January 5, 1961

To: Members of IRE Subcommittee 27.4

Enclosed please find a draft of Section 5 and Section 6 of our proposed Standard of Measuring Interference Output. These incorporate the points discussed at the December 2, 1960 meeting.

Please review these before our next meeting.

Very truly yours,

V.J. Mancino

V.J. Mancino, Chairman
Subcommittee, 27.4

VJM:js

Mancuso

3/10/61

December 20, 1960

IRE 27.4 Proposed Standards

Methods of Measurement of Transmitter External Wiring Spurious Output

5. Spurious Output appearing on Transmitter External Wiring

5.1 General. The Spurious Output appearing on the external wiring of a transmitter which may consist of harmonic (or non-harmonic) components, may be measured by measuring the voltage developed across a known impedance network with the use of a calibrated frequency-selective voltmeter or receiver.

5.2 Equipment required:

5.2.1 Impedance Network. The spurious output appearing on external wiring should be measured with the use of an impedance network whose characteristic is known. This network shall be inserted in the external ~~lead~~ wire whose spurious output is to be measured, at a convenient point close to the point of entry of the wire to the transmitter hardware, such that the spurious output voltage is developed from the wire to ground. The network must have a connection means for cables to the calibrated frequency-selective voltmeter or receiver. The circuit of this network is shown in figure 5A and its impedance curve is shown in figure 5B. (Make same as Pg 20 of MIL-I-26600)

5.2.2 Variable Attenuator. A calibrated variable attenuator is needed to provide a means for adjusting the output indication level of the measuring instrument so as not to overload the frequency selective voltmeter or receiver. It may also be useful in checking for spurious responses.

5.2.3 Frequency-selective voltmeter or receiver. A frequency-selective voltmeter or receiver (may be more than one) which can tune to the carrier and any spurious output frequency of interest, is needed.

If a receiver is used, it must have an output indicator. The receiver cabinet should incorporate good shielding techniques and the power lines should be well filtered.

5.2.4 Coaxial Switches. Coaxial switches (or suitable means for changing connections) may be required when using a calibrated signal generator for calibration purposes.

5.2.5 Measuring Equipment Enclosure. To prevent pickup of extraneous radiations during the measurements, the measuring equipment should (if necessary) be enclosed within a suitable shielded enclosure and the signal from the pickup device brought into the shielded enclosure through a well-shielded cable.

5.2.6 Calibrated Signal Generator. A calibrated signal generator (or generators) to cover the carrier frequency and any spurious frequencies of interest is needed.

5.3 Measurement Procedure.

5.3.1 Standard Method. NOTE: The standard method measures the voltage of the spurious output developed across a known impedance network.

5.3.1.1 Connect the equipment as shown in figure 3.

5.3.1.2 Operate the transmitter under test in its intended manner with its output connected to a shielded dummy load.

5.3.1.3 Tune the frequency-selective voltmeter or receiver through the frequency range of interest with the calibrated variable attenuator adjusted for maximum sensitivity of the measuring circuit. When a spurious output is found, adjust the attenuator to obtain a suitable reference indication on the output indicator of the measuring instrument.

CAUTION: In all frequency-selective voltmeters or receivers spurious

responses may occur by: (1) Desensitization of the receiver by the entry of a strong off-channel signal through the antenna input, (2) the entry of a strong on-channel signal through the receiver case or power lines, such signals by-passing the calibrated input attenuator. These responses must be known or determined for the particular device used.

In addition care must be taken to insure that the spurious signal being measured can be actually attributed to the equipment under test. This is easily determined by momentarily turning off the equipment under test.

5.3.1.4 If a frequency-selective voltmeter is used, calibrate it according to the recommended manufacturer's procedure and measure the spurious output signal. If a receiver is used it must be calibrated by means of appropriate calibrated signal generators.

5.3.1.5 The level of the spurious output is calculated as follows:

5.3.1.5.1 CW Spurious Output. CW Spurious Output Level (DB above 1uV) = meter reading in DB above 1uV (or substituted signal generator reading) + cable loss in DB (between the impedance network and the calibrated variable attenuator)

5.3.1.5.2 Broadband Spurious Output

Broadband Spurious Output Level (DB above 1uV per MC) = meter reading in DB above 1uV (or substituted signal generator reading) + Cable loss (DB) $-10 \log_{10}$ (impulse bandwidth in MC).

5.3.2 Alternate Method. NOTE: The alternate method is used when it is inconvenient to use the standard method due to reasons of inaccessibility or other considerations. ~~due to the large current carrying capacity of the external wiring.~~ For this method a clamp-on current transformer of known characteristics is used. The spurious output is determined by measuring the current induced in the clamp-on current transformer. Due to the inherent limitations of this method the results will measure somewhat

5.3.2.1 Connect the equipment as shown in figure 4.

5.3.2.2 Operate the transmitter under test in its intended manner with its output connected to a shielded dummy load.

5.3.2.3 Tune the frequency-selective voltmeter or receiver through the frequency range of interest with the calibrated variable attenuator adjusted for maximum sensitivity of the measuring circuit. When a spurious output is found, adjust the attenuator to obtain a suitable reference indication on the output indicator of the measuring instrument.

CAUTION: In all frequency-selective voltmeters or receivers spurious responses may occur by: (1) Desensitization of the receiver by the entry of a strong off-channel signal through the antenna input. (2) the entry of such signals by-passing the calibrated input attenuator. These responses must be known or determined for the particular device used.

In addition care must be taken to insure that the spurious signal being measured can be actually attributed to the equipment under test. This is easily determined by momentarily turning off the equipment under test.

5.3.2.4 If a frequency-selective voltmeter is used, calibrate it according to the recommended manufacturer's procedure and measure the spurious output signal. If a receiver is used it must be calibrated by means of appropriate calibrated signal generators.

5.3.2.5 The level of the spurious output is calculated as follows:

5.3.2.5.1 CW Spurious Output. Spurious Output Level (DB above uA) = Meter Reading in DB above 1uV (or substituted signal generator reading) +cable loss in DB (between the clamp-on current transformer and the calibrated variable attenuator) + voltage to current conversion factor in DB.

5.3.2.5.2 Broadband Spurious Output. Spurious Output Level (DB above 1uA per MC) = Meter reading in DB above 1uV (or substituted signal generator reading) +cable loss in DB+ ~~voltage~~ current to ~~current~~ voltage conversion factor in DB - 10 $\log_{10}$ (impulse bandwidth in MC)

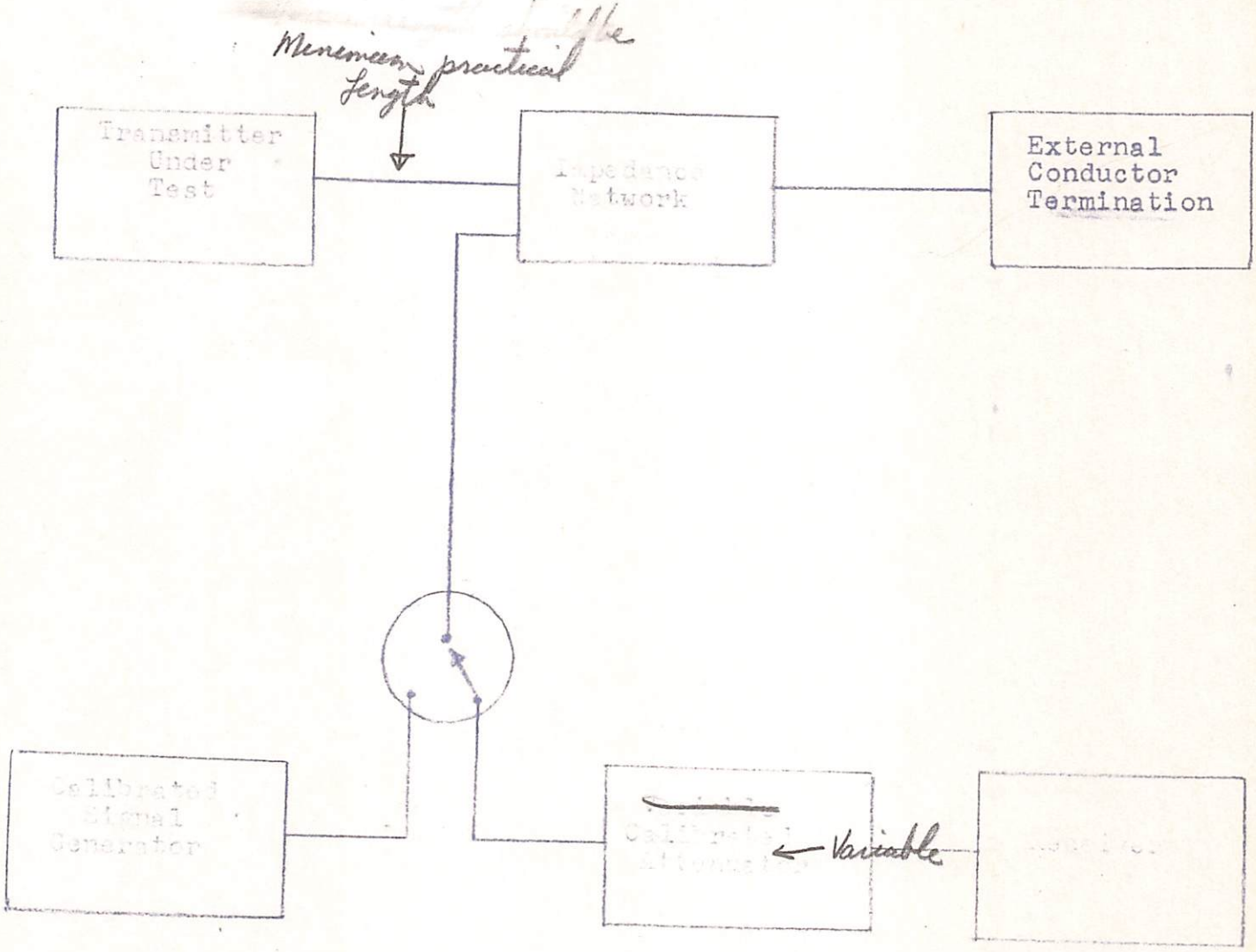
Minimum practical length
Transmitter Under Test
Impedance Network
External Conductor Termination
Calibrated Signal Generator
Variable

Figure 3

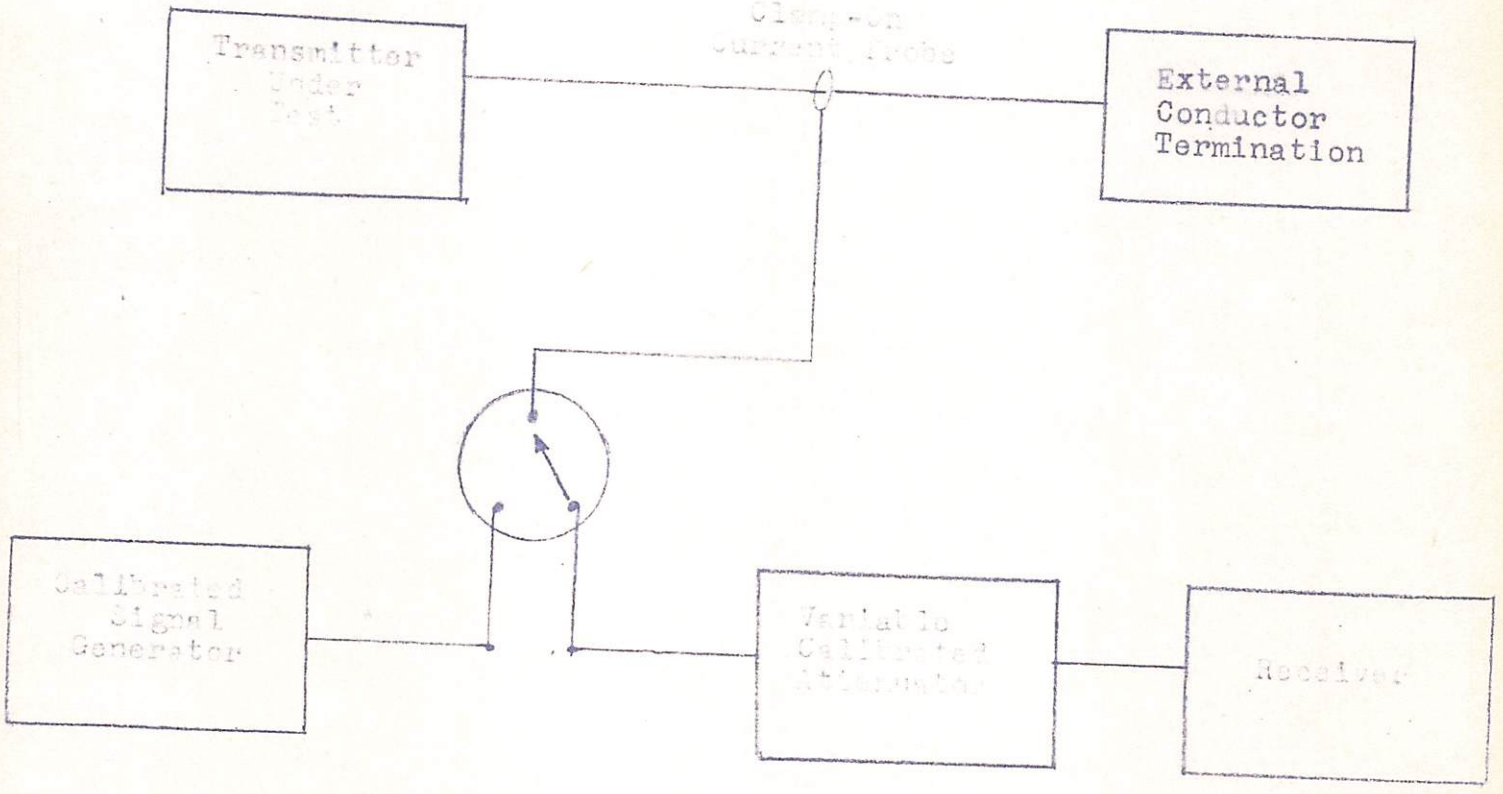
Transmitter
Under
Test
External
Conductor
Termination
Calibrated
Signal
Generator
Receiver

Figure 4

IRE 27.4 Proposed Standards

Methods of Measurement of Transmitter Cabinet Radiation

6. Spurious Output Due to Transmitter Cabinet Radiation.

6.1 General. The Spurious Output radiated from a transmitter, which may consist of harmonic (or non-harmonic) components, may be measured by measuring the voltage induced in a receiving antenna with the use of a calibrated frequency-selective voltmeter or receiver.

6.2 Equipment Required:

6.2.1 Pickup Device. The radiated spurious output should be measured with a pickup device which is connected to a calibrated frequency-selective voltmeter or receiver by an impedance matching network or balun. This pickup device may be a rod or loop for frequencies below 25MC, a resonant dipole for frequencies from 25MC to 1000MC, and a horn antenna for frequencies above 1000MC. The pickup device must be calibrated over its useful frequency range so that it may be used to ~~read open circuit voltage (antenna induced voltage).~~ measure the intensity of the electromagnetic field.

6.2.2 Interference-Free Area. The radiated spurious output shall be measured in an area sufficiently free from ambient interference and physical obstructions for the purposes of this measurement. It is desirable that the ambient interference level during testing be at least 6 db below the interference limits specified in the appropriate specifications. However, in the event that at the time of measurement the levels of ambient interference plus the spurious output of the item under test are not above the specified limit, such tested item shall be considered to comply with the specified requirements. In addition any frequency whose identity is definitely established such as a broadcast station is exempt from this requirement.

6.2.3 Variable Attenuator. A calibrated variable attenuator is needed to provide a means for adjusting the output indication level of the measuring instrument so as not to overload the frequency selective voltmeter or receiver. It may also be useful in checking for spurious responses.

6.2.4 Frequency-selective Voltmeter or Receiver. A frequency-selective voltmeter or receiver (may be more than one) which can tune to the carrier and any spurious output frequency of interest, is needed. If a receiver is used, it must have an output indicator. The receiver cabinet should incorporate good shielding techniques and the power lines should be well filtered.

6.2.5 Coaxial Switches. Coaxial switches (or suitable means for changing connections) may be required when using a calibrated signal generator for calibration purposes.

6.2.6 Measuring Equipment Enclosure. To prevent pickup of extraneous radiations during the measurements, the measuring equipment should (if necessary) be enclosed within a suitable shielded enclosure and the signal from the pickup device brought into the shielded enclosure through a well-shielded cable.

6.2.7 Calibrated Signal Generator. A calibrated signal generator (or generators) to cover the carrier frequency and any spurious frequencies of interest is needed.

6.3 Measurement Procedure.

6.3.1 Standard Method. NOTE: The standard method ~~is used when it is desired to obtain~~ measures the absolute level of the radiated spurious ~~response~~ signal at the point of measurement without regard to the rated power output of the equipment under test. If the desired result is to be a

measurement of the absolute field intensity one must make the measurement in the "radiation field". Measurements made at lesser distances as may be required at low frequencies will involve the "induction field" and the results will require interpretation.

6.3.1.1 Connect the equipment as shown in Figure 6.

6.3.1.2 Operate the transmitter under test in its intended manner with its output connected to a shielded dummy load.

6.3.1.3 Tune the frequency-selective voltmeter or receiver through the frequency range of interest with the calibrated variable attenuator adjusted for maximum sensitivity of the measuring circuit. When a spurious output is found, orient the pickup device for maximum response and adjust the attenuator to obtain a suitable reference ~~reading~~ indication on the output indicator of the measuring instrument.

CAUTION: In all frequency-selective voltmeters or receivers spurious responses may occur by: (1) desensitization of the receiver by the entry of a strong off-channel signal through the antenna input. (2) ~~the~~ the entry of a strong on-channel signal through the receiver case or power lines, ~~and~~ such signals by-passing ~~its~~ the calibrated input attenuator. These responses must be known or determined for the particular device used.

In addition care must be taken to insure that the spurious signal being measured can be actually attributed to the equipment under test. This is easily determined by momentarily turning off the equipment under test.

6.3.1.4 If a frequency-selective voltmeter is used, calibrate it according to the recommended manufacturer's procedure and measure the spurious radiated signal. If a receiver is used it must be calibrated by means of appropriate calibrated signal generators.

6.3.1.5 The level of the spurious output is calculated as follows:

6.3.1.5.1 CW Spurious Output. CW Spurious output level (field intensity, DB above luV per meter) = meter reading in DB above luV (or substituted signal generator reading) + cable loss (between pickup device and the calibrated variable attenuator) + antenna factor.

6.3.1.5.2 Broadband Spurious Output. Spurious output level (field intensity, DB above luV per meter, per MC) = Meter reading (DB above luV) + cable loss (DB) + Antenna Factor (DB) - 10 $\log_{10}$ (impulse bandwidth in MC).

6.3.1.6 To determine the radiation pattern and to evaluate path loss a multiplicity of measurement points varying in azimuth and radius should be used.

6.3.2 Alternate Method. NOTE: The alternate method measures an equivalent radiated power of the spurious signal.

6.3.2.1 Connect the equipment as shown in Figure 7. It should be noted that the pickup device must be located in the "radiation field" of the transmitter.

6.3.2.2 Operate the transmitter under test in its intended manner with its output connected to a shielded dummy load.

6.3.2.3 At the point of measurement tune the frequency-selective voltmeter or receiver through the frequency range of interest with the variable attenuator adjusted for maximum sensitivity of the measuring circuit. When a spurious output is found, orient the pickup device for maximum response and adjust the attenuator to obtain a suitable reference indication on the output indicator of the measuring instrument.

~~6.3.2.4 The pickup device is oriented for maximum signal into the frequency selective voltmeter or receiver and an indication is obtained.~~

6.3.2.4 De-energize the transmitter.

6.3.2.5 A calibrated signal generator or other suitable source of

controlled oscillation is now used in conjunction with an appropriate radiating device to supply the substituted power. This radiating device is located at or in the near vicinity of the transmitter. Thus, essentially the same path is utilized for both the transmitter power and the substituted power.

6.3.2.6 Energize the calibrated signal generator and tune to the spurious frequency on the frequency selective voltmeter or receiver obtained in 6.3.2.3.

6.3.2.7 ~~Rotate~~ Orient the radiating device for maximum signal into the frequency-selective voltmeter or receiver.

6.3.2.8 Adjust the level of the calibrated signal generator to give the same indication at the frequency-selective voltmeter or receiver which was noted in 6.3.2.3.

6.3.2.9 To determine the substituted power, the input impedance and the effective gain of the radiating device must be known. The equivalent power of the spurious signal in watts can now be calculated as follows:

(1) $P = I^2 Ra$ *

Where Ra = ~~Rg + R + jX~~ radiation resistance of the radiating device.

~~* This to be completed at the next meeting of IRE 27.4~~

I = current supplied by the signal generator.

(2) $$I = \frac{E_g}{R_g + (R + jX)}$$

E_g = sig gen open circuit voltage

R_g = signal generator internal impedance, (normally 50 Ω)

$(R+jX)$ = Terminal impedance of the Radiating Device

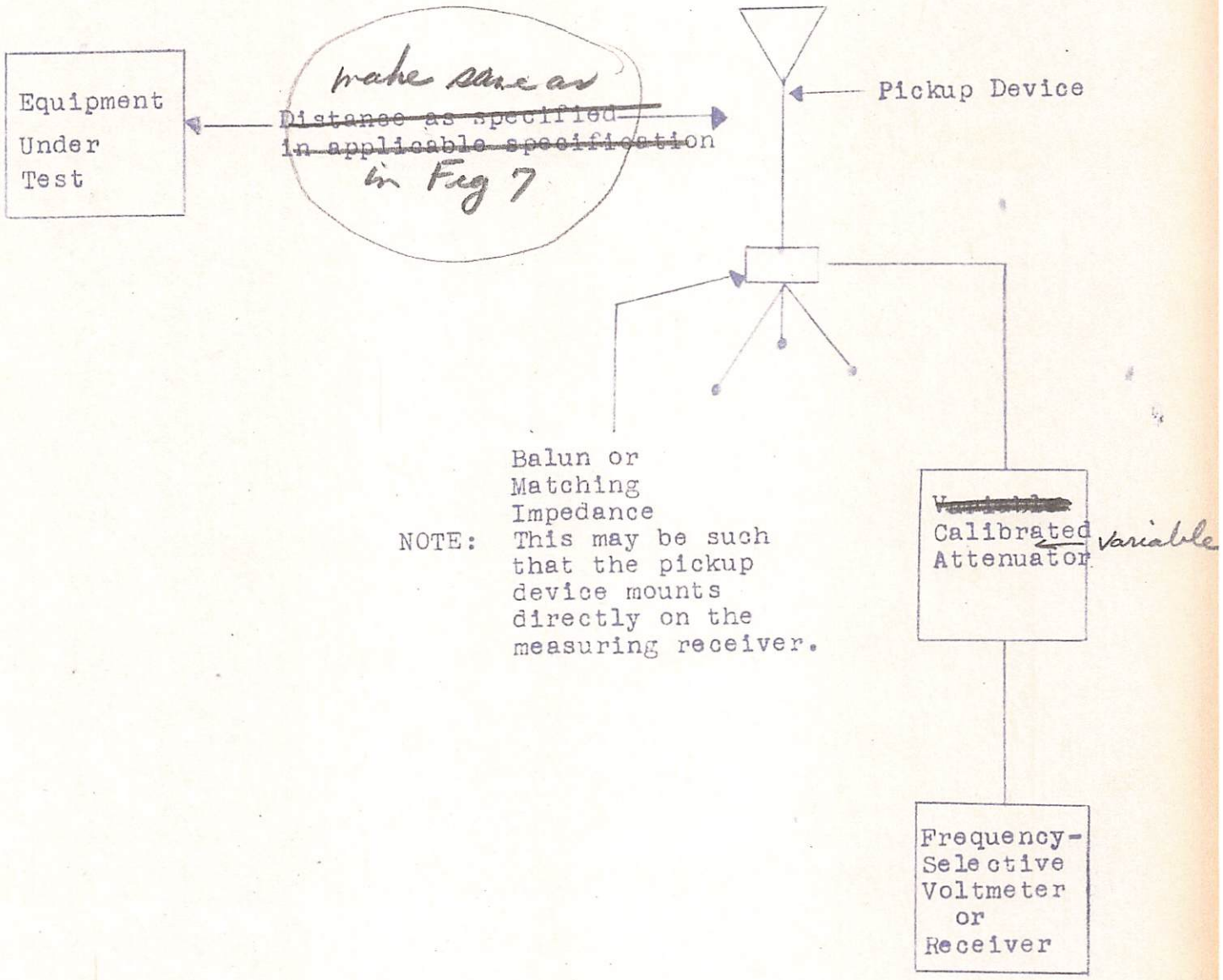
Equipment Under Test
make same as
~~Distance as specified in applicable specification~~
in Fig 7
Pickup Device
Balun or Matching Impedance
NOTE: This may be such that the pickup device mounts directly on the measuring receiver.
~~Variable~~
Calibrated variable Attenuator
Frequency-Selective Voltmeter or Receiver

Figure 6

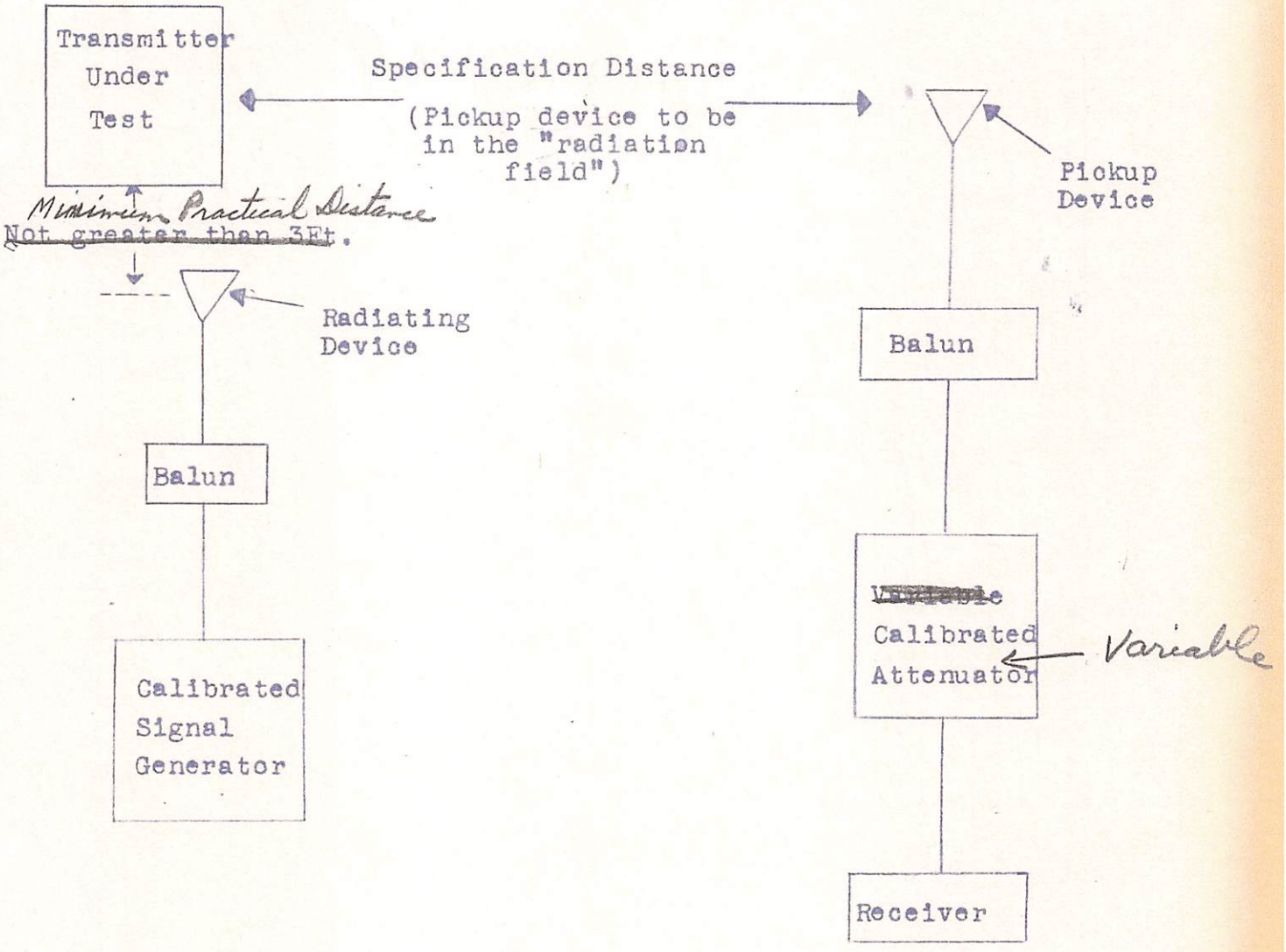
Transmitter Under Test
Specification Distance
(Pickup device to be in the "radiation field")
Pickup Device
Minimum Practical Distance
Not greater than 3Ft.
Radiating Device
Balun
Balun
Calibrated Signal Generator
Calibrated Attenuator
Variable
Receiver

FIGURE 7

MARCUS