Progress report on CB radar equipment July - September 1953

National Research Council of Canada. Radio and Electrical Engineering Division

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NATIONAL RESEARCH COUNCIL OF CANADA

RADIO AND ELECTRICAL ENGINEERING DIVISION

PROGRESS REPORT

ON

CB RADAR EQUIPMENT

JULY - SEPTEMBER 1953

OTTAWA

OCTOBER 1953

COUNTER-BOMBARDMENT RADAR EQUIPMENT (AN/MPQ-501)

GENERAL

During this quarter, the individual units of the radar were given final system tests in the laboratory, packaged, and mounted in the test vehicle — a standard 2½-ton M 133 truck chassis with a special radar cabin.

The necessary power control and signal cabling in the vehicle was completed, and the preliminary testing of the complete radar equipment was begun.

The accumulation and packing of spare parts and assemblies for shipment to Shilo, Manitoba, was started. Also details of preliminary firing trials at Connaught Ranges, South March, Ontario, were completed, including the selection of mortar and radar sites.

A preliminary technical description of the radar (ERA-251), a description of its mechanical features, and drills for taking the equipment in and out of action were prepared. A brief outline of the mathematics of the computer was also completed and published (ERA-261).

ANTENNA

Additional measurements were made on the components of the antenna system in an effort to determine the extent of the various losses in the array and scanner. As reported previously, measurements on the complete assembly had shown the over-all gain of the system to be of the order of 37 to 38 decibels above that of a half-wave dipole, except near the region of zero scanning angle where the gain rose to 42 decibels. A measured gain curve showing the effect for the lower beam appears on the following page, and the obvious inference is that at zero scanning angle, where the array is feeding almost directly into the fixed parallel-plate region, the energy reflected from the teeth and corners is considerably reduced with a consequent increase in gain.

While these measurements gave an indirect indication of the relative scanner losses as a function of scanning angle, they did not provide any information as to the absolute losses. The reflector was therefore set up and fed with a primary source consisting of the array, a short parallel-plate region, and a horn — these components being of the same type as were used in the scanner. The primary feed was moved relative to the reflector until the E-plane radiation patterns were made as similar

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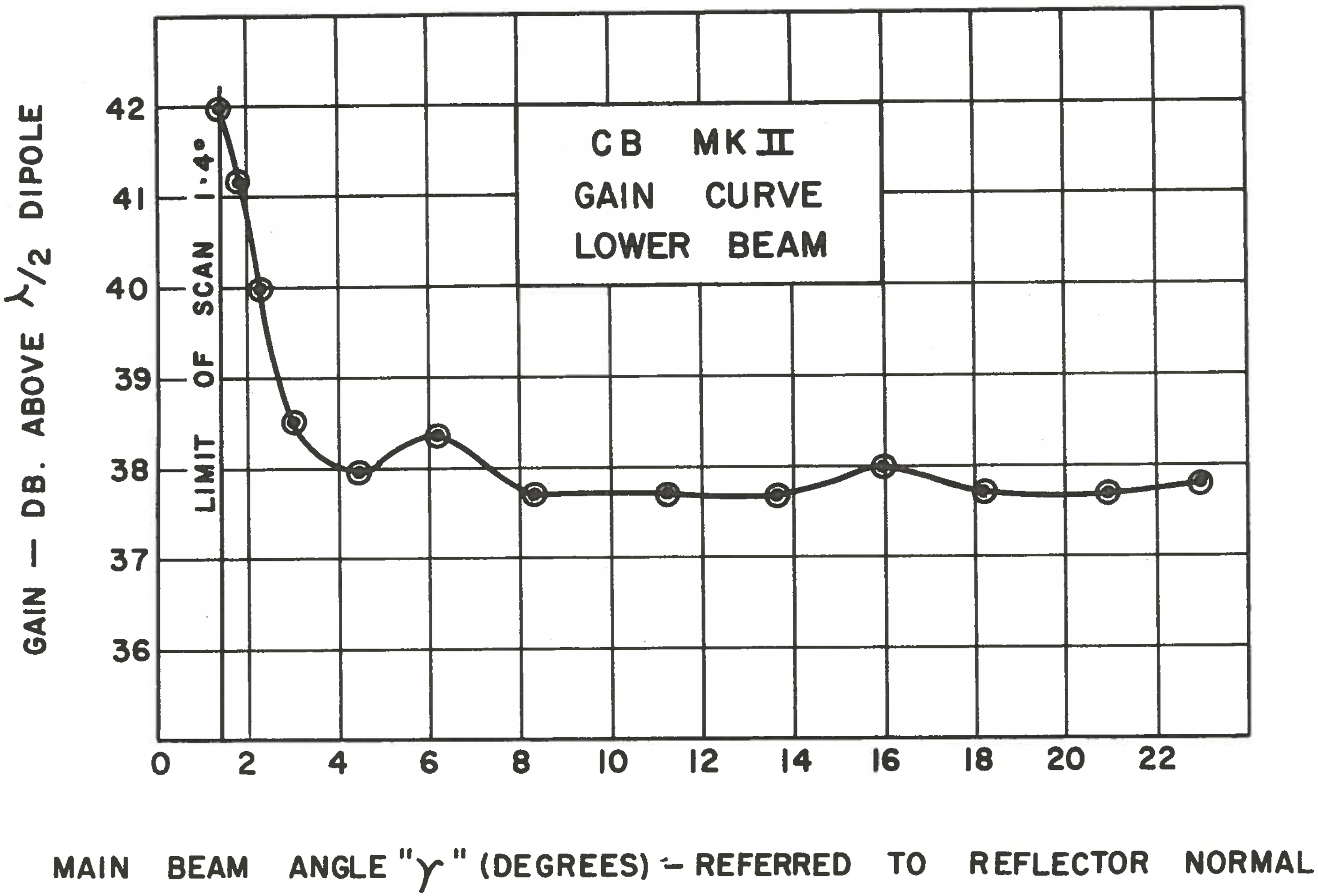


CB MK II
GAIN CURVE
LOWER BEAM
GAIN — DB. ABOVE λ/2 DIPOLE
42
41
40
39
38
37
36
LIMIT OF SCAN 1·4°
0
2
4
6
8
10
12
14
16
18
20
22
MAIN BEAM ANGLE "γ" (DEGREES) — REFERRED TO REFLECTOR NORMAL

as possible to those obtained earlier when the complete scanner was used to flood the reflector. The gain was then measured and found to be 41.5 decibels above that of a dipole, a figure actually 0.5 decibel less than the maximum gain measured using the scanner. Allowing for errors in measurement, it would appear then that the losses in the scanner, when in the zero-scan position, are not noticeably different from those obtained when the scanner is replaced by a short parallel-plate region.

In addition to this gain measurement, a measurement was made of the loss in the flat load which terminates the array. This test showed that 35 percent of the input power was lost in the load, or an additional loss of 1.9 decibels.

As a result of these tests it was found that the maximum loss in the system approached 7 decibels. It is reasonable to suppose that a re-design of the array would reduce the fixed loss in the flat load, and that a re-design of the scanner teeth and corners would reduce the loss in the scanner at other than zero scanning angles.

RECEIVER

The receiver was tested with the modulator, and after slight modifications to the AFC circuit, appeared to operate satisfactorily.

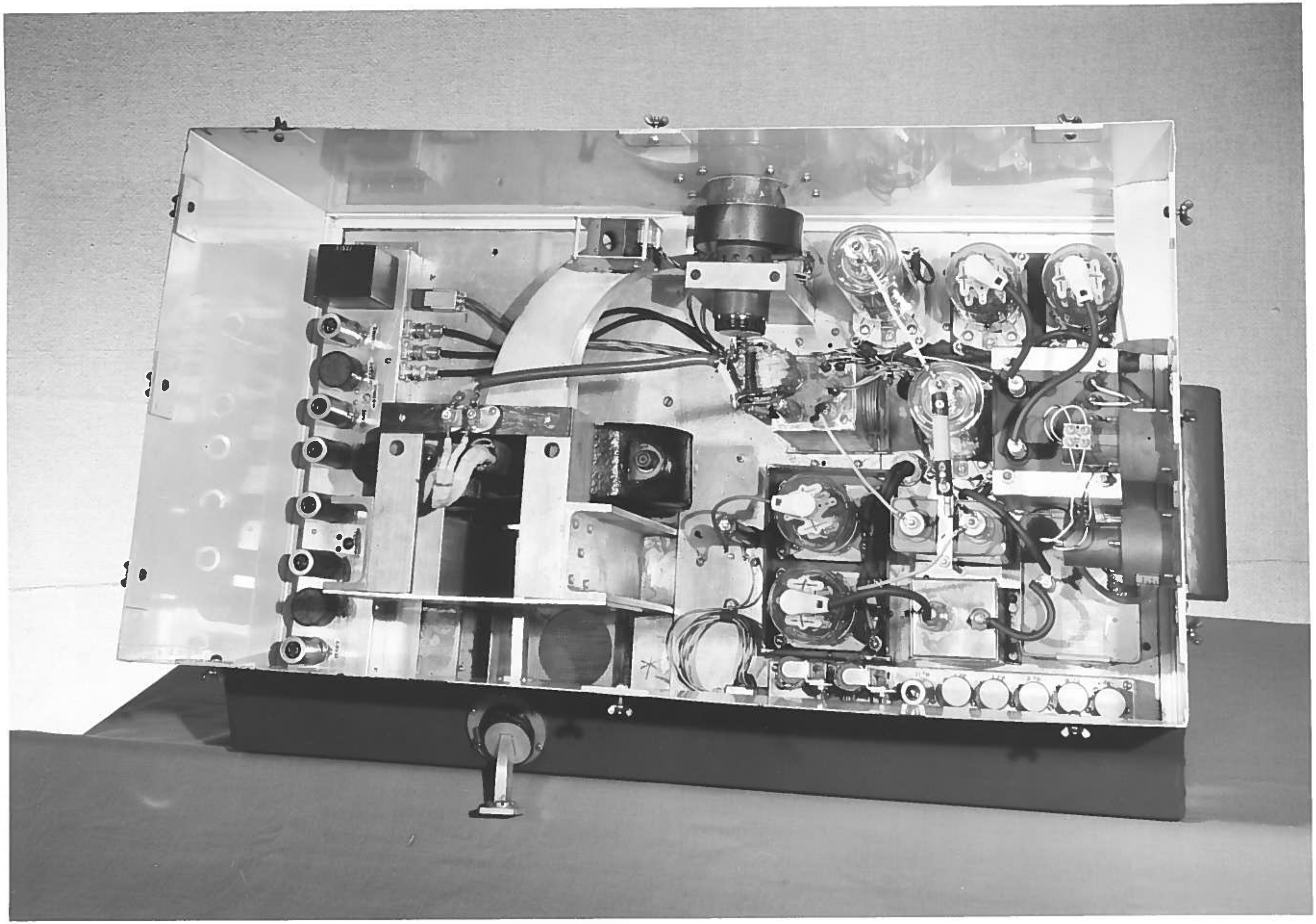
A new video amplifier is being constructed to replace the present video amplifiers and video preamplifier. This amplifier incorporates a beam identification circuit, designed to delay and feed back upper beam echoes, thus giving both a normal and a slightly delayed echo from the upper beam, to permit identification of the echoes from the upper beam.

TRANSMITTER

The transmitter was completed and tested at full output. Additional forced air ventilation was included to limit the temperature rise within the case to 20°C. Photographs of the transmitter and its associated power supply are included in this report.

COMPUTER

The computer units were interconnected by laboratory test cabling, and problems were set in from the computer test set described in an earlier report.



TRANSMITTER
TOP VIEW

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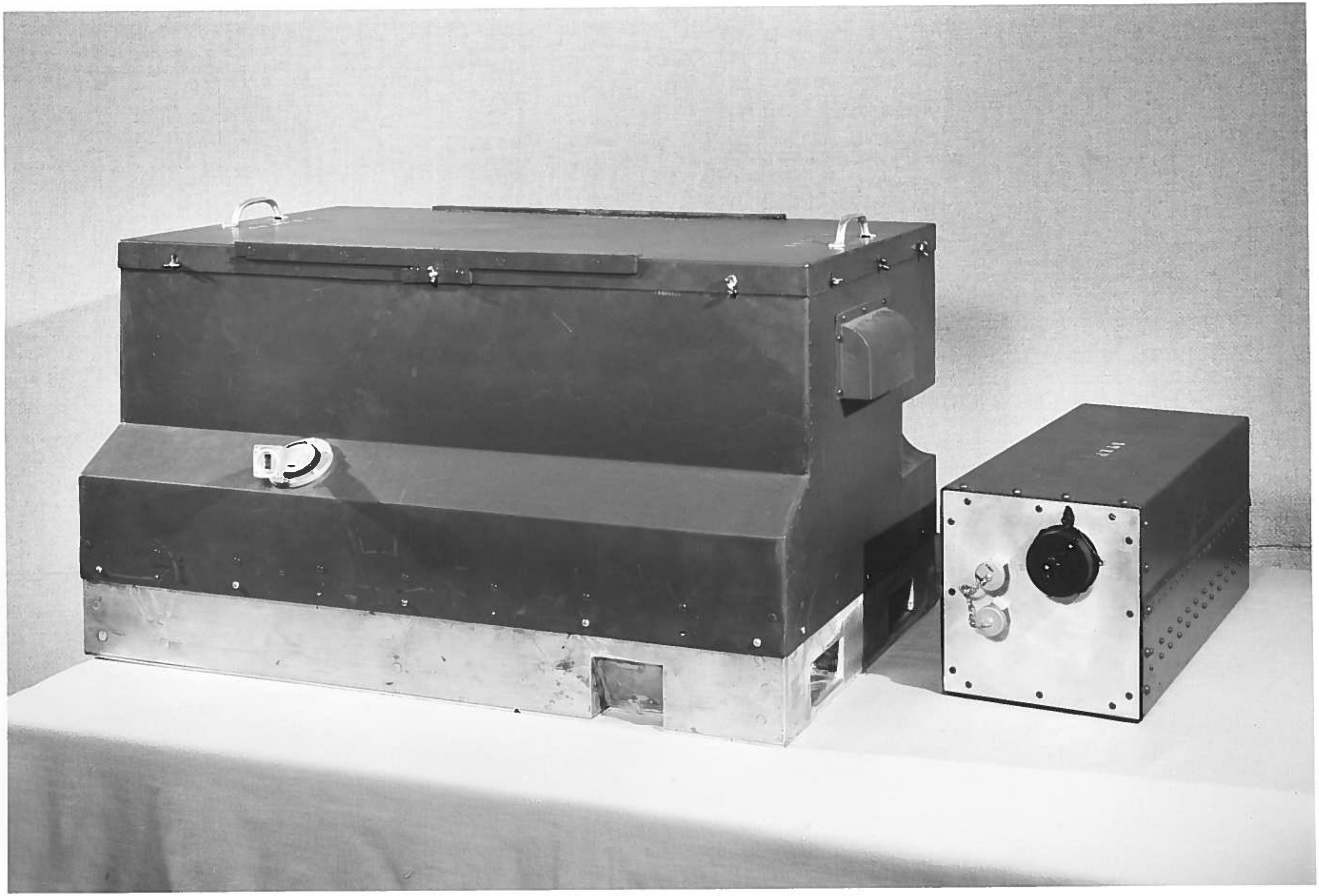

TRANSMITTER AND (ON RIGHT) POWER SUPPLY
FOR TRANSMITTER AND RECEIVER

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POWER SUPPLY FOR TRANSMITTER AND RECEIVER
(CASE REMOVED)

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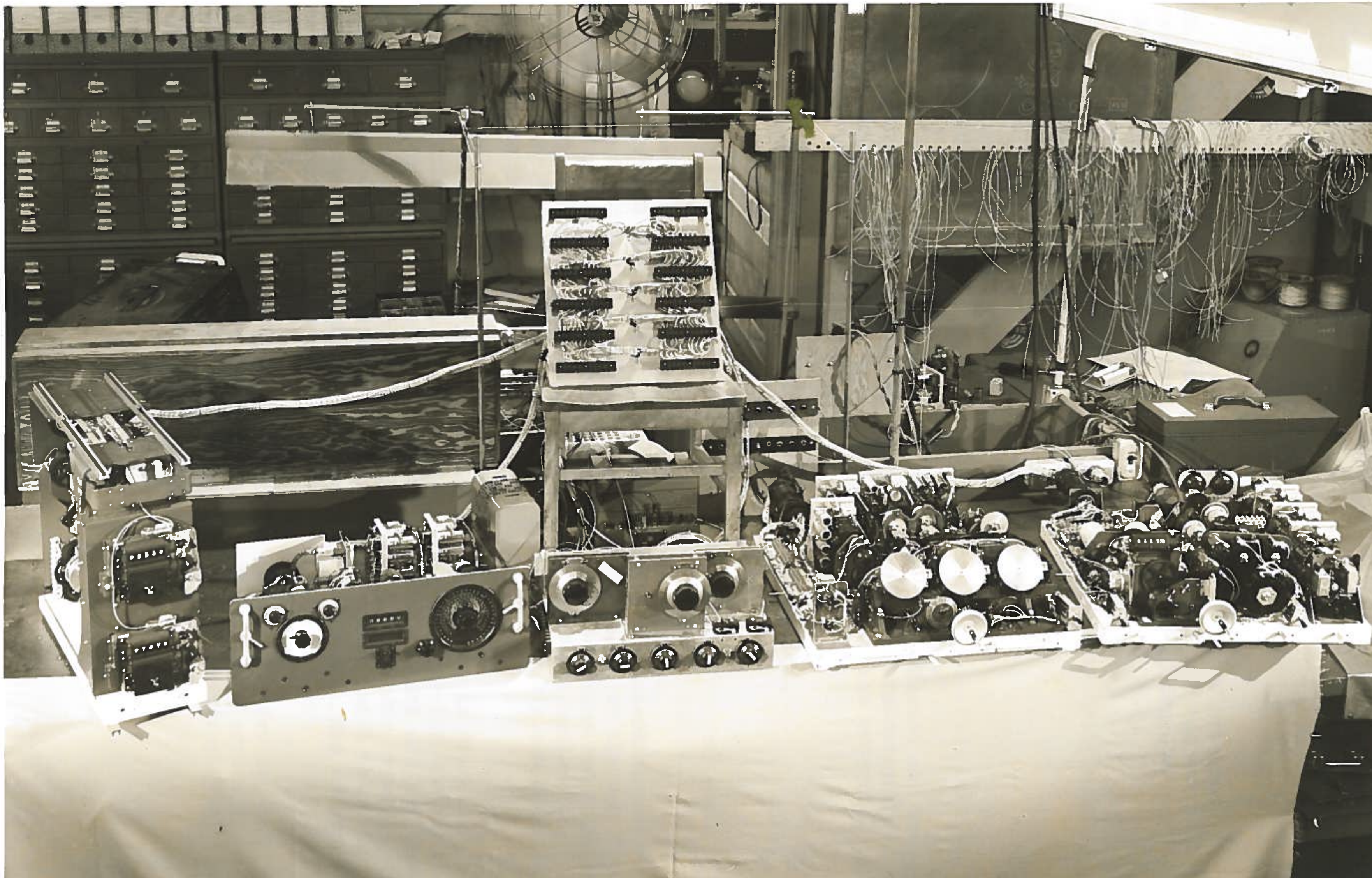

LABORATORY TESTING OF COMPUTER

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The results achieved from an extensive series of problems, in which all relevant parameters were varied throughout their operational ranges, indicated an overall accuracy of compution of 15 to 20 meters, which is considered quite satisfactory.

A photograph showing the equipment used in this test is included in this report.

TEST SET

The electronic portion of the test set was completed and tested. This test set, which is provided with facilities for the measurement of power, wavelength, and receiver sensitivity, will form part of the essential test equipment to be supplied with the radar.

Assembly of the test set is virtually completed.

TRAINER

It is most likely that the major error in the determination of mortar locations under field conditions will be that made by the operator in setting the marker on the successive positions of the received signals. A training device was designed and built to permit the evaluation of operator errors, and to assist the operator in improving his accuracy through experience with the equipment.

The trainer simulates the display as closely as is practical, displaying signals sequentially at two locations preset by the instructor with a known time interval between them. Both the locations and the time interval are variable throughout the range found in the radar itself. The operator has controls, similar to those in the radar, with which to position the marker and to set in the time interval noted. His errors can be read from calibrated controls.

Two operators were trained, with the aid of this device, and showed considerable improvement with training. The average errors in position and time were small enough to permit the overall accuracy of the radar to be met.

VEHICLES

As mentioned in the previous report (ERA-255), three possible mounts for the equipment are under consideration, namely, the M 133 truck, a two-wheeled trailer, and the FV 603 armoured personnel carrier. No decision has been made as to the final mount.

The equipment has been mounted on the M 133 for trial purposes, but the two-wheeled trailer has now been delivered and tested with an equivalent dummy load. The cable drums and their mounts, which will be carried on the towing vehicle, have been designed and are being fabricated.

Designs for the mountings required on the FV 603 personnel carrier are well advanced.

MOVING-RIDGE SCANNER

The possibility of using a slotted waveguide array with a moving ridge as a scanning antenna was investigated and reported in the unclassified Progress Report (ERA-234) of April-June, 1952. Later, experimental verification of the theory was obtained.

A short ridge-guide section (without slots) was built and tested. These tests showed that the change in wavelength with ridge penetration is exactly as predicted by theory. The attenuation varies somewhat with ridge penetration but is not excessive. With silver guide the total ohmic loss in a 5-foot array should not exceed 1 or 1.5 decibels.

A 46-slot array was designed and built. The experimental model incorporated all the mechanical features that would be required in the final design. So far only electrical tests have been made on the model, and the radiation pattern was found to be in good agreement with the design objectives. The half-power beam width is 1.9 degrees and stays constant over a 10-degree scan. Maximum side-lobe levels are more than 20 decibels below the peak of the main beam. The variation of scanning angle with ridge penetration is as predicted.

A bench setup is being built for mechanical tests. Design of a full-length double array for the CB project has been initiated.