DEVELOPMENT OF THE SEMI-AUTOMATIC TWO-WAY RADIO STATION AS-3

Progress Report No. 5

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Progress Report #5

Radio Station AS-3

May 1, 1957

EA-122-1

GENERAL

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REPORTING PERIOD

This report covers the work accomplished by [redacted] on the development of the AS-3 Semi- STAT automatic Two-way Radio Station during the period 11 March to 1 May, 1957.

PERSONNEL ASSIGNED

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Personnel assigned to this project on a full-time basis are:

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[redacted] Project Engineer
[redacted], Development Engineer

In addition, consultive and administrative assistance of [redacted] Vice President in Charge of Engineering, [redacted] STAT Director, Development and Research Engineering, and [redacted] STAT Senior Project Engineer, were drawn upon as required.

CONFERENCES

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No conferences were held during this report period. It is expected that a conference during May will be held here at [redacted] STAT [redacted]

TECHNICAL DISCUSSION

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TRANSMITTER AT-3

Mechanical and Packaging. The transmitter has been rebuilt to include ganging of the final amplifier tank capacitor as mentioned in the progress report for the preceding period.

The keying circuit and the multivibrator have been built as a sub-assembly (to facilitate assembly and service).

In connection with the tuning mechanism, a visual indication of correct tuning can be readily achieved. During the next period a switch will be incorporated to allow the user to read final amplifier drive

on the tuning meter.

Tuning procedure will consist of tuning for maximum drive using the tuning control, then peaking power output with the antenna loading capacitor control and the antenna loading coil control.

A function switch is now ready for incorporation in the engineering model. It has the following positions: (1) Start, (2) Receive, (3) Key, (4) Message. Sample miniaturized switches are on order for evaluation.

Resistive loads necessary for power measurements are on order but have not as yet arrived.

Multivibrator. The multivibrator circuit was bread-boarded to test the feasibility of using it in two modes - the present free-running mode, and a bi-stable mode. The bi-stable mode would be used to follow the output of the Keyer, and reduce the Keyer output voltage requirement by the multivibrator "gain."

Circuit work is still in process on this method, but thus far satisfactory operation in both modes has not been realized.

Final Amplifier. As noted earlier in this report, the final amplifier tank capacitor has been included in the tuning chain. This will assist in insuring that the amplifier tank circuit and antenna-matching network are tuned to the proper crystal harmonic (or fundamental). Tuning procedure will probably consist of final resonating the tank to the desired frequency with the antenna substantially decoupled, and then progressively coupling in the antenna, while simultaneously maintaining resonance, until proper loading is achieved. An auxiliary frequency dial will aid in finding the initial resonance.

Antenna Matching Network. The design of the antenna matching network requires that the final amplifier output impedance of approximately 1380 ohms be matched to antennas having impedances ranging from 50 to 1200 ohms with a phase angle of plus or minus 45 degrees. Figure 5-1 is the analysis of this requirement in terms of realizable components.

Bread-board evaluation of the design values of L and C indicate that it will be necessary to have two variable controls for efficient antenna matching and hence power transfer over the wide impedance variations expected.

A special switch has been designed to switch the capacitive sections of the network. Requests for samples are being prepared for distribution to vendors.

During the next period operational data on power output, key click radiation, harmonic generation, etc. should be available. Construction of the necessary loads must, of course, be accomplished first.

KEYER AK-3

A commercial tape recorder has been modified to accept the Keyer pickup head. Using a sample tape prepared on the Coder, output pulses of 20 millivolts peak-to-peak were measured. A Tektronix Type 310 Oscilloscope connected directly to the unloaded pickup head was used to make the measurement.

The alignment of the head with respect to the tape, and the magnetic circuit, are being improved. It is expected that these refinements will produce a considerable increase in pulse output.

The output amplitude information will determine the gain of the Keyer amplifier, in conjunction with the Transmitter keying input voltage requirement.

CODER AC-3

A linkage to displace one of the record heads for the dash code has been designed, fabricated, and incorporated in the Coder mechanism, which completes the mechanics of this preliminary model. This particular design will now be tested and evaluated before further packaging work on it is done.

A simplified alternate mechanism is also being studied.

Three additional record heads have been cast in Scotchcast No. 2, a material possessing excellent adhesive and casting properties. These are currently being magnetized and tested.

Further work on the record heads is predicated on the results of the tests.

BATTERY ABA-3

After the method of interconnection between units has been established, a connector will be built into the battery case and venting provided. The Type ACT8X cell is to be environmentally tested.

DC POWER SUPPLY AP/BA-3

The design of this supply is held up until the receiver choice - hence receiver power supply requirements - has been made.

AC POWER SUPPLY AP/AC-3

Component design values for iron-cored components have been established and sample orders placed. The other items are in the process of design.

A bread-board supply will be assembled and tested during the next report period.

CARTRIDGE CA-3

Design and fabrication of the cartridge cover have been completed. New spring motors have been tested, and a reduction in torque requirements of 50% over the previous type achieved.

Currently, weight reduction through use of a redesigned gear mounting plate is being worked on.

Samples of tape from various vendors are on order and will be tested.

SYSTEMS

The basic units of the complete AS-3 system not having been established (receiver), neither interconnection nor packaging can proceed.

REQUESTED ACTION

[redacted] would like to repeat the request of Progress Report #4, for a conference at an early date for the purpose of discussing the following two major items: STAT

(1) Method of operational packaging and the type of connecting devices to be used between units. It is desired to determine whether plug-in or a sliding locking type of device is most applicable. STAT

(2) Our work has reached a position where it is desirable to have a Printer (ATP-3) and Receiver (RR-) to facilitate further design of the complete system.

Prepared by: [redacted] Approved by: [redacted]

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FIGURE 5-1

DESIGN OF ANTENNA MATCHING NETWORK

Object: To design an antenna matching network to match the the Transmitter AT-3 final amplifier tube impedance of 1380 ohms to an antenna impedance of 50 to 1200 ohms and a phase angle of plus or minus 45 degrees.

Circuit: A pi network is the circuit configuration to be used. It offers greater harmonic reduction than other types of matching networks, and can match the wide impedance variations. The value of C_1 and other arbitrary assignments is based on practical considerations of available space and components.

Method: A graphical method making use of the Smith impedance chart is used. This chart is a plot of resistance (on the X axis) and circles of constant impedance with centers on the resistive axis. Inductive reactance is plotted above the axis, capacitive reactance below.

Figure 5-1c shows as a shaded area the plot of antenna impedance on the Smith chart.

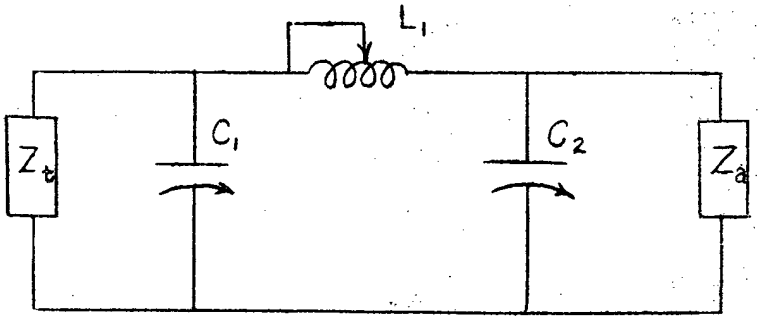


Figure 5-1c is replotted on Figure 5-1d.

The following design values are assigned to make the graph:

Z_a = Antenna impedance = 50 to 1200 ohms $\pm 45°$.

Z_t = Tube impedance = 1380 ohms.

C_1 = Amplifier tank capacitor = 360 μμf at 3 mc;
30 μμf at 30 mc.

f = Design frequency = 3 mc.

From the graph, the values of L_1, the matching network reactor, and C_2, the matching network capacitor, can be established.

Referring to Figure 5-1d, the Smith chart graph indicates that practical values of L_1, such as 10 to 15 microhenries, will require C_2 to have 3500 to 2000 μμf of capacity.

A choice of 13 microhenries for L_1 was made, based upon availability and desirable L/C ratio.

At a frequency of 3 mc, and at the lowest antenna impedance of 50 ohms $+45°$, we calculate

L_1 = 13 μh $\qquad$ C_2 = 2600 μμf

and at f = 30 mc, with Z_a = 1200 ohms at 45°, the highest antenna impedance, we again calculate

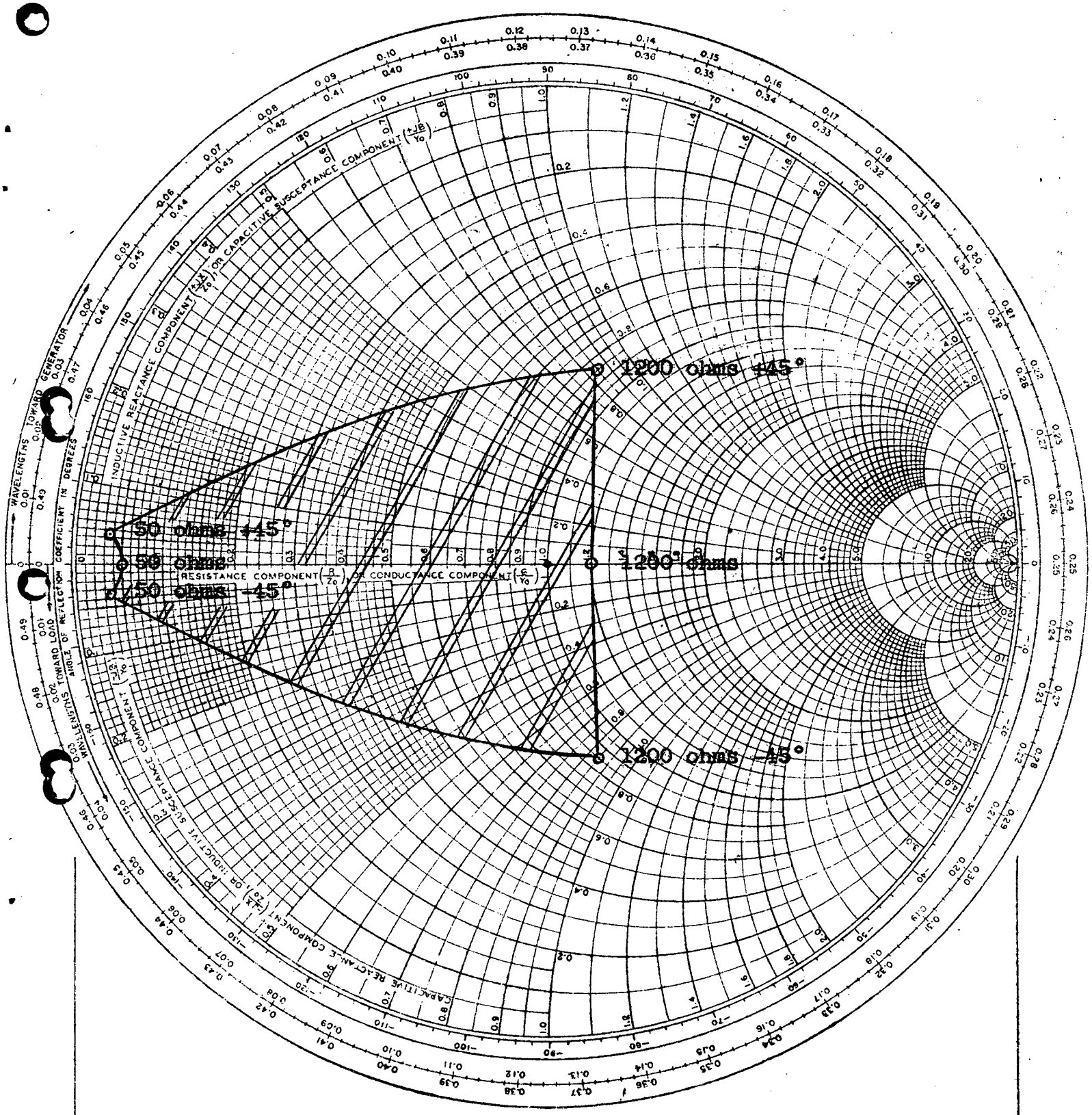
L_1 = 0.76 μh $\qquad$ C_2 = 32 μμf

Using the above calculated high and low limits for L_1 and C_2, we conclude:

L_1 should be capable of varying from 0.76 to 13 microhenries;
C_2 " " " " " " 2600 to 32 μμf.

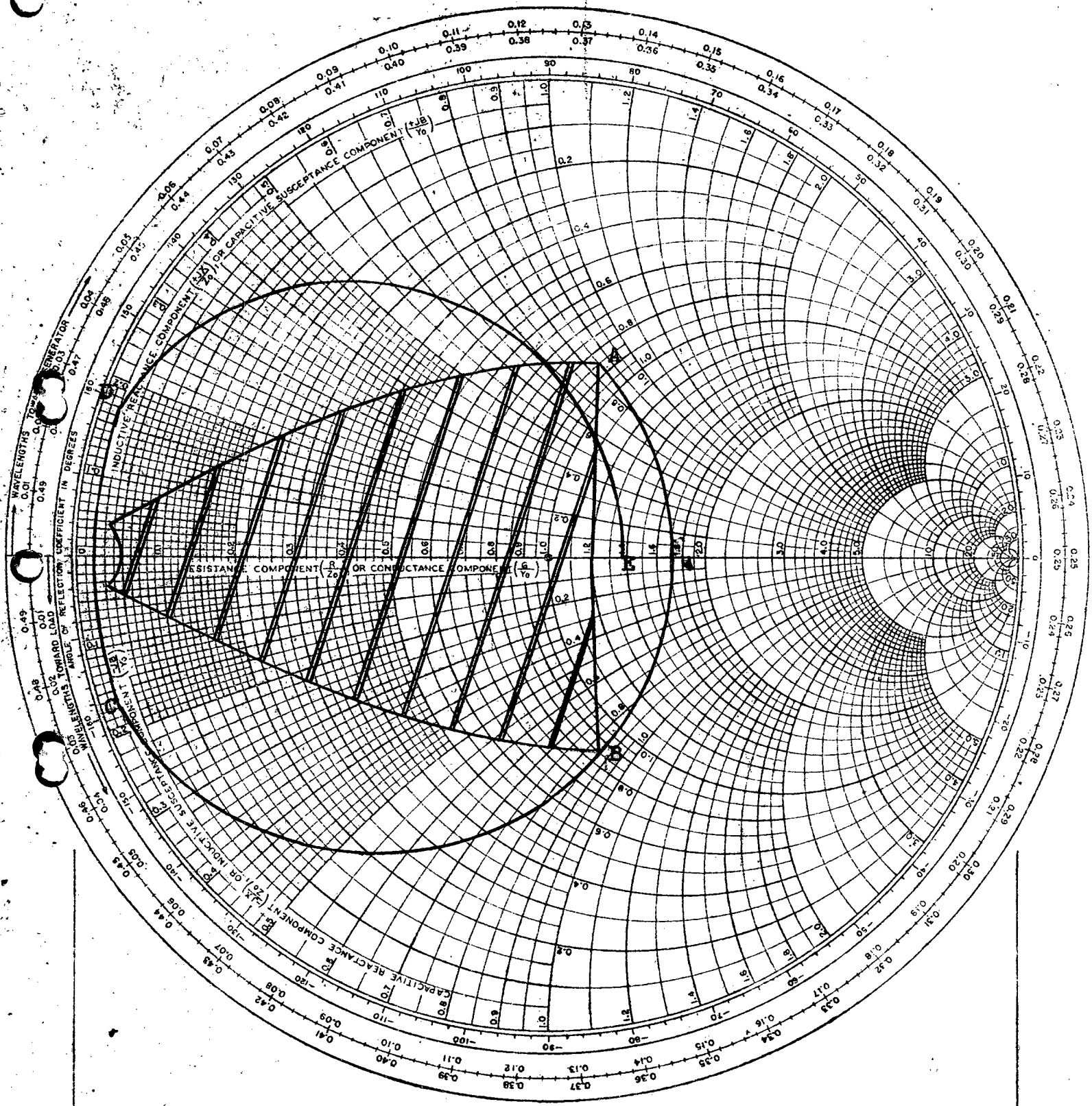
NAME AT-3	TITLE GRAPH OF ANTENNA IMPEDANCES	DWG. NO. 5-1C
SMITH CHART Form 756-N	GENERAL RADIO COMPANY, CAMBRIDGE, MASSACHUSETTS	DATE 5-1-57

IMPEDANCE OR ADMITTANCE COORDINATES

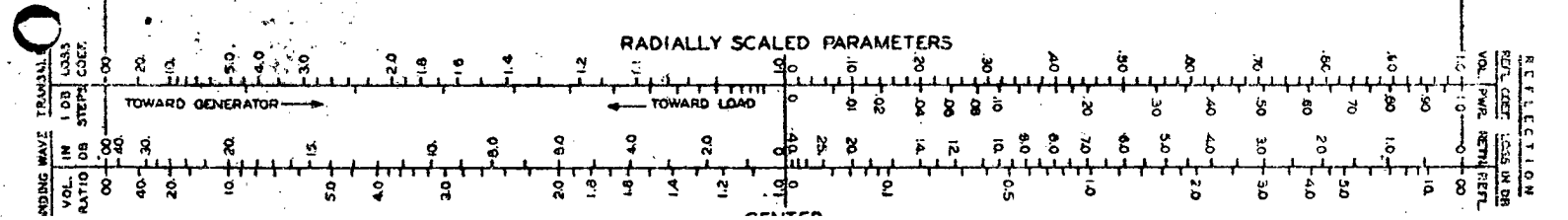


NAME AT-3	TITLE MATCHING NETWORK DESIGN	DWG. NO. 5-1d
SMITH CHART Form 756-N	GENERAL RADIO COMPANY, CAMBRIDGE, MASSACHUSETTS	DATE 5-1-57

IMPEDANCE OR ADMITTANCE COORDINATES



RADIALLY SCALED PARAMETERS



N. J.