Progress report on CB and MZPI radar equipments, July-September, 1948

National Research Council of Canada. Radio and Electrical Engineering Division

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SECRET

LABORATORIES

OF

THE NATIONAL RESEARCH COUNCIL OF CANADA

RADIO AND ELECTRICAL ENGINEERING DIVISION

PROGRESS REPORT

ON

CB AND MZPI RADAR EQUIPMENTS

JULY - SEPTEMBER, 1948

OTTAWA

OCTOBER, 1948

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of
The National Research Council

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COUNTER-BOMBARDMENT RADAR EQUIPMENT

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Purpose The purpose of this equipment is to locate motars, within any ten-degree sector, out to a range of at least 5,000 yards. For all other purposes for which this radar may be useful, a maximum range of 25,000 yards will be available.

Status at the end of June, 1948. The design of the electronic portion of the radar associated with the CRT displays and with the range-measuring circuits was well advanced. The azimuth-sweep-generating system had been constructed in its final form and the design of the range-measuring circuits had been completed, but for some further checking of the accuracy of the associated inductive goniometers, which is still in progress.

Considerable time had been spent in designing wide-band video amplifiers to provide signal voltages for the CRT displays.

A detailed study of the data transmission system had been started, with the assistance of summer students, for the purpose of achieving a better over-all understanding of what would ultimately be required.

Associated with the data transmission system are the two computer mechanisms, the coordinate converter and the extrapolating computer. The former had been designed and built, and one deck of the latter had been constructed in an experimental form. Its operation was satisfactory except for a slight creep in the ball-and-disc multipliers.

The antenna and scanner had been designed and tested, but some further work on these units may still be required. An experimental modulator and its trigger circuits had been built, and provision for interlaced firing of two similar modulators was made in order to allow the quality of the display to be improved for applications in which a range of less than 12,000 yards will be used.

Modification of the Windsor carrier had advanced to the point where the antenna could be mounted and levelled.

Progress during July-September, 1948 Tests were made on a number of 3J31 magnetrons to determine conditions for alternate firing of two of these tubes with the same antenna. These tests have been temporarily postponed due to shortage of personnel. Information, some of which has since arrived, was sought from England regarding parallel operation of magnetrons. Developmental work was continued on the basis of a single magnetron working under conditions of maximum power output at the expense of tube life, in preparation for initial field tests. It is expected that paralleled magnetrons will be used later to increase the total power output and at the same time allow full tube life.

Assembly of the r-f head was commenced but shortage of personnel has retarded this work.

Investigation of non-linearity in the scanner was commenced with a view to determining its cause and the measures necessary to eliminate it.

The azimuth sweep generator unit has been completely wired and tested. The r-f jitter evident earlier with the bread-board layout has been eliminated in this new unit. Some slight non-linearity near the extremes of the sweep has been removed by re-designing the balanced detector circuit.

Work on the ranger awaits the completion of the video amplifiers. An initial test, in which the marker pulses were put through the 'B'-scope video channel, gave encouraging results, however.

The 'B'-scope video amplifier has been completed and tested. The response of this six-stage amplifier is now uniform up to a frequency of 15 mc. The 'A'-scope video amplifier is being adjusted to give a response flat to 10 mc. Only the two output stages present substantial difficulty, for the voltage output must be about 150 volts to provide an adequate deflection on the 'A'-scope.

A capacitive goniometer has been completed and tested. This unit utilizes silver-plated bakelite condenser plates, lightly scored to produce the four quadrants required. Results show the capacitive goniometer to have a maximum error of $\pm$ 1.8 yards. A series of similar tests were run on the Mark 1-A inductive goniometer and its error was determined to be $\pm$ 1.3 yards. Tests now being completed on the Mark 1-B inductive goniometer yield an error of about $\pm$ 1 yard, and there is some indication that the accuracy can be improved. This constitutes better accuracy than that of the

large goniometer now in use.

A 400-cycle power amplifier, with sufficient output to supply the information system, has been designed, built and tested. Due to the fact that the autosyn amplifiers (Standard Pioneer-Bendix units) saturate at relatively small input voltages and the follow-up drive motors have a limited top speed, it has been found necessary to incorporate a second channel in the information system to prevent the transmitters and receivers getting out of step. Preliminary work has been done on this, but the final additions to the various units have not yet been made.

Possible designs of the extrapolating computer have been thoroughly analysed, together with the possibility of using various corrective terms to increase the accuracy of mortar location. As a result, a multi-deck mechanical calculator has been designed, which should reduce the extrapolation error to a practical minimum. Detailing of these units is well under way. An alternative electrical unit is under consideration but has not yet been tested.

A variable-delay unit was designed and built for use with a laboratory high-speed scope that will be employed as a monitor for initial field tests.

The field-trials trailer has been completely wired and renovated. A new table has been installed and connecting cables etc, are being collected. The 400-cycle gasoline-driven generator has been overhauled and tested for overload.

MICROWAVE ZONE POSITION INDICATOR - MK. II (MODIFIED A.A. NO. 4 MK 6)

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Summary As a part of the program to increase the range of this equipment, an antenna of greater power-handling capacity is required. After successful tests of an experimental antenna had been made, the prototype antenna was designed. This antenna will consist of a section of a 2 by 14 foot parabolic cylinder fed from a slotted waveguide. Beam positions will be determined by means of a hydraulic rocking mechanism.

Progress Mechanical design details of all items required for this program had been finalized during the previous quarter, and good progress has since been made on the fabrication of the various items.

The remodelled king pin and king pin housing assembly have been completed and re-installed in the trailer. This assembly also includes the new circular wave guide through the king pin, and the slip-ring assembly. All equipment removed during the dismantling of the original king pin has also been re-installed.

The hydraulic operating mechanism has been completed and is ready for installation on the rotating frame, as soon as the frame itself is completed. The antenna framework has been completely sheeted and this unit is also ready to assemble on the rotating frame.

Considerable difficulty has been experienced in the fabrication and assembly of the rotating frame and wave guide. These difficulties have now been overcome and assembly of the unit is progressing.

The design of the wave-guide array with high power-handling capacity has been completed. Outputs as high as two megawatts can be attained with a high factor of safety, and it is believed quite likely that outputs as high as five megawatts can be handled.

The array is thirteen feet long and is non-resonant. It is composed of forty-five 3/8-inch, shunt, dumbbell slots with vinylite and glyptal. The impedance band width of this array is exceptionally broad because of the low Q of the wide

3/8-inch slots. The voltage standing-wave ratio is less than 1.15 over a band width greater than thirteen per cent; that is, over the range 9.7 cm to 11 cm. This may be compared with a band width of only four per cent in a similar non-resonant array of the usual 3/16-inch slots. At the same time the pattern band width is also considerably improved. Secondary lobes are less than twenty per cent of the main lobe over a band width greater than eight per cent, as compared with a similar band width of four per cent for a corresponding array of 3/16-inch slots.

The vinylite and glyptal slot coverings have been subjected to weathering tests in cold and tropicalization chambers over a period of three months and are believed to be satisfactory for use in climatic extremes.

A report entitled "The Design of Practical High Power Slotted Wave Guide Arrays" (ERA-161) has been prepared and will be issued within a few weeks. This report covers the theoretical aspects of such arrays.

DISTRIBUTION

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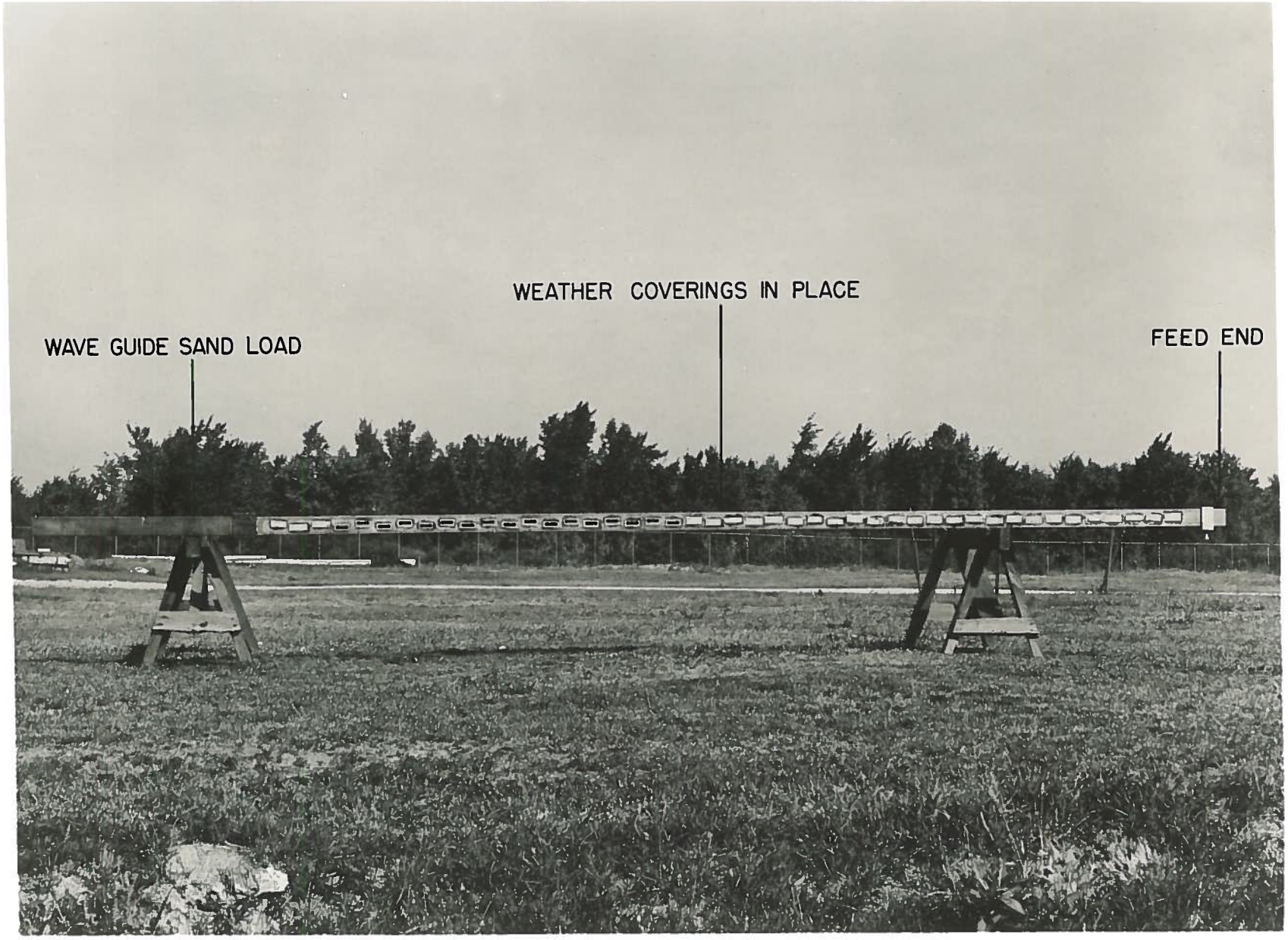

NON-RESONANT WAVE GUIDE ARRAY OF $\frac{3}{8}$-INCH DUMBBELL SLOTS