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**SEALING OF SYNTHETIC SAPPHIRE TO GLASS**

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**ELECTRONIC COMPONENTS LABORATORY**

*JANUARY 1954*

**WRIGHT AIR DEVELOPMENT CENTER**

**Statement A**  
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**SEALING OF SYNTHETIC SAPPHIRE TO GLASS**

*Emil Benz*  
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*January 1954*

*RDO No. 111-101*

Wright Air Development Center  
Air Research and Development Command  
United States Air Forces  
Wright-Patterson Air Force Base, Ohio

## FOREWORD

This report was initiated by the Electronic Components Laboratory, Directorate of Research, Wright Air Development Center, Wright-Patterson Air Force Base, Ohio. Work was accomplished under RDO No. 111-101, GENERAL INVESTIGATION OF ELECTRON TUBES, with Mr. Leo L. Gibbs as the project engineer. Mr. Emil Benz was in charge of the task under this RDO.

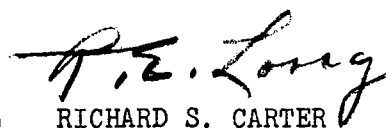
ABSTRACT

A new method of sealing synthetic sapphire to glass by using an electric arc is described. Its advantages and applications are analyzed.

PUBLICATION REVIEW

The publication of this report does not constitute approval by the Air Force of the findings or the conclusions contained therein. It is published only for the exchange and stimulation of ideas.

FOR THE COMMANDER:



RICHARD S. CARTER  
Colonel, USAF  
Chief, Electronic Components  
Laboratory  
Directorate of Research

## GENERAL

Sealing synthetic sapphire to glass is widely used as in infrared detecting cells, disks or windows in wave guides, or high frequency power tubes. Up to now, the sealing process (AF Technical Report No. 6495, MAKING AND SEALING SYNTHETIC SAPPHIRE WINDOWS TO INFRARED DETECTING CELLS) could be performed only by highly skilled glass blowers. The procedure was cumbersome and the risk of damaging the expensive sapphire disks was high.

The new sealing method here described is speedier and can be used by unskilled personnel. The process can be better controlled, resulting in more uniform sealing. This is an important improvement for mass production.

## DESCRIPTION OF ARRANGEMENT

Let us assume, as an example, that a flat sapphire disk is to be sealed to a glass tube. Corning Glass No. 751, as described in AF Technical Report No. 6495, is to be used as sealing glass. The tube with the sapphire disk on top, both of approximately the same diameter, is placed in the chuck of a vertical glass lathe and connected to a swivel joint, from which a side arm leads to a vacuum pump (Fig. 1). A pressure difference of about 20 millimeters is required to avoid displacement of the disk during the sealing operation. An electric furnace above the tube (Fig. 1) preheats the sealing area.

Two opposite graphite rods in horizontal position point to the area to be sealed. Between the rod tips and the outer edge of the glass-sapphire connection is a distance of about  $1/32$  inch. The furnace is located approximately one inch above the graphite rods.

A high voltage transformer, regulated by a variac, provides an arc discharge between the graphite rods and the glass-sapphire combination. By raising or lowering the sealing area, it can be moved into the furnace or between the two graphite rods. Figure 2 is a photograph of the equipment.

## SEALING OPERATION

The glass tube, with sapphire disk on top, is rotated slowly at about 40 rpm, while a holding vacuum is applied. The sealing area is preheated in the furnace to about 500°C, then lowered into position between the graphite rods. The voltage is turned on immediately for three to four seconds, and the sealing is performed. The vacuum is then released, and the sealed tube can be raised for annealing in the overhead furnace or placed in an annealing oven.

The distance of the graphite rods from the sealing oven and the disk diameter determine the arc voltage to be used. For sealing 1/2-inch disks, 15,000 volts are adequate. This power should be supplied by a high impedance source.

Sealing disks two of each in sizes 1/4 inch, 1/2 inch, and 5/8 inch in diameter were manufactured and tested as follows (Fig. 3):

1. Preheated to 400°C.
2. Dipped into boiling water, then into cold water.
3. Dipped into liquid nitrogen followed by exposure to room temperature.
4. Checked for leakage with a leak detector.

The disks showed no failures by this test procedure. Synthetic sapphire can be sealed to any kind of glass or metal tubing by using graded seals.

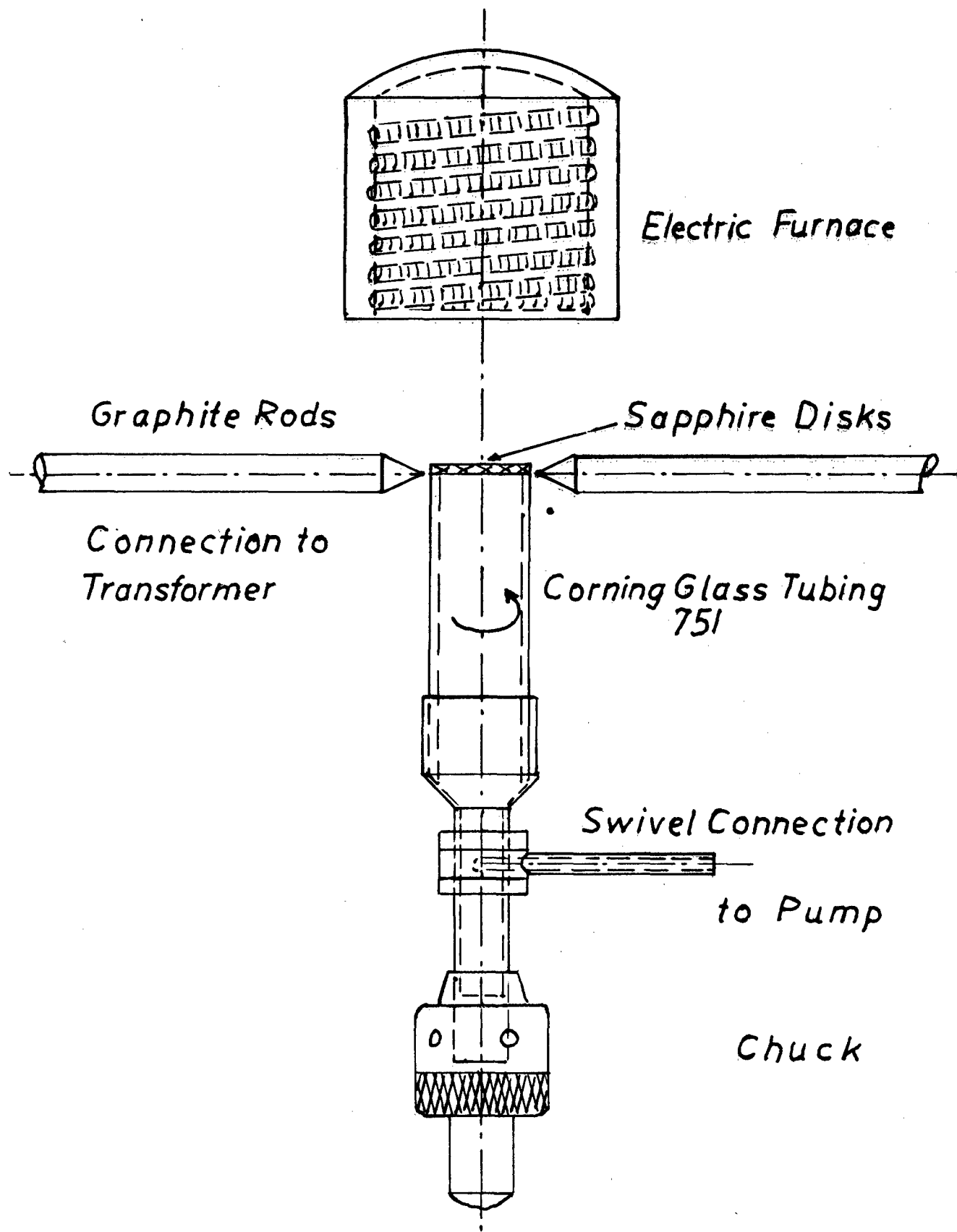


Fig. 1 - Diagram of Sealing Arrangement

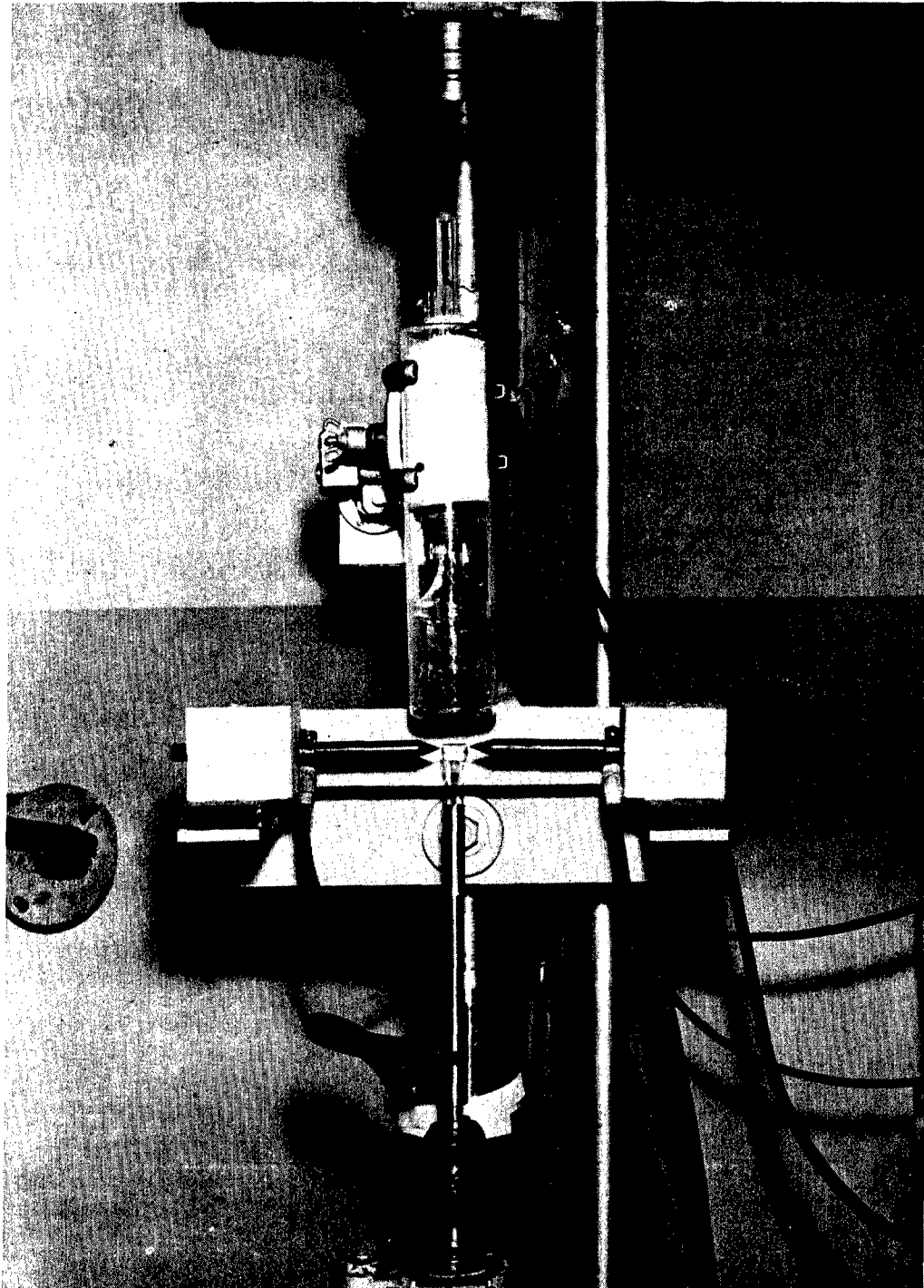


Fig. 2 - Glass Lathe Arrangement for Sealing

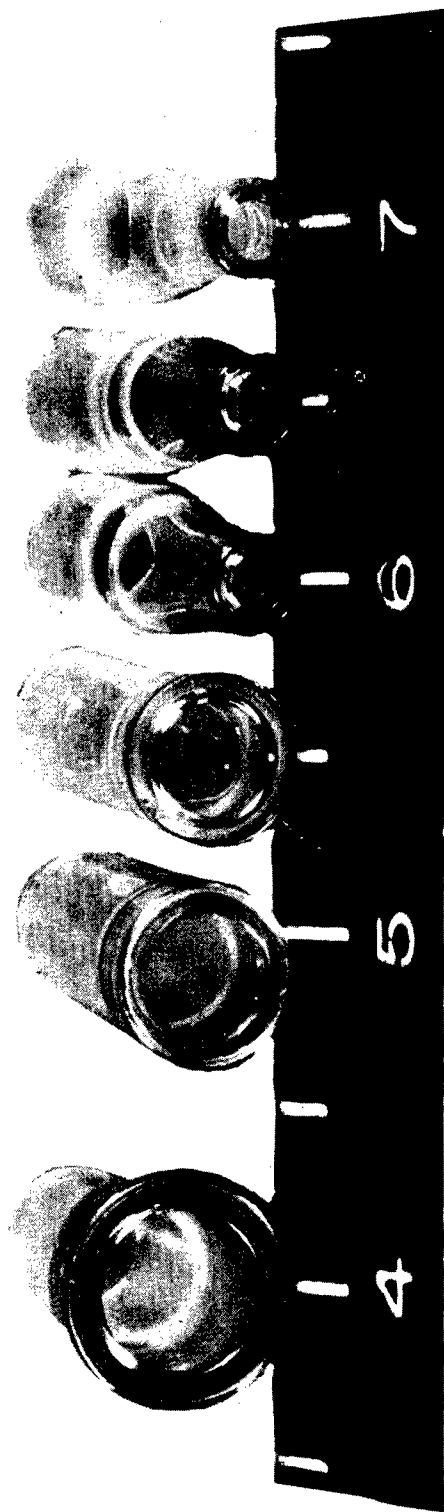


Fig. 3 - Three Sizes of Synthetic  
Sapphire Sealed to Glass

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