ENGINEERING RESEARCH INSTITUTE
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WIDE-RANGE TUNING METHODS AND TECHNIQUES APPLICABLE TO SEARCH RECEIVERS

QUARTERLY PROGRESS REPORT NO. 12, TASK ORDER NO. EDG-4
Period Covering April 1, 1954 to June 30, 1954

Electronic Defense Group
Department of Electrical Engineering

By: L. W. Orr
L. Beavis
T. W. Butler, Jr.
R. Bradley
H. Diamond
W. Parker
H. W. Welch, Jr.
M. Winsnes

Approved by: H W Welch
H. W. Welch, Jr.

Project 2262

CONTRACT NO. DA-36-039 sc-63203
SIGNAL CORPS, DEPARTMENT OF THE ARMY
DEPARTMENT OF ARMY PROJECT NO. 3-99-04-042
SIGNAL CORPS PROJECT 29-194B-0

July, 1954

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ABSTRACT

The progress of the Electronic Defense Group on Task EDG-4 is reviewed for the quarter ending June 30, 1954. Several Technical Reports are nearing completion. Investigation of high frequency electric tuned swept oscillators is being continued, and results of further Barkhausen noise measurements on ferroelectri specimens are being analyzed. A panoramic display unit has been designed for testing electric tuned front ends for search receiver, and construction work has been started.

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1. PURPOSE

This report reviews the progress made by the Electronic Defense Group in the study of wide-range tuning methods and techniques applicable to search receivers during the second quarter of 1954.

2. PUBLICATIONS AND REPORTS

There were no publications or reports issued during the quarter, but three technical reports are nearing completion and will be issued shortly. These are Technical Report No. 31, "Interim Report on Ferroelectric Materials," by H. Diamond and L.W. Orr, Technical Report No. 32, "Ferromagnetic and Ferroelectric Tuning," by L. W. Orr, and Technical Report No. 33, "The Negative Capacity Amplifier," by L. C. Beavis.

3. FACTUAL DATA

3.1 Use of Ferromagnetic and Ferroelectric Materials in the Tuning of RF Components

3.1.1 Ferromagnetic Materials. (L. W. Orr) Several meetings were held with members of Task 6 to determine a more satisfactory method of handling routine field-sensitivity tests on ferrite cores. Such tests are to be representative of the core behavior in tuning units, and will show the variation of μ_1 and Q at various frequencies as the dc magnetic field is varied. The construction of several new devices was decided upon to achieve this, and these are now in the planning and development stage.

3.1.2 Ferromagnetic and Ferroelectric Tuning. (L. W. Orr) Technical Report No. 32, "Ferromagnetic and Ferroelectric Tuning", is nearly completed and will be issued shortly. A critical comparison is made between ferromagnetic and ferroelectric tuning on the basis of presently known materials and techniques. The table of contents is as follows:

3.1.3 Ferroelectric Materials. Technical Report No. 31, entitled "Interim Report on Ferroelectric Materials, is now nearing completion and will be issued shortly. The table of contents is as follows:

The report covers the work to date of a continuing survey of ferroelectric materials, with particular attention to their application in high frequency swept oscillators.

<u>3.1.4 High Frequency Swept Oscillator</u>. (H. Diamond and L. W. Orr) A high-frequency swept oscillator with electric tuning has been constructed. The oscillator uses two 6J4's in push-pull and two Aerovox Hi-Q 40 capacitors as the variable elements. The frequency is swept from 26 to 48 mc when combined voltages of 400 volts at 60 cycles and 600 volts dc are applied to the variable elements.

An investigation is now in progress to determine the relative behavior when the oscillator is swept at 60 cycles compared with slow manual sweep. A low plate voltage is furnished to the oscillator to restrict the amplitude of oscillations and hence reduce the dielectric heating of the tuning elements.

3.1.5 Barkhausen Noise Measurements in Ferroelectric Specimens. (H. W. Welch, M. Winsnes, and W. Parker) Using the equipment previously described[1], a series of new measurements have been made on several specimens of ferroelectric ceramics. In these measurements the ungated noise is measured as the 60 cycle ac drive and dc bias voltages are varied. The results are now being analyzed to determine the correlation between noise output and the various parameters causing it.

A communications receiver was used to attempt to measure the Barkhausen noise spectrum. The acceptance band of the receiver between half power points was 2.7 kc. The specimen was driven with an ac voltage as large as possible without danger of breakdown, and coupled to the antenna terminals of the receiver through a high pass filter and unity gain amplifier for impedance matching.

In the frequency range from 600 to 900 kc, the Barkhausen noise generated in the specimen was just barely audible in the receiver output. The fraction of total noise falling within the acceptance band of the receiver was small compared to the circuit noise of the system; it gave only 10 per cent increase in the AVC voltage when the 60 cycle drive was applied to the specimen.

It was therefore impossible to obtain the Barkhausen noise spectrum by this method, but the tests are indicative of the relatively low level of this source of noise. When a combined ac and dc fields are applied so that the specimen is cycled without the polarity of the field changing sign, the noise is much reduced.

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[1]Quarterly Progress Report No. 10, Task EDG-4, January 1954

It is expected, therefore, that in a ferroelectric-tuned search receiver swept at a 60 cycle rate, the Barkhausen noise will be of the same order of magnitude as other sources of noise inherent in the receiver. Although no quantitative measurements were made on the noise in the ferroelectric-tuned broadcast receiver,[1] it was found that the overall noise level was not unusually large.

3.1.6 Panoramic Display Unit. (T. W. Butler, Jr., L. W. Orr, and W. Parker) A panoramic display unit has been designed and construction has started. This unit, to be known as PANDU, will serve as a versatile testing facility for front ends of electric-tuned search receivers. It will consist of a rack mounted set of panels comprising two regulated power supplies, a high voltage power supply and 60 cycles sweep modulator, a signal generator, IF strip, detector and display oscilloscope. A test shelf will be furnished to hold various models of receiver front ends. With this unit it will be possible to compare the effectiveness of various front end designs of search receivers using electric tuning, and to study the tracking problem.

The initial program will be the investigation of electric tuned front ends consisting of a local oscillator and tuned mixer which are swept at 60 cycles, and operate in the 27 to 55 mc band.

3.1.7 Program for the Next Interval. The development of a better method of handling the field sensitivity tests on magnetic cores will be completed, and the necessary additional equipment constructed.

The reports referred to in Section 2 will be completed and published. The investigation of ferroelectric materials will continue with emphasis on the development of high frequency electric tuned swept oscillators and front ends

[1]Quarterly Progress Report No. 8, Task EDG-4, (Part I), July 1953

for search receivers.

The panoramic display unit (PANDU) will be constructed and used to test front end designs for electric tuned search receivers in the 27 to 55 mc frequency range.

Results of tests on Barkhausen noise in ferroelectric specimens will be analyzed and correlated with the various parameters of the circuit. Upon completing this investigation, a technical report will be prepared.

3.2 Investigation Of Techniques for Signal Detection and Frequency Determination

3.2.1 Voltage-Tunable Magnetrons. (R. W. Bradley) During the last quarter, the system[1] adopted for determining the off-carrier noise of the voltage tunable magnetron has been altered. The crystal mixer and 200 mc IF amplifier introduced noise sufficient to mask the off-carrier noise contributed by the magnetron. The crystal mixer and amplifier used were taken from available equipment and hence did not meet completely the desired specifications. However, it was thought undesirable to begin any amplifier or mixer development program if a simpler alternative existed.

Revisions of the system (Figs. 1 and 2) incorporate a standard communications receiver as the IF amplifier. The receiver has a better noise figure and variable frequency selectivity. The new system has a variable IF frequency (the signal frequency of the receiver) which, though much lower than 200 mc, will permit a wider variety of measurements if the magnetron energy at the image frequency is adequately low.

Also, steps have been taken to obtain two other mixers, which with newly developed low noise crystals will materially reduce the noise of the mixer.

[1]Quarterly Progress Report No. 11, Task EDG-4

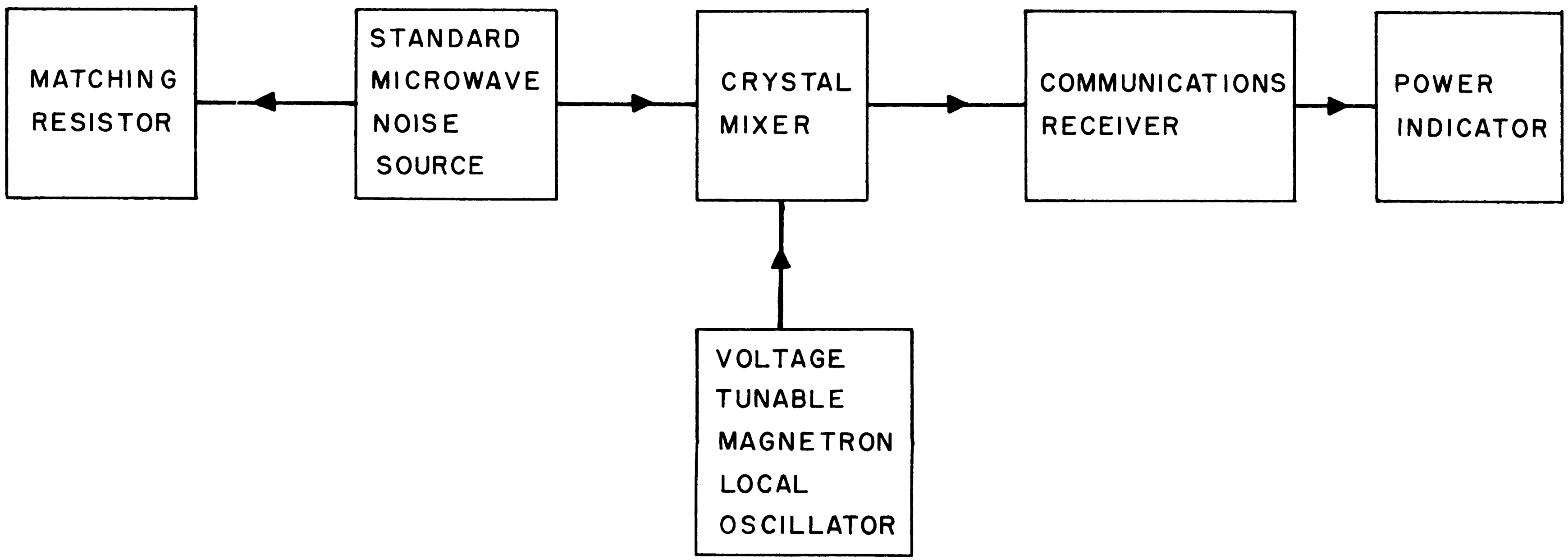

FIG. I

NOISE MEASURING EQUIPMENT.

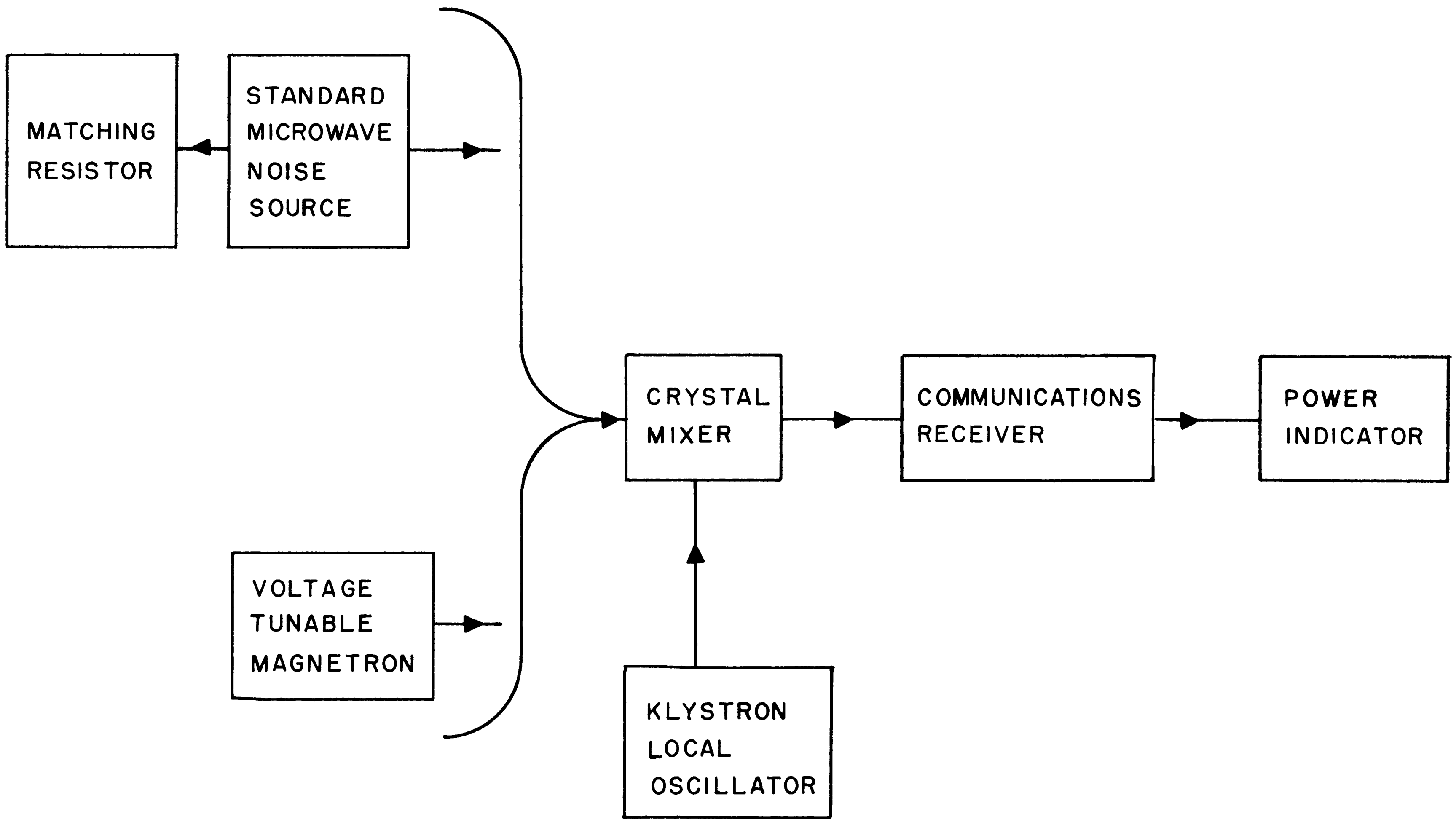

FIG. 2

NOISE MEASURING EQUIPMENT.

3.2.2 Program for the Next Interval. Work for the next quarter will begin with measurements on the mixer and the IF receiver with system tests following.

In one case (Fig. 1) an attempt will be made to simulate microwave receiver operation with the magnetron as the receiver local oscillator. By measuring the power output with and without the microwave noise source operating, an RF noise figure for the system may be obtained. From this RF noise figure, IF receiver noise figure, and the conversion gain of the mixer, an apparent noise temperature for the crystal can be obtained. A comparison of this apparent noise temperature with the noise temperature of the crystal alone will give an indication of the noise contribution of the magnetron.

In the second case, (Fig. 2) measurements of the magnetron power output spectrum similar to those of earlier tests will be made. From measurements of power output with and without the microwave noise source operating and with the magnetron substituted for the noise source, the noise power output of the magnetron may be determined. Measurements of the off-carrier sideband noise will be made. One fault of this system is the difficulty of obtaining sufficient rejection of the carrier frequency output. The highly selective communications receiver to be used is intended to minimize this problem.

4. CONCLUSIONS

There has been a slight delay in the preparation and publication of technical reports scheduled for this quarter, but these are nearing completion and will be issued shortly. The remaining work is proceeding according to schedule.

5. PROGRAM FOR THE NEXT INTERVAL

This has been outlined in Sections 3.1.7 and 3.2.2.

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