INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TRANSMITTER – NARROW BAND RECEIVER 30 to 300 kHz – 10 Watts – for 48, 125, 250 V.D.C. with Optional Voice Communication

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SUPERSEDES 41-944.34 dated August 1973
*Denotes change from previous issue.

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rier test pushbutton and the phase and ground carrier-start relay contacts. Opening of any of these contacts allows current to flow from fused positive through resistor R_C and the diode D_1 to the transmitter control terminal TC/6, thus starting carrier transmission at full output. The potential of terminal TC/6 rises to plus 20 volts, limited by a Zener diode in the transmitter proper. The reception of carrier from either the local or remote transmitter normally causes a saturated current of about 200 ma. to flow in the alarm and holding coils (AL and RRH) in the type KA-4 (or equivalent) receiver auxiliary relay.

If the protective relays call for stopping the transmission of carrier, closing of CSP or CSG contact connects the transmitter control circuit back to fused negative, thus stopping any carrier transmission regardless of how it was started.

If a relaying carrier channel is also used for an auxiliary function such as telemetering or supervisory control, the keying contact for this function is connected into the carrier-start circuit in series with the carrier test pushbutton. Such a contact must be normally closed (in the non-operating condition). An auxiliary relay in the receiver output, usually in place of the alarm relay, energizes the telemetering or supervisory control equipment through contacts on the auxiliary relay.

Carrier Control For Other Functions

If a type TC set is keyed on-off for telemetering or supervisory control only (no protective relaying.) one of the circuits show in Figure 16 can be used. Arrangements are shown for either a normally-closed or normally-open carrier-start contact. In the former case, a diode is required to allow using the Voice adapter for push-to-talk voice communication between stations. Note that continuous telemetering must be interrupted when it is desired to use the carrier channel for voice communication.

The receiver output can be connected for either 200 ma. or 20 ma. operation as shown in Figure 11. The 200-ma. output is preferable (if a choice is available) because of a slightly better time constant in the 200 ma. receiver output circuit. In some cases, both the 200-ma. and 20-ma. outputs may be used together. For example, the 200-ma. output can be used with a standard carrier auxiliary relay (for directional-comparison relaying), while the 20-ma. output feeds a 2000-ohm receiver relay used with supervisory control equipment. The connections shown in Fig. 11 would be used for this case, with the receiver relay holding coil (RRH) in place of the 33-ohm resistor and the 2000-ohm supervisory relay in the 20-ma. output in place of the RRH and AL coils shown. The alarm function would be provided by the supervisory control equipment.

CHARACTERISTICS

Frequency range	30-300 kHz (50-300 kHz for phase comparison relaying)
Transmitter output	10 watts into 50 to 70 ohm resistive load
Harmonics	55 db below 10 watts
Receiver sensitivity	40 mv. input for 180 ma. minimum output current
Receiver selectivity	500 Hz bandwidth (3 db down); 3kHz wide at 65 db down
Transmitter-receiver Channel rating	50 db
Input Voltage	48, 125, or 250 V. d-c
Supply voltage variation	42-56V, 105-140V, 210-280V
Battery Drain:	
48 V.D.C.	0.5 amp standby, 1.35 amp transmitting
125 V.D.C.	0.25 amp standby, 1.1 amp transmitting
250 V.D.C.	1.5 amp standby or transmitting
Temperature range	−20 to +60°C around chassis

Frequency Spacing

The minimum recommended frequency spacing between two Type TC carrier sets operated in parallel without hybird units is shown on the curve of Fig. 12. For example, at 100 kHz, the minimum spacing is 8 kHz. Closer spacing would result in the generation of intermodulation products caused by the non-linear load presented by each transmitter to the other one.

The minimum frequency spacing between a TC carrier channel and an adjacent transmitter signal keyed on-off at a rate of 60 pulses per second can be determined from the nomograph of Fig. 13. Using the example shown by the dashed line, consider a type TC set used on a channel with a normal attenuation of 15 decibels. The TC receiver would be set to give a margin of 15 db below the normal received signal, or for a sensitivity of –30 db (relative to a 24.5 volt, 10-watt signal). The interfering signal is assumed to be a 10-watt transmitter at the same location. To determine the minimum frequency spacing of the TC receiver from this interfering signal, lay a straight edge between the –30 db point on the receiver sensitivity scale and the zero-dc point on the interfering transmitter scale. The resulting line crosses the channel spacing scale at 2 kHz. For this example, a channel spacing of at least 2 kHz should be used. (In order not to conflict with the limits of Fig. 12, an r-f hybrid may be needed between the TC set and the other transmitter, depending on the actual application.)

For protective relaying applications to 3-terminal lines, the transmitter frequencies are offset 100 hertz to prevent a slow beat or cancellation of the received signal when two transmitters send blocking signals to the third terminal. The three transmitters operate at fc, fc + 100 Hz, and fc –100 Hz. All receivers operate at the channel center frequency (fc).

INSTALLATION

The type TC transmitter-receiver is generally supplied in a cabinet or on a relay rack as part of a complete carrier assembly. The location must be free from dust, excessive humidity, vibration, corrosive fumes, or heat. The maximum ambient temperature around the chassic must not exceed 60°C.

ADJUSTMENTS

Transmitter

There are two adjustable controls on the transmitter printed-circuit board: (1) the power output control R112, and (2) base bias control R142 for transistors Q104 and Q105. The control R142 is factory adjusted for a quiescent (no-signal) current of 0.2 ± 0.05 ma. d.c. at terminal 2 of transformer T103. This applies a small amount of forward base bias to transistors Q104 and Q105 to minimize cross-over distortion. A thermistor (R141) is included for temperature compensation. This control (R142) need not be changed except as described in the MAINTENANCE section.

The other adjustment on the transmitter is the power output control R112 on the transmitter printed circuit board. Disconnect the coaxial cable from the assembly terminals and replace with a 50 to 70 ohm noninductive resistor of at least a 10-watt rating. Use the value of the expected input impedance of the coaxial cable and line tuner. If this is not known, assume 60 ohms. Connect the T106 output lead to the corresponding tap. Connect an a-c vacuum tube voltmeter (VTVM) across the load resistor. Turn the transmitter power output control R112 to minimum (full counterclockwise).

Now turn on the power switch on the panel and note the d-c voltage across the two pin jacks TP1 and TP2. If this is in the range of approximately 42 to 46 volts, throw the carrier-test switch SW101 on the panel to the ON position. Slowly advance the output control R112 on the transmitter printed circuit board until about 10 volts is obtained across the output load resistor. At this point, check the adjustment of the series output tuning coil L105 by loosening the knurled shaft-locking nut and moving the adjustable core in and out a small amount from its initial position. Leave it at the point of maximum voltage across the load resistor.

Now continue to advance the output control R112 until the output voltage tabulated in the following table is obtained across the load resistor. Recheck the setting of L105 to be sure it is at its maximum point for 10 watts output. Tighten the locking nut.

Note: For 200-300kHz sets, inductor L105 is a pot core and the foregoing adjustment check is generally unnecessary since there is little chance of its setting being disturbed. However, if desired, the pot core setting can be checked using a screwdriver to vary the setting of the adjustable core. There is no locking device as the adjustable core is held in place by friction.

Turn off the carrier test switch SW101, remove the load resistor, and reconnect the coaxial cable circuit to the transmitter.

T106	Voltage for 10 Watts Output
50	22.4
60	24.5
70	27.0

Transmitter Filter

Normally, the output filter (FL102) will require no readjustment except as noted under Adjustments-Transmitter, as it is factory tuned for maximum second and third harmonic rejection, and for series resonance (maximum output at the fundamental frequency) with a 60-ohm load. A small amount of reactance in the transmitter output load circuit may be tuned out by readjustment of the movable core of L105. This may be necessary with some types of line coupling equipment. The adjustable cores of L102 and L103 have been set for maximum harmonic rejection at the factory, and no change should be made in these settings unless suitable instruments are available for measuring the second and third harmonic present in the transmitter output.

Follow the procedure outlined in the line tuner instructions for its adjustment.

Receiver

The receiver board has two controls; the i.f. input control R239 which is factory-set to give a sensitivity of 40 mv. for 180 ma. output, and the local oscillator output control R212. The oscillator output is preset at the factory of 0.5 volt. This setting can be checked by connecting an a-c VTVM between receiver test points TP202 and TP206 (shield lead of VTVM). The voltmeter reading with the equipment energized, but not transmitting, should be 0.5 volt rms. Note Fig. 5 for location of components on the receiver printed board.

The other adjustment on the receiver is the gain control R207 which is front-panel mounted. It is recommended that the receiver gain normally be set for a 15-db operating margin to allow for reasonable variations in receiver input signal level without affecting the output blocking current. This adjustment can be made in two ways, as follows:

1. First, measure the normal received signal from the remote terminal (after the line tuners have been adjusted) by starting the remote transmitter and measuring the voltage across the coaxial cable at the receiving terminal. This signal should preferably be measured with a tuned voltmeter such as the Sierra carrier-frequency voltmeter. If a simple VTVM is used, have the remote transmitter tuned on and off several times to be sure the VTVM reading is actually the remote signal. Note the reading. Now disconnect the coaxial cable, and feed a signal into the carrier assembly at the coaxial terminals from a separate signal generator. Set the signal generator to the received frequency at a level 15 db below the previously measured incoming signal. With a 0-250 ma. (minimum) d-c milliammeter plugged into J203, adjust the receiver gain control unit an output current of about 100 ma, is obtained. As this point is on the steep portion of the receiver output-input curve, it may be difficult to set the gain control for exactly 100 ma. This is not necessary, however, as the signal is not normally at this value. This is the operating setting of the receiver gain control. Return the coaxial cable connections to normal.

   NOTE: Do not energize the local transmitter when making the foregoing adjustment as the signal generator may be damaged.

2. As an alternate procedure if no signal generator is available, the local transmitter itself may be used as the signal generator. First determine the normal received signal from the remote terminal as explained previously under (1). Then turn off the remote transmitter.

   Now turn on the local transmitter and reduce its output to a value 15 db below the normal received signal level. Then adjust the receiver gain control to give 100 ma. output as before. When this adjustment has been made, reset the local transmitter to its normal 10-watt output level.

In applications where the line attenuation is low and a strong signal is received, the adjustment of the receiver gain control R207 becomes critical. For such applications, the setting of i-f gain control R239 may be reduced to lower the overall receiver gain. The front-panel control R207 will then have a smoother and more gradual control as the knob is rotated, making it easier to obtain the 15-db margin setting. For such a strong-signal condition, it is recommended that with R207 at maximum, the i-f gain control R239 be adjusted to give 100 ma. receiver output current for an input r-f voltage 25 db below the normal received signal level. Then the front panel control R207 is set for the normal 15-db margin as previously described.

MAINTENANCE

Periodic checks of the received carrier signal will indicate impending failure so that the equipment can be taken out of service for correction. At regular maintenance intervals, any accumulated dust should be removed, particularly from the heat sinks. It is also desirable to check the transmitter power output and receiver sensitivity at such times, making any necessary readjustments to return the equipment to its initial settings.

Voltage values should be recorded after adjustment in order to establish reference values which will be useful when checking the apparatus. The readings will remain fairly constant over an indefinite period unless a failure occurs. However, if transistors are changed, there may be considerable difference in these readings without the overall performance being affected.

Typical voltage and current values are given in Table I through IV. Voltages should be measured with a VTVM. Readings may vary as much as ±20%.

Adjustment of R142 on Transmitter Board

The small adjustable resistor (pot.) R142 sets the forward base bias on transmitter transistors Q104 and Q105 to the proper point for class-B operation. This is a factory adjustment and need not be changed unless transistors Q104 or Q105 (or both) are replaced. However, if these transistors are changed, or if the R142 setting is disturbed in error, the following adjustment procedure should be followed to reset R142:

First remove d-c power from the TC carrier set assembly. Unsolder the lead from terminal 2 of transformer. T103 (just above FL101) and temporarily connect a low-range d-c milliammeter (0-1.0 or so) between the removed lead (+) and T103 terminal 2 (–). Turn the slotted control on the small pot (R142) to full counterclockwise. Now, apply power to the TC carrier set, but do not transmit carrier. Advance the pot until the d-c milliammeter reads 0.2 mA d.c. ± 0.05 mA. Turn off the power, remove the milliammeter, and solder the lead back on terminal 2 of T103. Again apply d-c power and proceed with the transmitter adjustment as described in the ADJUSTMENTS section.

Replacement of Q107-Q108

The two transistors Q107 and Q108 in the transmitter power-amplifier stage are a matched pair with the gain of the two units matched within 5%. If one of the transistors fails, both should be replaced with a new matched pair. This is necessary to keep the second harmonic of the transmitter output at an acceptabely low value. The pair of transistors * should be ordered as "2 of style 187A673H16 transistors."

CHANGE OF OPERATING FREQUENCY

The parts required for changing the operating frequency of a type TC carrier set are as follows:

Transmitter

1. Oscillator Crystal (Y101), specify frequency

   NOTE: Modify A-B-C jumpers on transmitter board if required for new frequency. See table marked "‡" under internal schematic (Fig. 7).

2. R136 Jumper

   For operation in 30-50kHz range, clip off R136 as indicated in Fig. 3.

3. Capacitors C111 & C113 (on Power Amp. board)

   a. 39-50 kHz – 0.47 mfd. – S#188A293H01
   b. 50.5-75 kHz – 0.22 mfd. – S#188A293H02
   c. 75.5-100 kHz – 0.15 mfd. – S#188A293H03
   d. 100.5-150 kHz – 0.10 mfd. – S#188A293H04
   e. 150.5-300 kHz – 0.047 mfd. – S#188A293H05

4. Transmitter Module Mounting Plate

   When changing from a frequency of 200kHz or below to a frequency above 200kHz, the following is also necessary:

   Transmitter module mounting plate S#691B610H01 and associated hardware.

   This is necessary to raise the transmitter printed circuit board (module) away from the main panel as the 200.5-300kHz receiver input filter FL201 mounts underneath it. See Fig. 2.

5. Zener Diode Z104

   For the 200.5-300kHz range, a type 1N2999B zener diode Z104 is mounted on the Q108 heat sink adjacent to the protective diode Z103. Remove the lead from the Q108 heat sink (see Fig. 2 for location) and connect it to the insulated terminal of zener diode Z104.

6. FL101 and FL102

   Filter FL101 is a small series-resonant tuned circuit between the driver and power amplifier stages of the transmitter. It has just two terminals. Filter FL102 is a larger assembly, described under OPERATION. It has three external connections: input, output, and ground. This filter is mounted by four corner posts. To replace, unsolder the three leads, remove the nuts from the mounting posts, and lift the filter assembly from the posts. The new filter can now be installed.

Inductors L101, L102, and L103 in these filters are adjustable over a limited range, but forty-two combinations of capacitors and inductors are required to cover the frequency range of 30 kHz to 300 kHz. The widths of the frequency groups vary from 1.5 kHz at the low end of the channel frequency range to 13 kHz at the upper end. A particular assembly can be adjusted over a somewhat wider range than the width of its assigned group since some overlap is necessary to allow for component tolerances. The nominal kHz adjustment ranges of the groups are:

30.0–31.5	72.5– 76.0	160.0–169.5
32.0–33.5	76.5– 80.0	170.0–180.0
34.0–36.0	80.5– 84.5	180.5–191.5
36.5–38.5	85.0– 89.0	192.0–200.0
39.0–41.0	89.5– 94.5	200.1–207.0
41.5–44.0	95.0–100.0	207.1–214.0
44.5–47.0	100.5–106.0	214.1–222.0
47.5–50.0	106.5–112.5	222.1–230.0
50.5–53.5	113.0–119.5	230.1–240.0
54.0–57.0	120.0–127.0	240.1–250.0
57.5–60.5	127.5–135.0	250.1–262.0
61.0–64.0	135.5–143.0	262.1–274.0
64.5–68.0	145.5–151.0	274.1–287.0
68.5–72.0	151.5–159.5	287.1–300.0

If the new frequency lies within the same frequency group as the original frequency, the filters can be readjusted. If the frequencies are in different groups, it is possible that changes only in the fixed capacitors may be required. In general, however, it is desirable to order complete filter assemblies adjusted at the factory for the specified frequency.

A signal generator, a frequency counter, and a vacuum-tube voltmeter are required for readjustment of FL101. The signal generator and the counter should be connected across terminals 4 and 5 of transformer T103 and the voltmeter across terminals 1 and 2 of transformer T104. The signal generator should be set at the channel center frequency and at 2 at 3 volts output. The core screw of the small inductor should be tuned to the position that gives a true maximum reading on the VTVM. Turning the screw to either side of this position should definitely reduce the reading. The change in inductance with core position is less at either end of the travel than when near the center and consequently the effect of core screw rotation on the VTVM reading will be less when the resonant inductance occurs near the end of core travel.

The procedure for readjustment of the 2nd and 3rd harmonic traps of filter FL102 is somewhat similar. A signal generator and a counter should be connected to terminals 3 and 4 of transformer T105 and a 500-ohm resistor and a VTVM to the terminals of protective gap G101. The ground or shield lead of all instruments should be connected to the grounded terminal of the transformer. Set the signal generator at exactly twice the channel center frequency and at 5 to 10 volts output. Turn the core screw of the large inductor, L102, to the position that gives a definite minimum reading on the VTVM. Similarly, with the signal generator set at exactly three times the channel center frequency and 5 to 10 volts output, set the core screw of the small inductor, L103, to the position that gives a definite minimum reading on the VTVM. Then remove the instruments and the 500-ohm resistor.

If the change in frequency is enough to require a different filter, it will come factory adjusted as described in the foregoing paragraph.

After all the tabulated changes have been made for the new frequency, the transmitter can be operated with a 50 to 70-ohm load (depending on which tap of T106 is used) connected to its output, and inductor L105 can be readjusted for maximum output at the changed channel frequency by the procedure described in the ADJUSTMENT section.

If a frequency-sensitive voltmeter is available, the second and third harmonic traps may be adjusted (or checked) without using an oscillator as a source of double and triple the channel frequency. Connect the frequency-sensitive voltmeter from TP109 to ground and adjust the transmitter for rated output into the selected load resistor. Set the voltmeter at twice the channel frequency and, using its tuning dial and db range switch, obtain a maximum on-scale reading of the second harmonic. Then vary the core position of L102 until a minimum voltmeter reading is obtained. Similarly, tune the voltmeter to the third harmonic and adjust L103 for minimum voltmeter reading. It should be noted that this procedure may not give the true magnitude of the harmonics because of the large value of fundamental frequency voltage present at the tuned voltmeter input terminals. This condition will overload the input circuit of some commercial instruments. However, the procedure is satisfactory for adjusting the traps for maximum harmonic rejection.

If accurate measurement of the harmonic levels is desired, the frequency-selective voltmeter is connected, through a rejection filter, to the terminals of the 60-ohm load resistor. The filter must provide high rejection of the fundamental. A twin-T filter is suitable for this purpose. The insertion losses of this filter at the second and third harmonics must be measured and taken into account.

TABLE I
Receiver D.C. Measurements

Note: All voltages are negative with respect to Pos. 45V. (TP206).

TEST POINT	STANDBY (No Signal)			WITH 40 M.V. INPUT		
TP201	35-38			35-38		
TP202	0			0		
TP203	11-12			11-12		
TP204	< 0.5			2- 3		
TP205	18-22			18-22		
TRAN-SISTOR	E*	B*	C*	E*	B*	C*
Q201	36.5	37	42.0	36.5	36	42.0
Q202	36.5	37.5	43.0	36.0	35.5	43.0
Q203	<0.5	0	18.0	<0.5	0	18.0
Q204	2.1	2.75	18.0	2.7	2.9	18.0
Q205	2.2	2.8	18.0	2.5	2.7	18.0
Q206	2.2	2.8	11.0	2.6	2.8	11.5
Q207	<0.5	<0.5	22.0	2.0	2.2	5.0
Q208	<0.5	<0.5	44.0	11.7	2.0	2.0

*E – Emitter, B – Base, C – Collector
All voltages read with d-c vacuum-tube voltmeter.
<0.5 means "less than 0.5V."

* TABLE II
Receiver RF Measurements

Note: Taken with 100kHz receiver filter, 0.040 volt input signal, and gain control R207 at maximum. Depending on receiver frequency and transistor characteristics, the following values will vary appreciably.

TEST POINT	TYPICAL A-C VOLTAGE
FL201-IN to Gnd.	0.020
FL201-OUT to Gnd.	0.027
Q203 - E to TP206	0.047
Q203- C to TP206	1.650
Q204 - B to TP206	0.012
Q204 - C to TP206	0.200
Q205 - B to TP206	0 .007
Q205 - C to TP206	0.380
Q206 - B to TP206	0.110
Q206 - C to TP206	2.350
TP202 to TP206	0.500

All voltages read with a-c vacuum-tube voltmeter.

TABLE III

Transmitter D-C Measurements

Note: All voltages are positive with respect to Neg. DC.(TP104). All voltages read with d-c VTVM.

TEST POINT	CARRIER OFF	CARRIER ON
TP101	8.5 volts d.c.	8.5 volts d.c.
TP102	<0.5	20
TP103	<0.5	19.5
TP105	<0.5	9
TP106	44	24
TP107	44	24
TP108	45	44
TP110	0.65	0.7
TP111	0.65	0.7
TP112	0	<0.5
TP113	45	44
J101 (Front Panel)	5 ma. max.	0.6 amp.

TRAN-SISTOR	E	B	C	E	B	C
Q101	7.8	7.9	2.0	7.8	7.8	1.8
Q102	8.1	8.7	1.0	8.1	8.7	1.0
Q103	<0.5	<0.5	<0.5	20.0	20.0	9.0
Q104	<0.5	0.6	45	<0.5	0.75	44
Q105	<0.5	0.6	45	<0.5	0.75	44
Q106	0	<0.5	44.5	0	0.8	1.2
Q107	44.3	44.2	0	24	24	0
Q108	45.0	44.7	44.5	44.2	44.0	24.2

Receiver

1. Receiver Oscillator Crystal (Y201), specify frequency, and modify A-B-C jumpers as required.
2. Receiver input filter (FL201), specify frequency.
3. Resistors R211-R238 Combination
   See values in Fig. 7 below internal schematic.
4. If the operating frequency is reduced, the receiver gain will probably be higher. In this case, a reduction in the setting of the i-f input control R239 will give the 40-mv. sensitivity. If the new operating frequency is higher, the receiver gain may be lower.

TABLE IV

Transmitter RF Measurements

Note: "Carrier-on" voltages taken with transmitter set to 10 watts output (24.5 volts across 60 ohms). These voltages subject to variation, depending on frequency and transistor characteristics.

TEST POINT	A-C VOLTAGE
T101-3 to TP104	1.5 volts, rms.
TP103 to TP102	0.2
Q103-C to TP104	1.1 ϕ
TP110 to T102-4	0.2
TP111 to T102-4	0.2
Q104-C to TP104	3.3
Q105-C to TP104	3.3
T103-4 to Gnd.	1.1
T104-1 to Gnd.	1.4
Q107-B to TP107	0.5 volts, rms.
Q108-B to TP113	0.5
Q107-C to TP107	14-16
Q108-C to TP113	14-16
T105-4 to Gnd.	105
T106-2 to Gnd.	100-160 *
TP109 to Gnd.	30-50 *
J102 to Gnd.	24.5

Note: T101-3 = tap 3 of Transformer T101
Q104-C = Collector of Transistor Q104
TP105 = Test point 105
All voltages read with a-c VTVM
* These values may vary considerably with frequency.
ϕ High impedance circuit. VTVM causes significant loading.

Recommended Test Equipment

I. Minimum Test Equipment for Installation
   a. Milliammeter 0-250 ma. DC
   b. 60-ohm 10-watt non-inductive resistor.
   c. A-C Vacuum Tube Voltmeter (VTVM). Voltage range 0.01 to 30 volts, frequency range 60 Hz to 330 kHz input impedance – one megohm, minimum.

d. D-C Vacuum Tube Voltmeter (VTVM).

Voltage Range:	0.1 to 300 volts
Input Impedance:	1.0 megohm, min.

II. Desirable Test Equipment for Apparatus Maintenance.

a. All items listed in I.

b. Signal Generator

Output Voltage:	up to 10 volts r.m.s.
Frequency Range:	20 to 330 kHz

c. Oscilloscope

d. Ohmmeter

e. Capacitor checker

f. Frequency counter

g. Frequency-selective voltmeter

Renewal Parts

Repair work can be done most satisfactorily at the factory. However, replacement parts can be furnished, in most cases, to customers who are equipped for doing repair work. When ordering parts, always give the complete nameplate data.

ELECTRICAL PARTS LIST

Transmitter Section

SYMBOL	RATING	STYLE NUMBER
C101	0.1 mfd, 200 V. DC	187A624H01
C102	.005 mfd, 300 V. DC	187A694H29
C103	180 pf. 500 V. DC	187A695H29
C104	0.25 mfd, 200 V. DC	187A624H02
C105	0.25 mfd, 200 V. DC	187A624H02
C106	0.25 mfd, 200 V. DC	187A624H02
C107	0.25 mfd, 200 V. DC	187A624H02
C108	0.50 mfd, 200 V. DC	187A624H03
C109	0.25 mfd, 200 V. DC	187A624H02
C110	0.25 mfd, 200 V. DC	187A624H02
† C111	(See Table Below)	–
C112	39 pfd, 500 V. DC	187A695H12
† C113	(See Table Below)	–
C114	100 pf. 500 V. DC	187A695H23
C115	100 pf. 500 V. DC	187A695H23
C116	0.001 mfd, 500 V. DC	187A694H11
CA	Part of FL101	Vary with Frequency
CB, CC, CD, CE	Part of FL102	Vary with Frequency
† FREQ.	C111, C113	Style Number
30 - 50 kHz	0.47 mfd, 400 V. DC	188A293H01
50.5- 75 kHz	0.22 mfd, 400 V. DC	188A293H02
75.5-100 kHz	0.15 mfd, 400 V. DC	188A293H03
100.5-100 kHz	0.1 mfd, 400 V. DC	188A293H04
150.5-300 kHz	0.047 mfd, 400 V. DC	188A293H05
D101	1N457A	184A855H07
D103	1N4818	188A342H06
D104	1N91	182A881H04
D005	1N4818	188A342H06
D106	1N91	182A881H04
G101	Type RVS Arrester	632A026A01
J101	Closed Circuit Jack	187A606H01
J102	Banana Plug Jack	2 of 185A431H01
J103	Coaxial Cable Jack	187A633H01
J104	24-Term Receptacle	187A699H01
J105	12-Term Receptacle	629A205H02

ELECTRICAL PARTS LIST

Transmitter Section (Cont.)

SYMBOL	RATING	STYLE NUMBER
L101	Part of FL101	
L102	FL102 Trap Coil (2nd Harmonic)	Vary with Frequency
L103	FL102 Trap Coil (3rd Harmonic)	
L104	400 mh.	292B096G01
L105	FL102 Coil (part of series-resonant circuit tuned to fundamental freq.)	Vary with Frequency
L106	2MH	3500A27H01
Q101	2N2905A	762A672H10
Q102	2N2905A	762A672H10
Q103	2N525	184A638H13
Q104	2N3712	762A672H07
Q105	2N3712	762A672H07
Q106	TI-481	184A638H11
Q107	2N3792 Matched Pair	187A673H16
Q108	2N3792	187A673H16

SYMBOL	OHMS	± TOL %	WATTS	STYLE NUMBER
R101	5,600	5	1	187A643H45
R102	2,200	10	0.5	187A641H35
R103	10,000	10	0.5	187A641H51
R104	100,000	5	0.5	184A763H75
R105	390	5	0.5	184A763H17
R106	1,200	5	0.5	184A763H29
R107	10,000	10	0.5	187A641H51
R108	100,000	5	0.5	184A763H75
R109	390	5	0.5	184A763H17
R111	1,200	5	0.5	187A763H29
R112	1 K Pot	20	0.25	629A430H02
R113	4,700	5	0.5	184A763H43
R114	10,000	10	0.5	187A641H51
R115	150	5	0.5	184A763H07
R116	100	5	0.5	184A763H03
R117	1,000 48 V dc	5	25	1202588
	3,750 125 V dc	5	25	1202955
	8,500 250 V dc	5	25	1267310

ELECTRICAL PARTS LIST

Transmitter Section (Cont.)

SYMBOL	OHMS	±TOL %	WATTS	STYLE NUMBER
R118	10,000	2	0.5	629A531H56
R119	62	2	0.5	629A531H03
R120	10,000	5	2	185A207H51
R121	10	5	2	187A683H01
R122	10	5	0.5	187A290H01
R123	10	10	0.5	187A290H01
R124	100	10	1	187A644H03
R125	1,000	10	0.5	187A641H27
R126	4,700	10	1	187A644H43
R127	10	10	0.5	187A640H01
R128	2,200	5	1	187A644H35
R129	2.7	10	0.5	184A636H14
R130	10	10	0.5	187A640H01
R131	4,700	5	1	187A644H43
R132	2.7	10	0.5	184A636H14
R133	0.27	10	1	184A636H18
R134	0.27	10	1	184A636H18
R135	3,000	10	5	188A317H01
R136	12,000	10	0.5	184A763H53
R137	15,000	10	2	187A642H55
R138	1,000	10	0.5	187A641H27
R139	1,000	10	0.5	187A641H27
R140	68	2	0.5	629A531H04
R141	30	Type 3D202 Thermistor		185A211H06
R142	25K Pot	20	1/8	629A430H13
R143	20K	2	0.5	629A531H63

SYMBOL	RATING	STYLE NUMBER
T101	10,000/400 ohms	205C043G01
T102	10,000/400 c.t.	714B666G01
T103	1930/60 ohms L633000	1962694
T104	Turns ratio, 1/0.5, Pri-/each sec.	292B526G01
T105	10/500 ohms	292B526G02
T106	500/50 - 60 - 70 ohms	292B526G02
Y101	30-300 kHz crystal per 328C083	Specify Frequency
Z101	Zener Diode 1N5357B (20V. ±5%)	862A288H03
Z102	Zener Diode 1N2999B (56V. ±5%)	629A798H04
Z103	Zener Diode 1N2999B (56V. ±5%)	629A798H04
Z104	Zener Diode 1N2999B (56V. ±5%)	629A798H04

ELECTRICAL PARTS LIST

Receiver Section

SYMBOL	RATING	STYLE NUMBER
C201	0.1 mfd., 200 V. DC	187A624H01
C202	300 pf. 500 V. DC	187A695H35
C203	180 pf. 500 V. DC	187A695H29
C204	0.25 mfd., 200 V. DC	187A624H02
C205	0.25 mfd., 200 V. DC	187A624H02
C206	0.25 mfd., 200 V. DC	187A624H02
C207	0.25 mfd., 200 V. DC	187A624H02
C208	0.25 mfd., 200 V. DC	187A624H02
C209	0.25 mfd., 200 V. DC	187A624H02
C210	0.25 mfd., 200 V. DC	187A624H02
C211	0.1 mfd., 200 V. DC	187A624H01
C212	0.25 mfd., 200 V. DC	187A624H02
C213	2.0 mfd., 200 V. DC	187A624H05
C214	0.25 mfd., 200 V. DC	187A624H02
C215	39 pfd., 500 V. DC	187A695H12
C216	200 pfd. 500 V. DC	762A757H11
D201	1N457A	184A855H07
D202	1N457A	184A855H07
D203	1N4818	188A342H06
D204	1N4818	188A342H06
FL201	Receiver Input Filter 30-300 kHz	Specify Frequency
FL202	Receiver i.f. Filter - 20kHz (2 sections)	762A613G01
J201	Receiver Coax. Input Jack	187A638H01
J202	Closed Circuit Jack (20MA)	187A606H01
J203	Closed Circuit Jack (200MA)	187A606H01
L201	33 mh.	187A599H02
Q201	2N2905A	762A672H10
Q202	2N2905A	762A672H10
Q203	2N2905A	762A672H10
Q204	2N2905A	762A672H10
Q205	2N2905A	762A672H10
Q206	2N2905A	762A672H10
Q207	2N3645	849A441H01
Q208	2N4903	187A673H13

ELECTRICAL PARTS LIST

Receiver Section (Cont.)

SYMBOL RESISTORS	RATING			STYLE NUMBER
	OHMS	± TOL. %	WATTS	
R201	10,000	10	0.5	187A641H51
R202	2,200	10	0.5	187A641H35
R203	10,000	10	0.5	187A641H51
R204	100,000	5	0.5	184A763H75
R205	390	5	0.5	185A763H17
R206	1,200	5	0.5	184A763H29
R207	25 K Pot.	10	2	185A086H07
R208	10,000	10	0.5	187A641H51
R209	100,000	5	0.5	184A763H75
R210	390	5	0.5	184A763H17
R211	51	5	0.5	187A290H18
R212	1 K Pot.	20	0.25	629A430H02
R213	1,200	5	0.5	184A763H29
R214	5,600	5	1	187A643H45
R215	20,000	5	0.5	184A763H58
R216	3,600	5	0.5	184A763H40
R217	620	5	0.5	184A763H22
R218	33	5	0.5	187A290H13
R219	10,000	10	0.5	187A641H51
R220	20,000	5	0.5	184A763H58
R221	1K	5	0.5	184A763H27
R222	3,600	5	0.5	184A763H40
R223	620	5	0.5	184A763H22
R224	33	5	0.5	187A290H13
R225	10,000	10	0.5	187A641H51
R226	20,000	5	0.5	184A763H58
R227	1K	5	0.5	184A763H27
R228	3,600	5	0.5	184A763H40
R229	620	5	0.5	184A763H22
R230	10	5	0.5	187A290H01
R231	2,000	5	0.5	184A763H34
R232	1,200	5	2	185A207H29
R233	4,700	10	2	187A642H43
R234	5,100	5	0.5	184A763H44
R235	470	10	1	187A644H19
R236	4,700	10	1	187A644H43

ELECTRICAL PARTS LIST

Receiver Section (Cont.)

SYMBOL	OHMS	RATING ±TOL.%	RATING WATTS	STYLE NUMBER
R237	170	5	40	1336074
R239	1 K Pot	20	0.25	629A430H02
R240	50	Sensistor	0.25	187A685H08
T201	10,000/100 Ohms			714B666G01
T202	10,000/400 Ohms			205C043G01
T203	25K/300 Ohms			205C043G03
Y201	50-320kHz Crystal per 328C083			Specify Frequency
Z201	1N3027B (20V ±5%)			184A449H07
Z202	1N1789 (56V ±10%)			584C434H08

Power Supply Section

SYMBOL	FUNCTION	DESCRIPTION OR RATING	STYLE NUMBER
C1	(+) to (–) bypass	0.45 mfd. 330 VAC	1723408
C2	A-C grounding	0.5 mfd. 1500 VDC	1877962
C3	A-C grounding	0.5 mfd. 1500 VDC	1887962
F1, F2	Overload Protection	1.5a, 48/125 VDC	11D9195H26
F1, F2	Overload Protection	2.0a, 250 VDC	478067
PL1	Neon Pilot Light 125/250 Volts	120 Volts	183A955H01
PL1	Filament-type for 48 Volts	55 Volts	187A133H02
Q1	Series Regulator	Type 2N6295 Silicon Transistor	3503A41H01
R1	125V: Series dropping	26.5 ohms, 3½"	04D1299H44
R2	125V: Series dropping	Same as R1	04D1299H44
R3	125V: Current limiting	500 ohms, 3½"	1268047
	48V: For 48 VDC, R1 = R2 = 0	–	–
	48V: R3 = 26.5 ohms	3½"	04D1299H44
R4	Current limiting	100K, 0.5 watt	184A763H75
SW1	Power Switch	3a, 250V. AC-DC 6a, 125V. AC-DC	880A357H01
SW101	Carrier Test	Same as SW1	880A357H01
TP1	Test Point (+)	Pin Jack – red	187A332H01
TP2	Test Point (–)	Pin Jack – black	187A332H02
Z1	Voltage Regulator	1N2828B (45V.)	184A854H06
Z2	Surge Protection	1N3009A (130V.) Zener Diodes	184A617H12
Z3	Voltage Reg. for 250V.	1N2813B (15V.)	184A854H11

† R238 - omit above 50kHz – 22K, 30-50kHz, S#187A641H59

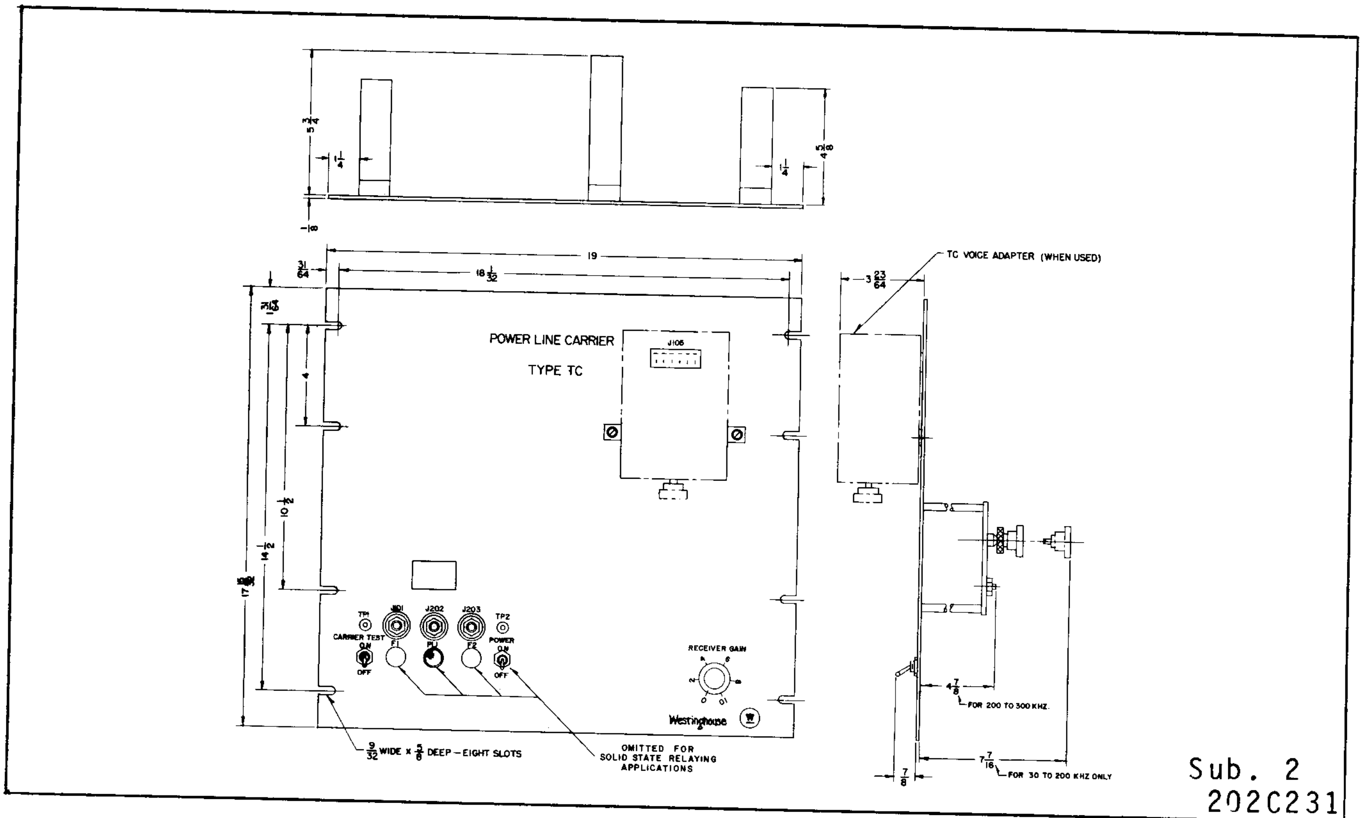


Fig. 1 Type TC Carrier Assembly – Outline

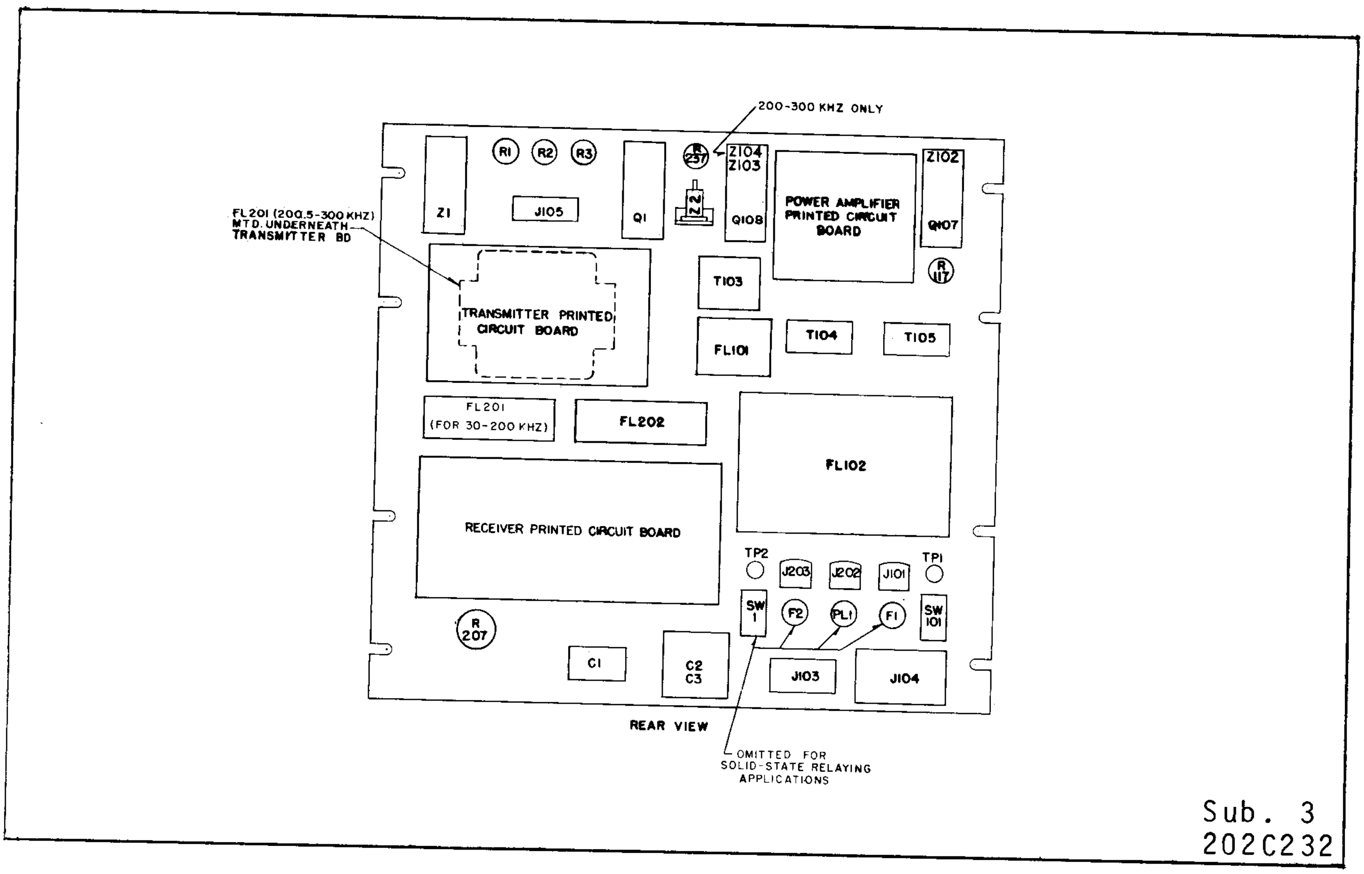


Fig. 2 Type TC Carrier Assembly – Parts Location

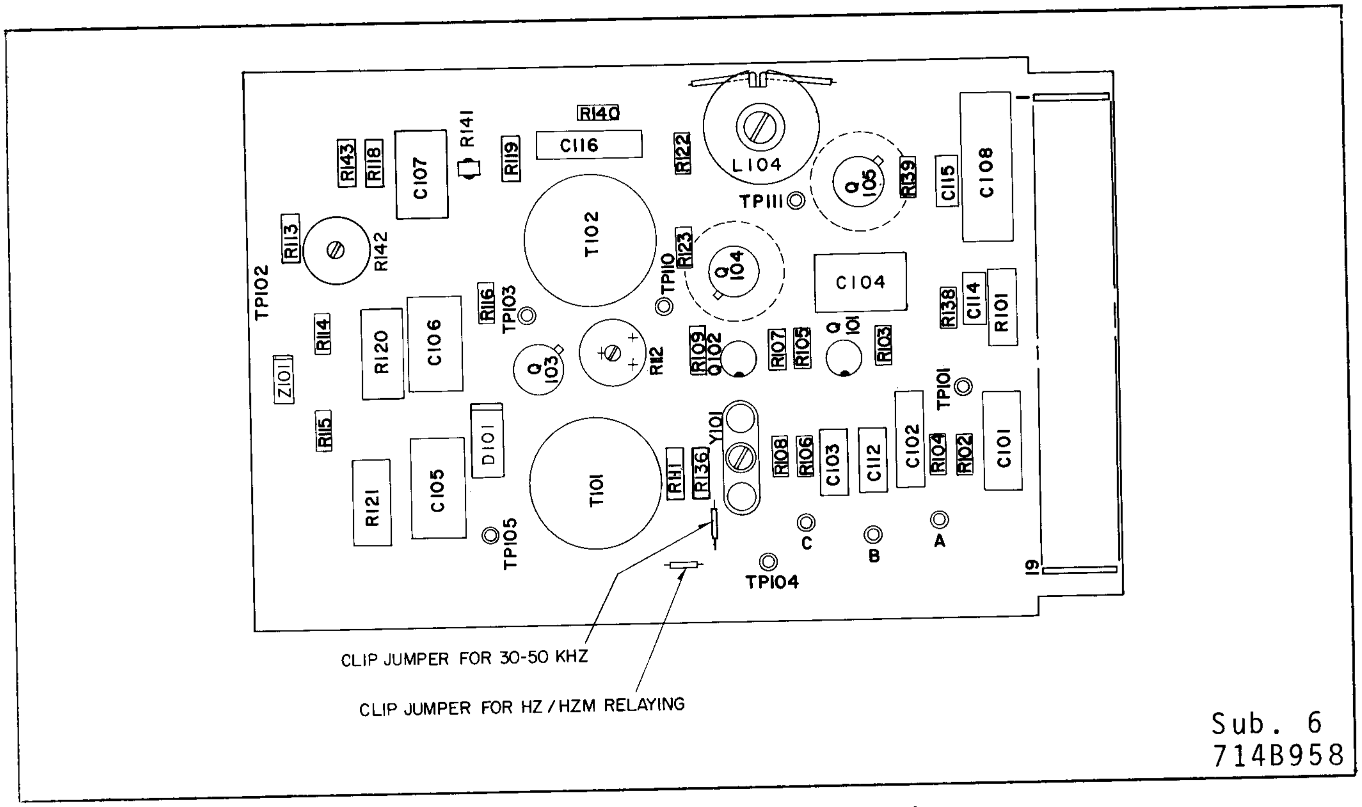


Fig. 3 Transmitter Printed Circuit – Parts Location

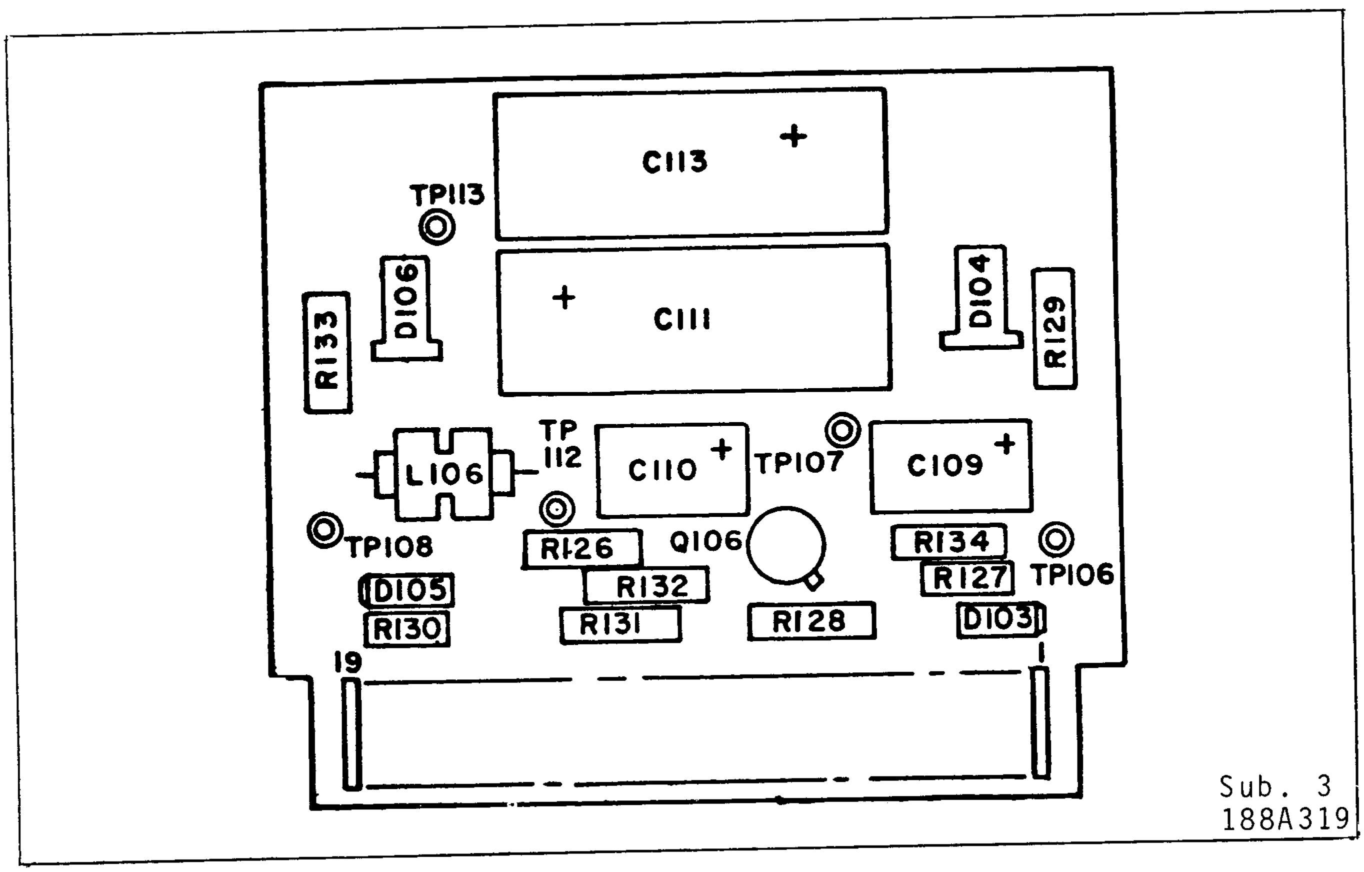
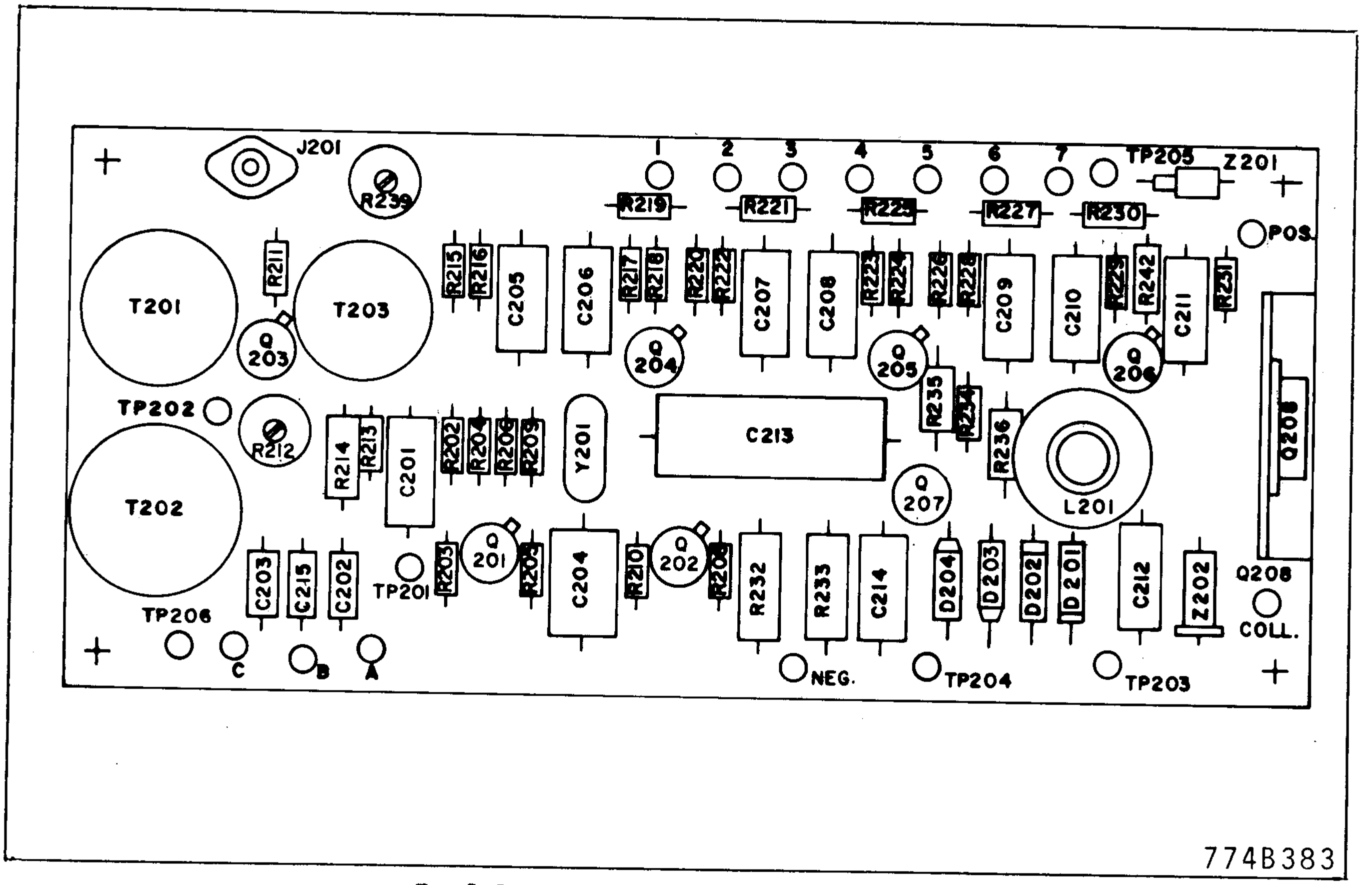


Fig. 4 Power Amplifier Printed Circuit – Parts Location



* *Fig. 5 Receiver Printed Circuit – Parts Location*

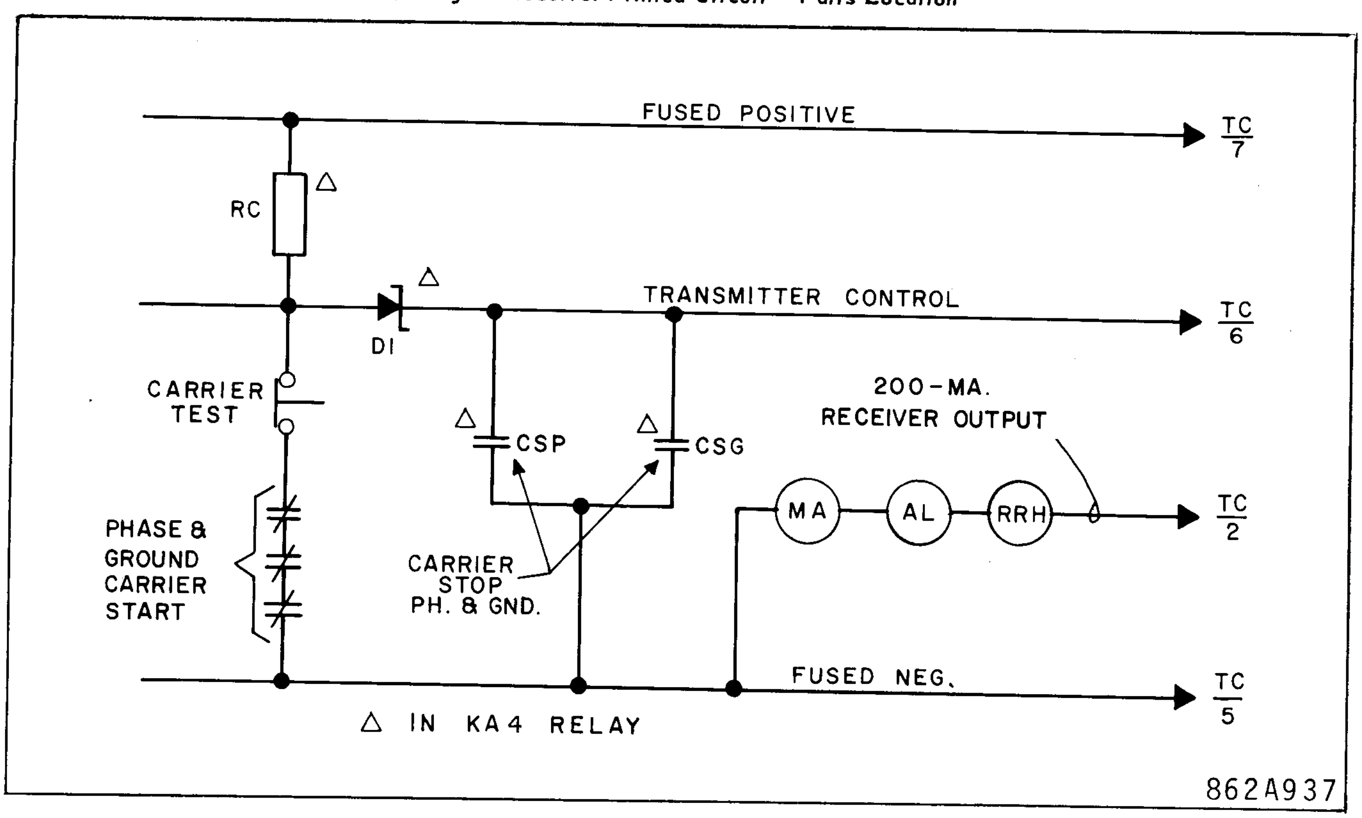


Fig. 6 Elementary K-Dar Carrier Control Circuits

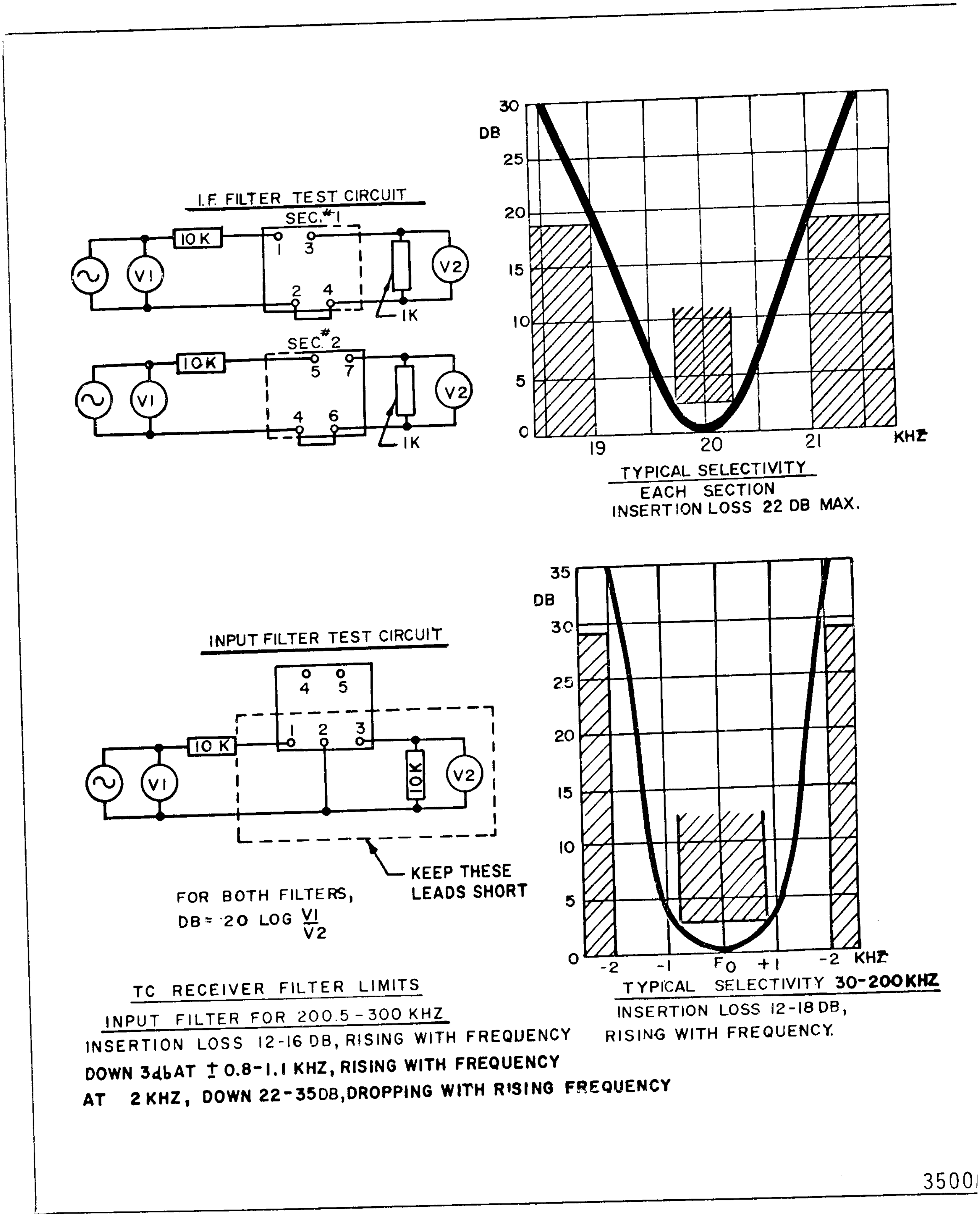


Fig. 8 Receiver Filter Characteristics

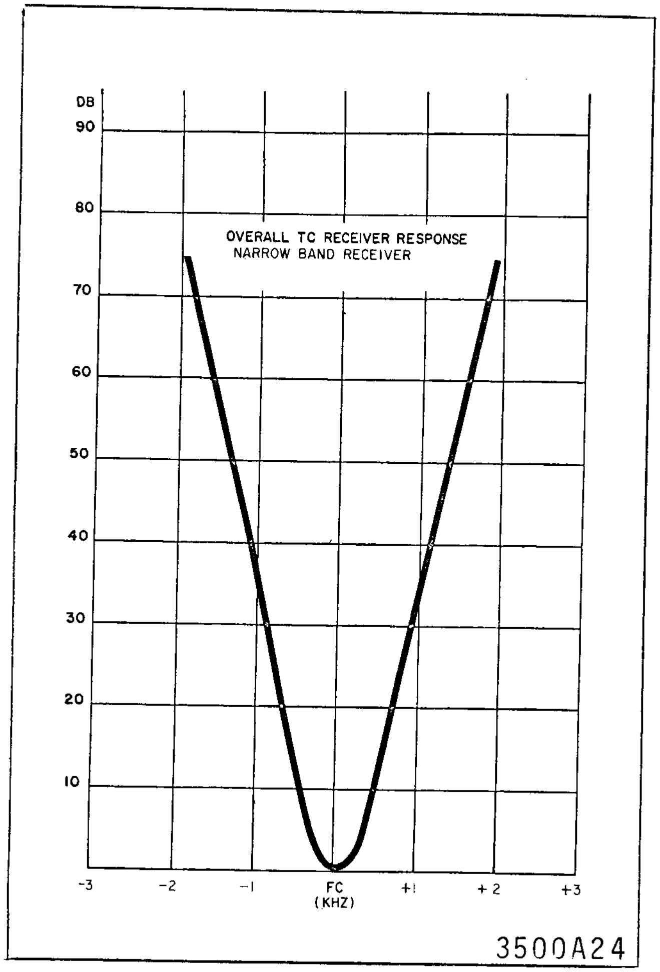


Fig. 9 Overall Selectivity Curve 3500A24

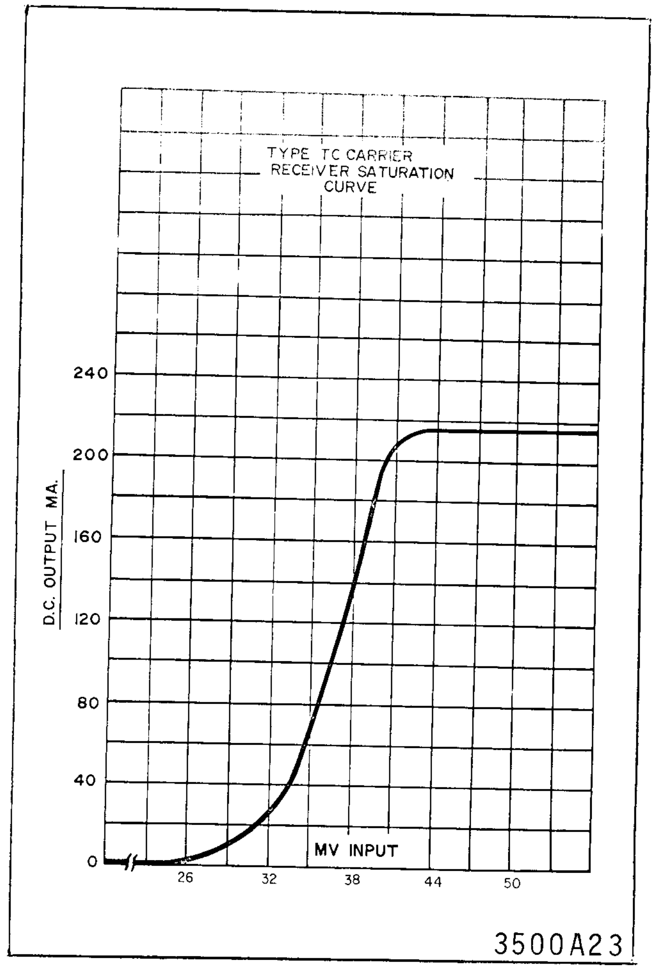


Fig. 10 Receiver – 200 ma. Output Characteristic.

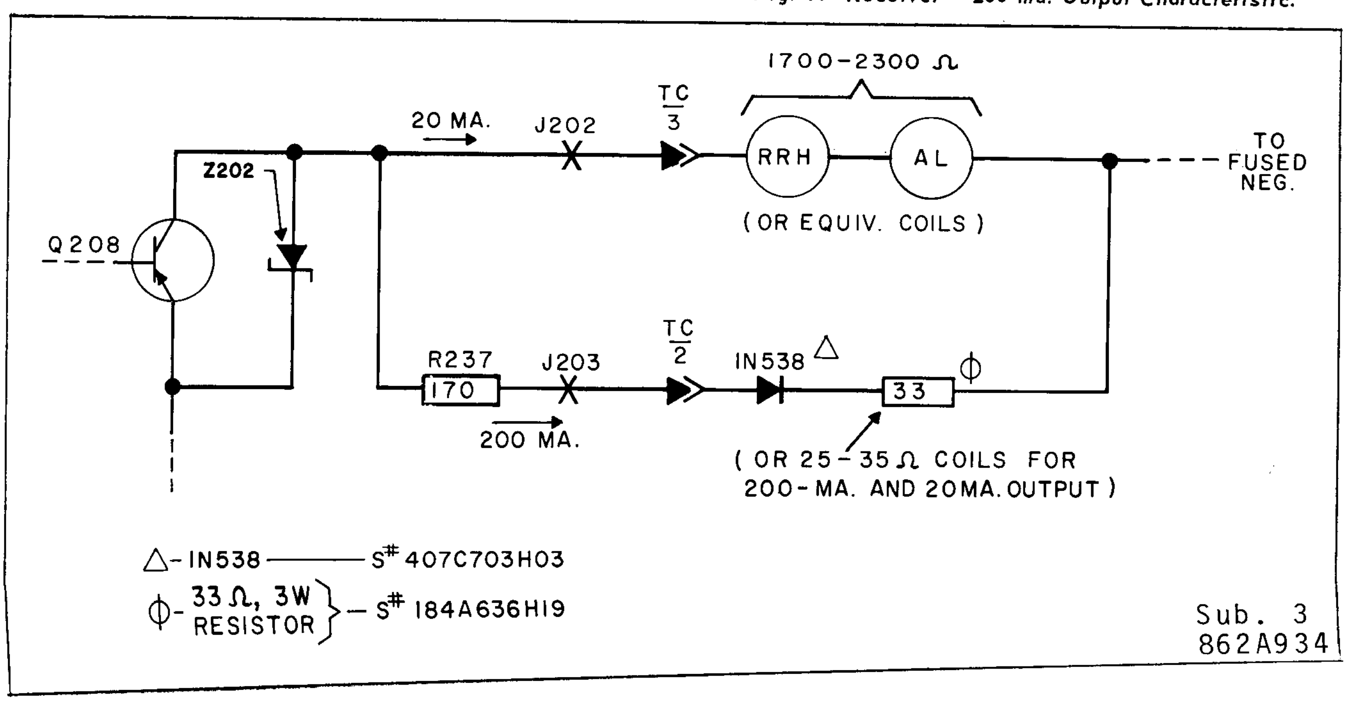


Fig. 11 TC Receiver Output for 20-ma. Operation

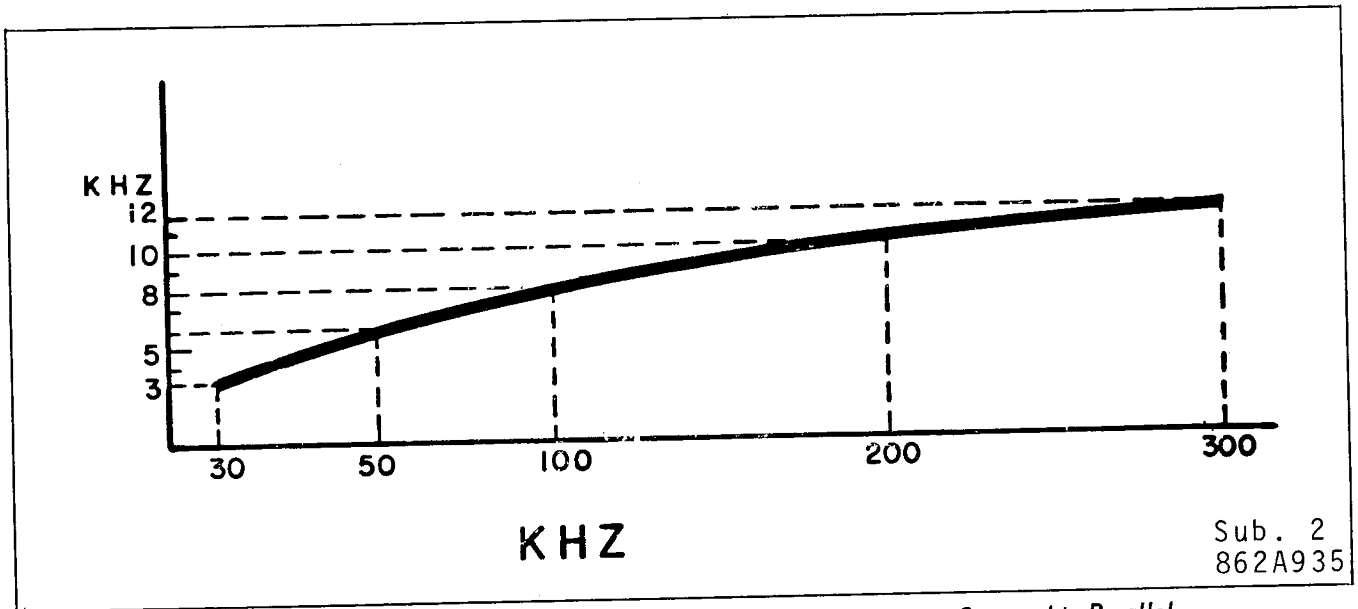


Fig. 12 Minimum Frequency Spacing for Two 10-Watt Transmitters Operated in Parallel.

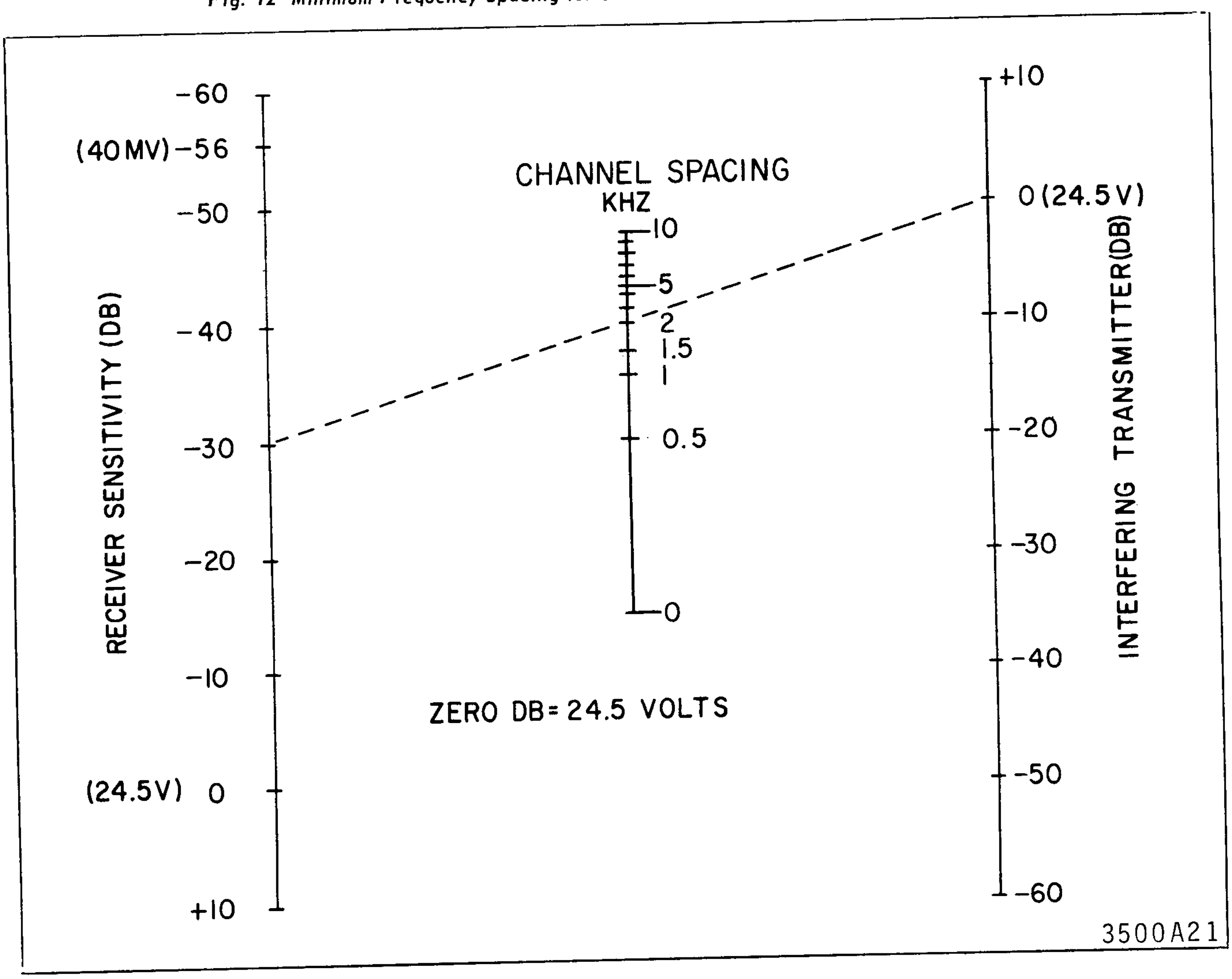


Fig. 13. Minimum Channel Spacing for Keyed Carrier 60 p.p.s.

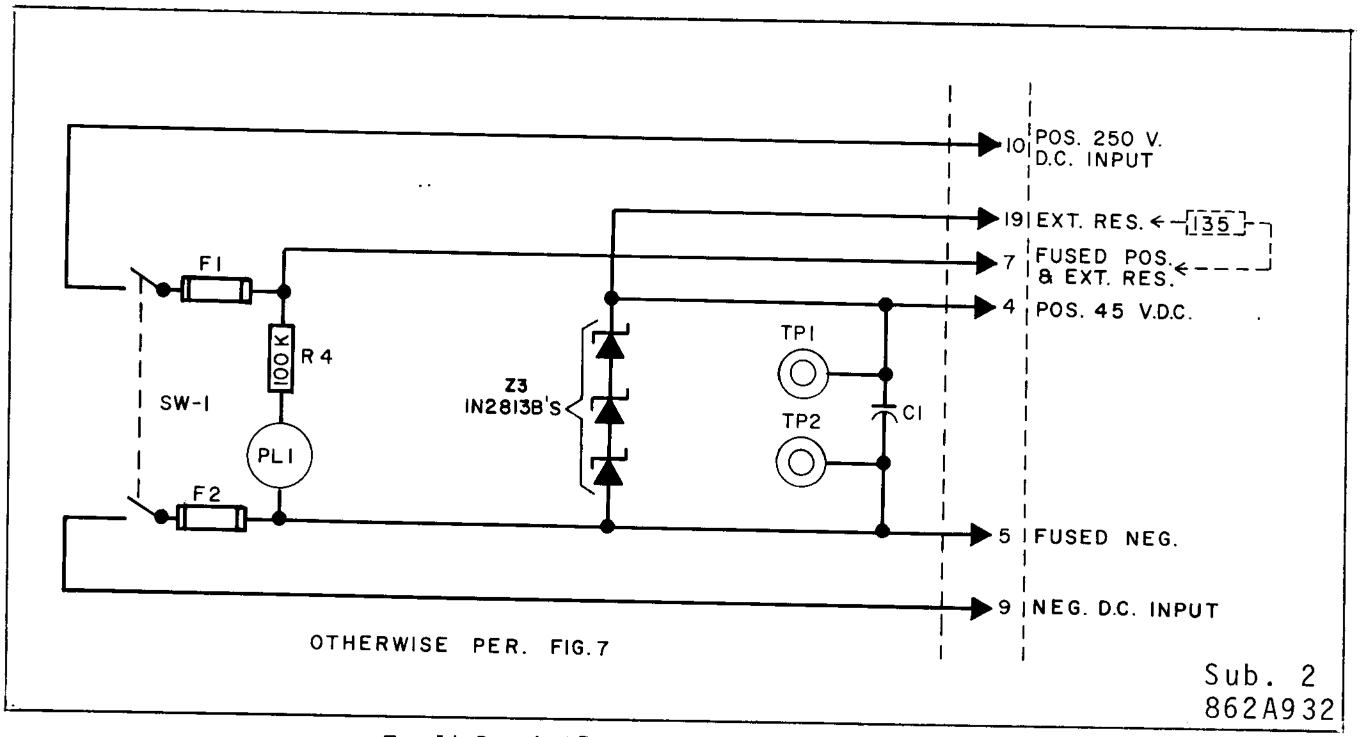


Fig. 14 Detail of Power Supply Section for 250-volt Supply

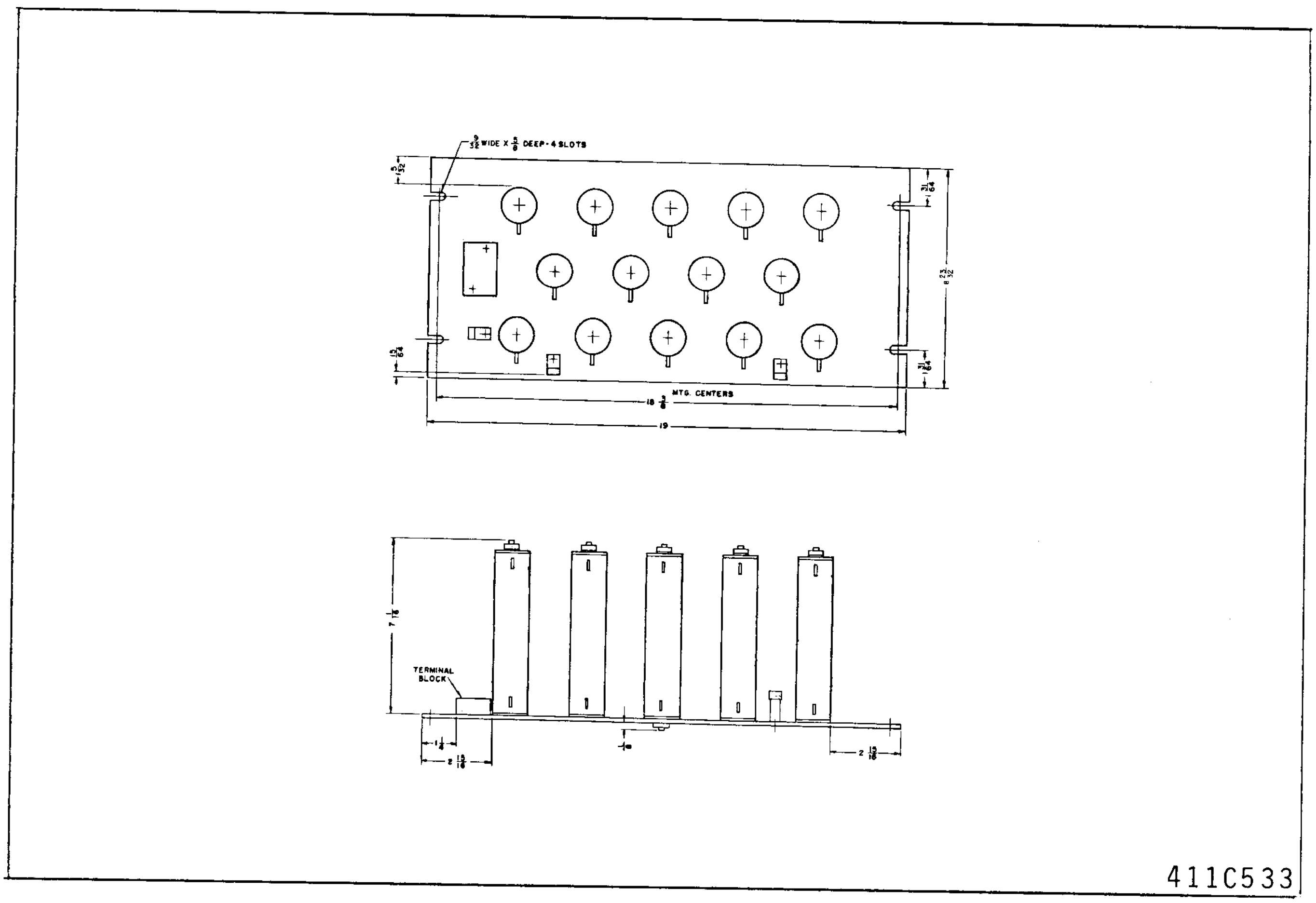


Fig. 15 Outline of External Resistor Unit for 250-Volt Operation.

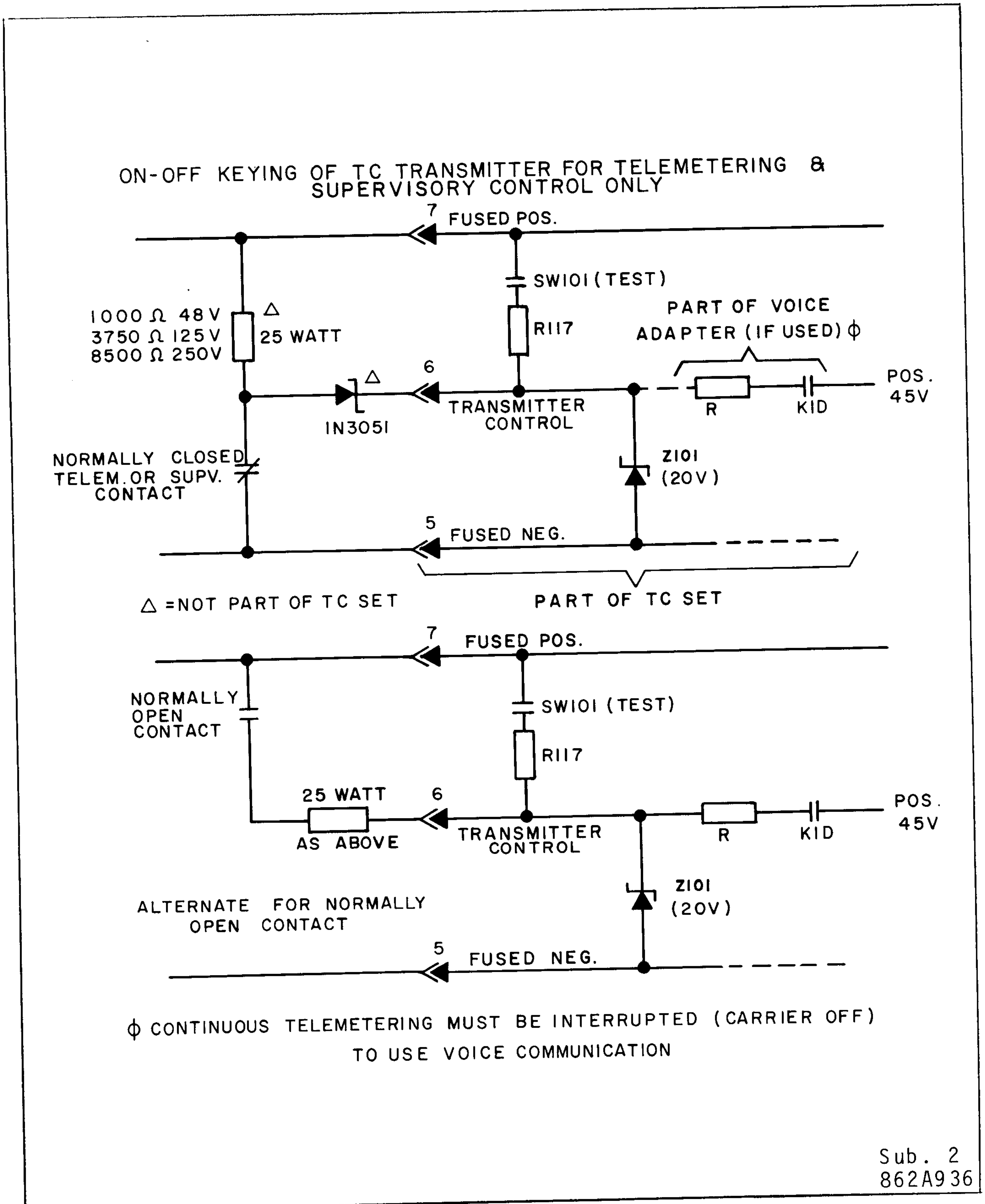


Fig. 16 External Circuitry For On-Off Keying of Type TC Transmitter For Telemetering or Supervisory Control (Without Protective Relaying) From Either Normally-Closed or Normally-Open Contact.

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