure should be distributed uniformly across the entire surface.

5. Brazed assemblies should be allowed to air-cool to minimize warpage or distortion and to avoid damage to the brazed joint. Smaller assemblies may be quenched in water after the temperature has dropped to 250°C (482°F). Larger assemblies should not be water-quenched until the temperature has dropped to 150°C (302°F).

6. In all cases, the brazing operation should be performed at the lowest possible temperature and with the greatest speed consistent with good braze strength in order to retain the maximum physical and mechanical properties of the backing material.

   In all cases, heat only the portion of the backing material necessary for braze. On certain assemblies, parts of the backing not immediately adjacent to the braze area may be water cooled by immersion or flooding during brazing.

IV. Heat Treatment of Certain Materials Following Brazing

The physical and mechanical properties of ELKONITE® 3W53, ELKONITE® 10W53 and ELKONITE® TC-53 may be improved by heat treatment following brazing.
The hardness and electrical conductivity of ELKONITE® 3W53, ELKONITE® 10W53, and ELKONITE® TC-53 may be improved after brazing by heat treatment at 450°C (842°F) for 4 hours. When so treating an assembly of these ELKONITE® with CMW® 73 or CMW® 100, the part must be furnace-cooled down to 350°C (662°F) after which it may be air-cooled. With other copper-base backing materials, this method of cooling is unnecessary. ELKONITE® must not be heat treated in salt baths.

V. General Notes:

1. Always heat the work uniformly. Due to its greater density, the ELKONITE® will require more heating than the copper-alloy backing material.

2. The work should be shielded from bright lights and drafts of air. Lighting conditions will affect the operator's judgment of temperature and drafts will cause surface cooling and misjudgment of the temperature.

3. Whenever possible, the ELKONITE® should be tinned before brazing. When this is impracticable, the ELKONITE® should be moved back and forth on the backing for a reasonable period of time (1/2 to 2 minutes) to assure complete tinning of both metals. Under such a procedure, an excess of brazing filler metal is desirable.

4. In designing ELKONITE® and copper alloy components which are to be joined together by brazing, it should be borne in mind that the coefficients of linear expansion of ELKONITE® and the copper-base alloys are dissimilar, and dimensions of the components must be selected accordingly. This variation in expansion also causes warpage, due to brazing, particularly in larger parts. This requires that finish machining be done after brazing.

TABLE

MATERIAL	LINEAR COEFFICIENT OF EXPANSION (in/in/°C) x 10^{-6} thru brazing range (25 - 700°C)
Electrode or Contact Facing	
ELKONITE® 1W3	11.50
ELKONITE® 3W3	10.83
ELKONITE® 5W3	9.87
ELKONITE® 10W3	9.75
ELKONITE® 3W53	10.83

ELKONITE® 10W53	9.75
ELKONITE® TC-5	12.67
ELKONITE® TC-10	12.00
ELKONITE® TC-20	10.17
ELKONITE® TC-53	10.17
ELKON® 100W	4.97
ELKON® 100M	5.99
ELKONITE® 20S	10.13
ELKONITE® 35S	12.37
ELKONITE® 50S	13.83
ELKONITE® G-12	15.33
ELKONITE® G-13	14.50
ELKONITE® G-14	12.00
ELKONITE® G-17	12.50
ELKONITE® G-18	11.83

Copper Base Alloys

ELKALOY® A	17.0
ELKALOY® D	18.0
CMW® 3	17.6
CMW® 353	16.2
CMW® 28	16.3
CMW® 73	17.8
CMW® 100	17.6
CMW® 328	17.6
Copper	17.0

PART B: HEAT TREATMENT OF COPPER-BASE ALLOYS PRIOR TO RE-BRAZING OF NEW ELKONITE® CONTACT OR ELECTRODE FACINGS

After one or more ELKONITE® refacings have been brazed to the copper alloy backing, the hardness and mechanical properties of the backing may have been reduced to a point where the material no longer has adequate strength. Mechanical properties of the backing material may be restored in some of the copper materials after removal of the previous facing as follows:

1. Heat Treating Procedures

    1. ELKALOY® A and Copper
       ELKALOY® A and copper receive their hardness and strength from cold working only and therefore cannot be heat treated to restore these properties. Re-brazing should be carried out at the lowest temperature and the greatest speed possible. Re-machine the braze surface to assure it is clean and square.

    2. CMW® 3

a. Solution Anneal and Quench from 980°C (1796°F) into cold water.
b. Heat for 8 hours at 450°C (842°F).
c. Remachine braze surface to assure it is clean and square.
d. Braze new ELKONITE® facing.

3. CMW® 328
   a. Solution Anneal and Quench from 925°C (1697°F) into cold water.
   b. Heat for 1 hour at 450°C (842°F).
   c. Remachine braze surface to assure it is clean and square.
   d. Braze new ELKONITE® facing.

4. CMW® 28
   a. Solution Anneal and Quench from 910°C (1670°F) into cold water.
   b. Heat for 2 hours at 520°C (968°F).
   c. Remachine braze surface to assure it is clean and square.
   d. Braze new ELKONITE® facing.

5. CMW® 353
   a. Solution Anneal and Quench from 925°C (1697°F) into cold water.
   b. Heat for 3 hours at 530°C (986°F), cool to room temperature and heat 3 hours at 425°C (796°F).
   c. Remachine braze surface to assure it is clean and square.
   d. Braze new ELKONITE® facing.

6. CMW® 73
   a. Solution Anneal and Quench from 800°C (1472°F) into cold water. (In no case shall the temperature exceed 810°C [1490°F]).
   b. Heat for 2 hours at 300°C (572°F).
   c. Re-machine braze surface to assure it is clean and square.
   d. Braze new ELKONITE® facing.

7. CMW® 100
   a. Solution Anneal and Quench from 950°C (1742°F) into cold water.
   b. Heat for 16 hours at 450°C (842°F).
   c. Re-machine braze surface to assure it is clean and square.
   d. Braze new ELKONITE® facing.

General Information of Procedure 1.

Solution Anneal and Quench

Pieces should be soaked at temperature long enough to ensure uniform heating throughout the piece. The total time the piece is held in the furnace will depend upon the size and shape, and upon the total load in

the furnace, but should be as short as possible. A suggested time would be 15 minutes for small loads or thin parts or 30 minutes for large loads or thick parts.
Pieces shall be quenched in cold water and agitated vigorously until cool. The shortest possible time should be consumed in removing the pieces from the furnace and getting them into the quenching bath. This is very important on small or thin pieces.
Solution Annealing temperature should be maintained within ± 10°C.

Aging

Wherever possible, the aging treatment should be carried out in a salt bath to ensure more uniform heating of the pieces. In cases where this is impractical or impossible, it is permissible to age in a furnace, providing the temperature can be controlled within plus or minus 10°C and that the piece is uniformly heated. ELKONITE® or ELKONITE®-faced assemblies must not be heat treated in salt baths.

Protection During Heat Treatment

All heat treatment should be carried on in a salt bath or in a furnace with a neutral or reducing atmosphere to prevent oxidation and scalding of the parts.

Warping or Distortion

Pieces of considerable length, of complicated design or of varying cross section are likely to be distorted or warped during heat treatment. Where possible, such pieces should be quenched and aged in a restraining fixture.

The American Welding Society defines a brazing filler metal as a metal to be added when making a braze. Brazing filler metals are metals or alloys which have a melting temperature above 425°C (800°F), but below those of the metals being joined. The clearly defined term "brazing filler metal" has replaced some of the terms which were formerly used; i.e., hard solder, silver solder, gold solder, and brazing alloy.

The information contained herein is believed to be correct, but no guarantee or warranty with respect to accuracy, completeness or results is implied and no liability is assumed.