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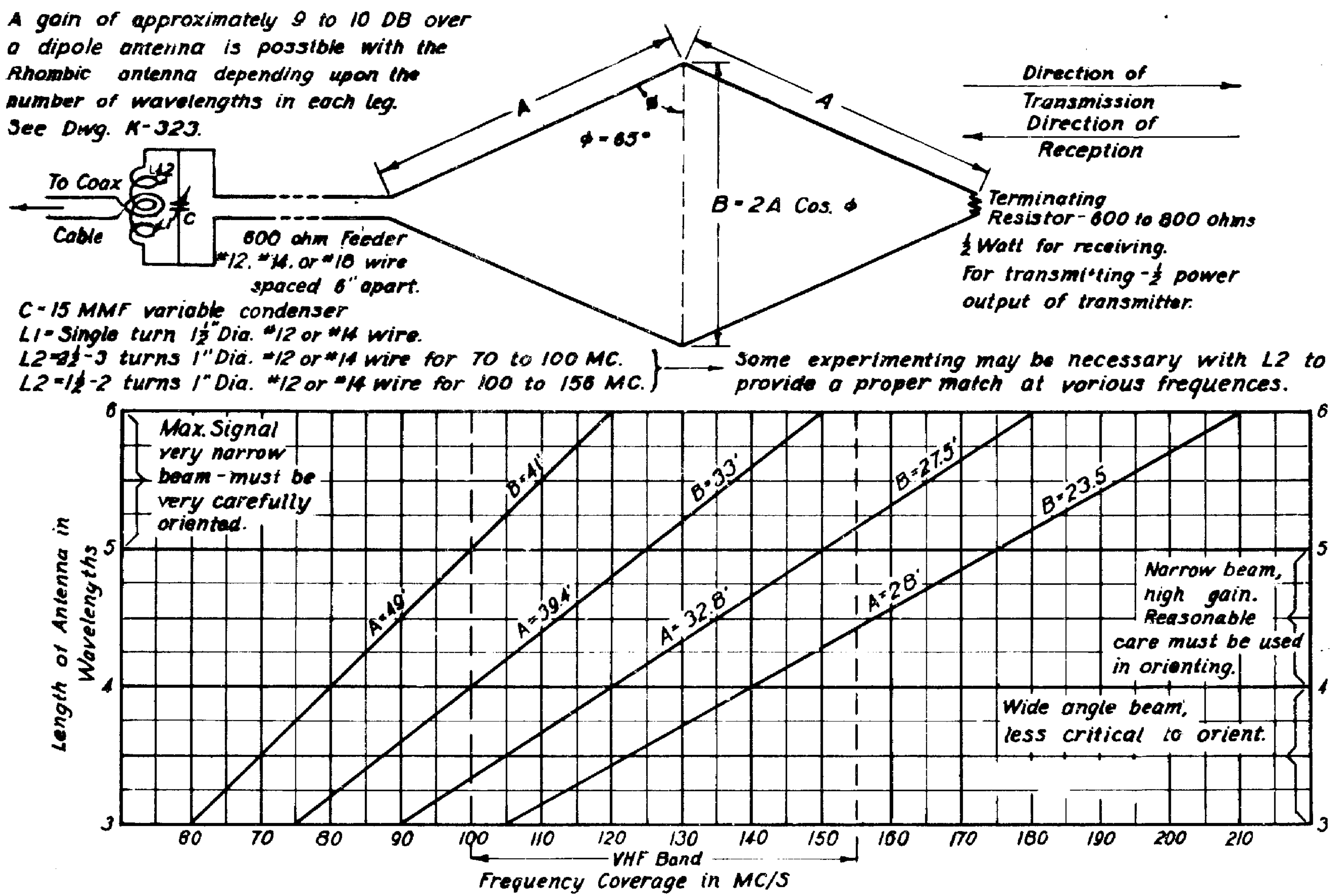


VERTICAL RHOMBIC ANTENNA DESIGN CHART FOR VARIOUS FREQUENCIES & WIDTH OF BEAM

Fig. 3

24-27592

VERTICAL RHOMBIC ANTENNAS FOR VHF OPERATION

Application - The use of directional antennas for V.H.F. point-to-point radio communication should be considered when one or more of the following conditions exist:

1. Transmission is along one axis only;
2. Increased range is required in one direction;
3. Back radiation is to be suppressed for security or interference elimination.

Military Requirements - The rhombic type of directional antenna, practical examples of which are illustrated in Figures 5 and 6, appears to be the most practical type of directional antenna satisfying the military requirements of:

1. High power gain and directivity;
2. Simple design for assembly;
3. Non-critical as to adjustment;
4. Extremely light in weight.

Characteristics - The rhombic, as generally used, is one of several types of directive antenna systems based upon non-resonant radiating elements. Such elements have the advantage of operating over a wide band of frequencies without readjustment and are, therefore, particularly desirable under conditions where numerous frequencies are to be employed. The rhombic antenna is made up of four non-resonant wires arranged in the form of a diamond or rhomboid. Radio frequency energy is fed into one end of the diamond by means of a balanced transmission line. The radiating wires are terminated at the other end by a non-inductive resistor equal to the characteristic impedance (600 to 800 ohms). This terminating resistor should be capable of dissipating approximately one half of the transmitter power output. For receiving, a 1/2 watt resistance is ample. The directional characteristic of the radiation from each leg is as shown in Figure 1. When the tilt angle has the optimum value (Figure 2), all

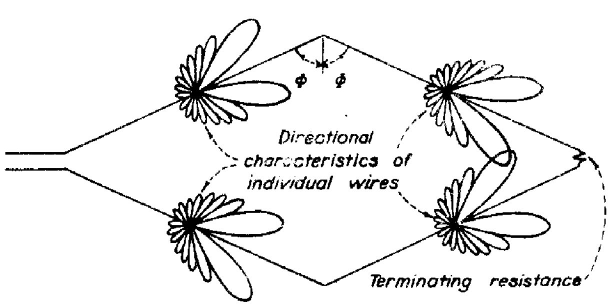


Fig. 1 - RHOMBIC ANTENNA

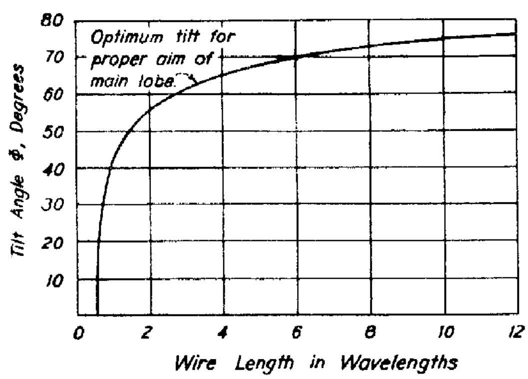
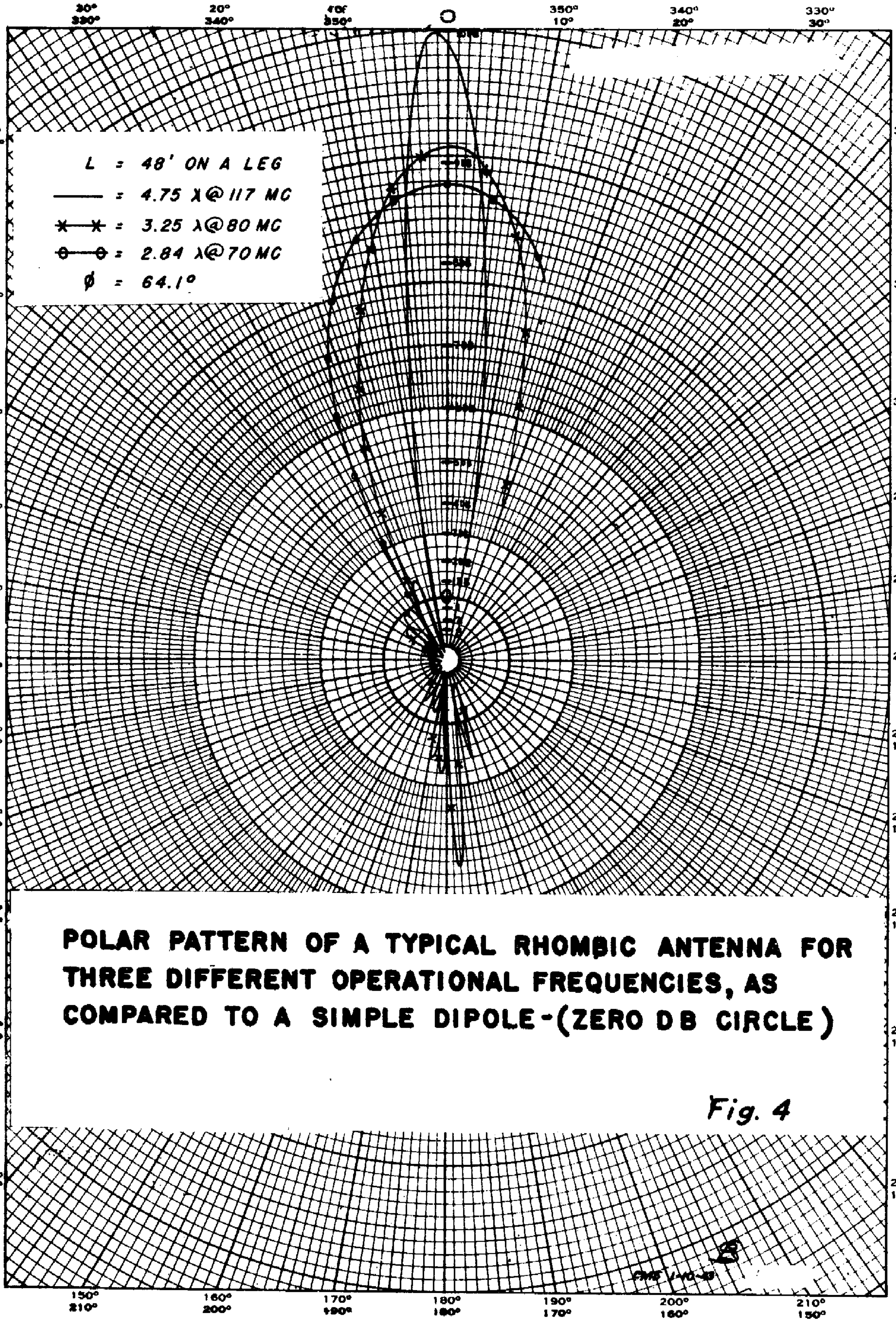


Fig. 2 - OPTIMUM TILT ANGLE FOR RHOMBIC ANTENNA



POLAR PATTERN OF A TYPICAL RHOMBIC ANTENNA FOR THREE DIFFERENT OPERATIONAL FREQUENCIES, AS COMPARED TO A SIMPLE DIPOLE-(ZERO DB CIRCLE)

Fig. 4

four legs have major lobes which add up in the direction of a line drawn through the apexes and the side lobes cancel out.

The directional characteristics of a rhombic antenna are not very greatly affected by a small deviation of tilt angle from that shown as optimum, provided each leg is longer than three wave lengths. The tilt angle is the angle made by the wires at the center with respect to the vertical. Consequently the rhombic can be used to great advantage over a considerable frequency range without adjustment. The dimensions given for the four rhombic antennas recommended (Figure 3) were designed for A=3 wavelengths at the minimum frequency of a particular band and a leg length of 4 wavelengths was used in determining the angle (65°), from which B=2 A (cos of the angle) = .84 A.

Construction and Installation - Figure 3 is very useful in selecting a rhombic antenna design for a particular frequency having the desired directivity and signal strength. The dimensions A and B for each of the four antennas are given and the number of wavelengths in each leg corresponding to a particular frequency can immediately be determined. The directivity and gain to be expected can then be determined by reference to the curves of Figure 4.

The polar patterns of Figure 4 represent the power gain measured on a typical rhombic antenna at various azimuths, and three different frequencies.

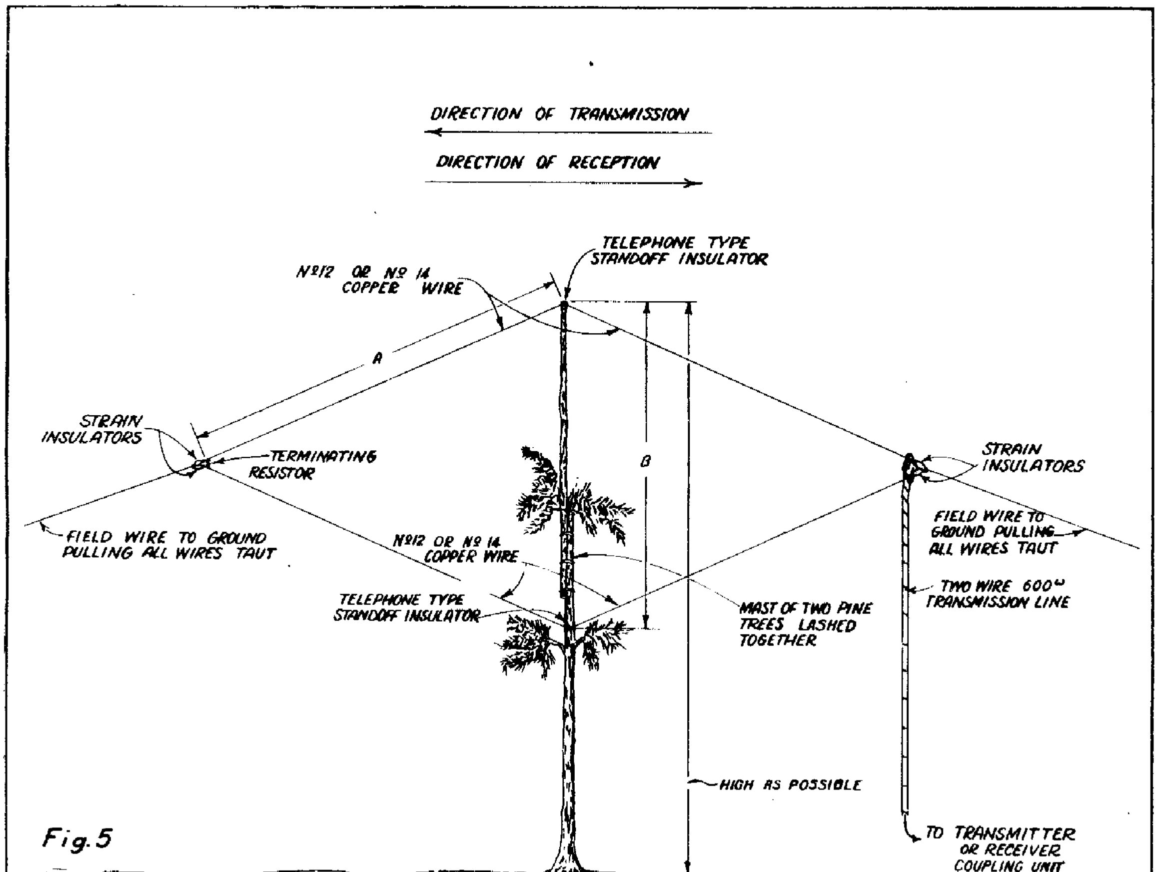


Fig. 5

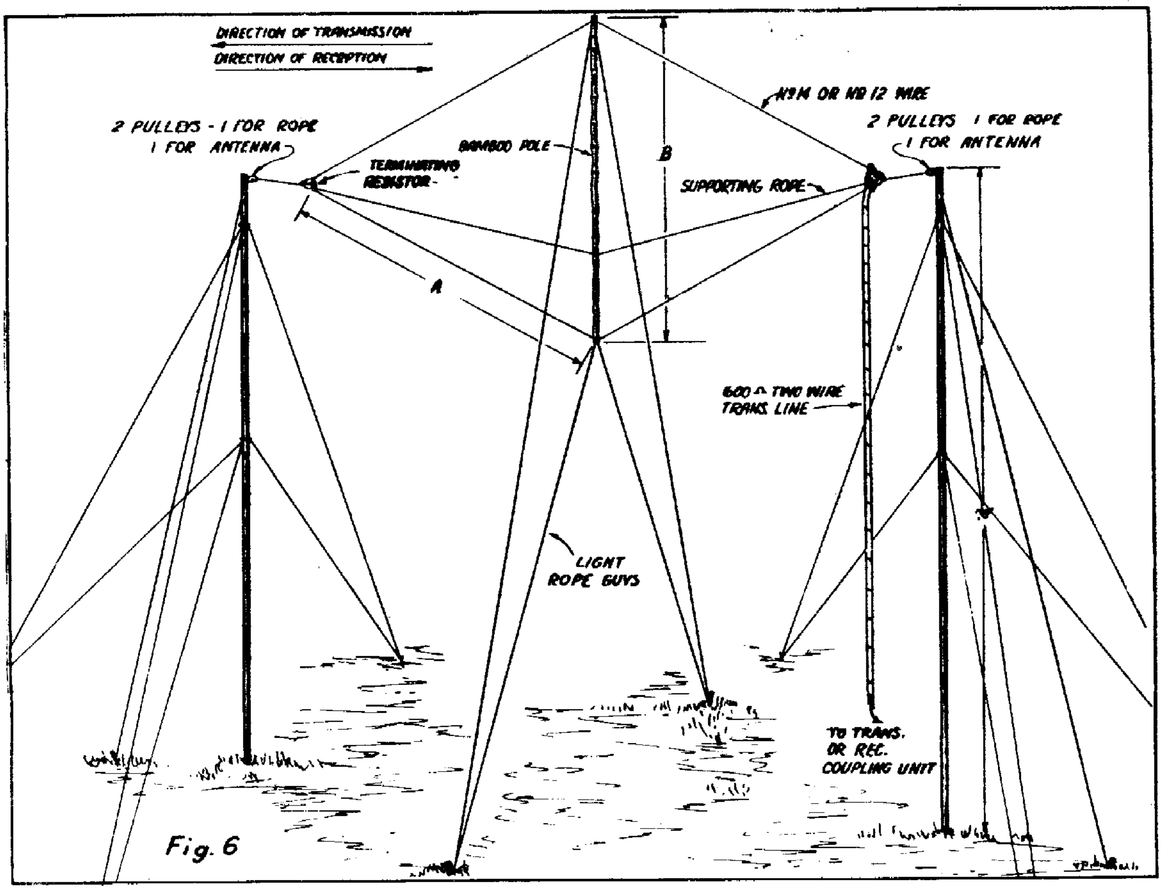


Fig. 6

(Exactly the same directivity and gain is obtained when using the rhombic as a receiver or transmitter antenna).

The antenna is erected in a vertical plane primarily because most Signal Corps V.H.F. equipment is designed for use with vertically polarized radiation fields. Vertical construction is also much simpler, requiring fewer supporting structures.

Operation of the same antenna at higher frequencies results in each leg becoming a greater number of wavelengths, with a resultant increase in signal strength in the straight-ahead direction but having a still narrower angle of coverage. Operation at lengths greater than 6 wavelengths, while giving a very strong signal, is not recommended unless some accurate means are available to orient or beam the antenna at the other station with which it is operating. The single support type of construction shown in Figure 5 is the simplest and most desirable because of the ease with which its direction can be changed.

A coupling unit must be used for connecting the 600 ohm transmission line to the 70 ohm coaxial cable from the transmitter or receiver. This unit consists of a single turn loop, connected to the coaxial cable fitting close-coupled to a parallel tuned coil and condenser circuit, which in turn is connected across the terminals of the transmission line. The variable capacitor used in this circuit permits maximum transfer of energy from the coaxial line to the two-wire lines by tuning the feeders to resonance. (See Figure 3 for

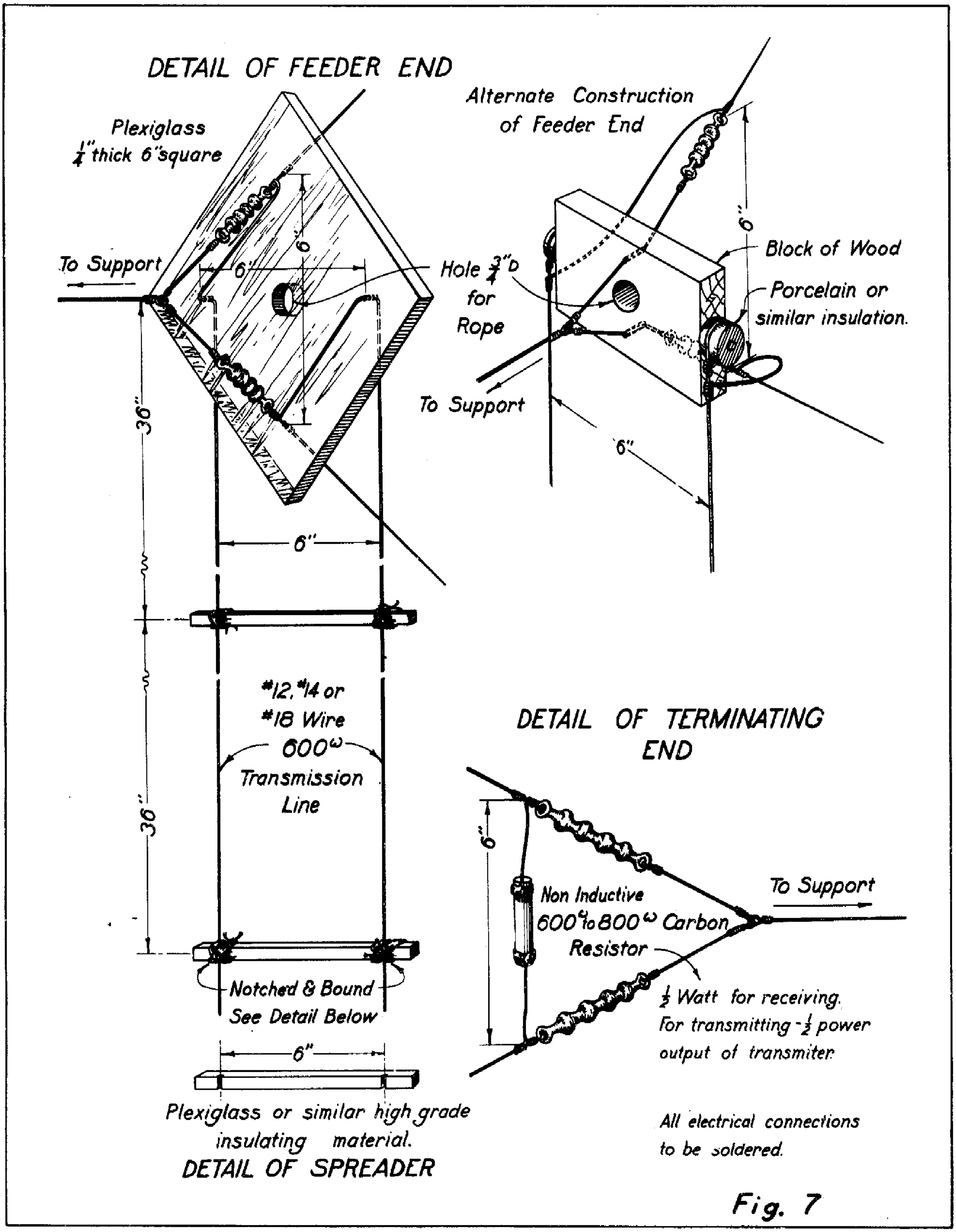
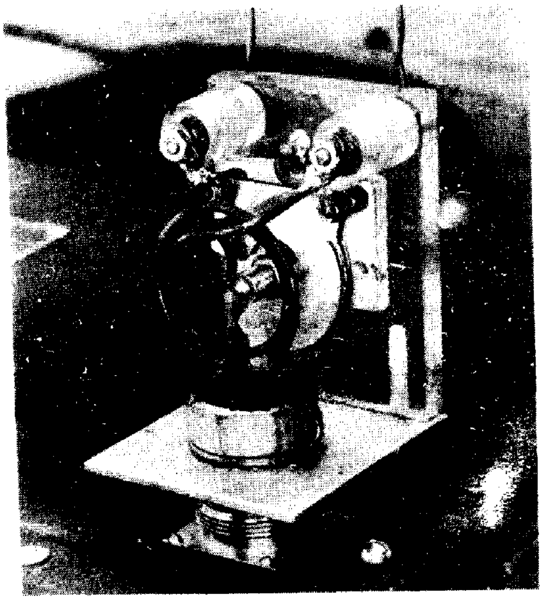
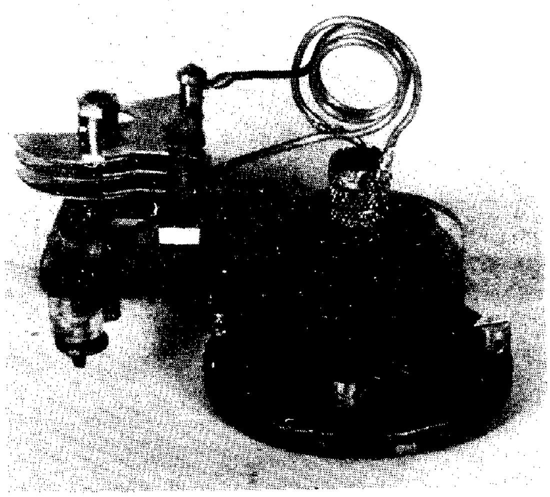

DETAIL OF FEEDER END
Plexiglass
¼" thick 6" square
To Support
6"
6"
Hole ¾" D for Rope
36"
6"
36"
#12, #14 or
#18 Wire
600ω
Transmission
Line
Notched & Bound
See Detail Below
6"
Plexiglass or similar high grade
insulating material.
DETAIL OF SPREADER
Alternate Construction
of Feeder End
6"
Block of Wood
Porcelain or
similar insulation.
To Support
6"
DETAIL OF TERMINATING
END
6"
Non Inductive
600ω to 800ω Carbon
Resistor
To Support
½ Watt for receiving.
For transmitting - ½ power
output of transmiter.
All electrical connections
to be soldered.

Fig. 7

schematic and electrical values.) Figures 8 and 9 show coupling units used with Signal Corps equipment.

The terminating resistance at the far end of the rhombic must be non-inductive and is best made up of carbon resistors. If one resistance of the correct value is not available, two or more units may be connected in series, parallel or series-parallel to obtain the proper value. The resistance value is not critical, any value between 600 and 800 ohms will work satisfactorily. If elimination of back radiation is not an important consideration and a resistor is not available, the resistor may be omitted without loss of forward gain.





Typical coupling units. Figure 8 (left) as used with SCR-522; Figure 9 as used with BC-640 Transmitter or BC-639 Receiver.

If a Mobile D/F station SCR-566 antenna switching relay (JB-45) is available, the same rhombic antenna can be used for transmitting and receiving. Send-receive switching is already provided for within the SCR-522 so that external antenna switching is not necessary when using this set.

Construction Advantages over Other Types - The rhombic antenna as described herein has been found to be the most effective system of directional antenna of many types tested. The types that gave results most closely approaching those obtainable with the rhombic were cumbersome and could not easily be made up in the field because of necessary precision adjustment of spacings, lengths of elements, and availability of materials and tools necessary for fabrication. Supporting structures required for most other types of directional arrays were also necessarily heavy, not easily obtained and even when available, the problems of mounting the arrays presented difficult mechanical problems.

CORRECTION---RHOMBIC ANTENNA ARTICLE, MAY ISSUE

In the article "Vertical Rhombic Antennas for VHF Operation" in the May 1943 issue of the Signal Corps Technical Information Letter, an error appeared in the legend on the Polar diagram, Figure 4, page 6. The length L was given as 48 feet whereas it should have been 40 feet. This does not alter the polar patterns as they appear in this illustration, nor will it change the wavelength ratios listed in the legend.