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National Research Council of Canada. Radio and Electrical Engineering Division

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NATIONAL RESEARCH COUNCIL OF CANADA
RADIO AND ELECTRICAL ENGINEERING DIVISION

CLASSIFIED PROGRESS REPORT NO. 30

(JULY - SEPTEMBER 1962)

Declassified to
ORIGINAL DESIGN BY
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OTTAWA

OCTOBER 1962 NRC # 35436

FOREWORD

This Classified Progress Report is intended to present a convenient quarterly summary of some of the classified aspects of the research and development program of this Division, for the information of the Services in Canada, the United Kingdom, and the United States, and of laboratories and other organizations in these countries which are engaged in work similar to ours and which have been supplying us with reciprocal information. Unclassified material, whether or not it is of Service interest, appears in our open publications and will not be covered here. The format of this report is such that the account of each project may be separated from the whole without loss of security grading. It is thought that this feature may be appreciated by some agencies, such as the Project Coordinating Centre of the Department of National Defence, where they may prefer to file the individual sheets according to their own systems. It also permits us to issue the separate sheets to persons who may have an interest in certain selected projects but who do not require the remainder of the report.

A list of classified reports issued by the Division each quarter is included. There is no automatic distribution for these reports — the circulation list for each is determined by the nature and interest of the work described. Requests for copies of these reports, to be directed to the Document Control Office of this Division, will be given every consideration, subject to security regulations. Recipients of these documents should note that Canadian approval is required for release to other persons, organizations, or governments of any classified information (including this Classified Progress Report) which may be issued by this Division.

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COUNTER MORTAR RADAR (AN/MPQ-501)

Reference: Army. DND Project B22-38-50-01

Period under review: July-September 1962

STATUS

The production model was shipped to Shilo, Manitoba, on schedule, and tested for three weeks in July. It passed its acceptance trials.

It was prepared for delivery to Germany by the manufacturer and shipped by RCAF transport aircraft early in September. Initial tests there have been quite satisfactory and formal trials in Germany are scheduled for November.

ANTENNA

Electrical Tests

Tests of the production model, Serial 1, with respect to patterns, gain, VSWR, and beam position, have been completed.

Polarizer

Tests of the production polarizer on the Serial 1 antenna have been completed. A mean ellipticity ratio of 0.94, corresponding to a cancellation ratio of 2500, was observed. The gain was measured for each polarization and, in comparison with the normal antenna gain, is consistent with a one-way loss of 0.25 db in the polarizer.

Maintenance Boresight Device

Tests have been completed on a device for maintenance checks of the scanner boresight at close range. The apparatus consists of a pair of small horn probes with associated circuitry for amplitude comparison of signals picked up at a separation of three feet. It is used passively with the scanner operating at normal power at a range of 600 feet. Present tests indicate that the sensitivity is at least 0.2 mil. No evidence of any consistent error due to ground or other reflections was noted; however, in view of the brevity of the tests, there should be careful observation for inconsistencies in subsequent use of the apparatus.

STORAGE UNIT

Construction of the units is 75 percent complete, and work is progressing satisfactorily. It is anticipated that evaluation tests will be commenced in October ; field trials will follow.

IMPROVEMENTS TO GROUND RADARS

Reference: Navy, Army, RCAF. DND Project D48-38-03-27

Period under review: July-September 1962

AN/FPS-507 HEIGHT FINDER

A joint study with the RCAF Air Defence Command was carried out on the AN/FPS-507 Height Finder for surveillance in a jammed environment. Preliminary work showed that the radar was incapable of providing a full surveillance role with a useful data rate. However, in a limited surveillance role — that is, horizontal scanning over a 60 degree sector using the slowest vertical nod rate — it is capable of an average data renewal rate of 30 seconds which is adequate in a manual system of operation.

Three trials have been held, two without, and one with ECM. After initial familiarization with the PPI display of a nodding height finder, controllers easily carried out successful interceptions in a non-ECM environment. Four aircraft in a single cell provided the ECM on the last test. Crossover range was approximately 100 miles, but because of the PPI display, controllers had difficulty in maintaining tracks.

During the severe ECM environment, it was easier to detect targets on the RHI display than on the associated PPI display. If the RHI and PPI displays of the height finder video are monitored together, they present a three-dimensional display, synchronized in azimuth. This combination has merit in an ECM environment, since the operator can readily refer to the RHI display to assist in target recognition.

RADAR PERFORMANCE EVALUATION

Reference : RCAF . DND Project 098-38-02-09

Period under review : July-September 1962

Another shipment of metallized Melinex balloons was received. These were talced; therefore, the folds of the balloons did not adhere to each other as in the previous shipment. An attempt was made to test these balloons under pressure but there were small pinhole leaks. This difficulty is being discussed with the manufacturer.

Quotations have been called for a balloon made of a different type of material. This material is two layers of Mylar with some metallizing between the layers. The diffusion rate should be reduced with two layers of Mylar, since the small holes are not likely to be in alignment.

MINIATURE BROAD-BAND INTERCEPT RECEIVER

Reference: Army. DND Project D48-38-03-27

Period under review: July-September 1962

Two developmental models of this miniature battery-operated intercept receiver were produced earlier by the National Research Council [1]. The receiver, which may be hand-held, tripod-mounted, clipped to a belt, or worn in webbing, alerts the user by audio tone if he is illuminated by pulsed radars in the frequency range 2 to 20 gc/s. Preliminary field tests [2] showed the sensitivity to be greater than 2×10^{-4} watts per square meter over most of the frequency range for radar pulse lengths near 1 μ sec. This permits detection of the AN/PPS-4 radar at ranges in excess of 10 kilometers under line-of-sight conditions. Battery life of more than 180 hours can be expected.

Five field-evaluation models of this receiver were produced by Canadian Arsenals Ltd., Toronto, and are undergoing user tests. These units, now known as "Micradet" detectors, have been described fully in a recent brochure [3]. The present detector is $3\frac{3}{4} \times 2\frac{1}{2} \times 2\frac{1}{2}$ inches and weighs 14.3 ounces.

A contract was given by the Napkin Committee to Canadian Arsenals Ltd. to develop a horn antenna, compatible with the NRC-built receivers, that will provide coverage of the 20 to 40 gc/s frequency band.

Circuit investigations completed in the period under review have ensured more reproducible performance from the manufactured units, and demonstrated that an increase of about $1\frac{1}{2}$ db in sensitivity can be achieved with a more expensive transistor in the input circuit. Furthermore, a bistable multivibrator was incorporated experimentally to improve detection of high-recurrence-frequency pulse trains (to 14 kc/s), with a small sacrifice in sensitivity, however.

Gain control circuits were developed, allowing up to 30 db sensitivity variation, to increase the accuracy of azimuth determination when saturation signals are encountered.

References

1. J.K. Pulfer, "A Miniaturized Crystal-Video Receiver", NRC Report ERB-577, January 1961 (Confidential)
2. A. Hendry, "Preliminary Field Evaluation of C.A.L. Micradet Receiver", NRC Report ERB-608, April 1962 (Confidential)
3. Army Equipment Engineering Establishment, Ottawa, Canada, "Radar Illumination Detector (Micradet) for Patrol Use" (Confidential)

SOUND-RANGING COMPUTER

Reference: Army. DND Project B105-38-50-08

Period under review: July-September 1962

PURPOSE

The purpose of this equipment is to provide a sound-ranging system which will reduce errors in film reading, in application of meteorological corrections, and in calculation of locations. It will provide equipment for magnetic storage of sound data, and facilities for computation of sound source locations by means of a special digital computer.

COMPUTER

Construction of the new 512-word data store and 1024-word program store has been completed and they are now being checked out. The paper tape reader circuitry is being wired. It will be possible to write information from the paper tape onto the magnetic drum, or in the case of a program of less than 1024 words, it can be written into the program store directly from the paper tape.

The binary toggle switches on the computer control console have been replaced with rotary octal switches to facilitate fault finding and program check out.

PROGRAM

The initial computer program for the solution of the sound-ranging problem has been written and a tape has been prepared. Sound arrival time differences between every other microphone, as well as between adjacent microphones, are considered and each intersection is weighted in determining the location. Facilities have been provided in the program for ranging (sound adjustment) as well as location. Meteorological corrections are applied using a weighted wind and temperature. The estimated computing time required to determine a location is 40 seconds.

RECORDER

A new tape has been punched with the required number of holes for photoelectric counting and installed.

MAGNETIC DRUM

Track-sequencing circuitry has been finalized with the addition of a special start circuit for the track sequencer to enable it to gate the first drum track for writing when the tape approaches its playback speed. A similar start circuit is being used to start the sequencer and initiate the search display when reading.

DISPLAY CONSOLE

The track selection switches, filtering, gain, identification and read-write-erase switches have been wired in. Five positions each, for filtering and gain, have been provided, with the lowest high-frequency cutoff at 4 c/s of the original recording.

REPORT

A report (ERB-603P) entitled "Canadian Sound-Ranging System", was tabled at the NATO meeting in July. The meeting agreed to write a draft specification based on the current Canadian military characteristics.

IMPROVEMENT OF HF DF TECHNIQUES

Reference: Navy. DND Project A14-30-10-24

Period under review: July-September 1962

The unclassified work associated with this project is reported in vol. 12, no. 3 of the quarterly Bulletin of the Radio and Electrical Engineering Division. No classified work was done during the period under review.

MODEL ANTENNA STUDIES FOR RCN

Reference: Navy. DND Project A12-55-40-16

Period under review: July-September 1962

HF ANTENNAS

Since completion of the development of the HF antenna system for the General Purpose Frigate, major changes in the ship's superstructure have been made by DGFE/RCN. A new $\frac{1}{20}$ -scale model mock-up, based on the revised drawings, is under construction and further impedance measurements are planned. The two antennas being investigated are the folded-foremast and the discage.

As a result of our investigations on broad-band antennas, a systematic study of a base-fed biconical monopole was carried out in order to determine the effect of the physical parameters on the VSWR. A paper describing the experimental results has been prepared.

ECM ANTENNAS

Radiation pattern measurements have been started on the 300 to 1100 mc/s experimental direction-finding antenna. The patterns exhibit a squint and efforts are being made to eliminate this undesirable characteristic.

Design parameters for a four-arm conical-spiral antenna for providing optimum ECM coverage have been established, and the construction of a 300 to 7000 mc/s antenna is under way.

JAMMING STUDIES

Reference: DRB. DND Project D48-44-20-01

Period under review: July-September 1962

The aim of the project is to study the use of carcinotrons and other devices for jamming, and to develop experimental jamming equipment.

During the period under review, experimental activity on this project was concluded and no more is planned, but consultation services will be continued as required. A paper entitled "High Level Video Noise Sources" which summarized some past work, and another entitled "The Impulse Response of a Synchronously Tuned Amplifier" were completed and submitted for publication. In final revision is a paper on "The Impulse Response of Bandpass Amplifiers". No decision has been reached on the future of the draft report on the dynamic power variations encountered in type "M" carcinotrons. Monitoring of the Project Napkin study at Canadian Arsenals Ltd. was continued. Instrumentation for frequency spectra measurements was assembled at Canadian Arsenals Ltd. and their measurement program was resumed. Preliminary discussions were held on the DOT radar/RCAF jammer interference problem, and some comments on "Electronic Jamming for the ERA 1970" were prepared for the Defence Research Board.

X-BAND GROUND SCATTER MEASUREMENTS

Reference: RCAF . No project number

Period under review: July-September 1962

The RCAF has made a proposal for an electronic airborne jammer which would combine the masking properties of a conventional jammer with the main advantage of a decoy — that is, the possibility of diverting the interceptor from the target to decoy. Briefly, the output of the airborne jammer is fed to a directional antenna, with very low side lobes, directed at the ground below the jamming aircraft. To an interceptor, the jamming appears to come from the ground rather than from the aircraft. At the same time, the jamming is strong enough to mask active radar returns from the jamming aircraft, even though the jamming enters through the side lobes of the interceptor's radar antenna.

Early trials indicated that this method of jamming AI radars was feasible. As a result of delay in the receipt of an AI radar to be used in the quantitative measurements, little work has been done on this project in the period under review.

CLASSIFIED REPORTS ISSUED

Pulfer, J.K.
and
Lindsay, A.E.

A Transistor Telemetry Transmitter (ERB-598, Limited)

A solid-state telemetry transmitter developed for use in the Black Brant III series of upper atmosphere research rockets is described. The power output of the transmitter is 1 watt at 225.7 mc/s. The circuit was designed with a minimum number of parts, and with components which operate well within their ratings, so as to provide maximum reliability. The manufacture of this transmitter is the subject of an agreement between Bristol Aero-Industries Ltd. of Winnipeg and Canadian Patents and Developments Ltd.

Wong, J.Y.
and
Kirk*, P.A.

Development of a Broadband HF Transmitting Antenna System for the General Purpose Frigate (ERB-611, Confidential)

A broadband HF transmitting antenna system has been developed for the General Purpose Frigate, consisting of a folded tetrahedron and discage antennas. The results of model impedance measurements of a number of different antenna configurations are given.

* Royal Canadian Navy