WR62 butted to WR90

While the standard frequency range for WR62 is generally listed as 12.4 to 18 GHz, its cutoff frequency is 9.486 GHz so it passes 10.368 GHz without excessive loss. In the 1991 MUD proceedings Kent Britain re[ported in print that he has tested a length of WR62 pices at 10 GHz frequencies and found the loss reasonable, and in that (and the many times he has repeated that experience at CSVHF and MUD) article he says he heard his first 10 GHz EME signals through a WR62 switch. Others have reported using a WR62 switch at 24 Ghz butting WR42 flanges to the WR62 flanges.

WR62 butted to WR90

The waveguide spectrum between the cutoff frequency and the lowest recommended frequency has a little more loss than the rated frequenty range but not seriously until the frequency is close to the cutoff frequency. The insertion loss at the cutoff frequency is serious but not inifinite. It increases going below the cutoff frequency so that at 1/10th the cutoff frequency the loss is about 10 dB per waveguide width of length. This has been used for VHF and HF adjustable attenuators for at least ¾ century.

WR62 butted to WR90

The LF pass frequency spectrum (between cutoff and the lowest recommended frequency) was not recommended because the wavelength changes more rapidly with frequency the closer to the cutoff frequency and below the minimum reocmmended frequency the change is rapid enough to wreck radar pulses by changing the velocity of propagation cross the pulsed radar spectrum. Radar can't stand modified pulse envelopes and work. But for ham radio modes that diversity of wavelength vs frequency is not really a problem with typical bandwidths under 2 kHz even for digital data.

WR62 butted to WR90

I am sure that a several wavelength taper will have the least insertion loss and the greatest bandwidth without any tuning. Its just inconvenient to make well. I have seen literature that suggested such a taper needed to be something other than a straight taper for the best bandwidth. Rad Lab Volume 9 page 364 suggests a taper should be a multiple of ½ wave long. Of course through the taper the guide wavelength changes. Page 364 offers formulas for computing the length. It reports such a linear taper having a SWR better than 1.05:1 over a 12 % bandwidth.

WR62 butted to WR90

I think the second best adapter would be a short waveguide a quarter wave long (guide wavelength) with dimension A = SQRT (0.400 x 0.311) and B = SQRT (0.900 x 0.622) inches. 0.3537 high by 0.748 inches pretty close to the dimensions of WR75 (0.375 x 0.750 inside).which could probably be an option in experiments. For details see Rad Lab volume 9 page 363 for a WR90 to WR112 quarter wave transformer.

WR62 butted to WR90

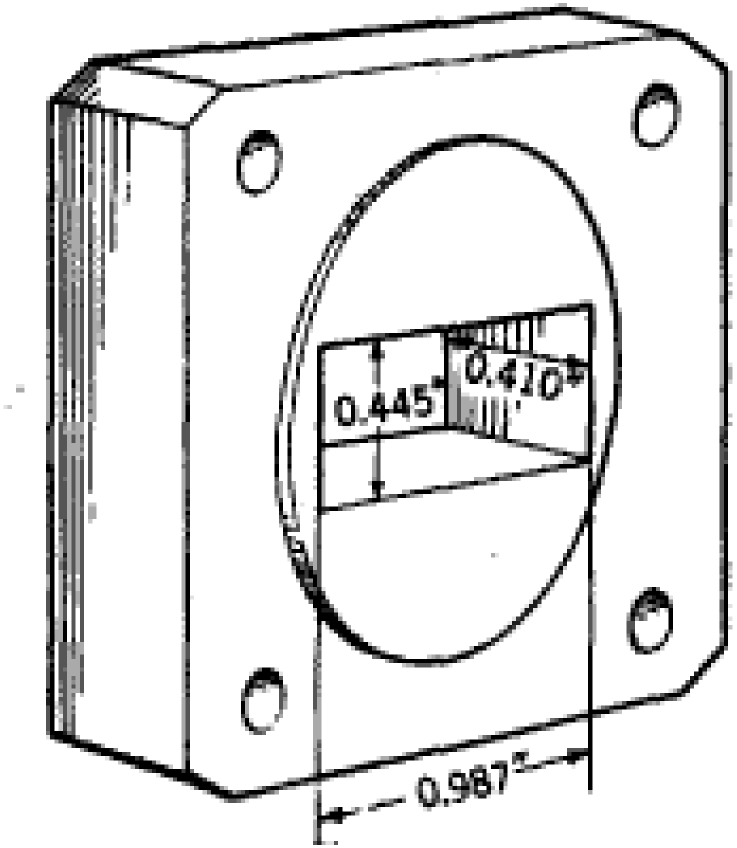


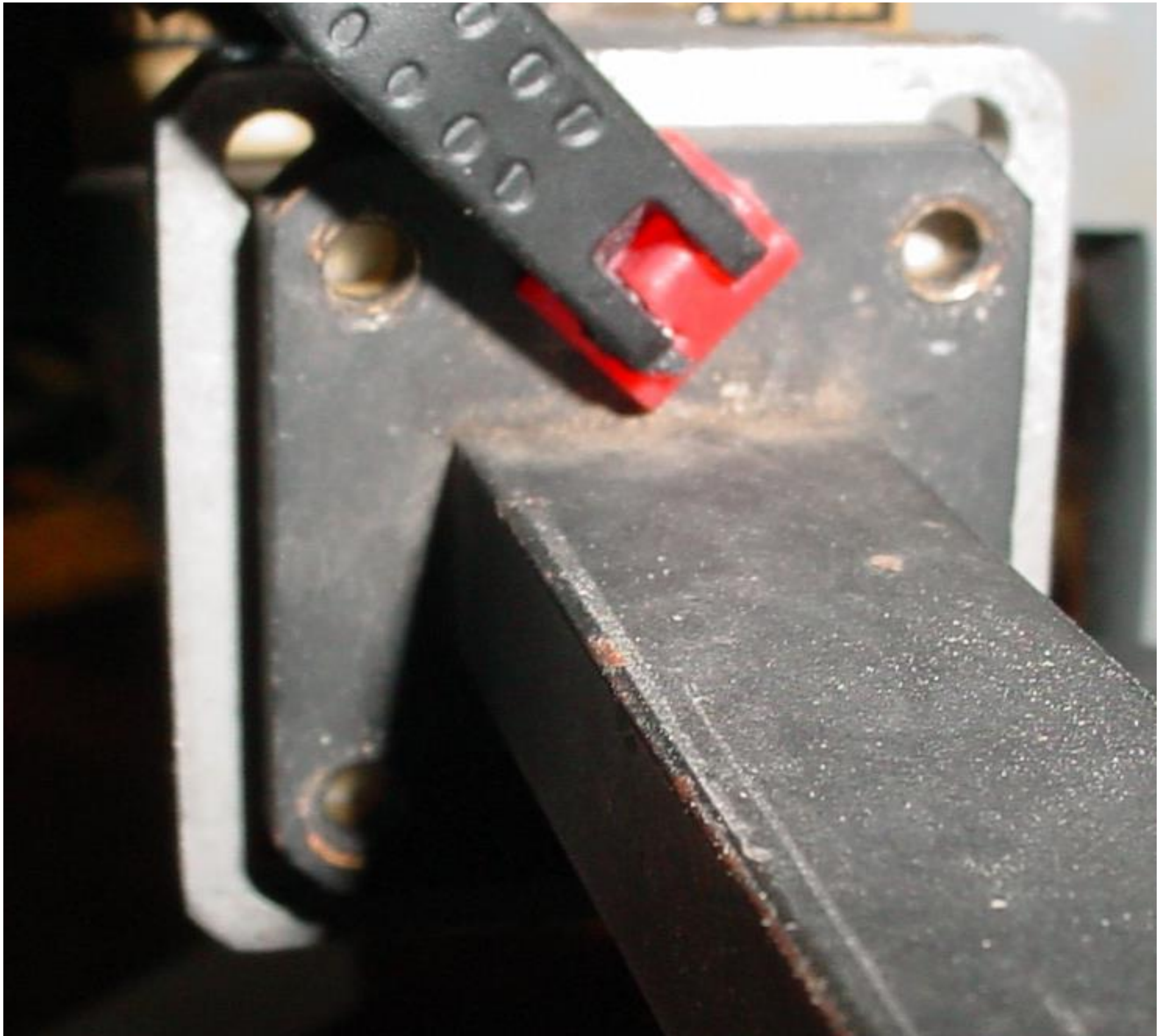
Fig. 6·50.—Quarter-wavelength transformer from 1- by ½-in. rectangular waveguide (0.050-in. wall) to 1¼- by ⅝-in. rectangular waveguide (0.064-in. wall). Army–Navy designation UG-80/U.

WR62 butted to WR90

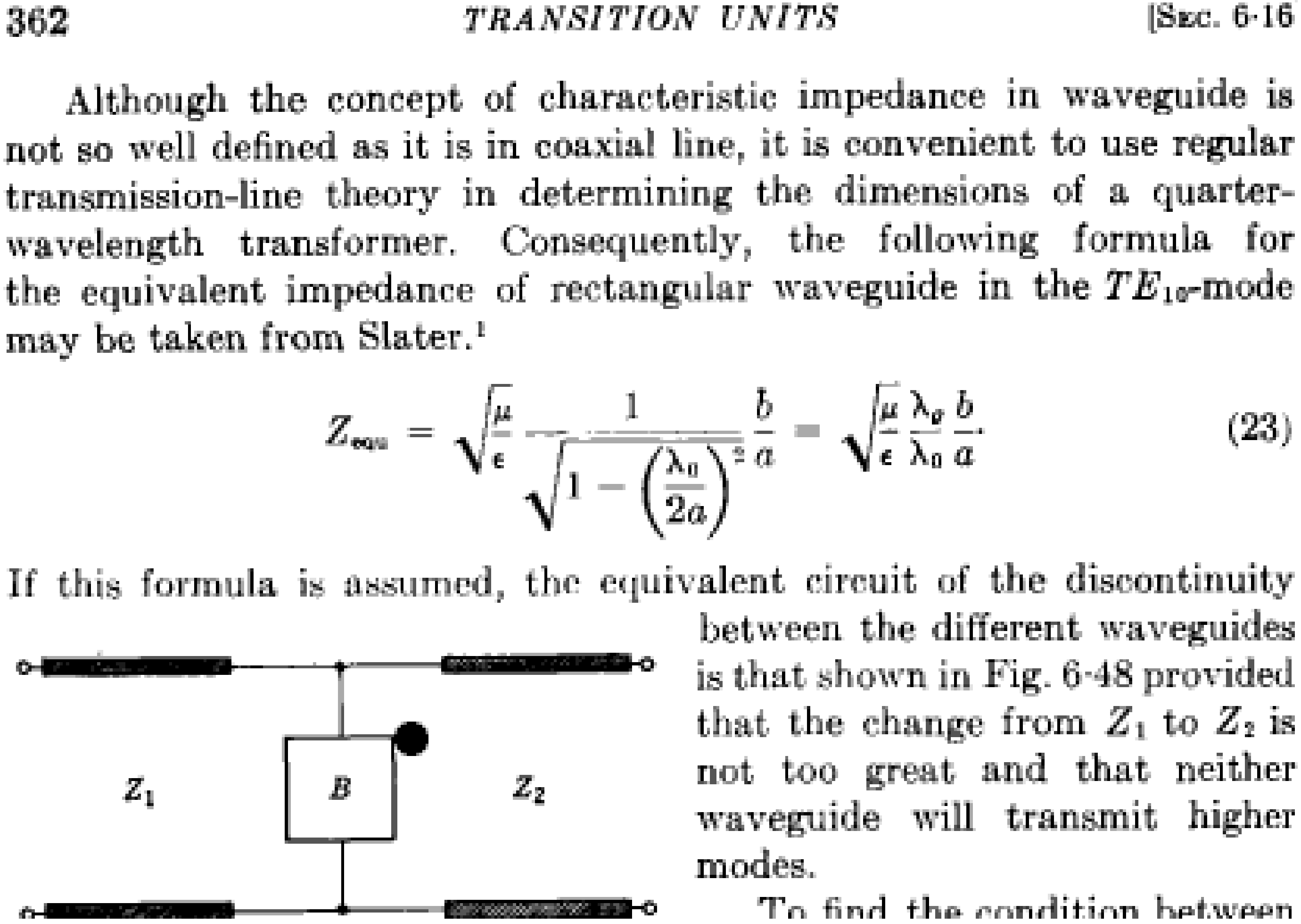
In this the height is for sure the square root of the products of the two guide heights 0,445”. The width is 98.2% of the square root of the products of the two guide widths. The adjacent text says the SWR was less than 1.03 from 3;13 to 3.53 cm. The 0.410 thickness is quarter wave guide wavelength at the center frequency of the design. Probably designed for a waveguide impedance of the square root of the product of the two guides.

Since the flange holes of the WR90 and WR62 don't line up and the WR62 flange isn't small enough to clear the WR90 screws, this quarter wave plate would allow for tapping 8 screw holes to make a neat assembly.

WR62 butted to WR90



WR62 butted to WR90



362 *TRANSITION UNITS* [Sec. 6·16

Although the concept of characteristic impedance in waveguide is not so well defined as it is in coaxial line, it is convenient to use regular transmission-line theory in determining the dimensions of a quarter-wavelength transformer. Consequently, the following formula for the equivalent impedance of rectangular waveguide in the TE_{10}-mode may be taken from Slater.[1]

$$Z_{equ} = \sqrt{\frac{\mu}{\epsilon}}\,\frac{1}{\sqrt{1-\left(\frac{\lambda_0}{2a}\right)^2}}\,\frac{b}{a} = \sqrt{\frac{\mu}{\epsilon}}\,\frac{\lambda_g}{\lambda_0}\,\frac{b}{a}. \qquad (23)$$

If this formula is assumed, the equivalent circuit of the discontinuity between the different waveguides is that shown in Fig. 6·48 provided that the change from Z_1 to Z_2 is not too great and that neither waveguide will transmit higher modes.

To find the condition between

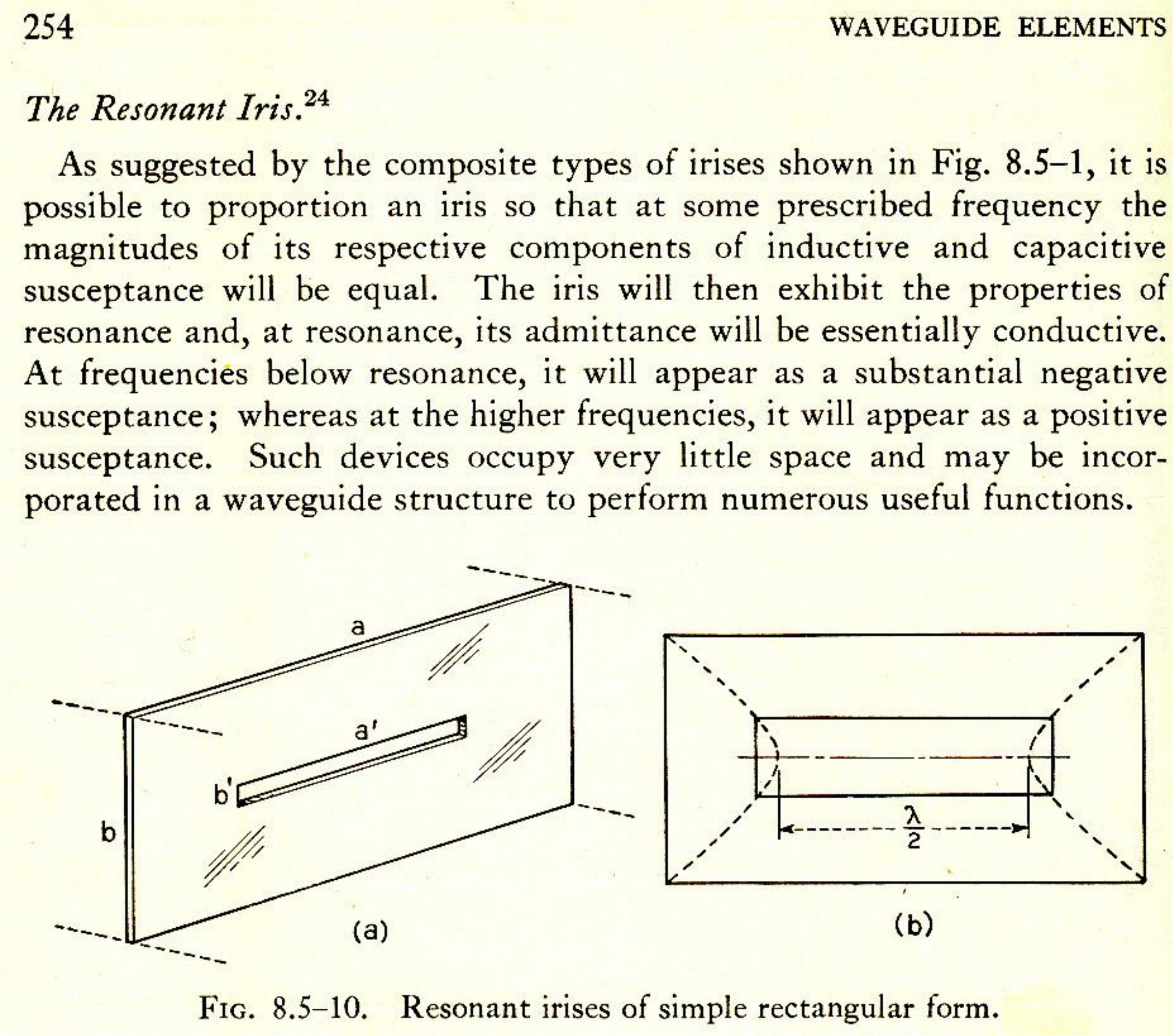
WR62 butted to WR90

Using the right side the Z of WR62 at 10368 is 1.238812 and WR90 is 0.573758 a ratio of 2.159, not trivial.

From the large waveguide side of such a junction, the smaller guide looks like a resonant iris.

Southworth in his book “Principles and Applications of Waveguide Transmission” on page 254 shows a formula for computing the resonant frequency of such an iris.

WR62 butted to WR90



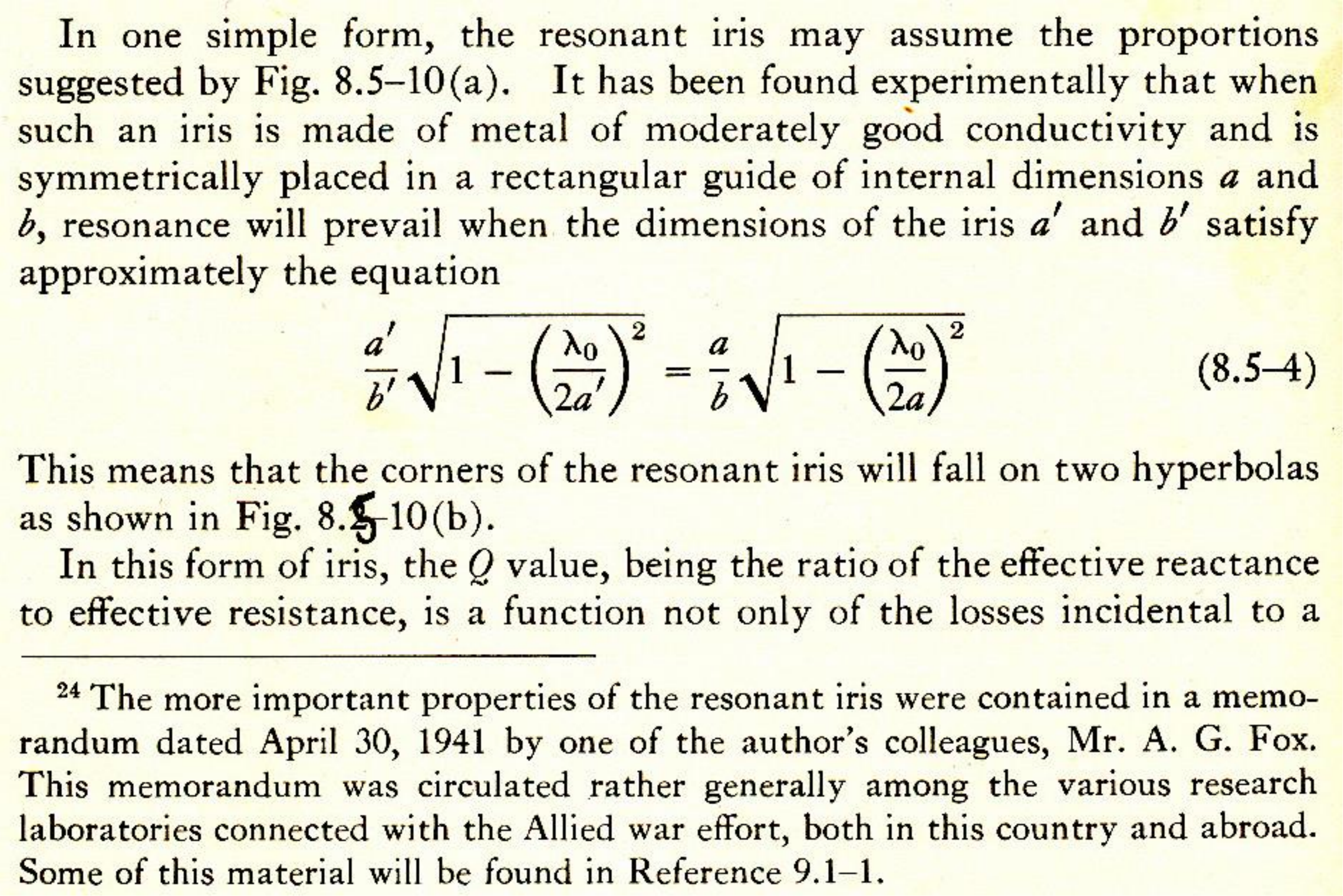
254 WAVEGUIDE ELEMENTS

The Resonant Iris.[24]

As suggested by the composite types of irises shown in Fig. 8.5–1, it is possible to proportion an iris so that at some prescribed frequency the magnitudes of its respective components of inductive and capacitive susceptance will be equal. The iris will then exhibit the properties of resonance and, at resonance, its admittance will be essentially conductive. At frequencies below resonance, it will appear as a substantial negative susceptance; whereas at the higher frequencies, it will appear as a positive susceptance. Such devices occupy very little space and may be incorporated in a waveguide structure to perform numerous useful functions.

Fig. 8.5–10. Resonant irises of simple rectangular form.

WR62 butted to WR90



In one simple form, the resonant iris may assume the proportions suggested by Fig. 8.5–10(a). It has been found experimentally that when such an iris is made of metal of moderately good conductivity and is symmetrically placed in a rectangular guide of internal dimensions a and b, resonance will prevail when the dimensions of the iris a' and b' satisfy approximately the equation

$$\frac{a'}{b'}\sqrt{1-\left(\frac{\lambda_0}{2a'}\right)^2} = \frac{a}{b}\sqrt{1-\left(\frac{\lambda_0}{2a}\right)^2} \qquad (8.5\text{–}4)$$

This means that the corners of the resonant iris will fall on two hyperbolas as shown in Fig. 8.5–10(b).

In this form of iris, the Q value, being the ratio of the effective reactance to effective resistance, is a function not only of the losses incidental to a

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[24] The more important properties of the resonant iris were contained in a memorandum dated April 30, 1941 by one of the author's colleagues, Mr. A. G. Fox. This memorandum was circulated rather generally among the various research laboratories connected with the Allied war effort, both in this country and abroad. Some of this material will be found in Reference 9.1–1.

WR62 butted to WR90

I have written a C program to run lambda from 1.2 to 4 cm and to quit when wavelength gets more that twice the a dimension of either guide. No resonance turned up for that frequency sweep. Then I solved the equation for b' to resonate at 10.3681 GHz. It says the height of such an iris would be 0.3655 cm or 0.1427” to look resonant. That might be a matching scheme not ever tried before. I haven't tried it.

Otherwise the iris appears as a shunt capacitance. So it can be tuned by a capacitive screw a quarter wave from the junction in the WR90 side or an inductive screw in the junction or a half wave wave from the junction.

WR62 butted to WR90

The wooden load in WR62 that I made with the WR62 slotted line has a VSWR or 1.16:1 at 12.000 GHz and 1.18:1 at 10.366 GHz. Not perfect but pretty good. A longer taper showed 1.15:1 at both frequencies. With the WR90 slotted line the long taper showed a VSWR or 1.02:1 at 12 GHz but 1.64 @ 10.369 GHz with the apertures centered. So it appears the flange is looking like a resonance iris. Southworth page 254 noted above helps that solution but not completely. Though a VSWR of 1.64 might be tolerable.

WR62 butted to WR90

My Narda WR90 termination showed a VSWR on the WR90 slotted line of 1.025:1 at 12.009 GHz and 1.025 at 10.369 GHz.

On the WR 62 slotted line the VSWR was 1.15:1 at 12.077 GHz and 1.47:1 at 10.3693 GHz. There were some variations depending on the alignment of the two waveguides. I didn't determine a best alignment, centered, a corner, a top, a bottom, or a side surface.

WR62 butted to WR90

The Rad Lab volumes full set are available on line at KO4BB.com and at https://www.febo.com/pages/docs/RadLab/ I know Donn has them on DVD because he gave me a copy several years ago. I have a couple DVD, small thumb drives, and a couple SD cards with me to hand out.

73, KØCQ