Note, that around ϕ = 10%, below which W_R will appear insignificant and become hard to read, you are close to the commonly accepted lower limit ρ = 2, below which improved antenna match becomes less and less worthwhile in many systems. Experimentally, using the THRULINE, it is readily shown that minimizing ϕ below 10% produces little gain in W_L. TV transmitter antenna lines, and VHF Omni-range transmitters, are among systems requiring much lower levels of reflected power for reasons other than simple power transmission. Note also in Fig. 4-1a, the very small level of reflected power, ϕ = .06 percent, corresponding to ρ = 1.05. With a single Element, detection of reflected power is possible down to about ϕ = 1 percent, ρ = 1.2; if W_F approaches full scale, measurement is possible down to about ϕ = 5 percent, ρ = 1.5.

LOW-REFLECTION MEASUREMENTS may be extended below this with two Elements. Say 80 watts are available, and you have 100 watt and 10 watt Elements.

Measure W_F with the 100 watt Element. Remove 100 W Element and insert 10 watt Element.

CAUTION: 10 watt Element must be ONLY in the REFLECTED direction. ARROW toward TRANSMITTER. Insert and remove ONLY this way.

Now read W_R on the 10 watt Element.

SPECIAL NOTE

DON'T ROTATE 10 watt Element while TRANSMITTER is on. Always use great care with LOW SCALE Elements on HIGH power RF lines. Inadvertent exposure of these Elements to too much FORWARD or even too high reflected power may permanently damage the measuring Element or the microammeter.

In this case, measurement down to at least .5 watt reflected is possible which means to

$$\phi = \frac{.5}{80,} \text{ say .6 percent, or to about } \rho = 1.16$$

and detection of reflections is possible down to about .1 watt,

$$\phi = \frac{.1}{80} = .00125, \text{ say .1 percent, or to about } \rho = 1.06$$

Caution is necessary in the above method, and preferably it should not be used with Element ranges differing more than 100 to 10, although 250 to 10 can be used with extreme caution. With certain Elements now available down to 1 watt full scale this method is usable with medium and low power transmitters.

4. MEASUREMENT & MONITORING OF TRANSMITTER POWER

Little more need be said about this, in view of LOAD POWER paragraph above. The THRULINE is useful for continuous monitoring of transmitter output, and may be found useful in continuous monitoring of reflected power, for instance in checking intermittent antenna or line faults.

Like diode devices generally, the THRULINE indicates the carrier component on amplitude modulation, with very little response to sideband components added by modulation.

5. TESTING OF LINES, CONNECTORS, FILTERS, ETC.

The THRULINE is highly useful for this purpose, and may be employed in several ways.

(a) VSWR (Insertion) or ϕ (Insertion) may be measured with the line terminated in a good load resistor (TERMALINE). The lower limits of sensitivity in this are given above under LOW REFLECTION MEASUREMENTS.

(b) ATTENUATION (Power lost by heat in the line) as well as VSWR (Insertion) and ϕ (Insertion) may be measured by inserting the unknown line between two THRULINES, or between two RF bodies used with one meter and one set of Elements. (End of line to be terminated in a load resistor). This method applies also to insertion between the THRULINE and a TERMALINE absorption wattmeter.

Very small values of attenuation require allowance for normal instrument errors. The correction may be determined by direct rigid connection of the THRULINES, or of the THRULINE-TERMALINE combination, in cascade. Slight juggling of zero settings is permissible for convenience in eliminating computation, provided readings are being taken fairly well up on scale.

(c) ATTENUATION BY OPEN OR SHORT CIRCUIT METHOD. Neater by far than method (b) is one depending on the high directivity (null balance) to which the THRULINE Elements are held. They should, and do, exhibit good equality between forward and reflected readings when the load connector is open or short circuited. In this condition ϕ = 100 percent, the forward and reflected waves being equal in magnitude, and $\rho = \infty$ Say that this is checked on open circuit, and then a length of line of unknown attenuation, also open circuited, is connected to the load connector. The ratio ϕ then shown is the attenuation in two passes along the line (down and back).

Expressed in dB, (using the equation $N_{dB} = \log \frac{W_F}{W_R}$),

the dB figure may be compared with published data for line type and length by remembering to halve N_{dB}* because twice the line length is actually being measured.

This measurement should be supplemented by one of ϕ (Insertion) as in (a) above, or at least by dc con-

*Or to double the line length.