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NATIONAL RESEARCH COUNCIL OF CANADA
RADIO AND ELECTRICAL ENGINEERING DIVISION

CLASSIFIED PROGRESS REPORT NO. 13
(APRIL - JUNE 1958)

Declassified to
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Authority

S. A. MAYMAN

Date

NOV 26 1992

OTTAWA
JULY 1958

NRC #35418

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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CONFIDENTIAL

COUNTER MORTAR RADAR (AN/MPQ-501)

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

Period under review: April - June 1958

PURPOSE OF EQUIPMENT

The primary role of this radar is the detection and location of mortars to ranges of at least 7000 meters. A parabolic extrapolation through two points located on the bomb trajectory is made by means of a computer. The mortar location is given as a map grid reference and contour. Range and bearing to the mortar are indicated also. Secondary roles include location of airburst, fall of shot, vehicles, and personnel.

GENERAL DESCRIPTION

The radar is designed for mounting on an AFV 603 armored personnel carrier in order to achieve a high degree of mobility, reliability, and protection for operators and equipment. The antenna, transmitter, and generator assemblies are mounted outside, while the display and control equipment are inside the body of the vehicle. No cabling or external stabilization of the vehicle is necessary on site; consequently the equipment may go into, or out of action with minimum delay and manpower. The design is generally suitable for mounting on the new Canadian tracked vehicle. Consideration of modifications required to take full advantage of the new vehicle is being continued.

STATUS OF PROTOTYPE

The Users' Trials at Camp Shilo, Manitoba, were terminated just short of completion because of a structural failure involving faulty welding in the antenna assembly. This assembly was known to be in need of modification to provide greater ruggedness, and consideration had already been given to this problem. The uncompleted tests pertained to relatively minor points, and success on these may well be assumed on the basis of previous experience. The results achieved during the trial period showed a marked improvement as the personnel developed familiarity, and indicate that the performance specifications have been met.

POLARIZER

The full-size prototype was completed and tested on the McGill-NRC scanner. Measurements were made at frequencies representing the two ends and the center of the band. Both beams were checked throughout the scan angle.

The mean ellipticity ratio measured was 0.925, corresponding to a cancellation

ratio of 22.2 db, and was not less than 0.900.

Beam shift was less than 1 mil. Side lobes were not more than 5% of the main beam.

Manufacturing problems are being investigated. Drawings have been prepared, incorporating mechanical changes to facilitate production. A sketch design has been made of a mount and control assembly by means of which the polarizer can be moved in or out of its operating position from inside the radar cab.

STORAGE TUBE DISPLAY

This display was checked using artificial signals, with and without noise. Satisfactory storage can be achieved even with one frame only displaying the signal. Application of the electronic marker presents some difficulty and this is still receiving attention. When the production model of the radar is made available it is intended that this display will be wired in for initial assessment.

COMPUTER

The trajectory equations of a projectile subjected to air resistance in flight were evolved and adapted to the computer equations for parabolic extrapolation. Results indicate that the parabolic extrapolation equations apply equally well to trajectories modified by an air resistance factor.

ACQUISITION RADAR MODIFICATIONS (AN/MPS-501B)

Reference: Army. No DND project number.

Period under review: April - June 1958

Modifications of the AN/MPS-504 radar are described under "Anti-Jamming Measures against Carcinotrons" on page 4.

ANTI-JAMMING MEASURES AGAINST CARCINOTRONS

Reference: Army. DND Project B22-38-20-23

Period under review: April - June 1958

During the period under review, work was concentrated on modifying a standard Army AN/MPS-504 Radar for participation in the carcinotron jammer trial known as "Operation Burnt Cork".

RECEIVER

- a) The preamplifier was replaced by a wide-band unit (approximately 20 mc/s wide at -3 db) and with an overall gain of 30 db.
- b) The main receiver unit was replaced by a logarithmic receiver capable of filling the role of a linear receiver when so required. In the logarithmic mode the dynamic range is approximately 80 db.
- c) A Dicke-Fix receiver was installed as a switchable option. The limit level is continuously variable from below the RMS thermal noise level to about 20 db above RMS noise.

POST DETECTOR

- a) A video enhancer was installed. The CAL unit originally installed has proved to be unacceptable and the original experimental model has been used.
- b) A delay line video integrator was built. This device, with associated test gear, was incomplete when the radar left NRC and has not yet been installed. Laboratory tests indicate that it may be expected to work satisfactorily.

REMOTE DISPLAY

A 5-inch remote PPI display, with camera mount, was fitted. Facilities permit the addition, on each photograph, of a coded record showing the type of anti-jamming devices in use when the photograph was taken.

IMPROVEMENTS TO GROUND RADARS

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

Period under review: April - June 1958

DICKE-FIX RECEIVER

This item is covered in the section "Anti-Jamming Measures Against Carcinotrons" (page 4).

LOGARITHMIC RECEIVER

Two identical logarithmic receivers were constructed for the "Burnt Cork" exercise, one for use with the Army's AN/MPS-504 and one with the RCAF's AN/CPS-6B. Both were logarithmic from 20 db below thermal noise level to better than 60 db above noise level. Small signal bandwidths were 1 mc/s. A fast time constant with a forward time of 10 μ sec and a reverse time of 0.2 μ sec was included in the video circuits. Baseline clipping was also available.

Using the logarithmic i.f. strip, a linear receiver output was also provided with small signal gain and bandwidth identical with those of the logarithmic receiver. Either a long time constant or a fast time constant with the same characteristics as in the logarithmic receivers was available in the video circuit. The addition of the linear receiver feature provides a simultaneous comparison between logarithmic and linear operation. Canadian Arsenal's model of the logarithmic receiver designed for use with the AN/MPS-504 has been received and is undergoing trials.

ANTENNA PATTERN RECEIVER

The NRC model of this receiver is on loan to the RCAF for the "Burnt Cork" trials. It will be used to measure the jamming signal strength received by the AN/CPS-6B.

AZIMUTH TIME RECORDER

Canadian Arsenal's model of the recorder was received by NRC. At the WSEG trials in March-April, it was found that the output of the receiver portion of this model did not increase with increased jamming strength. This was traced to the use by CAL of circuits in the cathodes of the infinite impedance detectors which differed from those used by NRC. The use of long time constants allowed excess grid current to flow when strong jamming signals were received. This disturbed the bias on all i.f. stages, reducing the receiver output.

AUTOMATIC STROBE TRIANGULATION DISPLAY (ASTRID)

Reference: RCAF and Project "Napkin". No project number.

Period under review: April - June 1958

This project is concerned with the problem of rapidly determining the position of a number of jammer-equipped aircraft when bearing information alone is obtainable from the strobes generated by radars in the presence of jamming. For this purpose a display had been built such that the strobe pictures from three radar sites could essentially be presented simultaneously on the one display, with the centers of the three rotating scans disposed on the tube to represent the three radar sites. The usefulness of the display was tested with a simulator or strobe generator. From the results it became apparent that several operators co-operating with each other are necessary for "de-ghosting", i.e., for distinguishing true from false intersections, when a number of jammers are present. As a result a more sophisticated system was designed for field trials, with two horizontal-face triangulation displays so that at least four people could observe each display.

During the period under review work progressed on these displays. In addition to the facility to present three strobe pictures simultaneously, each display will have four "joystick" controls for manual positioning of electronic markers. These will be used to transfer positions from one triangulation display to another, as well as to an Intercept Controller's display of the AN/UPS-35A type. One display console has been received from the Model Shop and is being wired. All of the necessary circuits have been designed and tested and most have been built in final form.

To transmit strobe information from one radar station to another it is proposed to transmit continuous antenna azimuth information and a low bandwidth video signal. Low-frequency carriers will be used for the azimuth and video signals so that both kinds of information can be carried on a single circuit of telephone quality. One set of transmitting equipment is complete, and a receiving set is nearing completion.

It is expected that sufficient equipment for a three-station field trial will be available by midsummer and that installation will be complete by September 1. A four-channel tape recorder and revised circuitry ought to be ready shortly thereafter. This will enable the recording of a complete exercise for analysis, training, and an interesting set of experiments on the utility of speeding up the data flow rate.

FLIGHT PLAN CORRELATION EQUIPMENT

Reference: RCAF . DND Project C98-39-30-02

Period under review: April - June 1958

No work was done on this project during the review period. No future work is planned unless further interest is shown by the Services or DOT.

The project was declassified to "open" and an unclassified report (ERB-448) entitled "Flight Plan Correlation using the Charactron" was issued by the Radio and Electrical Engineering Division.

REMOTE RADAR DISPLAY

Reference: Army, RCAF. No DND project number.

Period under review: April - June 1958

No further work was done on this project. A preliminary report, "A Broadband Data Transmission System for use with Radar" (ERB-469, Restricted) was issued by the Radio and Electrical Engineering Division.

LOW ANGLE DETECTION

Reference: Army, RCAF. No DND project number.

Period under review: April - June 1958

A report describing the new detector circuit is in preparation. A new display is being constructed.

SOUND-RANGING COMPUTER

Reference: Army. No DND project number.

Period under review: April - June 1958

A miniature automatic computer (MINIAC) is to be built to investigate the requirements of a digital computer suitable for solving the sound-ranging problem. The computer will have a word length of eight binary digits (including the sign digit) and be capable of fixed point addition, subtraction, and multiplication.

It is planned to use apertured ferrite plates for the memory of the computer. Memory capacity will be 256 words of eight digits each. However, fast access will be provided only to 16 words.

Regulated power supplies of 6 volts, 5 amperes and 3 volts, 5 amperes, are being built to operate the transistor circuitry.

SECRET

INSTANTANEOUS MICROWAVE DIRECTION FINDER (AN/UPD-501)

Reference: Navy, RCAF. DND Project A12-44-10-03

Period under review: April - June 1958

The purpose of this equipment is to detect a pulsed radar transmission instantaneously and to indicate the bearing in an unambiguous manner. It consists of a four-channel crystal video receiver with the signal displayed on a cathode-ray tube as a radial line. The angle of the line with respect to a reference represents the bearing of the signal.

UHF ANTENNA

The antenna operating in the frequency band from 500 to 1000 mc/s was measured for bearing errors in both vertical and horizontal planes of polarization. The antenna system consists of eight spiral antennas on a 10-inch-diameter cylinder. Bearing errors were satisfactory over most of the band, but were greater than 20° below about 600 mc/s. This probably could be corrected by increasing the size of the whole structure. No further work is being done on this antenna since there is no urgent requirement for it.

PROTOTYPE ANTENNAS

The three prototype antennas — S-band vertical polarization, L-band vertical polarization, and L-band horizontal polarization — were tested by DND Inspection Services for shock and vibration. They will be returned to Cossor (Canada) Ltd. for modification to bring their performance up to military specifications.

ANECHOIC ANTENNA COUPLER

Several units of the anechoic antenna couplers for S-band and for X-band were measured for VSWR and for transmission loss in order to establish a standard for specification purposes. Cossor (Canada) Ltd. have almost completed six units of each frequency band for evaluation as production prototypes.

A coupler unit for the band 11.0 to 20.0 Kmc/s was completed. A concave-shaped weatherproof cover of Fiberglas and epoxy resin was moulded. The reflection coefficient of the completed coupler is satisfactory for testing the UPD-501 antennas operating in this frequency band.

Several modifications have been made on the coupler for the 1.0 to 2.35 Kmc/s band. The VSWR and loss of the modified coupler are being checked.

TEST SET

The developmental model of the UPM-501 test set was tested under vibration by DND Inspection Services. It will next be sent to the Operational Evaluation Unit in Halifax before the specification is completed and a production contract let.

A second model is being fabricated with several mechanical improvements, as a portable signal source in the laboratory. A report on the use and performance of this unit is being prepared.

CRYSTAL MOUNTS

Fifty coaxial crystal mounts were purchased. These units were made to the NRC Mark V design. After correcting a number of faults, measurements of VSWR and uniformity of sensitivity were made. Both measurements indicated an improvement over previous experimental units.

CRYSTAL SENSITIVITY

Thirty-six type 1N23E crystals were received from the Navy and RCAF for testing. The performance of these crystals, which were from three manufacturers, was about equal for low-level video detection. Compared with the 1N23B, the tangential sensitivities were about 1 db better at S-band and about 3 to 4 db better at X-band. The spread in sensitivity of the 1N23E crystal was about 1.5 db at S-band and about 2 db at X-band. This is very little better than the 1N23B crystals.

CRYSTAL MONITOR

An equipment which may be used for checking the relative performance of crystals was developed. It generates a pulsed 50 mc/s signal which is coupled into the video cable. Crystals in the antenna can be checked from the operator's position at the indicator. The design has been completed and a model is being built for evaluation.

VIDEO AMPLIFIERS

Several types of transistor wideband video amplifiers were built and tested. A rise time of 60 μ sec was obtained in a four-stage amplifier with a gain of about 30 db. As the amplifier was DC coupled, reproduction of long pulses was also good.

ANALOG BEARING ERROR DEVICE

NRC Report ERB-477 entitled "An Analog Instantaneous Amplitude Comparison Direction Finder", by F.V. Cairns, has been completed.

SHORE-BASED HIGH-FREQUENCY DIRECTION FINDER (AN/GRD-501)

Reference: Navy. DND Project A14-38-10-10

Period under review: April - June 1958

Experiments were begun on various types of short pulse generators of reasonable power to be used as harmonic test transmitters to calibrate the direction finder. Two reports have been prepared; one on the antenna coupling circuits of the equipment, and the other dealing with polarization error tests of the prototype antenna and of a conventional antenna.

Several failures have occurred in the band-changing contacts of the receiver. These were found to be due to insufficient wiping pressure on the flexible contact strips. Application of silicon grease to the contacts has remedied the faults. Other routine maintenance of the equipment is being continued while it is being used operationally by the RCN.

SHIPBORNE HIGH-FREQUENCY DIRECTION FINDER

Reference: Navy . DND Project A17-38-20-19

Period under review: April - June 1958

Work on this project is being resumed after being delayed by work on the Shipborne Short-Signal Intercept Receiver (DND Project A17-38-20-24) . There is no progress to report.

SHIPBORNE SHORT-SIGNAL INTERCEPT RECEIVER

Reference: Navy. DND Project A17-38-20-24

Period under review: April - June 1958

This is a short-term project aimed at producing two receivers capable of indicating the presence of a large-amplitude short-duration signal occurring within a 1-mc/s bandwidth.

A model of this receiver was completed in May and demonstrated to RCN representatives who expressed satisfaction with its electrical performance. Minor mechanical modifications are being made to some of the chassis to improve their resistance to vibration.

NRC has undertaken to train an operator in the use of this equipment at the Naval Training Station, Ottawa, and operating instructions have been written. Maintenance instructions have also been prepared.

Both models of this equipment are very near completion and there should be no delay in delivering them as soon as they are requested by the RCN.

IMPROVEMENT OF HF DF TECHNIQUES

Reference: DND Project A14-38-10-24

Period under review: April - June 1958

The performance of AN/GRD-501 equipment was measured on different tasks, using groups of operators of different ability and experience. It is hoped from the overall results of these trials to reach decisions regarding operator training requirements, instrumental aids to operators, and the operational techniques which may be considered for improving performance.

A report on the derivation and application of HF DF corrections to bearing observations is almost completed.

Equipment for transforming a twin-channel bearing display into a decimal counter readout is being tested with the purpose of using it to record the time averages of "wandering" bearings accurately.

MAGNETIC SIGNATURES OF ALUMINUM MINESWEEPERS

Reference: Navy. DND Projects A20-05-60-02 and A12-05-60-04

Period under review: April - June 1958

Earlier in the year, trials were conducted on a Canadian minesweeper to determine all components of the magnetic field which contribute to the signature of the ship, and to determine the effectiveness of the ship's degaussing system in reducing the signature. The data obtained have been analyzed and a report is being prepared.

A prominent feature of the ship's signature was a large magnetic field under the starboard side, about midway along the length of the ship. This unsymmetrical component of signature could not be compensated by the symmetrically arranged degaussing coil system. An investigation showed that a magnetic clutch in the motor generator of the 400-cycle power supply was the origin of this field.

A 400-cycle power supply of the same type has since been brought into the laboratory. Facilities have been set up for measuring its field. An experimental investigation of a system for compensating the field of the clutch by the use of a degaussing coil is in progress.

DYNAMIC CHARACTERISTICS OF THE INDUCED FIELD
IN FERROMAGNETIC BODIES

Reference: Navy. DND Project A12-05-60-04

Period under review: April - June 1958

It is planned to continue the study of "tilt" effect in degaussed iron parts of rolling ships. The object is to determine the frequency characteristics (magnitude and phase) of the magnetic field of iron parts subjected to a time-varying exciting field, and in addition to determine the characteristics of the required degaussing field. Previous work has covered the case of solid iron cylinders. This will be extended to the study of hollow iron cylinders.

TELEMETRY ANTENNA FOR CARDE TEST VEHICLE

Reference: CARDE. No DND project number

Period under review: April - June 1958

At the request of CARDE, Valcartier, Que., a program has been under way to develop a telemetry antenna system for a new propulsion test vehicle. CARDE requirements call for an antenna system near the nose of the vehicle, in proximity to the telemetry equipment, since it is not feasible to run coaxial cable from the nose to an antenna system located near the tail, because of the heat generated by the rocket motor. The geometry of the vehicle launching tower further dictates that external projections occur in line with the three control fins. Pattern studies at $\frac{1}{13}$ -scale have shown satisfactory performance using three unipole antennas inclined at 45° to the vehicle center-line, and spaced 120° around its circumference. Two of these are excited in push-pull, and the third operates as a parasitic element.

Two sets of three prototype antennas were constructed by CARDE. One set consisted of tapered blade unipoles, constructed in accordance with an electrical design supplied by this Division. The second set consisted of tapered cylindrical unipoles, of lower weight and drag than the first set. The impedance of these antennas was measured by the Division, using a full-scale mock-up of the forward part of the vehicle, and matching and phasing networks were designed. As was expected, the blade antennas could be matched to a satisfactory value of 1.4 across the band of 215 to 235 mc/s, but the voltage standing-wave ratio of the rod antennas rose to 3 in the same band.

The antennas and matching networks have been returned to CARDE. To complete the project a final report, ERB-480, has been prepared for publication.

ANTENNA FOR AIRBORNE EARLY WARNING

Reference: USAF. No DND project number.

Period under review: April - June 1958

After the successful operation of the Mark IIA antenna (see NRC Report ERB-464, "An Antenna for Airborne Early Warning" (Confidential)), a second antenna, the Mark IIB for monopulse operation, was designed and built. This antenna does not include an IFF section, but provides dual-channel operation at the radar frequency. A conducting vane divides the "cheese" reflector and feed system into two parts which can be excited either in, or out of phase, through independent coaxial inputs. The antenna pattern, as measured on the prototype, for the in-phase or "sum" channel is almost identical with that obtained for the Mark IIA antenna, while the out-of-phase or "difference" channel produces a split beam. The antenna has been matched satisfactorily over an 8-mc/s band, and has been delivered to Lincoln Laboratory for flight trials.

Pattern measurements of a $\frac{1}{10}$ -scale model mounted on a $\frac{1}{10}$ -scale model of the WV-2 aircraft have yet to be made.

ECM ANTENNA SYSTEM FOR B-52 AIRCRAFT

Reference: USAF. No DND project number.

Period under review: April - June 1958

In cooperation with Division IV, Lincoln Laboratory, a program to design a suppressed ECM antenna system for the B-52 aeroplane for operation in the UHF band has been initiated. To date most of the effort has been devoted to the fabrication of a suitable Fiberglas $\frac{1}{10}$ -scale model. Radiation pattern measurements are currently being carried out on an antenna consisting of a slot located on the side of the fuselage just forward of the leading edge of the wing.

MODEL ANTENNA STUDIES FOR HMCS "ST. LAURENT"

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

Period under review: April - June 1958

From the results of scale-model measurements, two broadband antennas were designed for HMCS "St. Laurent" to cover the HF band of 2 to 30 mc/s. The low frequency antenna for operation from 2 to 5 mc/s is a folded-monopole configuration. A brief description of this antenna is as follows. The foremast of the ship serves as the grounded element of a folded-monopole antenna, and an auxiliary mast (acting as the driven element) is placed near the foremast. The top end of the auxiliary element is electrically short-circuited to the mast and the driven element is fed at the base. In order to meet the VSWR requirement of 3.5 to 1, the antenna is operated in conjunction with a matching network which consists of a simple transmission line transformer. A recommendation has been submitted to EEC/Royal Canadian Navy that a "folded-foremast antenna" be installed on a DE ship for operational evaluation.

A second antenna was designed to operate satisfactorily from 5 mc/s to 30 mc/s. In this configuration, the smokestack acts as the sleeve portion of a sleeve monopole antenna. Radiation pattern measurements are currently being carried out on a $\frac{1}{48}$ -scale model of the DE257.

X-BAND WAVEGUIDE SWITCH FOR THE ROYAL CANADIAN NAVY

Reference: Navy. DND Project A12-55-10-02

Period under review: April - June 1958

The purpose of this project is to develop suitable fast-acting switches to allow switching of the full magnetron power of X-band radars from the antenna to a dissipative load.

With the issuance of NRC Report ERB-452 (Confidential), entitled "A Fast-acting High-power X-band Waveguide Switch", work on this project has been terminated, and will not be reported further.

JAMMING STUDIES

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

Period under review: April - June 1958

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

The study is concerned with both the properties, capabilities and limitations of the more promising generators of jamming signals and the manner in which such signals affect various systems, so that the feasibility of jamming can be predicted. The knowledge of what may be expected in the way of jamming by a hostile force, and the susceptibility of our defences to such jamming is necessary in defence system planning.

Preparation of NRC Report ERB-472 entitled "Jamming Tests of the 'Local Oscillator Off' Fix" was completed and the report was issued during the period under review.

Jamming tests on the AN/SPG-48 naval fire control radar were continued. Measurements of minimum detectable signal and minimum locking signal were obtained for a stationary target. The instrumentation was improved as the work proceeded. A means of simulating a moving target has been provided, and a number of the previous tests are being repeated using targets moving at various speeds. Tests have also been conducted to determine the requirements which an interfering pulse must meet in order that it take over control of the range gate from the desired pulse during automatic tracking.

A number of power supplies required for M-carcinotron operation, which use 3-phase, 400-cps power, were constructed. This is a continuing low priority activity with the aim of making portable operation more feasible should this be required.

The three-stage distributed amplifier using printed circuits was constructed, and adjustment is nearing completion. This amplifier, which provides 50 db gain over a 63-mc/s bandwidth, is for use in the 0.1-50 mc/s noise source.

The project has been retarded by unavoidable changes in personnel and the necessity of training new technicians.

SECRET

ANTENNA FOR X-7769 CARCINOTRON JAMMER

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

Period under review: April - June 1958

During the period under review the modified dielectric slab antenna for S-band was completed, and tests by the RCAF indicate satisfactory performance.

Consideration has been given to the design of an L-band jammer antenna. The requirement is for an antenna omnidirectional in the horizontal plane, with a maximum in the vertical plane slightly below the horizon. Mounting is to be on the underside of the C-119 aircraft. A power-handling capacity of 500 watts is required, and the frequency range is from 1200 to 1400 mc/s.

Scaling of the dielectric slab antenna is not feasible on account of the large size of the slab. It seems that the best solution will be a quarter-wavelength sleeve dipole. A Ku-band model of the antenna and aircraft has been built, and pattern-taking is in progress. A full-scale sleeve dipole has been built, and impedance measurements will commence shortly.

VULNERABILITY OF THE DOPPLER DETECTION SYSTEM TO COUNTERMEASURES

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

Period under review: April - June 1958

The purpose of this project is to study the Doppler Detection System with a view to determining what countermeasures might be used against it, how effective they might be, and what might be done to counter them .

A study of the vulnerability of the Doppler Detection System to jamming by an airborne repeater jammer was completed, and NRC Report ERA-331, "Vulnerability of the Doppler Detection System to Countermeasures — Airborne Jamming" has been issued giving the results of the investigation .

In answer to a request from AFHQ, a list of technical requirements for an airborne superregenerative repeater was prepared and submitted. These requirements were finalized by studying the results of flight trials made in the period October to December 1957 .

The problems of optimizing velocity sorting detection in a backward-wave amplifier operating as an autodyne detector, underwent further study in the period under review . It was found that instability of the electron beam occurred at some frequencies, decreasing the usefulness of the tube in broadband operation . As a result, this study has been postponed until a new model of the tube with improved collector geometry is received .

INSTANTANEOUS MICROWAVE FREQUENCY INDICATOR

Reference: DRB. No DND project number.

Period under review: April - June 1958

The purpose of this project is the development of a microwave instantaneous frequency-indicating device based on the principle of amplitude comparison of the video detected output of a set of bandpass filters. A TWT amplifier is required to maintain sensitivity roughly equivalent to that of a crystal video receiver in an instantaneous direction finder. The gain of the TWT amplifier must compensate for the losses involved in power division and padding in the frequency indicator and for the lower gain of the frequency indicator antenna.

The 12-filter S-band frequency indicator was completed. The error of this system on a direct reading linear scale will probably be about ± 20 mc/s, compared with ± 30 mc/s on an 8-filter frequency indicator. However, some difficulties are still being experienced with this system. Further work on direct calibration by a reference signal from a buzzer RF power source and a calibrated cavity indicates that the error can be reduced to ± 10 mc/s. The equipment used for direct calibration is suitable only for laboratory use at this stage.

The tangential sensitivity of the 8-filter frequency indicator was measured to be -60 dbm at 3000 mc/s, falling to -50 dbm at the edges of the frequency band, with a commercial, permanent magnet focussed, TWT amplifier. With a low noise TWT amplifier preceding the permanent magnet focussed TWT, the tangential sensitivity was between -80 and -85 dbm at the 2700 to 3500 mc/s bandwidth of this TWT.

Considerable work was done on a fast-acting automatic gain control to make possible frequency indication on a pulse from the tangential level up to about one watt, without manual adjustment of the gain. A satisfactory solution has not yet been found.

GROUND-TO-AIR COMMUNICATIONS USING IFF (CUFF)

Reference: RCAF . DND Project C37-28-01-05

Period under review: April - June 1958

No further work was done on this project during the period under review.

HIGH ALTITUDE MODIFICATIONS TO AN/APX-6 IFF TRANSPONDERS

Reference: RCAF. No DND project number.

Period under review: April - June 1958

This project has been completed and a report is in preparation.

CLASSIFIED REPORTS ISSUED

The following classified reports were issued by the Radio and Electrical Engineering Division during the period under review :

Cumming, W.A. An Antenna for Airborne Early Warning (ERB-464, Con-
 and fidential)
Barnes, J.C.

In co-operation with Division IV, Lincoln Laboratory, Massachusetts Institute of Technology, an antenna has been developed for use with an airborne early warning radar system operating in the frequency range 650-700 mc/s. The antenna, which has been delivered to Lincoln Laboratory for flight testing on a WV-2 aircraft, is a dual type, incorporating an interim IFF antenna in addition to the radar antenna.

The radar antenna-aircraft combination has been evaluated by means of a pattern study at 1/10th scale, the results of which are summarized below for the center frequency. The limits given refer to the variations which occur as the antenna scans through 360° of azimuth rotation.

- 1) Peak gain: 25.6 to 27.2 db above isotropic
- 2) Depression angle of main beam: -6° to -11°
- 3) Gain at 0° depression angle: 19.1 to 23 db above isotropic
- 4) Largest "close-in" E-plane side lobe at depression angle of main beam: -19.3 to -26 db below peak
- 5) Largest "far-out" E-plane side lobe at depression angle of main beam: -21 to -27 db below peak
- 6) Largest "close-in" E-plane side lobe at 0° depression angle: -18 to -27 db below maximum level at 0° depression angle
- 7) Largest "far-out" E-plane side lobe at 0° depression angle: -20 to -30 db below maximum level at 0° depression angle
- 8) E-plane beamwidth at 0° depression angle: 5.4° to 6° between 3-db points
- 9) E-plane beamwidth at depression angle of main beam: 5.2° to 5.8° between 3-db points

Hendry, A. Field Measurements on First Production Model of AN/MPQ-501 Counter Mortar Radar, at Camp Shilo, Manitoba, 25-28 March, 1958 (ERB-471, Restricted)

An investigation of deficiencies in the receiving system of the AN/MPQ-501 Counter Mortar Radar was carried out. Field reports of poor video amplifier rise time and high scanner VSWR were confirmed, while AFC circuit operation which had been reported as poor, was observed to be satisfactory. An overall check of the transmitter and receiver indicates that system performance is generally satisfactory, although improvements in the video amplifier circuitry are necessary in order to obtain an acceptable rise time. A table of recent equipment faults is included, together with recommendations which, if implemented, should improve system reliability considerably.

Humphries, J. A Broadband Data Transmission System for use with Radar (ERB-469, Restricted)

A compact data transmission system, capable of relaying full-bandwidth radar information to a remote plan position indicator is described. The remote display is reproduced with no appreciable degradation of quality.

A method of pulse-time modulation is used to transmit antenna positional information with an overall accuracy of $\pm 1^\circ$. The radar video signals and the necessary information pulses are time-shared in a way that permits the use of a single communication channel with a minimum bandwidth of 1.5 mc/s. The system was designed to be compatible with standard television microwave relay equipment.

Jones, S.G.
and
Shepertycki, T.H. Jamming Tests of the "Local Oscillator Off" Fix (ERB-472, Secret)

The range of an aircraft self-screened by FM-by-noise jamming was reported to have been determined by the simple expedient of switching off the local oscillator of the radar. The potential usefulness of the technique was investigated in laboratory jamming tests. The modifications to the conventional radar receiver which are required or desirable are outlined. Quantitative results of the effects of varying a number of receiver and jammer parameters are presented, and conclusions are stated.

Pedersen, B.O.
and
Morris, R.M. Frequency Characteristics of the Degaussing Field for Solid
Ferromagnetic Cylinders (ERA-332, Secret)

Dynamic effects due to rolling and pitching cause an error in the "tilt" compensation of a ship's degaussing system. A ferromagnetic cylinder with a degaussing system attached has been considered here to be representative of a ferromagnetic component in the rolling ship.

It is shown that a body oscillating in a constant magnetic field is nearly equivalent to a fixed body in an oscillating field. The frequency characteristics required of a degaussing system for a fixed cylinder in an oscillating field are studied both theoretically and experimentally. The possible improvement obtainable in ship degaussing by introduction of dynamic elements in the tilt compensation system may be estimated from the results of this investigation.

Pulfer, J.K. Vulnerability of the Doppler Detection System to Countermeasures
Report No. 2 — Airborne Jamming (ERA-331, Secret)

The vulnerability of the Doppler Detection System to jamming by an airborne superregenerative repeater was studied. A theoretical investigation of some of the problems encountered in airborne repeater jamming was made, and results are presented. Measurements of ground echo levels, and field strengths along particular jamming tracks are included.

Pulfer, J.K. Application of a Backward-wave Amplifier to Microwave
Autodyne Reception (ERB-463, Confidential)

A microwave receiver using a single-circuit backward-wave amplifier as a combination radio-frequency amplifier and homodyne local oscillator is described. The amplifier tube is operated at a value of beam current just above that required to maintain oscillation. It is shown that in this way, the high gain and narrow bandwidth of the single-circuit backward-wave amplifier may be utilized in an electronically tunable microwave receiver. The resultant sensitivity is 10 to 15 db worse than that obtainable from a good superheterodyne. The loss in sensitivity is due entirely to the high noise figure of the backward-wave amplifier, which can theoretically be reduced to a value comparable with that of a superheterodyne. The advantages

of the receiver are its simplicity and its lack of image difficulties. Rejection of off-frequency signals is such that they are attenuated by at least 50 db.

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