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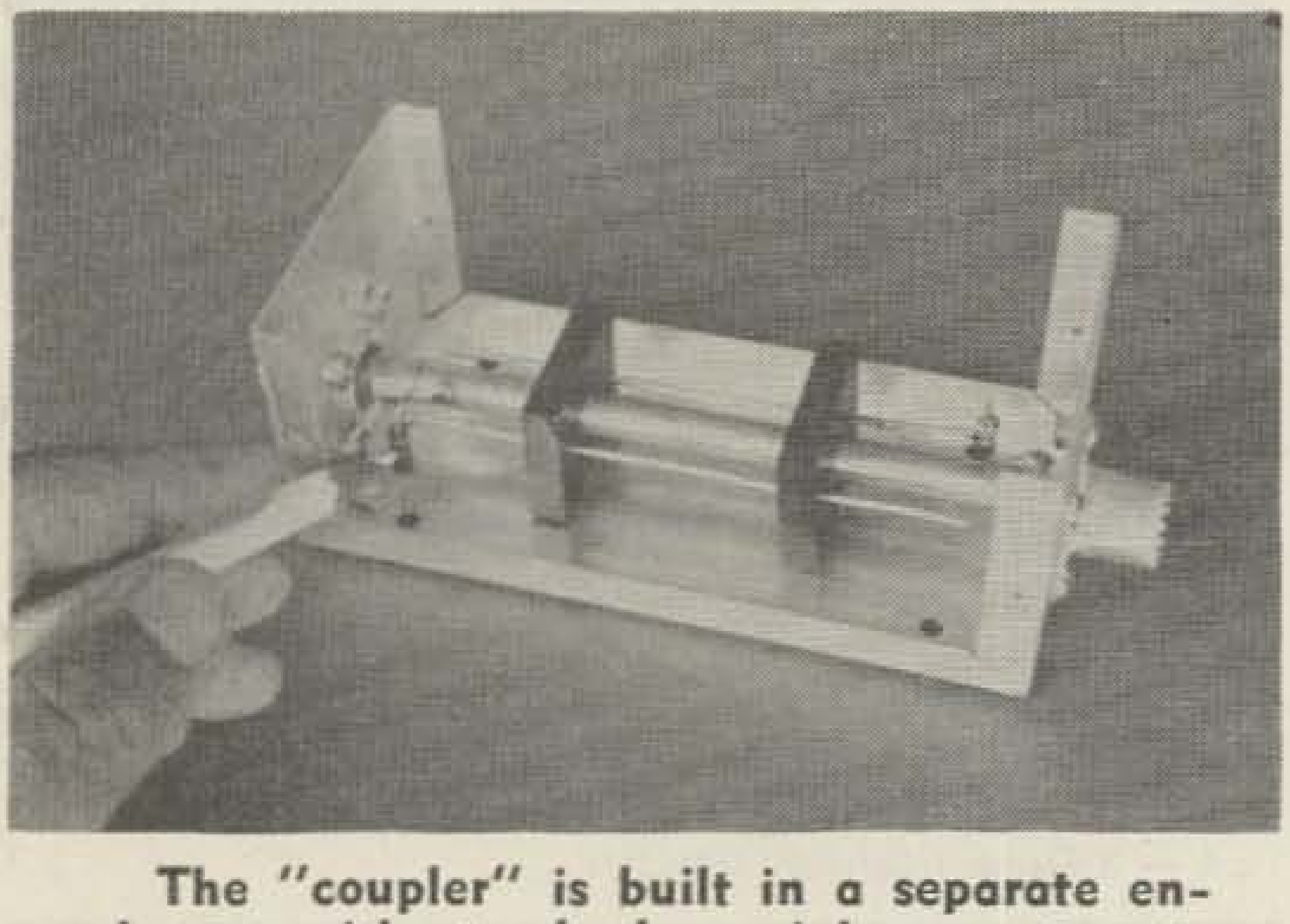
73 Tests

the Knight-Kit P-2 SWR/Power Meter

Standing wave ratio is a subject of discussion and controversy on the amateur airwaves, and is of special concern to those limited in transmitter power. Like the weather, everyone talks about swr, but no one seems to know much about it! However, Allied Radio (100 N. Western Ave., Chicago 80, Illinois) has just made a new Knight-Kit available which is bound to stir up the curiosity of newcomers and old-timers alike regarding swr.

The P-2 SWR/Power Meter Kit (Catalog # 83 YX 627R) sells for $14.95, and consists of two units, a 2 x 5 x 2½ inch coupler and a 2⅞ x 6¼ x 3 inch indicator, connected by a 4-foot shielded cable. Standard SO-239 rf coaxial receptacles are part of the coupler unit, which may be left in the transmission line permanently with negligible power loss.



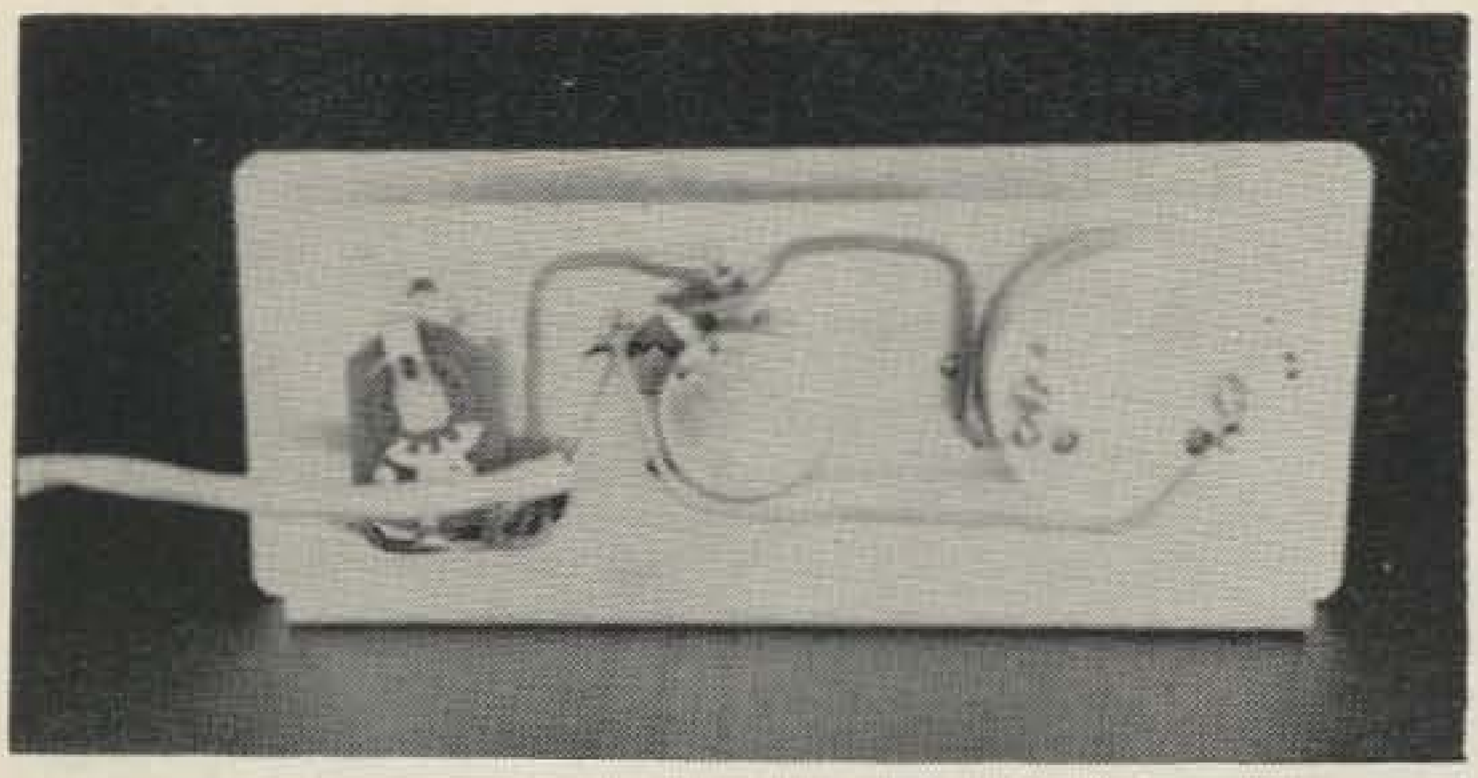
The "coupler" is built in a separate enclosure, with standard coaxial connectors to allow convenient attachment to the transmission line.
The resistor value used depends on the impedance value of the transmission line with which the coupler is to be used.

The coupler may be assembled for use with either 52 or 72 ohm coaxial transmission line, and may be used from 3.5 to 432 megacycles. No external ac power or batteries are required for its operation. It will handle a kilowatt of rf power, yet requires less than a watt at 432 mc for a full scale reading of the 100 microamp meter in the indicator unit. Unfortunately, the red and black meter scales are on a gray background (to match the unit two-tone gray color scheme); a white meter background would enhance visibility in subdued lighting, since the meter is not illuminated.

Assembly of the units is very clearly shown in the detailed assembly manual and the photos accompanying this article. No real problems were encountered in the construction, which takes about 1½ hours if done carefully, as it should be. The author's unit worked perfectly when completed, and no adjustments were required.

During construction of the indicator unit, it would be wise to mount the knobs on the power switch and sensitivity potentiometer shafts right after placing the meter dress panel on the meter sub-panel. This makes it much easier to handle the panel as it is being installed in its case. The black sheet metal screws used to hold the rubber mounting feet are rather brittle, and should be installed without too much "brute force" to avoid breaking the tips of the screws. Also, avoid over-tightening these screws, or they will go *through* the rubber feet; just tighten until the feet are snug, or use a flat washer under the head of each screw.

When assembling the coupler, the place-



The complete wiring of the indicator subpanel involves only a few wires, and a 2-conductor shielded cable which goes to the coupler unit.

ment of several of the parts is critical, and the instructions should be followed closely. Two sets of resistors are supplied with the unit. If you intend to use the coupler with 52 ohm transmission line use the 160 ohm resistors; for 72 ohm line, use the 100 ohm resistors. If the parts tend to shift during handling, use pencil marks on the copper rod and chassis to allow you to return the parts to the proper location when ready to solder. The coupler has no markings on it, and it would be wise to mark J1 XMTR on the end with the connecting cable, and J2 ANT on the other end.

The schematic diagram of the P-2 SWR Meter is shown in Fig. 1. The design of the instrument follows that of the time-proven and justly popular Monimatch of QST and ARRL Handbook fame. This instrument, sometimes known as a reflectometer, consists of a short section of coaxial transmission line with two pickup loops which are connected to rf voltmeter circuits. One of these circuits is so positioned with respect to the center conductor of the transmission line section as to read the incident or forward power component of voltage in the line while the other reads the reflected component. In the P-2 instrument, the circuit associated with diode CR-1 is the forward power voltmeter and the circuit associated with CR-2 is the reflected power voltmeter. Resistors R-1 and R-2 must be adjusted to match the characteristic impedance of the line being measured to balance out the undesired voltage component. In use, the instrument is switched

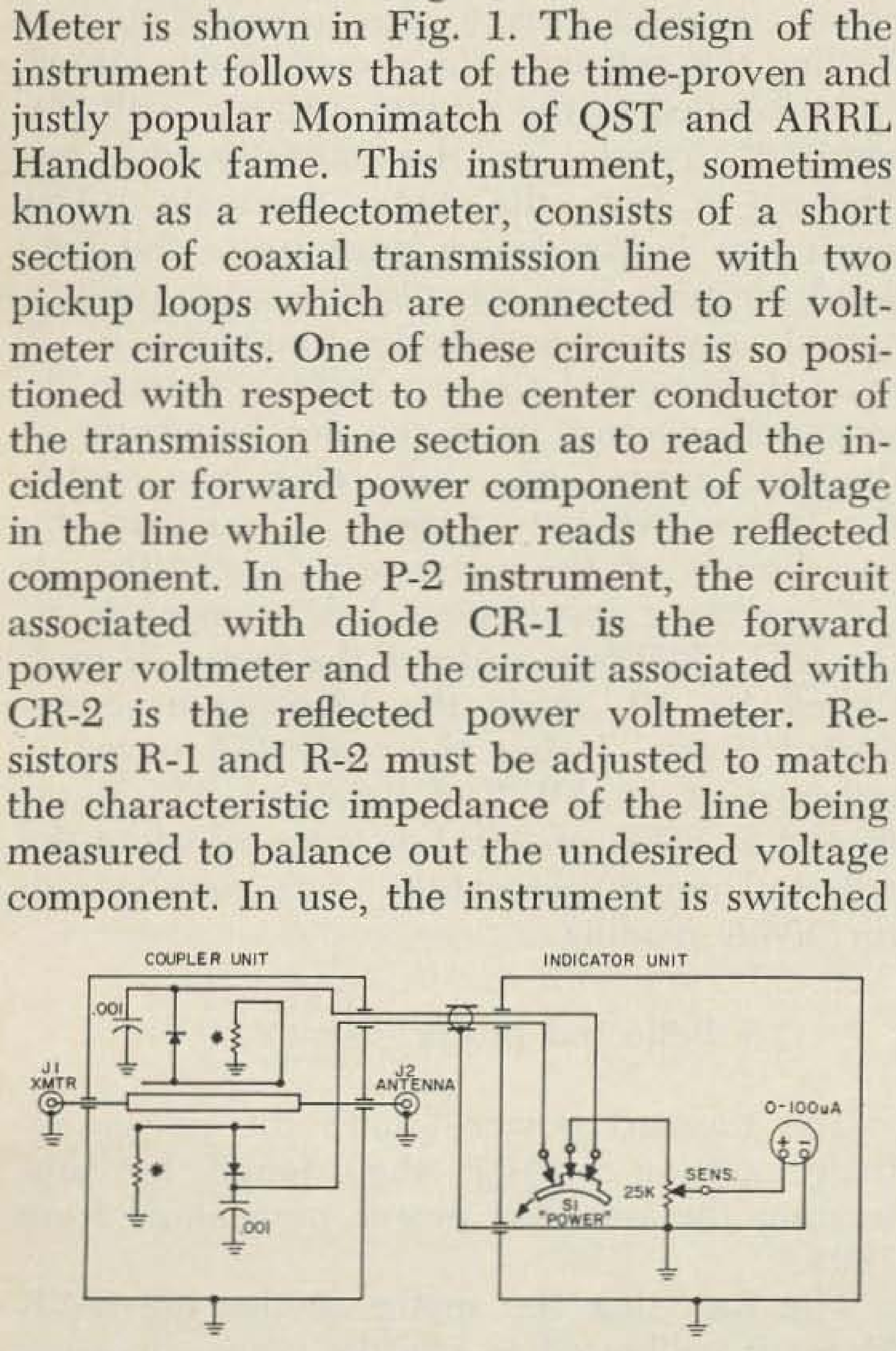
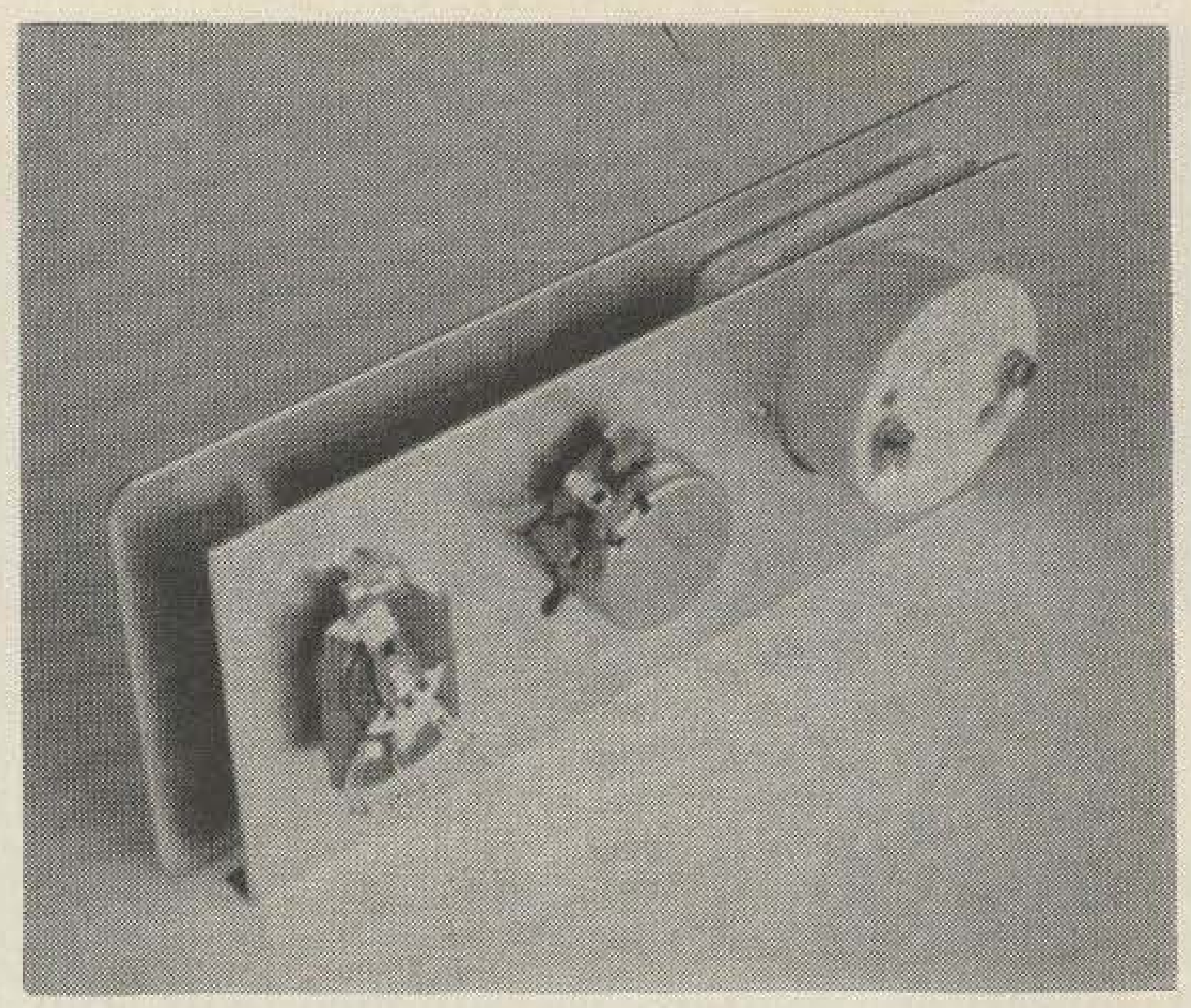


FIGURE 1



The indicator unit contains a sub-panel to hold the meter, switch and pot, with a "dress" panel for the nomenclature.

to the forward power position and the sensitivity control adjusted for full scale meter deflection. The instrument is then switched to the reflected power position and the existing standing wave ratio read directly from the meter scale.

In use, the J1 receptacle of the coupler is connected to the transmitter output connector (using a jumper cable or a double-male connector) and J2 goes to the transmission line feeding the antenna. The transmitter is turned on and tuned in the normal manner, with the sensitivity control on the indicator unit positioned to keep the meter on scale. (The swr meter Power switch must be in the Forward position. You can peak your transmitter output very conveniently by tuning for maximum deflection of the swr meter). Adjust the sensitivity control, once you are tuned up, so the meter reads CAL. (full scale). Now switch the Power switch to Reflected, and read the swr directly on the meter top scale. Although the operating instructions fail to mention it, the REL. POWER scale of the meter, if multiplied by 10, reads the percentage of reflected power! Notice that only 11% power is reflected at an SWR of 2.0, and 25% is reflected at SWR of 3.0. You may calculate the reflected power percentage quite simply from the SWR reading:

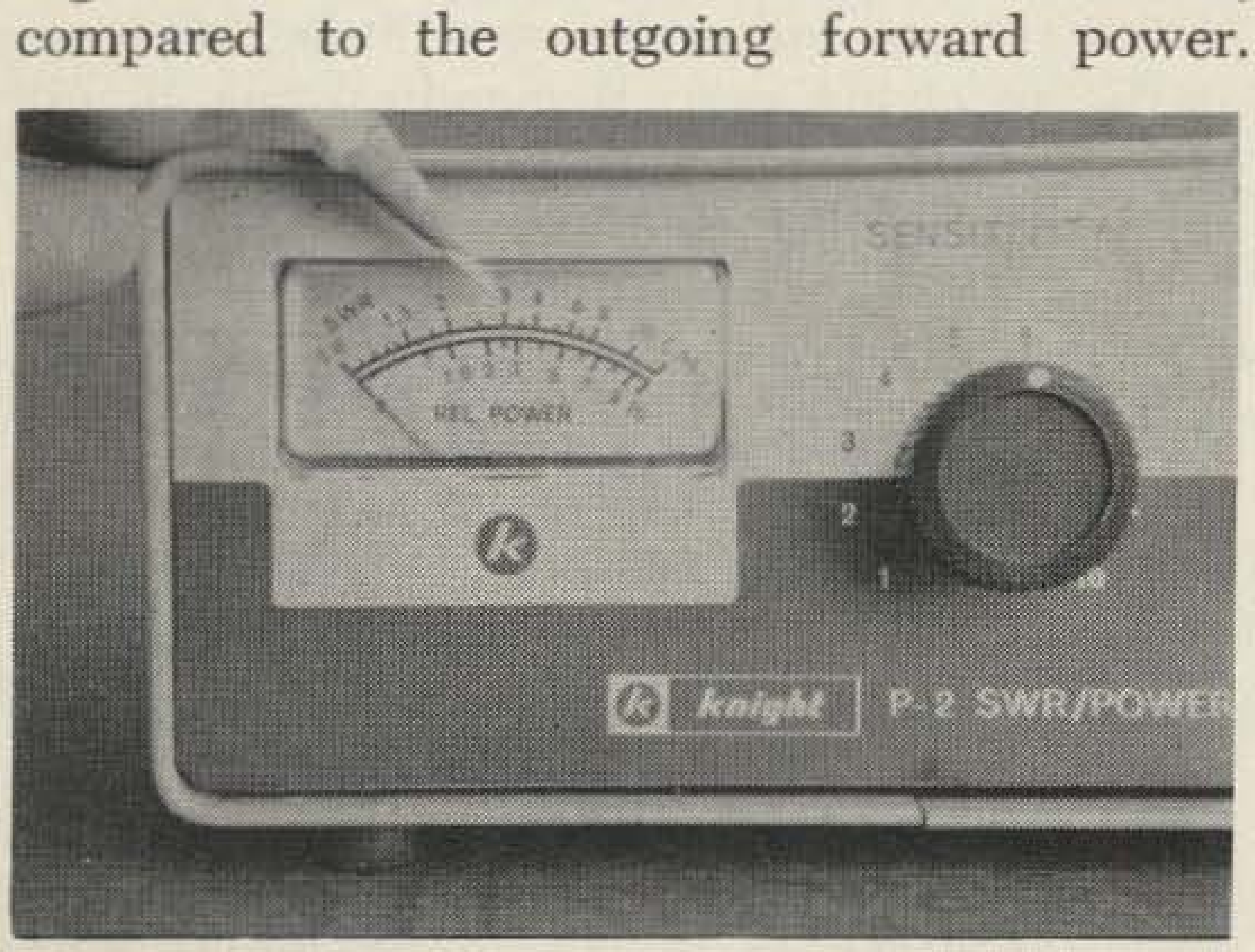
$$\%\ \text{Reflected power} = \left(\frac{\text{swr}-1}{\text{swr}+1}\right)^2$$

The forward power (that's the power actually getting out) is then found by subtracting the reflected power percentage from 100%.

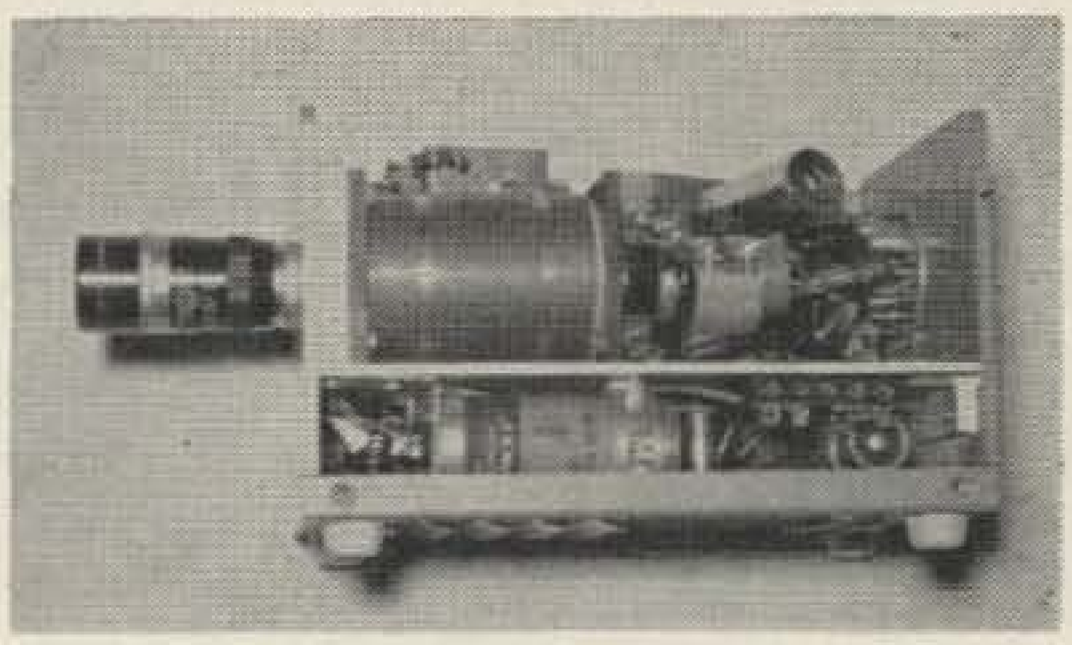
The fact that the meter of the P-2 SWR Meter is calibrated in relative power deserves some explanation. The reflectometer type of SWR meter is quite dependent on frequency for any given output indication. Note that 45 watts is required for full scale deflection at 1.8 mc while only ½ watt is required for full scale deflection at 432 mc. This ratio is perfectly normal for this type of meter. However, it prevents the inclusion of absolute power scales in an all band instrument. Despite this, the relative power scale is quite convenient for transmitter tuning, etc.

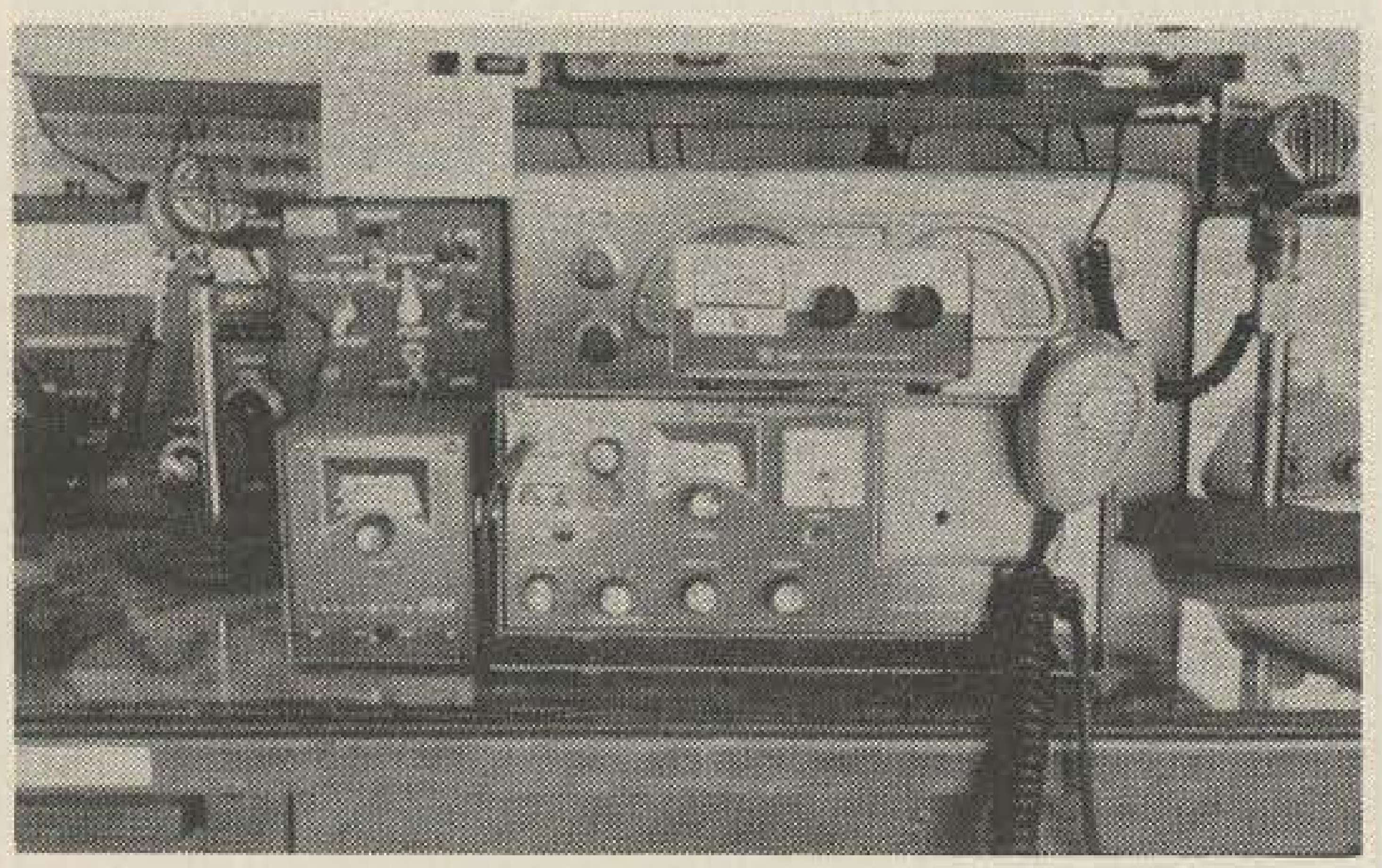
The calibration of the completed unit may be checked several ways. The instructions go through an alignment procedure which requires a non-reactive dummy load. At the higher frequencies and for high power this might pose a problem. A simple way to make a quick check is to *reverse* the coupler in the transmission line, connecting J2 to the transmitter output, and J1 to the transmission line. Now set CAL on the meter with the Power switch in the Reflected position, and read swr in the Forward position. If the same swr is obtained as using the coupler the correct way, the unit is well balanced. If not, the position of the diode connections to the pick-up wires in the coupler must be adjusted slightly, as described in the manual. The author's unit required no adjustments.

Be careful about quoting your swr readings with too much certainty. You see, it just so happens that the swr read at the transmitter is *always lower* than the actual swr at the transmitter. The reason is simple: the forward power is attenuated on its way to the antenna by line loss, and the power reflected at the antenna is also attenuated by the transmission line on its way back to the transmitter. Therefore, the percentage of reflected power reaching the swr meter is less than it should be, compared to the outgoing forward power.



The meter is calibrated to SWR of 20. The lower scale, multiplied by 10, reads percent reflected power. For example, at SWR of 3, 25% power is reflected from the load.





A typical "neat" station!

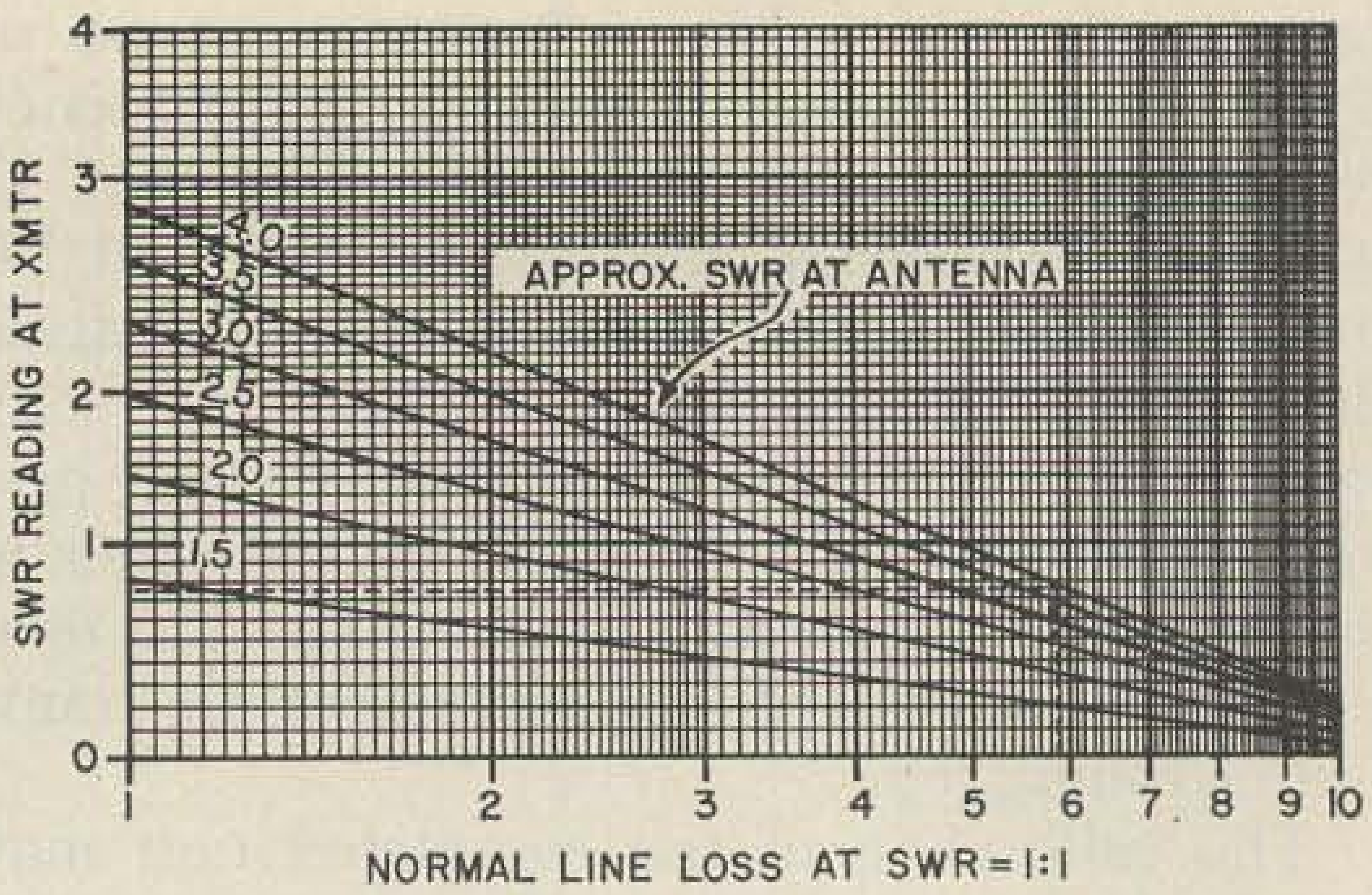
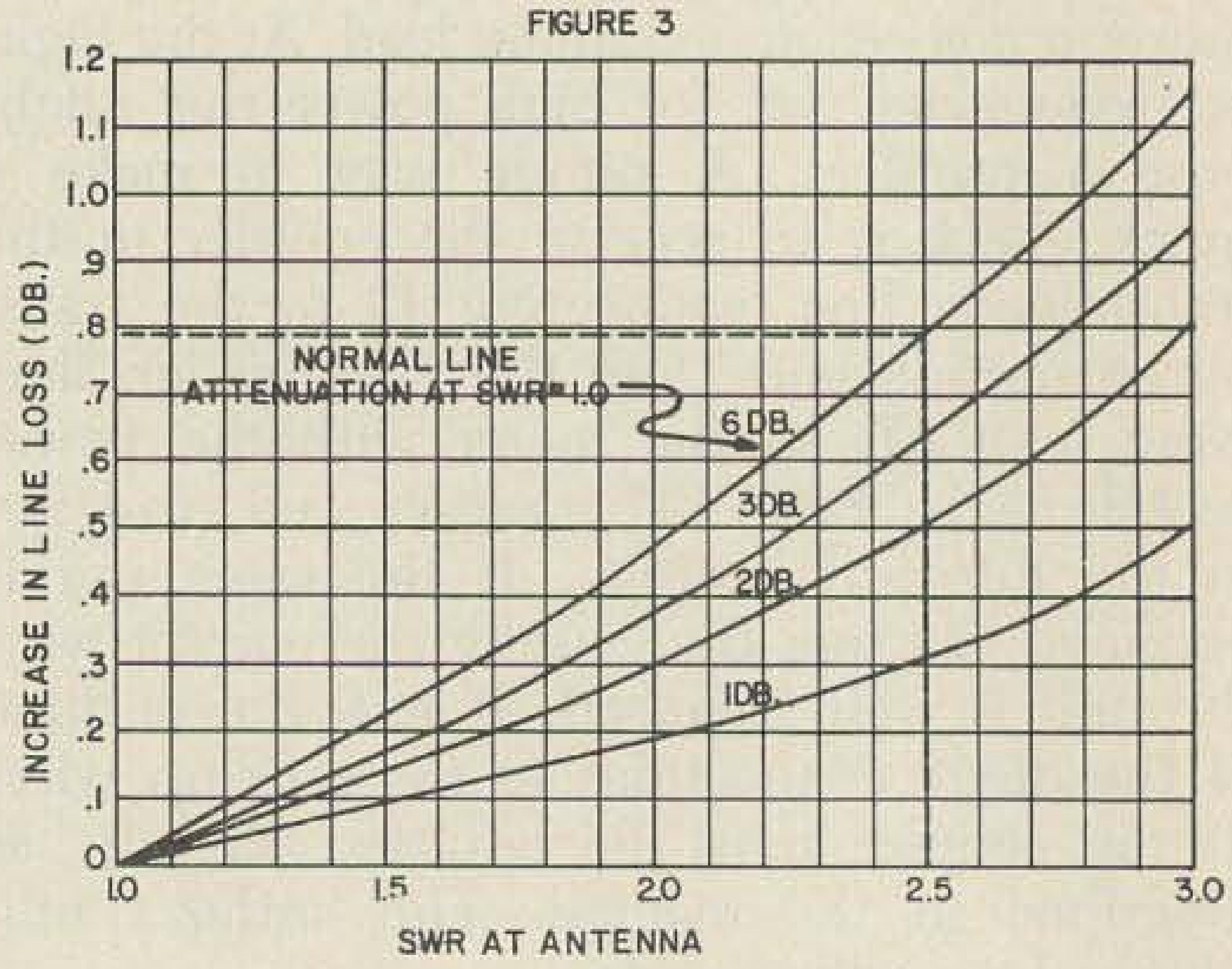


FIGURE 2

FIGURE 3



Since the swr meter is usually located at the transmitter, this variation can be considerable. Look at Fig. 2 for a shock. If the basic transmission line loss (at swr of 1.0) is 6 db, and the swr at the antenna is 4.0, the swr meter will only read 1.37. You can estimate your basic line loss from tables that list the loss per 100 feet for different types of transmission line at various frequencies; the *Radio Amateur's Handbook* has this information in a graph in the transmission line section.

Swr has a couple of other villainous features: it increases your transmission line loss, and lowers the power limitation of the transmission line. Fig. 3 shows the added loss to a transmission line due to swr. For example, if the line loss at swr of 1.0 is 6 db, but the actual swr at the antenna is 2.5, the line loss will be increased by another .79 db. At higher swr this effect can be a lot worse; at swr of 10, with a basic line loss of 6 db, the increase in loss will be 4.5 db. As for the power limitation, caused by the increased peak voltages of the standing waves, the allowable power is equal to the rated power (at swr of 1.0) divided by the swr:

$$\text{Allowable power} = \left(\frac{\text{Rated power}}{\text{swr}}\right)$$

Generally speaking, unless you have high transmission line losses to begin with, an swr of 3.0 or less will make very little difference at the receiving end. Remember, one S unit is 6 db. at the receiver. But it all makes for good conversation on the air.

Specifications of the Knight-Kit P-2 SWR/Power Meter

Minimum rf power for full scale deflection	**45 watts at 1.8 mc** **½ watt at 432 mc**
Maximum rf power	**1 kilowatt**
Input and output impedance	**52 or 72 ohms**
Power requirements	**none**
Frequency coverage	**1.8 to 432 mc**
Meter sensitivity	**100 microamperes full scale**
Meter scales, standing wave ratio	**1:1 to 20:1**
Relative power	**0 to 10**
Kit assembly time	**1 to 2 hours**
Cost	**$14.95 in kit form**