INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE JZ 72.36 LINE COUPLING TUNERS

Two-Frequency Phase-to-Ground Line Coupling Tuner

-with a two-winding matching transformer

-for single coaxial cable input

Type	Style	Description
JZ 72.36	293B336A17	-(see title above)
JZ 72.36D	290B883A34	- with drain coil
JZ 72.364	290B883A35	- with .006 MFD series capacitor
JZ 72.364D	290B883A36	- with .006 MFD. series capacitor and drain coil

SUPPLEMENTARY DATA

DRAWINGS	REFERENCES
FIGURE 1 - Schematic	899C325
FIGURE 2 - Outline	50-B-7683
FIGURE 3 - Line Coupling Tuner Adjustment	205C475
FIGURE 4 - Inductance of Line Tuning Coil	358433
FIGURE 5 - Frequency Calibration of Trap Circuit	358434
FIGURE 6 - Capacitance of Trap Circuit at Line Tuner Frequency	358436
FIGURE 7 - Carrier Frequency L-C Product	358437
FIGURE 8 - Lead-In Bushing Assembly	862A186

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.

APPLICATION

JZ 72.36 Line Coupling Tuners are designed to provide efficient phase-to-ground coupling for two carrier frequencies from a single coaxial cable through a single coupling capacitor to a power line.

DESCRIPTION

Mechanical Description

The line tuner is mounted in a cabinet suitable for outdoor installation. Knockouts are provided on each side of the cabinet for the capacitor lead-in bushing. Knockouts for 1½ inch conduit for the coaxial cable are located in the bottom of the cabinet. The outline, mounting dimensions and the location of the knockouts are shown in Fig. 2.

All electrical components are mounted on a hinged panel which can be opened for making the coaxial cable, capacitor lead-in and ground connections. The grounding switch, spark gap, tuning controls, metering jacks and all tap connections are accessible from the front of the panel.

Electrical Description

The electrical circuits are shown in Fig. 1. The coaxial cable connects through a Jack, J-1 to the primary of a matching transformer, T-1. The secondary winding of the transformer connects through a Jack, J-2, to two line tuning coils, L-1. The trap circuit consists of the tapped inductance L-2, which has an adjustable powdered-iron core, and tuning capacitors C-3 and C-4. Links on the front of the panel provide for connecting the tuning capacitors in series, one capacitor alone, or both capacitors in parallel. The protector unit, consists of an adjustable spark gap SG-1 and a knife switch S-1.

The spark gap protects the equipment from excessive voltage surges. The knife switch is provided for grounding the lead-in from the coupling capacitor while adjustments are being made.

The JZ 72.364 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 72.36D tuner. If both capacitor and drain coil are included, the tuner is Type JZ 72.364D

CHARACTERISTICS

Frequency Range:	30 to 200kHz.
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 72.36 - .00075 to .004 mfd. JZ 72.364- .00075 to .015 mfd.
Minimum Frequency Separation	25% of the lower frequency

INSTALLATION

It is recommended that the Line Tuner be located as near to the coupling capacitor as possible. The mounting dimensions are shown in Fig. 2.

Remove the upper knockout from the side of the cabinet nearest the coupling capacitor and install the porcelain bushing for the capacitor lead-in as described in the following section.

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 in cable is shown in Fig. 8. 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.

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 element 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.

Coaxial Cable

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 conductor 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.

Follow the instructions given in Fig. 1 for the connection of the coaxial cables. Remove the shield braid so that one to two inches of the inner insulation is exposed. The outer jacket of the coaxial cable should cover the shield braid as much as possible to insulate it against the high voltage that may exist between the shield braid and the tuner cabinet during a fault. Connect the cable shield to terminal 2 as indicated in Fig. 1 but do not ground these leads to the tuner cabinet. See that the coaxial cable leads are positioned so that the exposed portion of the cable shield and its lead are spaced away from the metal cabinet proper. The coaxial cable is grounded at the carrier equipment end only. The use of two-winding transformers allows grounding of the coaxial-cable shield braid at the carrier-set end only, and this eliminates any path for the flow of 60-cycle current (during a ground fault) through the coaxial cable and transformer winding.

PRELIMINARY ADJUSTMENTS

JTION: 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 is adjusting this tuner is to determine the two operating frequencies. In general, to prevent excessive losses and poor tuning, the higher of the two frequencies should be at least 125 per cent of the lower frequency.

The following procedure will determine the approximate adjustment the line tuning coils and trap circuit. The section with the single line tuning coil should be tuned to the lower frequency while the section with the trap and line tuning coil should be tuned to the higher frequency.

For these calculations:

F1 = lower frequency in KHz.
F2 = higher frequency in KHz.
*Co = capacitance in MMF of coupling capacitor.
Ct = capacitance in MMF of trap circuit at frequency F2.
L1 = inductance in MH of tuning coil for frequency F1.
L2 = inductance in MH of tuning coil for frequency F2.
Lh = inductance in MH required to resonate capacitance Co at frequency F2
Lc = inductance in MH required to compensate capacitance Ct at frequency F2.
Lp = inductance in parallel with inductance L1 to resonate coupling capacitor Co at frequency F2.

*For the JZ 72.364 and JZ 72.364D Tuners, Co is the series combination of C5(.006 MFD) and the coupling capacitor. For this case use the formula

$$Co = \frac{(.006)(\text{value of coupling capacitor})}{(.006) + (\text{value of coupling capacitor})}$$

Matching Transformer Taps	Coaxial Tap	T1 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.

A. Calculation of adjustment for the lower-frequency section.

1. Refer to Fig. 7 and determine the LC product for frequency F1.
2. Divide the LC product by the value in micro-microfarads of the coupling capacitor Co.

   $L_1 = \frac{LC}{Co}$ = MH inductance for resonance at F1.

3. Refer to Fig. 4 for the tap number on the line tuning coil for this value of inductance.

B. Calculation of adjustment for the higher frequency section.

1. Refer to Fig. 5 for the capacitor combination and the trap coil tap number required to tune the trap circuit to frequency F1.
2. Determine the percentage that the trap frequency F1 is below the line tuner frequency F2 by using the following formula:

   $\frac{F2 - F1}{F2}$ X 100 = percentage

3. Refer to Fig. 6 and determine the capacitance, Ct, of the trap circuit, for the trap tuning capacitance, and per cent separation determined above.
4. Refer to Fig. 7 and determine the LC product for frequency F2.
5. Divide the LC product by the value of capacitance determined above to obtain the inductance value, LC, required in the tuning coil to compensate for the capacitance of the trap circuit.

   $Lc = \frac{LC}{Ct}$ = MH inductance

6. Divide the LC product by the value in micro-microfarads of the coupling capacitor to determine the inductance value, LC, required to resonate the coupling capacitor at frequency F2.

$$L_h = \frac{LC}{Co} = \text{MH inductance}$$

7. Calculate the value of inductance, Lp, which must be paralleled with the inductance, L1, of the low frequency section (from A-2 above) to obtain the inductance, Lh, determined above.

$$Lp = \frac{(L1)\ (Lh)}{L1 - Lh} = \text{MH inductance}$$

8. Add the inductance values Lc and Lp to determine the inductance L2, required in tuning coil in the high frequency section of the line tuner.

$$L2 = Lc + Lp = \text{MH inductance}$$

9. Refer to Fig. 4 for the tap number on the line tuning coil for this value of inductance.

Sample Calculation

Assume

F1 = 160KHz
F2 = 200KHz
Co = 4000 MMF

A. Low Frequency Section

1. Refer to Fig. 1 and determine LC product for F1: LC = 980.

2. $L1 = \frac{LC}{Co} = \frac{980}{4000} = 0.245$mh. For resonance at 160KHz

3. Refer to Fig. 4 for tap number on tuning coil 0.245 mh = Use tap 67 and short unused taps.

B. Higher Frequency Section

1. Refer to Fig. 5 for the capacitor combination and the trap coil tap number to tune trap circuit to F1. Trap at 160KHz = 1100 MMF and tap 100.

2. Determine the percentage that the trap frequency F1 is below the line tuning frequency F2.

$$\frac{F2 - F1}{F2} \text{X}100 = \frac{200 - 160}{200} \text{X } 100 = 20\%$$

3. Refer to Fig. 6 and determine the capacitance, Ct, of the trap circuit for the trap tuning capacitance and percentage as determined in B-1 and B-2 above.

At 20% and 1100 MMF, Ct = 390 MMF.

4. Refer to Fig. 7 and determine the LC product for F2: LC = 630.

5. $Lc = \frac{LC}{Ct} = \frac{630}{390} = 1.61$ mh to compensate for capacitance of trap.

6. $Lh = \frac{LC}{Co} = \frac{630}{4000} = 0.157$ mh for resonance at 200KC.

7. Determine the value of inductance Lp, to be paralleled with Ll, the low-frequency section of A-2 above, to obtain the inductance Lh, determined in B-6 above.

$$Lp = \frac{Ll \times Lh}{Ll - Lh} = \frac{0.245 \times 0.157}{0.245 - 0.157} = 0.392 \text{ Mh}$$

8. Add the values Lc + Lp to obtain the inductance L2 required in higher frequency tuning coil section of line tuner.

$L2 = Lc + Lp = 1.61 + 0.392 = 2.00$ Mh

9. Refer to Fig. 4 for the tap number for inductance of L2 = 2.00mh use tap 184, short unused taps.

NOTE: The instructions in Fig. 4 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.

Final Adjustments

After making the connections of trap capacitors, trap coil taps, and line tuning coil taps as determined under Preliminary Adjustments, the circuits must be adjusted to meet the requirements of the particular installation.

Fig. 3 illustrates the preferred method of tuning the equipment. The dummy load resistors used must be of sufficient wattage to dissipate the transmitter output power. Please note: The differences in magnitude of the current, I6, obtained in 7(A) and that of I6 obtained in 7(B) may be due to the variation of line impedance with change in transmitter frequency. If this is so, use taps on T1 which produce current values as close as possible.

As an alternate means, the following procedure may be used for tuning the equipment.

Tuning Procedure

A. Low-Frequency Section

1. Set tap on L1 as calculated in A-3 of calculations.
2. Adjust transmitter to F1, the low frequency.
3. Open the link of Jack J-2 on the right of the panel, the low-frequency section of the tuner, and connect a thermocouple ammeter to the terminals. Open the link of other jack J-2, the high frequency section.
4. Turn on the local transmitter adjusted to frequency F1. Adjust the core of the tuning coil L-1 for maximum current in jack J-2. If the current is increasing with the coil all the way in or all the way out, change the connection to next higher or lower tap, respectively. This section is now tuned to resonance at low frequency F1.
5. Adjust the matching transformer, T-1, taps so that maximum current in jack J-2 is obtained. For each transformer tap change, recheck the adjustment of the tuning coil. If two transformer taps give the same reading of current, use the higher impedance connection.

B. Higher Frequency Section

1. Remove power from local transmitter and close grounding switch. Remove links of both jacks J-2. Connect lead on front of panel from trap unit to the left terminal of jack J-2 on left of panel. Remove connection of trap unit from terminal stud of S-1 on rear of panel. Connect this lead through a milliammeter to ground.

2. Adjust trap unit capacitor links and tap connection as determined in B-1 of calculations.

3. Turn on power of local transmitter, still adjusted to the lower frequency F-1. Adjust core of trap unit coil for minimum current in the milliammeter.

4. Remove power from the local transmitter and adjust the frequency to F-2, the higher frequency.

5. Reconnect the trap unit to switch S-1 terminal stud. Replace links in both jacks J-2. Connect a milliammeter to jack J-1. Adjust the tap connection of the line tuning coil on the left to tap determined in B-9 of the calculations.

6. Open grounding switch and turn on power of local transmitter. Adjust the core of the tuning coil on the left for maximum current in J-1. If the current is increasing when the core is moved all the way in or all the way out, change the tap connection to the next higher or lower, respectively.

C. Adjustments for By-Pass

A line tuner which is used to by-pass 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.

D. Adjustments of Protective Device

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 the power line.

MAINTENANCE

Routing 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 readjust 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 corr positions in case of unauthorized changes.

Ordering Replacement Parts

Replacement parts for this Line Tuner may be ordered through the nea 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 manufacturers designation.

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
-	Low Frequency Trap	Trap Unit Assembly	6294D16G01
-	Protector Unit	Protector Unit Assembly	1474014
		COMPONENT PARTS	
C-3	Capacitor-Trap Tuning	Mica-2200 mmf. ±5% 5000V	290B762H02
C-4	Capacitor-Trap Tuning	Same as C-3	
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
C-5	Series Capacitor (When Used)	Mica, 0.006 mfd.,±5%	584C256H03

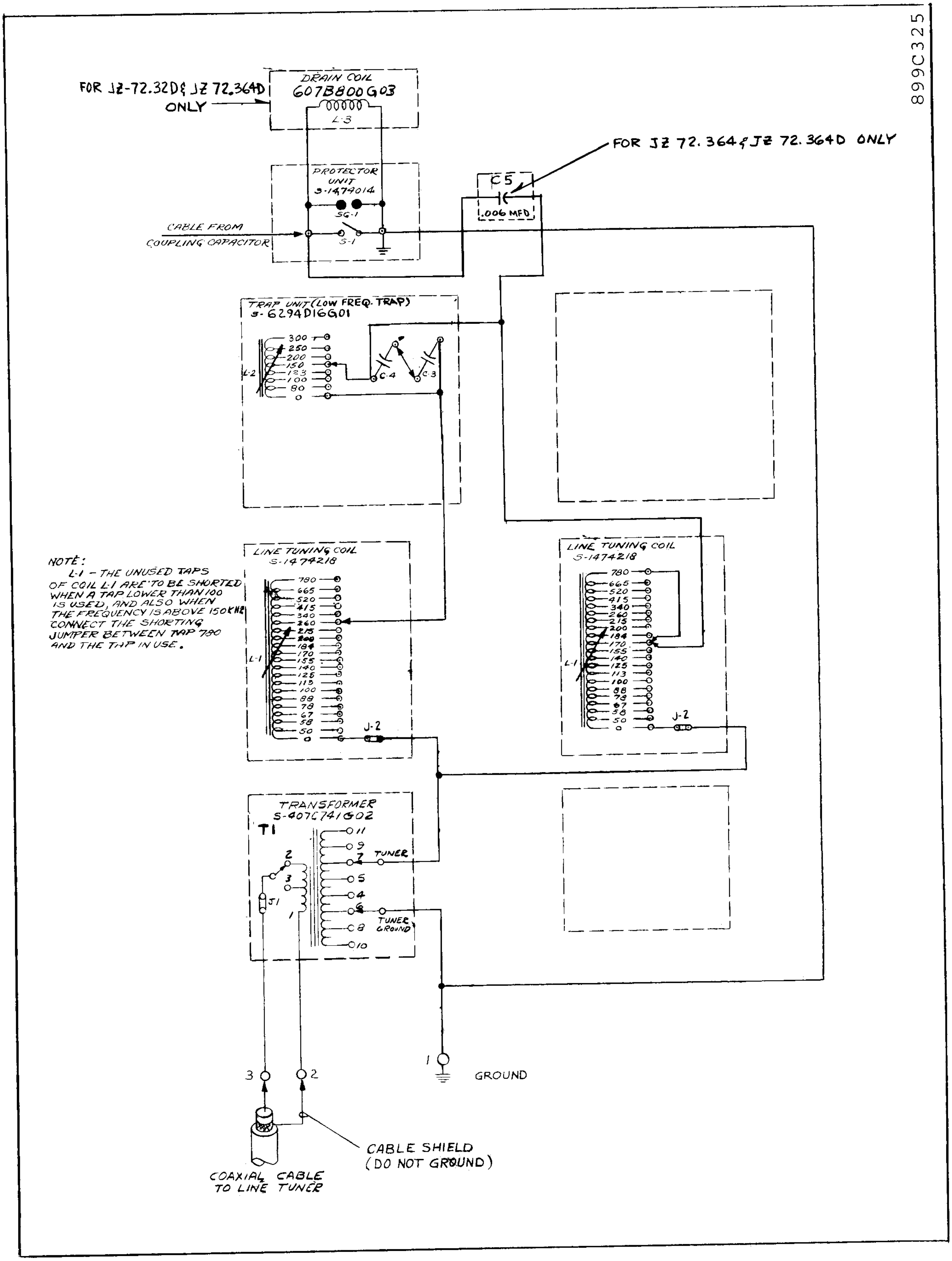

Fig. 1 Schematic

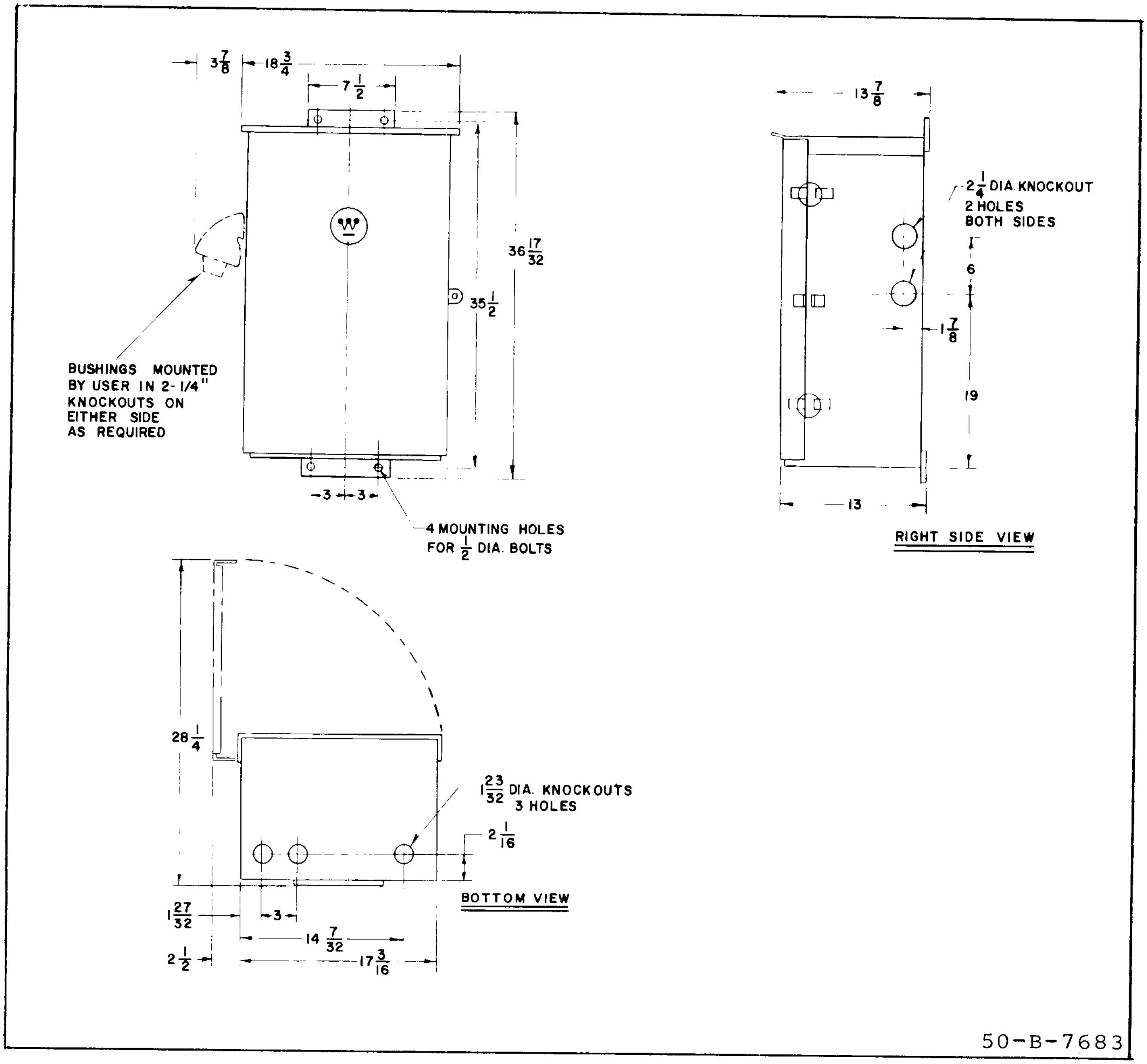

Fig. 2 Outline

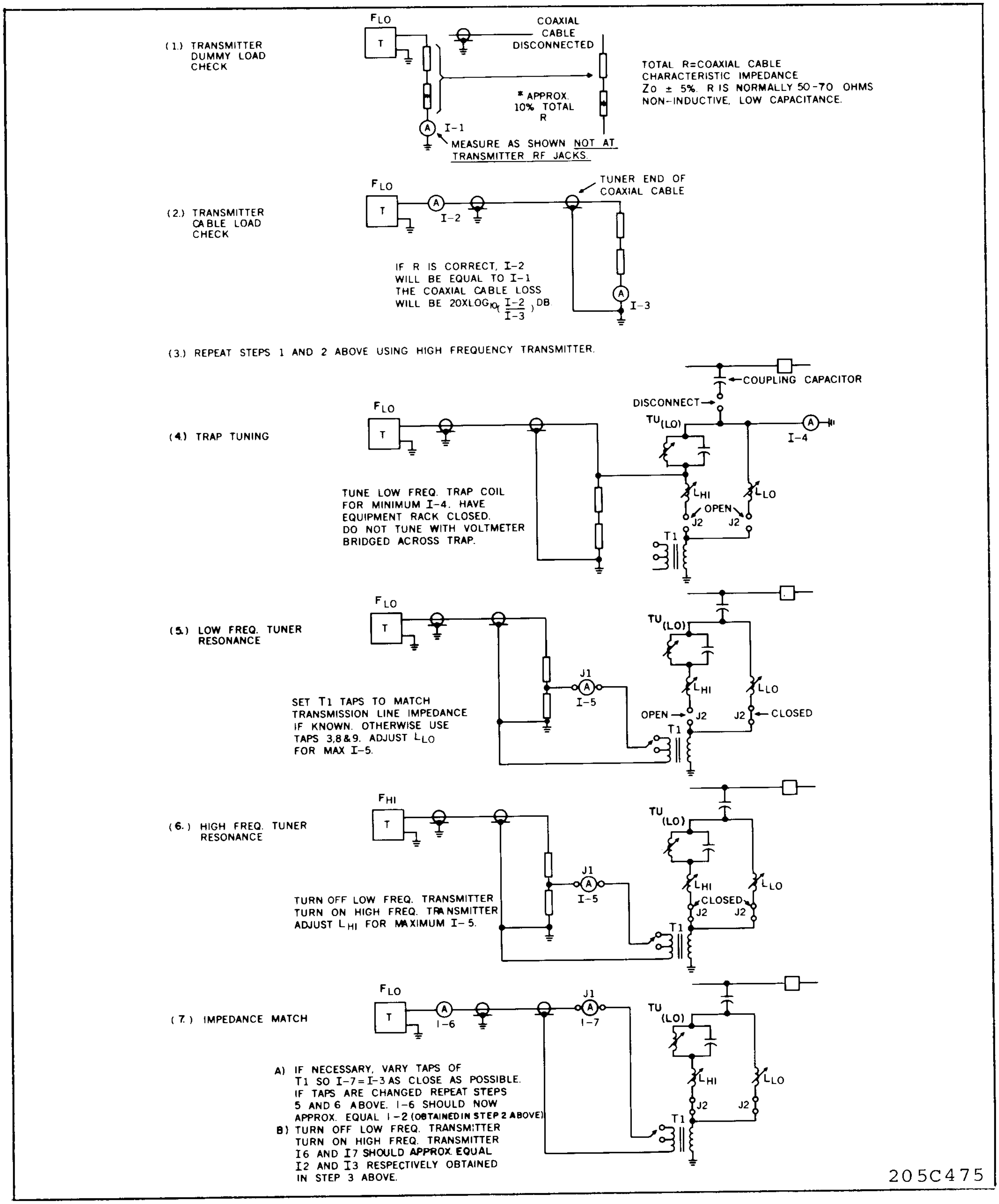

Fig. 3 Line Coupling Tuner Adjustment

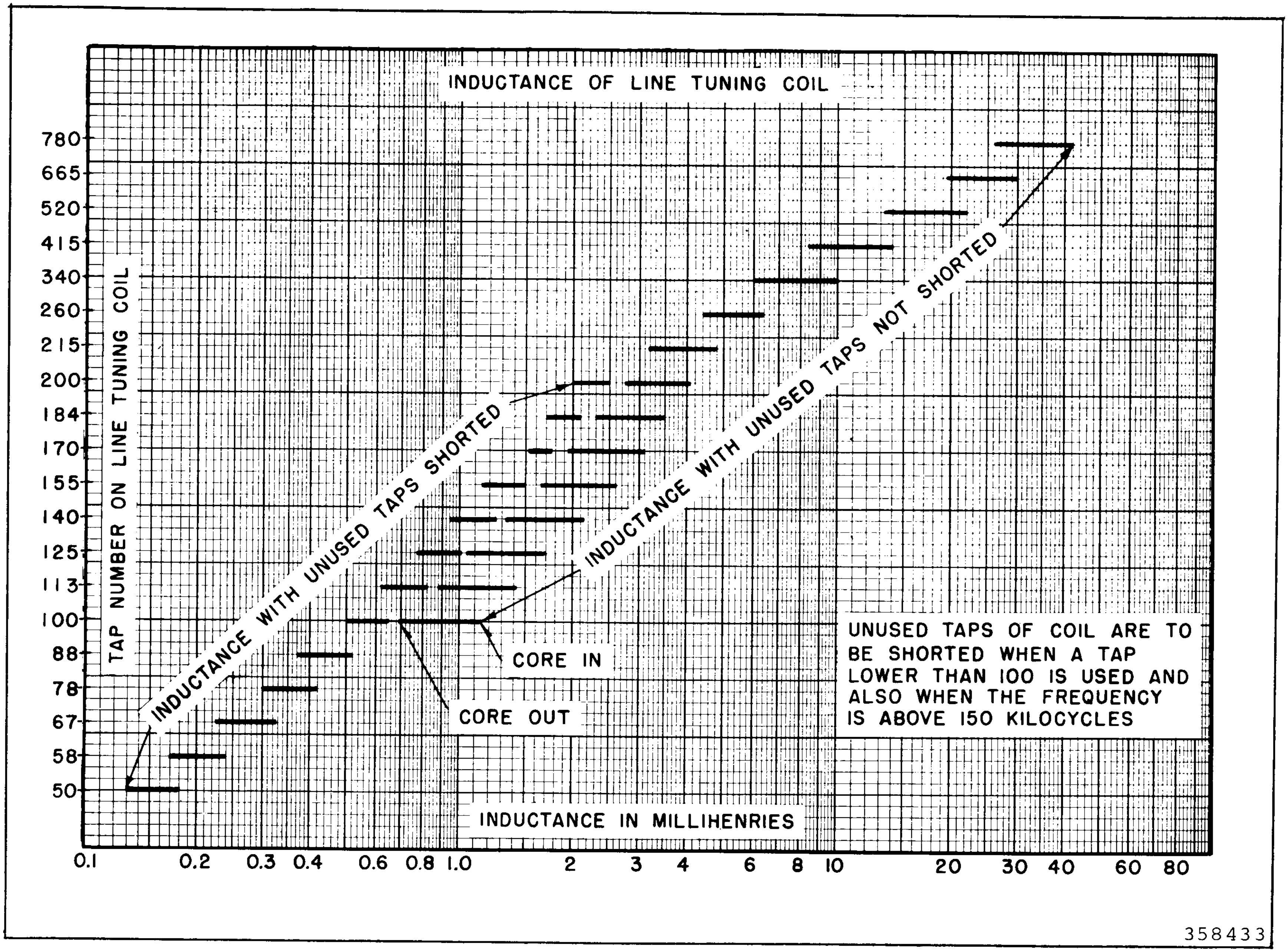

Fig. 4 Inductance of Line Tuning Coil

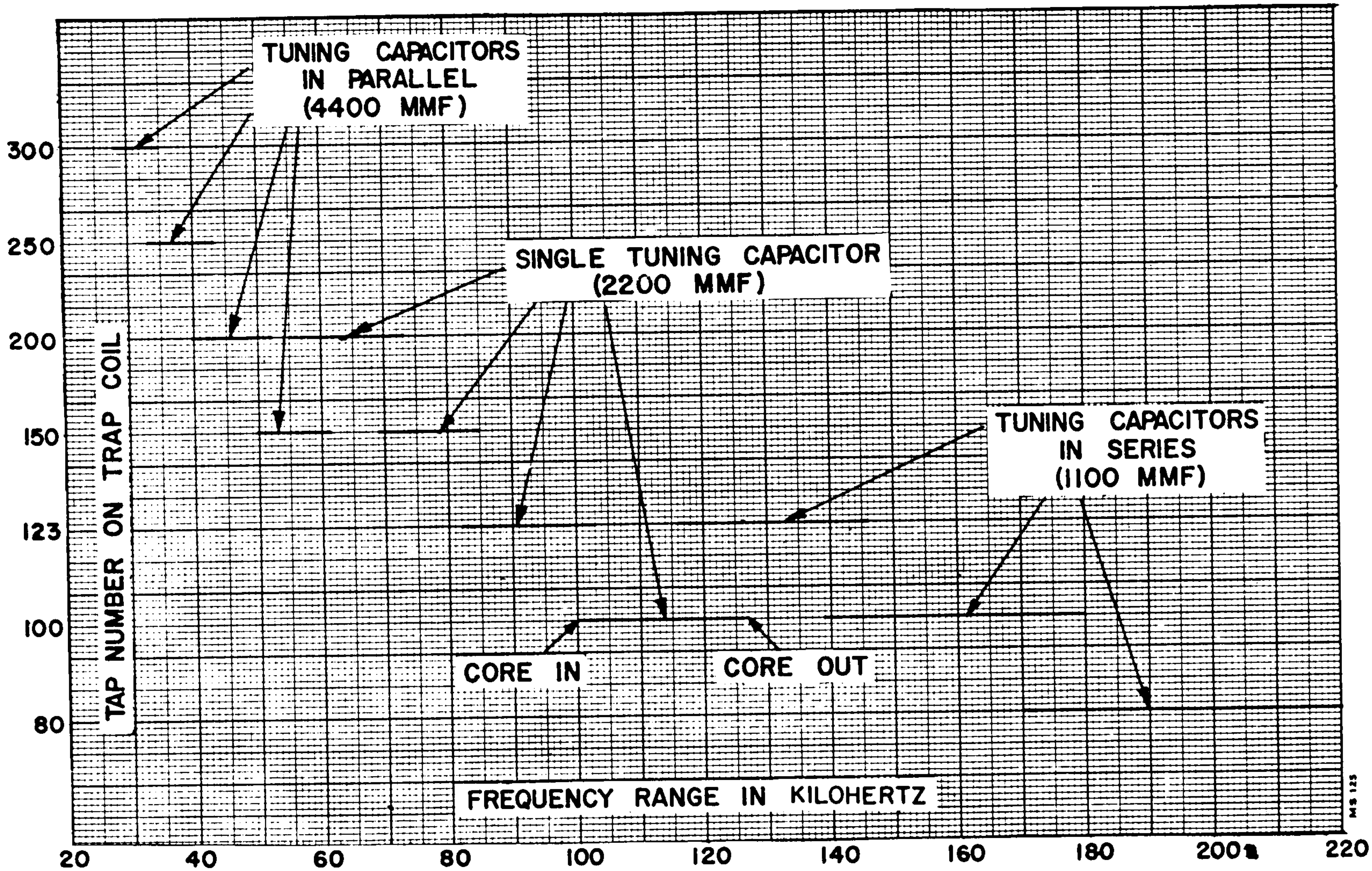

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Fig. 5 Frequency Calibration of Trap Circuit

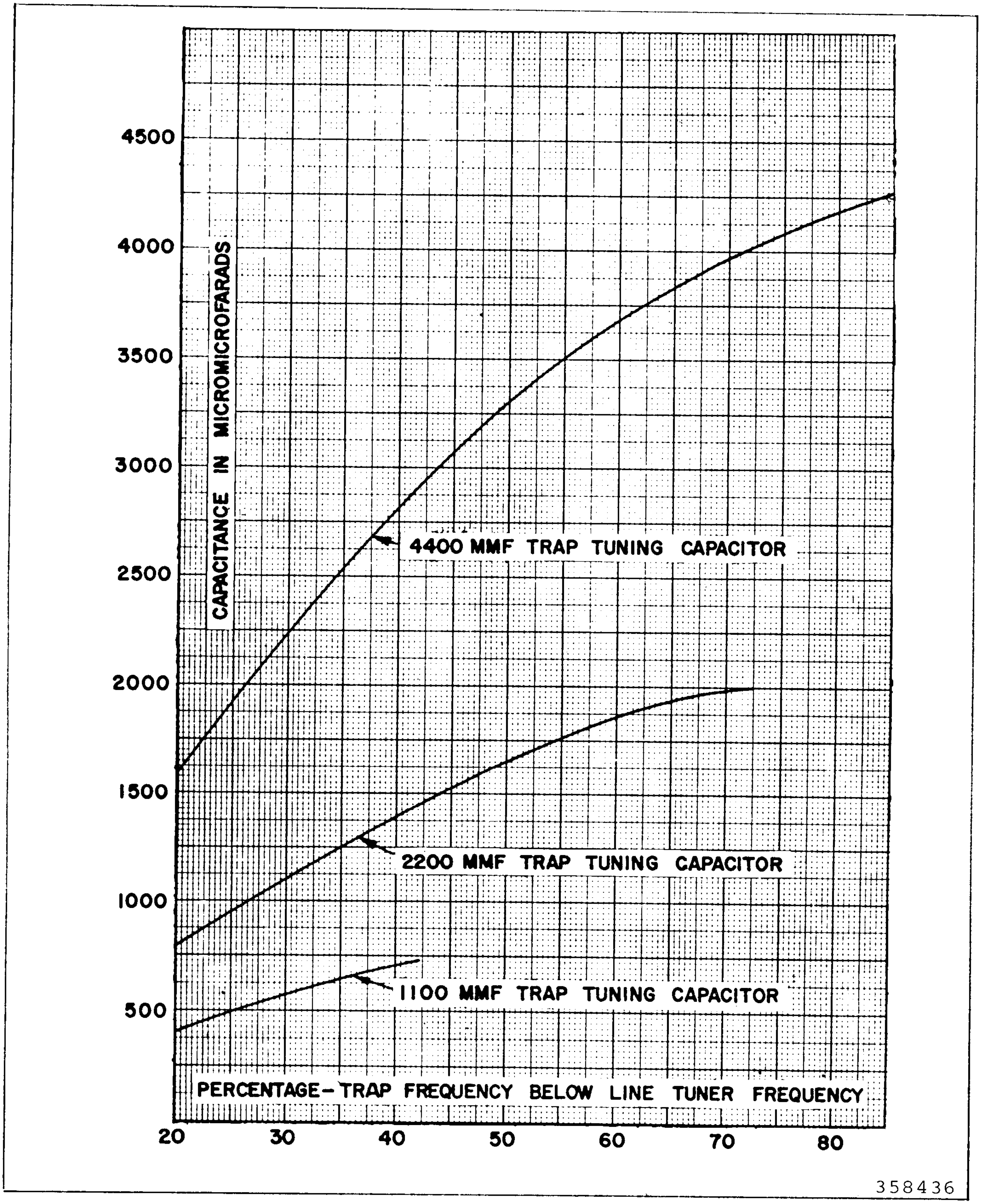

Fig. 6 Capacitance of Trap Circuit at Line Tuner Frequency

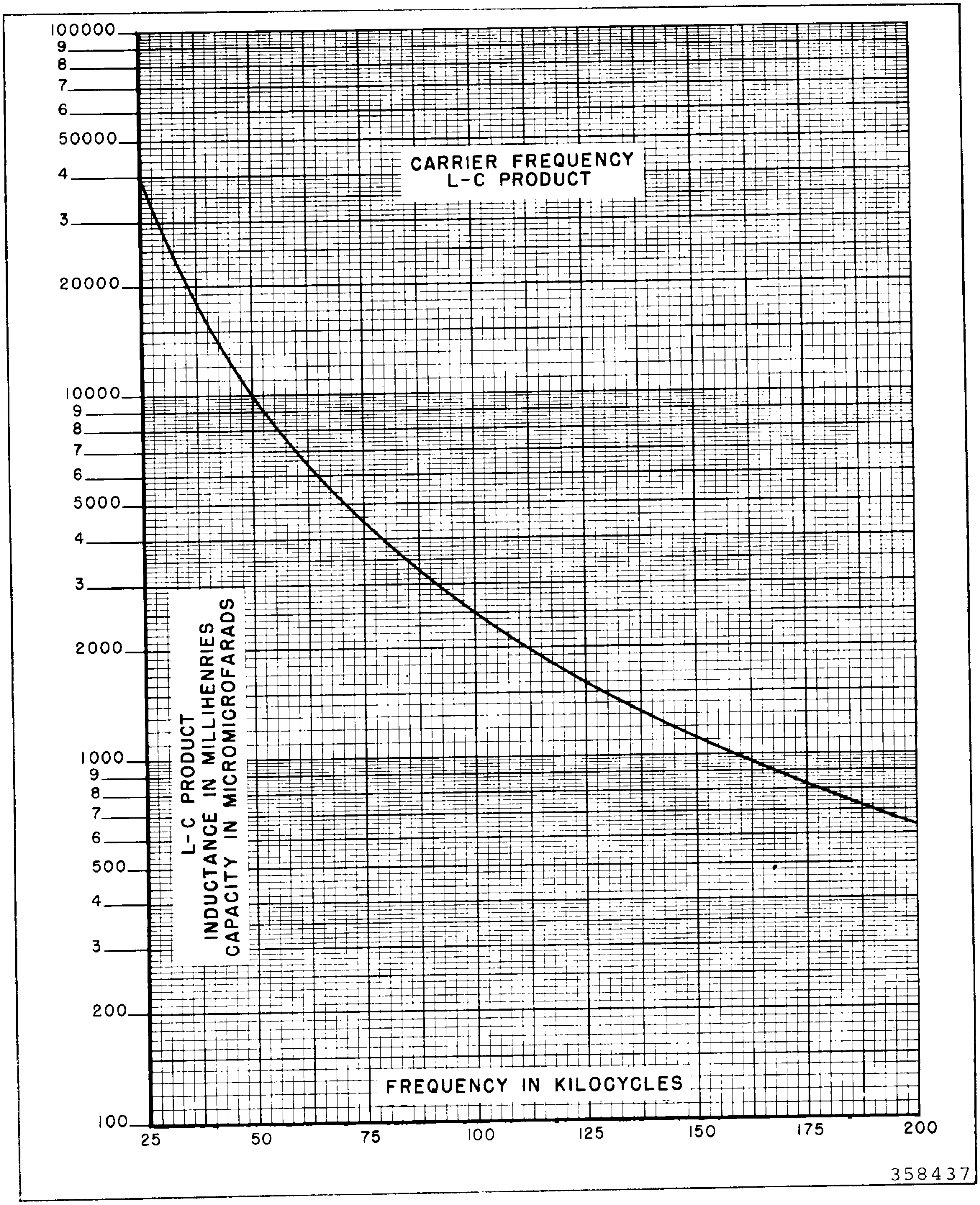

Fig. 7 Carrier Frequency L-C Product

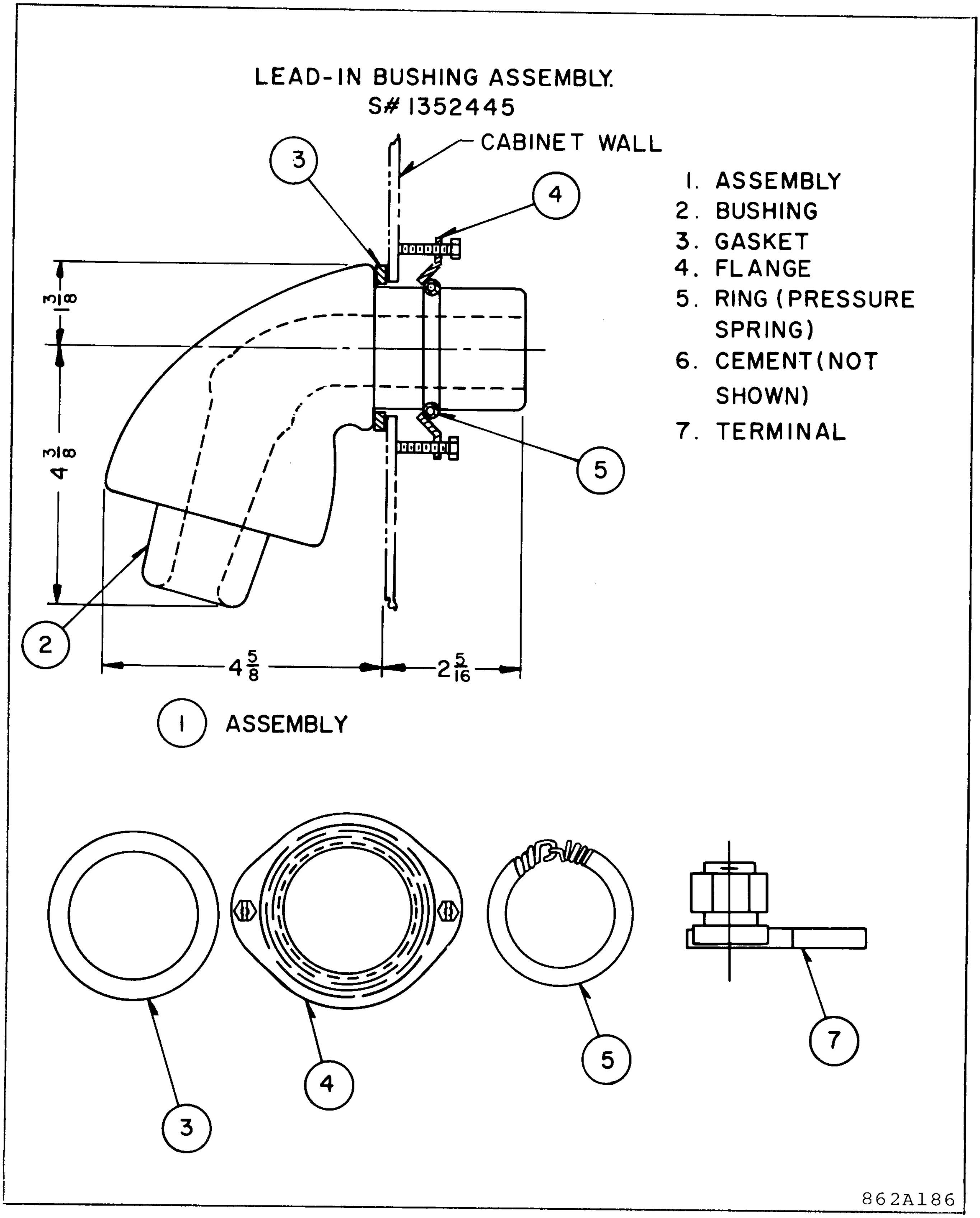

Fig. 8 Lead-In Bushing Assembly

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