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SHIP-SHORE DIVISION - CENTIMETER WAVE SECTION

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WAVEGUIDE ROTATING JOINT FOR X_{b1} BAND

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NRL Problem S558R-C

ABSTRACT

The rotating joint described in this report was designed with the following specifications in mind:

1. Bandwidth- A voltage standing wave ratio of 1.15 or less over the Xbl band.
2. Power- The ability to handle 280 KW. peak power with a safety factor of 1.2 and a load voltage standing wave ratio of 2:1.

A doorknob-type coaxial design was adopted to best meet the above specifications. The doorknob transitions were developed separately and joined together with a short length of concentric line.

The resulting rotating joint has the following characteristics:

1. Bandwidth- A voltage standing wave ratio of less than 1.05 over the Xbl band.
2. Power- The ability to handle at least 320 KW. peak power with a safety factor of 1.2 and a load voltage standing wave ratio of 2:1.

CONTENTS

PLATES

Dist:

BuShips	(5)
BuOrd	(3)
NRSL	(1)
CBA	(1)
JEIA	(1)

DESCRIPTION

1. This rotating joint was developed for use in a radar operating on the X_{b1}-band (4.54-4.80 cm.) as authorized in BuShips Problem S558R-C. A sketch of the joint is given in Figure 1 of Plate 1.

2. The doorknob type of coaxial to wave guide transition was selected as the best answer to the bandwidth and power requirements. The center conductor is rigidly fixed in a cone-shaped support in the fixed transition. The other end of the center conductor passes through a bearing and wave-trap assembly. The wave trap and bearing are built into a cone-shaped support which is identical in shape to the other doorknob. A low impedance is placed at the junction of the cone and the center conductor, and a high impedance at the bearing. The center conductor is free to turn in the bearing without affecting the impedance of the transition.

3. The rotating section is a short length of 7/8" x 7/32" concentric line with an impedance of approximately 83 ohms. The outer conductor is broken by a wave trap to allow rotation without requiring good mechanical contact between the two surfaces.

ELECTRICAL DESIGN

4. The transitions were matched separately at 4.67 cm. A slotted line was built into the piece of wave guide containing the transition, because it was found that the best connectors available caused enough reflection to produce unreliable results. A source of square wave modulated R.F. energy was fed into the wave guide and a matched load placed in a short concentric line section. The matched load was made with eight tapered resistive bakelite strips arranged radially in the concentric line. The strips are supported by a tapered polystyrene section placed well behind the points of the strips. A load about eight inches long has a voltage standing wave ratio of less than 1.005.

5. The bandwidth of a single fixed transition is given in Figure 2 of Plate 1. The voltage standing wave ratio of the bearing transition falls under the same end limits shown in Figure 2, but is somewhat higher in the center of the band.

6. A complete rotating joint was built up as shown in Plate 2. The bandwidth characteristic is given in Figure 3 of Plate 1. The voltage standing wave ratio of the joint is under 1.05 over the X_{b1}-band (5.6 percent frequency band). The variation in standing wave ratio with rotation is less than .1 db.

MECHANICAL DESIGN

7. The model joint was built from brass, using standard 3/4" x 1-1/2" x .063" wall wave guide. The diameter of the cone shaped supports was held to within .001". The position of the shorting plate was held within .002". A change in the cone diameter of a single transition causes a change in the standing wave ratio of about .08 db/mil. A change in the position of the shorting plate causes a change of about .04 db/mil.

POWER TEST

8. A test was conducted to check the power handling capacity of the joint. A QK-915 magnetron was available which supplied 300 Kw. peak power at 4.64 cm (6466mc). A polystyrene plug was placed between the rotating joint and the matched load to insert a mismatch. Another similar polystyrene plug was placed between the magnetron and the rotating joint to allow the magnetron to look into a match in spite of the load standing wave. The load standing wave was shifted through the line in 1/16 wavelength steps in order to apply the voltage maximum to all points in the line. At each step, the voltage equivalent was found from the power received in the water load and the standing wave ratio presented by the load. The joint withstood a voltage equivalent of at least 770 KW at all points in the line without breakdown.

REFERENCE

(a) BuShips ltr (915) Ser C-915-7815 of 16 Dec 1943 to Dir NRL (SRPPB).

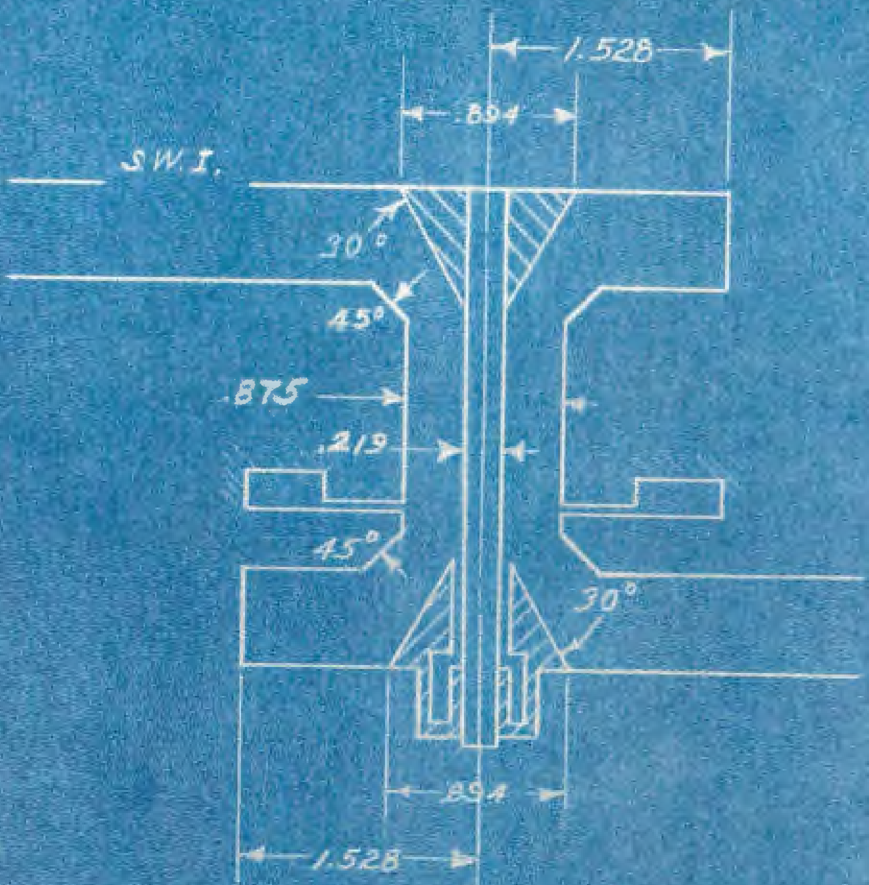
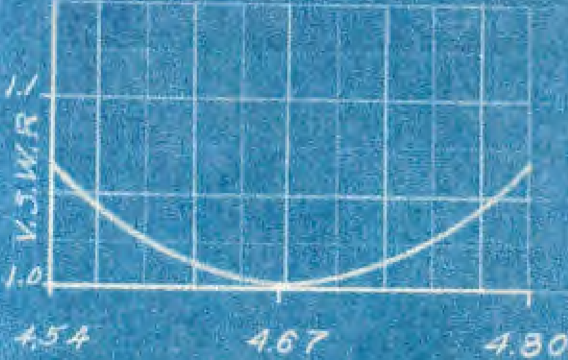


FIG 1

SINGLE TRANSITION



λ-cm.

FIG. 2

TOTAL JOINT

λ - cm.

FIG. 3

SKETCH AND BANDWIDTH CURVES

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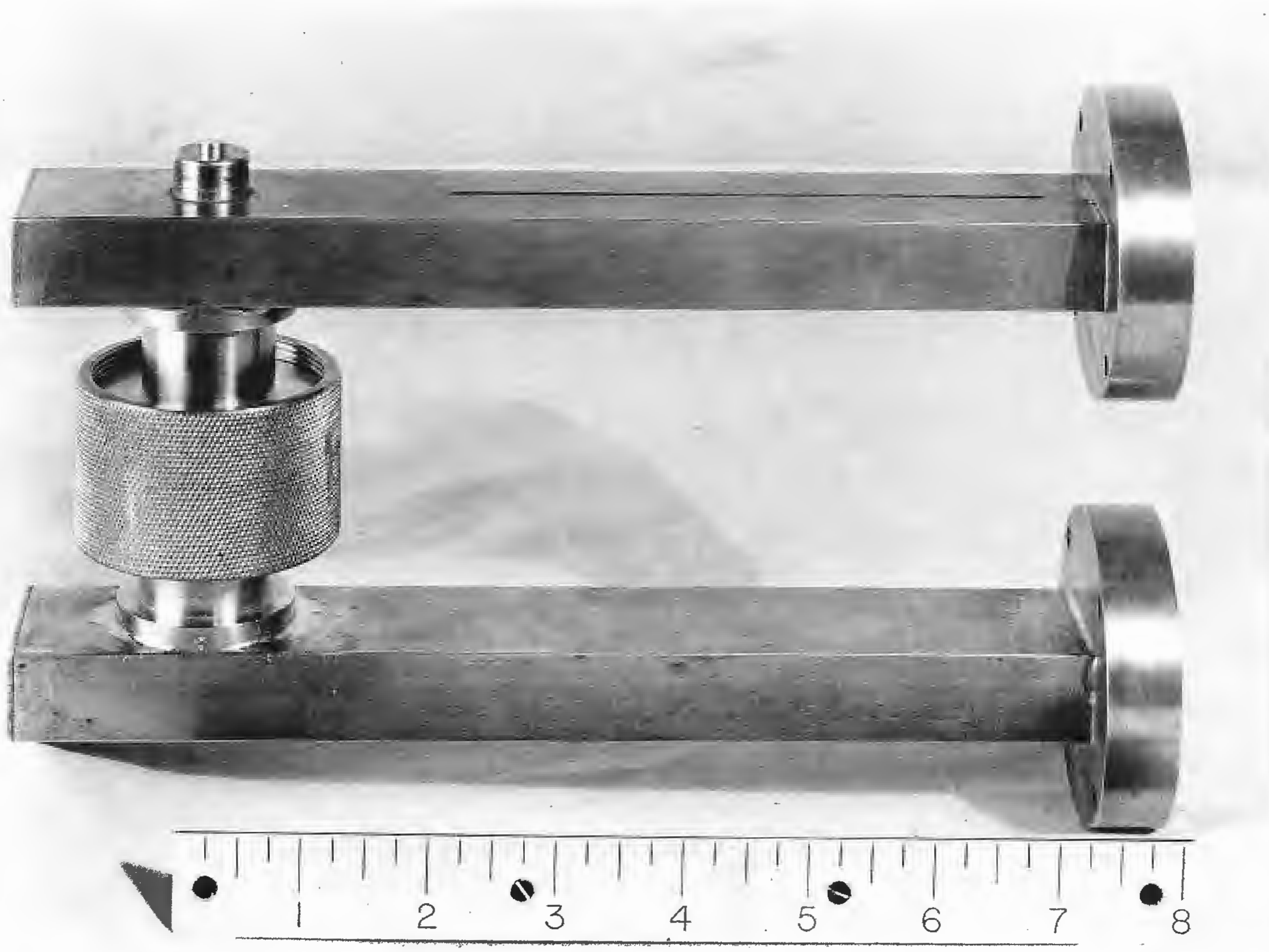
PLATE 1



ROTATING JOINT