Progress report on CB and MZPI radar equipments, January-March, 1953

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NATIONAL RESEARCH COUNCIL OF CANADA

RADIO AND ELECTRICAL ENGINEERING DIVISION

PROGRESS REPORT

ON

CB AND MZPI RADAR EQUIPMENTS

JANUARY - MARCH 1953

OTTAWA

APRIL 1953

COUNTER-BOMBARDMENT RADAR EQUIPMENT

GENERAL

The delivery of completed assemblies commenced early in January. The scanner was completed by McGill University early in the month, and was immediately assembled on the antenna mount built for the prototype. Details of both the mechanical fitting and results of the pattern tests will be found on pages 3 and 4.

Most of the containers for housing individual units of the console have been completed, and the backlog of machine time on the computer and antenna assemblies has been very substantially reduced. Essentially, the project has reached the assembly and test phase.

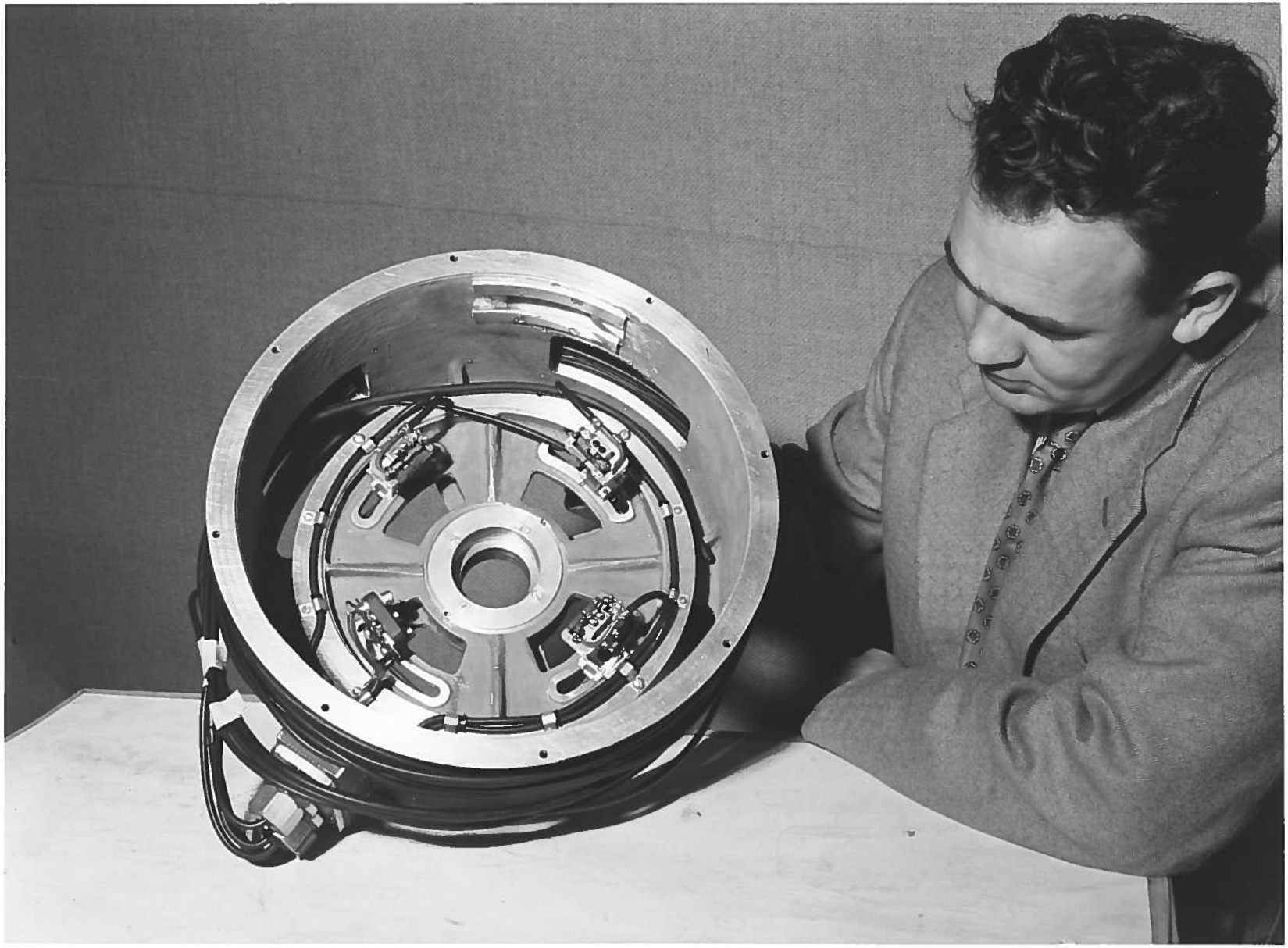
RECEIVER

The 6-megacycle bandwidth receiver (for use with the new 0.2-microsecond pulse length) has been completed. It consists of an intermediate-frequency preamplifier, a main intermediate-frequency amplifier, a detector, and a video cathode-follower output stage. A photograph of the main amplifier unit is included in this report. The plug-in relay visible in the photograph is used to select either a linear or a logarithmic gain characteristic. As a linear receiver, the overall gain from the intermediate-frequency input terminals to the detector output is 121 db, and the overall bandwidth is 6 megacycles.

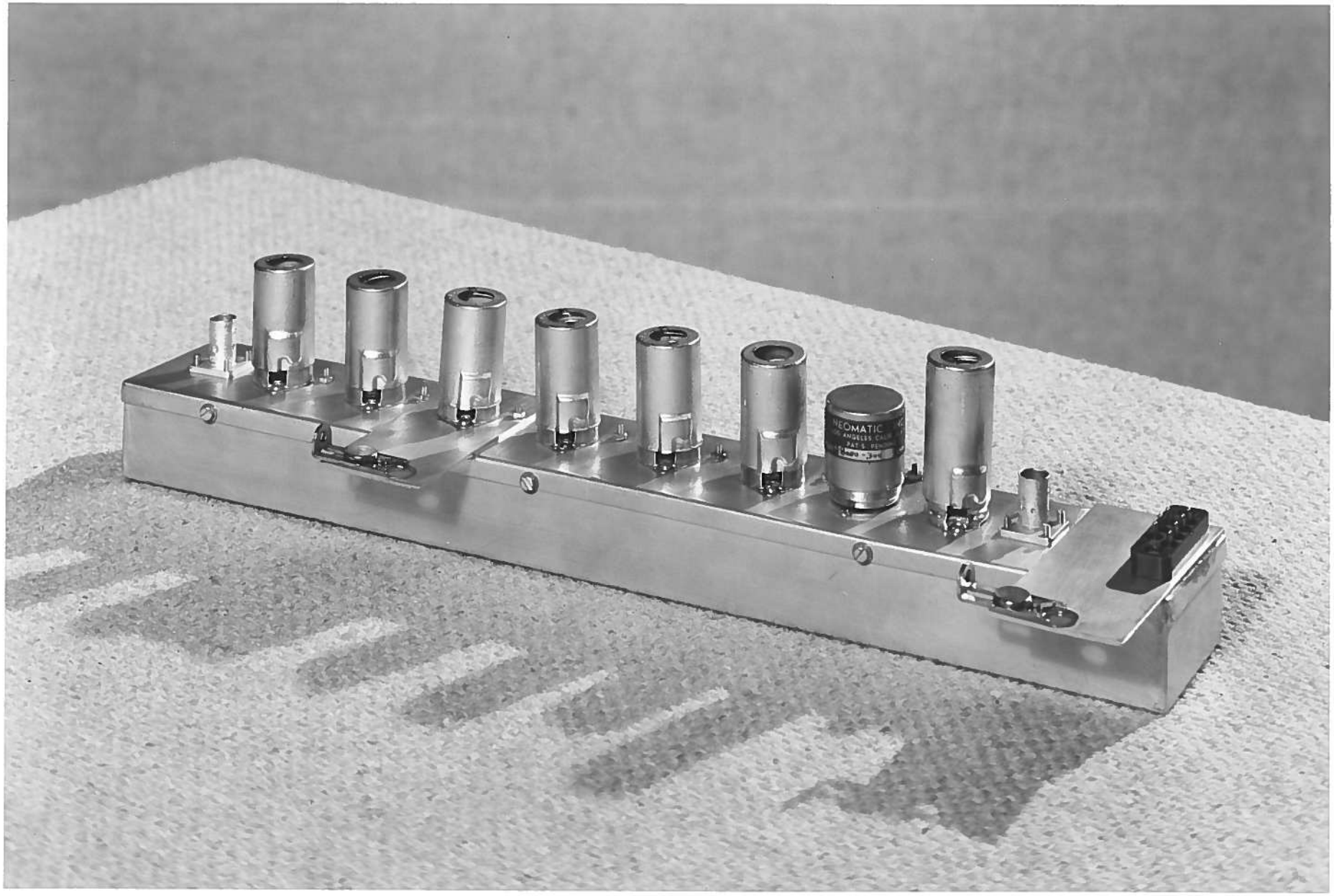
R-F HEAD

All components of the head have been mounted on the mounting plate, and are ready to be installed in the head compartment which has been finished and mounted at the end of the scanner. The inter-chassis cables have been made.

The cable distribution box for the head has been completed. The box also contains metering facilities, and gain and manual frequency controls (duplicating similar controls on the display panel) for use in adjusting and testing the performance of the head.



END BELL FOR SCANNER
SHOWING ADJUSTABLE MOUNTS FOR AZIMUTH PULSE COILS
AND BRUSHES FOR BEAM-CENTERING MOTOR



LIN/LOG INTERMEDIATE-FREQUENCY AMPLIFIER
(6-MC BANDWIDTH)

TRANSMITTER

The modified transmitter has been wired and tested at full power. Satisfactory results were obtained at the lower pulse recurrence frequency of 4500 pps; however, some anode heating in the hydrogen thyratron at 9000 pps indicates that parallel operation of two thyratrons will be necessary. Improved operation was obtained with a pulse transformer of new design.

CONSOLE POWER SUPPLIES

The four power supply units have been completed. Tests indicate that stability, voltage regulation, and temperature rise are within the specifications. The units were operated satisfactorily at 125 per cent of rated load.

POWER CONTROL PANEL

The power control panel unit contains the operating controls for the transmitter, as well as the equipment for control and distribution of 400-cycle and 24-volt d-c power. This unit has been built and tested. It is complete, with the exception of name plates for the front panel.

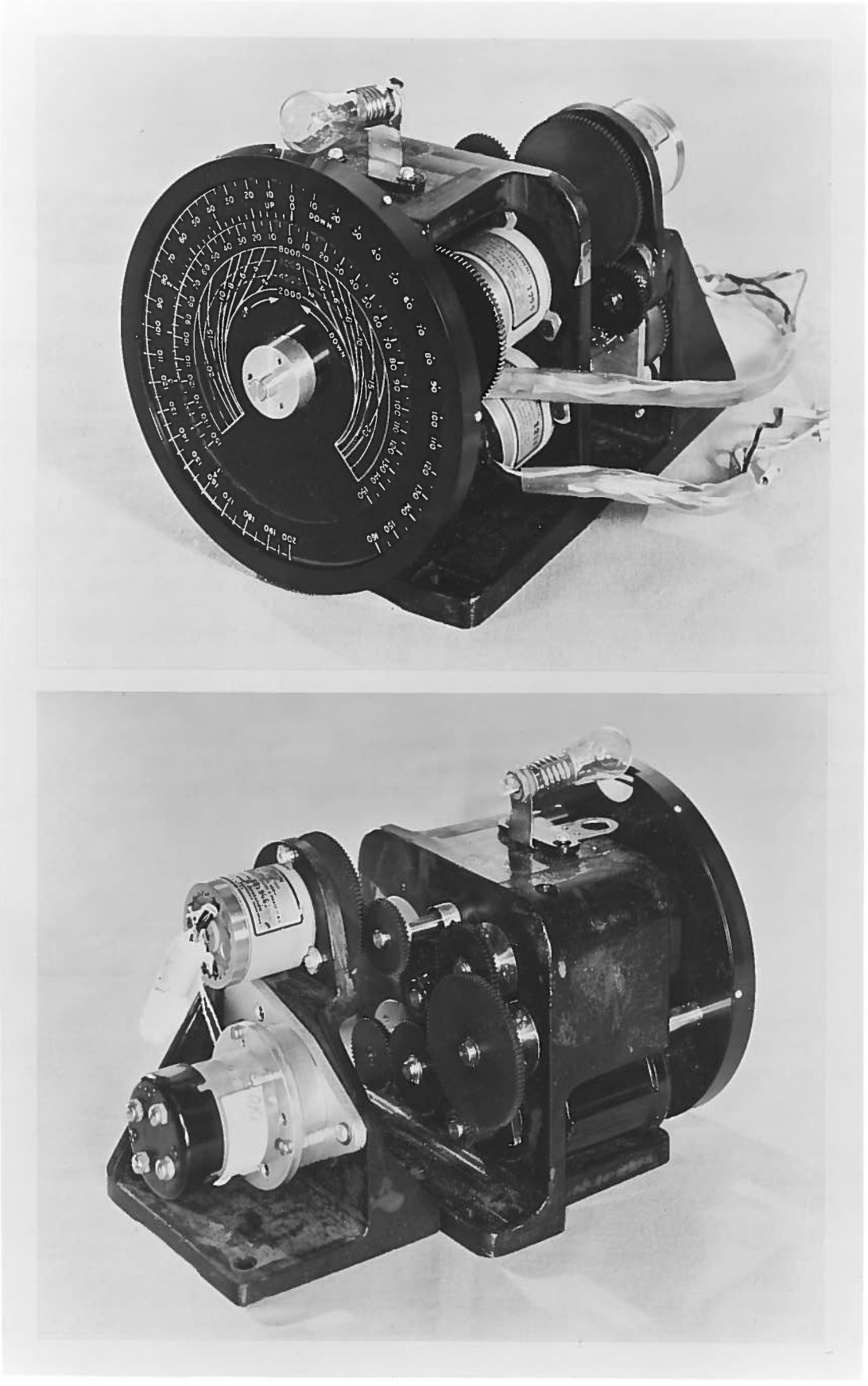
ELECTRONIC CONTROL UNIT

This heading comprises most of the range and azimuth electronic chassis. Some modifications made to the range calibrator improved its performance. Modifications to the azimuth brightening circuitry were commenced with a view to simplifying adjustment.

Layout of the front panel was commenced. This panel carries three meters with selector switches for use in monitoring performance and indicating power supply voltages, in addition to six switches controlling the operation of the equipment.

DISPLAY

The display unit has been assembled and wiring has commenced. The video amplifiers from the previous model have been mounted in this unit



WORKING PLANE AND ANGLE-OF-SIGHT SUB-ASSEMBLY
FOR ELEVATION UNIT OF COMPUTER

and will be used for the trials. A temporary high-voltage supply has been built and installed. This will be replaced by a smaller oil-filled unit when suitable 400-cycle transformers are received.

COMPUTER

Assembly of components on the machined castings is well advanced in the shop. One of these castings with its components, the Working Plane and Angle of Sight Sub-Assembly, is shown in the accompanying photograph.

The elevation unit has been wired and adjusted for satisfactory operation; the range unit has been wired and tested, but owing to certain backlash effects, satisfactory operation could not be obtained. Some minor changes in gear ratios are being made.

The test set, as designed, has been found to be of great assistance in adjusting the individual units separately. It is now proposed that this item become a part of the test equipment provided to the servicing workshop.

A device known as a "genstrip" has been designed to fit in the front panel of the range unit. This consists of a long strip of paper on which instructions for testing and adjustment are printed. Rollers may be turned to expose any desired part of the strip.

ANTENNA ASSEMBLY

(a) Mechanical Work

The Foster scanner was mounted on its frame in the theoretically correct position with respect to the reflector. Subsequent tests at the field station showed this to be the optimum position from a practical standpoint.

The end bell for the large end of the Foster scanner was completed. This assembly, shown in the accompanying photograph, includes adjustable mounts for the azimuth pulse coils, and brushes for the beam-centering motor. The entire coil and brush mount may be rotated to adjust for beam squint with change of transmitter frequency.

The elevation and azimuth drives and information systems were completed during the period under review and were found to be satisfactory.

CONFIDENTIAL

ANTENNA..C.B..MK II.....

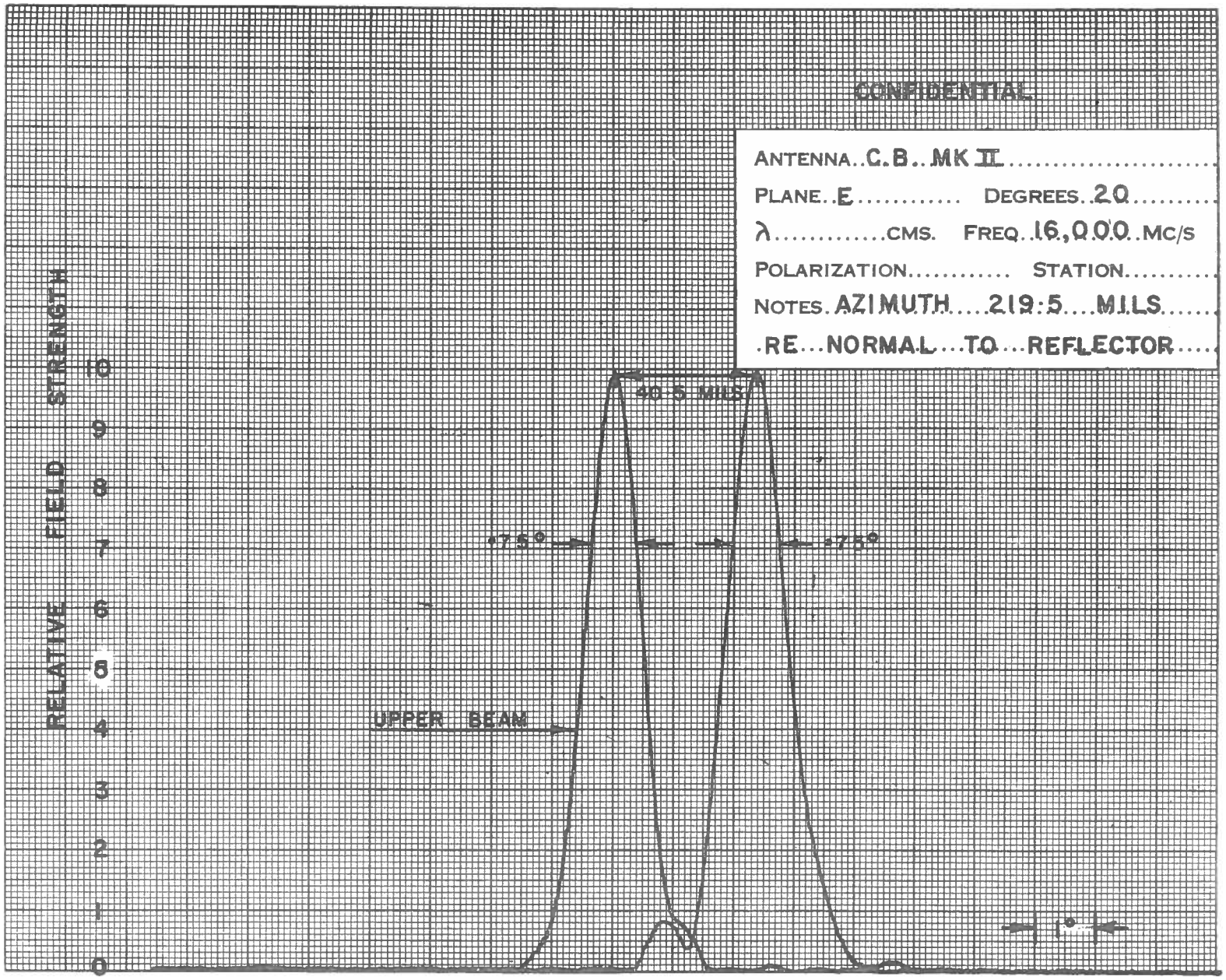
PLANE..E..... DEGREES..20.....

λ.....CMS. FREQ..16,000..MC/S

POLARIZATION..... STATION.....

NOTES. AZIMUTH....219·5....MILS.....

.RE...NORMAL...TO...REFLECTOR....



CONFIDENTIAL

ANTENNA..C.B..MK.II.....

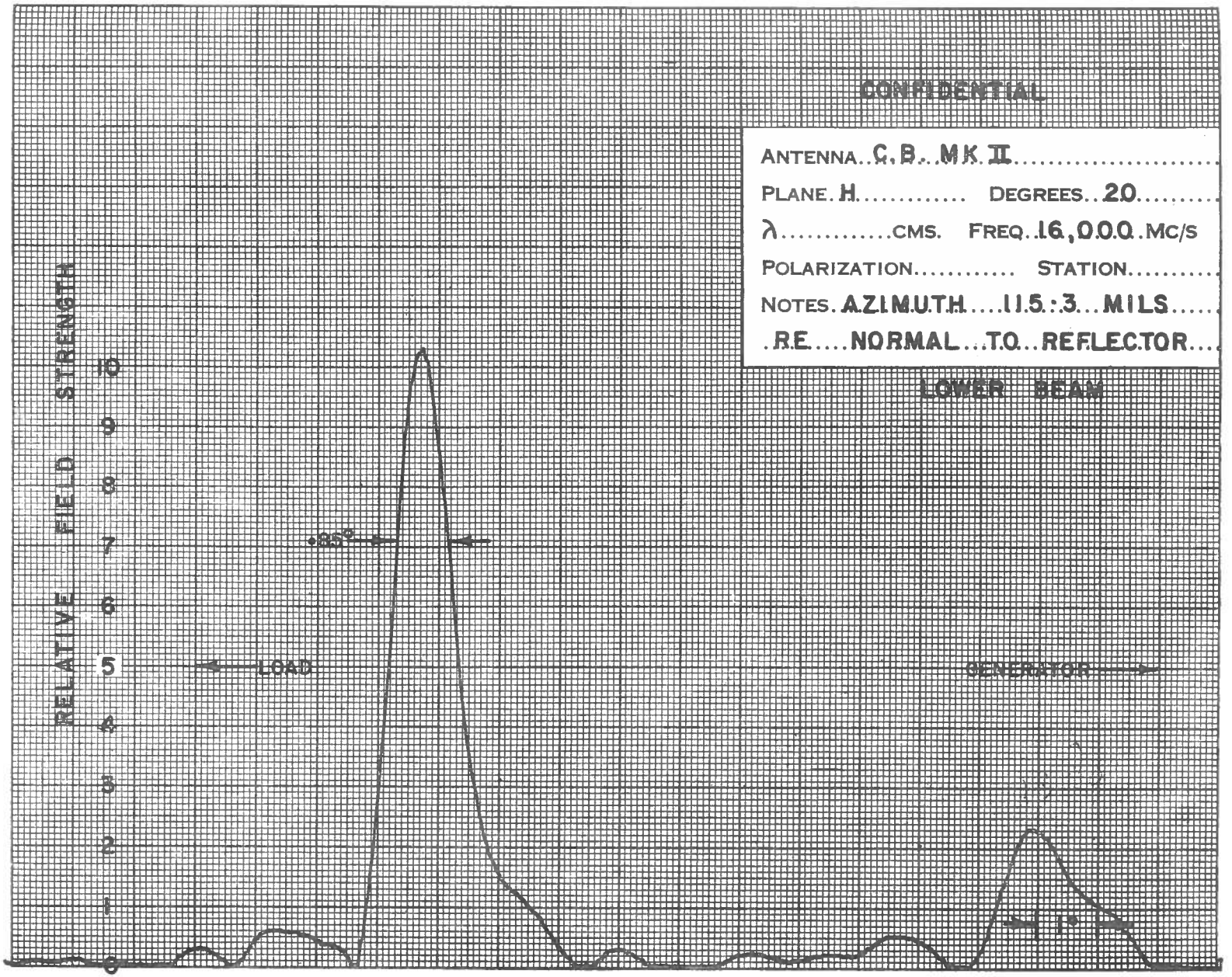
PLANE..H..... DEGREES..20.....

λ.....CMS. FREQ..16,000..MC/S

POLARIZATION..... STATION.....

NOTES. AZIMUTH....115.:3...MILS.....

.RE....NORMAL...TO..REFLECTOR...



REFLECTOR AND SCANNER TEMPORARILY MOUNTED ON TEST VEHICLE
FOR CHECKING ANTENNA PATTERNS

(b) Antenna Tests

Measurements of the radiation patterns, gain, and input VSWR of the antenna assembly were carried out, prior to the final assembly and testing of the set. In order to facilitate these measurements the reflector and scanner were mounted in their final positions on the truck, as shown in the photograph. Follow-up systems were installed, which made it possible to connect the automatic antenna pattern recorder drum to either the azimuth or elevation drive of the antenna, thus greatly reducing the time necessary for pattern-taking.

Both E- and H-plane patterns were studied for various positions of the scanner rotor, at three frequencies in the band of operation of the magnetron. The E-plane patterns were found to be quite satisfactory, and substantially independent of either scanning angle or frequency. A typical pattern for this plane is shown. It will be noted that a coma lobe is present on the upper side of the lower beam. Because of the off-focus feed, however, it is not of sufficient amplitude to be serious.

In the H-plane, second-order and third-order beams due to internal reflections in the scanner were found to be present. A typical example of the second-order beam appears in the pattern record. Detailed studies showed the second-order beam to have a maximum amplitude 12 db down from the peak of the main beam at a scanning angle of some 3° from normal. This level was found to decrease sharply near normal scan, and to decrease slowly as the scanning angle increased. The third-order beam exists only near normal scan and has a maximum amplitude of -20 db.

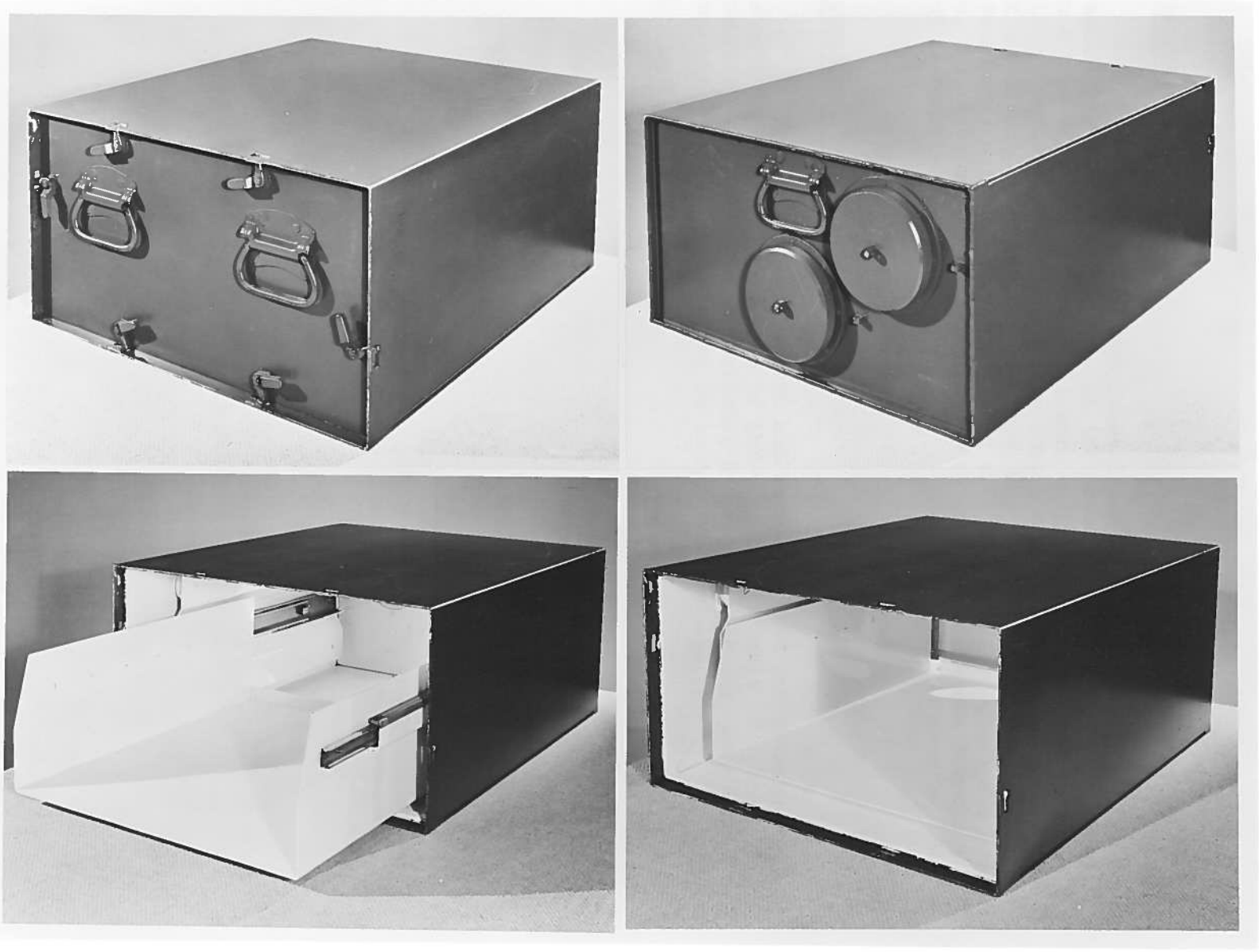
The effect of these internal reflections was quite evident in the gain measurements which showed a gain of 37 to 38 db over a dipole throughout most of the scan. This figure, however, rose sharply near normal scan to a value of some 42 db.

The input VSWR of the antenna was found to be quite satisfactory over the required frequency range, and to vary only slightly with rotor position.

While the tests indicate rather a low gain figure, it is felt that improvements can be made in the production model by re-designing the teeth with a view to reducing internal reflections.

PACKAGING

All packages for the computer were completed during the period under review.



TYPICAL CONTAINER FOR CB UNITS

VEHICLE

No decision has been reached yet as to the most suitable vehicle for the CB equipment. At the present time the set is mounted on a type-M133 army truck. (All work on this vehicle is now substantially complete.) It is possible that a specially designed trailer, or a self-propelled armoured vehicle, may prove to be more desirable. Accordingly an order has been placed with the Brantford Coach and Body Co. for construction of a trailer suitable for the antenna structure and accessories.

INSTRUCTION MANUALS

The general description has been completed and is being typed as an advance report (ERA-251) of the project. A table of operating controls, and the control functions, has been completed. Work on the complete technical description is being continued.

MICROWAVE ZONE POSITION INDICATOR MK.II

(Modified A.A. No.4, Mk.6)

BROAD-BAND SYSTEM

The second model of the electromechanical automatic frequency control chassis has been completed and tested in an experimental form. This chassis uses a new AFC circuit in which the discriminator action is provided by a pair of grid leak detectors which act also as a cathode-coupled amplifier. The present MZPI coil assembly may be used with this circuit. The d-c stability of this circuit is much improved; d-c stability is essential in this circuit because a shift in d-c level will cause false operation of the mechanical AFC servomechanism. In addition to improving the stability, the cathode-coupled amplifier connection has eliminated the floating power supply in the present AFC circuit.

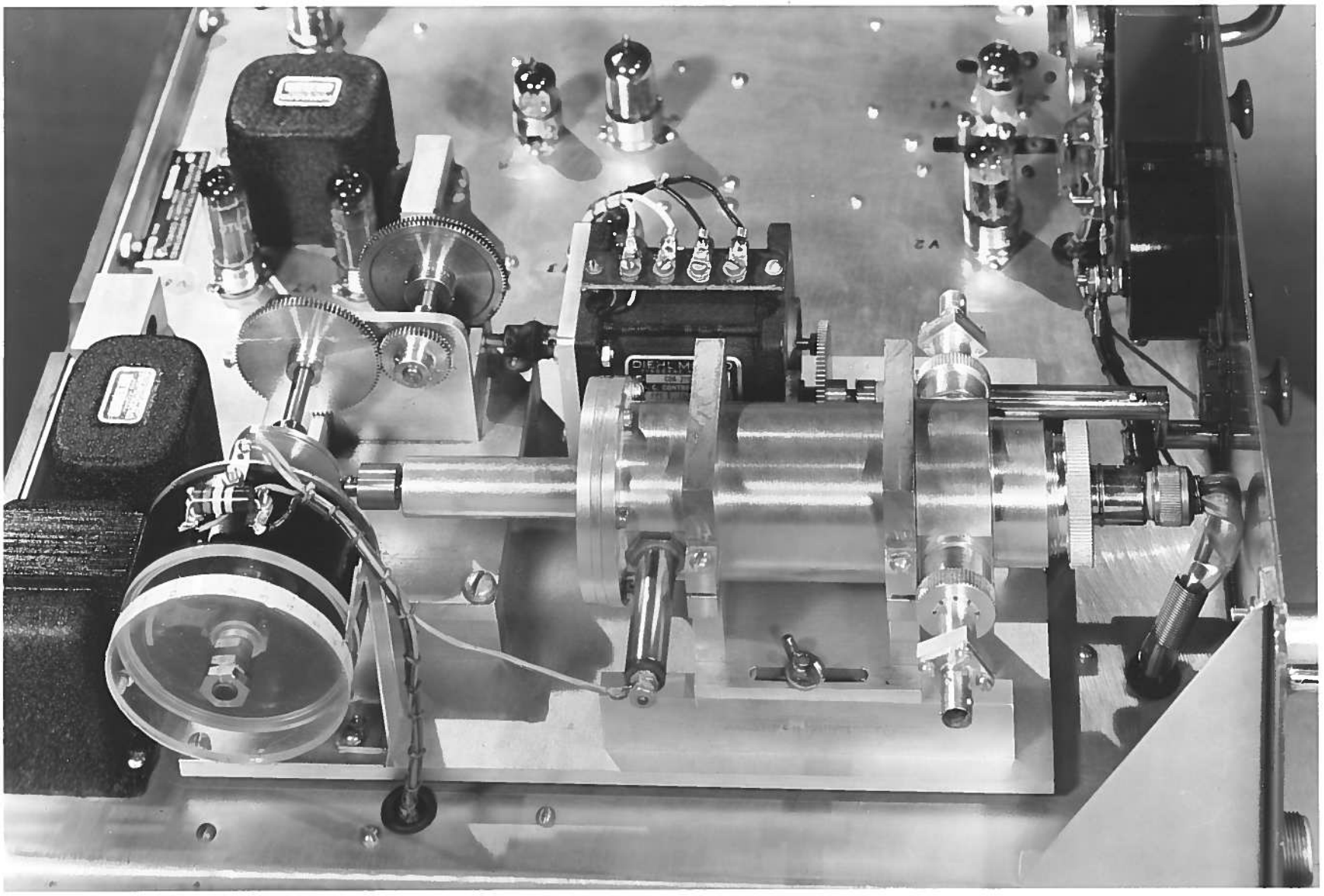
The system will follow the tunable magnetron as quickly as it can be tuned by hand. It will also search and lock on the correct sideband in about 6 seconds. The circuit would permit considerable improvement to this figure, if required. Mechanical tuning of the local oscillator is accomplished by a motor-driven cam.

The variation in AFC magnetron sample energy which can be tolerated between locking on the wrong sideband and failure to lock on the correct sideband is 15 db. This range has been achieved partly by Ratcliffe's circuit, and partly by an a-c coupling circuit from the discriminator output to the input of the electronic search-stop relay. During the search operation this coupling network provides a voltage input to the search-stop circuit which discriminates in favour of the correct sideband.

The electronic search-stop relay is a Schmitt trigger designed to remove the search voltage and connect the error voltage to the mechanical tuning servomechanism when the tuning of the local oscillator is approximately correct. It employs two tubes and requires no mechanical relay.

The accompanying photograph shows some features of the mechanical servomechanism, including the servo motor (above center of picture), the gear train, the tuning cam, the reflector tracking pot, and the local oscillator cavity.

The Directorate of Armament Development has requested that the circuit be tested on the radar now at Fort Bliss, Texas. Preparations for this are under way, in collaboration with Canadian Arsenals, Ltd. Because



LOCAL OSCILLATOR TUNING MECHANISM

SECRET

of the requirement that modification to the radar at Texas be held to a minimum, it has been found necessary to modify the radio-frequency components. In order to facilitate the modification, some parts of the duplexer have been borrowed from CAL, and assembly is under way in our shops.

In addition to the above work the broad band rotating coupler has been fitted into the trailer and tested.

"SINGLE ECHO" MONITOR UNIT

This unit displays the return from a single target as it is scanned by the radar antenna. A particular target is chosen on the PPI display by superimposing the intersection of the azimuth cursor line and the range strobe marker upon it.

Satisfactory operation of a "bread board" model was obtained. Except for the completion of the case, which has been delayed by pressure of work of higher priority, the construction and testing of an experimental model of functional design have been finished. Field tests of the unit are to be made when the MZPI equipment is available.