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NRL Report No. 4485

PROGRESS REPORT  
For The Period  
October Through December 1954

Work Performed  
on  
NRL Problem No. 74H03-01  
Supported Jointly by  
Los Alamos Scientific Laboratory  
and  
Office of Naval Research  
  
Nuclear Instrumentation Branch  
Radiation Division

NAVAL RESEARCH LABORATORY  
Washington 25, D. C.

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WEAPONS INSTRUMENTATION

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Sponsors:

NRL Problem No: 74H03-01

Photomultiplier Development

Measurements have been made to determine the frequency response and time delay of the NRL high-current photomultiplier. Measurements were made of the transit time from points across the cathode to the collector. The differences in transit time were found to be not more than  $1.3 \times 10^{-9}$  sec. and it is believed that this figure is partially set by the accuracy of the equipment and experimental technique.

In order to check further the response of the high-current tube, the cathodes of a high-current tube and a type 935 photodiode were illuminated with a common light source and the output current pulses were displayed directly on a TW-10 cathode-ray tube. Because of the physical characteristics of the type 935 photodiode its transit time spread should be in the region of  $1 \times 10^{-9}$  seconds or less. The pulses observed from both tubes were identical and had a rise time (10% to 90%) of  $8 \times 10^{-9}$  sec. From these measurements it is estimated that the total time spread of the high-current photomultiplier, due to transit time, unterminated reflections and lead length, is not greater than approximately  $3 \times 10^{-9}$  seconds.

The total transit time delay was measured to be between 20 and  $21 \times 10^{-9}$  sec. All measurements were made with a particular set of operating voltages applied to the tube. Other voltage distributions will result in different values.

Four more high-current tubes (HCM 109, 110, 111, 112) have been received from Capehart-Farnsworth Company. Steps were taken in the fabrication of these four tubes to reduce the hydrogen content within the tubes. The collector wires were heated to a glow in a vacuum after having been hydrogen fired; the tube was out-gassed at a higher temperature; and better light baffling was installed. Tests performed on these four tubes showed no noticeable improvement in regard to regeneration. However, a peak linear output current of 2-3 amperes was obtained from all four tubes. It is now planned that tubes will be fabricated in the near future in which none of the parts will be hydrogen fired.

## Cathode-Ray Tubes

No TW-11 tubes have been received from Rauland Corporation during this period.

A new method of supporting the deflecting helices has been proposed by Rauland and will be incorporated in the next tube. This should result in a reduction in the beam defocusing due to charge collection in the deflection structure. The next tube will also include the new 125 ohm matched connectors on the deflection system. Considerable work has been done on transmission line components and fittings for use with the TW-11, as described separately.

## Wide-Band Amplifiers

Five amplifiers of the improved "Ivy" type using 6CL6 tubes were built during this period and aligned and tested. These amplifiers have a considerable improvement in uniformity as built and require a much simpler alignment procedure than the previous Ivy amplifiers. They have a 3 db passband of 300 cps to 80 MC, have a gain of 135, can deliver 165 volts output with less than 2% nonlinearity, and have a rise time of 7 millimicroseconds. Figure 1 shows a typical frequency response curve and Figure 2 a typical linearity curve on these amplifiers. Three of these 6CL6 amplifiers have been sent to the Los Alamos Scientific Laboratory for use there.

Tests on the output stages of the proposed 300 mc broadband pulse amplifier using 4X150A tubes are continuing.

## Pulse Inverters

The impedance of the 52 ohm pulse inverter has been measured between 75 and 500 MC, as shown in Figure 3. The input impedance was measured with the output terminated in a 52 ohm resistive load. It is seen that the impedance is nearly constant at about 40 ohms, falling off at the higher frequencies. Also the phase angle is very nearly zero, becoming negative at the higher frequencies.

A 125 ohm inverter has been built using ferrite material similar to that in the 52 ohm inverter. Figure 4 shows a photograph of this inverter. It is designed to be used in a balanced deflection system, driving two 125 ohm lines, one directly and one through the inverter. The input impedance of the inverter is such that the parallel combination of the direct 125 ohm line and the inverter driving another 125 ohm line is very nearly 52 ohms and hence is very nearly matched when driven by a 52 ohm transmission line. The junction between the 52 ohm line and the direct 125 ohm line is made a part of the inverter to provide the best match. Impedance measurements of this inverter have not been made since appropriate 125 ohm loads were not available. However pulse measurements

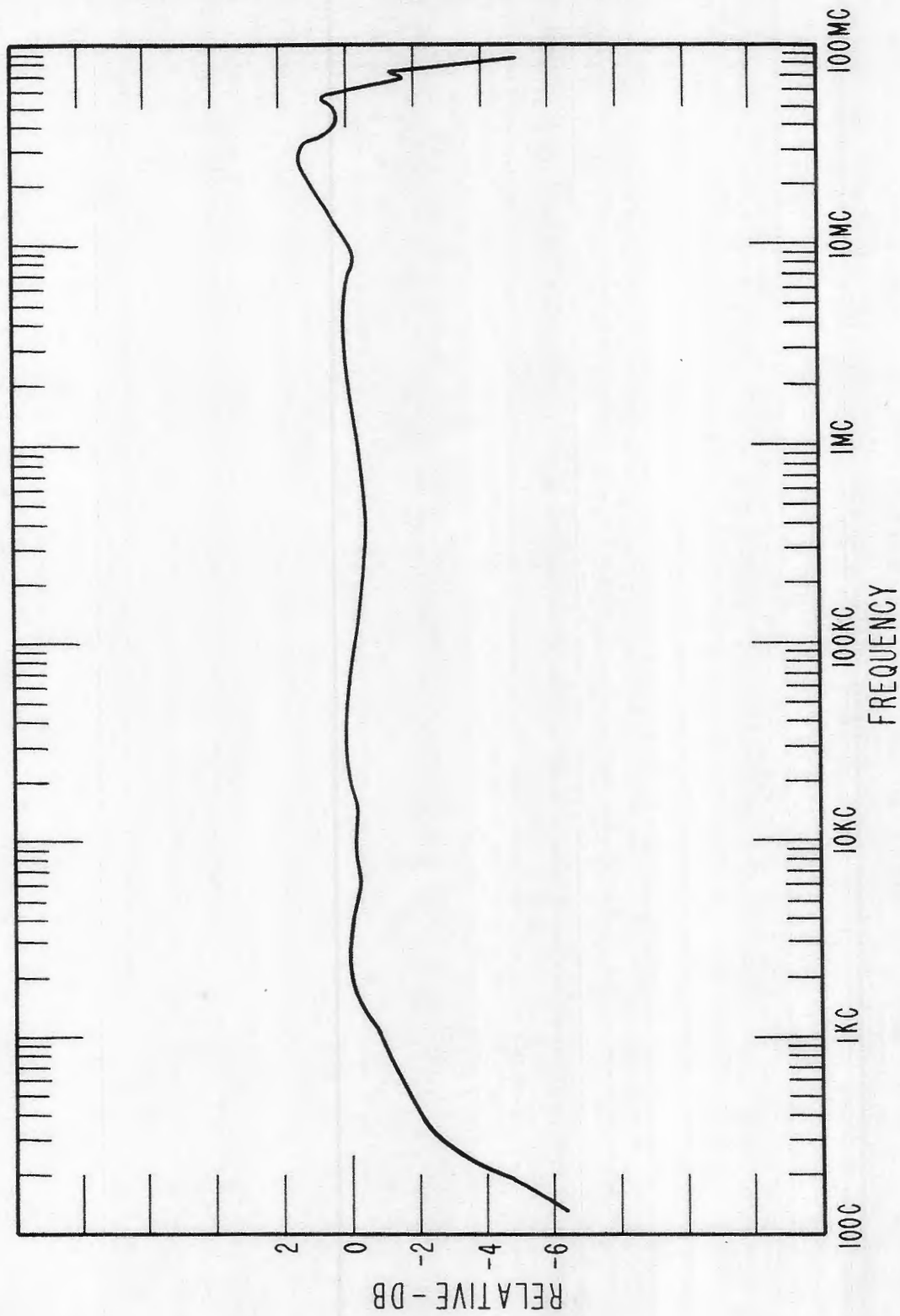


Fig. 1 Typical Frequency Response of 6CL6 Amplifier

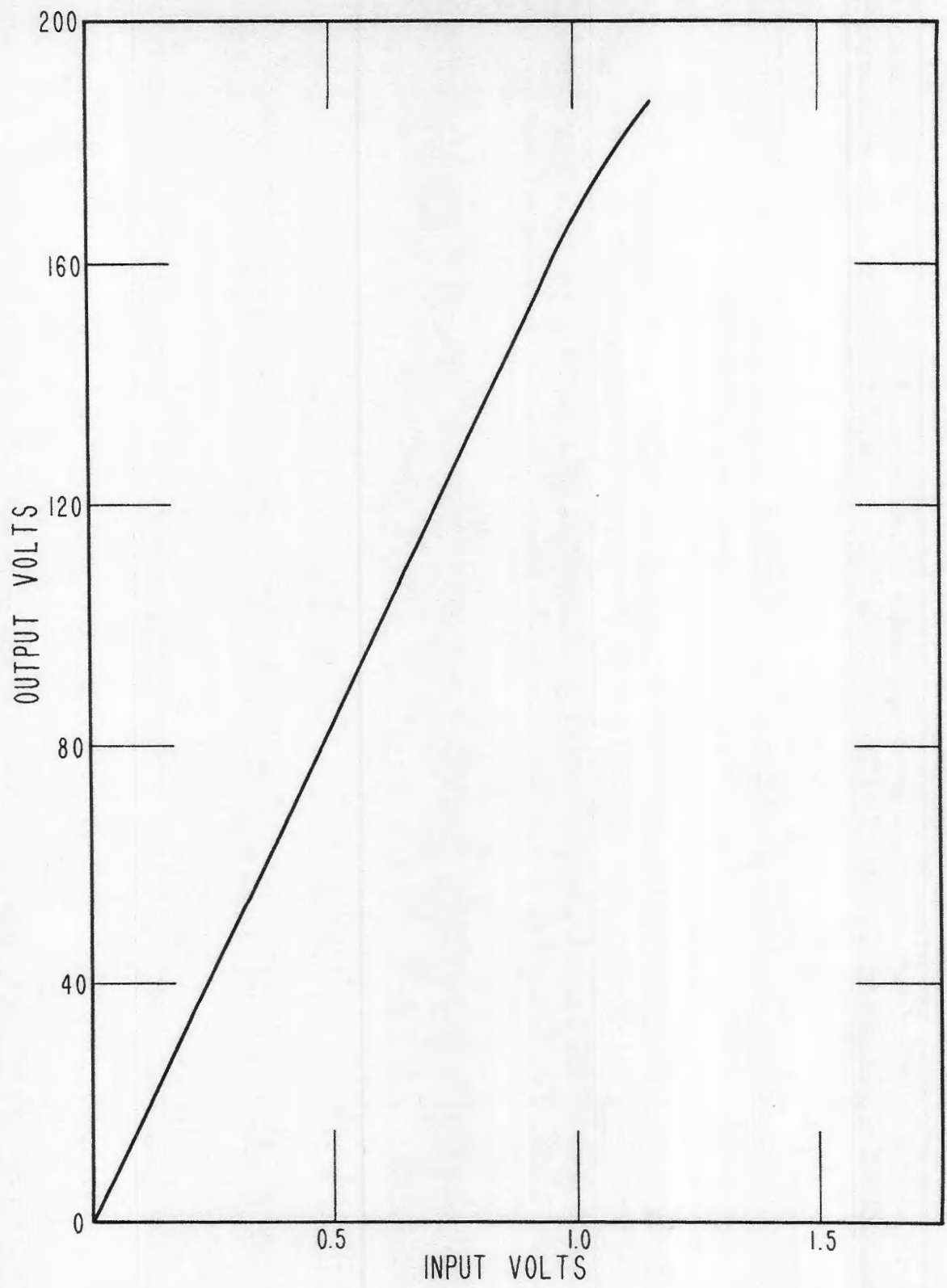


Fig. 2 Typical Linearity of 6CL6 Amplifie

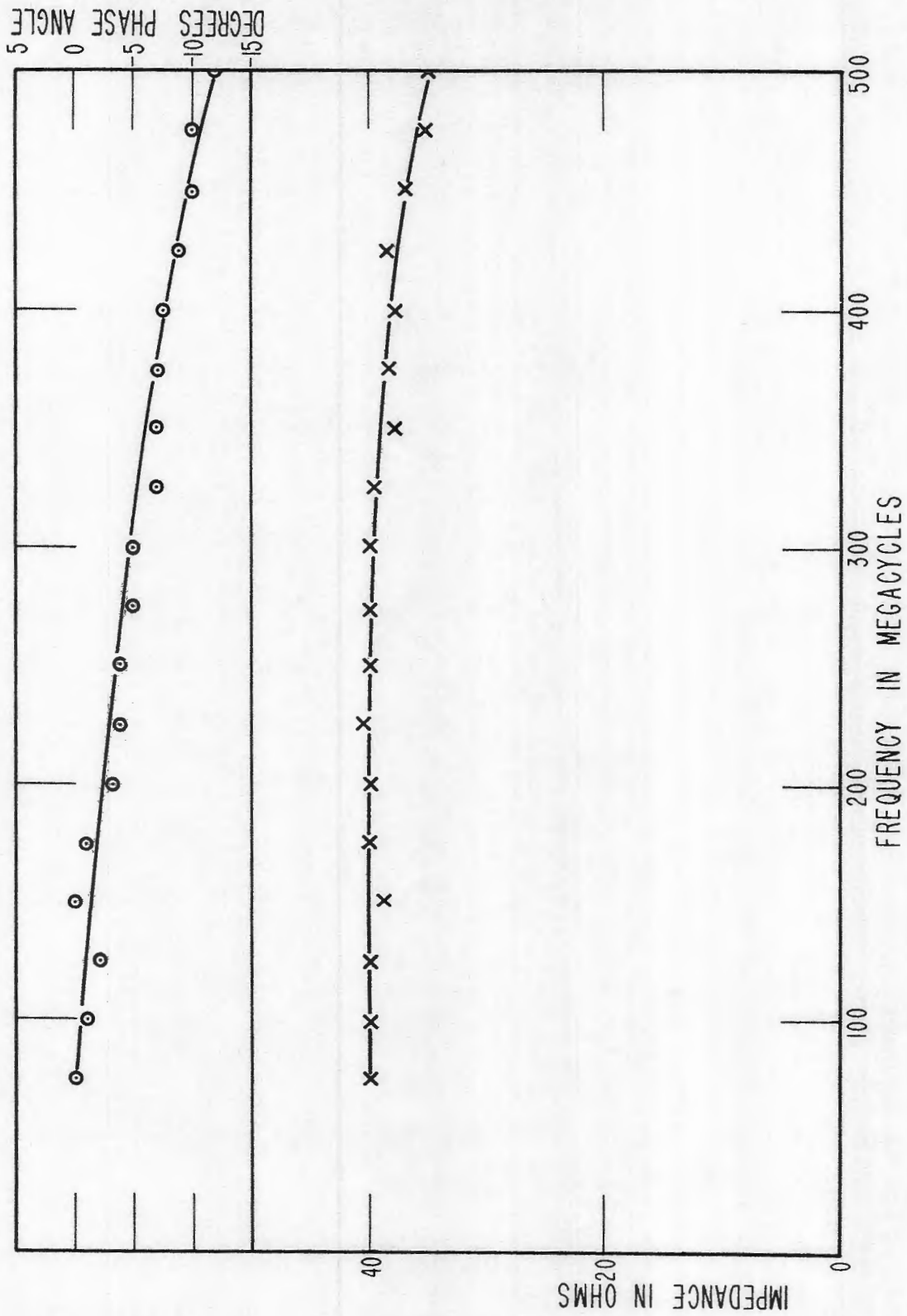


Fig. 3 Impedance Characteristics of 52 Ohm Ferrite Inverter

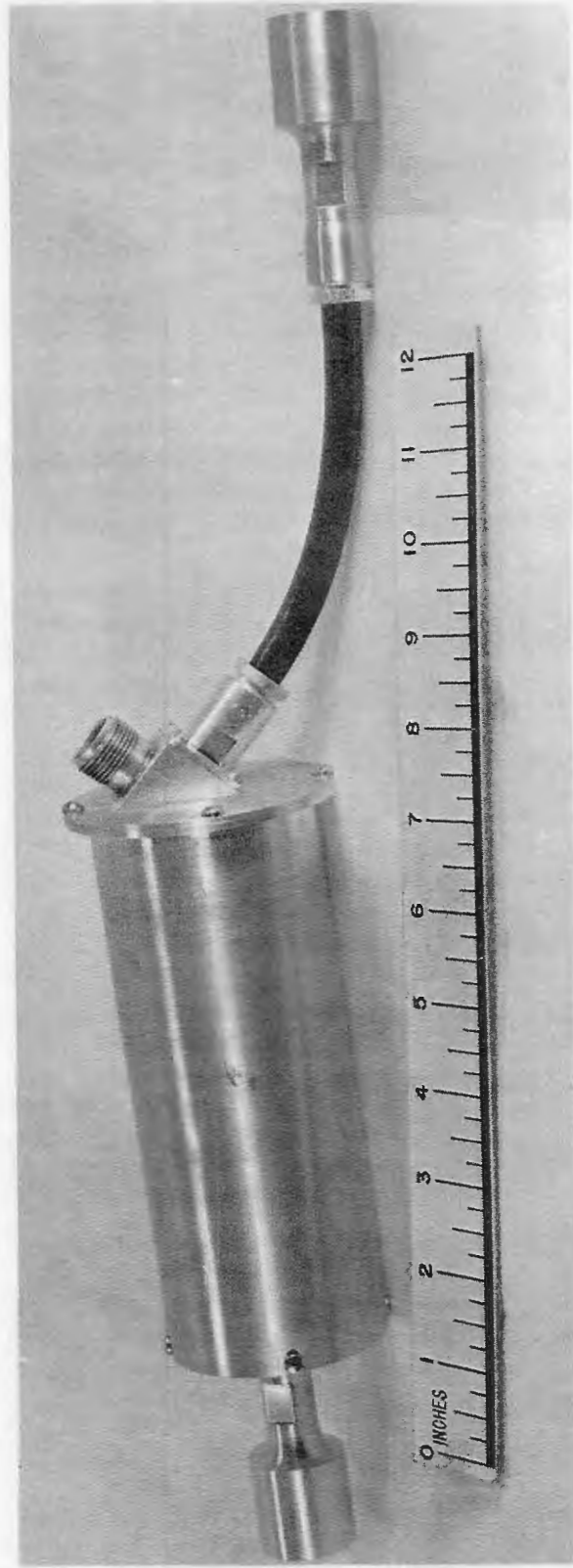


Fig. 4 125 Ohm Coaxial Inverter for Use in Balanced Deflection System.

show a good match to the 52 ohm line with some increase in impedance probably occurring at low frequencies. Figure 5 shows a disassembled view of the inverter. The transposition between the input connector and the 125 ohm line inside the inverter is quite critical and requires a careful balance between lead inductances and fringing capacities.

#### Transmission Line Components

It was originally felt that it might be possible to use 52 ohm connectors in the 125 ohm system. However it soon became obvious that the discontinuities introduced by these connectors produced reflections of undesirable magnitudes when very fast rising pulses were used. Hence it became necessary to design matched 125 ohm connectors for use with the cathode-ray tubes and the associated transmission lines. Figure 6 shows a pair of these matched connectors as used with 125 ohm RG-63/U cable. The connectors produce reflections as small or smaller than those introduced by standard HN connectors with RG-8/U cable. A modification of this connector is being built which will provide a positive lock between the connectors. However for many applications this is not necessary since these large connectors have a large seating area which tends to prevent disengagement.



Fig. 5 Disassembled View of 125 Ohm Inverter

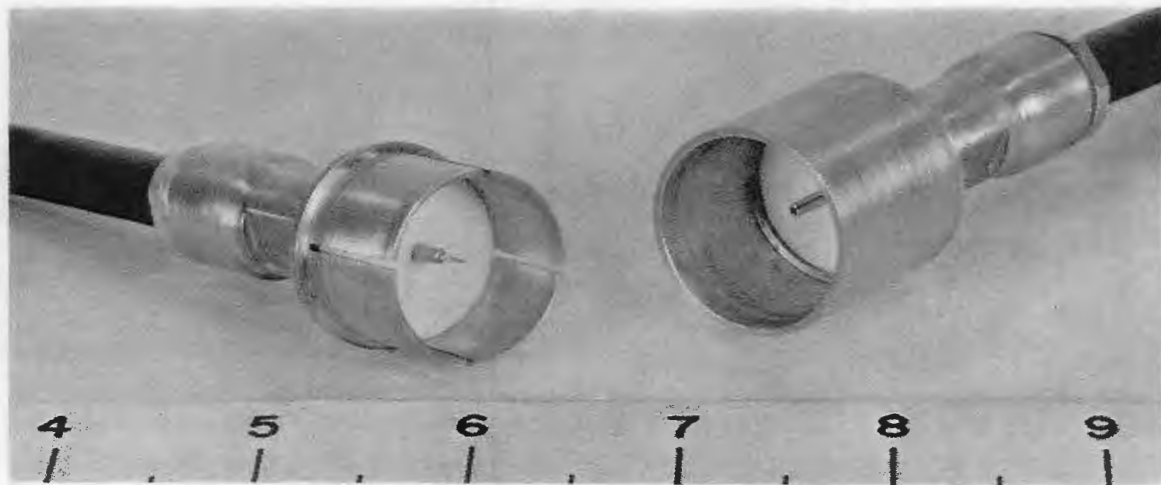
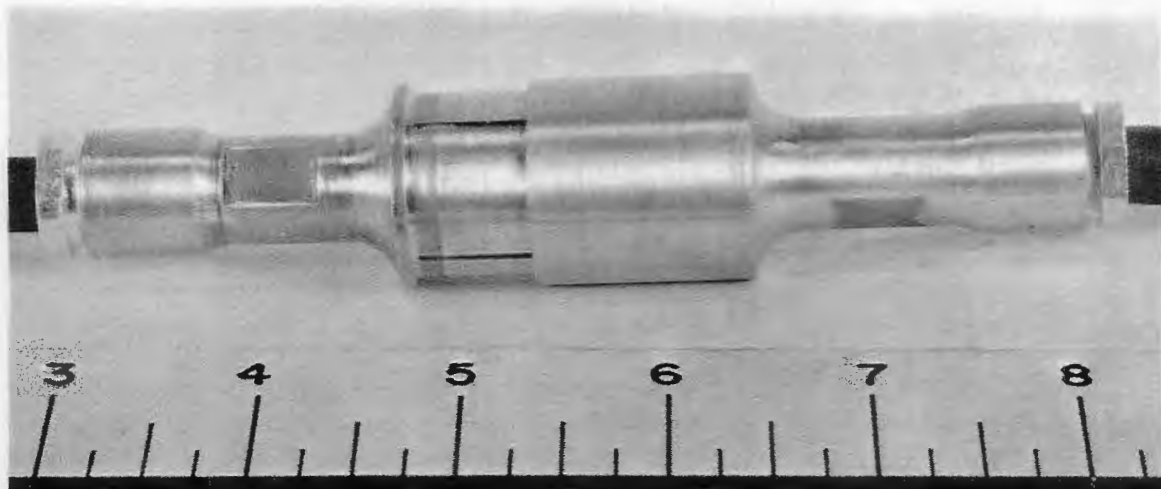
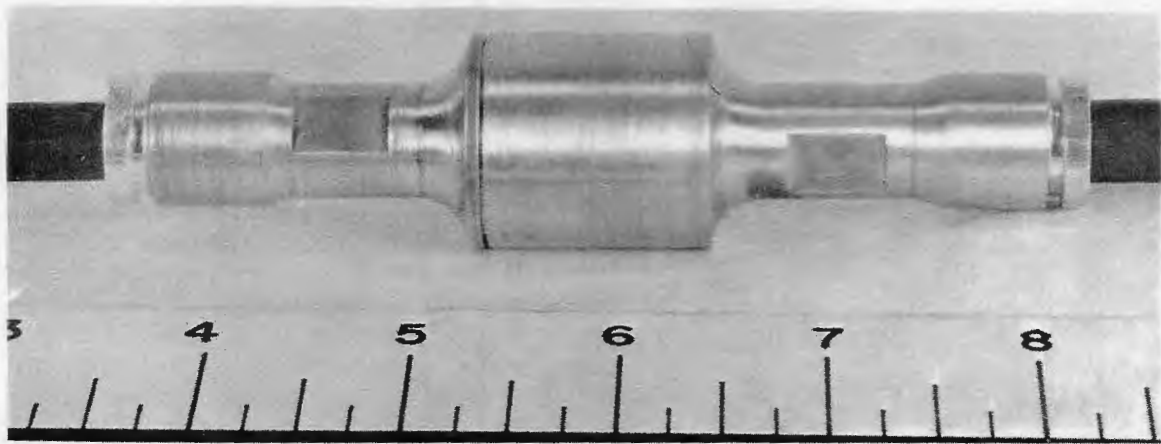


Fig. 6 Matched 125 Ohm Coaxial Connectors for Use with RG-63/U Cable