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DESIGN OF A SUPPRESSED LOCALIZER-ODR ANTENNA FOR THE A. V. ROE JETLINER

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THE INVESTIGATIONS AND DESIGN DESCRIBED IN THIS REPORT WERE CARRIED OUT UNDER CONTRACT WITH A. V. ROE CANADA LIMITED

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ABSTRACT

Design and test data are given for a suppressed Localizer-Omnidirectional Range (ODR) antenna installed in a plastic fin cap on the A. V. Roe Jetliner. The antenna has satisfactory electrical characteristics for Localizer-ODR service over the frequency range 108-118 megacycles per second, and occupies a space 22 inches long, 9 inches wide, and 8 inches high, above the top rib of the fin.

FIGURES

DESIGN OF A SUPPRESSED LOCALIZER-ODR ANTENNA

FOR THE A. V. ROE JETLINER

Antenna Specification

At the request of A. V. Roe Canada, Limited, the design of an antenna for Localizer-Omnidirectional Range (VHF) service on the A. V. Roe Jetliner was undertaken. The antenna was required to introduce no aerodynamic drag and to have the following electrical characteristics:

(a) Horizontal polarization

(b) A reasonably omnidirectional pattern in the normal plane of flight of the aircraft and in the region 10 degrees above and below this plane

(c) An impedance characteristic such that the antenna could be used satisfactorily for reception in the range 108-118 megacycles per second, when connected to the receiver by a 50-ohm coaxial transmission line.

Choice of Antenna Type and Location

A study of the aircraft indicated that the most promising location for an antenna appeared to be on top of the fin, inside a plastic fin cap. It appeared to be extremely difficult to design an antenna for mounting beneath the aircraft, which would have the required characteristics, and it was felt that if the antenna must go on top of the fuselage, the fin tip would be the most suitable location. In this position less shadow effect occurs beneath the aircraft than if the antenna were mounted close to the fuselage.

For an omnidirectional radiation pattern and minimum upward radiation, a closed loop would of course be the most suitable antenna. However, the small space available on top of the fin would permit a loop only 0.08λ in diameter, and such a loop would have extremely low radiation resistance. Accordingly it was decided to use a "U" dipole, shaped to fit the space available. Such an antenna has higher radiation resistance than the loop, but, of course, does radiate some energy skyward.

Radiation Patterns

A 1/20-scale copper-sprayed wooden model was obtained for use in the model pattern measurements. Conventional pattern-measuring techniques were used, in which a crystal detector inside the aircraft gave a measure of the radiation pattern of the antenna as the aircraft was rotated in a uniform, plane, electromagnetic field. The output of this detector was fed into a recorder, so that as the model rotated the polar diagram of the antenna was plotted automatically.

The radiation patterns shown in this report were measured at a frequency of 2,260 megacycles per second, corresponding to a full-scale frequency of 113 megacycles per second, the mid-frequency of the band. Further measurements showed the patterns to be sensibly the same at the end frequencies of the band. Polar diagrams were obtained for the following principal planes: $\theta = 90°$, $\phi = 0°$, and $\phi = 90°$, as defined in Fig. 1, and for each of the two polarizations, E_θ and E_ϕ. A study of the patterns shown in Fig. 2 indicates that a considerable amount of energy is directed skyward since the antenna is not a completely closed circular loop, but that the pattern in the principal plane is free from nulls and is reasonably omnidirectional. The cross-polarized radiation in the principal plane was found to be at least 20 decibels below the peak.

Antenna Impedance

The development of a prototype antenna with suitable impedance characteristics can be traced from the impedance curves of Fig. 3. The basic radiator consisted of a "U" shaped dipole made of sheet metal some four inches wide. The lengths of the dipole arms were adjusted to bring the antenna to resonance, but the resulting resistive component was extremely small. Accordingly the broad sheet-metal radiator was replaced with a folded dipole made of tubing, resulting in an antenna with a higher resistive component. However, as this resistance was still inadequate, a double folded dipole was used, resulting in a center frequency resistance of 17 ohms. As can be seen from Fig. 3, the standing-wave ratio of this antenna was excessive at the end frequencies, and so a parallel circuit, resonant at the center frequency, was connected across the antenna terminals. This circuit, consisting of two small lengths of shorted twin line and a variable tuning condenser, served to improve the match at the end frequencies.

A photograph of the antenna installed in the fin is shown in Fig. 4. The three elements of the folded dipole are plainly visible, and the "U" shape of the dipole can be noted. The two shorted transmission lines extend inside the fin, as does the balance-unbalance transformer which feeds the antenna, while the tuning condenser is mounted in a Bakelite housing which fits around the antenna terminals. Further mechanical details can be obtained from the assembly drawing of the prototype antenna (Fig. 5).

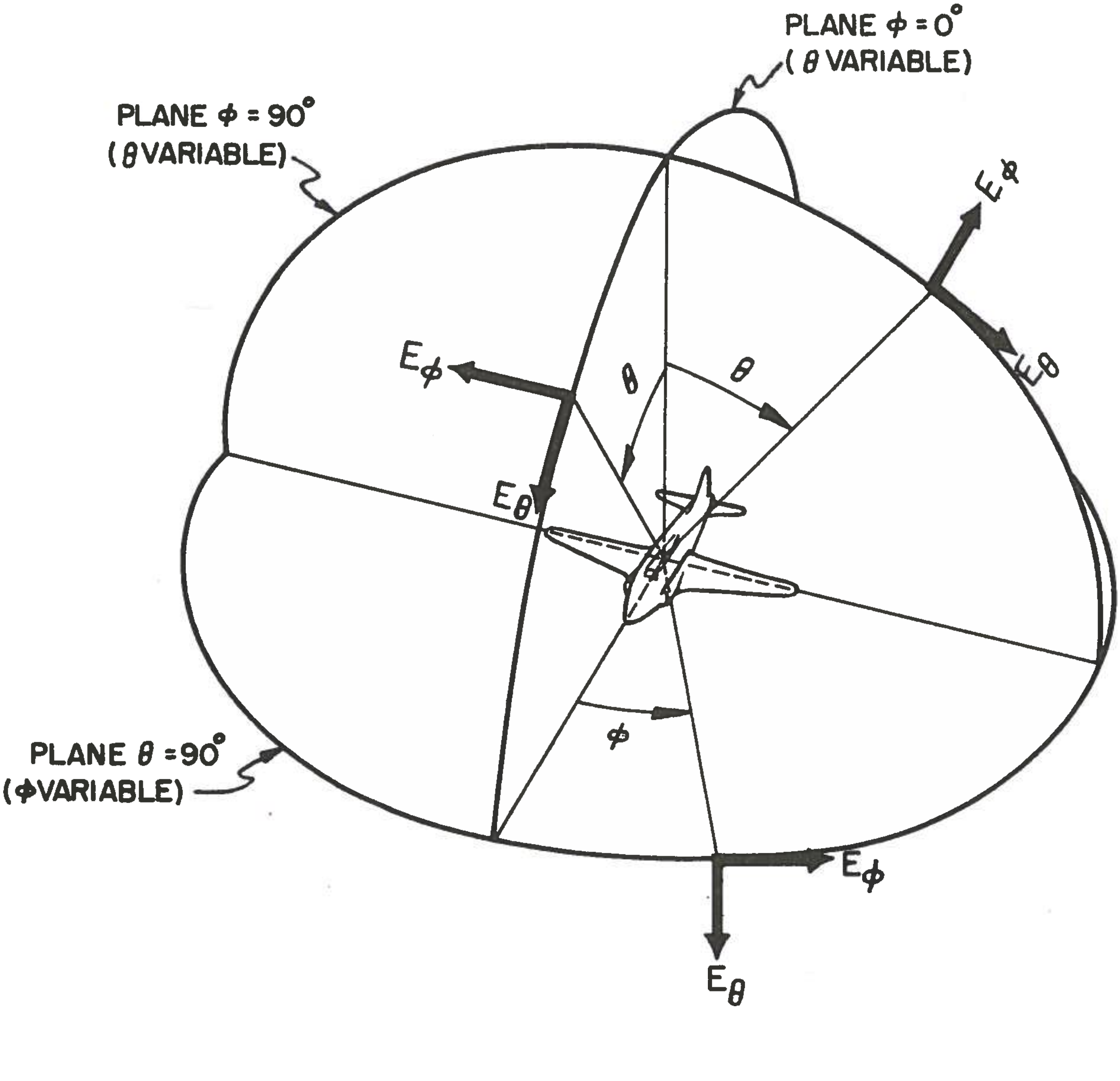

FIG. 1
SPHERICAL CO-ORDINATE SYSTEM

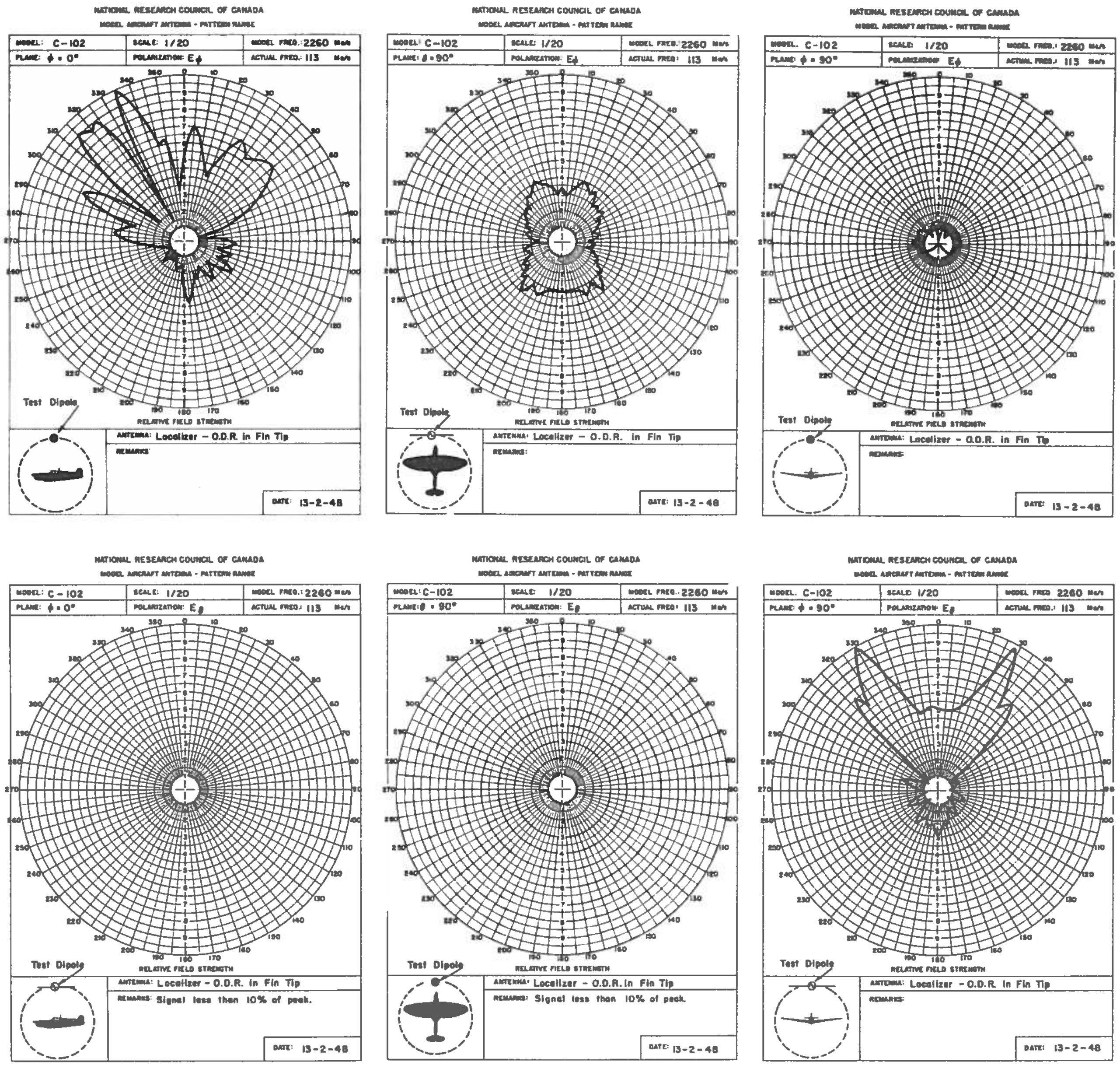

FIG. 2
RADIATION PATTERNS

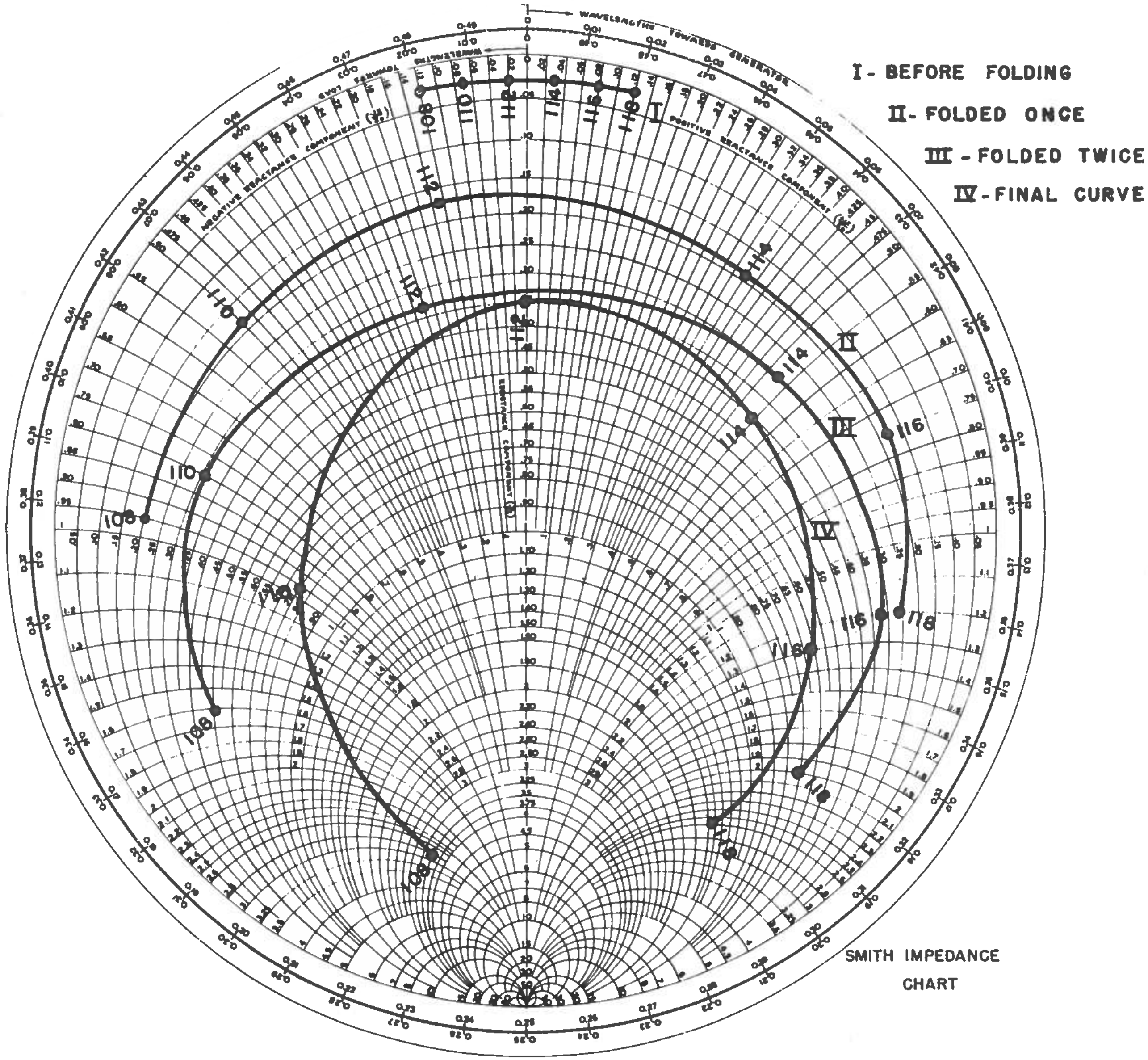

FIG. 3
IMPEDANCE CURVES OF THE ANTENNA
(NORMALIZED TO 50 OHMS)

FIG. 4
ANTENNA INSTALLED IN THE AIRCRAFT

15		1	CONDENSER ERIE N500-8-75$\mu\mu f$
14		1	CONNECTOR AMPHENOL 58-1R
13	AB-12-14A	1	ANTENNA TUBE
12	AB-12-13C	1	REAR ANTENNA SUPPORT
11	AB-12-12B	1	FRONT ANTENNA SUPPORT
10	AB-12-11A	2	"T" SECTION
9	AB-12-10A	10	ELBOW
8	AB-12- 9A	2	FEED BLOCK
7	AB-12- 8A	2	TUNING STUB
6	AB-12- 7C	1	MOUNTING PLATE
5	AB-12- 5B	1	TUBE
4	AB-12- 5B	1	TUBE
3	AB-12- 4B	1	END PLATE
2	AB-12- 3B	1	FEED SUPPORT
1	AB-12- 2A	1	FEED HOUSING
Item	Dwg. No.	Quan	Description

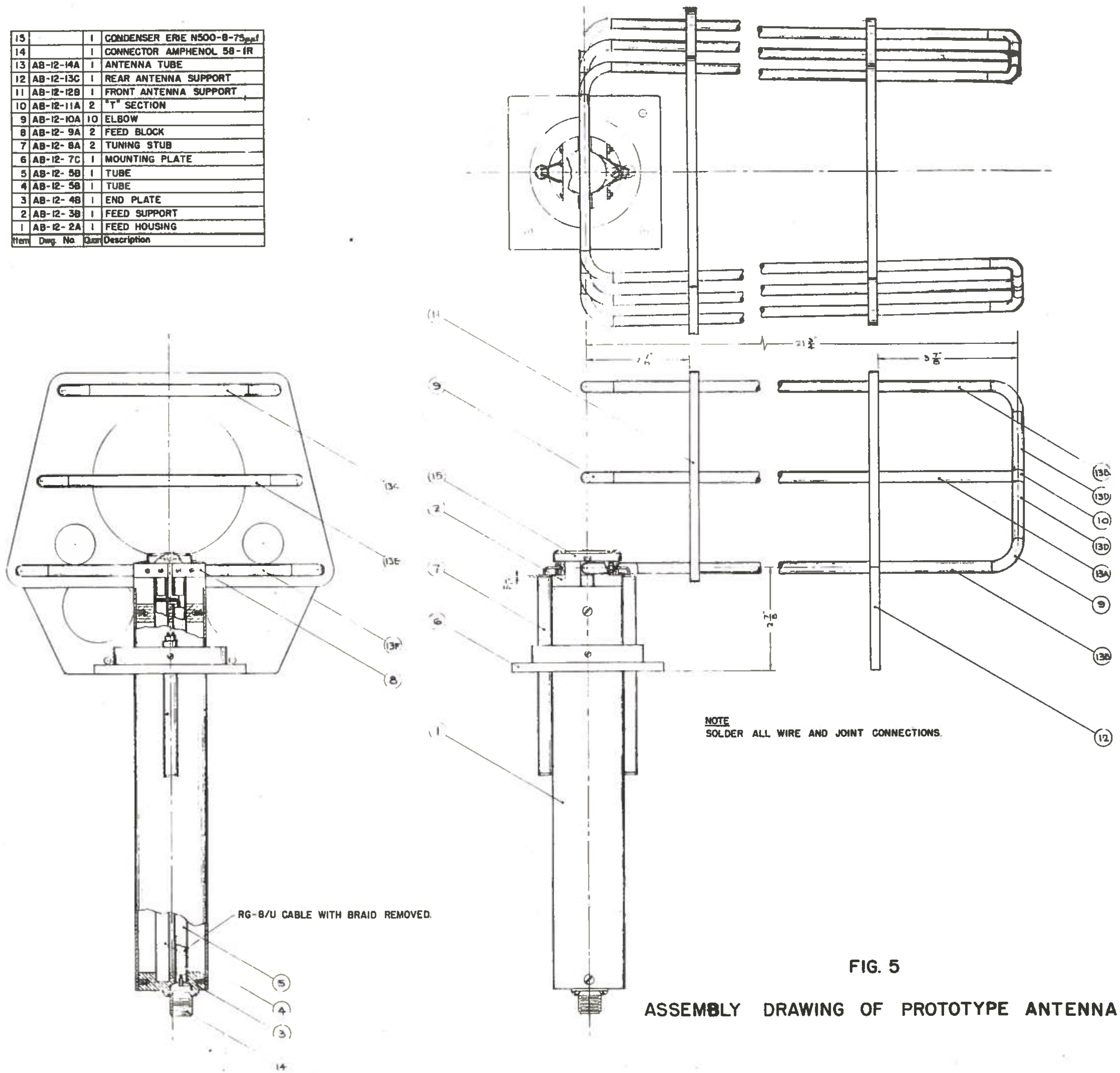

FIG. 5

ASSEMBLY DRAWING OF PROTOTYPE ANTENNA