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UNCLASSIFIED

TECHNICAL MANUAL

*for*

ANTENNA TUNING UNIT,

MODEL LFTD-1



THE TECHNICAL MATERIEL CORPORATION  
MAMARONECK, N.Y.

OTTAWA, ONTARIO

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2. TMC Part Number.
3. Equipment in which used by TMC or Military Model Number.
4. Brief Description of the Item.
5. The *Crystal Frequency* if the order includes crystals.

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All correspondence pertaining to Warranty Claims, return, repair, or replacement and all material or equipment returned for repair or replacement, within Warranty or otherwise, should be addressed as follows:

THE TECHNICAL MATERIEL CORPORATION  
Engineering Services Department  
700 Fenimore Road  
Mamaroneck, New York



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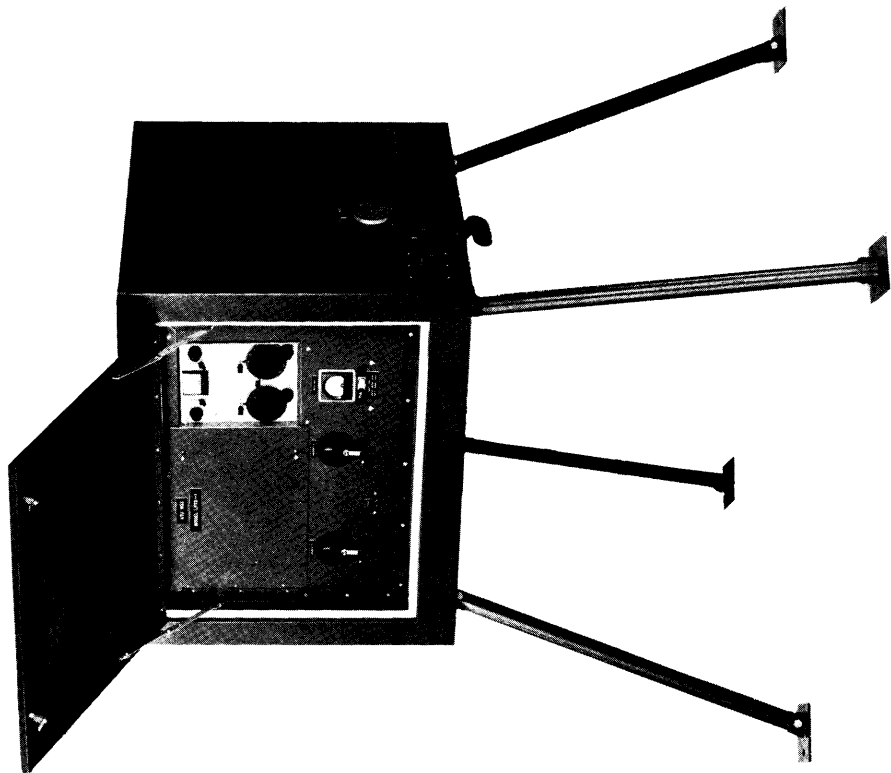
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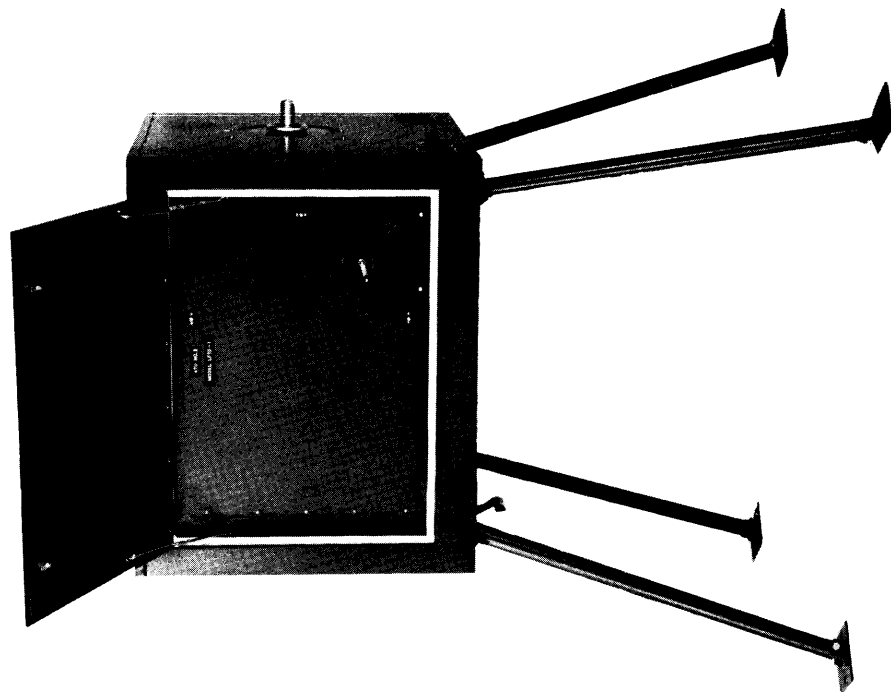


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9818-1



9818-2

ATU-1

ATU-2

Figure 1-1. Antenna Tuning Unit, Model LFTD-1

## SECTION 1

### GENERAL INFORMATION

#### 1-1. PHYSICAL DESCRIPTION

The Antenna Tuning Unit, Model LFTD-1 (figure 1-1) is contained in two weatherproof cabinets designed for outdoor installation on either a pre-prepared foundation (not supplied) or on tubular steel supporting legs provided with foot flanges for locating the units directly on the ground. Hinged (upwards) outer front doors give the required protection against contamination by atmospheric borne precipitation, dust, etc., while allowing ready access to the inner front panel for operation of controls. The inner front panels are also hinged (sideways) to facilitate maintenance and repair functions and to permit component adjustment where such cannot be realized from the front panel.

#### 1-2. FUNCTIONAL DESCRIPTION

The Model LFTD-1 is a self-contained tuning unit which allows the 50 OHMS output of the GPT-10K-LF transmitter to be matched to a folded unipole antenna. ATU-2 is connected in series with the antenna fold and serves to increase the apparent height of the tower to present a 50 OHM feedpoint resistive component. ATU-1 is connected in series with the antenna feedpoint (tower base) to cancel out the reactive component. In addition, an operating impedance bridge is supplied with ATU-1 to allow monitoring the quality of the impedance match during operation.

### 1-3 TECHNICAL SPECIFICATIONS OF MODEL LFTD-1

Frequency Range	300 KHZ to 550 KHZ
Power Rating	5KW Average, 10KW PEP
Antenna Height	150 Ft.
Antenna Type	Utility type 170KD (with TMC Kit #312)
Input	1-5/8" 50 OHM coaxial transmission line (with EIA flange)
Enclosures	Two (2) weatherproof aluminum enclosures #DO144 (33" high x 40" wide x 36" deep); finished TMC spec S-520.
VSWR	Not to exceed 1.5:1

## SECTION 2

### INSTALLATION

#### 2-1. INITIAL INSPECTION

The LFTD-1 Antenna Tuning Unit is a ruggedly constructed system with the basic characteristics of transportable type electronic equipments. It has been given a thorough mechanical check out by the manufacturer previous to shipment. Upon arrival at the operating site, inspect the packing cases and their contents immediately for any possible equipment damage. Inspect the packing cases to determine that you have received all those items ( see section 2-3 and 2-4) that are normally not shipped as "installed" parts.

Although the carrier is liable for any damage to the equipment caused during shipment The Technical Materiel Corporation will assist in describing and providing for repair or replacement of damaged items.

#### 2-2. CONNECTIONS

The mechanical and electrical connections required for the LFTD-1 are to be made after the two enclosures (ATU#1 and #2) have been positioned at the base of the 170KD Tower in accordance with drawing D237701 (Base Detail for the TMC Folded Unipole Kit #312). The connections should be made in accordance with the instructions that follow in paragraphs 2-3 and 2-4.

#### 2-3. MECHANICAL INSTALLATION

a. ENCLOSURE INSTALLATION - Each enclosure is mounted on four supporting legs (2" tubular) which are secured to top and foot flange plates by means of 1/2-13 x 3" bolts, nuts and flats. The top flange plates are permanently attached to

the enclosure. The foot flange plates should be firmly secured to the earth mounting surface by means of the anchor rods that are furnished. Naturally a concrete type foundation is preferred if it is available for the particular site.

b. CONNECTION OF TRANSMITTER OUTPUT TO ATU#1 INPUT - 1-5/8"

transmission line, terminating in an EIA flange is used as the r-f power feed line between the transmitter and the LFTD-1. The EIA flange of the line must be attached to the EIA flange of the #2061 End Terminal (ref. symbol ET) which is installed on ATU#1 (follow instructions supplied by the transmission line manufacturer; including pressurization instructions, if applicable).

c. CONNECTION OF ATU#1 OUTPUT (FT1) TO TOWER AT FEED

POINT ABOVE BASE INSULATOR - A length of 1/2" O.D. silverplated copper tubing is furnished for this connection. At FT1, connection is made to the 1/4-20 bolt of the silverplated "end lug". At the tower, connection should be made to a thoroughly scraped and cleaned area on the horizontal member of the tower.

d. CONNECTION OF ATU#2 OUTPUT (FT2) TO THE ANTENNA

FOLD WIRE LEAD - The alumoweld fold wire comes from the strain clamp (of Kit #312) and is to be inserted into the aluminum connector (CN1) which is mounted on the stud that passes through FT2. The alumoweld wire is secured in the connector by means of 3 pieces 1/4-20 x 11/16" UNC-2A hex head set screws.

e. CONNECTION OF THE GROUND SYSTEM TO THE LFTD-1 - Each

enclosure has a copper ground strap "pigtail" which must be bonded (silver soldered) to the Ground System which is common to the Tower and the Transmitter. Proper grounding of both enclosures is essential to the performance of the equipment and the protection of operating personnel against dangerous r-f voltages.

f. INSTALLATION OF THE R-F AMMETER (M1) - Previous to installation, the meter should be given a basic continuity check; and if possible an r-f current check against the Transmitter's r-f output meter (assuming 0-15 amp scale). The meter manufacturer specifies it as one calibrated for non-magnetic panel mounting. Consequently, an insulated mounting plate is provided for placement between the operating panel and the case of the meter. For shipment a shunt strap is connected across the meter terminals (this should now be removed). Note the location of the plus terminal of the meter. Install the meter and insulated plate on the operating panel of ATU#1. Now connect the short silver plated strap between the plus terminal of the meter and the "A" contact of Switch (SW1).

g. INSTALLATION OF THE CERAMIC VARIABLE VACUUM CAPACITOR (C1) - Previous to shipment this component has been tested against the peak voltage breakdown rating of the unit (50KV) with a Jennings JHP-70 Hipot Tester. If a Jennings JHP-70 (no other tester) is available on site, the capacitor should once again be tested. This component is critical to the proper performance of the LFTD-1.

The capacitor is to be mounted in ATU #1 by means of the two corona ring mounting flanges that are shipped in position with the enclosure. These flanges are mounted on 8" x 1" steatite insulators. To install the capacitor, proceed as follows:

(1) Turn the shaft of the capacitor to its full counterclockwise travel position (it will now be loose). Next, turn clockwise until the first sign of tightening. Stop, the capacitor now has its plates fully meshed; it is set a minimum reactance (max, capacitance).



(2) Remove the rear mounting flange and leave it at the rear of the enclosure.

(3) Set the veeder counter assembly to "zero".

(4) Carefully insert the variable end of the capacitor through the front mounting flange and allow the variable shaft to be inserted into the Teflon Coupler which is attached to the veeder counter control assembly. Secure the capacitor to the front mounting flange, but do not depend upon it to support the weight of the capacitor.

(5) Attach the rear mounting flange to its insulators and to the capacitor.

(6) Secure the capacitor shaft to the Teflon Coupler with the cotter pin that is provided. The counter should still read "zero"; and control handle should now be turned clockwise to its full travel which should be approximately 60 turns.

#### CAUTION

Never force the capacitor shaft and never go in the counterclockwise direction beyond the "zero" reading.

#### h. INSTALLATION OF OPERATING IMPEDANCE BRIDGE - The 0IB1-1-C

Bridge should be tested in accordance with the manufacturers instruction book (previous to installation).

The serial number and date of receipt of this electronic measurement device should be appropriately "logged". The Bridge is now ready for installation as follows:

(1) Attach the output connector/cable assembly to the female connector located on the righthand side of the Bridge.

(2) Attach the righthand side of the Bridge to the Enclosure by means of the right angle bracket provided for that purpose.

(3) Attach the upper lefthand corner of the Bridge to the enclosure with the small right angle bracket.

(4) Attach the input connector/cable assembly to the female connector that is located on the lefthand side of the Bridge. The input and output connector/cable assemblies are identical, but the center conductor "terminal lug" of the input one must be secured to the common contact of the Switch SW1; whereas, the center conductor "terminal lug" of the output one must be secured to the minus terminal of the r-f Ammeter (M1).

Finally, the copper shielding braid of both connector/cable assemblies must be secured to the chassis grounding bolt at the bottom, rear edge of the Bridge; and the silver plated copper tubing connection must be made between this grounding bolt and the enclosures 4" wide copper ground strap.

i. ADJUSTMENT OF HORN GAPS - Adjust horn gaps (HG1, HG2 and HG3) to 1/2" clearance between the closest points of the two rods.

j. INSTALLATION OF THE "J-PLUG" HANDLES - The J-Plug handles are merely the male portion of the assemblies designated J1, J2, J3 and J4. Do Not install J1 unless necessary (see Section 4-2).

#### 2-4. ELECTRICAL INSTALLATION

Each ATU has provision for sound powered telephone communication to the Transmitter and interlock protection to the Transmitter. Two connecting cable assemblies are provided in addition to a receptacle (R4) for use at the Transmitter end. The connecting cable assembly which has plugs (P1 and P4) is used between receptacles (R1 and R4) at the ATU#1 and Transmitter respectively. The connecting cable assembly which has plugs (P2 and P3) is used between receptacles (R2 and R3) at ATU#1 and ATU#2 respectively.

It is intended that whenever the inner doors of either ATU enclosure are opened,

the Transmitter interlock will open; thereby removing r-f power from the ATU's. See figure 7-2 for the A. C. Circuit (interlock/phones).

#### 2-5. INITIAL ADJUSTMENT

No special initial adjustments are required if the mechanical installation procedures have been carefully followed. If pressurized transmission line is used, its pressurization should be checked in accordance with the manufacturers instructions.

SECTION 3  
OPERATOR'S SECTION

3-1. GENERAL

Operation of Antenna Tuning Unit LFTD-1 has been designed for simplicity and rapid tuning. All adjustments are either by front panel controls, or by access from the front panels. In addition, an installed operating Impedance Bridge and R-F Ammeter are provided for field operation.

Since HIGH R-F VOLTAGES are present at times during tuning, it is imperative that safety measures be followed closely.

3-2. OPERATING PROCEDURE

A. When it is desired to tune-up on a frequency for which presets have been logged, either in the initial adjustment or subsequent adjustments, it will be necessary to set all veeder counters, coil taps, and J-plugs to their prescribed positions. Inductor L3 is a multiple winding coil (bifilar) with a "double" coil clip for adjusting inductance. The turns of one of the windings have referenced numbers on the forward insulated support bar of the unit.

CAUTION

The gold clip must always be on a numbered turn and the silver coil clip must be in the direction indicated by the arrow on the engraved instruction plate.

Now place SW1, in position "B" and apply approximately 1KW power to the unit. Adjust the Operating Impedance Bridge (in accord with the instruction for the unit) for a reading of resistance and reactance. If the resistance is in the range 15-100 ohms and reactance within ± 50 ohms,

proceed with the tune-up. If not, shut down the transmitter and check all settings.

Assuming that the impedance measurements are within the prescribed range, adjust C1 and L2 to obtain 50 j0 ohms on the bridge (or a VSWR not to exceed 1.5:1). In general, it will be found that C1 controls the system reactances, and L2 controls resistance in a direct manner (i. e. : increasing L2 increases resistance until crossover is reached). At this point power may be increased to 5KW and the reading of M1 checked. If readings are normal, SW1 should be placed in position "A". The unit is now ready for normal operations, B - If presets are not available for the intended operating frequency, it will be found convenient to accomplish the tune-up with the aid of a General Radio RF Bridge type 916-A or equivalent. When using this instrument, transmitter power must be off, the transmission lines disconnected from connector ET, and the type 916-A bridge connected to the ATU#1 input. SW1 should be in position "A".

In many cases, a 916-A bridge may not be available, so the following procedure will be found applicable primarily to the Operating Impedance Bridge included, but may be adapted to use with the 916-A bridge may not be adapted to use with the 916-A bridge.

If presets for any frequencies are available, choose the closest to the new operating frequency and set up as in Section "A". If the values obtained are within the limits prescribed, proceed normally as in Section A. If it is impossible to balance the bridge, or if the values are excessively at variance, it will be necessary to experimentally derive new settings for the components.

For new frequencies make initial settings as follows:

	300-400 KHZ	400-550 KHZ
SW <sub>1</sub>	B	B
J <sub>1</sub>	Open	Open
C <sub>1</sub>	200	200
J <sub>2</sub>	Closed	Closed
J <sub>3</sub>	Closed	Closed
L <sub>2</sub>	Maximum	300
L <sub>3</sub>	All Turns in	0 Turns
J <sub>4</sub>	Closed	Closed

Now, note the bridge readings, if possible (If not, vary L<sub>1</sub> and C<sub>1</sub> to bring the bridge on scale.) and make adjustments to bring them as close as possible to 50 j0 ohms as a first step, bring the reactive to 0 ohms by varying C<sub>1</sub> increasing the veeder reading if the feedpoint is (+), decreasing the veeder if it is (-). If the resistance is higher than 50 ohms remove turns from L<sub>3</sub>, decrease the veeder reading on L<sub>2</sub>, or both, as appropriate, until resistance at or near 50 ohms is reached. Then re-resonate to j0 with C<sub>1</sub>. If resistance is too low then more inductance is called for in L<sub>2</sub> and L<sub>3</sub>. In this manner, the operation should be able to obtain 50 j0 or a VSWR not over 1.5:1 at the feedpoint.

At the extremities of the operating band, it may be necessary to close J<sub>1</sub> and vary L<sub>1</sub> and C<sub>1</sub> to obtain the correct match once the preceeding method has reached optimum.

Now the transmission line should be reconnected, if the 916-A method has been used, and power applied to the unit. If satisfactory current reading result, SW<sub>1</sub> should be placed in position A and all new settings logged for future reference.

The LFTD-1 tuning unit is now ready for normal operation at a totally new frequency.

### 3-3. OPERATOR'S MAINTENANCE (See Section 2)

## SECTION 4

### PRINCIPLES OF OPERATION

#### 4-1. INTRODUCTION

The Model LFTD-1 Antenna Tuning Unit is shown schematically in figure 7-1. A simplified schematic diagram is given in figure 4-1.

#### 4-2. CIRCUIT DESCRIPTION

The circuitry of the Model LFTD-1 is contained in two enclosures: ATU-1 and ATU-2.

ATU-1 contains the antenna resonating capacitor, C1, and the L-network shunt arm L1. The antenna reactance of the folded unipole is always positive. C1 is normally adjusted to a value of negative reactance which is equal in magnitude to the reactive component of the impedance of the tower base. This latter reactive component is a function of the operating frequency, the electrical characteristics of the tower and fold, and the nature of the ground system. In general, it is the last component which must be adjusted.

L1 is not normally used unless it is impossible to achieve a resistive component of 50 OHMS. Consequently, for normal operation, J-Plug (J1) must be out (open circuit) so that only reactive component (C1) appears in series with the feed point of the antenna. When a 50 ohm feed point cannot be attained, C1 adjusted to provide a net excess a negative reactance so that, with C1, L1 (and J1) in the circuit an "L" network results which steps up the resistance to 50 ohms.

ATU-2 contains the antenna fold inductance composed of L2 and L3 in series. This inductance increases the effective electrical height of the antenna so that the feedpoint resistance can be made equal to 50 ohms.



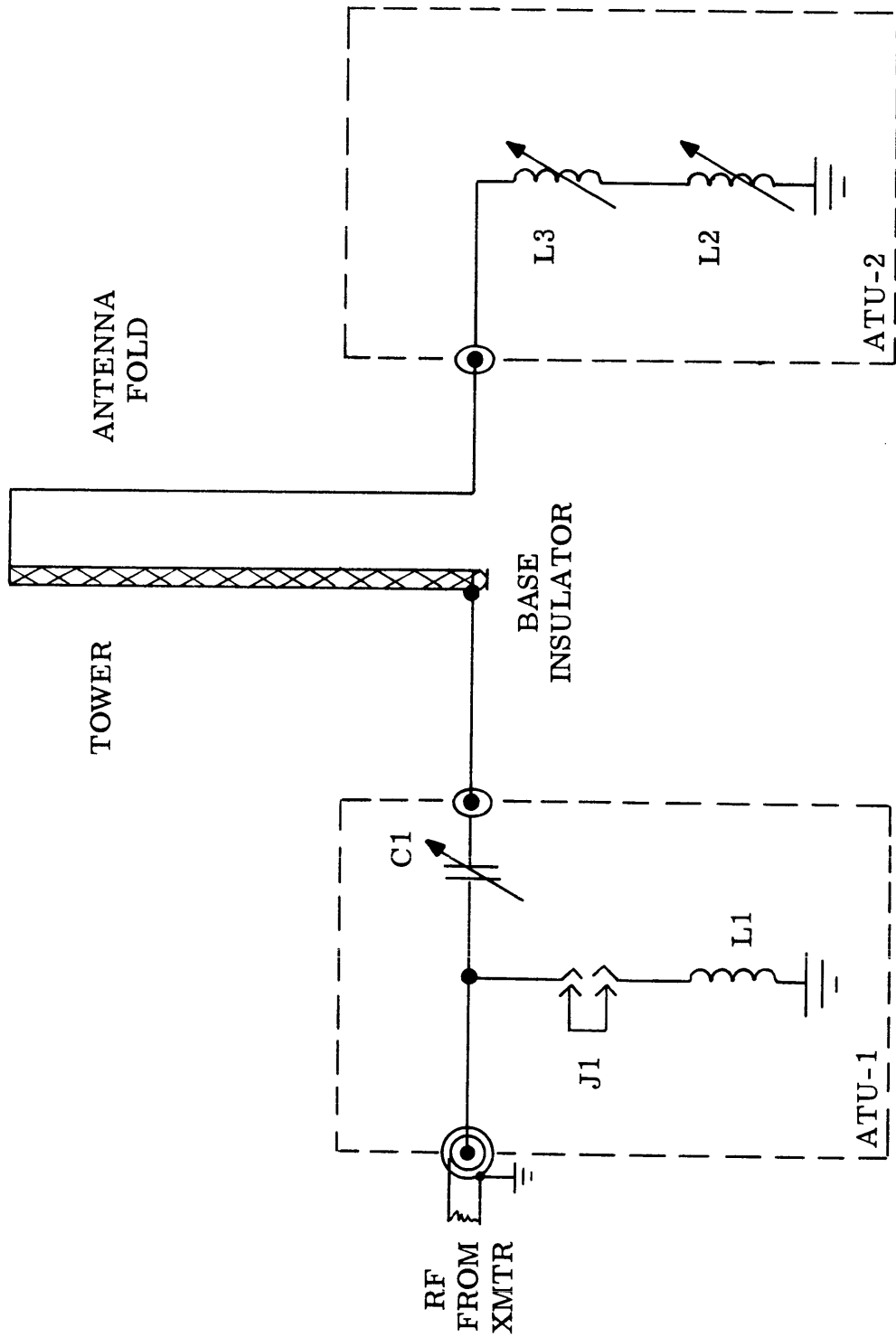


Figure 4-1. Simplified Schematic Diagram, Model LF7D-1

9818-3

### NOTE

L3 is a bifilar coil and the clip must be installed correctly to avoid a shorted turn. See Section 3 for a description of the proper connecting technique.

## SECTION 5

### TROUBLESHOOTING/MAINTENANCE

#### 5-1. INTRODUCTION

The LFTD-1 is basically a device which adjusts the impedance of the radiating antenna and matches that impedance to the impedance of the Transmitter/Transmission Line that is feeding the system. Proper impedance adjustment and matching is monitored by the readings of the R-F Ammeter (M1), the SWR meter of the Bridge and the VSWR meter of the Transmitter. The Transmitter VSWR Meter is the main trouble indicator of the system for it shows the degree of "mismatch" presented to the Transmitter by the LFTD-1 and its antenna. A severe mismatch will cause transmitter cutoff.

#### 5-2. TROUBLESHOOTING TECHNIQUES

If system failure occurs, first check Capacitor (C1) for possible voltage breakdown. A simple continuity check will not always prove that the capacitor is not shorted. The Jennings JHP-70 Hipot Tester should be used for this purpose.

Pressurization of the transmission line should be checked as a possible source of trouble.

#### 5-3. PREVENTIVE MAINTENANCE

The best preventative maintenance is to establish a periodic schedule of maintenance for the LFTD-1.

This should include:

- (a) Cleaning and tightening of all R. F. electrical connections
- (b) Voltage Breakdown testing of Capacitor (C1).
- (c) Checkout of A. C. circuit to determine that it is functioning properly with the Transmitter interlock.

#### 5-4. CORRECTIVE MAINTENANCE

The LFTD-1 should never be serviced with R-F power on. It should be serviced only by those with a thorough understanding of its principles of operation.

**SECTION 6**  
**PARTS LIST**

**6-1. INTRODUCTION**

Reference Symbols have been assigned to identify all major component parts of the LFTD-1 Antenna Tuning Unit. They are used for marking the components (adjacent to the part they identify) and are included on schematics and the Parts List. Item numbers referenced in the following Parts List can be found on figures 6-1 through 6-7.

## PARTS LIST

for

## ANTENNA TUNING UNIT, MODEL LFTD-1

ITEM NO.	REF. SYMBOL	DESCRIPTION	* CODE	MANUFACTURER PART NUMBER
1	J1	J-Plug (2 terminals).	A	C0203
	J2	Same as J1.		
	J3	Same as J1.		
	J4	Same as J1.		
2	M1	R.F. Ammeter (expanded scale) 0-15 amp Model 308.	B	308-2602110
3	SW1	Switch, Make-Before-Break (SPDT).	A	D0151
4	L1	R.F. Inductor (single winding) 47 uh variable rotary type.	A	M47-15V
5	L2	R.F. Inductor (trifilar winding) 12 uh variable rotary type.	A	D0147
6	L3	R.F. Inductor (bifilar winding) 130 uh fixed tapped type.	A	D0148
7	C1	Capacitor (ceramic vacuum) 60-1000 pf (50 KV, 170 amp) variable.	C	CVHP-1000-50 D1490
8	FT1	Feed-Through Insulator Assembly (G9 Melamine with corona shield).	A	D0140
	FT2	Same as FT1.		
9	CN1	Connector for fold wire lead.	A	C237709
10	OIB-1	Operating Impedance Bridge 5 KW average.	D	OIB-1-C
11	ET	End Terminal (for 1-5/8" transmission line).	E	2061
12	D0144	Weatherproof Enclosure (aluminum) 33" high x 40" wide x 36" deep. Finish: TMC #S-520 textured blue.	A	
13	HG1	Horn Gap Assembly.	A	B0402
14	HG2	Horn Gap Assembly.	A	B0403
	HG3	Same as HG2.		
15 16	R1	Receptacle (male, 5 pin) weatherproof (with cap and chain MS25043-16C).	F	MS3102E16S8P

\* See last page of parts list for complete listing of manufacturers.

PARTS LIST (CONT)

ITEM NO.	REF. SYMBOL	DESCRIPTION	* CODE	MANUFACTURER PART NUMBER
	R2	Same as R1.		
	R3	Same as R1.		
	R4	Same as R1.		
17 18	P1	Plug (female, 5 pin) weatherproof (with cap and chain MS25042-16C).	F	MS3106E16S8S
	P2	Same as P1.		
	P3	Same as P1.		
	P4	Same as P1.		
19	NONE	Sound Powered Handset (2 instruments, 2 conductor type).	G	SPT-102
20	NONE	Plug (equipped with item 19).	H	440
21	Phone	Jacks for phone plug (2 at each ATU).	H	JJ-016
22	IS1	Door Interlock Switch (SPDT).	I	3AC5
	IS2	Same as IS1.		
23	TB1	Terminal Board (8 terminals).	J	141-8
	TB2	Same as TB1.		

NON-DESIGNATED PARTS

24		Insulators 9-1/4" x 1-1/4" (for inductor L3).	K	E-1028
25		Insulators 8" x 1" (for capacitor C1).	K	E-61841
		Same as item 25 (for inductor L1)		
		Same as item 25 (for inductor L2)		
		Same as item 25 (for horn gap HG3).		
26		Insulators 5" x 1" (for J-Plugs J1,2,3 & 4).	K	E-13493
		Same as item 26 (for horn gaps HC1 & HC2)		
27		Corona Ring Mounting Flange (for variable end of capacitor C1).	A	C0185-4

\* See last page of parts list for complete listing of manufacturers.



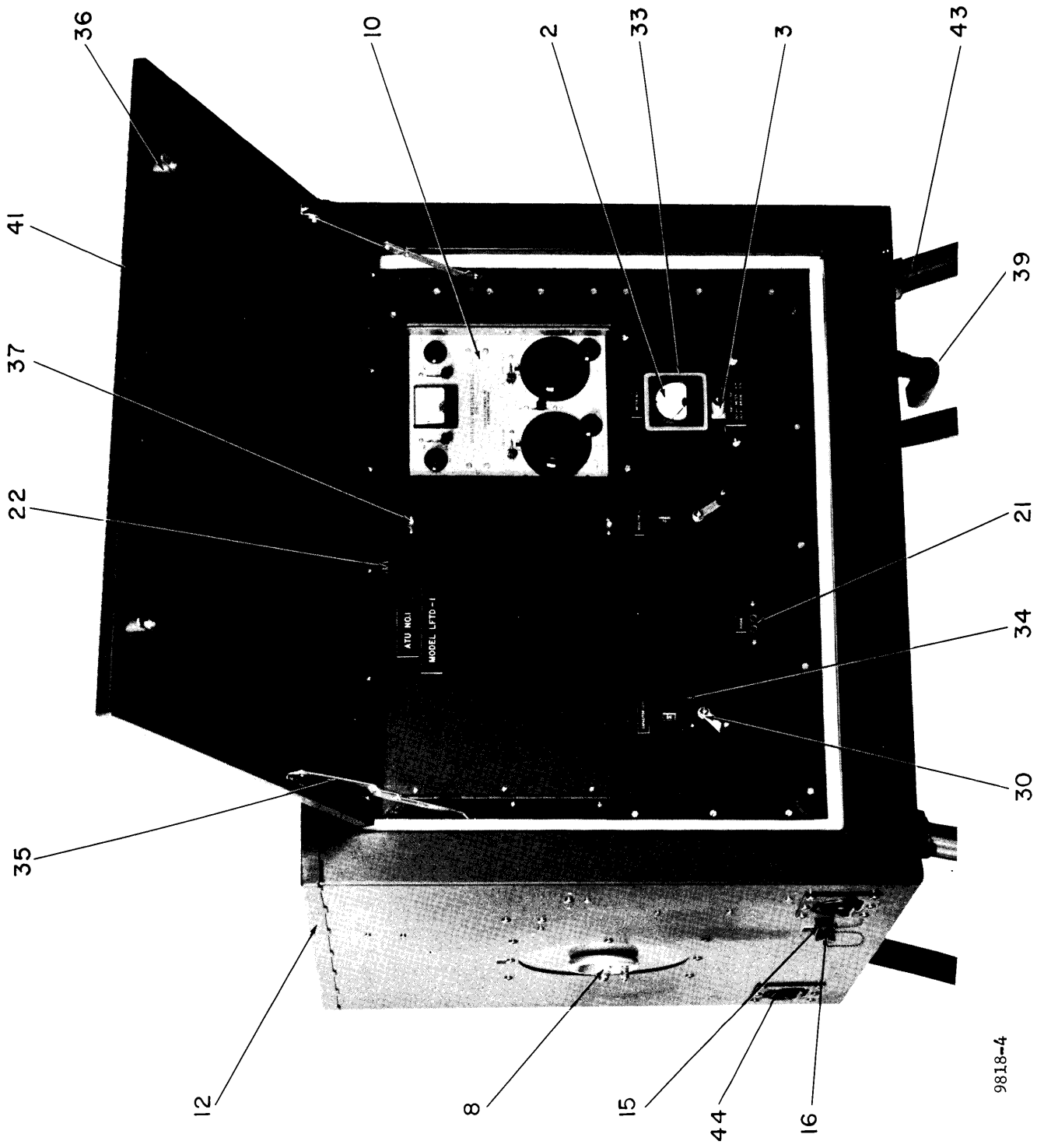
## PARTS LIST (CONT)

ITEM NO.	REF. SYMBOL	DESCRIPTION	* CODE	MANUFACTURER PART NUMBER
28		Corona Ring Mounting Flange (for fixed end of capacitor C1).	A	CO185-5
29		Bridge Input Connector/Cable Assembly (uses TRU 3528 connector and RG-8/U cable)  Same as item 29 (for output cable)	A	BO404
30		Veeder Counter Assembly (with removable handles) (for capacitor C1 and inductors L1 & L2).	L	3902-1
31		Insulated Flexible Couplings.	M	PL5004
32		Teflon Coupling (for capacitor C1).	A	BO405
33		Insulated Meter Mounting Plate (for meter M1; non magnetic calibration)	A	AO188
34		Front Panel Disk (for use with veeder counter assemblies)	A	B0067-1
35		Door Braces	N	4461/4K (US2C)
36		Door Locks	O	K-15760A
37		Door Fasteners (righthand)	P	43-1-2-0
38		Circuit Interconnection Tubing (1/2" OD silver plated copper tubing)	A	
39		Ground Strap (16 oz 4")	A	
40		A.C. Circuit Hook-Up Cable	Q	8722
41		Front Door Handle	R	1649
42		Coil Clips/Strap Assembly (gold clip & silver clip/strap)	A	BO406
43		Leg Assembly (for mounting D0144 cabinet)	A	
44		Flush Handles	S	176

\* See last page of parts list for complete listing of manufacturers.

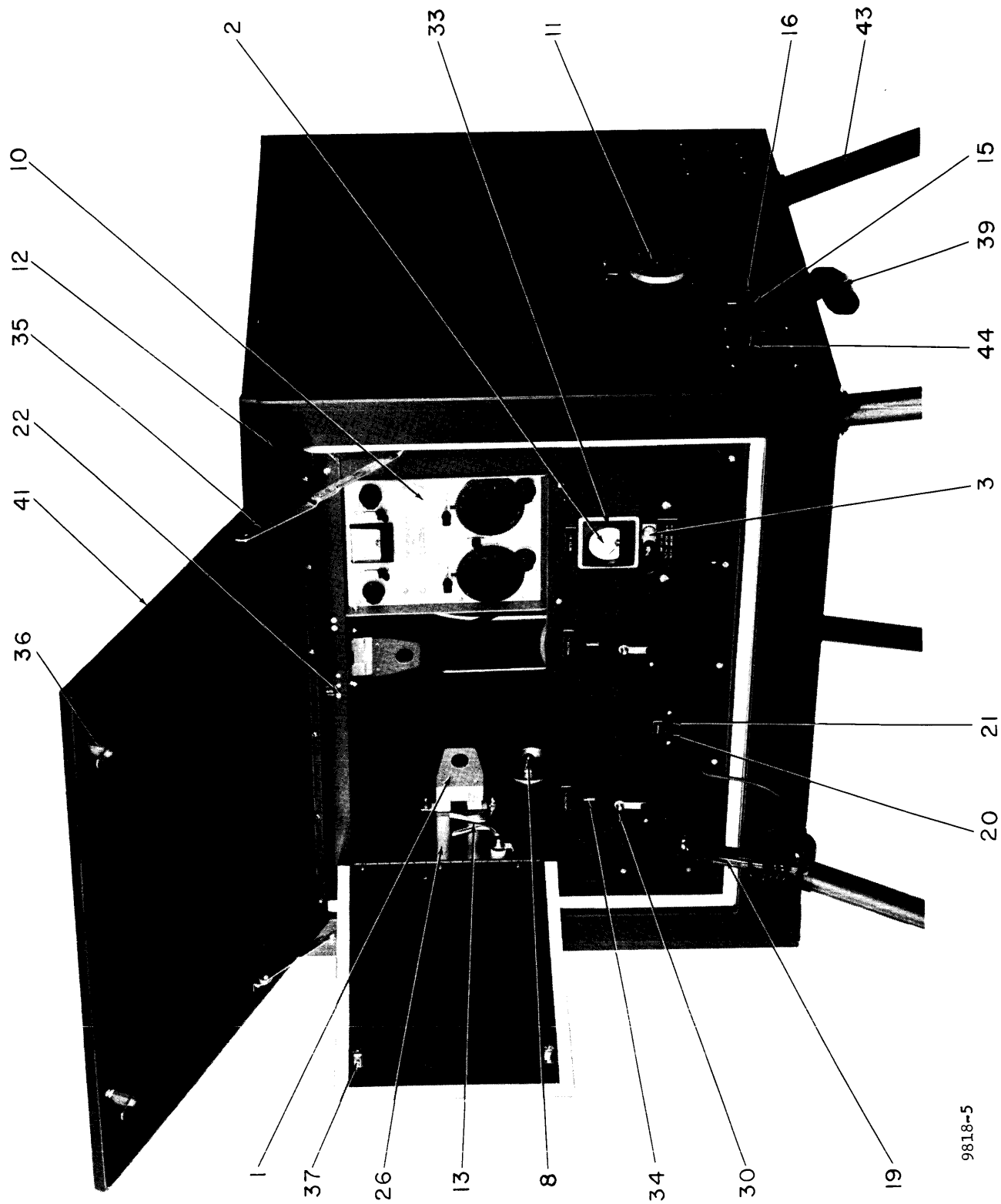
MANUFACTURERS CODE FOR LIST OF  
REPLACEABLE PARTS

- A. Multronics, Inc
- B. Weston
- C. Jennings
- D. Delta Electronics
- E. Andrew Corporation
- F. Cannon
- G. Wheeler Electronics
- H. Switchcraft
- I. MicroSwitch (3M)
- J. Cinch Jones
- K. American Lava
- L. Barker & Williamson
- M. Cardwell
- N. Stanley
- O. Corbin
- P. Southco
- Q. Belden
- R. H. & H. Smith
- S. National Mfg. Co.



9818-4

Figure 6-1. ATU-1 Component Location, Overall View, Inner Door Closed



9818-5

Figure 6-2. ATU-1 Component Location, Overall View, Inner Door Opened

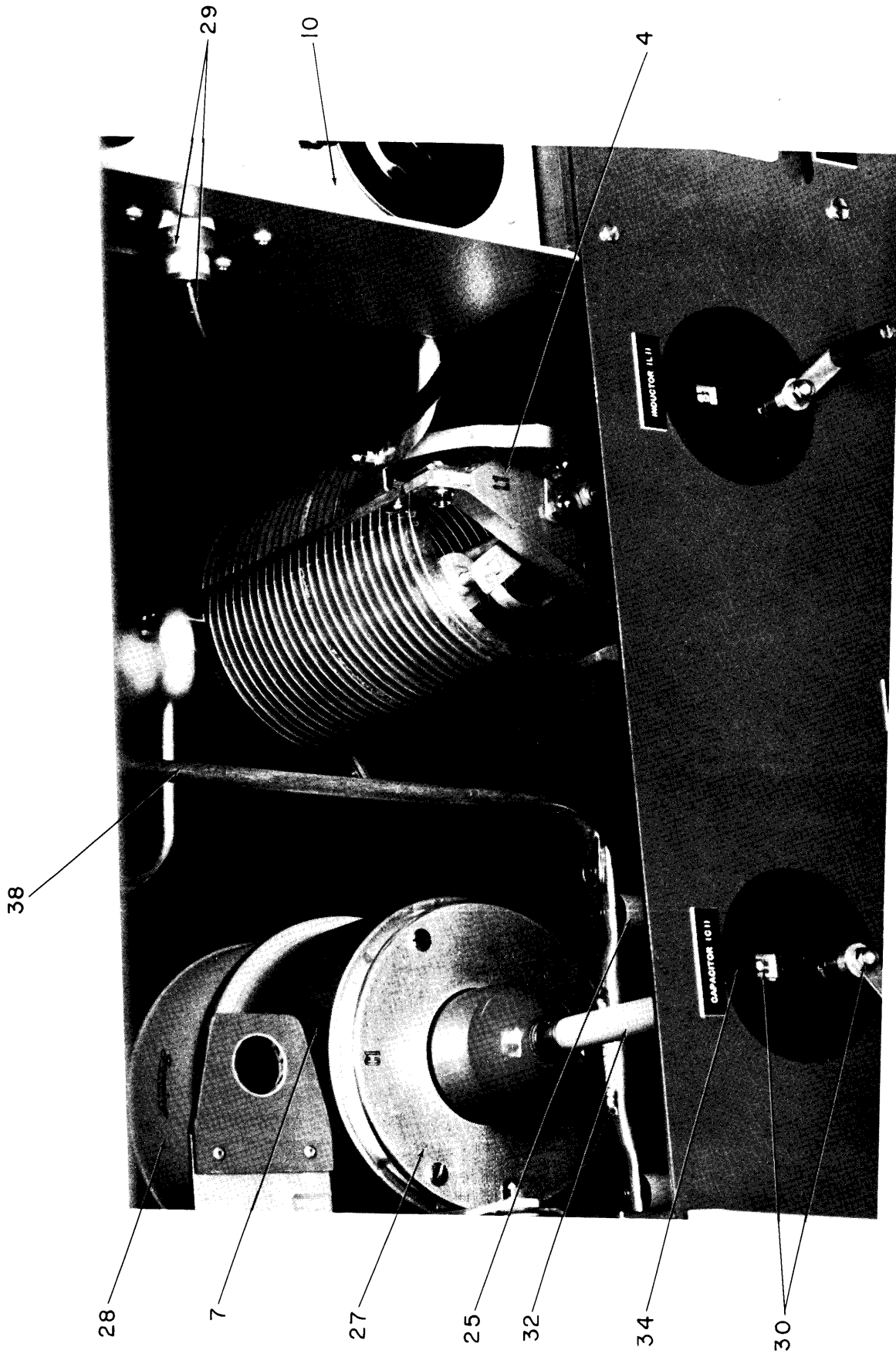
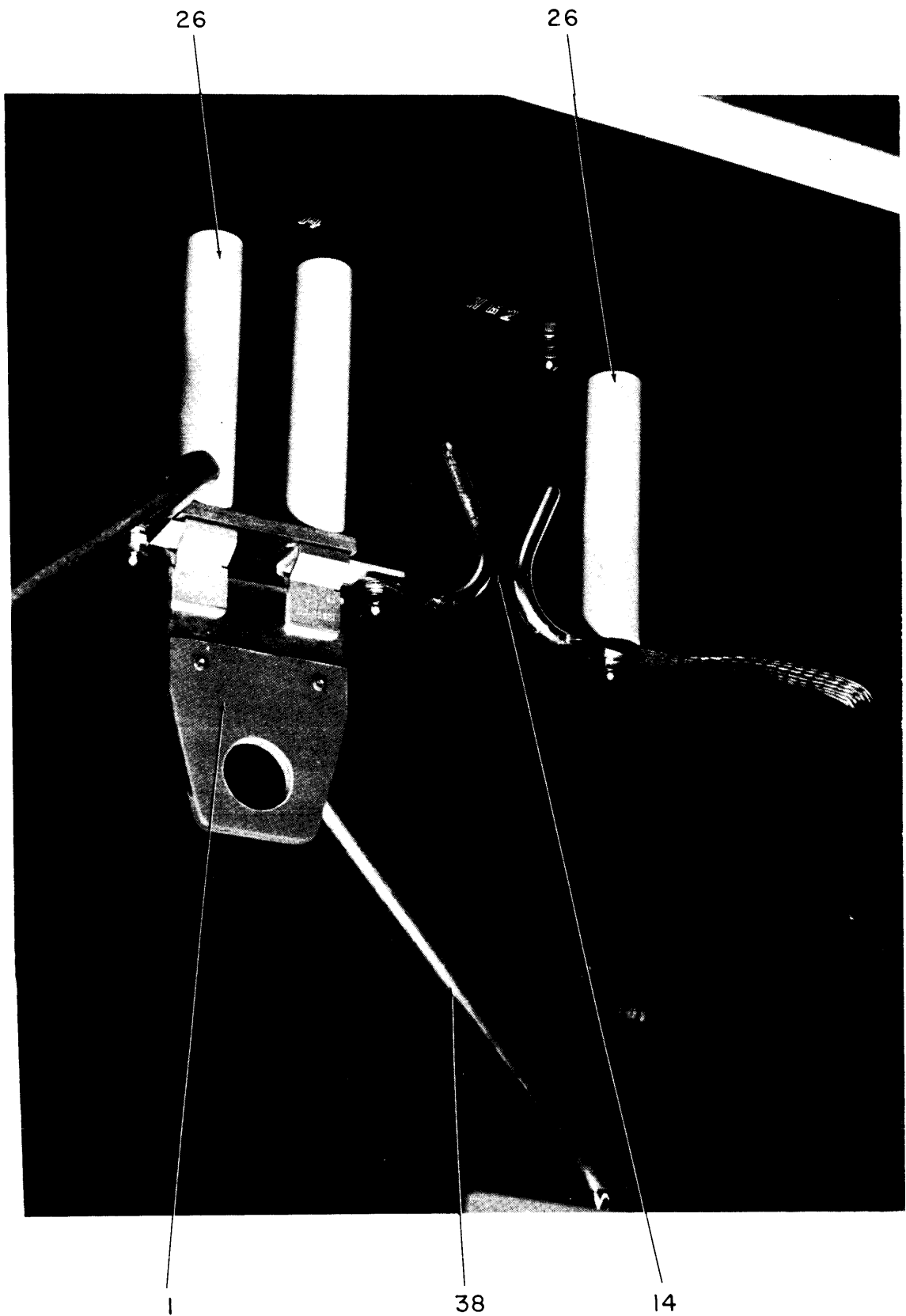


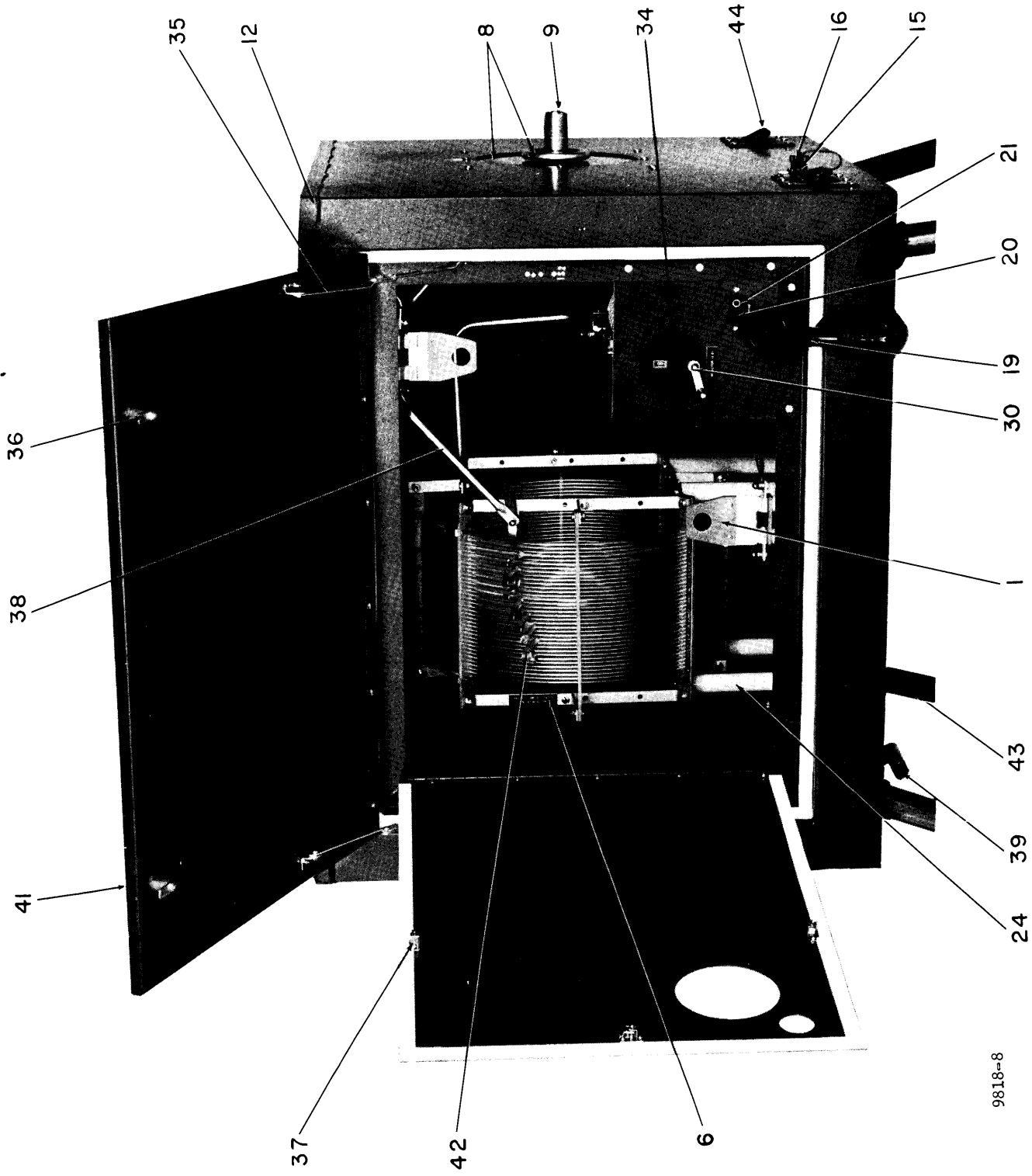
Figure 6-3. R-F Inductor and Capacitor Assembly, ATU-1

9818-6



9818-7

Figure 6-4. J-Plug and Insulators, ATU-1



9818-8

Figure 6-5. ATU-2 Component Location, Overall View, Inner Door Open



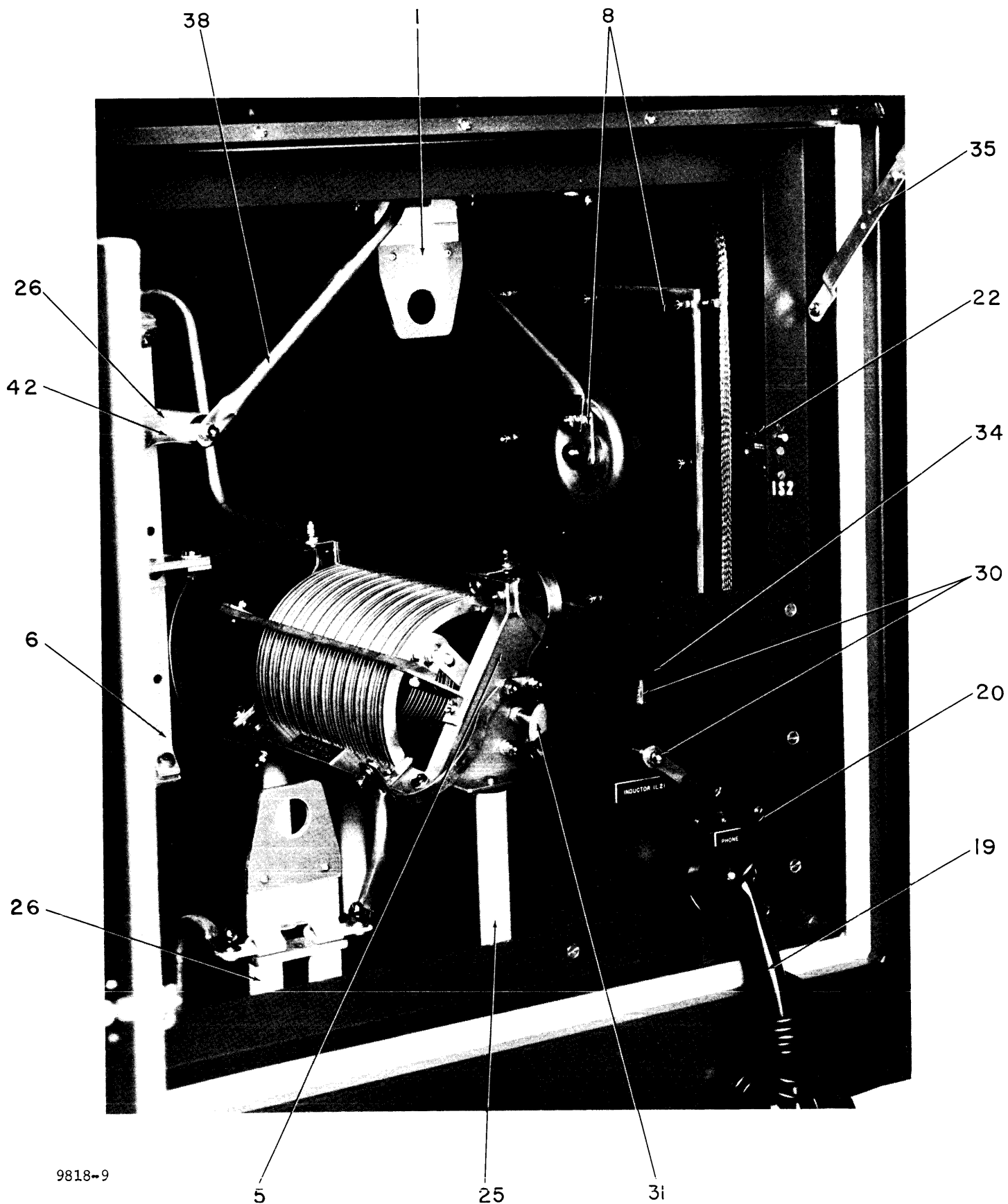
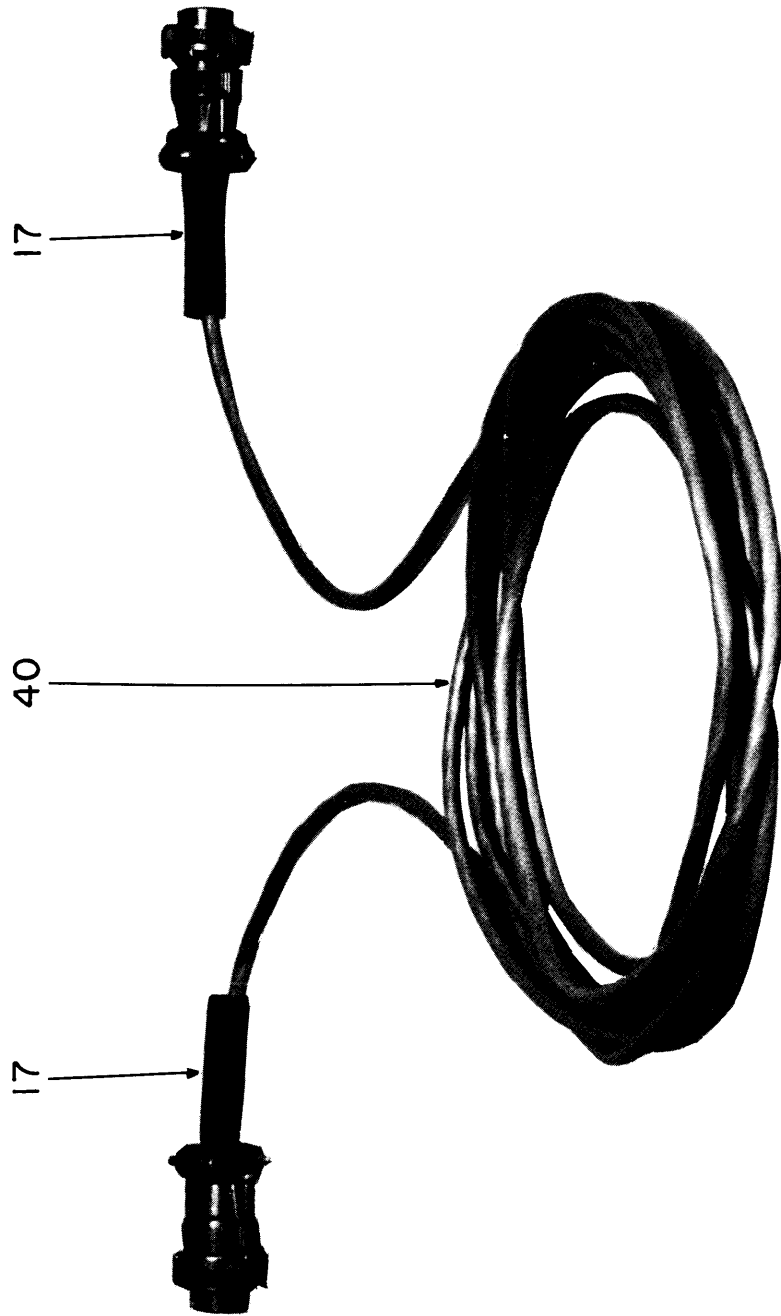


Figure 6-6. RF Inductor Compartment, ATU-2



9818-10

Figure 6-7. A-C Power Cable

SECTION 7  
SCHEMATIC DIAGRAMS

7-1. INTRODUCTION

Schematics for the R-F and A-C circuitry of the LFTD-1 are provided.

Figure 7-1. R-F Circuit  
Antenna Tuning Unit, LFTD-1, 5KW, 300-550KC

Figure 7-2. A-C Circuit  
A-C Circuit (Interlock/Phones), Model LFTD-1



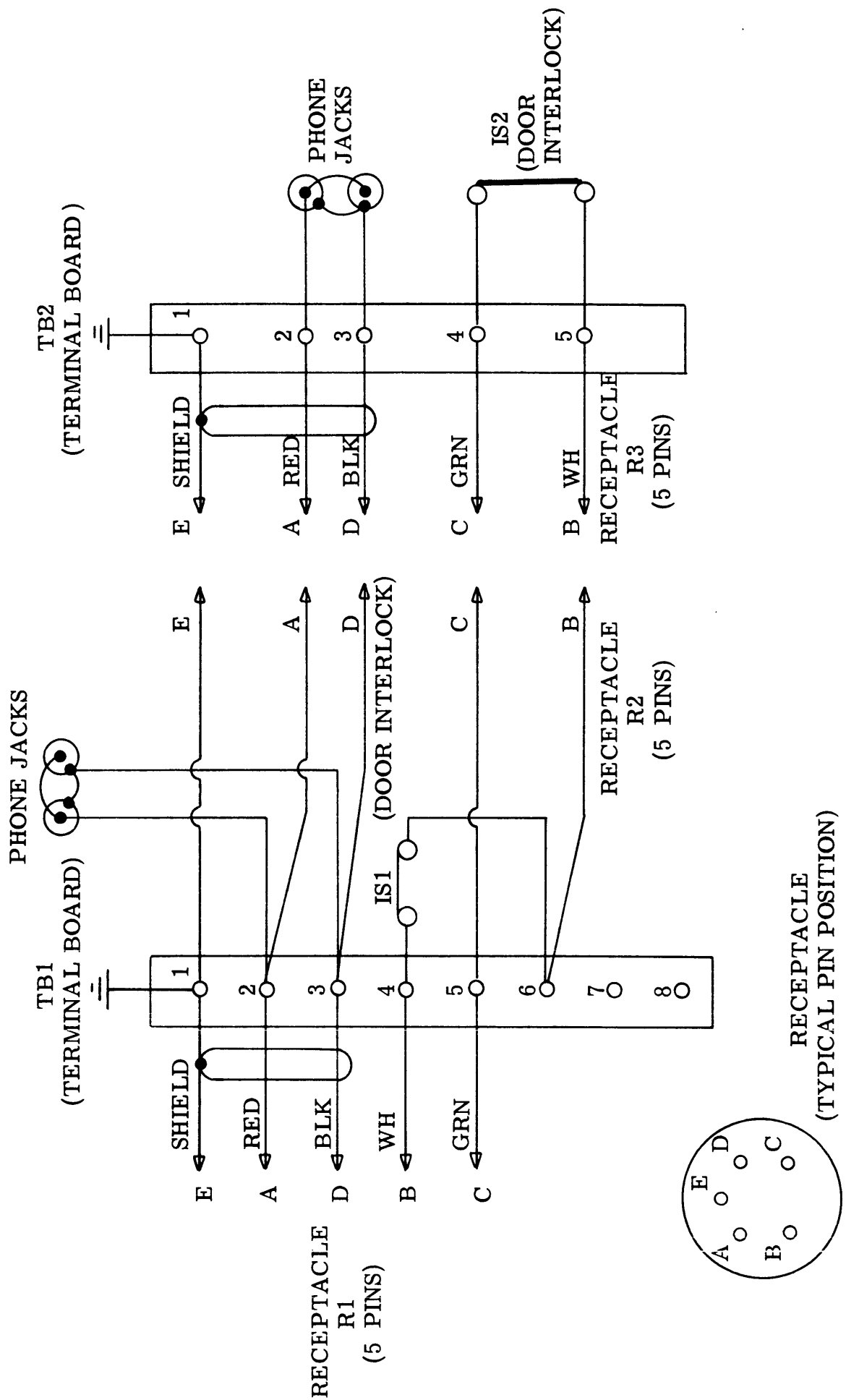


Figure 7-2. A-C Circuit (Interlock/Phones), Model LF7D-1