INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE JZ—71.6 LINE COUPLING TUNERS

SINGLE-FREQUENCY PHASE-TO-GROUND
LINE COUPLING TUNERS
WITH TWO-WINDING MATCHING TRANSFORMER

TYPE JZ 71.6	-	**STYLE 290B883AI2**	- **WITHOUT DRAIN COIL**
TYPE JZ 71.6D	-	**STYLE 606B363A09**	- **WITH DRAIN COIL**
TYPE JZ 71.64	-	**STYLE 606B363AI4**	- **WITH 0.006 MFD. SERIES CAPACITOR**

SUPERSEDES I.L. 41-949.1
COMPLETE REVISION

EFFECTIVE JULY 1967

SAFETY WARNING!

Protect your life while making adjustments! Before handling any part of the electrical circuits:

1. BE SURE THE GROUNDING SWITCHES IN THIS ASSEMBLY ARE IN THE "GROUNDED" OR CLOSED POSITION.

2. BE SURE THAT ALL POWER SWITCHES IN THIS ASSEMBLY ARE TURNED "OFF".

Protect the equipment against damage by not applying power until thoroughly familiar with the ADJUSTMENTS described in this book.

SAFETY FIRST!

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APPLICATION

The Type JZ-71.6 Line Coupling Tuners are designed for phase-to-ground coupling of a single carrier frequency from a coaxial cable through a coupling capacitor to a power line. The impedance matching transformer and line tuning coil, in conjunction with the coupling capacitor, provide a low loss circuit for coupling a carrier transmitter to the power line.

DESCRIPTION

Mechanical Description

The tuner is mounted in a cabinet suitable for outdoor mounting. Knockouts are provided on each side of the cabinet for the capacitor lead-in bushing and in the bottom of the cabinet for 1½ inch conduit for the coaxial cable. The outline, mounting dimensions and the location of the knockouts are shown in Fig. 3.

All of the electrical components are mounted on a hinged panel which may be opened for making the coaxial cable and capacitor lead-in connections. The transformer taps, tuning coil taps, grounding switch and spark gap are accessible from the front of the panel.

Electrical Description

The electrical circuits are shown on the Schematic Diagram Fig. 2. The coaxial cable center conductor is connected through jack J-1 to the matching transformer T-1, The coaxial cable shield is connected to terminal 1 of the matching transformer. The shield is not grounded, but may be by connecting a short jumper between terminals 1 and 2 of the cabinet terminal block. The high impedance tap of the transformer is connected through jack J-2 to the line tuning coil L-1. An adjustable spark gap SG-1 protects the equipment from excessive voltage surges. The knife switch S-1 is provided for grounding the lead-in from the coupling capacitor while adjustments are being made.

The JZ 71.64 tuner includes a 0.006-mfd. capacitor in series with the output lead to the protector unit. This allows the tuner to be used with coupling capacitors up to 0.015 mfd. When a drain coil is supplied with the tuner, it is identified as a Type JZ 71.6D tuner. If both capacitor and drain coil are included, the tuner is Type JZ 71.64D.

Typical response curves for the type JZ 71.6 tuners are plotted in Fig. 1. These curves were taken with an 1870-mmf. coupling capacitor and a 300-ohm resistive load. The tuner was adjusted for resonance (f_r) at 30, 100, and 200 kHz. respectively, for the three curves.

CHARACTERISTICS

Frequency Range:	30 to 200 kHz.
Input Impedance:	50 to 70 Ohms
Output Impedance:	100 to 1000 Ohms
Power Rating:	100 Watts Carrier-Unmodulated 25 Watts Carrier-100% Modulated
Coupling Capacitor Range:	JZ 71.6 – .00075 to .004 mfd. JZ 71.64 – .00075 to .015 mfd.

INSTALLATION

It is recommended that the Line Tuner be located as near the coupling capacitor as is practical. The mounting dimensions are shown on Fig. 3.

Remove the knockout from the side of the cabinet nearest the coupling capacitor for installation of the porcelain bushing for the capacitor lead-in.

Connections

CAUTION

Before making any connections to this equipment, turn off the power switch of the carrier transmitter and ground or open circuit the lead-in at the coupling capacitor.

The assembly of the Style 1352445 accessories for the coupling capacitor lead-in cable is shown in Fig. 7. Before permanently assembling the bushing in the cabinet wall, run the lead-in cable through the bushing and into the cabinet to determine the correct length of lead-in cable. Allow sufficient length of cable to connect to the grounding switch contact stud with the panel swung open. Mark the cable at the bushing to locate its position and remove the cable and bushing from the cabinet. Place the bushing in an inverted position with the openings level. Melt the cement supplied with the accessory package and pour it into the bushing. After the cement has hardened, install the bushing in the cabinet wall.

Remove the connection of the tuning unit from the terminal stud of the jaw contact of the grounding switch. Connect the capacitor lead-in cable to this

terminal stud using the cable terminal supplied with the bushing. Tighten the nut securely. Replace the connection from the tuning unit using the second nut. This will permit disconnecting the tuning unit without disturbing the coupling capacitor lead-in cable connection.

Two screws are mounted in the left wall of the cabinet for securing the coaxial cable. Connect the shield of the cable to terminal #2 and the center conductors to terminal #3. Connect a good ground to the cabinet and to terminal #1 of the terminal board. Run a copper bonding cable from the cabinet to the base of the coupling capacitor.

Coupling Capacitor Lead-In Cable

Since the lead-in cable between the coupling capacitor and the line tuning unit is in a high-impedance carrier-frequency circuit, care must be exercised to keep the leakage to a minimum value.

The lead-in cable should be supported with as few insulators as possible. The insulation of this lead-in cable with respect to ground must be much better than is ordinarily employed for the voltage which exists between these points, as it effectively shunts the reactive elements of the resonant circuit at carrier frequency. The impedance of this resonant circuit may be as high as five thousand ohms and leakage resulting from rain, snow, sleet, too long a lead-in cable, or too many supporting insulators will reduce the effective power output of the transmitter and the sensitivity of the receiver.

An installation which limits this leakage to a minimum will have less signal strength variation under adverse conditions, when reliable operation is of the greatest value.

The insulators used for supporting the lead-in cable should have at least a 7.5 kv rating. Care should be taken not to break the insulation of the cable when clamping it to the insulators. At least once a year the insulators should be washed to remove the accumulation of dirt.

For the lead-in, use a good quality rubber covered cable of at least 7500 volts service grade, with a conductor equivalent to No. 14 gauge or larger. This cable is usually supplied with the coupling capacitor.

ADJUSTMENTS

CAUTION

When making any tap adjustments or changing any connections in this tuner, make certain that the grounding switch is closed. Do not depend on the drain coil for personal safety. Do not touch any terminal when the transmitter is on.

The first consideration in adjusting this tuner is to determine the operating frequency and the capacitance of the coupling capacitor. The value of inductance required for resonance can then be determined as follows:

Refer to Fig. 6 for the L-C product at the carrier frequency. Divide the L-C product by the value in micro-microfarads of the coupling capacitor (Cc).

$$\frac{\text{L-C Product}}{\text{C in Unit}} = \text{mh inductance for resonance.}$$

Refer to Fig. 5 for the tap number of the tuning coil L-1 for this value of inductance.

For the JZ 71.64 tuner, in determining the required inductance, do not use the rated capacitance of the coupling capacitor for Cc. Because of the 0.006-mfd. capacitor (C1) in the tuner output circuit, the net capacitance must be calculated from the formula:

$$Co = \frac{(.006)\,(Cc)}{(.006 + Cc)}$$

where Cc is the rated capacitance of the coupling capacitor, and Co is the calculated value to use in the procedure described in the previous paragraph. (All values are in microfarads) For example, if the coupling capacitor is 0.006 mfd., then the net value of Co is 0.003 mfd. Similarly, for a 0.005 mfd. coupling capacitor, $Co = \frac{.006 \times .005}{.011} = .0027$ mfd. (Now use 2700 mmf. in determining required inductance.)

The final tuning may require changing the tuning coil connection to a higher or lower tap than the tap determined previously due to stray capacitance of the lead-in cable from the coupling capacitor to the tuner or to a slightly reactive power line.

The impedance of the different taps of the transformer T-1 are given in the following table:

Coaxial Tap	Tuner Taps	Line Impedance
2	4-5	100
3	4-5	139
2	6-7	193
3	6-7	268
2	8-9	372
3	8-9	517
2	10-11	720
3	10-11	1000

The average power line impedance is 500 to 600 ohms, and the usual coaxial cable impedance is 50 to 70 ohms. If the impedance of power line is known, connect the TUNER and COAX leads of the transformer to the corresponding taps. If the power line impedance is not known, connect the COAX lead to tap 3 and the TUNER leads to taps 8 and 9.

Open the link of jack J-2 and connect a thermocouple ammeter to the terminals.

Turn on the local transmitter and adjust the core of the tuning coil L-1 for maximum current in jack J-2. If the current is increasing with the core all the way in or all the way out, change the connection to the next higher or lower tap, respectively.

Adjust the transformer taps to obtain as nearly the same current in J1 as would be obtained with a 60-ohm resistive load on the coaxial cable. For a 10-watt transmitter, this current value is 0.41 ampere. For each transformer tap change, recheck the adjustment of the tuning coil for maximum current at J2. If two transformer taps give the same reading of current, use the higher impedance connection.

A procedure for more exact impedance match is shown in Fig. 4, Line Coupling Tuner Adjustment. The dummy load resistors must be of sufficient wattage rating to dissipate the transmitter output. Use the transformer tap connections given in this Instruction Book.

A line tuner which is used to bypass a circuit breaker should be adjusted with the circuit breaker open. However, since this may be difficult to arrange, an alternate method is to disconnect the coupling capacitor from the line and connect its high potential side to ground through a resistor. If the impedance of the line with circuit breaker open is known, use a resistor of this value. If the line impedance is not known, use a 500-ohm resistor.

Adjust the spark gap SG-1 to 0.015 inch spacing. Observe the gap while transmitting full carrier power. If the gap arcs over, increase the spacing until the arcing stops. The minimum spacing for the gap depends upon the carrier power, the capacitance of the coupling capacitor and the impedance of power line.

With some combinations of coupling capacitor values and the higher carrier frequencies, the tuning of the line tuning coil will be so broad that the exact adjustment for resonance is very difficult to determine by normal measurements. However, under these conditions, the frequency response curve for the coupling circuit will be so flat that an exact adjustment of the inductance of the line tuning coil is not necessary. For carrier frequencies above 150 kHz. and for coupling circuits with a Q of less than 2, adjust the inductance of the line tuning coil to the calculated value. Then adjust the ratio of the matching transformer T-1 so that the current in jack J-1 is approximately the same as the current measured when the coaxial cable is terminated in a 60 ohm resistor.

To determine whether or not the above adjusting procedure is applicable, calculate the Q of the coupling circuit as follows:

Calculate the reactance of the coupling capacitor at the operating frequency.

$$X_C = \frac{1}{2\pi FC}$$

Determine the approximate power line impedance.

For a single trapped line use a value of 500 ohms. For lines which are not trapped, divide 500 ohms by the number of lines leaving the bus.

Divide the reactance of the capacitor by the impedance of the line to determine the Q of the circuit.

$$Q = X_C/R$$

(Since this calculation is only an approximation, the possible reactance of the power line is neglected.)

Example: Coupling Capacitor — .00275 mfd.
Operating Frequency — 165 kHz.
Single Trapped Line — use 500 ohms

$$X_C = \frac{1}{2\pi FC} = 350 \text{ ohms}$$

$$Q = 350/500 = 0.7$$

For this installation, calculate the inductance required to resonate the coupling capacitor.

$$L = \frac{X_L}{2\pi F} = 0.34 \text{ mh}$$

Refer to Fig. 5.

For 0.34 mh use tap 78, with core at center of travel. Short unused turns.

NOTE

The instructions in Fig. 5 state that the unused taps are to be shorted when a tap lower than 100 is used and also when the frequency is above 150 kHz.

This procedure will leave a gap in the inductance range between tap 100 with the unused turns not shorted and tap 88 with the unused turns shorted. Continuous inductance adjustment can be obtained by using tap 113 with unused turns shorted as the next lower inductance tap below tap 100 with the unused turns not shorted

MAINTENANCE

Routine Checks and Records

This line tuner requires very little maintenance. It should be inspected occasionally to see if there has been excessive burning of the spark gap. If the discs show signs of burning, rotate the discs to a new position and re-adjust the gap. Usually a semi-annual or yearly inspection is sufficient.

A permanent record should be kept of the tap settings and the position of the tuning coil core so that they can be restored to the correct positions in case of unauthorized changes.

Ordering Replacement Parts

Replacement parts for this line tuner may be ordered through the nearest Westinghouse District Office.

When ordering, include:

1. The following data from the nameplate of the line tuner: (A) the type number, and (B) the style number.

2. The (A) electrical parts list symbol, (B) the function, (C) the description, and (D) the style number.

ELECTRICAL PARTS LIST

CIRCUIT SYMBOL	FUNCTION	DESCRIPTION	STYLE NUMBER
		SUB-ASSEMBLIES	
L-1	Line Tuning Coil	Line Tuning Coil Assembly	1474218
T-1	Transformer	Transformer Assembly	407C741G02
	Protector Unit	Protector Unit Assembly	1474014
		COMPONENT PARTS	
J-1	Jack-Coax Metering	Binding Post Type 2 Binding Posts 1 Shorting Link	 185A431H01 1474455
J-2	Jack-Line Metering	Same as J-1	
SG-1	Spark Gap	Disc Type	2 of 183A358H20 (discs only)
		OPTIONAL	
L-3	Drain Coil (When Used)	20,000 ohms minimum impedance over 30-200 kHz.	670B069G02
C1	Series Capacitor (When Used)	Mica, 0.006 mfd., ± 5% 3000V, PACW.	584C256H03

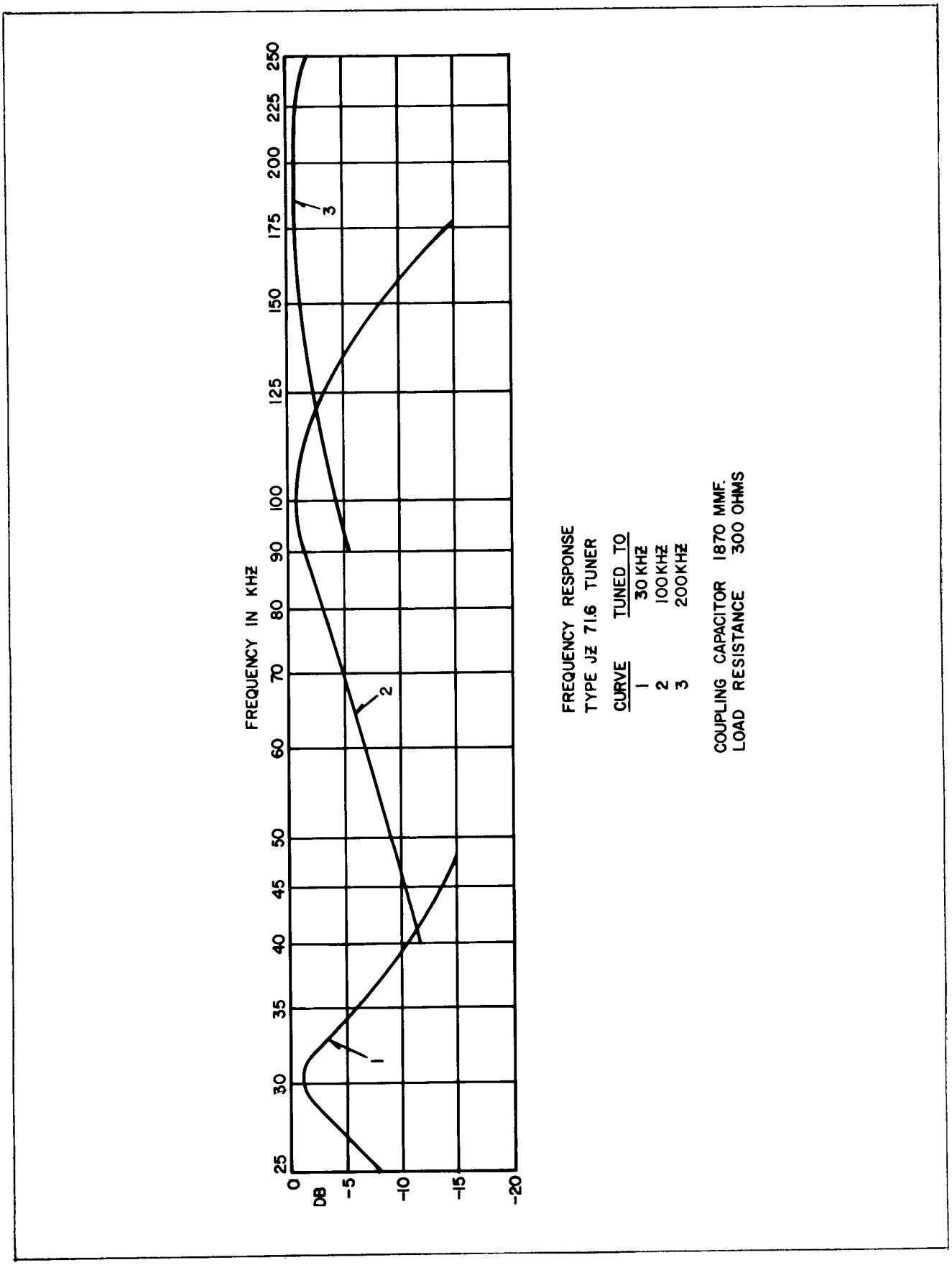


Fig. 1. Response Curves of JZ 71.6 Tuner. (Dwg. 862A346)

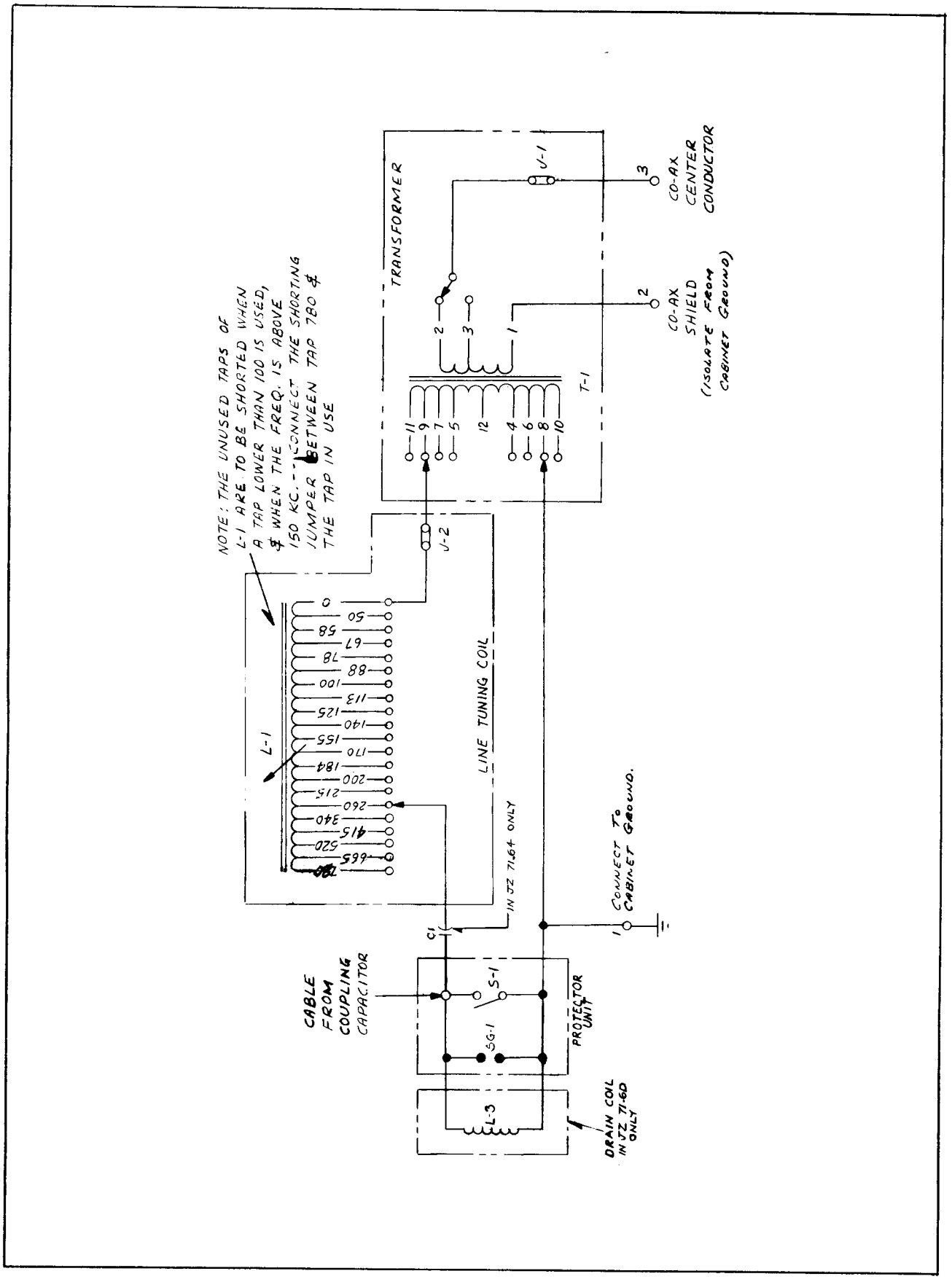


Fig. 2. Schematic Diagram (Dwg. 224B332)

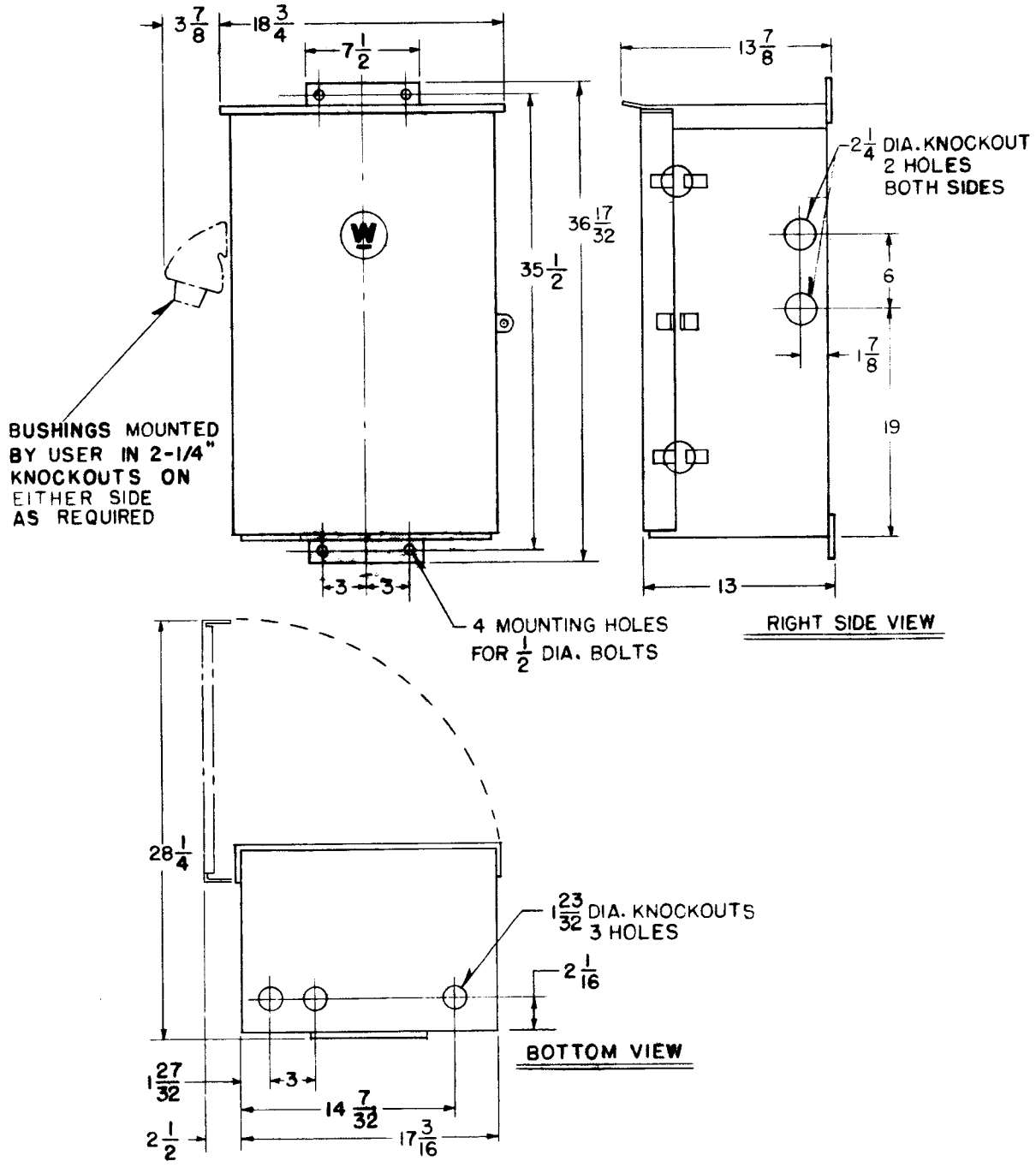


Fig. 3. Outline Drawing (Dwg. 50-B-7683)

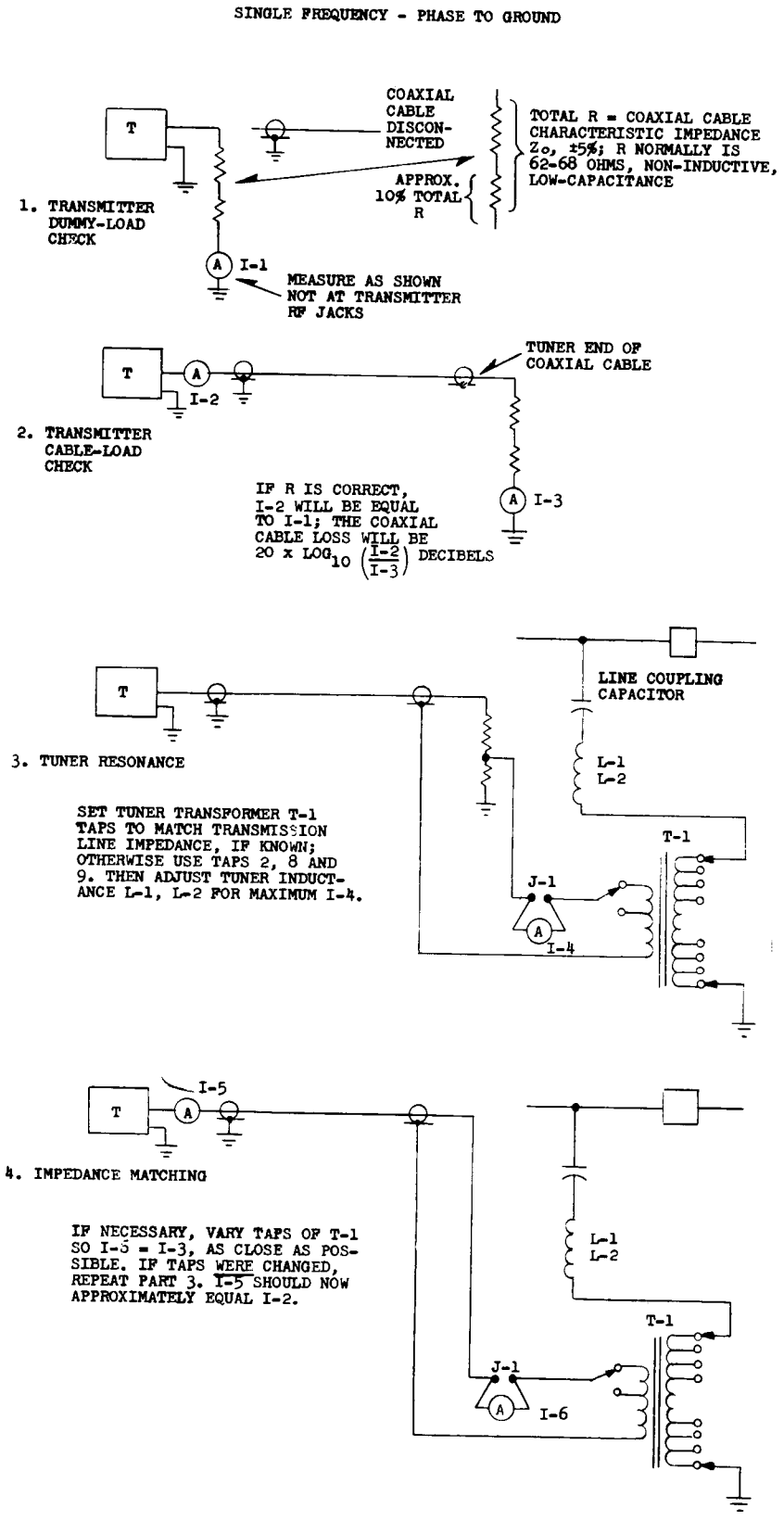


Fig. 4. Line Coupling Tuner Adjustment Procedure (Dwg. 224B334).

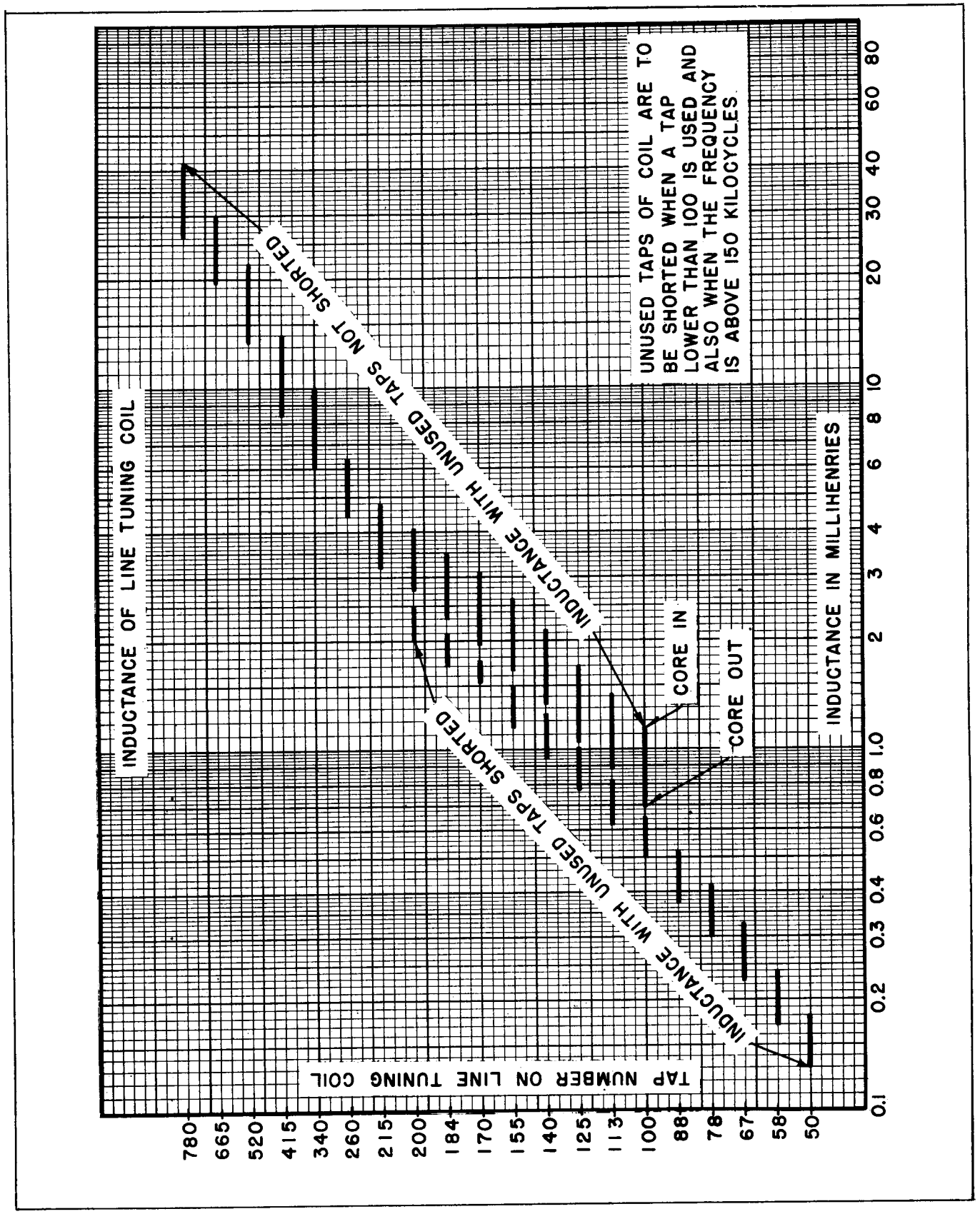


Fig. 5. Inductance of Line Tuning Coil (Curve 358433).

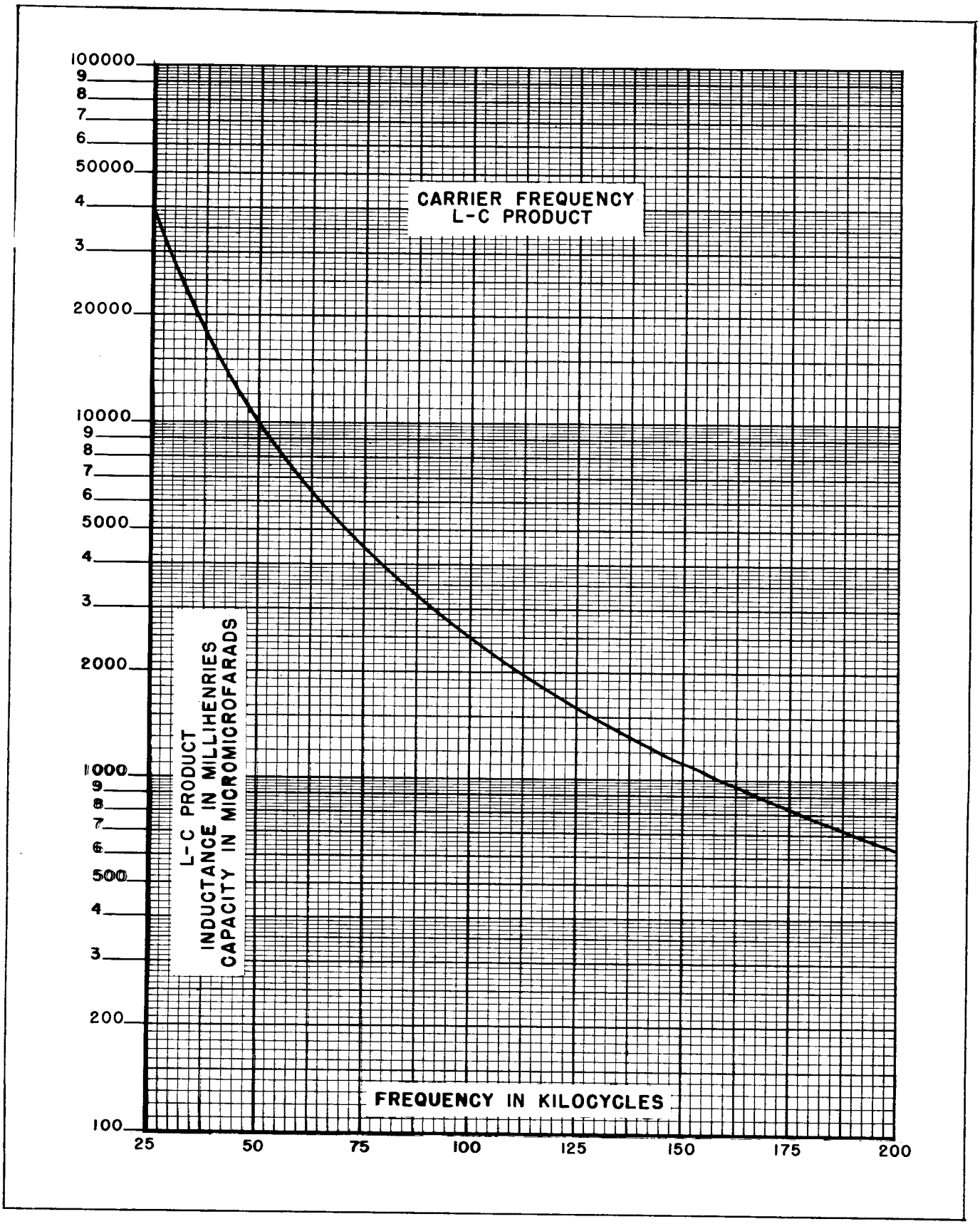


Fig. 6. Carrier Frequency L-C Product (Curve 358437).

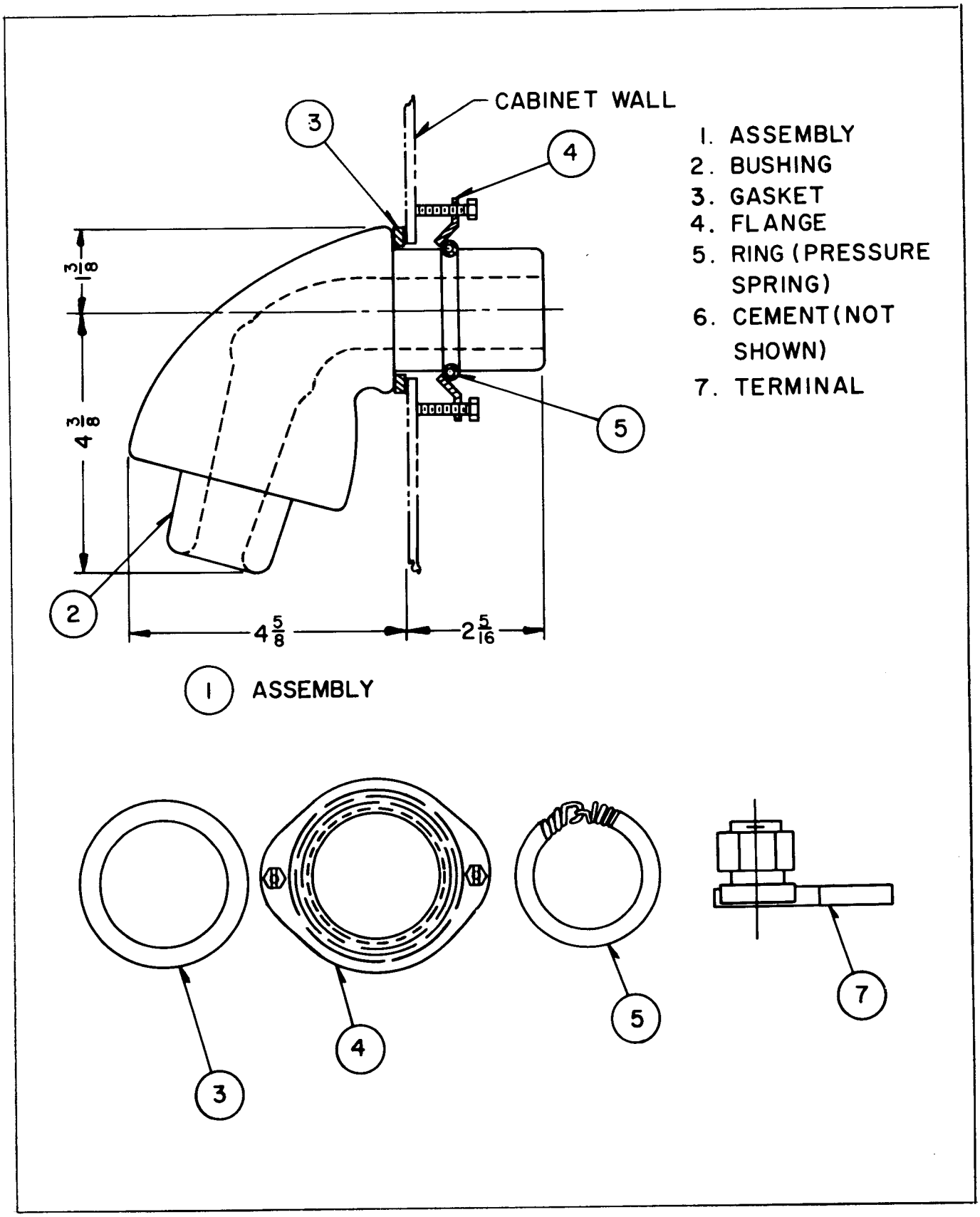
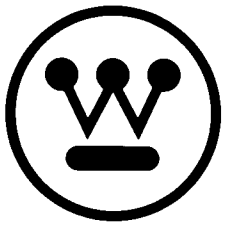


Fig. 7. Lead-In Bushing Assembly (862A186)



WESTINGHOUSE ELECTRIC CORPORATION
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TYPE JZ 71.6D	- STYLE 606B363A09	-	WITH DRAIN COIL
TYPE JZ 71.64	- STYLE 606B363AI4	-	WITH 0.006 MFD. SERIES CAPACITOR
TYPE JZ 71.64D	- STYLE 606B363AI9	-	WITH DRAIN COIL AND 0.006-MFD. CAPACITOR

SUPERSEDES I.L. 41-949.1A
*Denotes change from supers

EFFECTIVE JUNE 1968

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APPLICATION

The Type JZ-71.6 Line Coupling Tuners are designed for phase-to-ground coupling of a single carrier frequency from a coaxial cable through a coupling capacitor to a power line. The impedance matching transformer and line tuning coil, in conjunction with the coupling capacitor, provide a low loss circuit for coupling a carrier transmitter to the power line.

DESCRIPTION

Mechanical Description

The tuner is mounted in a cabinet suitable for outdoor mounting. Knockouts are provided on each side of the cabinet for the capacitor lead-in bushing and in the bottom of the cabinet for 1½ inch conduit for the coaxial cable. The outline, mounting dimensions and the location of the knockouts are shown in Fig. 3.

All of the electrical components are mounted on a hinged panel which may be opened for making the coaxial cable and capacitor lead-in connections. The transformer taps, tuning coil taps, grounding switch and spark gap are accessible from the front of the panel.

Electrical Description

The electrical circuits are shown on the Schematic Diagram Fig. 2. The coaxial cable center conductor is connected through jack J-1 to the matching transformer T-1, The coaxial cable shield is connected to terminal 1 of the matching transformer. The shield is not grounded, but may be by connecting a short jumper between terminals 1 and 2 of the cabinet terminal block. The high impedance tap of the transformer is connected through jack J-2 to the line tuning coil L-1. An adjustable spark gap SG-1 protects the equipment from excessive voltage surges. The knife switch S-1 is provided for grounding the lead-in from the coupling capacitor while adjustments are being made.

The JZ 71.64 tuner includes a 0.006-mfd. capacitor in series with the output lead to the protector unit. This allows the tuner to be used with coupling capacitors up to 0.015 mfd. When a drain coil is supplied with the tuner, it is identified as a Type JZ 71.6D tuner. If both capacitor and drain coil are included, the tuner is Type JZ 71.64D.

Typical response curves for the type JZ 71.6 tuners are plotted in Fig. 1. These curves were taken with an 1870-mmf. coupling capacitor and a 300-ohm resistive load. The tuner was adjusted for resonance (f_r) at 30, 100, and 200 kHz. respectively, for the three curves.

CHARACTERISTICS

Frequency Range:	30 to 200 kHz.
Input Impedance:	50 to 70 Ohms
Output Impedance:	100 to 1000 Ohms
Power Rating:	100 Watts Carrier-Unmodulated 25 Watts Carrier-100% Modulated
Coupling Capacitor Range:	JZ 71.6 – .00075 to .004 mfd. JZ 71.64 – .00075 to .015 mfd.

INSTALLATION

It is recommended that the Line Tuner be located as near the coupling capacitor as is practical. The mounting dimensions are shown on Fig. 3.

Remove the knockout from the side of the cabinet nearest the coupling capacitor for installation of the porcelain bushing for the capacitor lead-in.

Connections

CAUTION

Before making any connections to this equipment, turn off the power switch of the carrier transmitter and ground or open circuit the lead-in at the coupling capacitor.

The assembly of the Style 1352445 accessories for the coupling capacitor lead-in cable is shown in Fig. 7. Before permanently assembling the bushing in the cabinet wall, run the lead-in cable through the bushing and into the cabinet to determine the correct length of lead-in cable. Allow sufficient length of cable to connect to the grounding switch contact stud with the panel swung open. Mark the cable at the bushing to locate its position and remove the cable and bushing from the cabinet. Place the bushing in an inverted position with the openings level. Melt the cement supplied with the accessory package and pour it into the bushing. After the cement has hardened, install the bushing in the cabinet wall.

Remove the connection of the tuning unit from the terminal stud of the jaw contact of the grounding switch. Connect the capacitor lead-in cable to this

terminal stud using the cable terminal supplied with the bushing. Tighten the nut securely. Replace the connection from the tuning unit using the second nut. This will permit disconnecting the tuning unit without disturbing the coupling capacitor lead-in cable connection.

Two screws are mounted in the left wall of the cabinet for securing the coaxial cable. Connect the shield of the cable to terminal #2 and the center conductors to terminal #3. Connect a good ground to the cabinet and to terminal #1 of the terminal board. Run a copper bonding cable from the cabinet to the base of the coupling capacitor.

Coupling Capacitor Lead-In Cable

Since the lead-in cable between the coupling capacitor and the line tuning unit is in a high-impedance carrier-frequency circuit, care must be exercised to keep the leakage to a minimum value.

The lead-in cable should be supported with as few insulators as possible. The insulation of this lead-in cable with respect to ground must be much better than is ordinarily employed for the voltage which exists between these points, as it effectively shunts the reactive elements of the resonant circuit at carrier frequency. The impedance of this resonant circuit may be as high as five thousand ohms and leakage resulting from rain, snow, sleet, too long a lead-in cable, or too many supporting insulators will reduce the effective power output of the transmitter and the sensitivity of the receiver.

An installation which limits this leakage to a minimum will have less signal strength variation under adverse conditions, when reliable operation is of the greatest value.

The insulators used for supporting the lead-in cable should have at least a 7.5 kv rating. Care should be taken not to break the insulation of the cable when clamping it to the insulators. At least once a year the insulators should be washed to remove the accumulation of dirt.

For the lead-in, use a good quality rubber covered cable of at least 7500 volts service grade, with a conductor equivalent to No. 14 gauge or larger. This cable is usually supplied with the coupling capacitor.

ADJUSTMENTS

CAUTION

When making any tap adjustments or changing any connections in this tuner, make certain that the grounding switch is closed. Do not depend on the drain coil for personal safety. Do not touch any terminal when the transmitter is on.

The first consideration in adjusting this tuner is to determine the operating frequency and the capacitance of the coupling capacitor. The value of inductance required for resonance can then be determined as follows:

Refer to Fig. 6 for the L-C product at the carrier frequency. Divide the L-C product by the value in micro-microfarads of the coupling capacitor (Cc).

$$\frac{\text{L-C Product}}{\text{C in Unit}} = \text{mh inductance for resonance.}$$

Refer to Fig. 5 for the tap number of the tuning coil L-1 for this value of inductance.

For the JZ 71.64 tuner, in determining the required inductance, do not use the rated capacitance of the coupling capacitor for Cc. Because of the 0.006-mfd. capacitor (C1) in the tuner output circuit, the net capacitance must be calculated from the formula:

$$Co = \frac{(.006)\,(Cc)}{(.006 + Cc)}$$

where Cc is the rated capacitance of the coupling capacitor, and Co is the calculated value to use in the procedure described in the previous paragraph. (All values are in microfarads) For example, if the coupling capacitor is 0.006 mfd., then the net value of Co is 0.003 mfd. Similarly, for a 0.005 mfd. coupling capacitor, $Co = \frac{.006 \times .005}{.011} = .0027$ mfd. (Now use 2700 mmf. in determining required inductance.)

The final tuning may require changing the tuning coil connection to a higher or lower tap than the tap determined previously due to stray capacitance of the lead-in cable from the coupling capacitor to the tuner or to a slightly reactive power line.

The impedance of the different taps of the transformer T-1 are given in the following table:

Coaxial Tap	Tuner Taps	Line Impedance
2	4-5	100
3	4-5	139
2	6-7	193
3	6-7	268
2	8-9	372
3	8-9	517
2	10-11	720
3	10-11	1000

The average power line impedance is 500 to 600 ohms, and the usual coaxial cable impedance is 50 to 70 ohms. If the impedance of power line is known, connect the TUNER and COAX leads of the transformer to the corresponding taps. If the power line impedance is not known, connect the COAX lead to tap 3 and the TUNER leads to taps 8 and 9.

Open the link of jack J-2 and connect a thermocouple ammeter to the terminals.

Turn on the local transmitter and adjust the core of the tuning coil L-1 for maximum current in jack J-2. If the current is increasing with the core all the way in or all the way out, change the connection to the next higher or lower tap, respectively.

Adjust the transformer taps to obtain as nearly the same current in J1 as would be obtained with a 60-ohm resistive load on the coaxial cable. For a 10-watt transmitter, this current value is 0.41 ampere. For each transformer tap change, recheck the adjustment of the tuning coil for maximum current at J2. If two transformer taps give the same reading of current, use the higher impedance connection.

A procedure for more exact impedance match is shown in Fig. 4, Line Coupling Tuner Adjustment. The dummy load resistors must be of sufficient wattage rating to dissipate the transmitter output. Use the transformer tap connections given in this Instruction Book.

A line tuner which is used to bypass a circuit breaker should be adjusted with the circuit breaker open. However, since this may be difficult to arrange, an alternate method is to disconnect the coupling capacitor from the line and connect its high potential side to ground through a resistor. If the impedance of the line with circuit breaker open is known, use a resistor of this value. If the line impedance is not known, use a 500-ohm resistor.

Adjust the spark gap SG-1 to 0.015 inch spacing. Observe the gap while transmitting full carrier power. If the gap arcs over, increase the spacing until the arcing stops. The minimum spacing for the gap depends upon the carrier power, the capacitance of the coupling capacitor and the impedance of power line.

With some combinations of coupling capacitor values and the higher carrier frequencies, the tuning of the line tuning coil will be so broad that the exact adjustment for resonance is very difficult to determine by normal measurements. However, under these conditions, the frequency response curve for the coupling circuit will be so flat that an exact adjustment of the inductance of the line tuning coil is not necessary. For carrier frequencies above 150 kHz. and for coupling circuits with a Q of less than 2, adjust the inductance of the line tuning coil to the calculated value. Then adjust the ratio of the matching transformer T-1 so that the current in jack J-1 is approximately the same as the current measured when the coaxial cable is terminated in a 60 ohm resistor.

To determine whether or not the above adjusting procedure is applicable, calculate the Q of the coupling circuit as follows:

Calculate the reactance of the coupling capacitor at the operating frequency.

$$X_C = \frac{1}{2\pi FC}$$

Determine the approximate power line impedance.

For a single trapped line use a value of 500 ohms. For lines which are not trapped, divide 500 ohms by the number of lines leaving the bus.

Divide the reactance of the capacitor by the impedance of the line to determine the Q of the circuit.

$$Q = X_C/R$$

(Since this calculation is only an approximation, the possible reactance of the power line is neglected.)

Example: Coupling Capacitor — .00275 mfd.
Operating Frequency — 165 kHz.
Single Trapped Line — use 500 ohms

$$X_C = \frac{1}{2\pi FC} = 350 \text{ ohms}$$

$$Q = 350/500 = 0.7$$

For this installation, calculate the inductance required to resonate the coupling capacitor.

$$L = \frac{X_L}{2\pi F} = 0.34 \text{ mh}$$

Refer to Fig. 5.

For 0.34 mh use tap 78, with core at center of travel. Short unused turns.

NOTE

The instructions in Fig. 5 state that the unused taps are to be shorted when a tap lower than 100 is used and also when the frequency is above 150 kHz.

This procedure will leave a gap in the inductance range between tap 100 with the unused turns not shorted and tap 88 with the unused turns shorted. Continuous inductance adjustment can be obtained by using tap 113 with unused turns shorted as the next lower inductance tap below tap 100 with the unused turns not shorted

MAINTENANCE

Routine Checks and Records

This line tuner requires very little maintenance. It should be inspected occasionally to see if there has been excessive burning of the spark gap. If the discs show signs of burning, rotate the discs to a new position and re-adjust the gap. Usually a semi-annual or yearly inspection is sufficient.

A permanent record should be kept of the tap settings and the position of the tuning coil core so that they can be restored to the correct positions in case of unauthorized changes.

Ordering Replacement Parts

Replacement parts for this line tuner may be ordered through the nearest Westinghouse District Office.

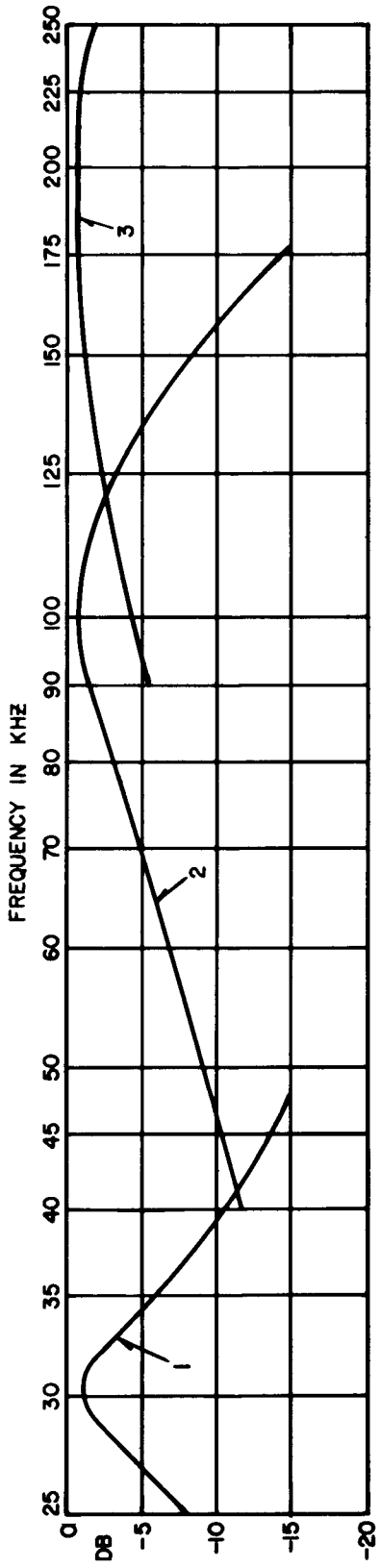
When ordering, include:

1. The following data from the nameplate of the line tuner: (A) the type number, and (B) the style number.

2. The (A) electrical parts list symbol, (B) the function, (C) the description, and (D) the style number.

ELECTRICAL PARTS LIST

CIRCUIT SYMBOL	FUNCTION	DESCRIPTION	STYLE NUMBER
		SUB-ASSEMBLIES	
L-1	Line Tuning Coil	Line Tuning Coil Assembly	1474218
T-1	Transformer	Transformer Assembly	407C741G02
	Protector Unit	Protector Unit Assembly	1474014
		COMPONENT PARTS	
J-1	Jack-Coax Metering	Binding Post Type 2 Binding Posts 1 Shorting Link	 185A431H01 1474455
J-2	Jack-Line Metering	Same as J-1	
SG-1	Spark Gap	Disc Type	2 of 183A358H20 (discs only)
		OPTIONAL	
L-3	Drain Coil (When Used)	20,000 ohms minimum impedance over 30-200 kHz.	670B069G02
C1	Series Capacitor (When Used)	Mica, 0.006 mfd., ± 5% 3000V, PACW.	584C256H03



FREQUENCY RESPONSE
TYPE JZ 71.6 TUNER

CURVE	TUNED TO
1	30 KHZ
2	100 KHZ
3	200 KHZ

COUPLING CAPACITOR 1870 MMF.
LOAD RESISTANCE 300 OHMS

(Dwg. 862A346)

Fig. 1. Response Curves of JZ 71.6 Tuner.

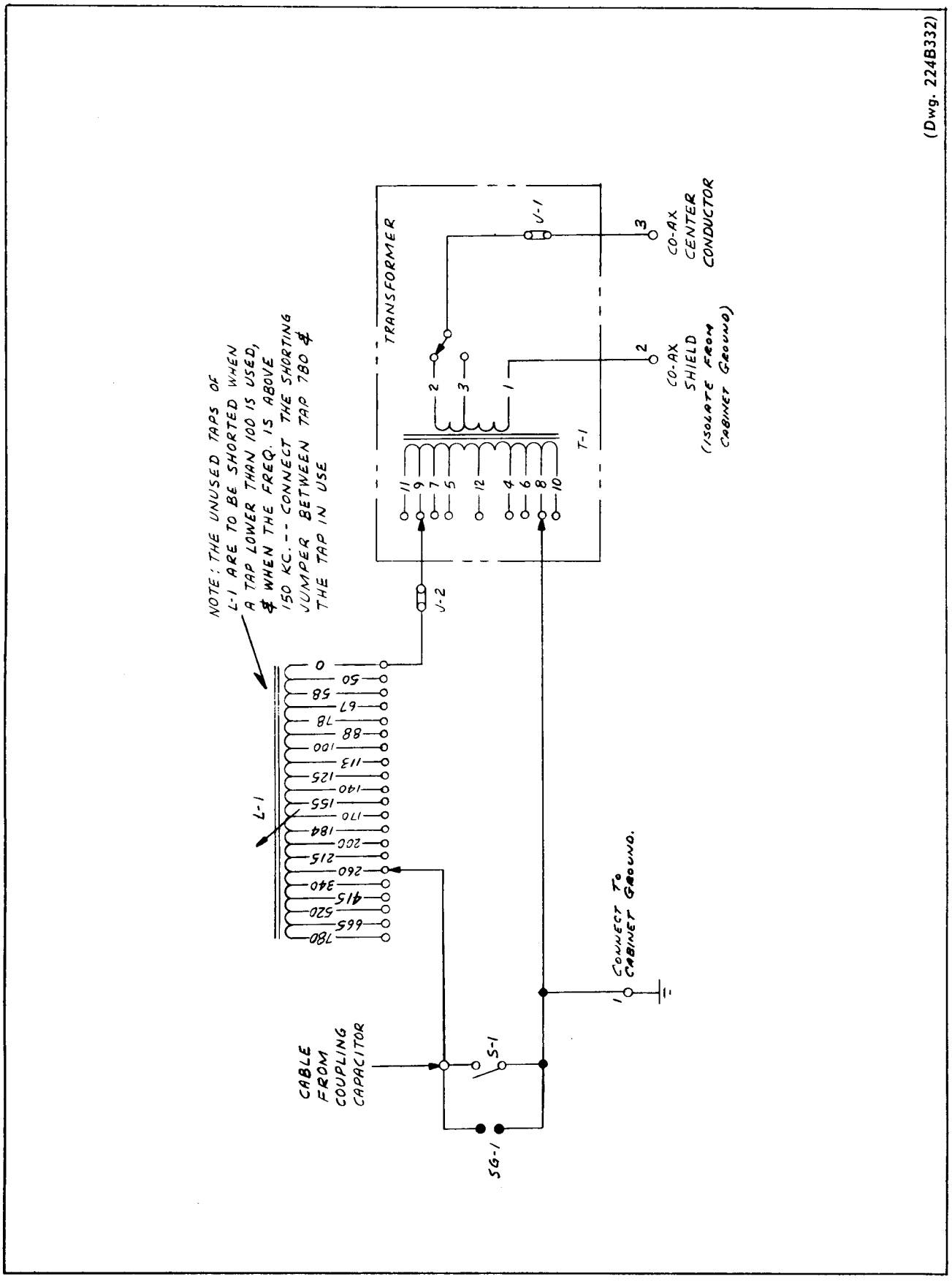


Fig. 2. Schematic Diagram

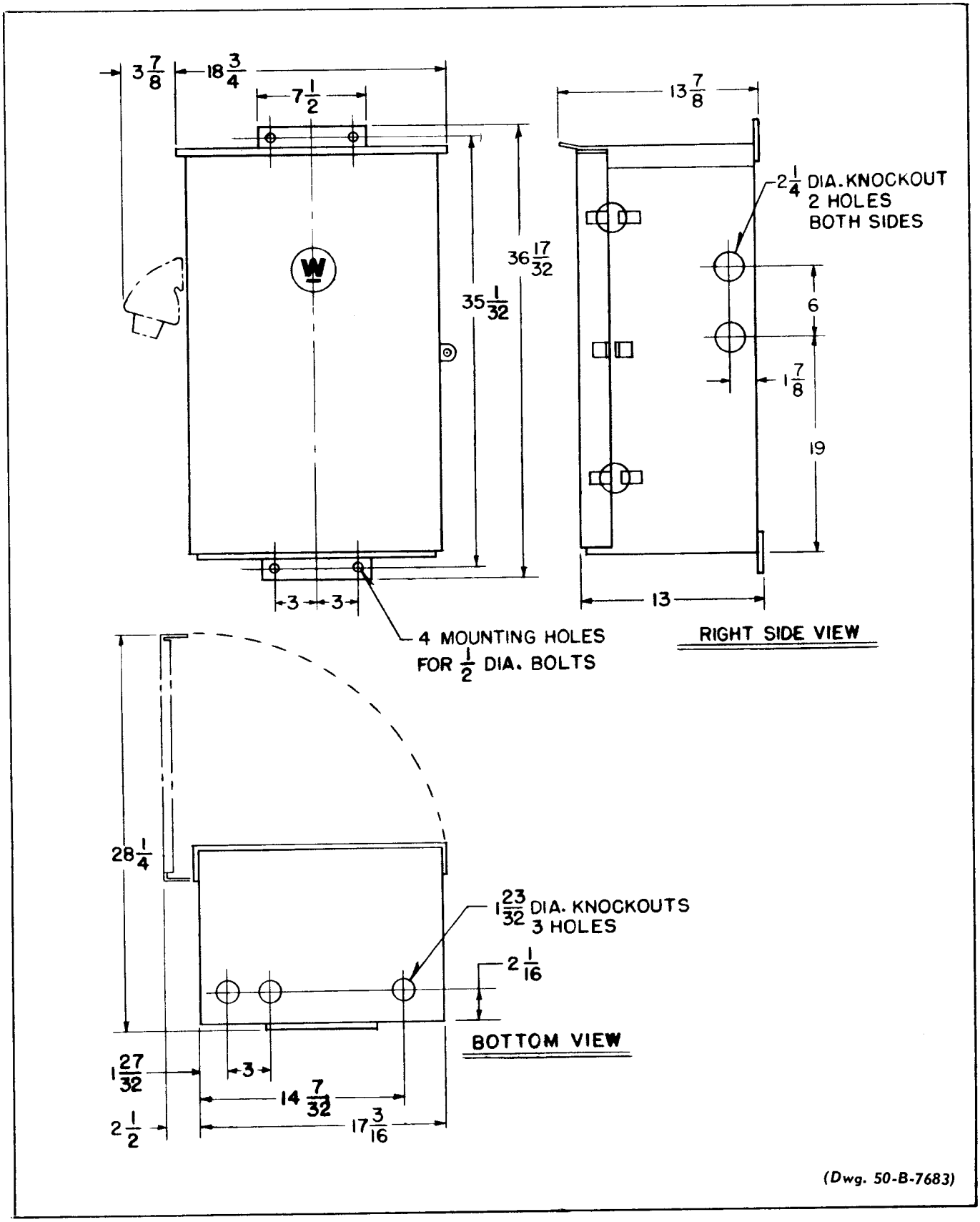


Fig. 3. Outline Drawing

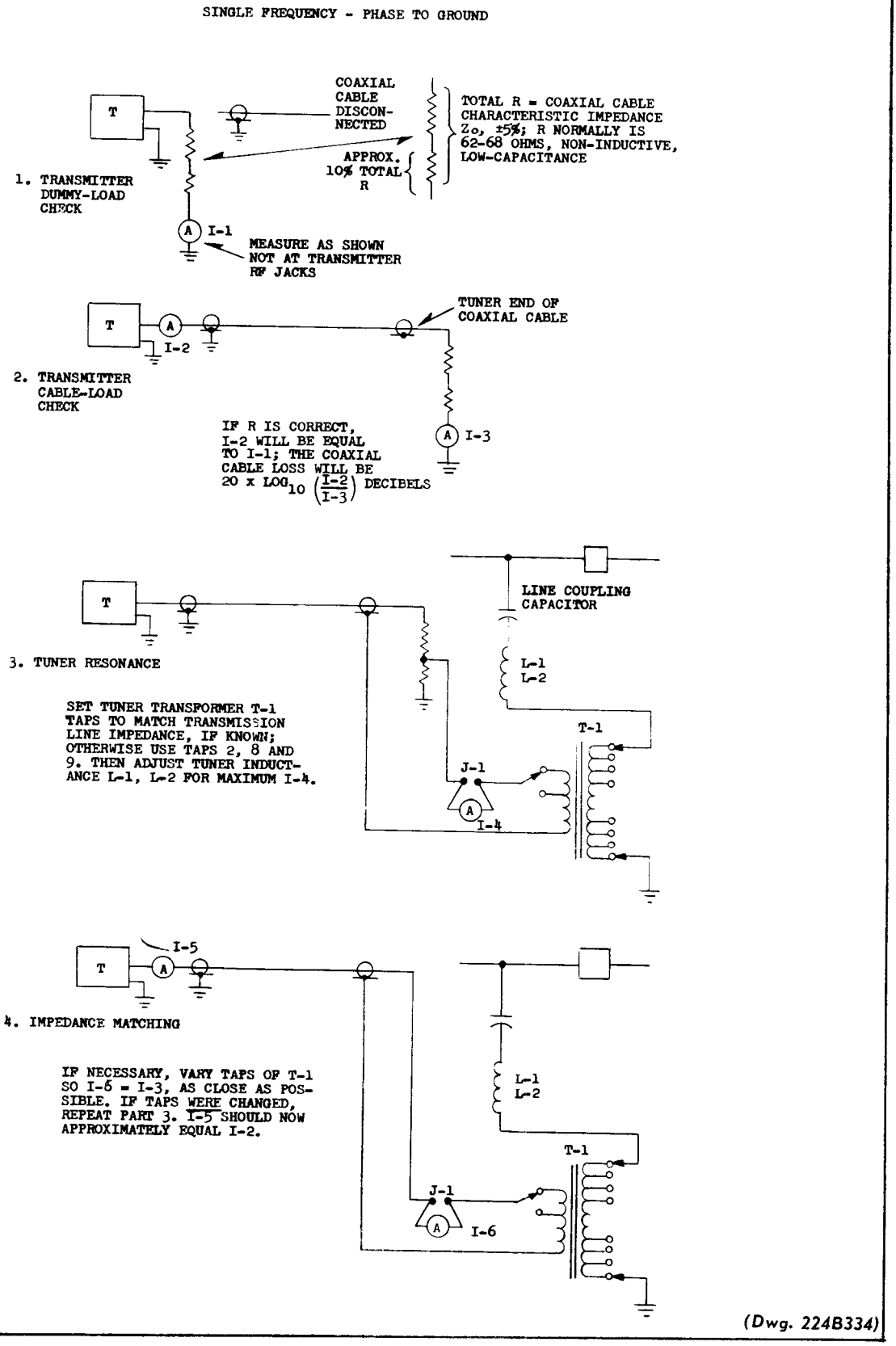


Fig. 4. Line Coupling Tuner Adjustment Procedure

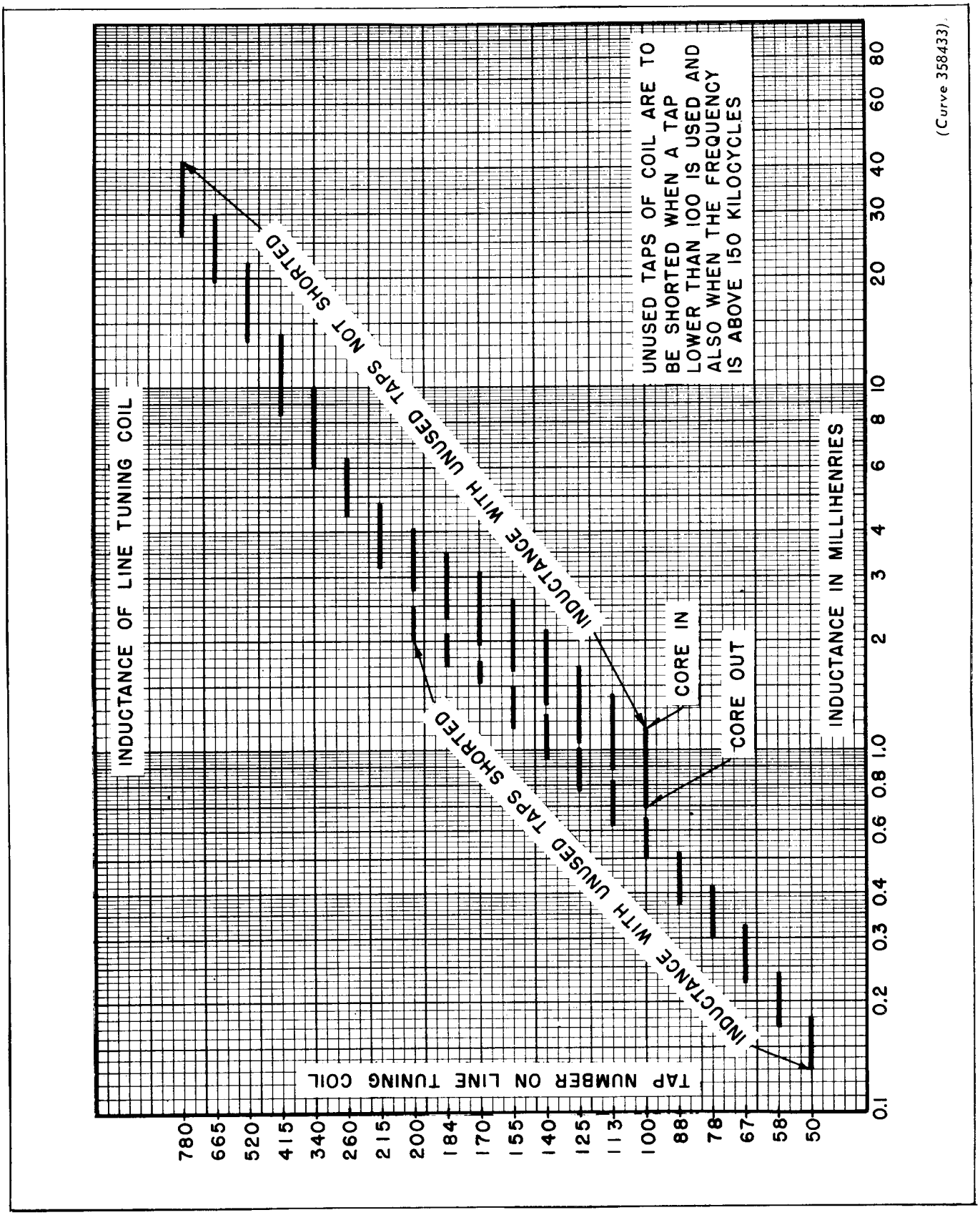


Fig. 5. Inductance of Line Tuning Coil

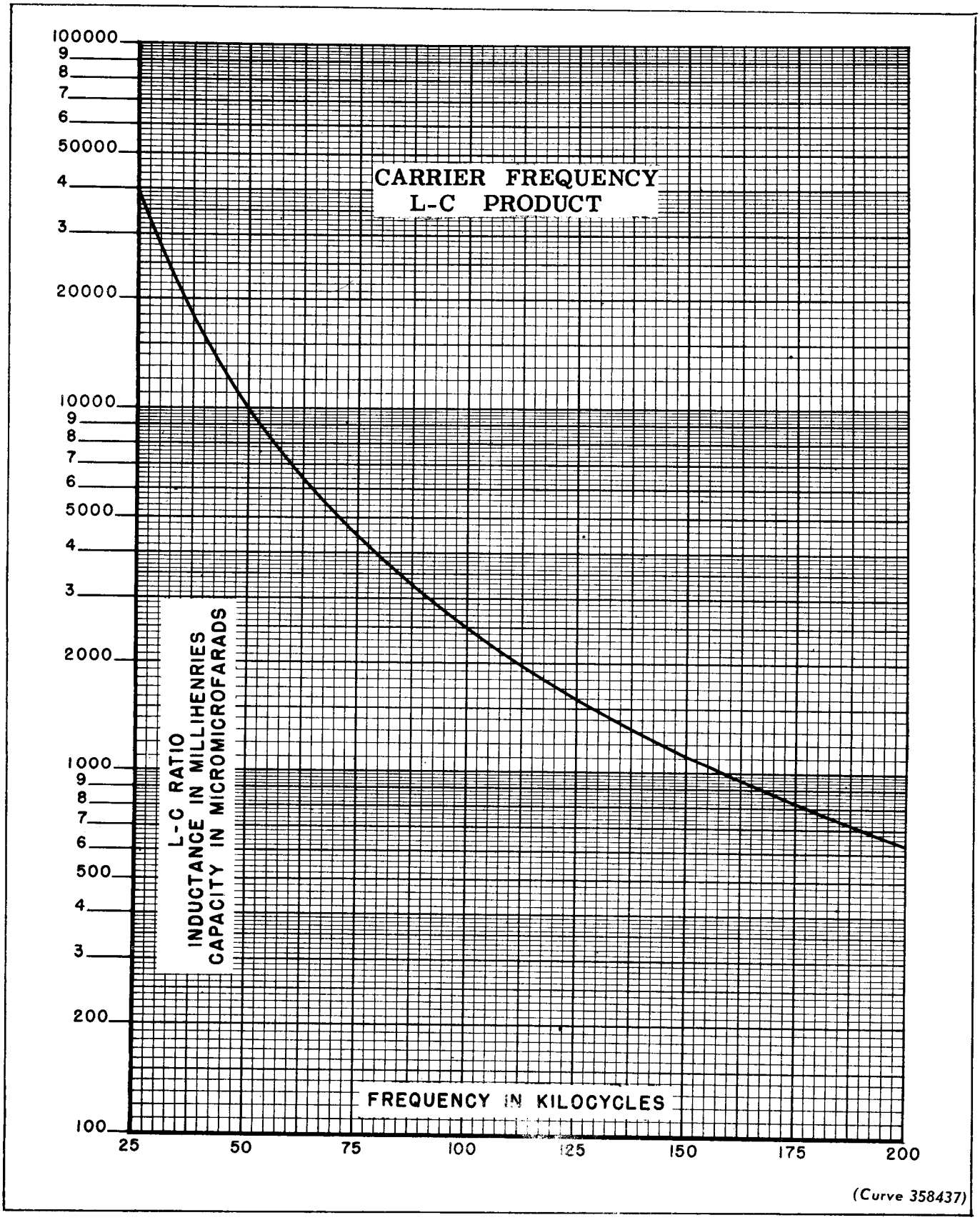


Fig. 6. Carrier Frequency L-C Product

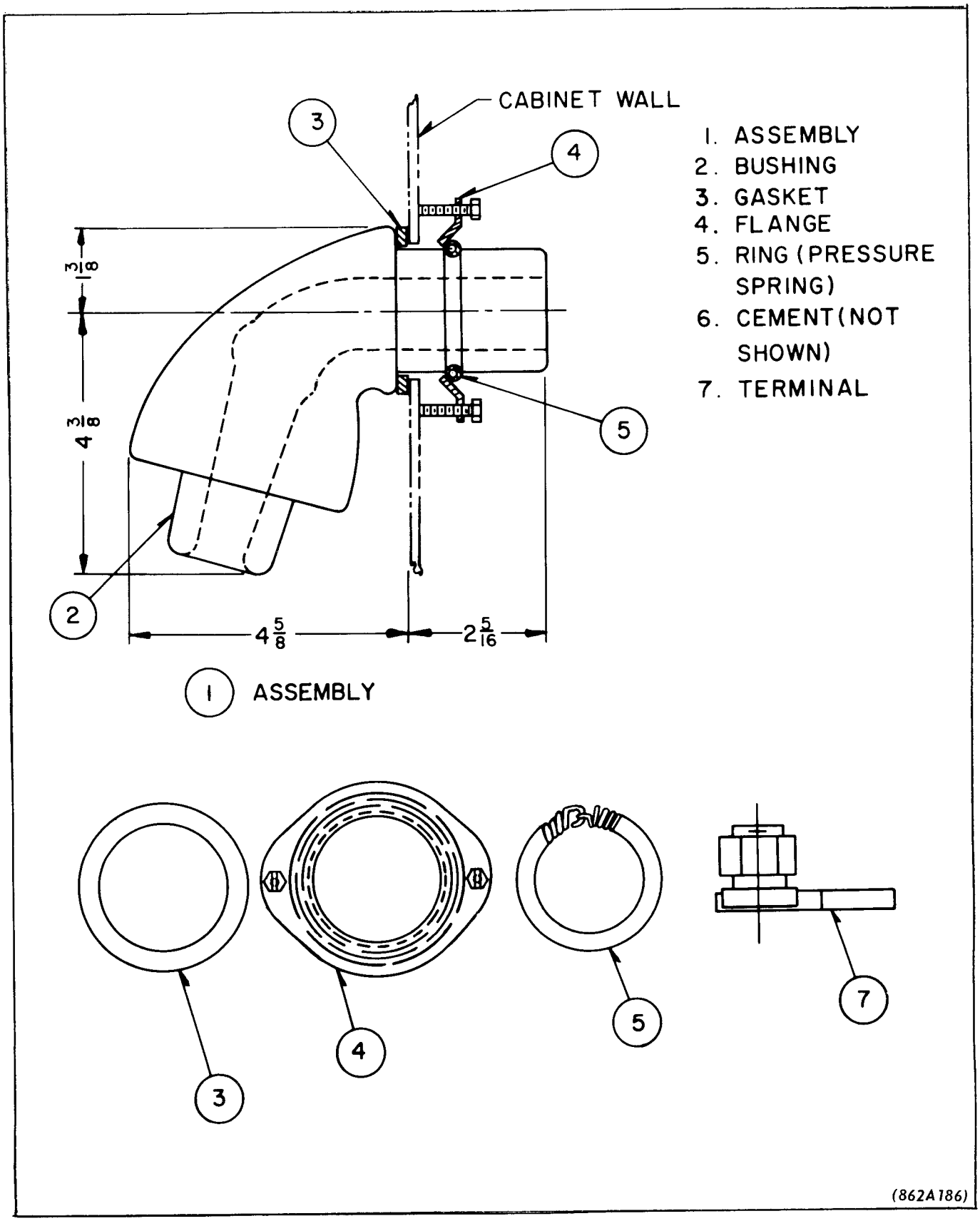
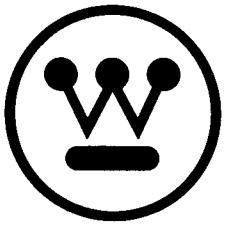


Fig. 7. Lead-In Bushing Assembly



WESTINGHOUSE ELECTRIC CORPORATION

RELAY-INSTRUMENT DIVISION **NEWARK, N. J.**

Printed in U.S.A.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE JZ—71.6 LINE COUPLING TUNERS

SINGLE-FREQUENCY PHASE-TO-GROUND
LINE COUPLING TUNERS
WITH TWO-WINDING MATCHING TRANSFORMER

TYPE JZ 71.6	- STYLE 290B883AI2	-	WITHOUT DRAIN COIL
TYPE JZ 71.6D	- STYLE 606B363A09	-	WITH DRAIN COIL
TYPE JZ 71.64	- STYLE 606B363AI4	-	WITH 0.006 MFD. SERIES CAPACITOR
TYPE JZ 71.64D	- STYLE 606B363AI9	-	WITH DRAIN COIL AND 0.006-MFD. CAPACITOR

SUPERSEDES I.L. 41-949.1B
*Denotes change from superseded issue.

EFFECTIVE JANUARY 1969

SAFETY WARNING!

Protect your life while making adjustments! Before handling any part of the electrical circuits:

1. BE SURE THE GROUNDING SWITCHES IN THIS ASSEMBLY ARE IN THE "GROUNDED" OR CLOSED POSITION.

2. BE SURE THAT ALL POWER SWITCHES IN THIS ASSEMBLY ARE TURNED "OFF".

Protect the equipment against damage by not applying power until thoroughly familiar with the ADJUSTMENTS described in this book.

SAFETY FIRST!

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SUPPLEMENTARY DATA

Drawings **References**

APPLICATION

The Type JZ-71.6 Line Coupling Tuners are designed for phase-to-ground coupling of a single carrier frequency from a coaxial cable through a coupling capacitor to a power line. The impedance matching transformer and line tuning coil, in conjunction with the coupling capacitor, provide a low loss circuit for coupling a carrier transmitter to the power line.

DESCRIPTION

Mechanical Description

The tuner is mounted in a cabinet suitable for outdoor mounting. Knockouts are provided on each side of the cabinet for the capacitor lead-in bushing and in the bottom of the cabinet for 1½ inch conduit for the coaxial cable. The outline, mounting dimensions and the location of the knockouts are shown in Fig. 3.

All of the electrical components are mounted on a hinged panel which may be opened for making the coaxial cable and capacitor lead-in connections. The transformer taps, tuning coil taps, grounding switch and spark gap are accessible from the front of the panel.

Electrical Description

The electrical circuits are shown on the Schematic Diagram Fig. 2. The coaxial cable center conductor is connected through jack J-1 to the matching transformer T-1, The coaxial cable shield is connected to terminal 1 of the matching transformer. The shield is not grounded, but may be by connecting a short jumper between terminals 1 and 2 of the cabinet terminal block. The high impedance tap of the transformer is connected through jack J-2 to the line tuning coil L-1. An adjustable spark gap SG-1 protects the equipment from excessive voltage surges. The knife switch S-1 is provided for grounding the lead-in from the coupling capacitor while adjustments are being made.

The JZ 71.64 tuner includes a 0.006-mfd. capacitor in series with the output lead to the protector unit. This allows the tuner to be used with coupling capacitors up to 0.015 mfd. When a drain coil is supplied with the tuner, it is identified as a Type JZ 71.6D tuner. If both capacitor and drain coil are included, the tuner is Type JZ 71.64D.

Typical response curves for the type JZ 71.6 tuners are plotted in Fig. 1. These curves were taken with an 1870-mmf. coupling capacitor and a 300-ohm resistive load. The tuner was adjusted for resonance (f_r) at 30, 100, and 200 kHz. respectively, for the three curves.

CHARACTERISTICS

Frequency Range:	30 to 200 kHz.
Input Impedance:	50 to 70 Ohms
Output Impedance:	100 to 1000 Ohms
Power Rating:	100 Watts Carrier-Unmodulated 25 Watts Carrier-100% Modulated
Coupling Capacitor Range:	JZ 71.6 – .00075 to .004 mfd. JZ 71.64 – .00075 to .015 mfd.

INSTALLATION

It is recommended that the Line Tuner be located as near the coupling capacitor as is practical. The mounting dimensions are shown on Fig. 3.

Remove the knockout from the side of the cabinet nearest the coupling capacitor for installation of the porcelain bushing for the capacitor lead-in.

Connections

CAUTION

Before making any connections to this equipment, turn off the power switch of the carrier transmitter and ground or open circuit the lead-in at the coupling capacitor.

The assembly of the Style 1352445 accessories for the coupling capacitor lead-in cable is shown in Fig. 7. Before permanently assembling the bushing in the cabinet wall, run the lead-in cable through the bushing and into the cabinet to determine the correct length of lead-in cable. Allow sufficient length of cable to connect to the grounding switch contact stud with the panel swung open. Mark the cable at the bushing to locate its position and remove the cable and bushing from the cabinet. Place the bushing in an inverted position with the openings level. Melt the cement supplied with the accessory package and pour it into the bushing. After the cement has hardened, install the bushing in the cabinet wall.

Remove the connection of the tuning unit from the terminal stud of the jaw contact of the grounding switch. Connect the capacitor lead-in cable to this

terminal stud using the cable terminal supplied with the bushing. Tighten the nut securely. Replace the connection from the tuning unit using the second nut. This will permit disconnecting the tuning unit without disturbing the coupling capacitor lead-in cable connection.

Two screws are mounted in the left wall of the cabinet for securing the coaxial cable. Connect the shield of the cable to terminal #2 and the center conductors to terminal #3. Connect a good ground to the cabinet and to terminal #1 of the terminal board. Run a copper bonding cable from the cabinet to the base of the coupling capacitor.

Coupling Capacitor Lead-In Cable

Since the lead-in cable between the coupling capacitor and the line tuning unit is in a high-impedance carrier-frequency circuit, care must be exercised to keep the leakage to a minimum value.

The lead-in cable should be supported with as few insulators as possible. The insulation of this lead-in cable with respect to ground must be much better than is ordinarily employed for the voltage which exists between these points, as it effectively shunts the reactive elements of the resonant circuit at carrier frequency. The impedance of this resonant circuit may be as high as five thousand ohms and leakage resulting from rain, snow, sleet, too long a lead-in cable, or too many supporting insulators will reduce the effective power output of the transmitter and the sensitivity of the receiver.

An installation which limits this leakage to a minimum will have less signal strength variation under adverse conditions, when reliable operation is of the greatest value.

The insulators used for supporting the lead-in cable should have at least a 7.5 kv rating. Care should be taken not to break the insulation of the cable when clamping it to the insulators. At least once a year the insulators should be washed to remove the accumulation of dirt.

For the lead-in, use a good quality rubber covered cable of at least 7500 volts service grade, with a conductor equivalent to No. 14 gauge or larger. This cable is usually supplied with the coupling capacitor.

ADJUSTMENTS

CAUTION

When making any tap adjustments or changing any connections in this tuner, make certain that the grounding switch is closed. Do not depend on the drain coil for personal safety. Do not touch any terminal when the transmitter is on.

The first consideration in adjusting this tuner is to determine the operating frequency and the capacitance of the coupling capacitor. The value of inductance required for resonance can then be determined as follows:

Refer to Fig. 6 for the L-C product at the carrier frequency. Divide the L-C product by the value in micro-microfarads of the coupling capacitor (Cc).

$$\frac{\text{L-C Product}}{\text{C in Unit}} = \text{mh inductance for resonance.}$$

Refer to Fig. 5 for the tap number of the tuning coil L-1 for this value of inductance.

For the JZ 71.64 tuner, in determining the required inductance, do not use the rated capacitance of the coupling capacitor for Cc. Because of the 0.006-mfd. capacitor (C1) in the tuner output circuit, the net capacitance must be calculated from the formula:

$$Co = \frac{(.006)\ (Cc)}{(.006 + Cc)}$$

where Cc is the rated capacitance of the coupling capacitor, and Co is the calculated value to use in the procedure described in the previous paragraph. (All values are in microfarads) For example, if the coupling capacitor is 0.006 mfd., then the net value of Co is 0.003 mfd. Similarly, for a 0.005 mfd. coupling capacitor, $Co = \frac{.006 \times .005}{.011} = .0027$ mfd. (Now use 2700 mmf. in determining required inductance.)

The final tuning may require changing the tuning coil connection to a higher or lower tap than the tap determined previously due to stray capacitance of the lead-in cable from the coupling capacitor to the tuner or to a slightly reactive power line.

The impedance of the different taps of the transformer T-1 are given in the following table:

Coaxial Tap	Tuner Taps	Line Impedance
2	4-5	100
3	4-5	139
2	6-7	193
3	6-7	268
2	8-9	372
3	8-9	517
2	10-11	720
3	10-11	1000

The average power line impedance is 500 to 600 ohms, and the usual coaxial cable impedance is 50 to 70 ohms. If the impedance of power line is known, connect the TUNER and COAX leads of the transformer to the corresponding taps. If the power line impedance is not known, connect the COAX lead to tap 3 and the TUNER leads to taps 8 and 9.

Open the link of jack J-2 and connect a thermocouple ammeter to the terminals.

Turn on the local transmitter and adjust the core of the tuning coil L-1 for maximum current in jack J-2. If the current is increasing with the core all the way in or all the way out, change the connection to the next higher or lower tap, respectively.

Adjust the transformer taps to obtain as nearly the same current in J1 as would be obtained with a 60-ohm resistive load on the coaxial cable. For a 10-watt transmitter, this current value is 0.41 ampere. For each transformer tap change, recheck the adjustment of the tuning coil for maximum current at J2. If two transformer taps give the same reading of current, use the higher impedance connection.

A procedure for more exact impedance match is shown in Fig. 4, Line Coupling Tuner Adjustment. The dummy load resistors must be of sufficient wattage rating to dissipate the transmitter output. Use the transformer tap connections given in this Instruction Book.

A line tuner which is used to bypass a circuit breaker should be adjusted with the circuit breaker open. However, since this may be difficult to arrange, an alternate method is to disconnect the coupling capacitor from the line and connect its high potential side to ground through a resistor. If the impedance of the line with circuit breaker open is known, use a resistor of this value. If the line impedance is not known, use a 500-ohm resistor.

Adjust the spark gap SG-1 to 0.015 inch spacing. Observe the gap while transmitting full carrier power. If the gap arcs over, increase the spacing until the arcing stops. The minimum spacing for the gap depends upon the carrier power, the capacitance of the coupling capacitor and the impedance of power line.

With some combinations of coupling capacitor values and the higher carrier frequencies, the tuning of the line tuning coil will be so broad that the exact adjustment for resonance is very difficult to determine by normal measurements. However, under these conditions, the frequency response curve for the coupling circuit will be so flat that an exact adjustment of the inductance of the line tuning coil is not necessary. For carrier frequencies above 150 kHz. and for coupling circuits with a Q of less than 2, adjust the inductance of the line tuning coil to the calculated value. Then adjust the ratio of the matching transformer T-1 so that the current in jack J-1 is approximately the same as the current measured when the coaxial cable is terminated in a 60 ohm resistor.

To determine whether or not the above adjusting procedure is applicable, calculate the Q of the coupling circuit as follows:

Calculate the reactance of the coupling capacitor at the operating frequency.

$$X_C = \frac{1}{2\pi FC}$$

Determine the approximate power line impedance.

For a single trapped line use a value of 500 ohms. For lines which are not trapped, divide 500 ohms by the number of lines leaving the bus.

Divide the reactance of the capacitor by the impedance of the line to determine the Q of the circuit.

$$Q = X_C/R$$

(Since this calculation is only an approximation, the possible reactance of the power line is neglected.)

Example: Coupling Capacitor — .00275 mfd.
Operating Frequency — 165 kHz.
Single Trapped Line — use 500 ohms

$$X_C = \frac{1}{2\pi FC} = 350 \text{ ohms}$$

$$Q = 350/500 = 0.7$$

For this installation, calculate the inductance required to resonate the coupling capacitor.

$$L = \frac{X_L}{2\pi F} = 0.34 \text{ mh}$$

Refer to Fig. 5.

For 0.34 mh use tap 78, with core at center of travel. Short unused turns.

NOTE

The instructions in Fig. 5 state that the unused taps are to be shorted when a tap lower than 100 is used and also when the frequency is above 150 kHz.

This procedure will leave a gap in the inductance range between tap 100 with the unused turns not shorted and tap 88 with the unused turns shorted. Continuous inductance adjustment can be obtained by using tap 113 with unused turns shorted as the next lower inductance tap below tap 100 with the unused turns not shorted

MAINTENANCE

Routine Checks and Records

This line tuner requires very little maintenance. It should be inspected occasionally to see if there has been excessive burning of the spark gap. If the discs show signs of burning, rotate the discs to a new position and re-adjust the gap. Usually a semi-annual or yearly inspection is sufficient.

A permanent record should be kept of the tap settings and the position of the tuning coil core so that they can be restored to the correct positions in case of unauthorized changes.

Ordering Replacement Parts

Replacement parts for this line tuner may be ordered through the nearest Westinghouse District Office.

When ordering, include:

1. The following data from the nameplate of the line tuner: (A) the type number, and (B) the style number.

2. The (A) electrical parts list symbol, (B) the function, (C) the description, and (D) the style number.

ELECTRICAL PARTS LIST

CIRCUIT SYMBOL	FUNCTION	DESCRIPTION	STYLE NUMBER
		SUB-ASSEMBLIES	
L-1	Line Tuning Coil	Line Tuning Coil Assembly	1474218
T-1	Transformer	Transformer Assembly	407C741G02
	Protector Unit	Protector Unit Assembly	1474014
		COMPONENT PARTS	
J-1	Jack-Coax Metering	Binding Post Type 2 Binding Posts 1 Shorting Link	 185A431H01 1474455
J-2	Jack-Line Metering	Same as J-1	
SG-1	Spark Gap	Disc Type	2 of 183A358H20 (discs only)
		OPTIONAL	
L-3	Drain Coil (When Used)	20,000 ohms minimum impedance over 30-200 kHz.	670B069G02
C1	Series Capacitor (When Used)	Mica, 0.006 mfd., ± 5% 3000V, PACW.	584C256H03

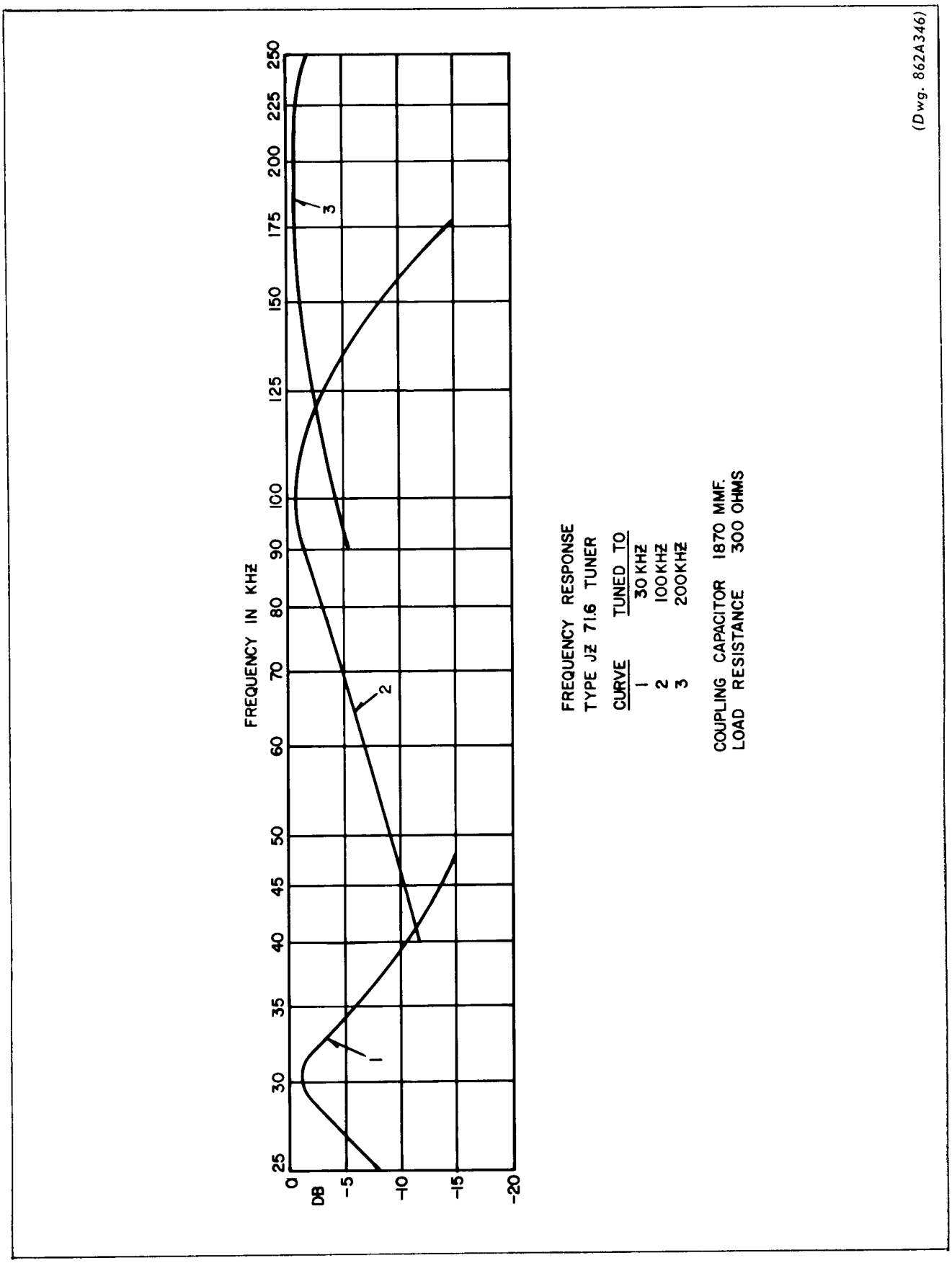
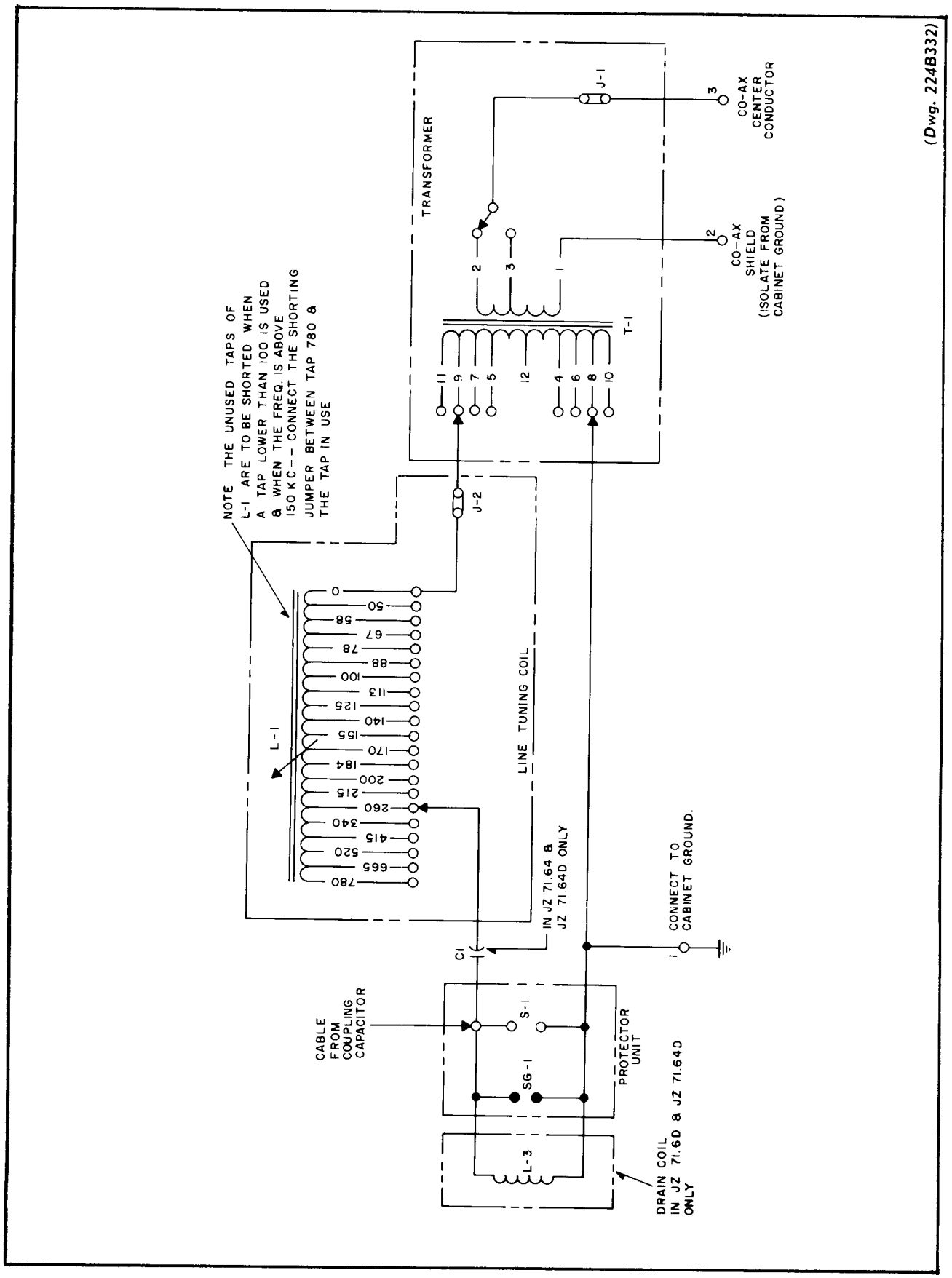
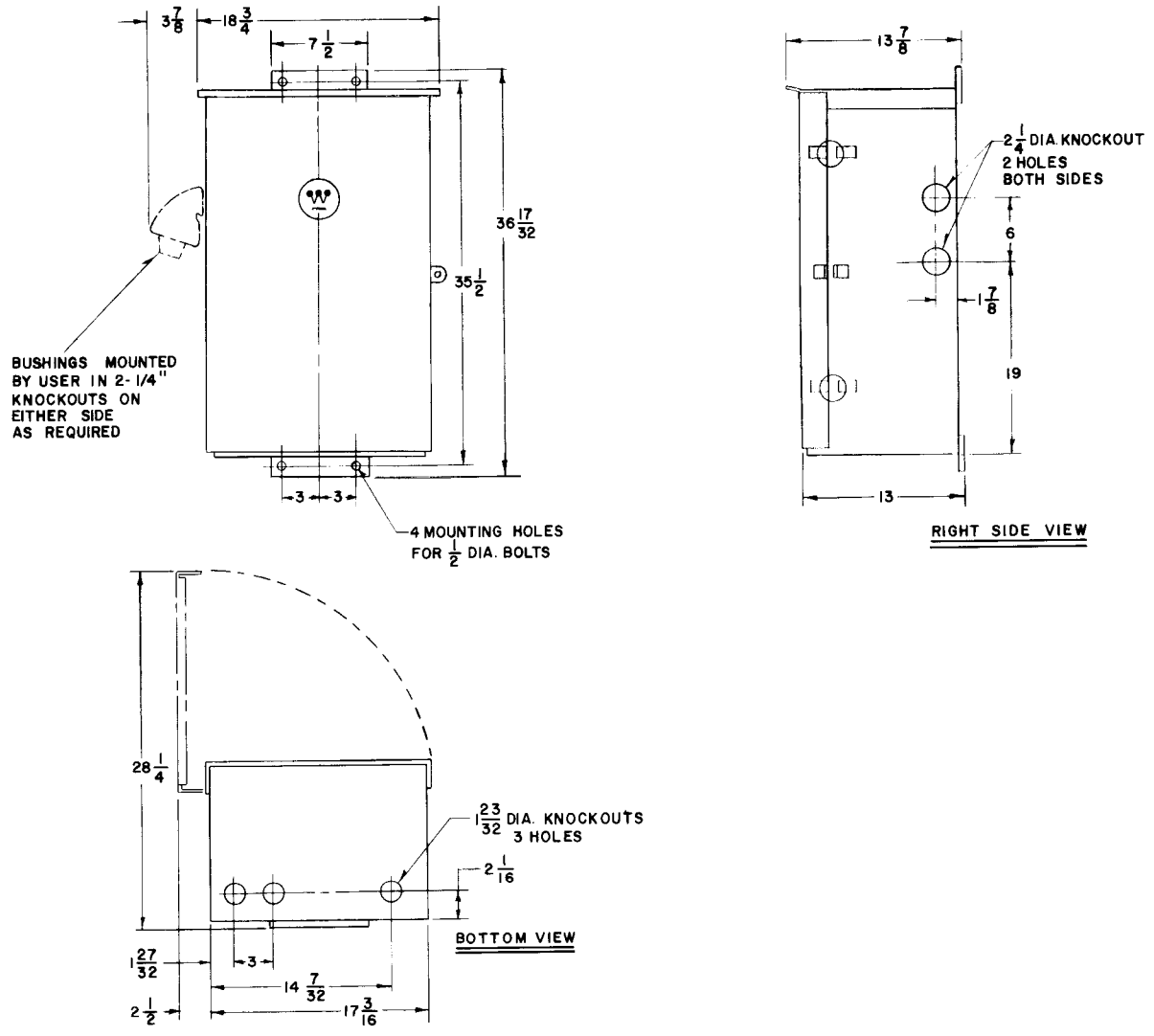


Fig. 1. Response Curves of JZ 71.6 Tuner.



* *Fig. 2. Schematic Diagram*



(Dwg. 50-B-7683)

* *Fig. 3. Outline Drawing*

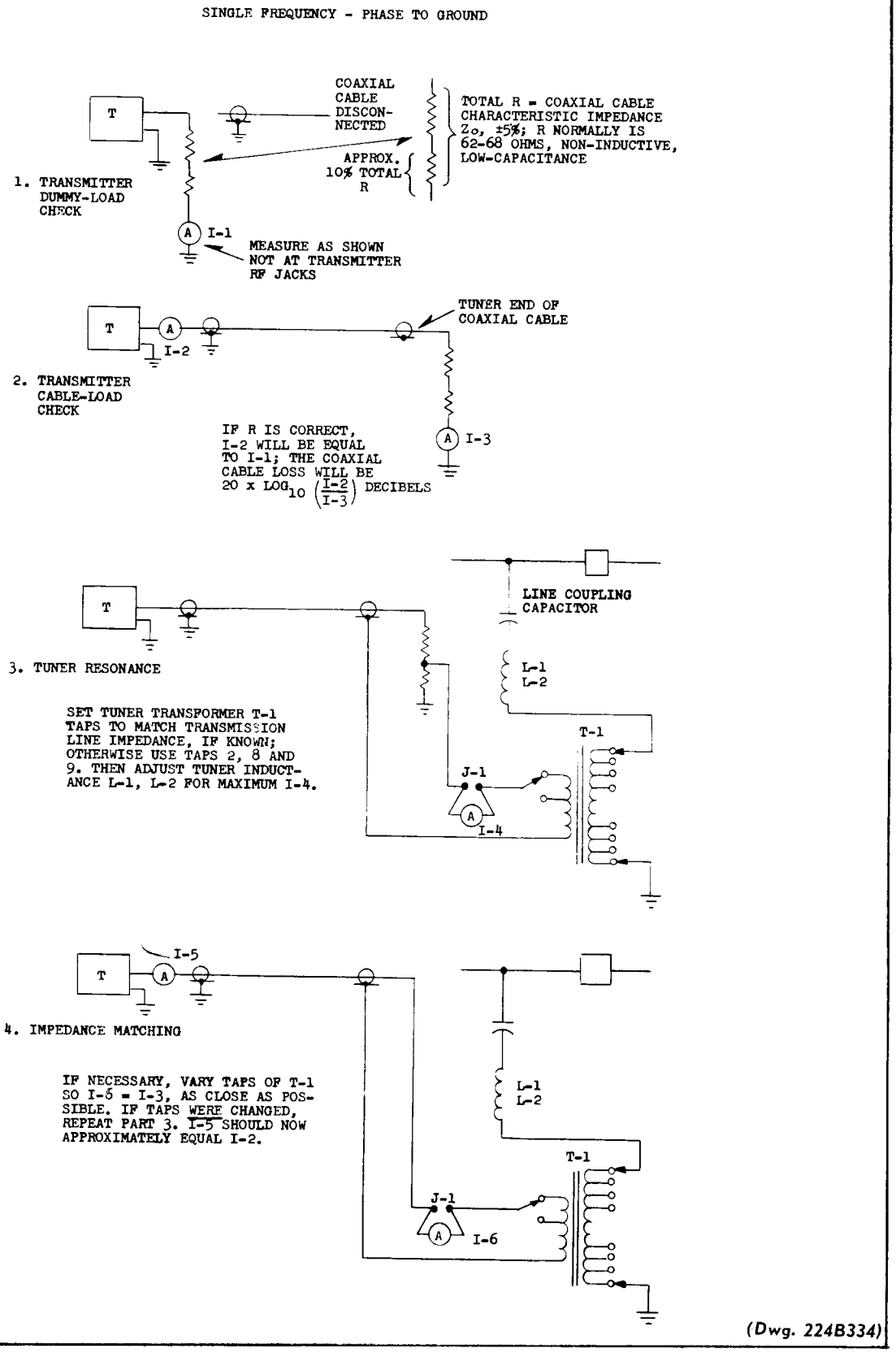
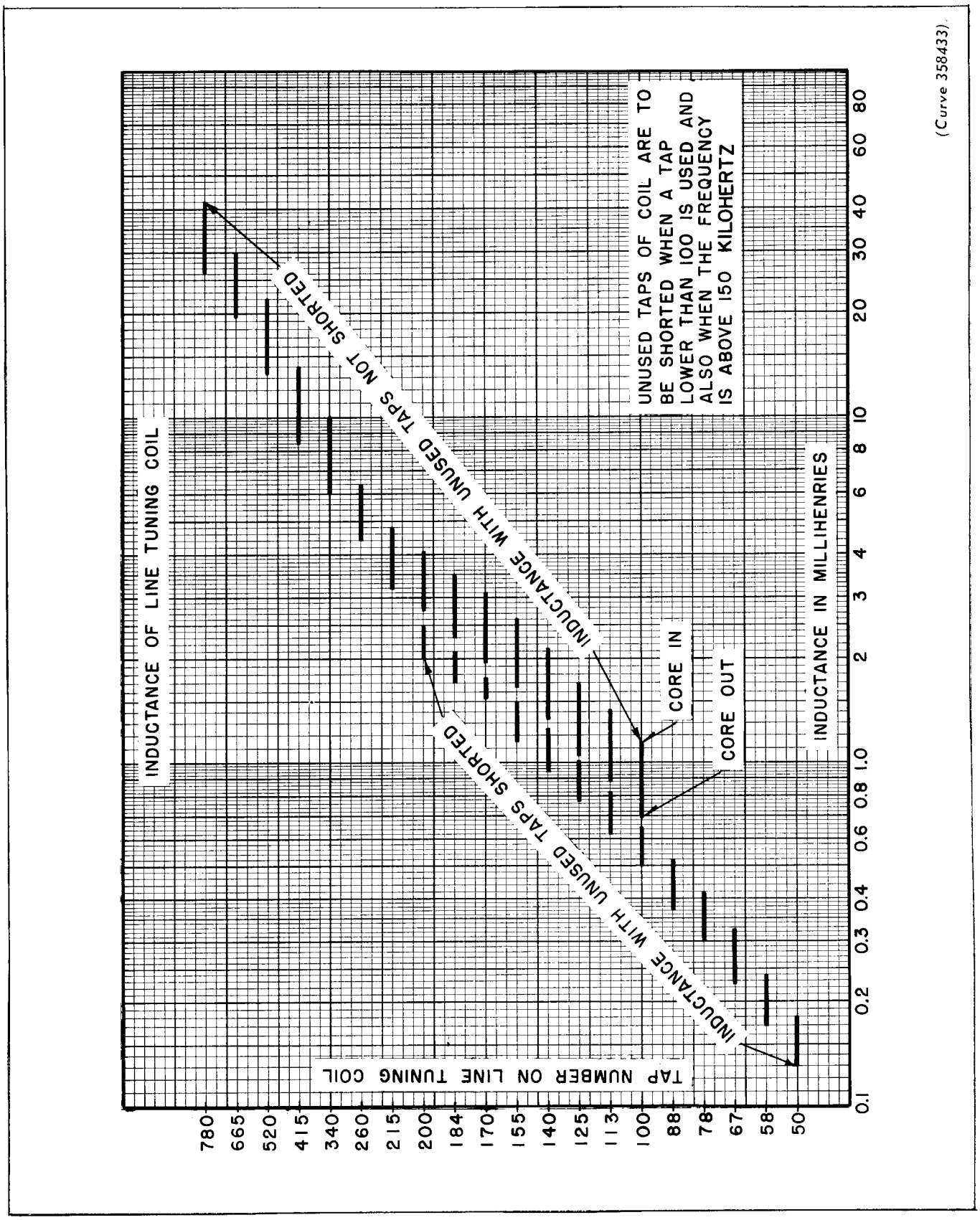
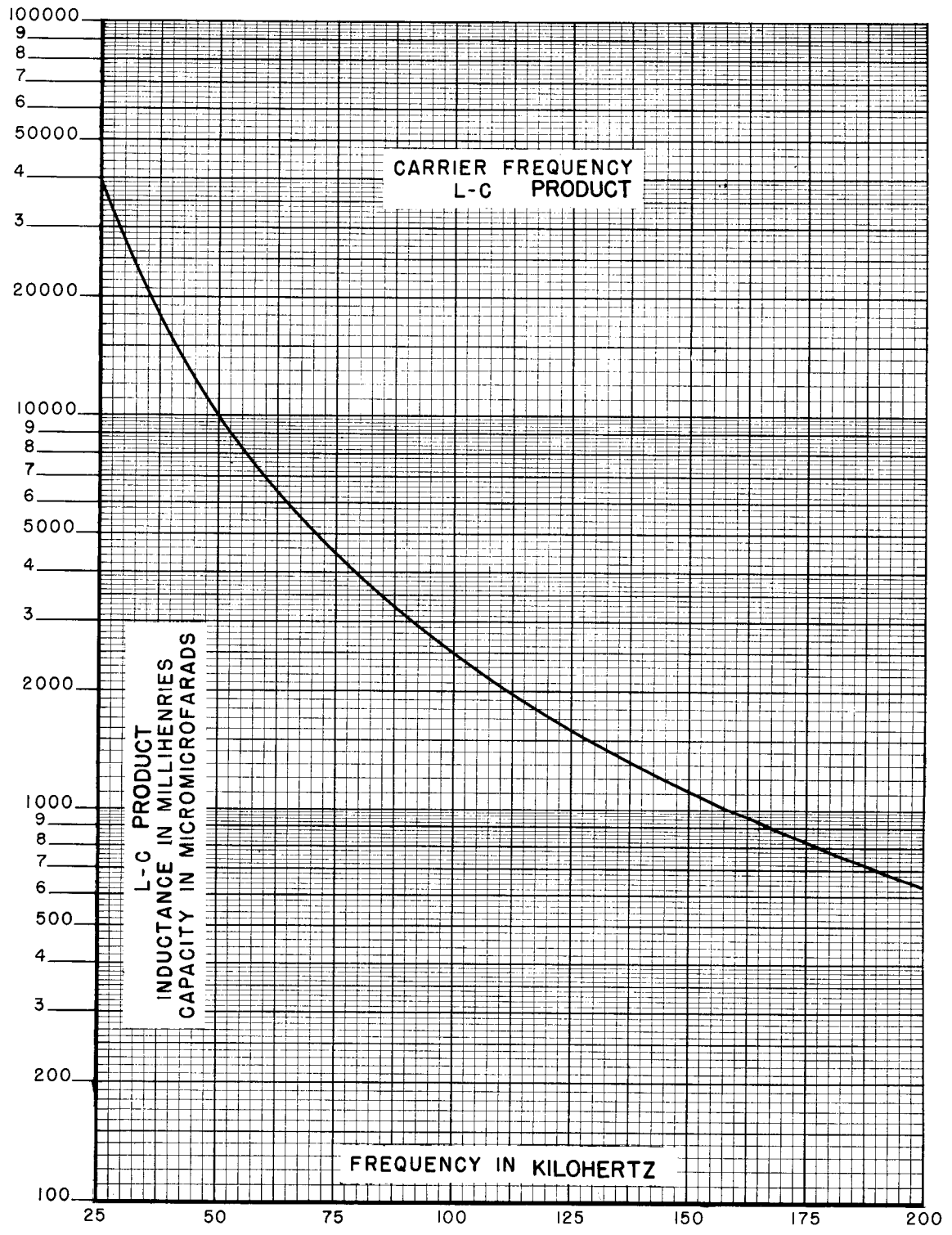


Fig. 4. Line Coupling Tuner Adjustment Procedure



* *Fig. 5. Inductance of Line Tuning Coil*



* *Fig. 6. Carrier Frequency L-C Product*

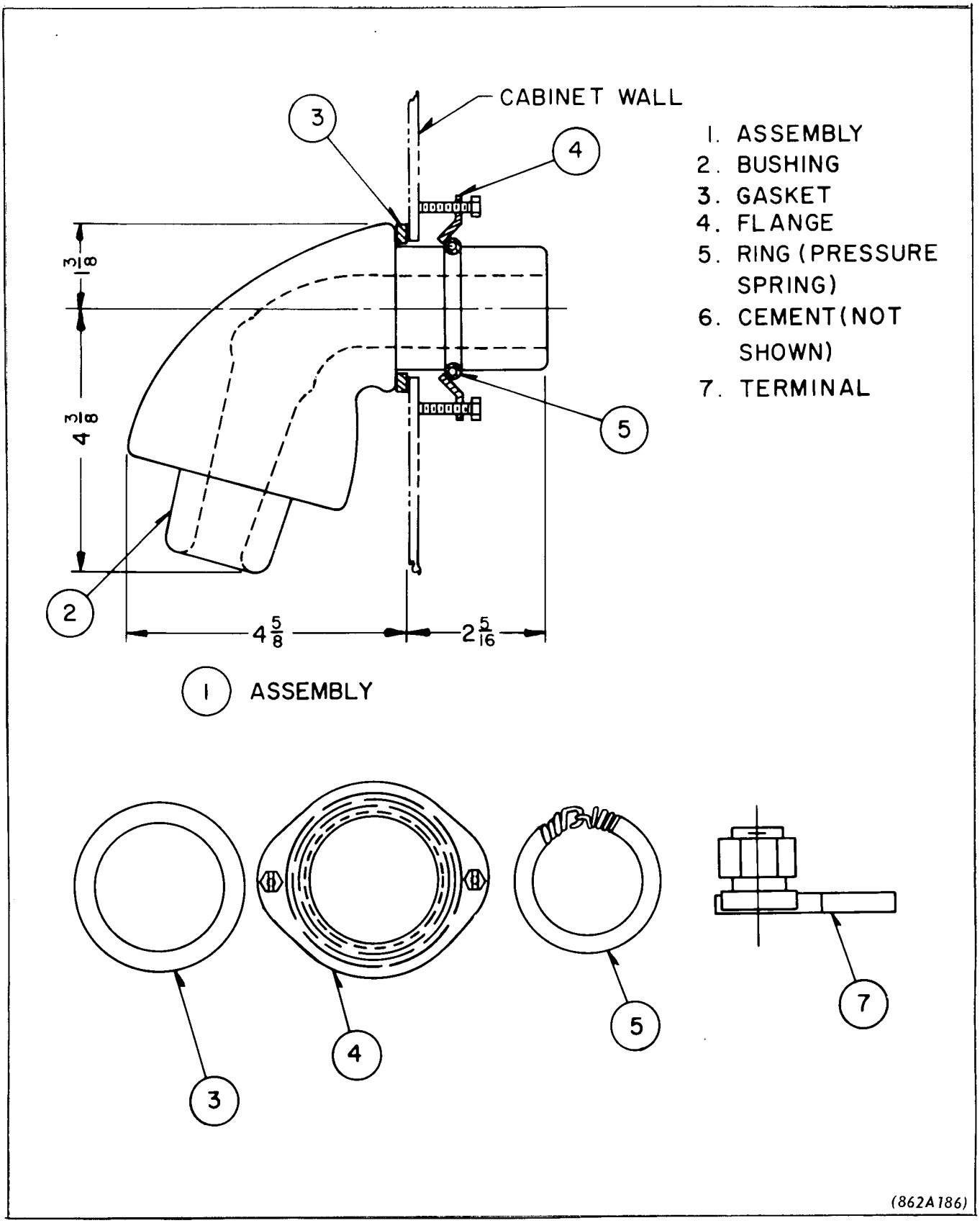
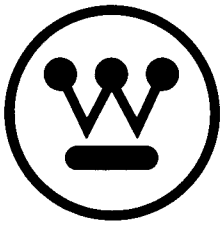


Fig. 7. Lead-In Bushing Assembly



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LINE COUPLING TUNERS
WITH TWO-WINDING MATCHING TRANSFORMER

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SUPERSEDES I.L. 41-949.1C
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EFFECTIVE NOVEMBER 1971

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The tuner is mounted in a cabinet suitable for outdoor mounting. Knockouts are provided on each side of the cabinet for the capacitor lead-in bushing and in the bottom of the cabinet for 1½ inch conduit for the coaxial cable. The outline, mounting dimensions and the location of the knockouts are shown in Fig. 3.

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The JZ 71.64 tuner includes a 0.006-mfd. capacitor in series with the output lead to the protector unit. This allows the tuner to be used with coupling capacitors up to 0.015 mfd. When a drain coil is supplied with the tuner, it is identified as a Type JZ 71.6D tuner. If both capacitor and drain coil are included, the tuner is Type JZ 71.64D.

Typical response curves for the type JZ 71.6 tuners are plotted in Fig. 1. These curves were taken with an 1870-mmf. coupling capacitor and a 300-ohm resistive load. The tuner was adjusted for resonance (f_r) at 30, 100, and 200 kHz. respectively, for the three curves.

CHARACTERISTICS

Frequency Range:	30 to 200 kHz.
Input Impedance:	50 to 70 Ohms
Output Impedance:	100 to 1000 Ohms
Power Rating:	100 Watts Carrier-Unmodulated 25 Watts Carrier-100% Modulated
Coupling Capacitor Range:	JZ 71.6 – .00075 to .004 mfd. JZ 71.64 – .00075 to .015 mfd.

INSTALLATION

It is recommended that the Line Tuner be located as near the coupling capacitor as is practical. The mounting dimensions are shown on Fig. 3.

Remove the knockout from the side of the cabinet nearest the coupling capacitor for installation of the porcelain bushing for the capacitor lead-in.

Connections

CAUTION

Before making any connections to this equipment, turn off the power switch of the carrier transmitter and ground or open circuit the lead-in at the coupling capacitor.

The assembly of the Style 1352445 accessories for the coupling capacitor lead-in cable is shown in Fig. 7. Before permanently assembling the bushing in the cabinet wall, run the lead-in cable through the bushing and into the cabinet to determine the correct length of lead-in cable. Allow sufficient length of cable to connect to the grounding switch contact stud with the panel swung open. Mark the cable at the bushing to locate its position and remove the cable and bushing from the cabinet. Place the bushing in an inverted position with the openings level. Melt the cement supplied with the accessory package and pour it into the bushing. After the cement has hardened, install the bushing in the cabinet wall.

Remove the connection of the tuning unit from the terminal stud of the jaw contact of the grounding switch. Connect the capacitor lead-in cable to this

terminal stud using the cable terminal supplied with the bushing. Tighten the nut securely. Replace the connection from the tuning unit using the second nut. This will permit disconnecting the tuning unit without disturbing the coupling capacitor lead-in cable connection.

Two screws are mounted in the left wall of the cabinet for securing the coaxial cable. Connect the shield of the cable to terminal #2 and the center conductors to terminal #3. Connect a good ground to the cabinet and to terminal #1 of the terminal board. Run a copper bonding cable from the cabinet to the base of the coupling capacitor.

Coupling Capacitor Lead-In Cable

Since the lead-in cable between the coupling capacitor and the line tuning unit is in a high-impedance carrier-frequency circuit, care must be exercised to keep the leakage to a minimum value.

The lead-in cable should be supported with as few insulators as possible. The insulation of this lead-in cable with respect to ground must be much better than is ordinarily employed for the voltage which exists between these points, as it effectively shunts the reactive elements of the resonant circuit at carrier frequency. The impedance of this resonant circuit may be as high as five thousand ohms and leakage resulting from rain, snow, sleet, too long a lead-in cable, or too many supporting insulators will reduce the effective power output of the transmitter and the sensitivity of the receiver.

An installation which limits this leakage to a minimum will have less signal strength variation under adverse conditions, when reliable operation is of the greatest value.

The insulators used for supporting the lead-in cable should have at least a 7.5 kv rating. Care should be taken not to break the insulation of the cable when clamping it to the insulators. At least once a year the insulators should be washed to remove the accumulation of dirt.

For the lead-in, use a good quality rubber covered cable of at least 7500 volts service grade, with a conductor equivalent to No. 14 gauge or larger. This cable is usually supplied with the coupling capacitor.

ADJUSTMENTS

CAUTION

When making any tap adjustments or changing any connections in this tuner, make certain that the grounding switch is closed. Do not depend on the drain coil for personal safety. Do not touch any terminal when the transmitter is on.

The first consideration in adjusting this tuner is to determine the operating frequency and the capacitance of the coupling capacitor. The value of inductance required for resonance can then be determined as follows:

Refer to Fig. 6 for the L-C product at the carrier frequency. Divide the L-C product by the value in micro-microfarads of the coupling capacitor (Cc).

$$\frac{\text{L-C Product}}{\text{C in Unit}} = \text{mh inductance for resonance.}$$

Refer to Fig. 5 for the tap number of the tuning coil L-1 for this value of inductance.

For the JZ 71.64 tuner, in determining the required inductance, do not use the rated capacitance of the coupling capacitor for Cc. Because of the 0.006-mfd. capacitor (C1) in the tuner output circuit, the net capacitance must be calculated from the formula:

$$Co = \frac{(.006)\,(Cc)}{(.006 + Cc)}$$

where Cc is the rated capacitance of the coupling capacitor, and Co is the calculated value to use in the procedure described in the previous paragraph. (All values are in microfarads) For example, if the coupling capacitor is 0.006 mfd., then the net value of Co is 0.003 mfd. Similarly, for a 0.005 mfd. coupling capacitor, $Co = \frac{.006 \times .005}{.011} = .0027$ mfd. (Now use 2700 mmf. in determining required inductance.)

The final tuning may require changing the tuning coil connection to a higher or lower tap than the tap determined previously due to stray capacitance of the lead-in cable from the coupling capacitor to the tuner or to a slightly reactive power line.

The impedance of the different taps of the transformer T-1 are given in the following table:

Coaxial Tap	Tuner Taps	Line Impedance
2	4-5	100
3	4-5	139
2	6-7	193
3	6-7	268
2	8-9	372
3	8-9	517
2	10-11	720
3	10-11	1000

The average power line impedance is 500 to 600 ohms, and the usual coaxial cable impedance is 50 to 70 ohms. If the impedance of power line is known, connect the TUNER and COAX leads of the transformer to the corresponding taps. If the power line impedance is not known, connect the COAX lead to tap 3 and the TUNER leads to taps 8 and 9.

Open the link of jack J-2 and connect a thermocouple ammeter to the terminals.

Turn on the local transmitter and adjust the core of the tuning coil L-1 for maximum current in jack J-2. If the current is increasing with the core all the way in or all the way out, change the connection to the next higher or lower tap, respectively.

Adjust the transformer taps to obtain as nearly the same current in J1 as would be obtained with a 60-ohm resistive load on the coaxial cable. For a 10-watt transmitter, this current value is 0.41 ampere. For each transformer tap change, recheck the adjustment of the tuning coil for maximum current at J2. If two transformer taps give the same reading of current, use the higher impedance connection.

A procedure for more exact impedance match is shown in Fig. 4, Line Coupling Tuner Adjustment. The dummy load resistors must be of sufficient wattage rating to dissipate the transmitter output. Use the transformer tap connections given in this Instruction Book.

A line tuner which is used to bypass a circuit breaker should be adjusted with the circuit breaker open. However, since this may be difficult to arrange, an alternate method is to disconnect the coupling capacitor from the line and connect its high potential side to ground through a resistor. If the impedance of the line with circuit breaker open is known, use a resistor of this value. If the line impedance is not known, use a 500-ohm resistor.

Adjust the spark gap SG-1 to 0.015 inch spacing. Observe the gap while transmitting full carrier power. If the gap arcs over, increase the spacing until the arcing stops. The minimum spacing for the gap depends upon the carrier power, the capacitance of the coupling capacitor and the impedance of power line.

With some combinations of coupling capacitor values and the higher carrier frequencies, the tuning of the line tuning coil will be so broad that the exact adjustment for resonance is very difficult to determine by normal measurements. However, under these conditions, the frequency response curve for the coupling circuit will be so flat that an exact adjustment of the inductance of the line tuning coil is not necessary. For carrier frequencies above 150 kHz. and for coupling circuits with a Q of less than 2, adjust the inductance of the line tuning coil to the calculated value. Then adjust the ratio of the matching transformer T-1 so that the current in jack J-1 is approximately the same as the current measured when the coaxial cable is terminated in a 60 ohm resistor.

To determine whether or not the above adjusting procedure is applicable, calculate the Q of the coupling circuit as follows:

Calculate the reactance of the coupling capacitor at the operating frequency.

$$X_C = \frac{1}{2\pi FC}$$

Determine the approximate power line impedance.

For a single trapped line use a value of 500 ohms. For lines which are not trapped, divide 500 ohms by the number of lines leaving the bus.

Divide the reactance of the capacitor by the impedance of the line to determine the Q of the circuit.

$$Q = X_C/R$$

(Since this calculation is only an approximation, the possible reactance of the power line is neglected.)

Example: Coupling Capacitor — .00275 mfd.
Operating Frequency — 165 kHz.
Single Trapped Line — use 500 ohms

$$X_C = \frac{1}{2\pi FC} = 350 \text{ ohms}$$

$$Q = 350/500 = 0.7$$

For this installation, calculate the inductance required to resonate the coupling capacitor.

$$L = \frac{X_L}{2\pi F} = 0.34 \text{ mh}$$

Refer to Fig. 5.

For 0.34 mh use tap 78, with core at center of travel. Short unused turns.

NOTE

The instructions in Fig. 5 state that the unused taps are to be shorted when a tap lower than 100 is used and also when the frequency is above 150 kHz.

This procedure will leave a gap in the inductance range between tap 100 with the unused turns not shorted and tap 88 with the unused turns shorted. Continuous inductance adjustment can be obtained by using tap 113 with unused turns shorted as the next lower inductance tap below tap 100 with the unused turns not shorted

MAINTENANCE

Routine Checks and Records

This line tuner requires very little maintenance. It should be inspected occasionally to see if there has been excessive burning of the spark gap. If the discs show signs of burning, rotate the discs to a new position and re-adjust the gap. Usually a semi-annual or yearly inspection is sufficient.

A permanent record should be kept of the tap settings and the position of the tuning coil core so that they can be restored to the correct positions in case of unauthorized changes.

Ordering Replacement Parts

Replacement parts for this line tuner may be ordered through the nearest Westinghouse District Office.

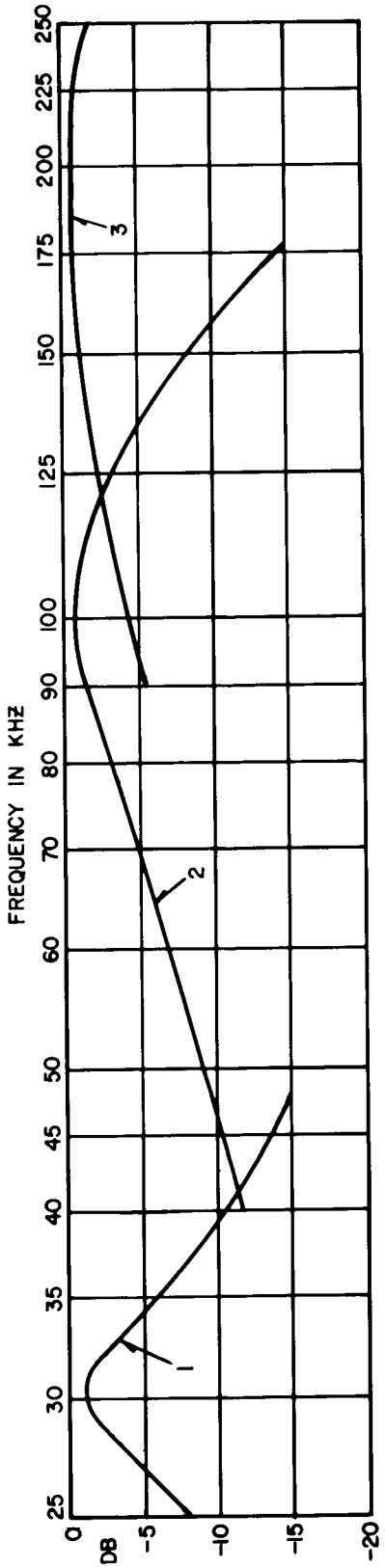
When ordering, include:

1. The following data from the nameplate of the line tuner: (A) the type number, and (B) the style number.

2. The (A) electrical parts list symbol, (B) the function, (C) the description, and (D) the style number.

ELECTRICAL PARTS LIST

CIRCUIT SYMBOL	FUNCTION	DESCRIPTION	STYLE NUMBER
		SUB-ASSEMBLIES	
L-1	Line Tuning Coil	Line Tuning Coil Assembly	1474218
T-1	Transformer	Transformer Assembly	407C741G02
	Protector Unit	Protector Unit Assembly	1474014
		COMPONENT PARTS	
J-1	Jack-Coax Metering	Binding Post Type 2 Binding Posts 1 Shorting Link	 185A431H01 1474455
J-2	Jack-Line Metering	Same as J-1	
SG-1	Spark Gap	Disc Type	2 of 183A358H20 (discs only)
		OPTIONAL	
L-3	Drain Coil (When Used)	20,000 ohms minimum impedance over 30-200 kHz.	* 718B988H01
C1	Series Capacitor (When Used)	Mica, 0.006 mfd., ± 5% 3000V, PACW.	584C256H03



FREQUENCY RESPONSE
TYPE JZ 71.6 TUNER

CURVE	TUNED TO
1	30 KHZ
2	100 KHZ
3	200 KHZ

COUPLING CAPACITOR 1870 MMF.
LOAD RESISTANCE 300 OHMS

(Dwg. 862A346)

Fig. 1. Response Curves of JZ 71.6 Tuner.

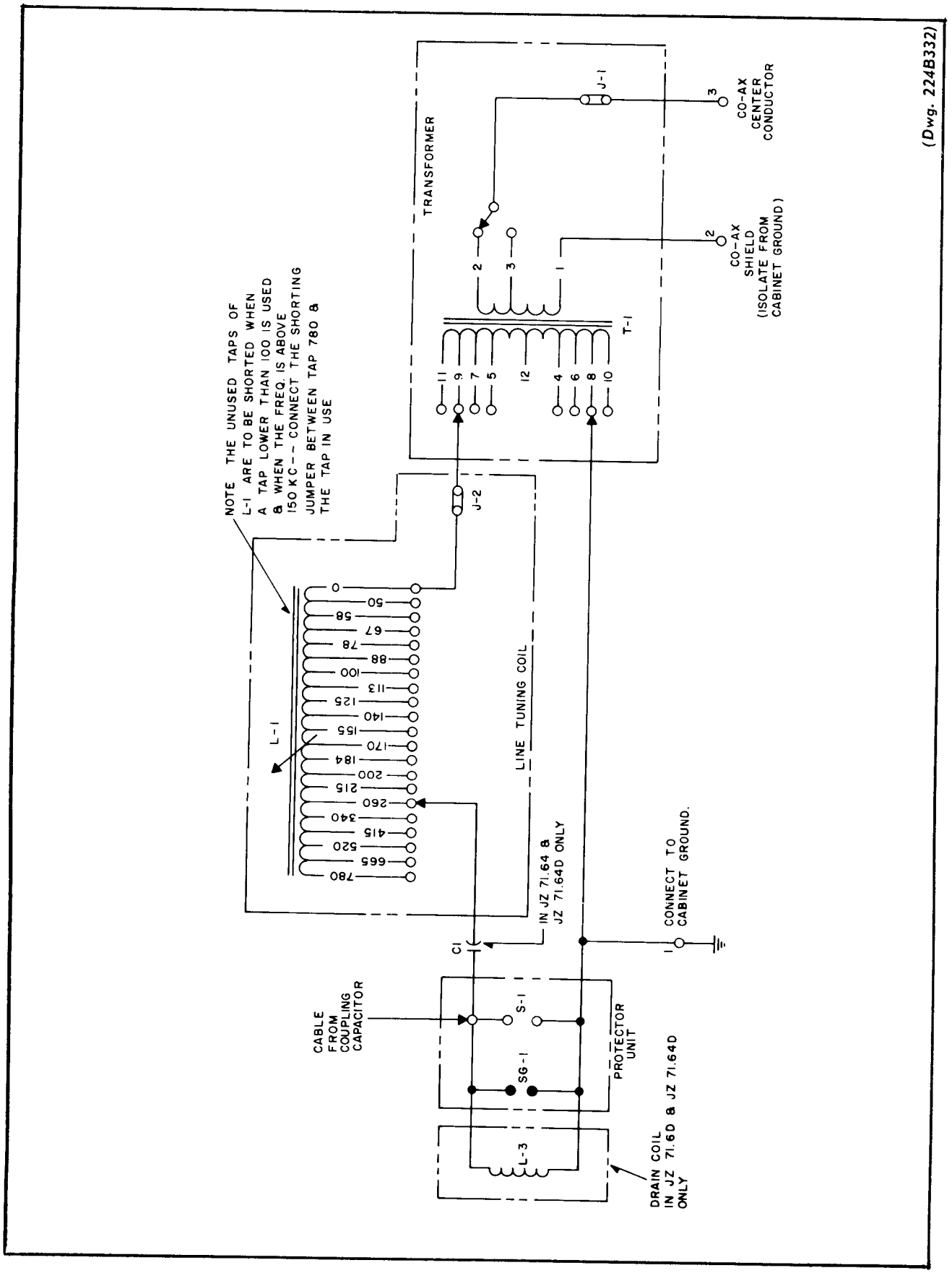
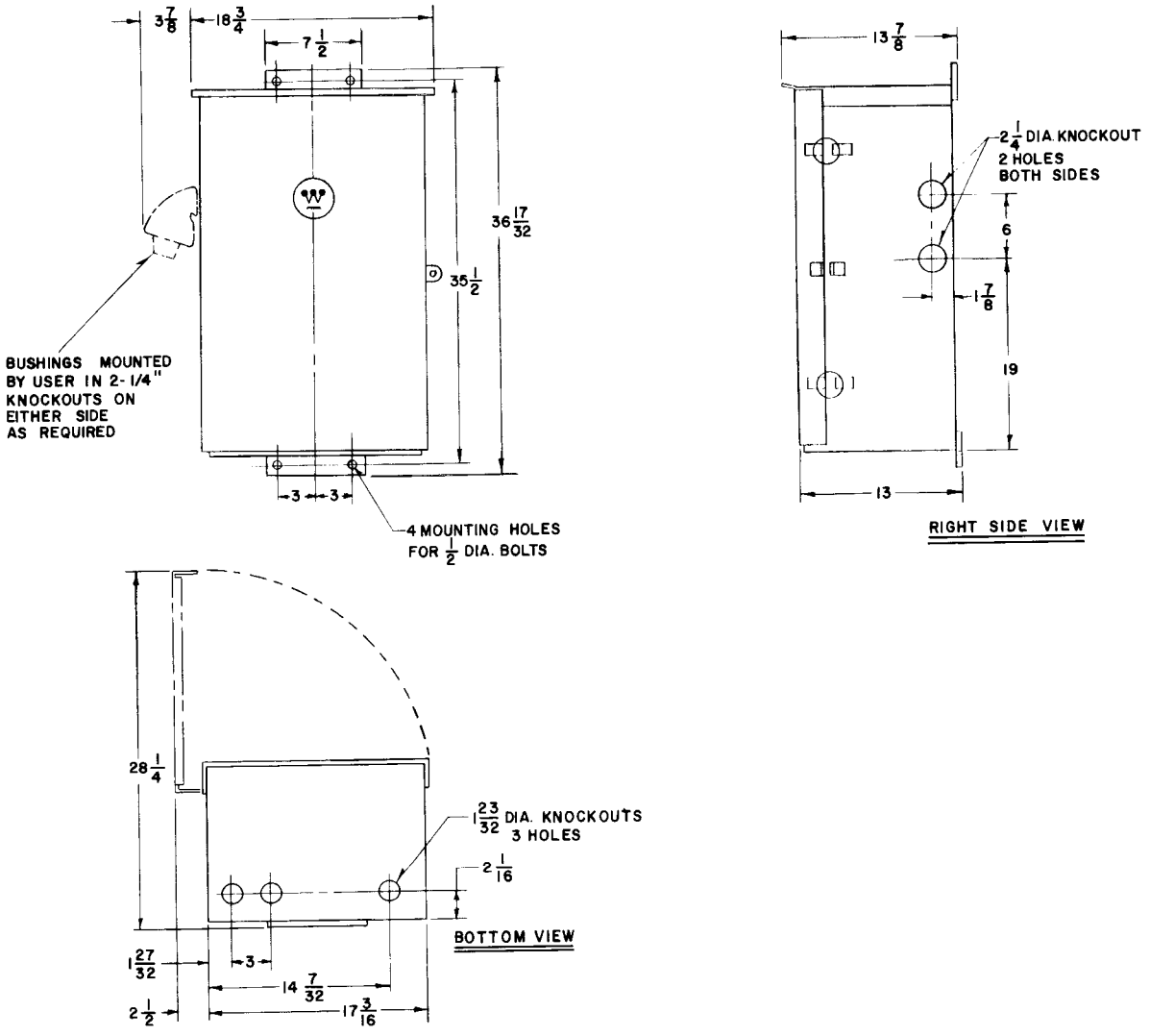
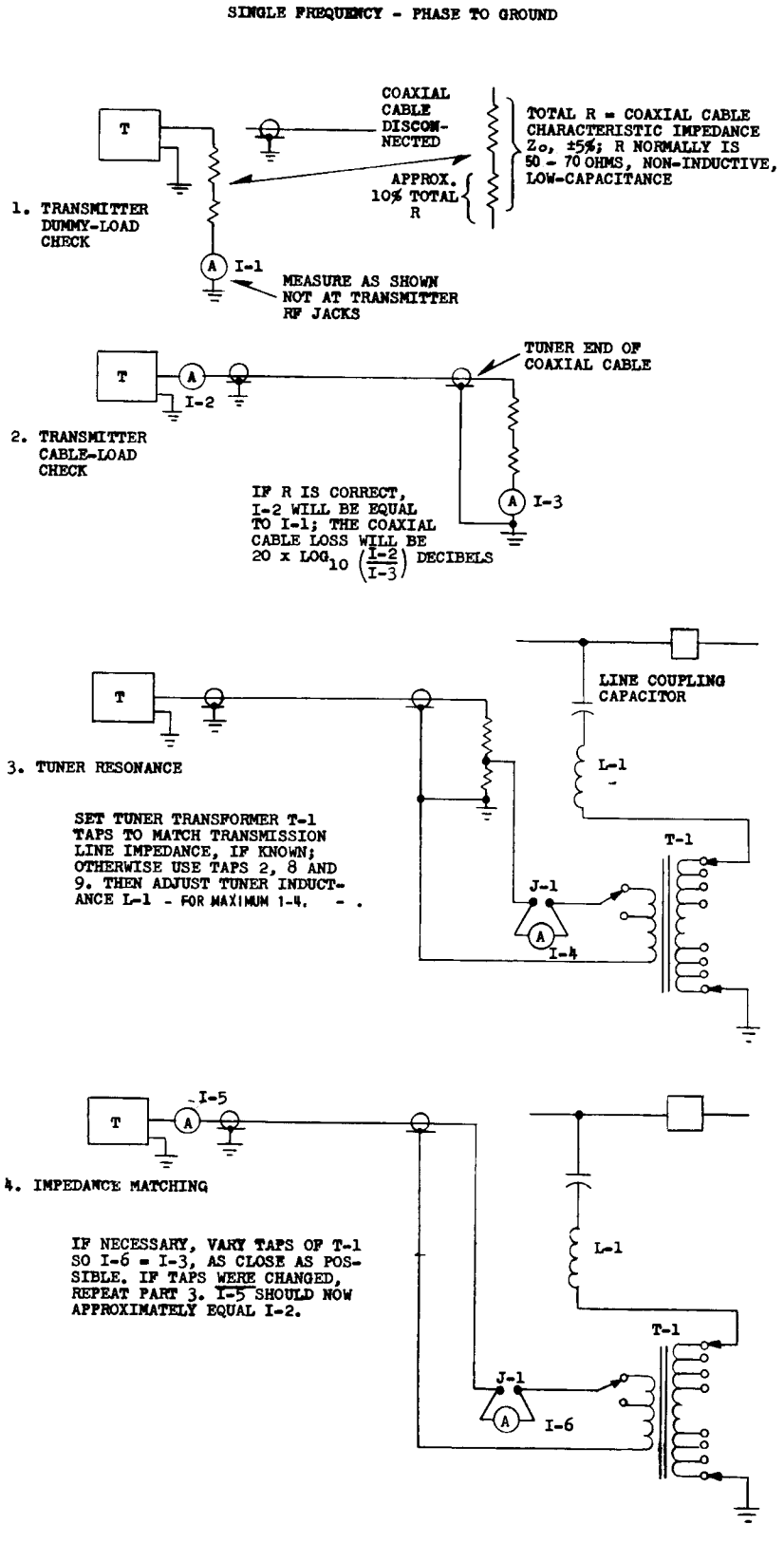


Fig. 2. Schematic Diagram



(Dwg. 50-B-7683)

* *Fig. 3. Outline Drawing*



* *Fig. 4. Line Coupling Tuner Adjustment Procedure*

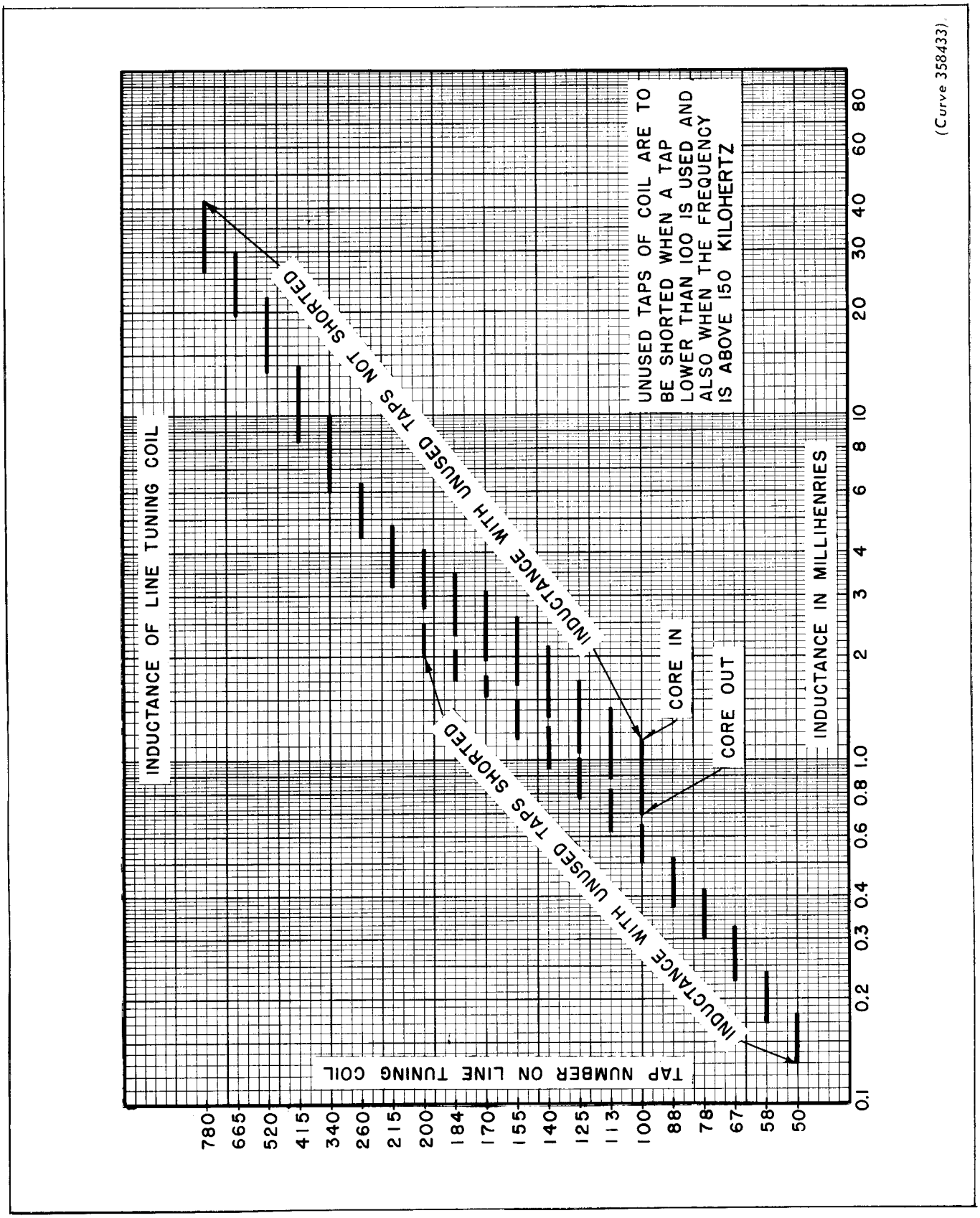


Fig. 5. Inductance of Line Tuning Coil

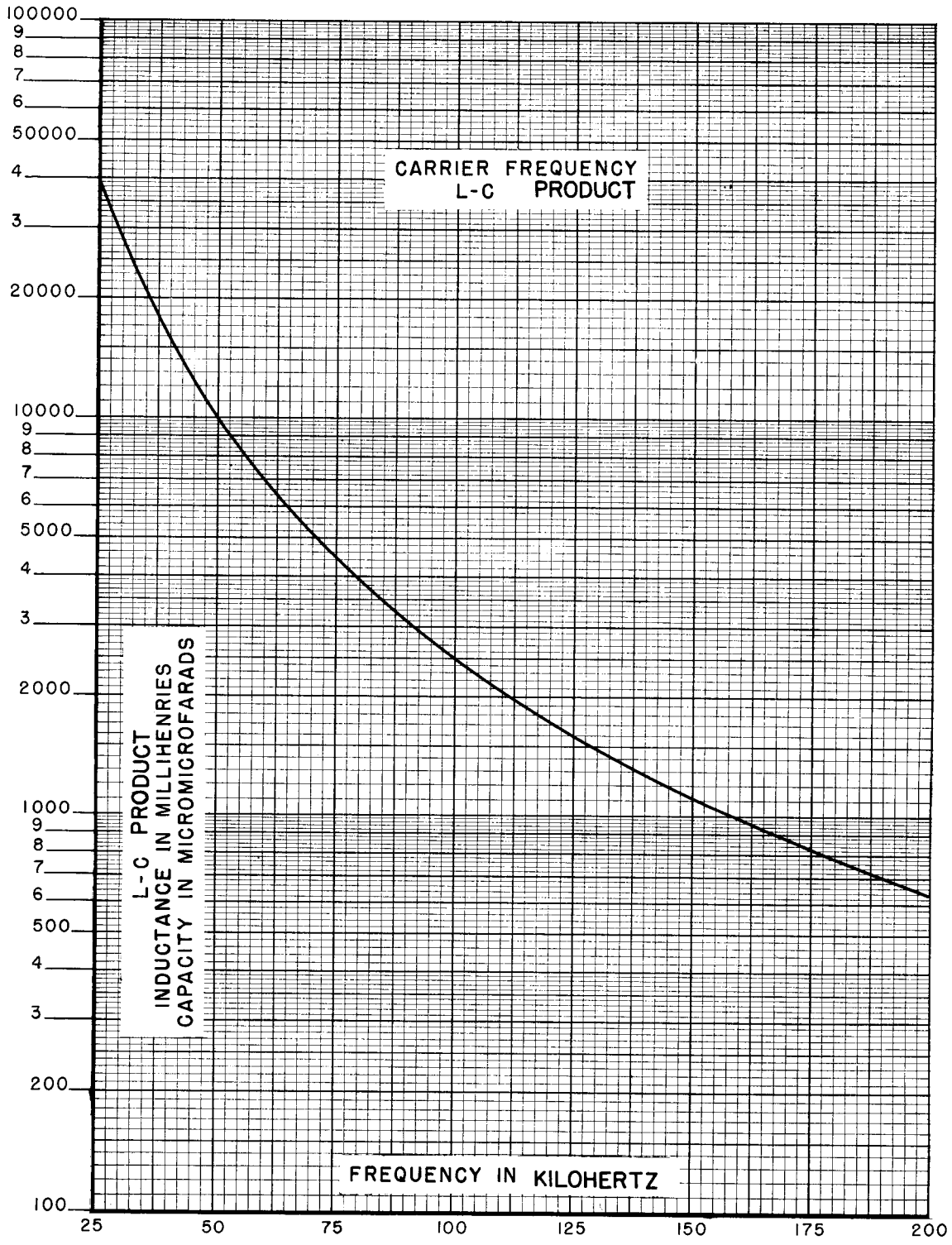


Fig. 6. Carrier Frequency L-C Product

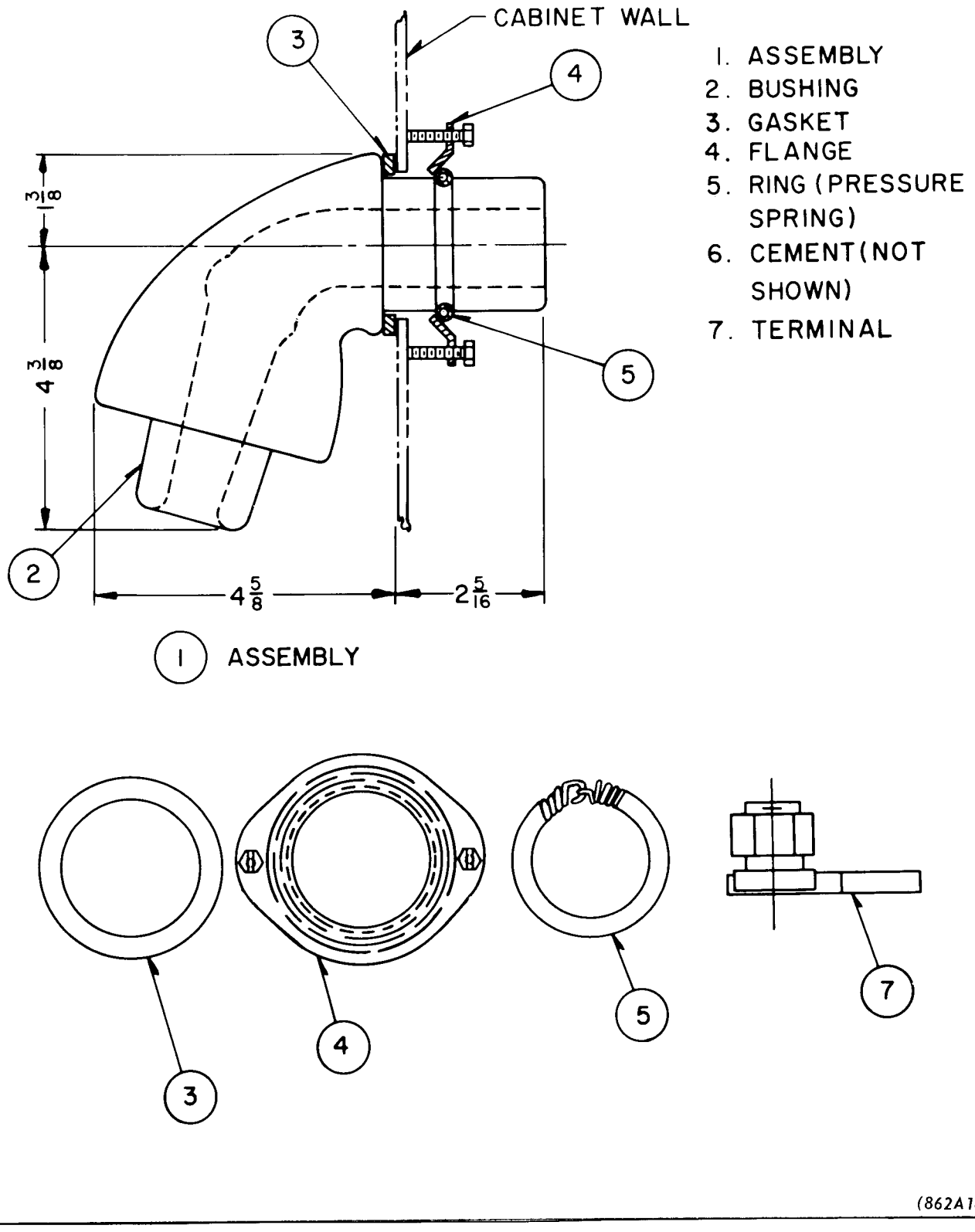
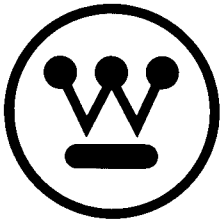


Fig. 7. Lead-In Bushing Assembly



WESTINGHOUSE ELECTRIC CORPORATION

RELAY-INSTRUMENT DIVISION

NEWARK, N. J.

Printed in U.S.A.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE JZ—71.6 LINE COUPLING TUNERS

SINGLE-FREQUENCY PHASE-TO-GROUND
LINE COUPLING TUNERS
WITH TWO-WINDING MATCHING TRANSFORMER

TYPE JZ 71.6	- STYLE 290B883AI2	-	WITHOUT DRAIN COIL
TYPE JZ 71.6D	- STYLE 606B363A09	-	WITH DRAIN COIL
TYPE JZ 71.64	- STYLE 606B363AI4	-	WITH 0.006 MFD. SERIES CAPACITOR
TYPE JZ 71.64D	- STYLE 606B363AI9	-	WITH DRAIN COIL AND 0.006-MFD. CAPACITOR

SUPERSEDES I.L. 41-949.1D
*Denotes change from superseded issue.

EFFECTIVE OCTOBER 1972

SAFETY WARNING!

Protect your life while making adjustments! Before handling any part of the electrical circuits:

1. BE SURE THE GROUNDING SWITCHES IN THIS ASSEMBLY ARE IN THE "GROUNDED" OR CLOSED POSITION.

2. BE SURE THAT ALL POWER SWITCHES IN THIS ASSEMBLY ARE TURNED "OFF".

Protect the equipment against damage by not applying power until thoroughly familiar with the ADJUSTMENTS described in this book.

SAFETY FIRST!

TABLE OF CONTENTS

SUPPLEMENTARY DATA

Drawings **References**

APPLICATION

The Type JZ-71.6 Line Coupling Tuners are designed for phase-to-ground coupling of a single carrier frequency from a coaxial cable through a coupling capacitor to a power line. The impedance matching transformer and line tuning coil, in conjunction with the coupling capacitor, provide a low loss circuit for coupling a carrier transmitter to the power line.

DESCRIPTION

Mechanical Description

The tuner is mounted in a cabinet suitable for outdoor mounting. Knockouts are provided on each side of the cabinet for the capacitor lead-in bushing and in the bottom of the cabinet for 1½ inch conduit for the coaxial cable. The outline, mounting dimensions and the location of the knockouts are shown in Fig. 3.

All of the electrical components are mounted on a hinged panel which may be opened for making the coaxial cable and capacitor lead-in connections. The transformer taps, tuning coil taps, grounding switch and spark gap are accessible from the front of the panel.

Electrical Description

The electrical circuits are shown on the Schematic Diagram Fig. 2. The coaxial cable center conductor is connected through jack J-1 to the matching transformer T-1, The coaxial cable shield is connected to terminal 1 of the matching transformer. The shield is not grounded, but may be by connecting a short jumper between terminals 1 and 2 of the cabinet terminal block. The high impedance tap of the transformer is connected through jack J-2 to the line tuning coil L-1. An adjustable spark gap SG-1 protects the equipment from excessive voltage surges. The knife switch S-1 is provided for grounding the lead-in from the coupling capacitor while adjustments are being made.

The JZ 71.64 tuner includes a 0.006-mfd. capacitor in series with the output lead to the protector unit. This allows the tuner to be used with coupling capacitors up to 0.015 mfd. When a drain coil is supplied with the tuner, it is identified as a Type JZ 71.6D tuner. If both capacitor and drain coil are included, the tuner is Type JZ 71.64D.

Typical response curves for the type JZ 71.6 tuners are plotted on Fig. 1. These curves were taken with an 1870-mmf. coupling capacitor and a 300-ohm resistive load. The tuner was adjusted for resonance (f_r) at 30, 100, and 200 KHz. respectively, for the three curves.

CHARACTERISTICS

Frequency Range:	30 to 200 kHz.
Input Impedance:	50 to 70 Ohms
Output Impedance:	100 to 1000 Ohms
Power Rating:	100 Watts Carrier-Unmodulated 25 Watts Carrier-100% Modulated
Coupling Capacitor Range:	JZ 71.6 – .00075 to .004 mfd. JZ 71.64 – .00075 to .015 mfd.

INSTALLATION

It is recommended that the Line Tuner be located as near the coupling capacitor as is practical. The mounting dimensions are shown on Fig. 3.

Remove the knockout from the side of the cabinet nearest the coupling capacitor for installation of the porcelain bushing for the capacitor lead-in.

Connections

CAUTION

Before making any connections to this equipment, turn off the power switch of the carrier transmitter and ground or open circuit the lead-in at the coupling capacitor.

* The assembly of the Style 719B629G01 accessories for the coupling capacitor lead-in cable is shown in Fig. 7. Allow sufficient length of cable to connect to the grounding switch contact stud with the panel swung open.

Remove the connection of the tuning unit from the terminal stud of the jaw contact of the grounding switch. Connect the capacitor lead-in cable to this

terminal stud using the cable terminal supplied with the bushing. Tighten the nut securely. Replace the connection from the tuning unit using the second nut. This will permit disconnecting the tuning unit without disturbing the coupling capacitor lead-in cable connection.

Two screws are mounted in the left wall of the cabinet for securing the coaxial cable. Connect the shield of the cable to terminal #2 and the center conductors to terminal #3. Connect a good ground to the cabinet and to terminal #1 of the terminal board. Run a copper bonding cable from the cabinet to the base of the coupling capacitor.

Coupling Capacitor Lead-In Cable

Since the lead-in cable between the coupling capacitor and the line tuning unit is in a high-impedance carrier-frequency circuit, care must be exercised to keep the leakage to a minimum value.

The lead-in cable should be supported with as few insulators as possible. The insulation of this lead-in cable with respect to ground must be much better than is ordinarily employed for the voltage which exists between these points, as it effectively shunts the reactive elements of the resonant circuit at carrier frequency. The impedance of this resonant circuit may be as high as five thousand ohms and leakage resulting from rain, snow, sleet, too long a lead-in cable, or too many supporting insulators will reduce the effective power output of the transmitter and the sensitivity of the receiver.

An installation which limits this leakage to a minimum will have less signal strength variation under adverse conditions, when reliable operation is of the greatest value.

The insulators used for supporting the lead-in cable should have at least a 7.5 kv rating. Care should be taken not to break the insulation of the cable when clamping it to the insulators. At least once a year the insulators should be washed to remove the accumulation of dirt.

* For the lead-in, use a good quality rubber covered cable, with a conductor equivalent to No. 14 gauge or larger. This cable is usually supplied with the coupling capacitor.

ADJUSTMENTS

CAUTION

When making any tap adjustments or changing any connections in this tuner, make certain that the grounding switch is closed. Do not depend on the drain coil for personal safety. Do not touch any terminal when the transmitter is on.

The first consideration in adjusting this tuner is to determine the operating frequency and the capacitance of the coupling capacitor. The value of inductance required for resonance can then be determined as follows:

Refer to Fig. 6 for the L-C product at the carrier frequency. Divide the L-C product by the value in micro-microfarads of the coupling capacitor (Cc).

$$\frac{\text{L-C Product}}{\text{C in Unit}} = \text{mh inductance for resonance.}$$

Refer to Fig. 5 for the tap number of the tuning coil L-1 for this value of inductance.

For the JZ 71.64 tuner, in determining the required inductance, do not use the rated capacitance of the coupling capacitor for Cc. Because of the 0.006-mfd. capacitor (C1) in the tuner output circuit, the net capacitance must be calculated from the formula:

$$Co = \frac{(.006)\,(Cc)}{(.006 + Cc)}$$

where Cc is the rated capacitance of the coupling capacitor, and Co is the calculated value to use in the procedure described in the previous paragraph. (All values are in microfarads) For example, if the coupling capacitor is 0.006 mfd., then the net value of Co is 0.003 mfd. Similarly, for a 0.005 mfd. coupling capacitor, $Co = \frac{.006 \times .005}{.011} = .0027$ mfd. (Now use 2700 mmf. in determining required inductance.)

The final tuning may require changing the tuning coil connection to a higher or lower tap than the tap determined previously due to stray capacitance of the lead-in cable from the coupling capacitor to the tuner or to a slightly reactive power line.

The impedance of the different taps of the transformer T-1 are given in the following table:

Coaxial Tap	Tuner Taps	Line Impedance
2	4-5	100
3	4-5	139
2	6-7	193
3	6-7	268
2	8-9	372
3	8-9	517
2	10-11	720
3	10-11	1000

The average power line impedance is 500 to 600 ohms, and the usual coaxial cable impedance is 50 to 70 ohms. If the impedance of power line is known, connect the TUNER and COAX leads of the transformer to the corresponding taps. If the power line impedance is not known, connect the COAX lead to tap 3 and the TUNER leads to taps 8 and 9.

Open the link of jack J-2 and connect a thermocouple ammeter to the terminals.

Turn on the local transmitter and adjust the core of the tuning coil L-1 for maximum current in jack J-2. If the current is increasing with the core all the way in or all the way out, change the connection to the next higher or lower tap, respectively.

Adjust the transformer taps to obtain as nearly the same current in J1 as would be obtained with a 60-ohm resistive load on the coaxial cable. For a 10-watt transmitter, this current value is 0.41 ampere. For each transformer tap change, recheck the adjustment of the tuning coil for maximum current at J2. If two transformer taps give the same reading of current, use the higher impedance connection.

A procedure for more exact impedance match is shown in Fig. 4, Line Coupling Tuner Adjustment. The dummy load resistors must be of sufficient wattage rating to dissipate the transmitter output. Use the transformer tap connections given in this Instruction Book.

A line tuner which is used to bypass a circuit breaker should be adjusted with the circuit breaker open. However, since this may be difficult to arrange, an alternate method is to disconnect the coupling capacitor from the line and connect its high potential side to ground through a resistor. If the impedance of the line with circuit breaker open is known, use a resistor of this value. If the line impedance is not known, use a 500-ohm resistor.

Adjust the spark gap SG-1 to 0.015 inch spacing. Observe the gap while transmitting full carrier power. If the gap arcs over, increase the spacing until the arcing stops. The minimum spacing for the gap depends upon the carrier power, the capacitance of the coupling capacitor and the impedance of power line.

With some combinations of coupling capacitor values and the higher carrier frequencies, the tuning of the line tuning coil will be so broad that the exact adjustment for resonance is very difficult to determine by normal measurements. However, under these conditions, the frequency response curve for the coupling circuit will be so flat that an exact adjustment of the inductance of the line tuning coil is not necessary. For carrier frequencies above 150 kHz. and for coupling circuits with a Q of less than 2, adjust the inductance of the line tuning coil to the calculated value. Then adjust the ratio of the matching transformer T-1 so that the current in jack J-1 is approximately the same as the current measured when the coaxial cable is terminated in a 60 ohm resistor.

To determine whether or not the above adjusting procedure is applicable, calculate the Q of the coupling circuit as follows:

Calculate the reactance of the coupling capacitor at the operating frequency.

$$X_C = \frac{1}{2\pi FC}$$

Determine the approximate power line impedance.

For a single trapped line use a value of 500 ohms. For lines which are not trapped, divide 500 ohms by the number of lines leaving the bus.

Divide the reactance of the capacitor by the impedance of the line to determine the Q of the circuit.

$$Q = X_C/R$$

(Since this calculation is only an approximation, the possible reactance of the power line is neglected.)

Example: Coupling Capacitor — .00275 mfd.
Operating Frequency — 165 kHz.
Single Trapped Line — use 500 ohms

$$X_C = \frac{1}{2\pi FC} = 350 \text{ ohms}$$

$$Q = 350/500 = 0.7$$

For this installation, calculate the inductance required to resonate the coupling capacitor.

$$L = \frac{X_L}{2\pi F} = 0.34 \text{ mh}$$

Refer to Fig. 5.

For 0.34 mh use tap 78, with core at center of travel. Short unused turns.

NOTE

The instructions in Fig. 5 state that the unused taps are to be shorted when a tap lower than 100 is used and also when the frequency is above 150 kHz.

This procedure will leave a gap in the inductance range between tap 100 with the unused turns not shorted and tap 88 with the unused turns shorted. Continuous inductance adjustment can be obtained by using tap 113 with unused turns shorted as the next lower inductance tap below tap 100 with the unused turns not shorted

MAINTENANCE

Routine Checks and Records

This line tuner requires very little maintenance. It should be inspected occasionally to see if there has been excessive burning of the spark gap. If the discs show signs of burning, rotate the discs to a new position and re-adjust the gap. Usually a semi-annual or yearly inspection is sufficient.

A permanent record should be kept of the tap settings and the position of the tuning coil core so that they can be restored to the correct positions in case of unauthorized changes.

Ordering Replacement Parts

Replacement parts for this line tuner may be ordered through the nearest Westinghouse District Office.

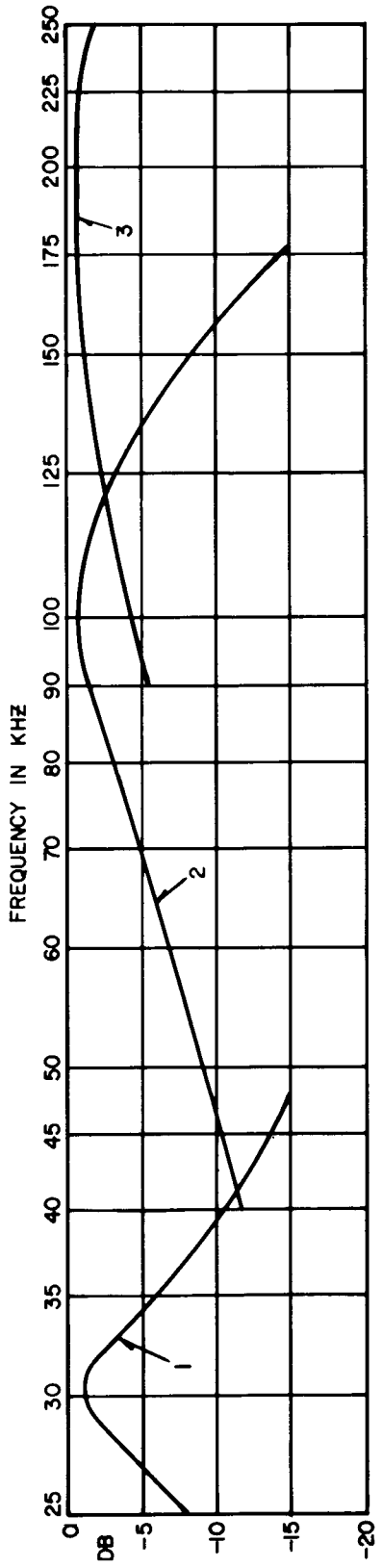
When ordering, include:

1. The following data from the nameplate of the line tuner: (A) the type number, and (B) the style number.

2. The (A) electrical parts list symbol, (B) the function, (C) the description, and (D) the style number.

ELECTRICAL PARTS LIST

CIRCUIT SYMBOL	FUNCTION	DESCRIPTION	STYLE NUMBER
		SUB-ASSEMBLIES	
L-1	Line Tuning Coil	Line Tuning Coil Assembly	1474218
T-1	Transformer	Transformer Assembly	407C741G02
	Protector Unit	Protector Unit Assembly	1474014
		COMPONENT PARTS	
J-1	Jack-Coax Metering	Binding Post Type 2 Binding Posts 1 Shorting Link	 185A431H01 1474455
J-2	Jack-Line Metering	Same as J-1	
SG-1	Spark Gap	Disc Type	2 of 183A358H20 (discs only)
		OPTIONAL	
L-3	Drain Coil (When Used)	20,000 ohms minimum impedance over 30-200 kHz.	* 607B800G03
C1	Series Capacitor (When Used)	Mica, 0.006 mfd., ± 5% 3000V, PACW.	584C256H03



FREQUENCY RESPONSE
TYPE JZ 71.6 TUNER

CURVE	TUNED TO
1	30 KHZ
2	100KHZ
3	200KHZ

COUPLING CAPACITOR 1870 MMF.
LOAD RESISTANCE 300 OHMS

(Dwg. 862A346)

Fig. 1. Response Curves of JZ 71.6 Tuner.

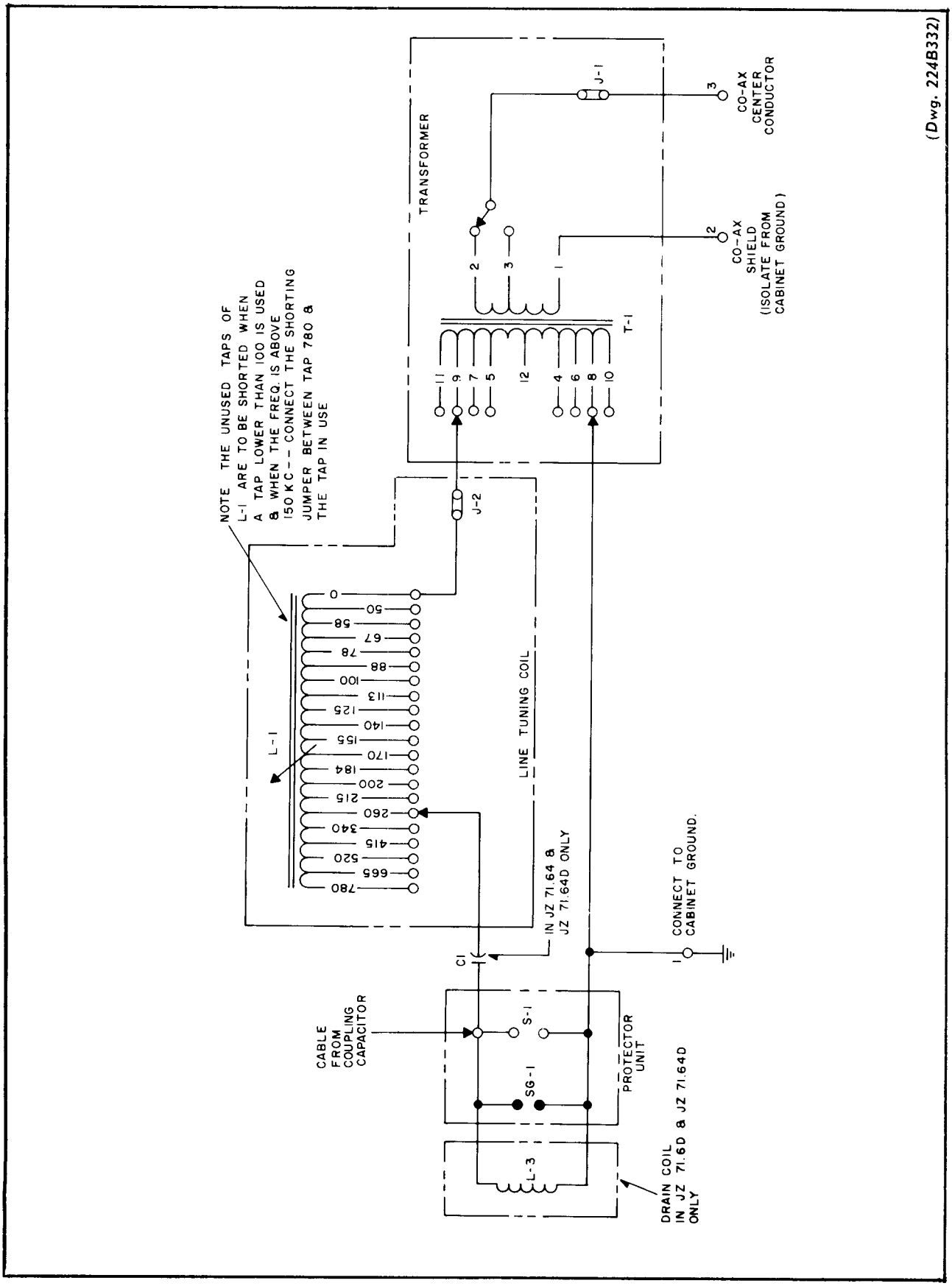
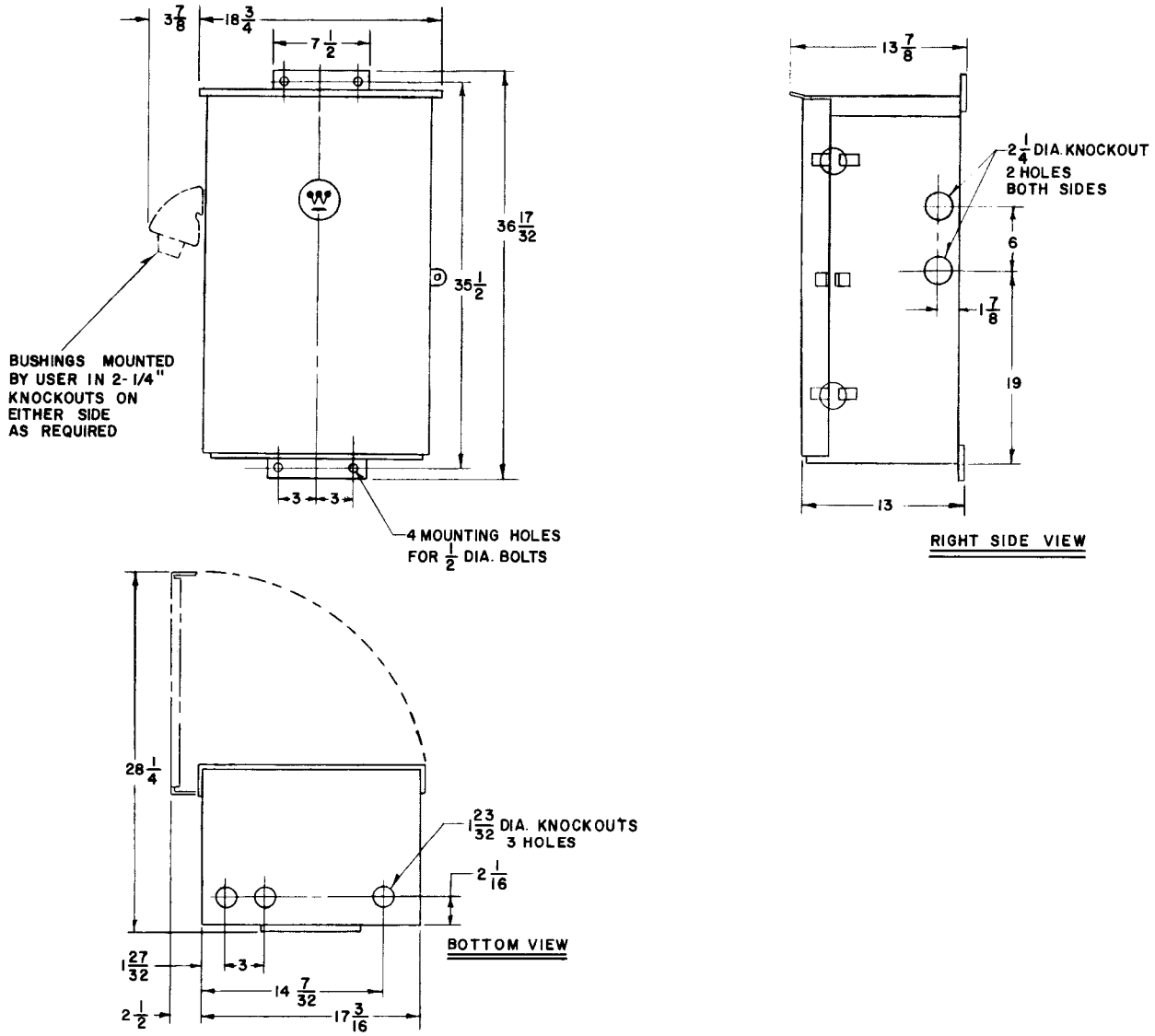


Fig. 2. Schematic Diagram



(Dwg. 50-B-7683)

* *Fig. 3. Outline Drawing*

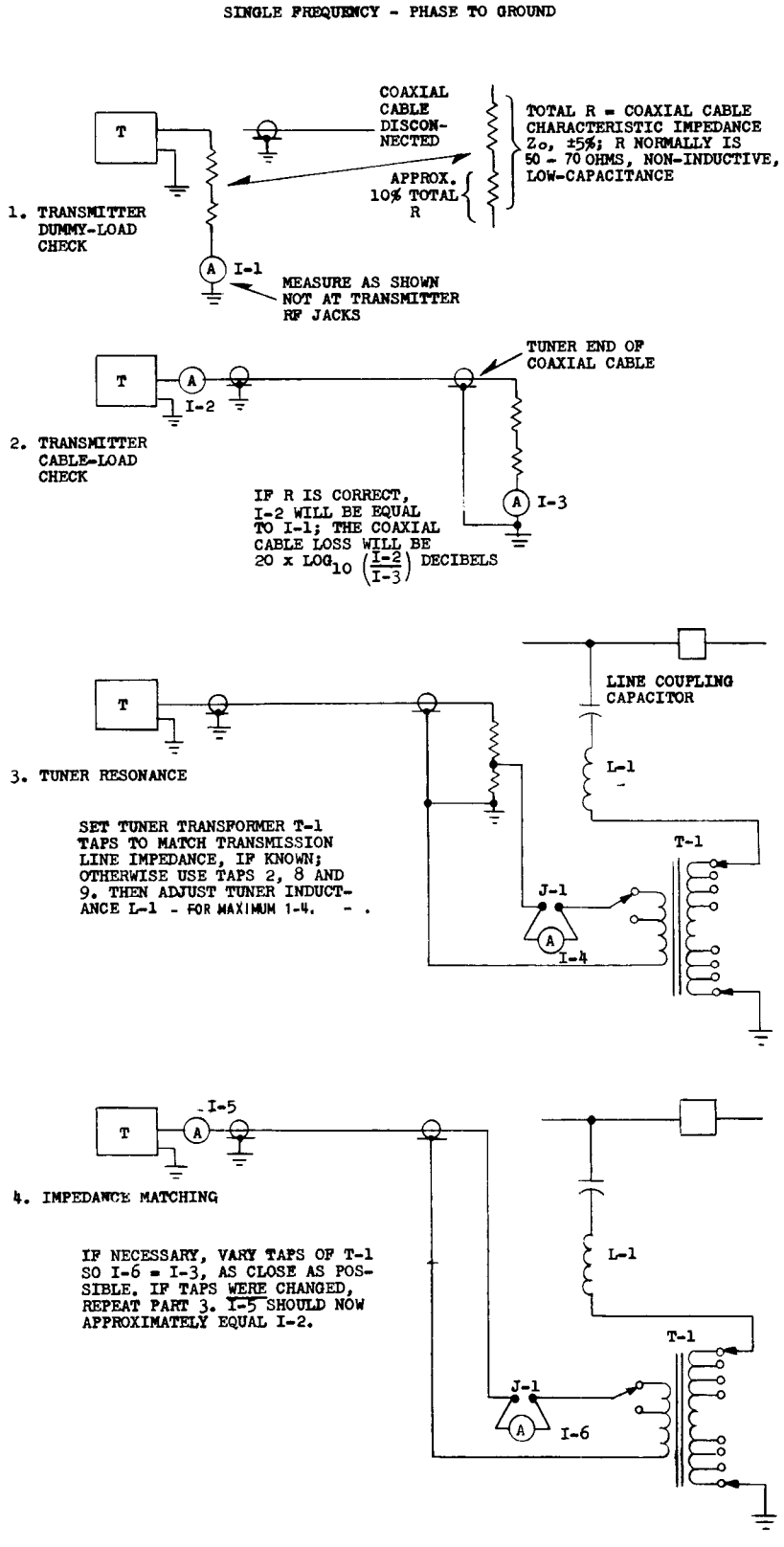


Fig. 4. Line Coupling Tuner Adjustment Procedure

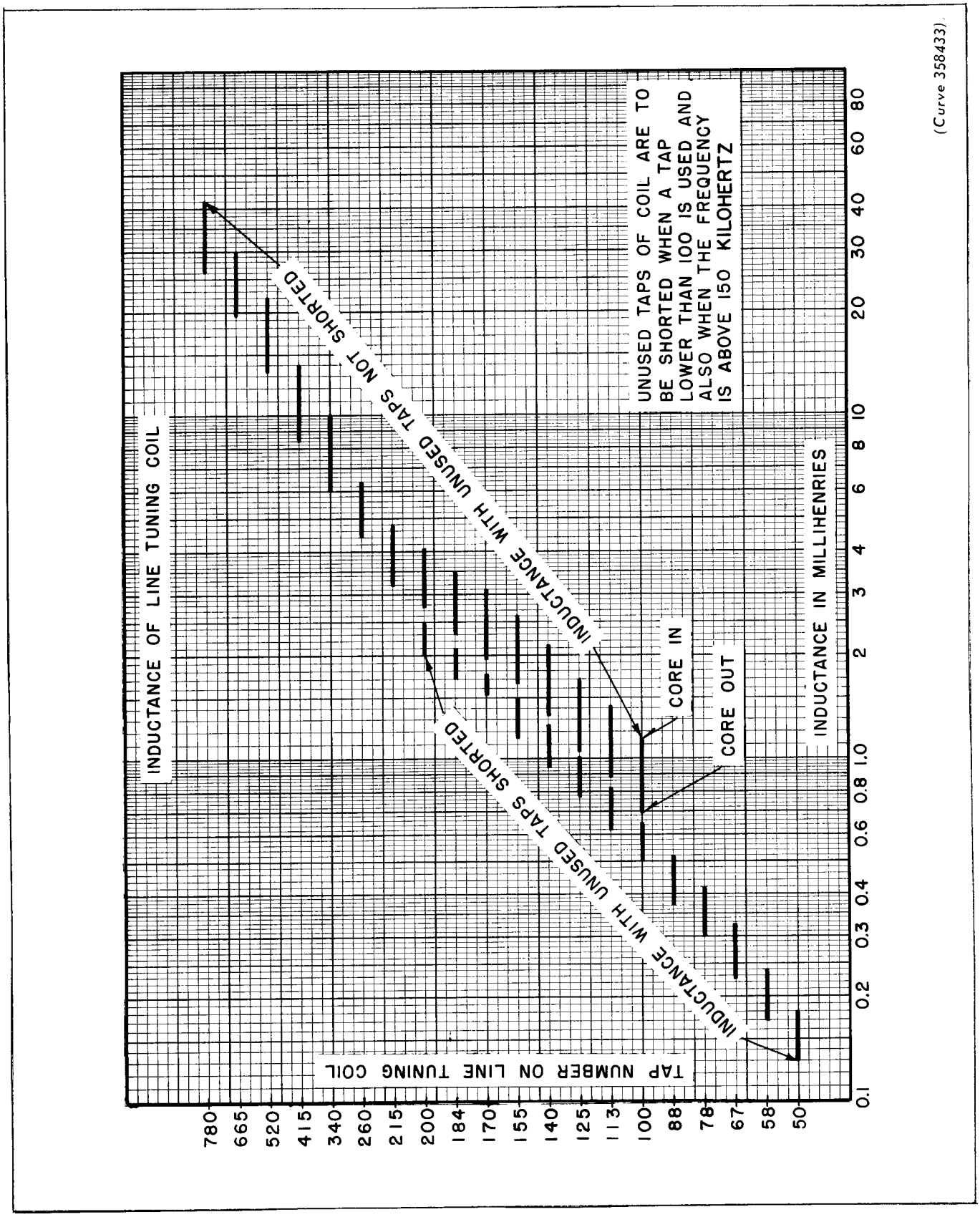


Fig. 5. Inductance of Line Tuning Coil

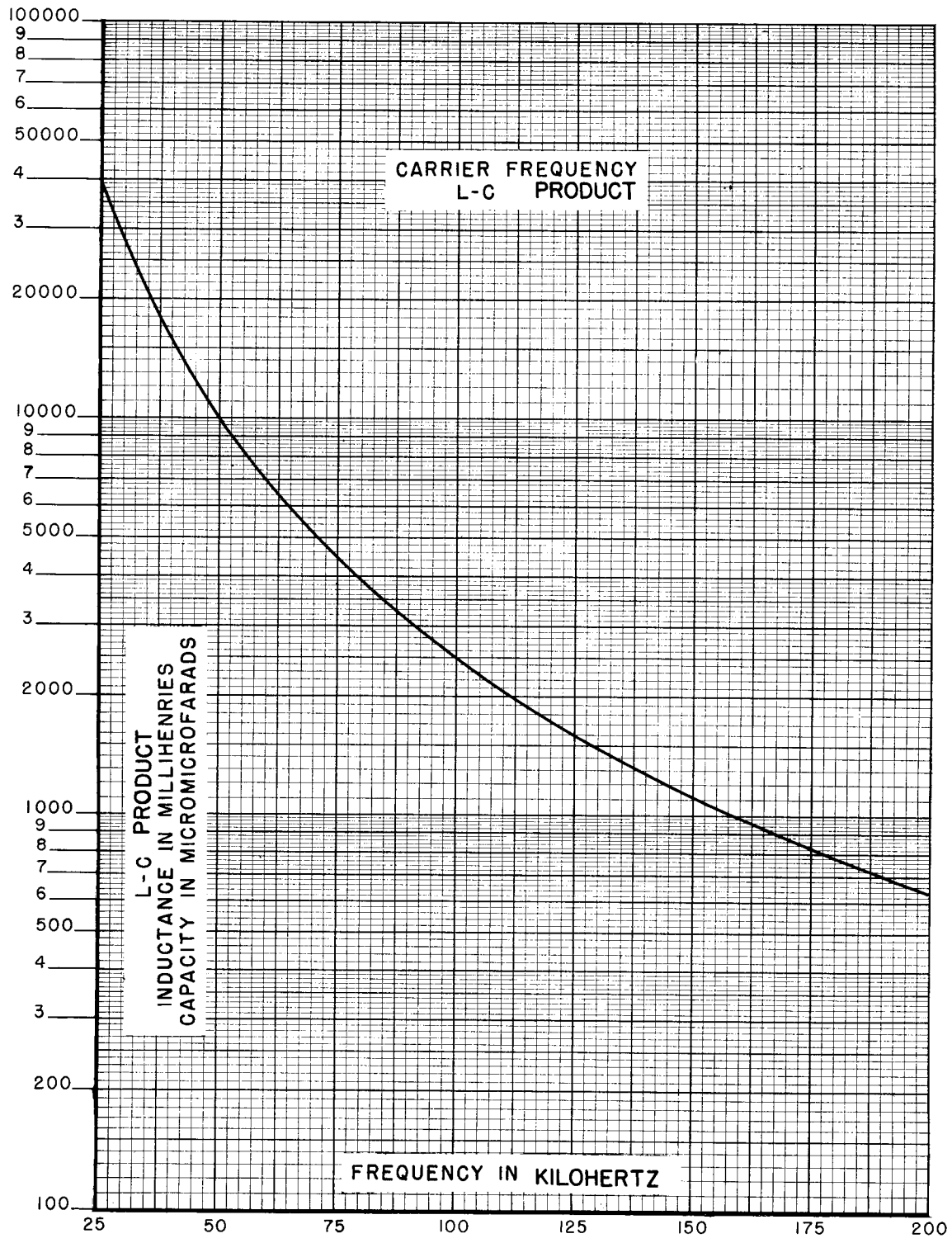
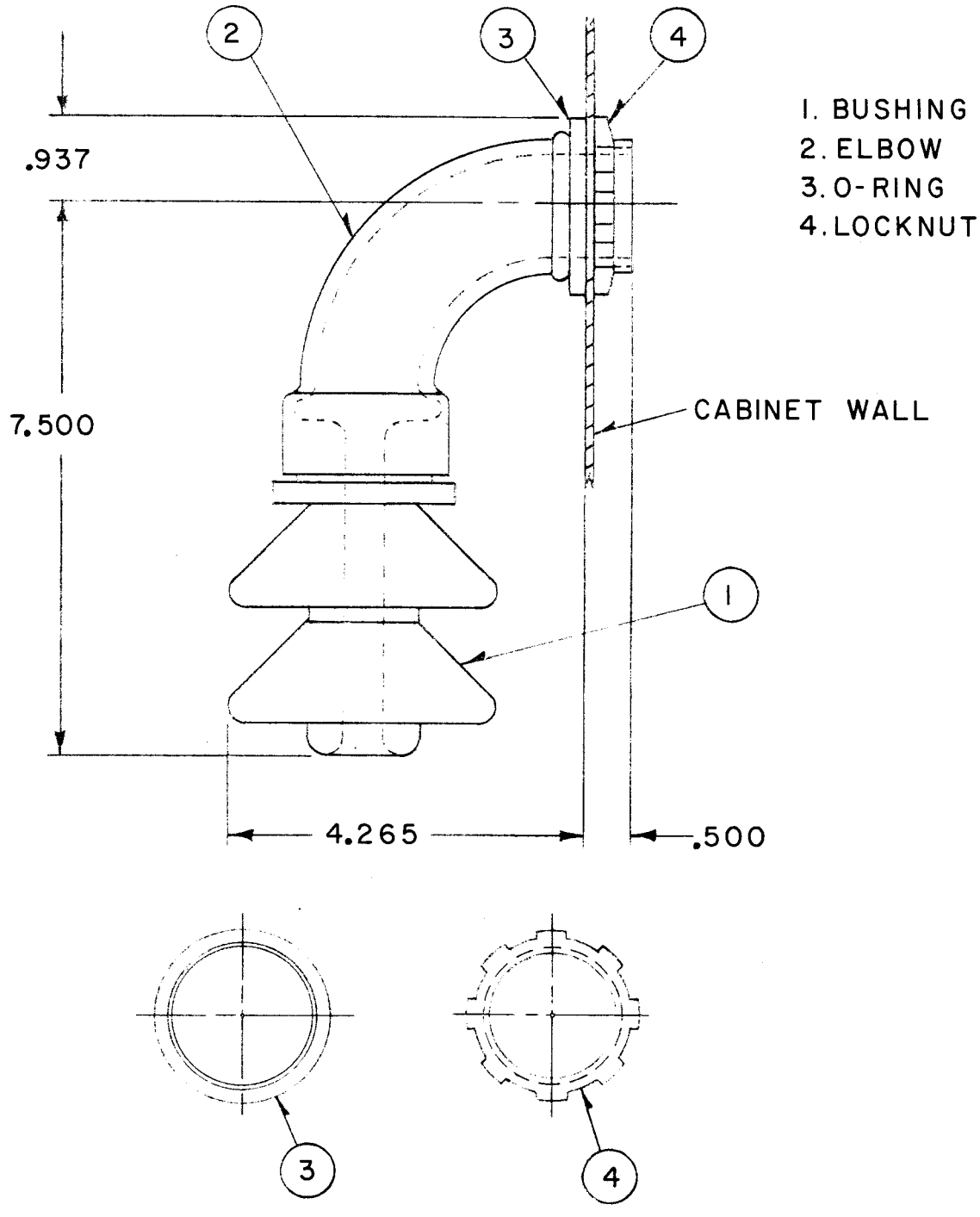
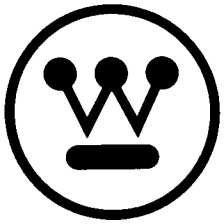


Fig. 6. Carrier Frequency L-C Product



* *Fig. 7. Lead-In Bushing Assembly*



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