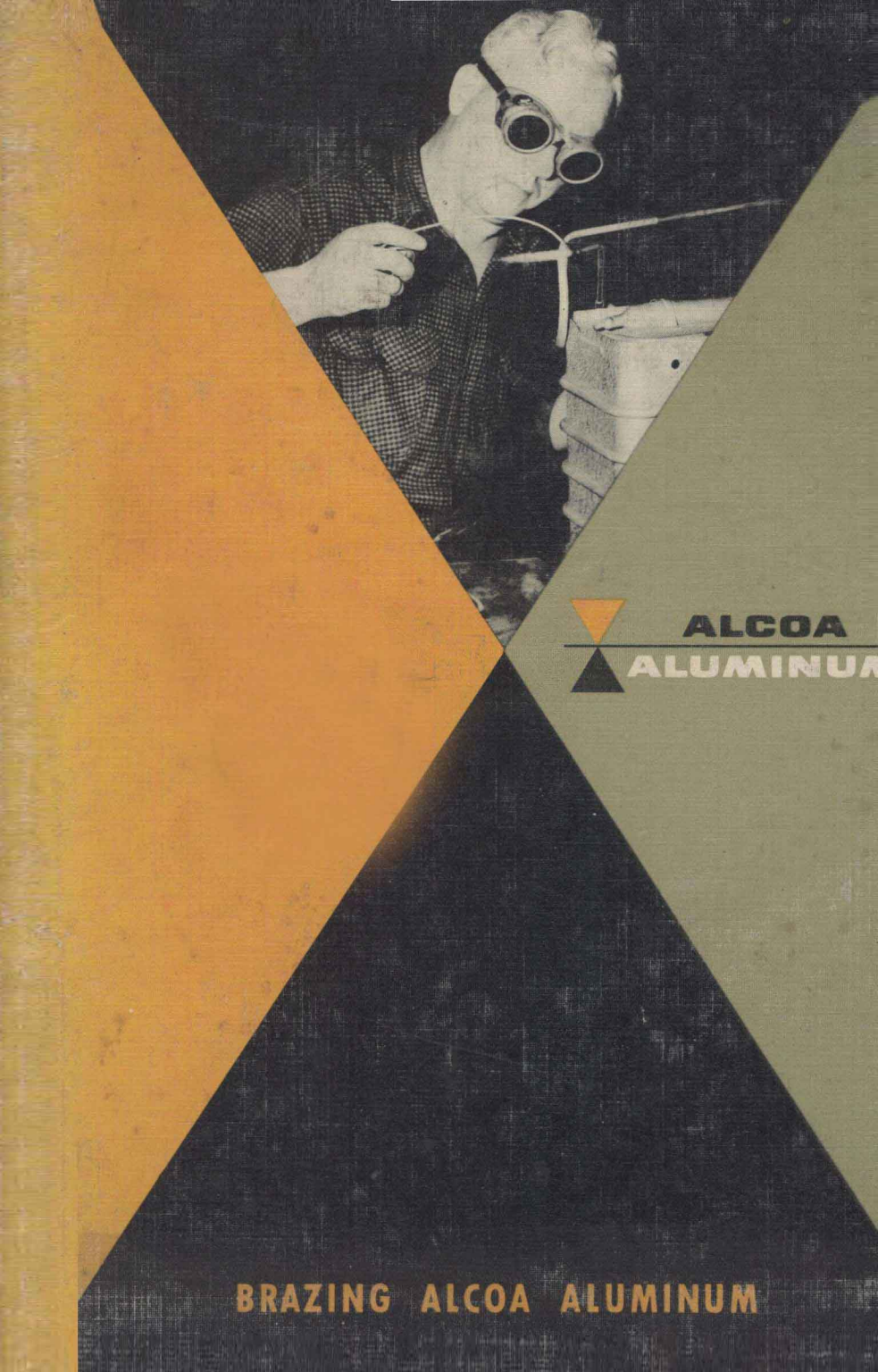

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BRAZING ALCOA ALUMINUM

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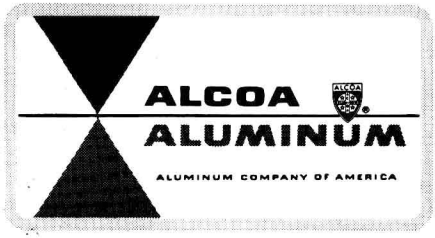
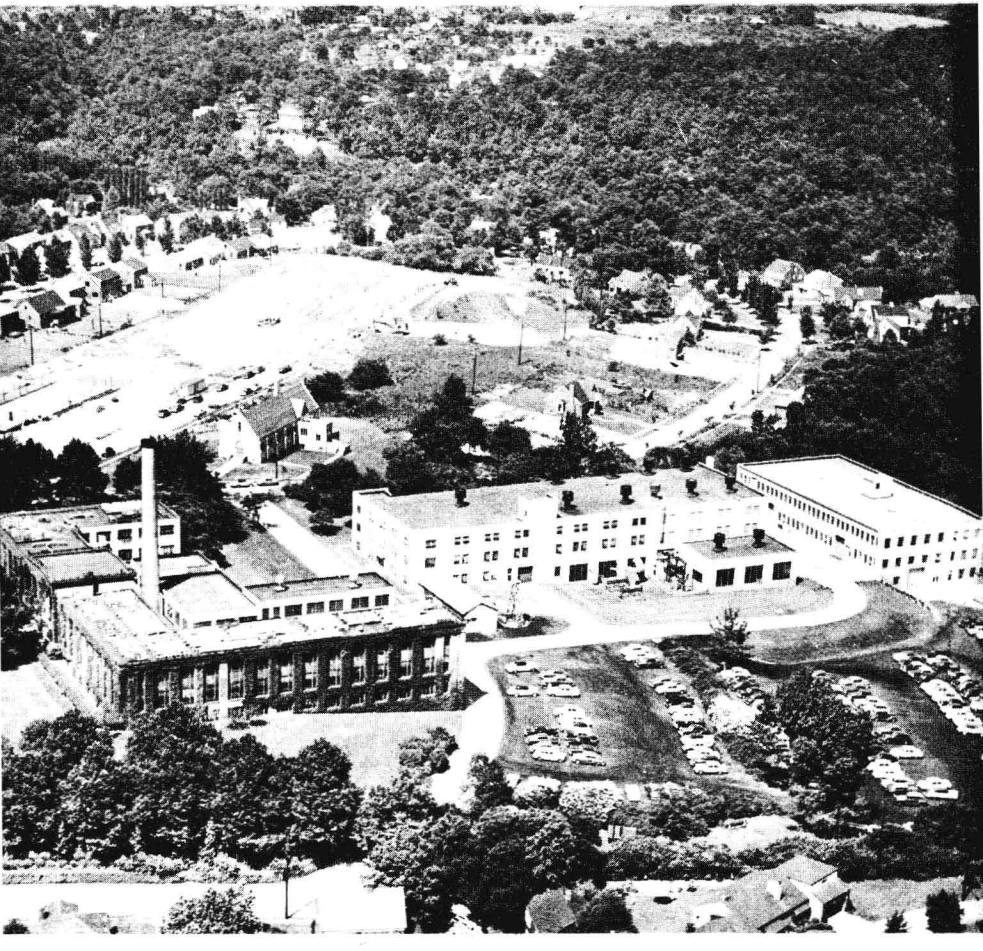


BRAZING ALCOA ALUMINUM



Alcoa Research Laboratory where new aluminum brazing developments originate.

FOREWORD

The brazing of aluminum is an art in which Alcoa has ploneered and to which Alcoa research and developmont have contributed many new techniques. These important developments in joining aluminum have brought new applications and new markets for the metal.

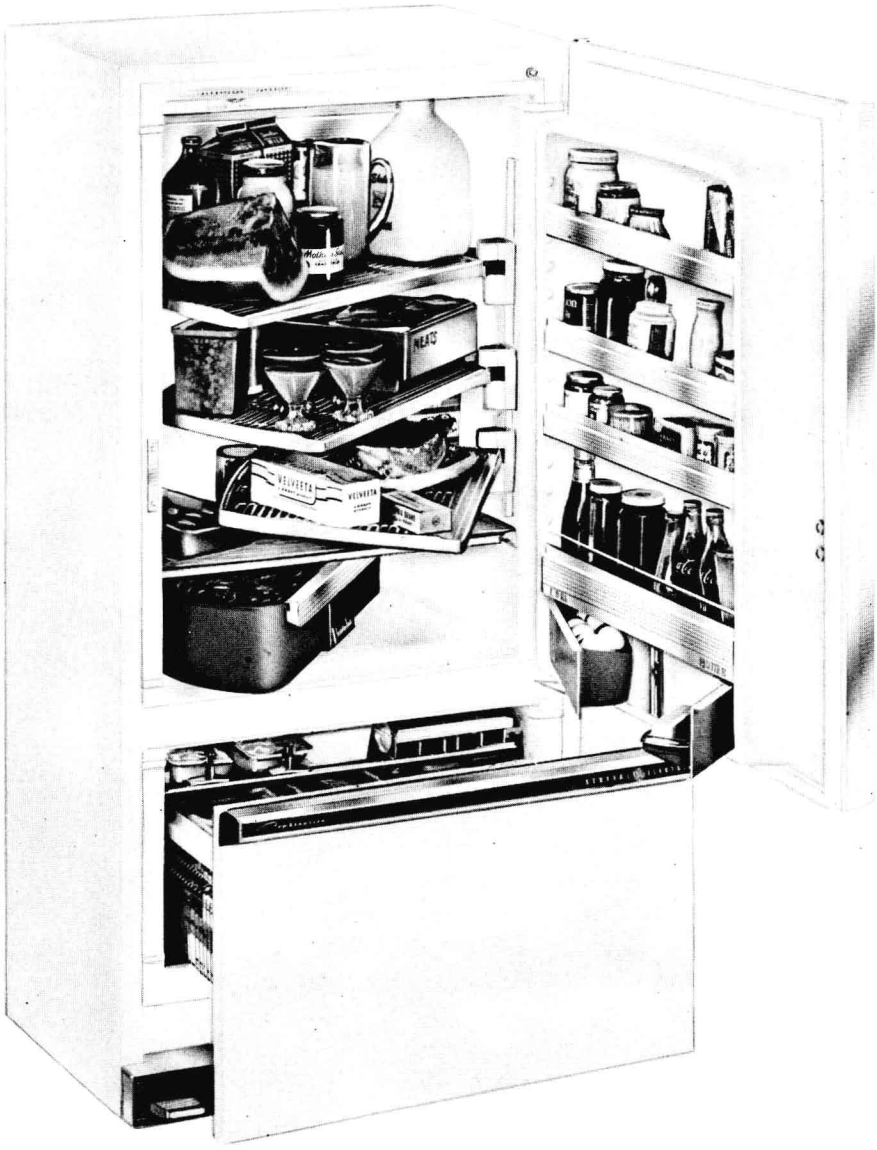
This book presents practical shop data on these brazing methods. Up-to-date knowledge of aluminum brazing processes can affect design, and this book will aid engineers and designers in selecting the best method at the drawing-board stage.

This book and its companion, *Welding Alcoa Aluminum,* succeed Alcoa's earlier *Welding and Brazing Alcoa Aluminum.* Fabricating and joining methods have been a key factor in the rapid expansion of the metal's use. These two new volumes reflect some of the growing technical knowledge that has supported this growth.

Some of the materials and methods discussed in the following pages are covered by patents or patent applications owned by Aluminum Company of America or by other companies, such as brazing equipment suppliers. Nothing here should be construed as an invitation to use any methods or materials without first making proper arrangements.

Tabular data and description in this book should answer most routine questions about brazing methods and materials. But we realize that many problems will need individual attention.

We cordially invite you to get in touch with your local Alcoa sales office. If you need further information or guidance, our sales representatives in cooperation with other Alcoa engineers will give you additional information you may need.



Modern home refrigerators employ brazed aluminum evaporators.

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CHAPTER **ONE**

INTRODUCTION TO BRAZING ALCOA ALUMINUM ALLOYS

Brazing is a way of joining aluminum parts with an alloy whose melting point is generally only slightly below the melting range of the parent alloy. The fact that the parent metal never gets hot enough to melt significantly constitutes the chief difference between brazing and welding. Brazing differs from soldering in that the filler material for brazing is an aluminum-base alloy.

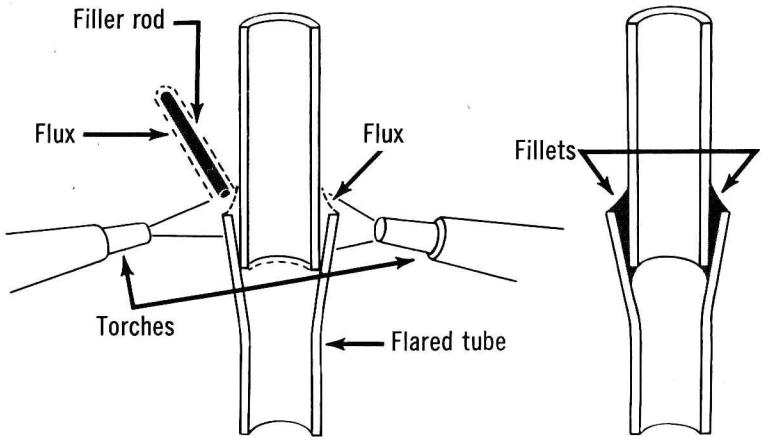
The word "brazing," of course, suggests "brass," and its root meaning comes from the time-honored art of joining iron and copper using various bronze or brass alloys. Copper-base alloys are not used in aluminum brazing. What is common to the older art is the idea of "flowing" metal into the joint.

The American Welding Society defines brazing as: "A group of welding processes wherein coalescence is produced by heating to suitable temperatures above 800° F and by using a nonferrous filler metal having a melting point below that of the base metal. The filler metal is distributed between the closely fitted surfaces of the joint by capillary action."

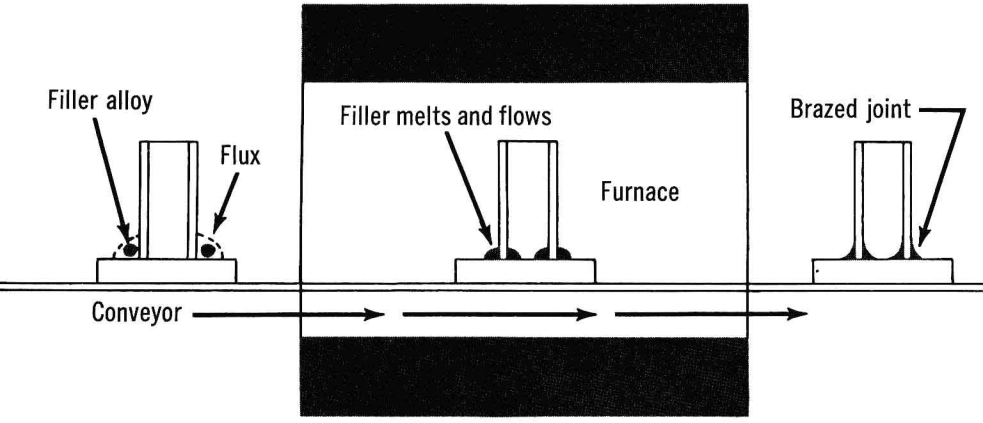
The most commonly used methods of brazing aluminum are: *torch brazing*, in which heat is applied by means of an oxyacetylene, oxyhydrogen or oxy-natural gas torch; *furnace brazing*, in which the assemblies are heated in a furnace; and *dip brazing* in which the entire assembly is immersed in a molten flux bath. Other methods are still in developmental stages. Already, many possible applications can be foreseen for such methods as induction brazing, block brazing and mechanized flame brazing. Another potentially useful method, particularly for tubular heat exchangers, is to dip the fluxed portions into a bath of molten brazing alloy.

Flux and capillary action are common to all brazing methods. Capillary action moves the filler metal into the joint, after the flux has removed oxide films, assuring complete penetration. Consequently, the possibility of flux entrapment and the mechanism of capillary action must be considered when decisions are made as to joint size and shape.

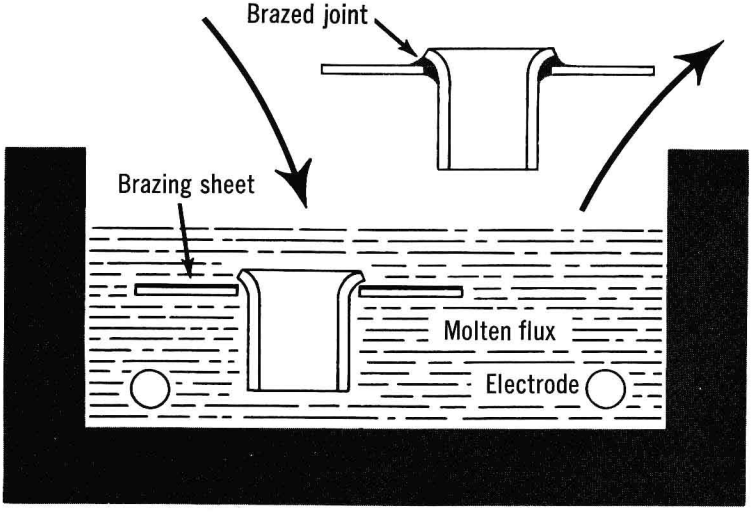
Successful brazing begins with the design. Parts should be designed with brazing in mind, because joints for other



Torch brazing *is widely used for making joints in aluminum tube.*

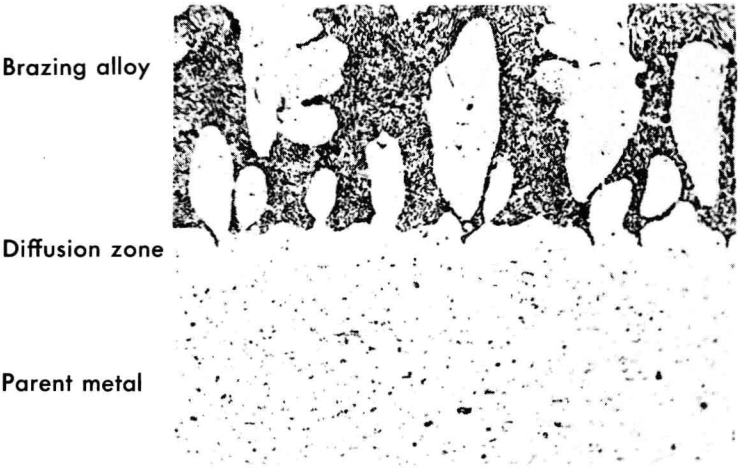


Furnace brazing *in continuous furnaces is used in production fabrication of various aluminum assemblies.*

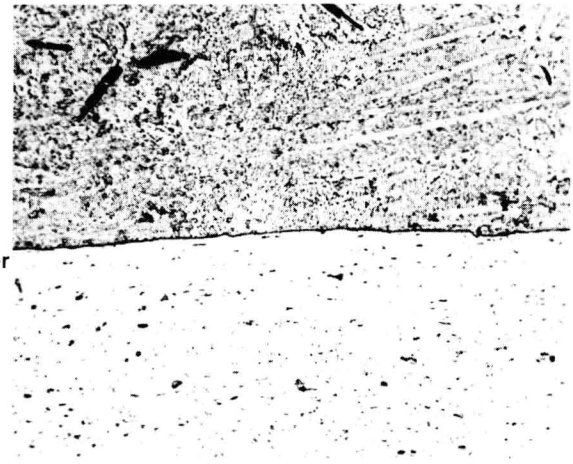


Dip brazing *lends itself to production of complex heat exchangers.*

Interface at weld and parent metal for argon-shielded tungsten-arc weld in 1100 alloy with 1100 filler metal.



Interface of brazing and parent metal for brazed joint in 3003 alloy with No. 718 Brazing Alloy and No. 33 Brazing Flux.



Interface at solder and parent metal for soldered joint in 3003 alloy made with tin-zinc solder and No. 64 Soldering Flux.

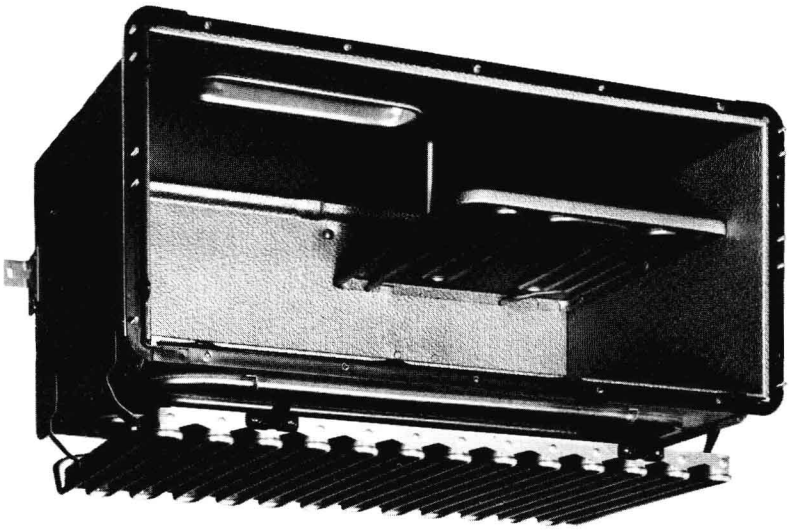
methods are not usually best for brazing. Nevertheless, failures in brazed assemblies do not necessarily occur at the joints. Brazing can produce joints that are as strong as they need to be.

WHERE IS BRAZING ADVANTAGEOUS?

Brazing enhances the versatility of aluminum. This method of making joints offers some unique design and fabricating freedoms that can lead to important cost savings.

Brazing, however, is not an auxiliary joining method. Designers and engineers should avail themselves of the advantages it can bring by considering it early in their planning. In this way, they will find more opportunities to simplify, to reduce weight and to cut manufacturing costs than would be possible during a design change at the last minute.

Aluminum brazing has been widely used in the fabrication



Aluminum tubing in this refrigerator evaporator was joined to flat and formed aluminum sheet by brazing.

of refrigerator evaporators, heat exchangers, fuel tanks, aircraft parts and similar products. Many of the successful aluminum brazing applications involve a large number of joints that can be made in a single operation.

Strong, heat-treatable aluminum alloys can be brazed in many cases. Because heat is applied to the entire assembly—at least, in the furnace and dip brazing processes—any prior heat treatment is partly undone. However, such brazing processes are essentially equivalent to solution heat treatment. By quenching and aging after brazing, heat-treatable alloys can be made to approximate their heat-treated properties.

Many joints can be brazed simultaneously. This means high production rates. Brazing offers the opportunity to make several thousand joints of uniformly high quality during one overall application of heat.

Complicated assemblies with many inaccessible joints, fabricated of both thick and thin material, can be joined in a single operation by furnace or dip brazing.

Less exacting skills are required. The mechanized nature of brazing processes permits operation by less skilled personnel.

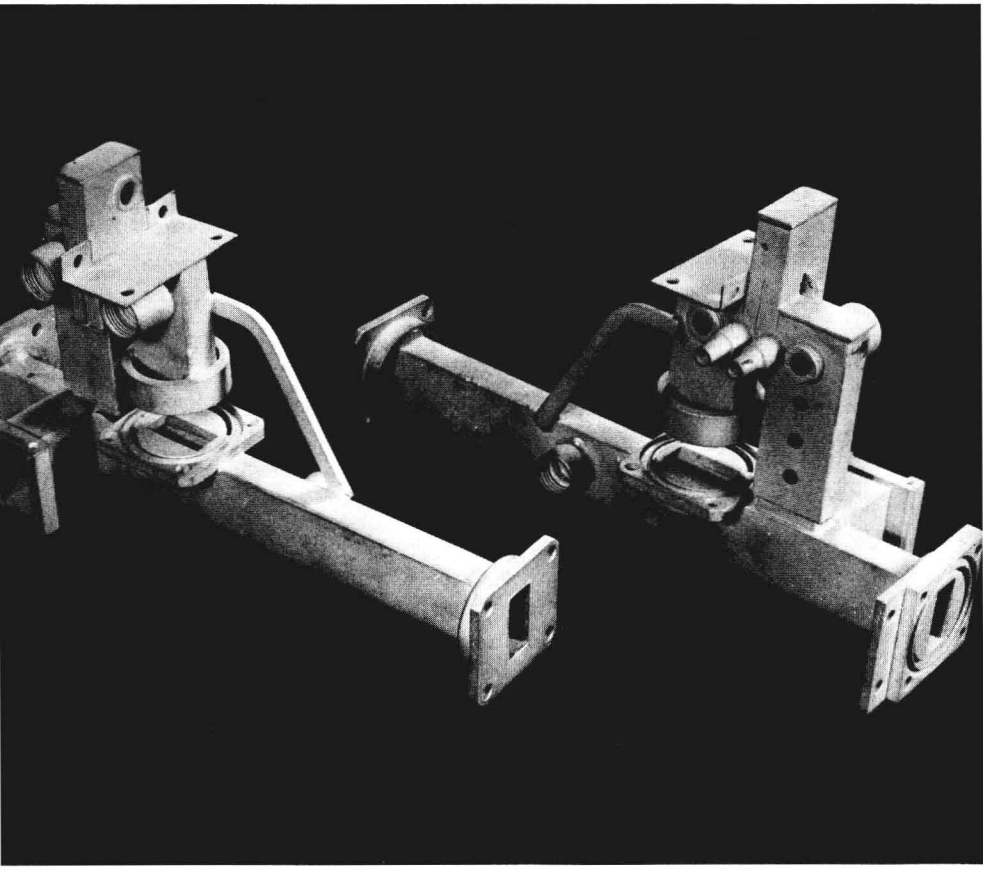
An all-aluminum structure is produced by brazing. Aluminum's inherently high resistance to corrosion, good strength and uniform finishing characteristics are retained.

The as-brazed shape gives good stress distribution and fatigue resistance. Capillary action in brazing produces fillets that have advantageous joint shapes. This contributes to good performance under repetitive stresses or vibration. Furthermore, the joint area can be increased to give greater strength.

Finishing costs are low. Because the molten filler is drawn into the joint space by capillary action, the as-brazed shape is smooth. It usually requires no finishing at all.

Thin sections are readily brazed without distortion. The comparatively low temperatures and the uniformly distributed heat used in brazing minimize distortion, but do not sacrifice joint efficiency or resistance to corrosion.

Production costs are lowered as a result of savings in time, material, weight, space, cost of rejects, inspection and finishing.



High-frequency electronic "plumbing" made by precision brazing aluminum extrusions, sheets, castings and bars.