CQ Reviews: The Drake MN-4 Antenna Matching Network

BY WILFRED M. SCHERER,* W2AEF

Much of the amateur transmitting equipment currently in use is designed with a fixed output impedance for matching to approximately 50-ohm essentially non-reactive loads. For other loads, where the s.w.r. or the reactance seen by the transmitter may be high, it is often impossible to sufficiently load the p.a. for maximum output. The same condition might exist even when some degree of variable loading is provided.

Such conditions are not as prevalent with well-designed beams, as they may be with dipoles, long wires, multi-band, loaded or random-length antennas. These antennas are often used either for regular or portable station operation, as a spare or to augment beam installations. In any event, the use of a suitable antenna coupler or matching network will make it possible for the transmitter to work into the required load not otherwise available.

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The Drake MN-4

The Drake MN-4 Antenna Matching Network is a bandswitched unit designed for this purpose, enabling operation with reactive loads that present an s.w.r. up to 5:1, or with resistive loads with a somewhat higher s.w.r., on the 10-80 meter bands. The MN-4 also will provide proper matching between an exciter and a linear amplifier. It is rated to handle 200 watts continuous-duty.

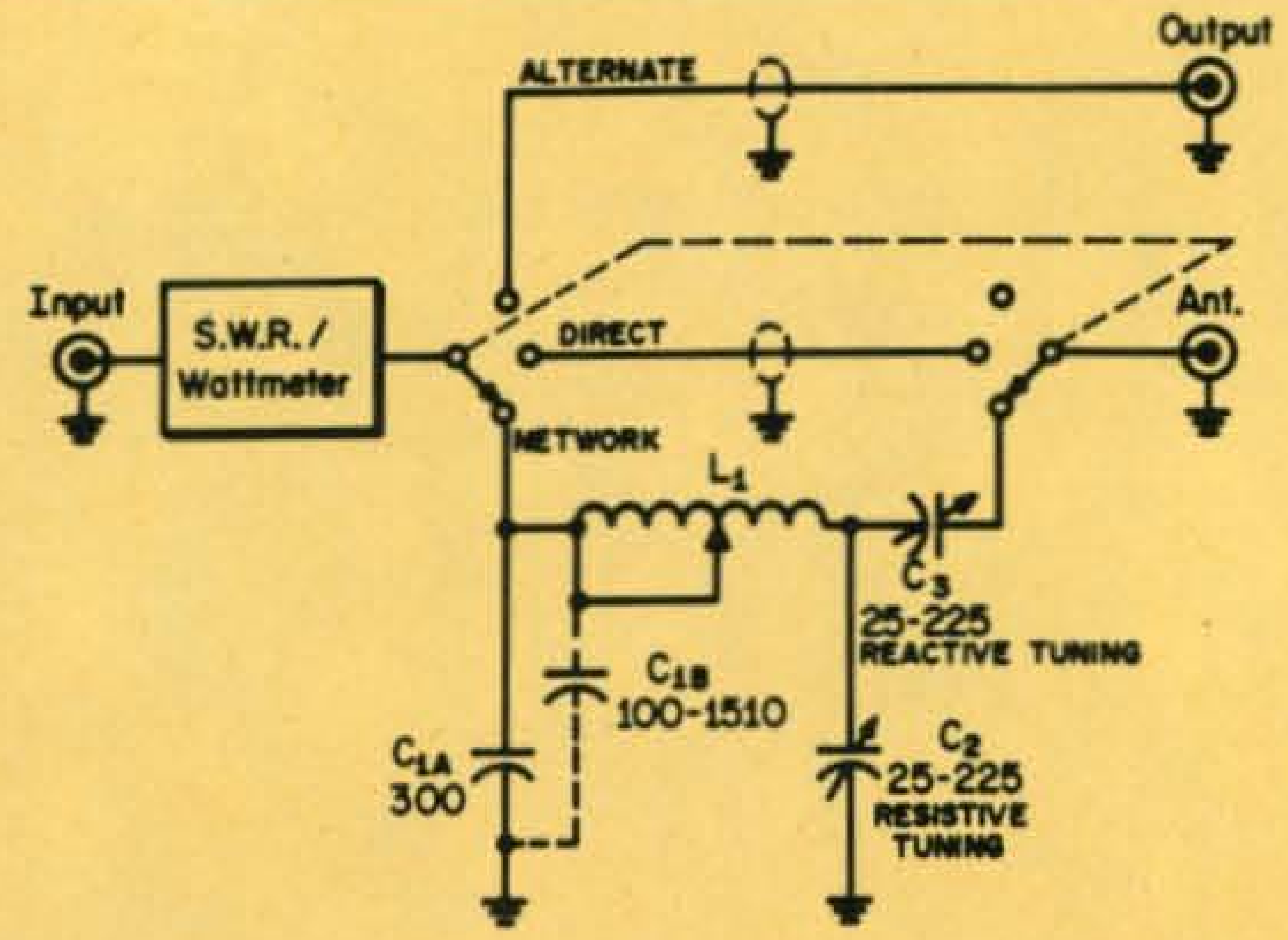


Fig. 1—Main circuitry for MN-4 Network. Various-size fixed capacitors are switched in parallel at C_{1B}, according to the band in use.

Another Model, the MN-2000, will be available for 2000 watts p.e.p.

The job also includes a directional wattmeter which can be switched to directly read the s.w.r. or the power with an existing feed system alone, or for operation in conjunction with the matching network, particularly when adjustments are being made thereon. It also provides output monitoring.

Another feature of the MN-4 is that it will provide 25-35 db of harmonic attenuation and thus possibly avoid the need for a separate low-pass filter to minimize output harmonics that might otherwise be transferred to the feedline and thereby cause TVI, or to provide a further harmonic decrease when a filter is already in use.

Convenient flexibility is provided by the inclusion of two switchable output connectors and with switch positions for feeding through the network or bypassing it.

Circuitry

The main circuitry for the matching system in the MN-4 is shown at fig. 1 and consists of a pi- network which in a way is a depature from the usual arrangement in that the input side is set for 50 ohms with fixed capacitors, while the output is tuned with a variable capacitor, C_2 (RESISTIVE TUNING), to provide the proper impedance ratio between the input of the network and the resistive component of the antenna system. Control C_3 (REACTANCE TUNING) tunes out the reactive component at the output side of the network.

Taps on L_1 and switched fixed input capacitors provide the necessary parameters for operation within the various ham bands. There are two positions for 80 meter band operation to allow a wide matching range without the need for an extra-large variable capacitor at C_2.

The wattmeter is the same type as the Model W-4, described elsewhere in this issue, except that it also has a scale calibrated directly for s.w.r. Although the continuous-duty rating of the MN-4 is 200 watts, the wattmeter scale is calibrated up to 300 watts. The s.w.r. scale is marked for ratios of 1:1 to 10:1. The wattmeter is located at the input side of the network to show when a 50 ohm resistive load is presented to the transmitter (as indicated by a 1:1 s.w.r.) during adjustment of the network.

A sensitivity control is included for the meter, but unlike that in the common s.w.r. indicator mentioned previously, the need for this control is not related to frequency, but rather, is used only to set the meter for a full-scale reading according to the power output from the transmitter, so that s.w.r. readings will be properly correlated.

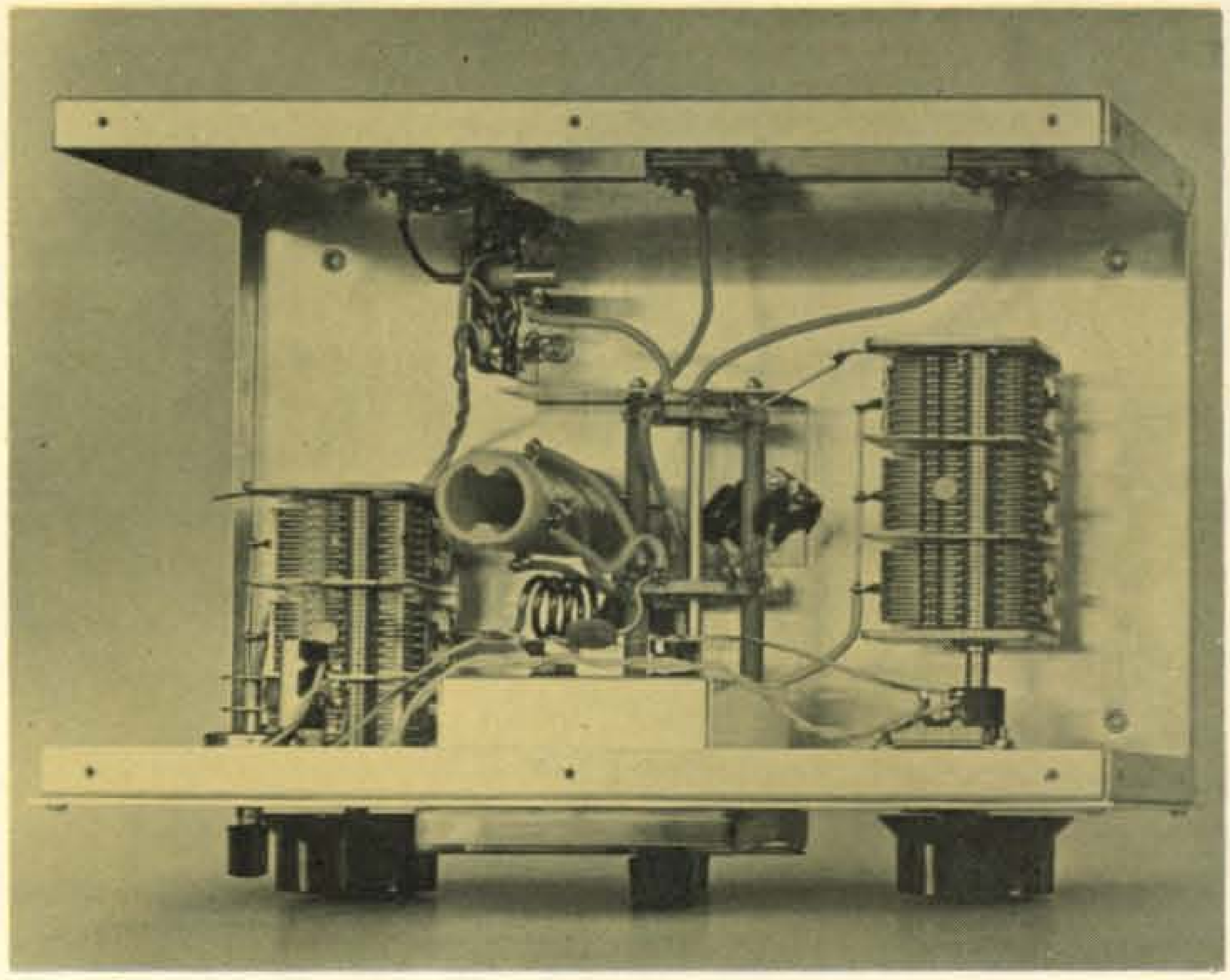
When the selector switch is set at one of the band positions, the matching network is engaged between the input and the *antenna* connector. A separate position connects the input directly to the connector, thus bypassing the network. Another position bypasses the network and connects the input directly to an *alternate* output connector. The setup thus makes it possible to quickly switch to an antenna that requires matching, or to either one that needs no matching, a dummy load or a linear amplifier.

Operation

Adjustment of the matching network can be concluded in a matter of seconds, simply requiring that the RESISTIVE and REACTIVE TUNING controls be alternately operated in a direction which finally results in a minimum or zero indication on the s.w.r. scale of the meter.

During the process, the transmitter p.a. occasionally may have to be repeaked; however, first tuning up the transmitter directly using a dummy load and then switching over to the matching network and antenna, will eliminate the need for further transmitter adjustments. This will hasten the job and reduce unnecessary on-the-air interference, as will the use of low power which also is recommended to avoid damage to either the

Interior view of the MN-4. The network inductor is viewed end-on at the left of the bandswitch with the 10-meter section nearer the panel. The sensing elements for the wattmeter are on a vertical board at the upper left.



transmitter or the matching unit. As little as 10 watts, applied to the MN-4 will usually be sufficient for tuning.

To make the work easier, a set of tuning curves is furnished to show the *approximate* settings on each band for 10-250 ohm resistive loads and capacitive or inductive loads which present a 5:1 s.w.r. Also from these curves, we can find the approximate load impedances according to the dial settings found in practice for a particular situation. Settings for reactive loads with less than a 5:1 s.w.r. are not indicated, but lie somewhere between the resistive and reactive curves.

After the correct settings have been found during tuneup on a specific frequency with a given antenna, they may be recorded for future reference when bands or antennas are to be changed.

The transmitter power *applied* to the matching network or a direct-fed load may be quickly found by depressing a rocker switch which sets up the wattmeter for forward-power readings. If it should be desired to read the s.w.r. presented either by the matching network or by a direct-fed load, such as a dummy or the antenna system alone [1], it may be done by pushing in the sensitivity-control knob and rotating it for a full-scale reading. When the knob is subsequently released, the meter then indicates the s.w.r. directly. In adition, reflected-power readings may be had using a somewhat similar calibrating method.

Performance

The MN-4 was tested using several transmitters with various coax-fed antennas and random-length end-fed radiators working against ground. A 1:1 matching s.w.r. for the transmitter could be easily obtained in most cases, except for a few situations which could not be resolved to better than a 2:1 s.w.r. This was due to the specified limitations imposed by reactive loads with an s.w.r. higher than 5:1, such as can be experienced with end-fed systems. In many cases this match was closed enough to permit full output of the p.a.

Although the MN-4 matches a transmission line or an antenna to a transmitter, it will not alter the s.w.r. between itself and the antenna, nor will it necessarily ensure transfer of all the available power into a radiator, unless the antenna system is resonant, especially if it is a grounded type. Nevertheless, in some off-resonance situations, the MN-4 will bring the system near resonance within about 3 db of maximum-power capabilities.

On the other hand, resonance and better efficiency with such antennas may be obtained by installing a loading coil between the matching unit and the antenna along with an r.f. ammeter connected in series between the *coil* and the *antenna lead,* and then adjusting the coil turns for maximum r.f. current with a given power reading on the wattmeter. The network, of course, must be readjusted whenever the loading coil is altered during this process. A separate loading coil also will often enable the matching s.w.r. to be brought down to 1:1 in cases where it is not otherwise possible.

Grounding

Careful attention to grounding both of
[*Continued on page 115*]

[1] Fed with 50-ohm coax.

own operating ability while accepting a challenge.

(6) Promotion of healthy, international competition, through DX awards and contests.

(7) Providing an excellent test for commercial amateur radio equipment under rugged operating and climatic conditions, useful to the design of future equipment.

(8) Providing an excellent source for the study of propagation phenomena, by operating continuously from areas normally devoid of signals on these frequencies, and by providing voluminous logs and data useful in future propagation predictions.

(9) Perfection of long-distance communication under difficult or marginal conditions.

And I could go on adding to that list of already-impressive advantages. Yes, DXpeditions are a most valuable segment of the amateur radio service. DXpeditions are here to stay. We should be thankful for that, recognize their value, and participate to the fullest extent possible. Just how these many advantages of DXing and DXpeditions can be put to use to actively preserve amateur radio throughout the world, will be discussed in future chapters.

NEXT MONTH: *On the Trail Again.*

Drake W-4 Review [*from page 32*]

We have so far related power readings only to s.w.r., but other needs for such readings may be that of determining the power-output capabilities of a transmitter and its efficiency, or the adjustment for optimum performance. This is best done with loads exhibiting less than a 2:1 s.w.r. Such tests should be conducted using a dummy load, not only to eliminate on-the-air interference, but also to avoid illegal operation when the d.c. input to the p.a. exceeds 1000 watts.

The W-4 has a 3" meter mounted in a clear-view plastic case that has a concave face which minimizes light reflections. The scale is finely calibrated and easy to read. There are four positions at the selector switch: two for reflected ranges of 200 and 2000 watts; two for forward ranges of 200 and 2000 watts. The 2000-watt positions are between the 200-watt ones, so that when you switch from forward to reflected power while high power is being used, you don't have to go through the 200-watt positions, thus avoiding the possibility of slapping the meter pointer against the end of the scale.

[*Continued on page 115*]

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Ranger II (wired)	359.50	259.50
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LA-500M "Spitfire" Linear	189.95	94.99

POLYTRONICS	Reg.	NOW*
PC-2 2m Transceiver	$349.50	$225.00

REGENCY	Reg.	NOW*
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SBT-3 80-40-20m SSB Xcvr	$299.50	$198.00
SBA-3 AC Supply	99.50	49.75

The size of the wattmeter case is 6″ × $3\frac{11}{16}$″ × 4″ (h.w.d.) and the removable sensing coupler is 2¼″ × 3½″ × 2½″. Besides the usual installation and operation procedures, the manual includes instructions for alignment or calibration, should this be required at some later date.

The Drake W-4 R.F. Wattmeter is priced at $49.50.—*W2AEF*

Drake MN-4 Review [*from page 67*]

the unit itself and the transmitter was found advisable, especially when an appreciable length of coax is used between both pieces of equipment or when a grounded-antenna system is involved. A separate ground lead for each generally is best, with the ground paths made independent of the coax shield connection between the equipment. Inadequate grounding may be evidenced by hand-capacity effects when the tuning knobs are grasped or released, or by a higher s.w.r. at the transmitter output (shown by a separate s.w.r. bridge) than that indicated by the MN-4's meter.

A thing to keep in mind when the network is in use is that the wattmeter indicates only the power *applied* to the *network, not* that going into the *radiator*. Also, a maximum insertion loss of 0.5 db (12% of power) through the network was measured as per the manufacturer's rating.

The effects of harmonic attenuation on TVI were not checked in practice, but the measured attenuation of second harmonic averaged 28 db for all bands, with higher-order harmonics found somewhat further down.

Although the unit is designed specifically for use with coax-type transmission lines, there may be more cases that relate to the need for matching to other type feed systems. For this reason we have gone into extra details on operation with systems such as the grounded antenna.

Dimensions for the MN-4 are 5½″ × 10¾″ × 8½″ (h.w.d.), including connectors.

The Drake MN-4 Antenna Matching Network is priced at $90. The Model MN-2000, for 2000 watts p.e.p. is $160. There are products of the R. L. Drake Company, 540 Richard St., Miamisburg, Ohio 45342.

—*W2AEF*