Progress report on CB and MZPI radar equipments April- June 1951
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NATIONAL RESEARCH COUNCIL OF CANADA

RADIO AND ELECTRICAL ENGINEERING DIVISION

PROGRESS REPORT

ON

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COUNTER-BOMBARDMENT RADAR EQUIPMENT

Antenna and Wave-guide Components

As a result of the request of the Canadian Army to alter the operating frequency of the set, plans for the necessary changes were considered and test equipment ordered for the new wavelength.

The main problem was the antenna, since an increase in scanning angle was requested. Studies showed the impracticability of using the lens-type scanner, barely satisfactory for a 10-degree scan, for scans wider than 15 degrees. Other possibilities were the Foster Scanner, and the Tin Hat 360° Scanner, developed by the RCA-Victor Company in Montreal. In addition, it was felt that this last might be drastically modified to give only 20-25° scan with considerable saving in size, weight, and feed complexities. Certain of these scanners favoured the use of oscillating feeds, and a mechanism was designed to test the feasibility of moving a three-foot length of RG-91/U wave guide so that the end oscillated along a 14-inch arc of a circle of 36-inch radius. This mechanism was to operate at speeds as high as 750 cycles per minute, and construction was started during the period under review.

Following a detailed examination of the problems of making and using each type of antenna, the Foster Scanner was selected as the 20-degree scanner, while it was decided that work would also be carried on with a lens-type antenna on lower priority, using foamed-loaded dielectrics rather than metal plates, and restricting the scan to 15 degrees. The Tin Hat Scanner was dropped, since its 360-degree characteristics led to excessive size when used for 20-25 degrees (as compared with the Foster Scanner). The Half Barrel, a derivative of the Tin Hat Scanner, was also dropped, because no experimental results were available. In addition, the feed problems for both were very difficult, leading to heavy rotating machinery unless a dual oscillating feed could be made practical and light. This information was also not available at that time.

Discussions were held with Professor Foster of McGill University regarding his scanners, and a contract was let to the University for the construction of a suitable scanner. All available test equipment was lent to McGill in order to facilitate the work. The desired scanner is to have an aperture about six feet wide, as in the original CB equipment, and about five feet high — this being slightly larger to compensate partially for the loss of gain due to the longer wavelength. It will make two 20-degree scans per rotor revolution, one above the other, and focussing in the vertical plane will be obtained from a single parabolic cylinder with a horizontal axis. The rotational speed will be at least 900 rpm — one-half that of the original CB scanner. Final design targets dates were not set before the end of the period, nor were the physical layout or constructional methods settled.

Computer

Electrical redesign of the computer has been started, with emphasis on the velocity correction factors. A new formula giving the necessary correction in terms of the time interval between echoes, rather than the velocity of the bomb, has been developed and work is proceeding to have the corrections set in automatically when the time interval is taken by the operator.

All computer circuits are being re-examined with a view to greater simplification and standardization and to increased accuracy of the computing and data transmission circuits.

Interconnecting Cables

Power and information cables which had been damaged, subsequent to the demonstration, by removal from ice on the field, were replaced and the radar was then restored to operating condition.

Visits to U.S. Establishments

In June a visit was made to Fort Bragg, N.C., where the AN-MPQ-4 set was seen in operation. Considerable valuable information was obtained through inspection of the equipment and discussions with those in charge of it. Visits were also made to the Evans Signal Laboratories and the Naval Research Laboratories, where information of value respecting radio-frequency components for the CB Radar on the new wavelength was obtained.

MICROWAVE ZONE POSITION INDICATOR MK.II

(Modified A.A. No.4, Mk. VI)

Modulator and Power Supply

The major components for a high-power modulator and power supply have been ordered. Plans, at present, are to construct a modulator for laboratory testing of high-power components. The modulator will form the basis of increased power for the MZPI equipment if this program is re-initiated. (It was for this latter purpose that the components were ordered originally.)

High-power Polarization Duplexers

Further work on polarization duplexers has shown that adequate crystal protection could be obtained only by the use of a T-R tube that suppresses harmonic leakage as well as fundamental leakage power, at power levels of one megawatt peak, or more, when using the British Thomson-Houston magnetrons.

A shunt-T duplexer has been designed using a pre-T-R section ahead of an REL type-64 high-Q T-R tube. The pre-T-R section consists of a low-Q iris shunted by two British type-CV-294 discharge tubes. During transmission, the discharge fills most of the resonant iris opening. High power tests were carried out at a peak power of 1.8 megawatts, a pulse recurrence frequency of 400, and a pulse length of 2 microseconds. These tests showed that high-order harmonics (sixth and above) were of sufficient power to cause random crystal burn-out when using a BTH magnetron. The use of a T-R tube or pre-T-R tube in which the discharge completely covers the input window is desirable. Existing tubes of this type are the 1B58 broadband T-R and the 1B38 pre-T-R.

High-Power Rotating Coupler*

Power-handling tests were carried out on the circular wave-guide rotating coupler. These tests showed no breakdown in excess of 2 megawatts peak at atmospheric pressure.

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* See Report ERA-191, A.C. Hudson and W. Lavrench, "A High-power Rotating Coupler for the Modified MZPI Radar (A.A.No.4, Mk.VI)".

Antenna

In order to simplify the mechanical design of the antenna it was decided to move the hinge point of the reflector approximately three inches. This was done in such a way as to leave the reflector in exactly the same position as before on the low beam, which is the most important. The reflector was then in a position slightly different from its original position on the medium and high beams. The maximum shift of the reflector was only about one-half inch, but it was felt, nevertheless, that patterns should be taken to ensure that the coverage had not been changed. A set of patterns was taken on the four-foot mock-up of the antenna, and from these a coverage diagram was plotted. It was found to agree, except in insignificant details, with that appearing in Fig.4 of Report ERA-193.

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