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#10038

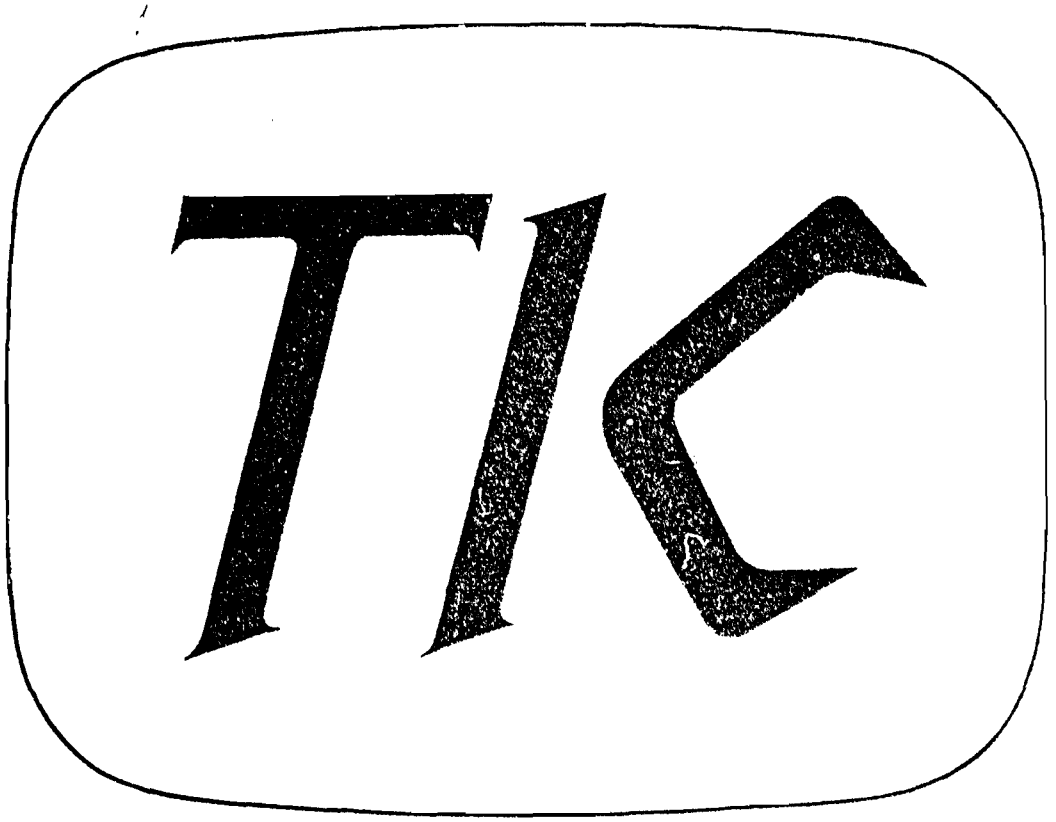
T.O. 33A1-5-361-21

TYPE T-30/30B/30B/B

VOR/ILS

RAMP TEST SET

INSTRUCTION MANUAL



TEL-INSTRUMENT ELECTRONICS CORP

AVIATION DIVISION

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U.S.A.

AIR FORCE 9-7-80-100

15 MAY 1980

T-3Ø, -30B, -30B/B

112021A

T-30/T-30B/T-30B/B

ADDENDU M

The following changes have been approved by the Tel-Instrument Electronics Corp. Engineering Department.

Due to extended delivery of the potentiometers normally used in these units, as shown on the Parts List in this manual, TIC has been forced to use substitute potentiometers in order to meet our scheduled shipping commitments.

A different style of Allen-Bradley potentiometer and some made by Beckman Instrument are being substituted. The following table furnishes the interchangeability information.

ALLEN-BRADLEY ZV TYPE (AS INDICATED ON PARTS LIST)			BECKMAN INST. TYPE (USED AS A SUBSTITUTE)	ALLEN-BRADLEY TYPES A2B & SV (USED AS A SUBSTITUTE)	
2K	ZV2021	(T-28A & B, T-29A & B)	62P-R2K	A2B202	SV2021
10K	ZV1031	(T-26A & B, T-27A & B, T-28A & B, T-29A & B)	62P-R10K	A2B103	SV1031
20K	ZV2031	(T-27A & B, T-28A & B, & T-29A & B)	62P-R20K	A2B203	SV2031

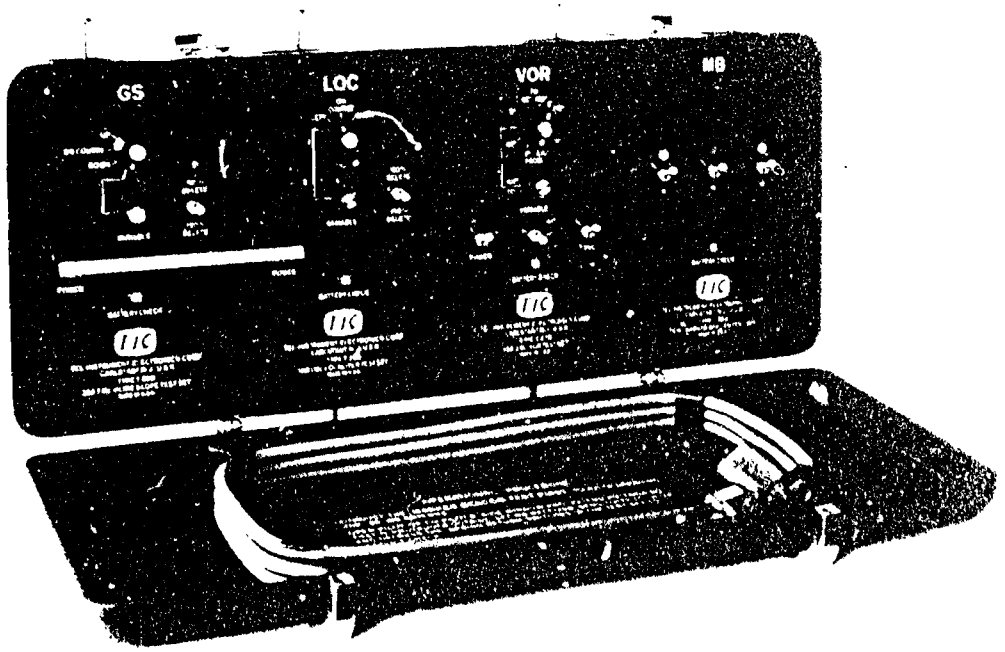
This unit is equipped with rechargeable nickel-cadmium batteries and a built-in battery charger. The charger delivers a constant current to the batteries and can remain plugged in indefinitely without damaging the batteries.

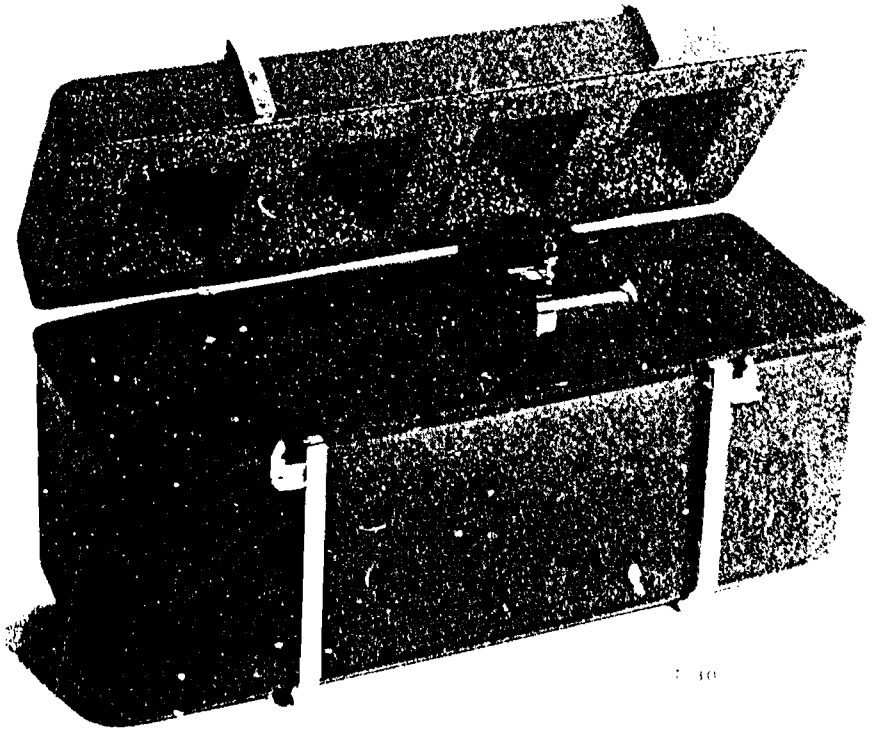
When fully charged the batteries can power any two modules in the Test Set simultaneously for at least ten hours of continuous operation. When in a discharged condition the batteries require 16 hours of charging to be brought up to full charge. To maintain a full charge it is recommended that the unit remain on charge when not in use.

To protect against accidental shorting of the batteries a 3/4 A fuse is connected in series with the batteries. This fuse is located inside the T-30B cabinet on a printed circuit board. A spare fuse is included on this board also.

The schematic, TIC Dwg. T-30AB-50-1-A, for the battery charger is located at the rear of the manual following the T-29B schematic. This circuit is used in both the old (T-30A/B) and the new (T-30B/B) configuration.

T-30/T-30B





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T-30/T-30B VOR/ILS Ramp Test Set

SECTION I
DESCRIPTION

1.1 GENERAL

The T-30B and T-30 VOR/ILS Ramp Tester is designed for one man operation of the VOR, MB, GS, LOC, flight director and auto-pilot from the cockpit or flight deck by radiating R. F. signals directly into the aircraft's antennas. The unit will permit compliance with CAT II periodic ramp check certification requirements. The test set complies with AC-170-6A which authorizes specific test frequencies for radiation. The test set is FCC TYPE ACCEPTED, and to our knowledge the first and only radiating test equipment to meet the stringent FCC requirements.

Each unit, in the test set, is operated from its own internal battery source consisting of four standard alkaline 9 volt batteries in series-parallel arrangement. These batteries are readily available in all parts of the world for operating transistor radios. Built in automatic protection is provided in each unit; should the battery voltage fall below a pre-set level, a unique voltage regulator circuit automatically deactivates the unit. The R. F. output from the test set remains constant and is not affected with lowering battery voltage. A meter in each unit indicates the voltage regulator's status, thus enabling the technician to easily check battery condition before transporting the unit to the check area. When into the red area batteries should be replaced. When the pointer does not move, the unit is inoperative and batteries must be replaced. Each modular unit can be serviced easily by removing four mounting screws on the bottom of the case. Battery life for normal operation is considered to be shelf life of the batteries.

The T-30B and T-30 is simple and straight forward in operation and functions primarily as a "go/no-go" gauge. Basically the instrumentation in all aircrafts have certain established operational tolerances. The purpose of the T-30B and T-30 is to establish that these tolerances are being met and to eliminate unnecessary equipment removals due to uncertainty of operation or pilot squawks.

NOTE:

For flight comparator checks, special versions of the T-30B can be provided. 2 sets of LOC and GS units are required, each set operating on different frequency.

The T-30B has undergone extensive field tests, in all types of commercial jet aircraft in service today including stretched DC-8's, and provides sufficient signal to operate the equipment directly from the cockpit. Marginal operation of equipment on the aircraft can easily be ascertained thru familiarization with the test set.

T-30B

SPECIFICATIONS

T-30B CONSISTING OF:
The T-26B, T-27B, T-28B, and T-29B built into a portable carrying case.
SIZE: 18" x 3-3/4" x 7-1/8". OVERALL WEIGHT: Only 10 lbs.

T-30 CONSISTING OF:
The T-26B, T-27B, T-28B, and T-29B individually packaged for separate hand-held operation when removed from portable carrying case.
SIZE: 16" x 6-1/4" x 8". OVERALL WEIGHT: 12 lbs.

T-26B 75.0 Mc MB TEST SET

R. F. SIGNAL:	75.0 MHz ± .01%
MODULATION:	400~ ± 2.5%
	1300~ ± 2.5%
	3000~ ± 2.5%
MODULATION LEVEL:	Not less than 70% each tone
POWER SUPPLY:	4 - 9V Mallory Mn-1604 Alkaline Batteries or Equivalent
TEMPERATURE RANGE:	-10° C to 50° C Operational
UNIT SIZE:	6-1/2 x 4 x 2-1/2"
UNIT WEIGHT:	1 lb. 10 oz.

T-27B VOR TEST SET

R. F. SIGNAL:	108.0 MHz ± .005%
R. F. MODULATION:	30~ ± 1% at 30% Modulation depth
	9960~ ± 1% at 30% Modulation depth
	Frequency Modulated at 30~ Deviation Ratio 16
VOR BEARINGS:	0° TO, 90° TO, 180° TO, 270° TO, 0° FROM, 90° FROM, 180° FROM, 270° FROM,
	Accuracy better than 0.5° at zero
TONE (IDENT)	1020~
PROVISIONS FOR VARYING:	0°, 90°, 180°, 270° ± 1° - For sticky needle checks
POWER SUPPLY:	4 - 9V Mallory Mn-1604 Alkaline Batteries or Equivalent
TEMPERATURE RANGE:	-10° C to 50° C Operational
UNIT SIZE:	6-1/2 x 4 x 2-1/2"
UNIT WEIGHT:	1 lb. 12 oz.

T-28B LOC TEST SET

R. F. SIGNAL:	108.1 MHz ± 005%
R. F. MODULATION:	90~ at 20% Modulation depth at 0 DDM 150~ at 20% Modulation depth at 0 DDM
ILS DEFLECTIONS:	
ON COURSE	
LEFT -	Approx. .155 DDM
RIGHT -	Approx. .155 DDM
VARIABLE -	0 to ± .190 DDM
POWER SUPPLY:	4 - 9V Mallory Mn-1604 Alkaline Batteries or Equivalent
TEMPERATURE RANGE:	-10° to 50° C Operational
UNIT SIZE:	6-1/2 x 4 x 2-1/2"
UNIT WEIGHT:	1 lb. 10 oz.

T-29B GS TEST SET

R. F. SIGNAL:	334.7 MHz .005%
R. F. MODULATION:	90~ at 40% Modulation depth at 0 DDM 150~ at 40% Modulation depth at 0 DDM
ILS DEFLECTIONS:	
ON COURSE	
UP -	Approx. .175 DDM
DOWN -	Approx. .175 DDM
VARIABLE -	0 to ± .280 DDM
POWER SUPPLY:	4 - 9V Mallory Mn-1604 Alkaline Batteries or Equivalent
TEMPERATURE RANGE:	-10° to 50° C Operational
UNIT SIZE:	6-1/2 x 4 x 2-1/2"
UNIT WEIGHT:	1 lb. 10 oz.

1.3 FRONT PANEL CONTROLS

T-26B 75.0 MHz MB TEST SET

1.31 ON-OFF Power Switch S1a
Spring return Airways or Z marker (white dot) provides 75.0 MHz modulated with 3000 Hz

1.32 ON-OFF Power Switch S2a
Spring return Outer Marker (blue dot) provides 75.0 MHz modulated with 400 Hz

1.33 ON-OFF Power Switch S3a
Spring return Middle Marker (amber dot) provides 75.0 MHz modulated with 1300 Hz

T-27B 108.00 MHz VOR TEST SET

1.31 ON-OFF Power Switch S4
Spring return. Must be depressed in order for test set to operate in any of its functions.

1.32 VOR Bearing Selector S3
Selects either 0°, 90°, 180°, 270° "To or From", or "Variable".

1.33 Tone Switch S1a
Spring return. Provides 1020 Hz modulation tone signal.

1.34 ± 1° Switch S1b
Spring return provides variation of ± 1° on any of 4 selected VOR bearings.

1.35 Variable Bearing Control R54
Varies bearing ± 10° from 100° "TO" or 280° "FROM".

T-28B 108.10 MHz LOC TEST SET

1.31 ON-OFF Power Switch S1
Spring return. Must be depressed in order for test set to operate in any ot its functions.

1.32 Four Position COURSE SWITCH S3
Provides: On Course, Left Course, Right Course, and Variable.

1.33 Delete Switch S2
Spring return. Deletes either 90 Hz or 150 Hz modulation signals.

1.34 Variable Course Control R30
Varies course indication ± .190 DDM.

T-29B 334.7 MHz GS TEST SET

1.31 ON-OFF Power Switch S1
Spring return. Must be depressed in order for test set to operate in any of its functions.

1.32 Four Position COURSE SWITCH S3
Provides On Course, Above Course, Below Course, and Variable.

1.33 Delete Switch S2
Spring return. Deletes either 90 Hz or 150 Hz modulation signals.

1.34 Variable Course Control R30
Varies course indication ± .280 DDM.

SECTION 2
COCKPIT OPERATING INSTRUCTIONS

2.1 GENERAL

The T-30B can be operated from either the pilots or co-pilots seat. Antennas for each of the four units are recessed for protection from damage and are telescopic. The Marker Beacon (MB) antenna is the largest of the four; therefore, it is recommended that the MB checks be made first. Once the MB check has been made there is usually no further need for the antenna to remain extended since no other checks using this unit are required. The only exception to this is when the middle marker signal is required to desensitize the Flight Director.

The cover of the T-30 is hinged and normally not removed. The cover is used to support the unit when placed in the operating position on your lap. Cover tension can be increased or decreased by adjusting the screws that act as the hinge pins. Two side action mechanical latches lock and unlock the cover.

2.2 OPERATION

Turn on the aircraft MB receiver and set the sensitivity control to "high". Check aircraft MB indicator Lamps to be sure they are not defective and set audio level pot to mid point. Extend the T-26B MB antenna in the T-30B and open pilots or co-pilots side window so that the antenna protrudes outside the aircraft. By depressing any one of the three spring return switches on the T-26B MB test set you will light up the appropriate lamp in the aircraft as well as hear the associated tone signal. Each of the switches is color keyed (white, blue, amber) and labeled A, O, M corresponding to the airways marker, outer marker and middle marker respectively. Due to marker beacon receiver insensitivity it may be necessary, in some cases, to move the antenna about in order to pick up the strongest signal. With marker beacon receivers that are operating properly this would not be required and would point out a weak receiver. On smaller aircraft such as the BAC 111 or DC-9 it is not necessary to extend the antenna out of window. The open window, however, offers an ideal spot to extend the 42" antenna so that it does not interfere with other personnel in the cockpit.

RETRACT THE ANTENNA AFTER THESE CHECKS HAVE BEEN MADE.

VOR CHECK

2.2 OPERATION

Tune the VOR receivers in the aircraft to 108.00 MHz. Extend the 4" antenna of the T-27B VOR test set in the T-30B. Note the five operating controls on the front panel.

1. On-Off power switch - spring return

2. Bearing switch - five position 0°, 90°, 180°, 270° "To" and "From" and "Variable"

3. ± 1° switch - spring return

4. Tone switch - spring return

5. Variable bearing control - varies ± 10° from 100° "To" or 280° "From"

ON-OFF SWITCH

The On-Off switch must be depressed in order for the test set to operate in any of its functions.

VOR BEARING SWITCH

To perform the VOR bearing checks, the T-27B bearing selector switch should be set to either 0°, 90°, 180° or 270°. The same bearing should be set into the VOR indicator with the OBS. By depressing the power switch the OBI should center on the indicator showing an on course indication. Note that the bearing selector switch offers "To" and "From" readings which should correspond with the information in the VOR indicator. If the OBI does not center, rotate the OBS until it does. It should be noted that the RMI will show corresponding readings. The amount of movement in degrees required to center the needle can be read as the bearing error at that particular heading. The same check can be made at all other points. The accuracy at 0° and 180° is less than 0.5° whereas at 90° and 270° it is better than 2°. The purpose of the 90° and 270° bearing check is to establish that the goniometer winding in the VOR indicator is not open and therefore the accuracy is not of utmost importance.

± 1° SWITCH

In any of the four selected bearings a VOR "sticky needle" check can be made by moving the ± 1° switch up or down and noting the one degree change in the OBI. This small shift of 1° assures the free movement of the indicator needle.

TONE SWITCH

The tone switch, when depressed, will operate a 1020~ tone thru the audio circuit of the VOR receiver thereby checking the audio system switching as well as the receivers.

VARIABLE COURSE KNOB

The Variable Course knob is operable when the VOR Bearing Switch is indexed to the variable position and the power switch is depressed. The dot on the Variable Control knob, when lined up with the reference line, is approximately the 100° radial on a "To" heading. With the VOR OBS set to approximately 100°, a change of ± 10° can be effected by varying the Variable Control knob left or right. This function permits an armed flight director to capture in a simulated VOR approach. The variation in the course is provided by the Variable Course knob and eliminates the need to reach over the control yoke and manually turn the OBS knob on the VOR indicator.

RETRACT THE ANTENNA AFTER THESE CHECKS HAVE BEEN MADE.

2.2 OPERATION

Tune the aircraft receivers to 108.10 MHz. This will automatically index the corresponding GS channel. Extend the 4" antennas of the T-28B LOC and T-29B GS test sets in the T-30B. Note the four operating controls on each front panel.

1. On - Off Power Switch

2. LOC and GS Four Position Course Switch

3. LOC and GS Variable Knob

4. Delete Switch

ON - OFF POWER SWITCH - Spring return

Both LOC and GS power switches are coupled together by a flexible bar which permits independent or simultaneous operation of both units. The switch must be depressed in order to operate the unit in any of its functions. By depressing the center of the flexible bar the GS and LOC operate simultaneously for Flight Director checks.

LOC FOUR POSITION COURSE SWITCH - Consisting of the following function:

On course, left of course, right of course and variable. The physical layout of the panel is such that when the course knob is turned left the LOC indicator swings left and conversely right when turned right. The deflection left or right is 150 μa or last dot on all indicators. This permits checks of all types of indicators whether two, three or five dot references are used. The variable position on the course switch references a potentiometer with a line pointing to the potentiometer knob. The dot on the knob, when lined up with the reference line, is the approximate "on course" position for ready reference.

Turning the knob either left or right results in a variable left or right indicator deflection of from center to approximately 185 μa each side. This function permits checkout of indicator "hang-up" on full deflection as well as flight director capture parameters. When the Flight Director and auto-pilot are engaged in this function, any variation left or right will automatically activate the auto-pilot and move the associated controls and control surfaces. Caution should be exercised to make certain that all control surfaces are free of obstructions before auto-pilot checks are performed. It is recommended that the aircraft's Hydraulic boost pumps are on when this check is made.

GS FOUR POSITION COURSE SWITCH

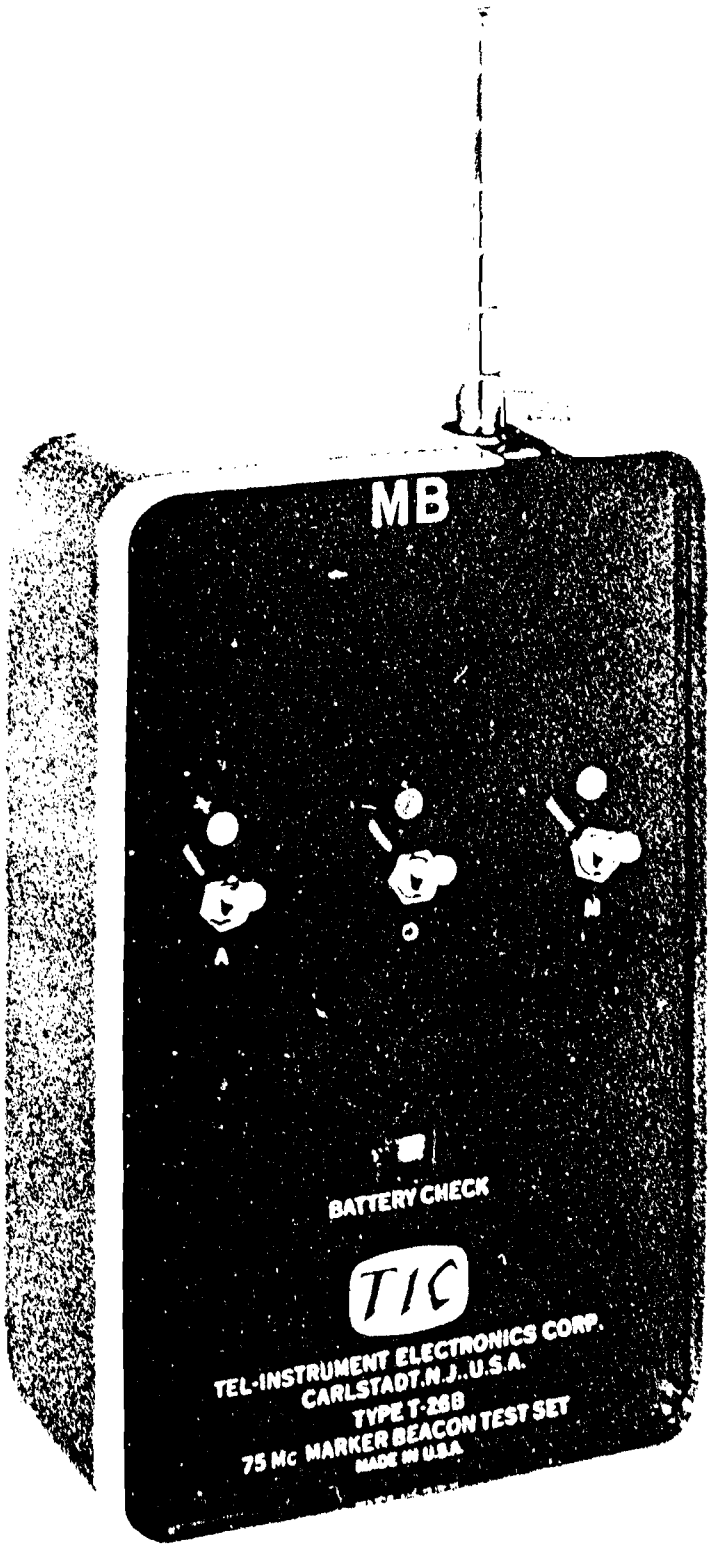
The functions are identical to the LOC with the exception of deflection up and down on the GS indicator. The physical layout of the panel is such that when the course knob is turned up the needle swings up and conversely down when turned down.

LOC AND GS DELETE SWITCHES - Spring return

This switch is used to delete either the 90 or 150 Hz modulation signals in the LOC or GS. The course selector knob must be set to "On Course" before performing this check. By deleting either of the signals the flag should appear on the indicator. This is a check to determine the flag operation when either of the signals are lost.

RETRACT THE ANTENNA AFTER THESE CHECKS HAVE BEEN MADE.

PART II
T-26B
MARKER BEACON TEST SET



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SECTION I
DESCRIPTION

1.1 GENERAL:

The T-26 Marker Beacon Ramp Tester is a completely self-contained Marker Beacon transmitter simulator.

Four readily available 9 volt batteries supply power to a transistor voltage regulator which maintains a constant output voltage. A front panel meter monitors the batteries and falls to the red scale when they must be replaced.

A stable L-C oscillator generates the Blue, Amber, or White marker frequency when the corresponding switch on the front panel is operated.

A 37.5 MHz crystal controlled oscillator drives an amplifier-doubler which is collector modulated by the selected tone signal.

With the collapsible antenna fully extended the power output is sufficient to energize the Marker Beacon indicators from the aircraft cockpit.

SECTION 2
OPERATION

2.1 GENERAL:

The T-26 Marker Beacon Ramp Tester provides a complete check of the Marker Beacon receiver system including antenna, input cables, receiver, and audible and visual indicators.

The three switches on the front panel are color-coded to correspond to the receiver indicator lamps. They are also labelled "A", "O", and "M" for Airways, Outer, and Middle marker.

After turning on the Marker Beacon receiver simply extend the T-26 antenna to its full length and operate one of the front panel switches. If the receiver system is operating properly the corresponding indicator lamp should light and a tone should be heard from the speaker or headphones. (On the larger aircraft it may be necessary to extend the T-26 antenna out of the cockpit window.)

Since the lamp circuit of the receiver is less sensitive than the audio circuit, a loss of system sensitivity will be indicated by inability to light the lamp.

SECTION 3
THEORY OF OPERATION

3.1 POWER SUPPLY:

The power supply consists of four 9-volt batteries connected in series parallel to supply 18 volts to the battery voltage regulator (Q1, Q3, and Q9). Q3 and Q9 form a differential amplifier which composes a portion of the output voltage at the base of Q9 with the voltage across the zener diode, CR1, at the base of Q3. The base current for the series regulator Q1 is supplied by Q3. Any increase in the output voltage results in a decrease in Q3 collector current and a corresponding decrease in Q1 collector current. This results in a decrease in output voltage. Conversely, a decrease in output voltage results in an increase in Q1 collector current. Thus Q1 acts as a variable resistance which maintains the output voltage constant. D. C. voltage control R3 adjusts the output of the regulator to 10V.

The collector-emitter voltage of Q1 is applied to the base-emitter of Q2. If the battery voltage exceeds the regulator output voltage by 1-1/2V or more the voltage across Q1 is sufficient to forward bias Q2 and the Battery Check meter reads in the white scale due to Q2 collector current. When the battery voltage no longer exceeds the output voltage by approximately 1-1/2V, Q2 collector current falls and the Battery Check meter reads in the red scale indicating that the batteries must be replaced.

Through the action of the voltage regulator a drop in battery voltage from 18V to 12V results in a drop in output voltage of less than 0.1V.

3.2 TONE GENERATOR:

The tone generator is an L-C oscillator with positive feedback to the emitter. Coils L1, L2 and L3 are transformers with the primary winding tuned to the desired frequency and the secondary winding used to supply positive feedback. The three parallel resonant circuits, L1-C2, L2-C3, L3-C4, (400, 1300, and 3000 Hz, respectively) are connected in series in the collector of Q4.

When the Blue Marker Switch (S1) is operated, power is applied to the unit and the short across the secondary of L1 is removed. This allows positive feedback to be applied to the emitter of Q4 at the frequency determined by L1-C2 (400 Hz). Potentiometer R10 is used to adjust the gain and feedback of the oscillator, Q4.

The secondaries of L2 and L3 remain shorted to ground through S2b and S3b, loading down the associated tuned circuits in the primary windings. This loading reduces the Q of the tuned circuits so they have no effect on the desired frequency.

When the Amber or White Marker Switch (S2 or S3) is operated, the operation of the circuit is the same as described for the Blue Marker Switch. R11 and R12 are used to adjust the gain and feedback for the Amber and White Markers respectively.

The tone generated by Q4 is connected to the base of emitter follower Q5 which acts as a buffer to minimize loading on the generator. The 120K resistor, R7, connected from the emitter of Q5 to the base of Q4 introduces negative feedback to improve the stability of Q4.

MODULATOR AND R. F. SECTION:

The oscillator, Q7, is a crystal-controlled Colpitts in a common-base circuit. At 37.5 MHz the crystal is series-resonant and presents a low impedance path for positive feedback to the emitter. The coil L6, across the crystal is used to neutralize the capacity of the crystal assembly. The collector tank, L4, C11, and C12 are tuned to 37.5 MHz to insure that the crystal operates at the proper harmonic.

The secondary of L4 couples the oscillator tank to the base of Q8, the modulated amplifier-doubler.

The emitter of Q8 is returned to ground through emitter-follower Q6. The base voltage of Q6 determines the effective collector supply voltage for Q8, and is adjusted by R16 to the proper level for maximum linear modulation. The desired tone signal is coupled to the base of Q6 through C6 and also appears at the emitter of Q6. Thus the collector-emitter voltage of Q8 is D. C. varying at an audio rate resulting in amplitude modulation of the collector current.

In the collector of Q8, coil L5 is tuned to 75 MHz by C15 and C14. Capacitors C15 and C14 act as an impedance transformer to match the impedance of the antenna. A 112.5 MHz trap L8, C19 is inserted in the antenna lead to eliminate spurious radiation at the third harmonic of the crystal oscillator.

A built in detector circuit, CR3, R25, and C16 is incorporated to facilitate adjustment of the R. F. circuits.

SECTION 4
TROUBLE SHOOTING AND MAINTENANCE

4.1 MAINTENANCE:

This unit should require very little maintenance other than replacement of batteries. In order to replace the batteries, remove the unit from the case by taking out the four screws underneath the case. Lift off the battery connector board (use a screwdriver if necessary) and replace the batteries. CAUTION: Be sure to observe correct polarity.

If a unit should become inoperative isolate the defective section by following the procedures outlined as indicated in the adjustments below.
After the defective section has been found, replace the associated transistors taking care to insert them correctly into their sockets. If new transistors do not correct the trouble and it becomes necessary to unsolder components, great care should be exercised to avoid damaging the printed circuit board. When troubleshooting the unit, refer to the block diagram and "Theory of Operation" section.

To remove the circuit board for service, consult Fig. 1Ca & b.

Remove the four screws marked "A", unsolder the lead to the antenna and slide the board out.

To replace the antenna, remove the screw marked "B" at the bottom end of the antenna and pull the antenna out. (See Fig. 1Cb). Insert the replacement antenna and fasten the bottom end as it was before.

CAUTION: Be sure to install the insulating washers to avoid shorting antenna to ground. ("C" on Fig. 1Cb).

4.2 VOLTAGE REGULATOR ADJUSTMENT:

1. Set D.C. power supply to 18V and connect to T-26B in place of batteries.

2. Turn on T-26B and adjust R3 (D.C. Voltage Control) for 10.5V across TP1 and TP2. (To increase the R.F. output this voltage can be set to 11V with a resulting decrease in battery life.)

3. Reduce D. C. supply voltage slowly while monitoring voltage across TP1 and TP2 and Battery Check meter on T-26B. Voltage across TP1 and TP2 should not fall more than 1% and input voltage should be less than 12V before Battery Check meter falls to red scale.

MB

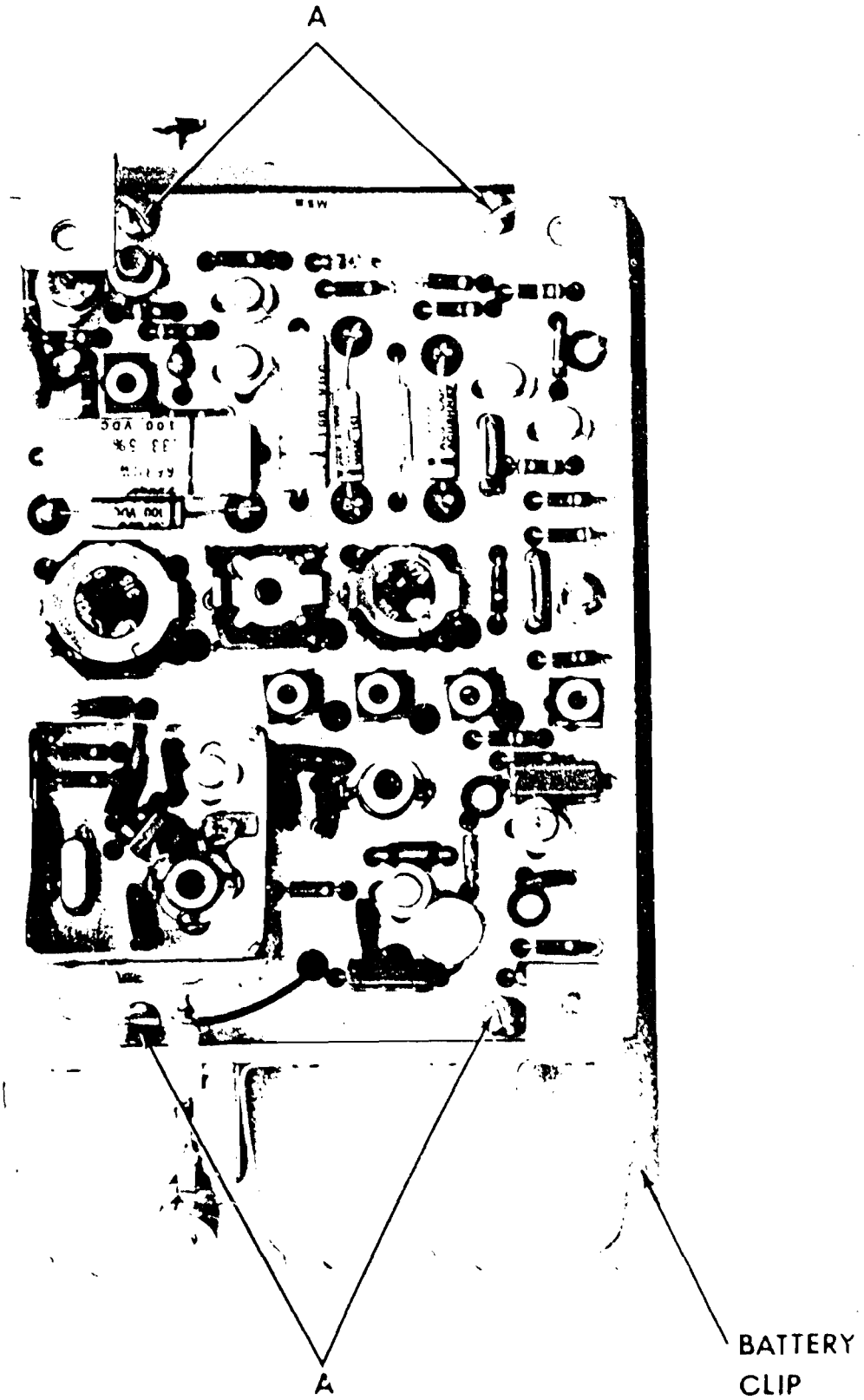


Figure 1Ca

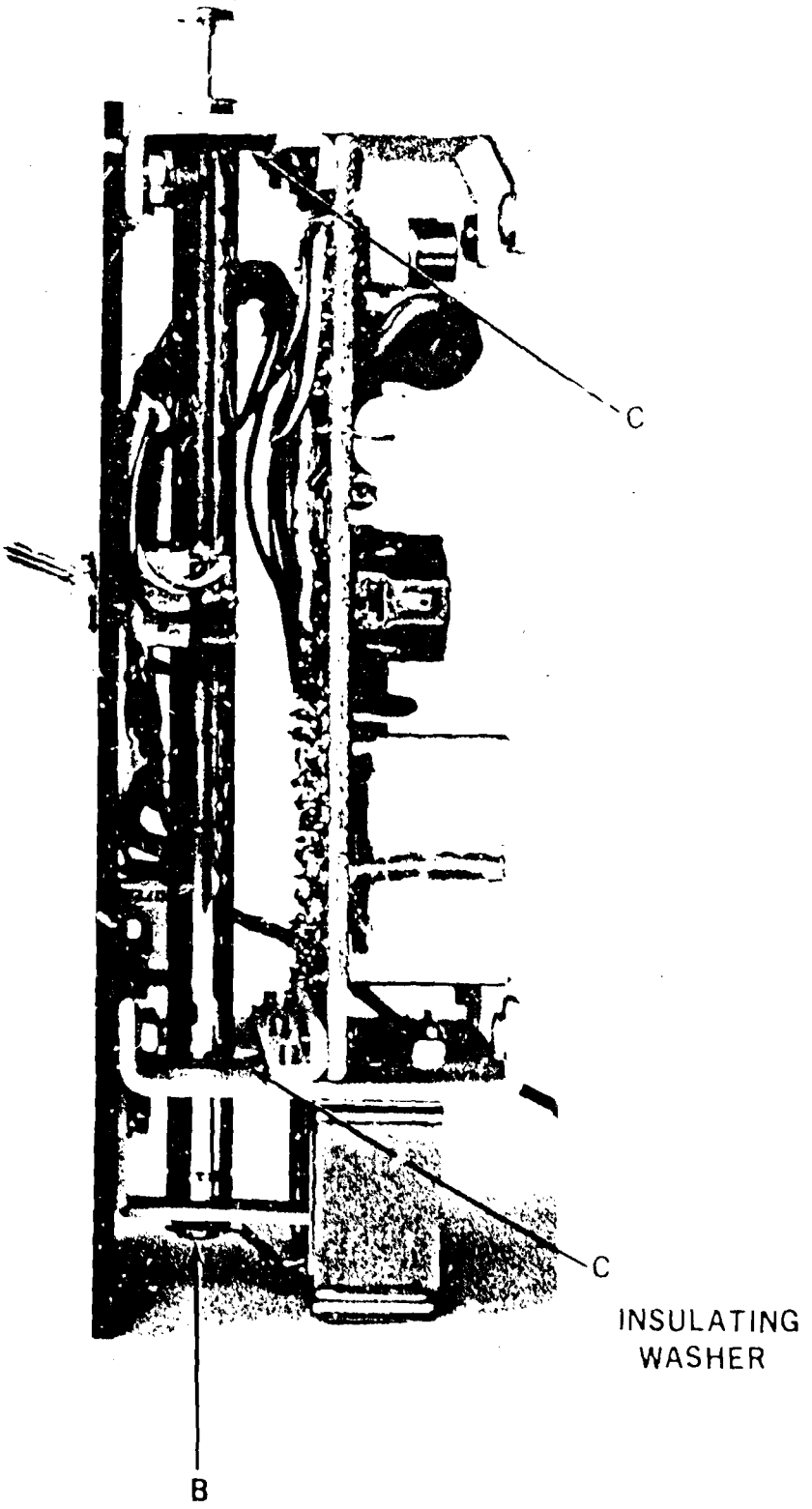


Figure 1Cb

4.3 TONE GENERATOR ADJUSTMENT:

1. Connect scope and counter to TP5. (Use capacitor in series with counter to eliminate D.C. component.)

2. Operate 400 Hz switch on T-26B. (Blue marker) and adjust R10 (400 Hz level) so signal appears on scope.

3. Adjust L1 for 400 Hz signal at TP5 as indicated by counter.

4. Adjust R10 (400 Hz level) so peaks of signal begin to clip. This is evidenced as a tilt as seen on scope. Note the amplitude of the scope signal.

5. Operate 1.3 kHz switch on T-26B (Amber marker) and adjust R11 (1.3 kHz level) so signal on scope is same amplitude as noted in step 4.

6. Adjust L2 for 1.3 kHz signal at TP5 as indicated by counter.

7. If signal amplitude has changed due to tuning L2, readjust R11.

8. Operate 3 kHz switch on T-26B (White marker) and adjust R12 (3 kHz level) so signal on scope is same amplitude as noted in step 4.

9. Adjust L3 for 3 kHz signal at TP5 as indicated by counter.

10. If signal amplitude has changed, readjust R12.

4.4 MODULATOR AND R.F. SECTION:

NOTE: A threaded plastic lock is used in coils L4 and L5. To adjust these coils remove the locks with a screwdriver and restore them after adjustments have been made.

1. Tune antenna trap L8, C19, to 112 MHz using grid dip meter.

2. Connect D.C. scope and VTVM to output of built-in detector, TP4.

3. Extend T-26B antenna to full length and operate one of the switches on the T-26B.

4. Adjust L4 (crystal oscillator coil) for maximum D.C. at TP4.

5. Adjust L5 and C15 (doubler-amplifier tank) for maximum D. C. at TP4.

6. The adjustments in steps 4 and 5 are interacting so they must be adjusted alternately for optimum output and linear modulation.

7. Adjust C19 for maximum D. C. at TP4.

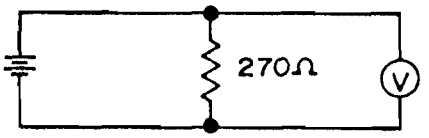
8. With T-26B power switch off, adjust position of scope trace to bottom of screen. Turn T-26B "On" and adjust R16 (% Mod-adj) so the detected tone signal just touches the Zero base-line and starts to flatten. (This is approximately 90% modulation.)

9. The D. C. voltage measured at TP4 should now be greater than 0.9V and the R. F. voltage measured at the base of the antenna should be greater than 0.6Vrms. (Use Sampling Voltmeter to measure R. F.)

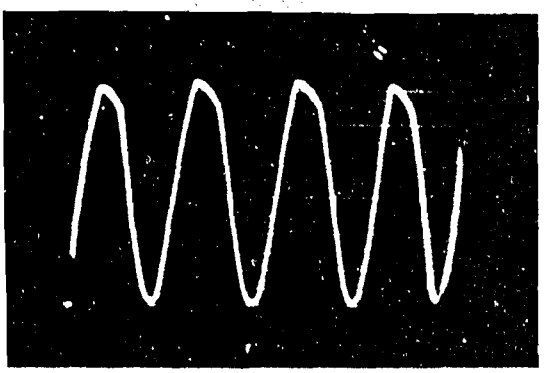
10. Couple counter to antenna with 2 inch loop and check that output frequency is 75 MHz ± .01%. (Remove Q5 for this check to eliminate spurious counts caused by modulation.)

IMPORTANT NOTE: When the ramp test set is checked against a test bench receiver the output from the ramp test set may be sufficient to overload the receiver. In this case an attenuator can be placed in the cable from the receiver antenna. The attenuation should be sufficient to insure that the receiver is not being overloaded. The input to the receiver can be determined by first measuring the A.V.C. voltage of the test receiver with the ramp test set turned on. Then feed a signal generator equipped with a calibrated attenuator into the receiver and determine what value of signal is required to achieve the same A.V.C. voltage as before.

NOTE: In some cases it has been observed that brand new Mn 1604 batteries have been found defective. Therefore it is recommended that all new batteries be checked under load before operation. Section 4 of Part 5 GS (page 4-1) outlines the procedure for checking the batteries.



If the voltage falls rapidly (0.4V or more) in 5 minutes, the battery should be considered defective.



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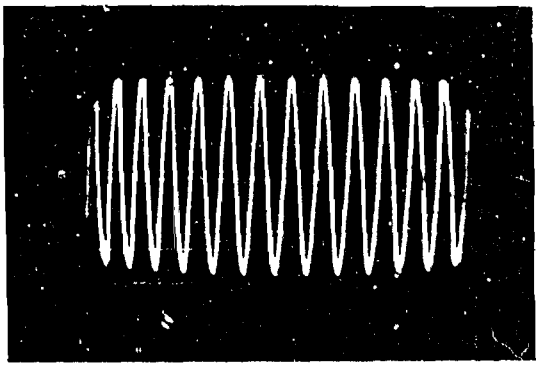

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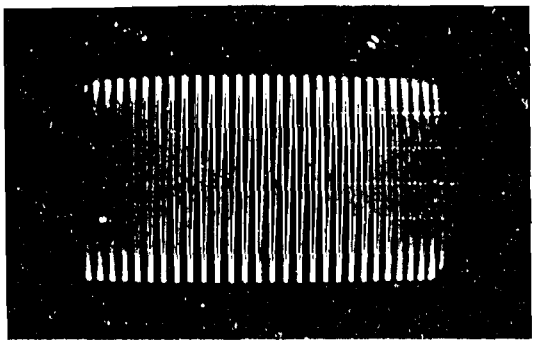
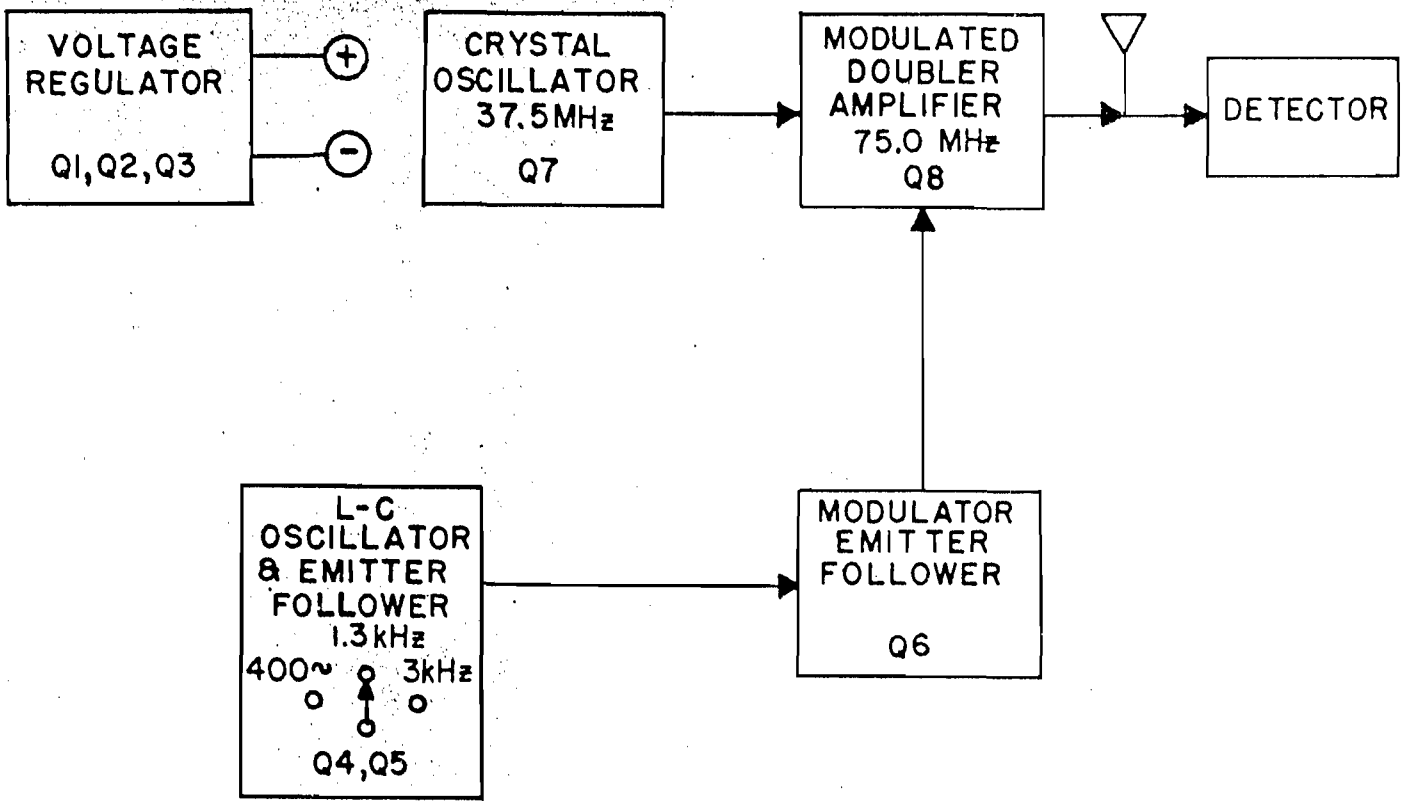


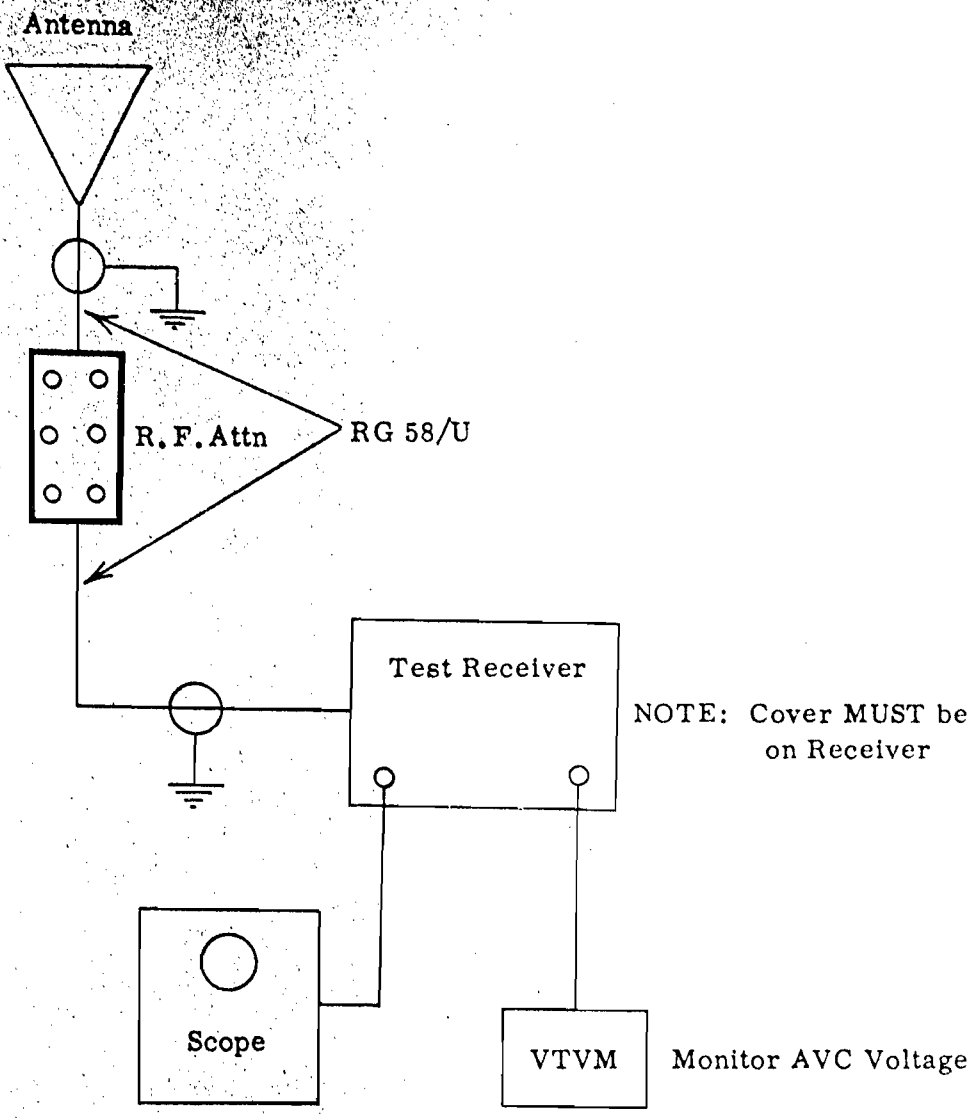
C

T-26B detector output signal. 1 ms/cm Horizontal. 0.38V/cm Vertical.

a. Outer Marker, 400 Hz.
b. Middle Marker, 1.3 kHz.
c. Airways Marker, 3 kHz.



BLOCK DIAGRAM



TYPICAL TEST RECEIVER SET-UP

T-26B-4-6

SECTION 5
TEST EQUIPMENT AND TOOLS

5.1 INSTRUMENTS REQUIRED:

VTVM
D. C. power supply Adjustable 10-20V.
Electronic Counter H. P. Model 524B or equivalent.
Oscilloscope DC-100 kHz or more.
Grid dip meter. Measurements Corporation Model 59 or equivalent.
Broadband Sampling Voltmeter H. P. Model 3406A or equivalent.

The radiation pattern of the ramp tester is affected by its metal case. For this reason it is recommended that the final adjustments be made with the unit placed in a test case which has been drilled to allow access to the necessary adjustments. A pre-drilled case is available from TIC and is identified as a "T-30A/T-30B Test Jig".

T-26B MARKER BEACON

MAIN CHASSIS

ITEM	DESCRIPTION		CIRCUIT DESIGNATION	QTY	TIC PART #
1	ANTENNA	WORKMAN MODEL A3		1	TA-2
2	BATTERY	EVEREADY #222	BT1 thru BT4 Incl.	4	TB-8
3	"	CLIP ASSEMBLY FOR 4 BATTERIES		1	TC-181-B
4	CLIP	KEYSTONE 80		4	TH-10
5	FEEDTHRU	TEFLON SELECTRO FT-100		1	TF-1
6	INDUCTOR	FIXED ANTENNA TIC MFR.	L8	1	TC-203D
7	METER	EMICO 802 PWR	M1	1	TM-7
8	SWITCH	TOGGLE ARROW-HART & HEGEMAN TM-6-M	S1,S2,S3	3	TS-81
9	WASHER	FIBER SHOULDER GENERAL CEMENT 6525C		1	TW-67

T-26B MARKER BEACON

PRINTED CIRCUIT BOARD

ITEM	DESCRIPTION	CIRCUIT DESIGNATION	QTY	TIC PART #
1	CAPACITOR TRIMMER, 9-35 pF ERIE TECHN. PROD. 538-011-E2PO-94K	C15	1	TC-65
2	" TRIMMER, 9-35 pF ERIE TECHN. PROD. 538-000-D	C19	1	TC-64
3	" FIXED, CERAMIC, DISC 1 KpF ERIE TECHN. PROD. 801	C7 thru C10, C13, C20, C21	7	TC-94
4	" FIXED, CERAMIC 0.47 µF 50V SPRAGUE 7C023474X0500E	C5, C6	2	TC-139
5	" " MICA 22 pF CM15C220J	C14, C18	2	TC-15
6	" " " 39 pF CM15B390J	C12	1	TC-18
7	" " " 68 pF CM15E680J	C11	1	TC-22
8	" " " 100 pF CM15C101J	C16	1	TC-23
9	" ELECTROLYTIC, TANTALUM, 15 µF 20V 10% SPRAGUE 196D156X0020JE3	C22	1	TC-152
10	" " TANTALUM, 150 µF 15V SPRAGUE 196D157X0015G3	C1	1	TC-172
11	" FIXED, POLYCARBONATE, 0.039 µF 50V 5% TRW X463UW	C4	1	TC-113
12	" FIXED, MYLAR, TUBULAR 0.12 µF 100V 10% TRW TYPE 663UW	C3	1	TC-126
13	" FIXED, MYLAR, TUBULAR 0.33 µF 100V 5% TRW TYPE 663UW	C2	1	TC-135
14	CRYSTAL 37.5 MHz TIC-55 PIEZO 6082291	Y1	1	TC-268
15	DIODE SILICON 1N87A	CR3	1	TD-7
16	" ZENER 1N705A or 1N5230B 4.8V	CR1	1	TD-10
17	INDUCTOR FIXED, 1.0 µH CRAMER Q-85	L6, L7	2	TC-196
18	" VARIABLE AMPLIFIER-DOUBLER TIC MFR.	L5	1	TC-203C

T-26B MARKER BEACON

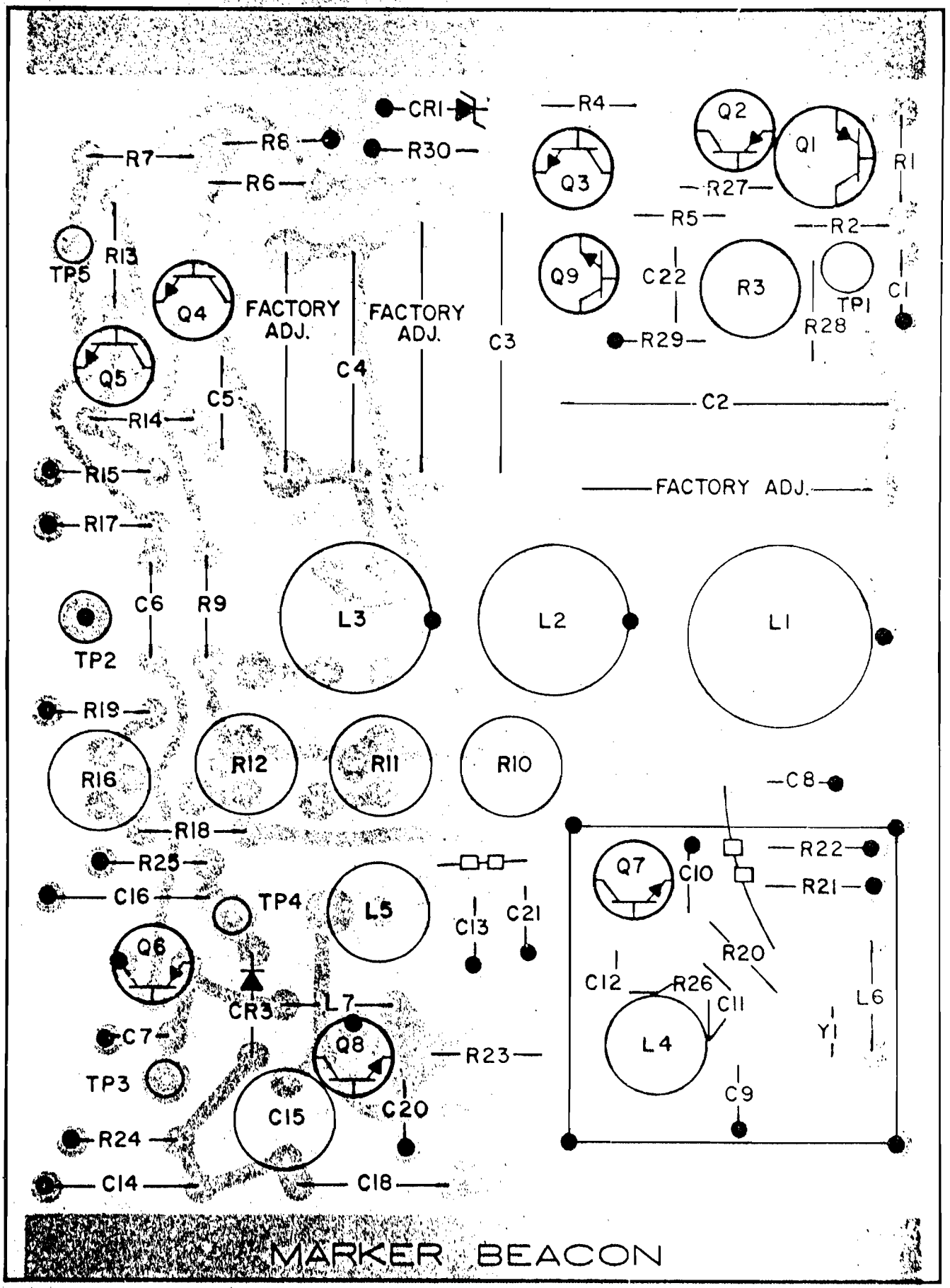
PRINTED CIRCUIT BOARD

ITEM	DESCRIPTION	CIRCUIT DESIGNATION	QTY	TIC PART #
19	INDUCTOR VARIABLE OSCILLATOR TIC MFR.	L4	1	TC-203B
19A	INSERT LOCKING CAMBRIDGE THERMIONIC CORP. # 2208-1 (used on L4 & L5)		2	TI-5
20	RESISTOR FIXED, COMPOSITION, 100Ω 1/4W 10% ALLEN-BRADLEY CB4701	R22	1	TR-145
21	" " " 120Ω " " ALLEN-BRADLEY CB1211	R9	1	TR-146
22	" " " 220Ω " " ALLEN-BRADLEY CB2211	R23	1	TR-148
23	" " " 1K " " ALLEN-BRADLEY CB1021	R1,R26	2	TR-155
24	" " " 1.2K " " ALLEN-BRADLEY CB1221	R17	1	TR-156
25	" " " 1.5K " " ALLEN-BRADLEY CB1521	R21	1	TR-157
26	" " " 2.2K " " ALLEN-BRADLEY CB2221	R8,R30	2	TR-159
27	" " " 3.9K " " ALLEN-BRADLEY CB3921	R20,R27	2	TR-162
28	" " " 4.7K " " ALLEN-BRADLEY CB4721	R5,14,28,29	4	TR-163
29	" " " 8.2K " " ALLEN-BRADLEY CB8221	R4,R13	2	TR-166
30	" " " 10K " " ALLEN-BRADLEY CB1031	R6	1	TR-167
31	" " " 12K " " ALLEN-BRADLEY CB1231	R15,R18,R19	3	TR-168
32	" " " 22K " " ALLEN-BRADLEY CB2231	R24,R25	2	TR-171
33	" " " 100K " " ALLEN-BRADLEY CB1041	R2	1	TR-179
34	" " " 120K " " ALLEN-BRADLEY CB1241	R7	1	TR-180
35	RESISTOR VARIABLE, CERMET, 500Ω, ALLEN-BRADLEY A2B501	R10,R11,R12	3	TP-38-A
36	" " " 10K, ALLEN-BRADLEY A2B103	R3,R16	2	TP-65-A
37	SOCKET TRANSISTOR, INDUSTRIAL ELECTRONIC HARDWARE MPT 4003-1 NYLON	XQ2 thru XQ7,XQ9	7	TS-34
38	" " INDUSTRIAL ELECTRONIC HARDWARE MPT 4004-1 NYLON	XQ8	1	TS-35
39	" " INDUSTRIAL ELECTRONIC HARDWARE MPT 6003-1 NYLON	XQ1	1	TS-36

T-26B MARKER BEACON

PRINTED CIRCUIT BOARD

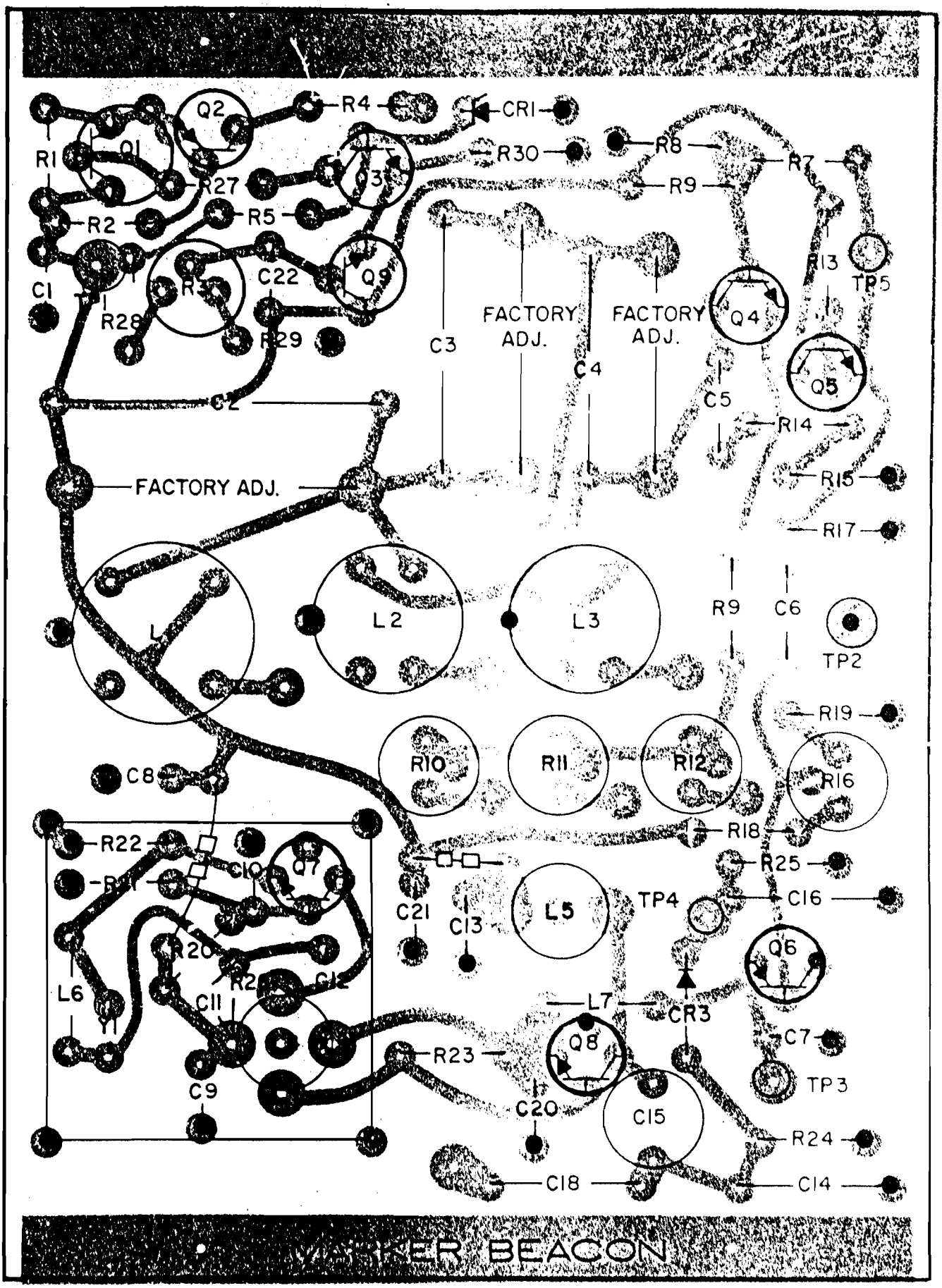
ITEM	DESCRIPTION				CIRCUIT DESIGNATION	QTY	TIC PART #
40	TRANSISTOR	2N4037	PNP	SILICON	Q1	1	TT-34
41	"	2N5179	NPN	SILICON	Q8	1	TT-36
42	"	FAIRCHILD SEMICOND.	FT3904 or 2N3904	NPN SILICON	Q3,Q4,Q5,Q7,Q9	5	TT-32
43	"	FAIRCHILD SEMICOND.	FT3906 or 2N3906	PNP SILICON	Q2,Q6	2	TT-33
44	TRANSFORMER	TIC	(400 Hz)		L1	1	TC-222
45	"	TIC	(1.3 kHz)		L2	1	TC-223
46	"	TIC	(3 kHz)		L3	1	TC-224



T-26B-5-6

SOLDER SIDE VIEW

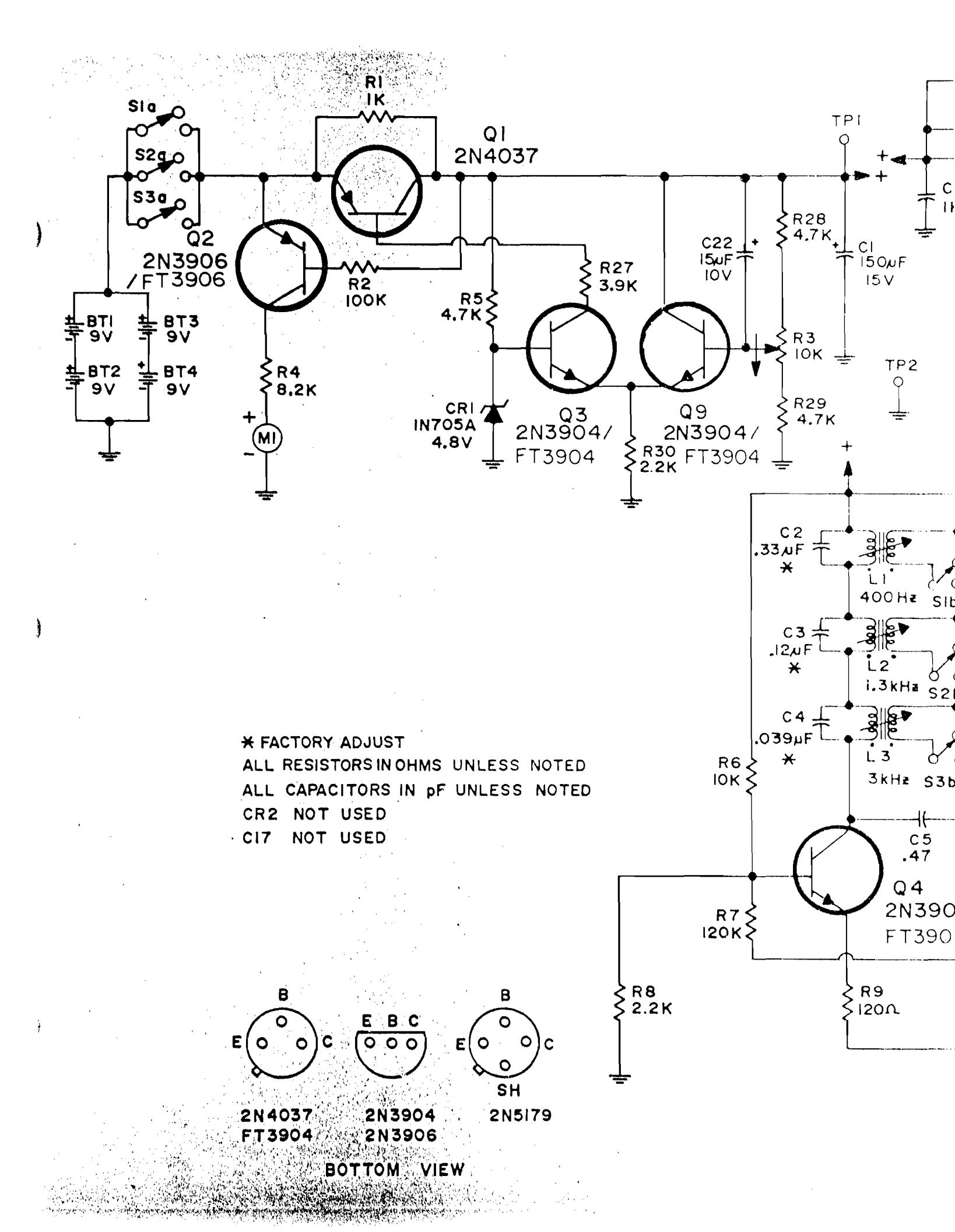
CHASSIS GND ●

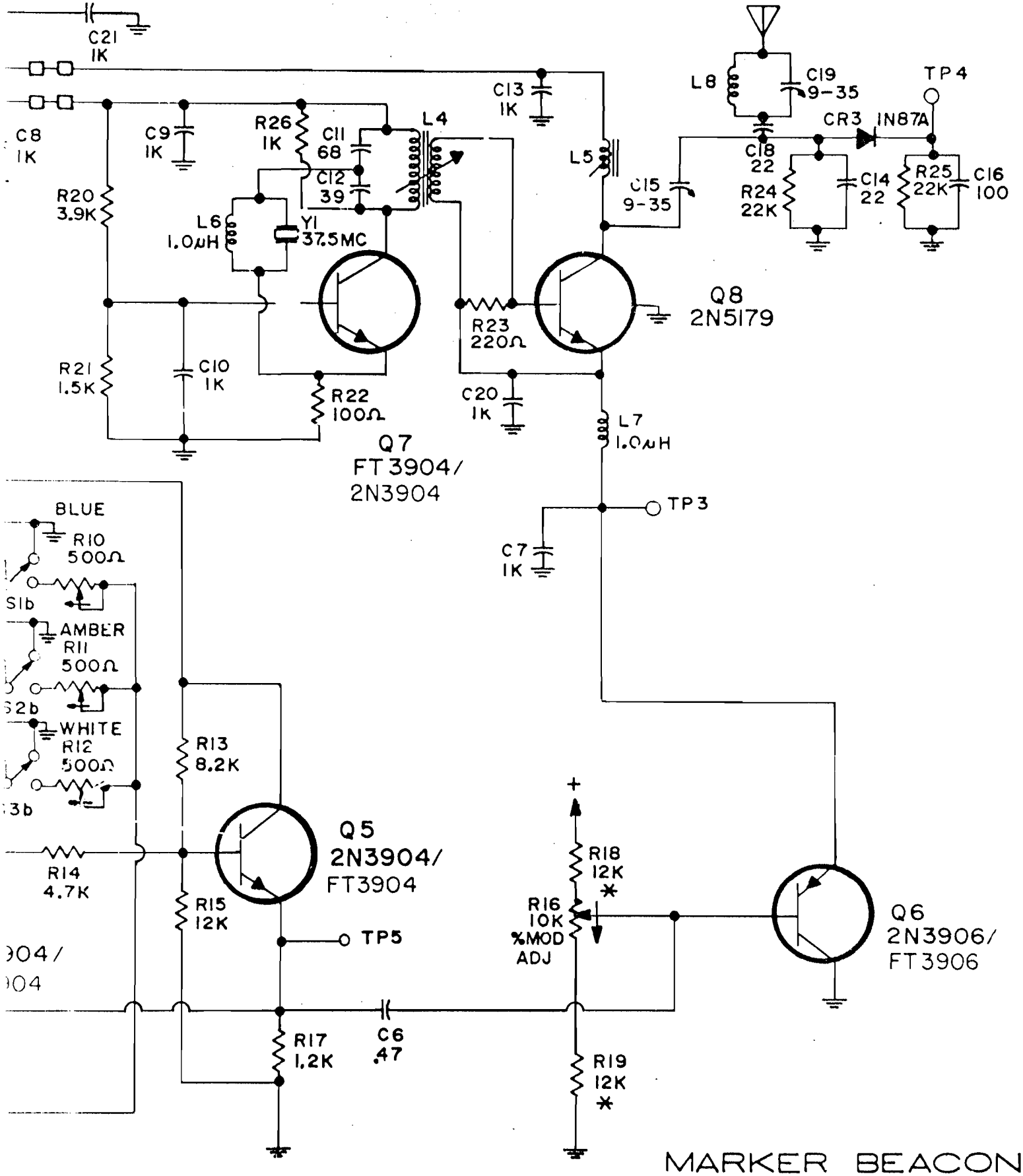


● CHASSIS GND

COMPONENT SIDE VIEW

T-26B-5-7


S1a
S2a
S3a
R1
1K
Q1
2N4037
Q2
2N3906
/FT3906
R2
100K
BT1
9V
BT2
9V
BT3
9V
BT4
9V
R4
8.2K
MI
R5
4.7K
R27
3.9K
CR1
IN705A
4.8V
Q3
2N3904/
FT3904
R30
2.2K
Q9
2N3904/
FT3904
R28
4.7K
C22
15µF
10V
C1
150µF
15V
R3
10K
R29
4.7K
TP1
TP2
C2
.33µF
*
L1
400Hz
C3
.12µF
*
L2
1.3kHz
C4
.039µF
*
L3
3kHz
R6
10K
C5
.47
Q4
2N390
FT390
R7
120K
R8
2.2K
R9
120Ω
* FACTORY ADJUST
ALL RESISTORS IN OHMS UNLESS NOTED
ALL CAPACITORS IN pF UNLESS NOTED
CR2 NOT USED
C17 NOT USED
B
E
C
E B C
B
E
C
SH
2N4037
FT3904
2N3904
2N3906
2N5179
BOTTOM VIEW



MARKER BEACON RAMP TESTER T-26B-50-1-B

ISSUE 1 7-12-72

PART III
T-27B
VOR TEST SET

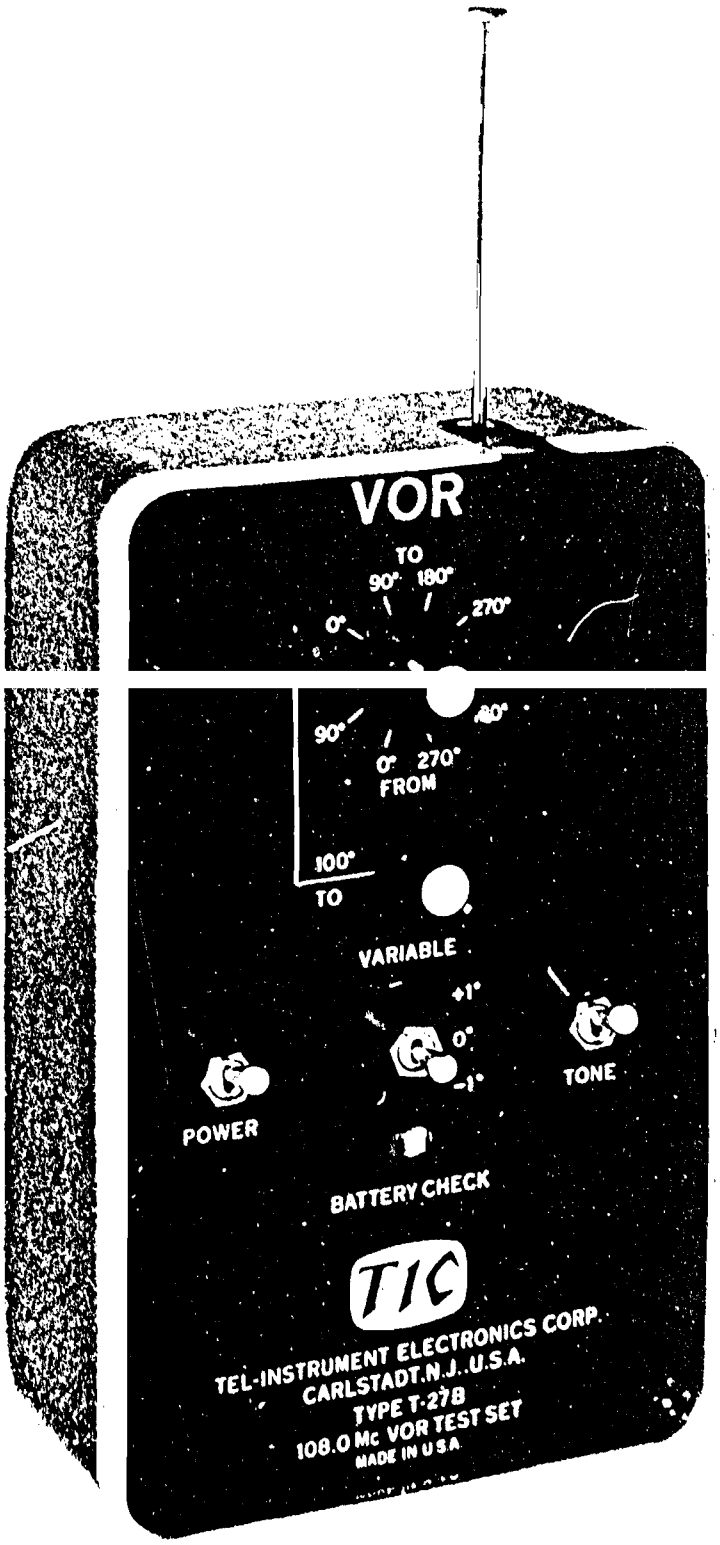


TABLE OF CONTENTS

ADDENDUM FOR THE TYPE T-27B

VOR RAMP TEST SET

To provide improved performance of the Type T-27B VOR Ramp Test Set, the following changes have been approved by the Tel-Instrument Electronics Corp. Engineering Department.

1. On the schematic, drawing No. T-27B-50-1-C, make the following corrections:

   A. In the antenna circuit, insert capacitor C40 between the lower end of L4 and the junction of CR2, CR7, L2, C35 and the collector of Q18. C40 is a 470 pF capacitor.

   B. Change the issue from 2 to 3 dated 2/15/74, ECO 931.

2. On the MAIN CHASSIS parts list change as follows:

   A. Add a new Item 3A to the parts list between Items 3 and 4 as follows: DESCRIPTION, CAPACITOR FIXED CERAMIC DISC 470 pF CENTRALAB DD471; CIRCUIT DESIGNATION, C40; QTY, 1; TIC PART #, TC-89.

ECO 931, 2/15/74 Effectivity, T-27B, S/N 510S and up; T-30B and T-30B/B, S/N 905 and up and T-30B-S302 and T-30B-S304, S/N 909 and up.

SECTION I
DESCRIPTION

1.1 GENERAL

The T-27B VOR Ramp Tester is a miniature VOR transmitter. It generates 0°, 90°, 180° and 270° "To" and "From" signals on the 108.0 MHz VOR channel. Provision is included for generating a bearing which is continuously variable ± 10° at 100° "To" or 280° "From". It also generates a 1020 Hz tone for checking the audio circuits of the receiver.

A 54 MHz crystal controlled oscillator is fed to an amplifier-doubler which delivers 108 MHz to the antenna. The 108 MHz carrier is amplitude modulated with a combined 30 Hz signal and a 9960 Hz frequency modulated signal or with a 1020 Hz tone signal.

An integrated circuit Wien Bridge oscillator supplies the low distortion 30 Hz signal which is used to frequency modulate the 9960 Hz generator. The 30 Hz signal is also fed to an inverter and RC phase shifter to generate any of the four bearings as selected by a front panel control. A front panel toggle switch causes a change of ± 1° in the selected bearing to check for sticky meter needle. The 30 Hz and 9960 Hz generators are temperature compensated for frequency stability.

Four 9 volt batteries in series-parallel supply 18 volts to an integrated circuit voltage regulator and metering circuit which delivers 7½ V as long as the battery voltage remains above 9.5 volts. When the battery voltage falls below 9.5 volts the meter falls to the red scale indicating that the batteries must be replaced.

SECTION 2
OPERATION

2.1 GENERAL

Tune the VOR receivers in the aircraft to 108.00 MC. Extend the 4" antenna of the T-27B VOR test set. Note the five operating controls on the front panel:

1. On-Off Power Switch - Spring return

2. Bearing Switch - Five position 0°, 90°, 180°, 270° "To" and "From" and "Variable"

3. ± 1° Switch - Spring return

4. Tone Switch - Spring return

5. Variable Bearing Control - Varies ± 10° from 100° "To" or 280° "From"

ON-OFF SWITCH

The On-Off switch must be depressed in order for the test set to operate in any of its functions.

VOR BEARING SWITCH

To perform the VOR bearing check, the T-27B bearing selector switch should be set to either 0°, 90°, 180°, or 270°. The same bearing should be set into the VOR indicator with the OBS. By depressing the power switch the OBI should center on the indicator showing an "On Course" indication. Note that the bearing selector switch offers "To" and "From" readings which should correspond with the information in the VOR indicator. If the OBI does not center, rotate the OBS until it does. It should be noted that the RMI will show corresponding readings. The amount of movement in degrees required to center the needle can be read as the bearing error at that particular heading. The same check can be made at all other points. The accuracy at 0° and 180° is less than 0.5° whereas at 90° and 270°, it is better than 2°. The purpose of the 90° and 270° bearing check is to establish that the goniometer winding in the VOR indicator is not open and therefore the accuracy is not of utmost importance.

± 1° SWITCH

In any of the four selected bearings, a VOR "sticky needle" check can be made by moving the ±1° switch up or down and noting the one degree change in the OBI. This small shift of 1° assures the free movement of the indicator needle.

TONE SWITCH

The tone switch, when depressed, will operate a 1020~ tone thru the audio circuit of the VOR receiver thereby checking the audio system switching as well as the receivers.

VARIABLE COURSE KNOB

The Variable Course knob is operable when the VOR Bearing Switch is indexed to the variable position and the power switch is depressed. The dot on the Variable Control knob, when lined up with the reference line, is approximately the 100° radial on a "To" heading. With the VOR OBS set to approximately 100°, a change of ± 10° can be effected by varying the Variable Control knob left or right. This function permits an armed flight director to capture in a simulated VOR approach. The variation in the course is provided by the Variable Course knob and eliminates the need to reach over the control yoke and manually turn the OBS knob on the VOR indicator.

SECTION 3
THEORY OF OPERATION

3.1 POWER SUPPLY

The power supply consists of four 9 volt batteries connected in series-parallel to supply 18 volts to the battery voltage regulator IC1. The voltage regulator maintains the output voltage constant as long as the battery voltage exceeds the output voltage by about 2½ V. Voltage Adjust potentiometers, R2, is used to set the output to 7½ V.

Q2 is connected across the battery to monitor the battery terminal voltage and operate the Battery Check meter. R1 is adjusted so the collector current of Q2 falls to zero (red scale on meter) before the regulator, IC1, goes of regulation due to low battery voltage. Therefore, the Battery Check meter will be in the red when the battery voltage has fallen to about 10V.

3.2 30 Hz OSCILLATOR

The 30 Hz signal is generated by a conventional Wien Bridge oscillator using an integrated circuit IC2. The frequency selective branches of the bridge are composed of C8, R30, and C7, R33, R8, R65. The resistive branches of the bridge are composed of R10, and a lamp, DS1, whose positive temperature coefficient stabilizes the oscillator output level.

Negative feedback is applied to pin 2 of IC2 and positive feedback is applied to pin 3 of IC2. The amount of negative feedback is adjusted by R9 to limit the distortion in the output signal to less than ½%. The oscillator output at pin 6 of IC2 is divided down by R38 and R71 to avoid overloading of the following stages.

Tone switch S1, changes the value of resistance in the RC branches of the Wien Bridge so the circuit oscillates at 1020 Hz.

3.3 PHASE-SHIFTING AND DEVIATION CONTROL CIRCUITS:

The 30 Hz signal from the oscillator is fed to the base of the para-phase amplifier Q5. The collector signal of Q5 (which is 180° out of phase with the emitter signal) is fed to the base of emitter follower Q4. The Q4 and Q5 emitter signals are used as the 0° "TO" and 180° "TO" bearings respectively. The 90° and 270° bearings are supplied by a 45° RC phase-shifting network connected between the emitters of Q4 and Q5. In the "Variable" position, a front panel control is connected in the 90° circuit to allow a continuously variable phase shift of approximately 20°, from 90° to 110°.

The gain control, R4, in the collector of Q5 is adjusted so the amplitudes at the emitters of Q4 and Q5 are equal. The adjustable RC combination (R5, C4) provides the slight correction necessary to compensate for phase shift in the amplifier. When C9 is switched in by S2 a deviation of plus or minus 1° is introduced.

Transistor Q10 is an emitter follower used as a buffer between the phase and deviation adjusting circuitry.

Potentiometer, R12, in the emitter of Q10 adjusts the level of the 30 Hz signal to the proper value for ± 480 Hz deviation of the 9960 Hz generator.

3.4 9960 Hz GENERATOR:

The 9960 Hz generator is an astable multivibrator (Q11 and Q12). The frequency is determined by the cross-coupling capacitors, C21 and C22, and the base bias voltage. The base bias voltage dividers, R44, R45, R48, and R51, are returned to potentiometer R14, which is adjusted for 9960 Hz. The four diodes, CR3-CR6, provide temperature compensation and tend to keep the frequency constant with temperature.

The 30 Hz signal from Q10 is applied to both bases through R49 and R50. This 30 Hz signal on the bases causes the 9960 Hz to vary in frequency, resulting in frequency modulation of the 9960 Hz at a 30 Hz rate. The deviation of the 9960 Hz signal is determined by the amplitude of the 30 Hz signal applied to the transistor bases.

The square wave output at the collector of Q11 is changed to a sine wave through the filtering action of R41, C24 and L7, C20.

3.5 MIXING AND AMPLIFYING CIRCUITS

The phase-shifted 30 Hz signal from the phase shifter is fed to the gate of source-follower Q13, and the filtered 9960 Hz from the 9960 Hz generator is fed to the base of emitter follower Q14. The source output of Q13 and the emitter output of Q14 are mixed in potentiometer R15, whose arm is adjusted to the point at which the 30 Hz and 9960 Hz signals are of equal amplitude.

The mixed 30 Hz and 9960 Hz signals at the arm of R15 are amplified by Q15. The potentiometer, R16, in the emitter of Q15, adjusts the gain of the amplifier by adjusting the amount of negative feedback applied to Q15 from the auxiliary R. F. detector, CR2, C25 and R69. This negative feedback serves to improve the waveshape of the output signal.

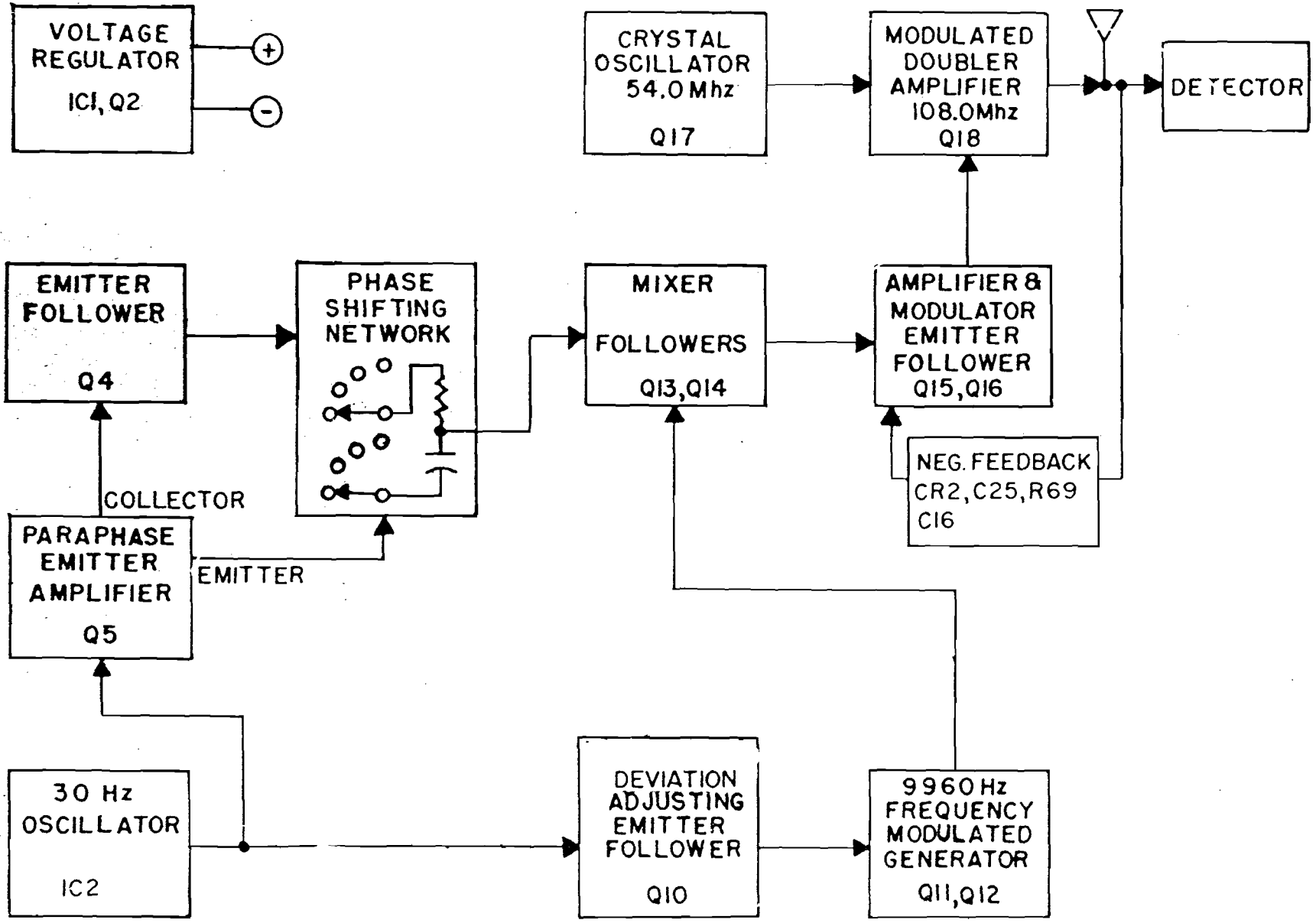
3.6 MODULATOR AND R. F. CIRCUITS

Transistor Q17 is a Colpitts-type crystal oscillator. The tank circuit (L1, C30 and C31) in the collector is tuned to 54 MHz. The crystal, Y1, operates in the series resonant mode and provides a low impedance feedback path to the emitter to sustain oscillation.

The secondary winding of L1 is coupled to the base of the modulated amplifier-doubler Q18. This transistor is normally cut off and is turned on by the positive peaks of the oscillator signal. The tank circuit (L2, C35) in the collector of Q18 is tuned to the second harmonic of the crystal oscillator to achieve doubling.

The emitter of Q18 is returned to ground through the modulator, Q16. This transistor is an emitter follower whose base voltage consists of a D.C. voltage determined by the setting of R17, and the amplified VOR signals, resulting in a varying D. C. voltage at its emitter. This varying voltage modulates the collector current of the amplifier-doubler Q18.

Diode, CR7, is a built-in detector which is used when adjusting the R. F. circuits. The output of the detector can also be used for checking the bearing accuracy of the T-27B, as described in Section 4.7.1 of the Trouble Shooting and Maintenance section of this book.



BLOCK DIAGRAM

SECTION 4
TROUBLE SHOOTING AND MAINTENANCE

4.1 MAINTENANCE:

This unit should require very little maintenance other than replacement of batteries. In order to replace the batteries, remove the unit from the case by taking out the four screws underneath the case. Lift off the battery connector board (use a screwdriver if necessary) and replace the batteries. CAUTION: Be sure to observe correct polarity.

If a unit should become inoperative isolate the defective section by following the procedures outlined as indicated in the adjustments below. After the defective section has been found, replace the associated transistors taking care to insert them correctly into their sockets. If new transistors do not correct the trouble and it becomes necessary to unsolder components, great care should be excercised to avoid damaging the printed circuit board. When troubleshooting the unit, refer to the block diagram and "Theory of Operation" section.

To remove the circuit board for service, consult Fig. 1Ca & 1Cb

Remove the four screws marked "A" unsolder the lead to the antenna, and slide the board out.

To replace the antenna, unscrew the teflon stop from the end of the antenna and pull the antenna out. Insert the replacement antenna and screw it into the teflon stop. See Fig. 1Cb.

4.2 VOLTAGE REGULATOR ADJUSTMENT:

1. Set D. C. power supply to 18V and connect to T-27B in place of batteries.

2. Turn on T-27B and adjust R2 (D. C. Voltage Control) for 7½V across TP1 and TP2. (To increase the R. F. output this voltage can be increased to 8½V with a resulting decrease in battery life.)

3. Reduce D. C. supply voltage slowly while monitoring Battery Check meter and voltage across TP1 and TP2. Voltage across TP1 and TP2 should not change before the Battery Check meter falls to the red scale. At this point the external D. C. supply voltage should be 10½V or less. If necessary, adjust R1 so the meter falls to the red scale just before the voltage at TP1 starts to fall.

VOR

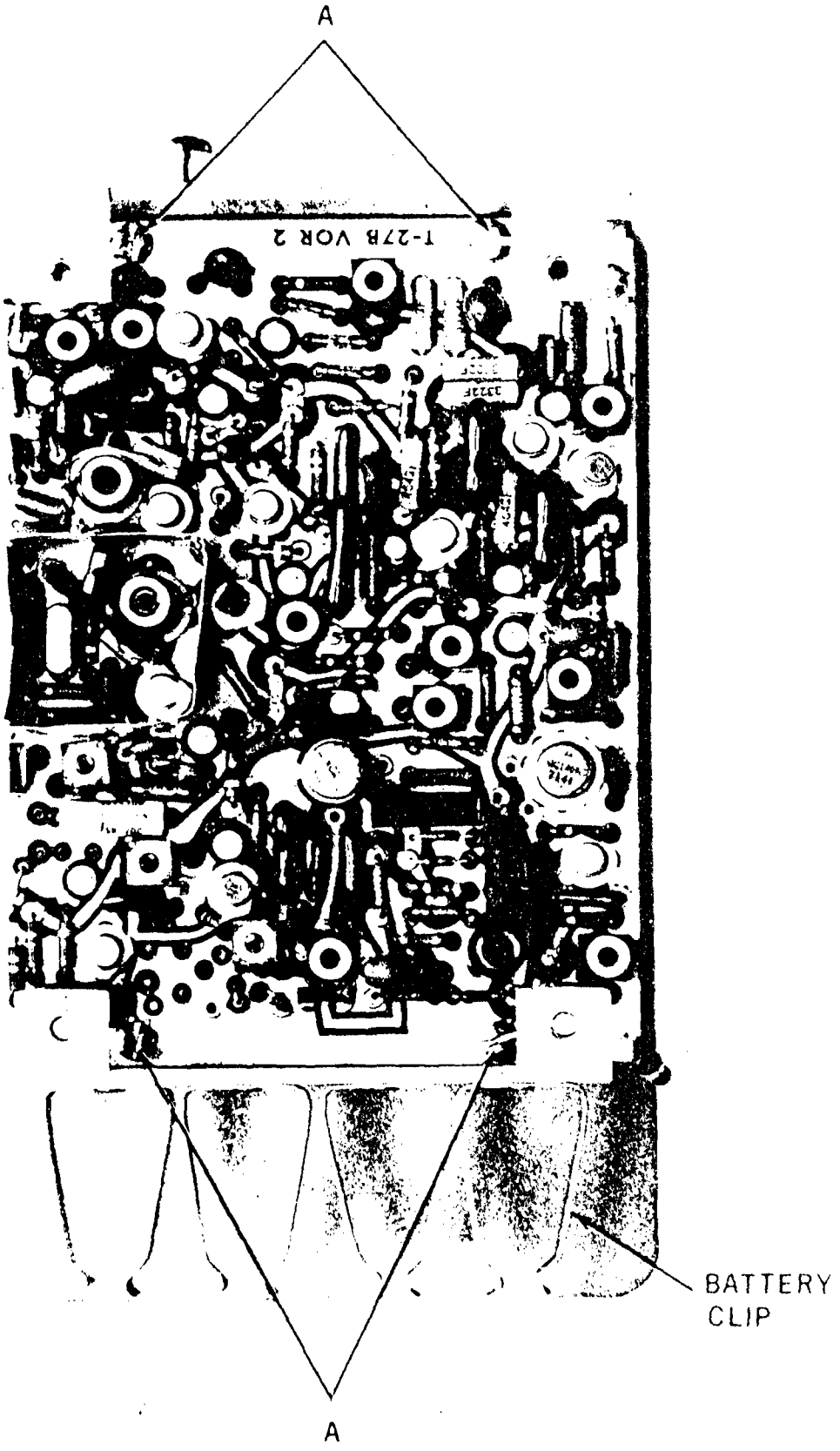


Figure 1Ca

VOR

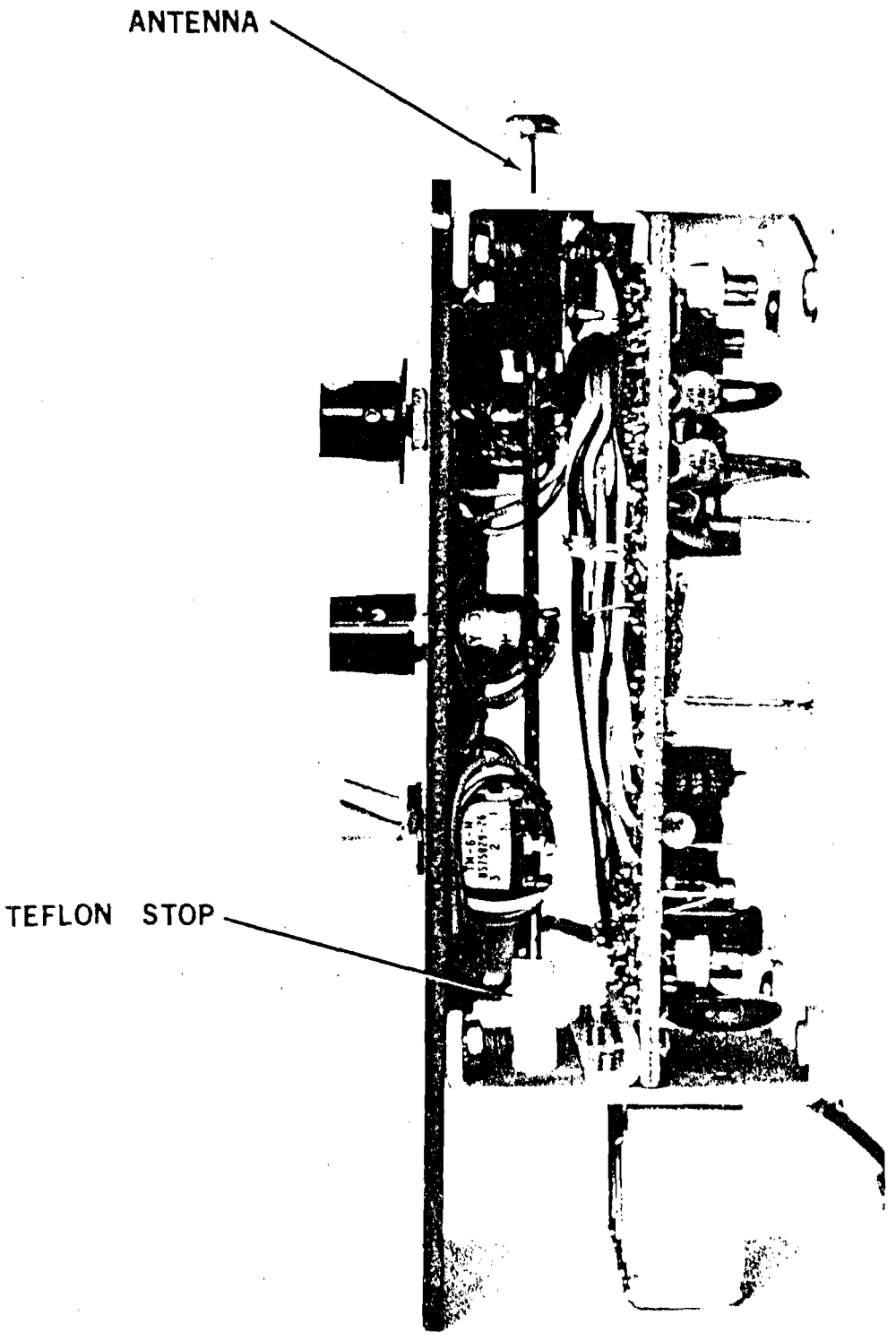


Figure 1Cb

4.3 30 Hz OSCILLATOR ADJUSTMENT

1. Connect scope, counter and distortion analyzer to TP3. (Use series capacitor in counter lead to remove D. C. component.)

2. Turn on Power switch on T-27B front panel.

3. Adjust R8 (30 Hz Freq.) so counter indicates 30 Hz.

4. Turn on Tone switch (keeping Power switch On) and adjust R7 (1020 Hz freq.) so counter indicates 1020 Hz.

5. Release Tone switch and adjust R9 (Dist. Control) to the point where the signal just starts to clip, then reduce the level 5% with R9. Distortion should be less than 1/2%.

4.4. PRELIMINARY PHASE SHIFTER ADJUSTMENTS

1. Set front panel Phase Switch at 0° "TO". Connect scope to TP13 and set scope for a convenient level.

2. Connect scope to TP12 and adjust R4 (0° - 180° Level Balance) so amplitude of 30 Hz signal is 90% of level noted in step 1.

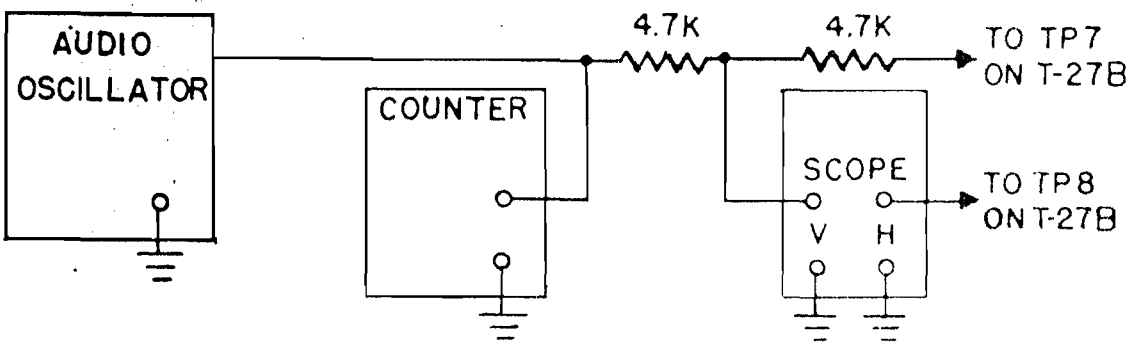
3. Connect TP10 to vertical scope amplifier and TP4 to horizontal scope amplifier to form 30 Hz Lissajous and remove Q11 from socket. If clipping is evident at TP10 adjust R16 (Amp. Gain).

4. With front panel Phase Switch at 0° adjust R5 (0° Phase Adjust) so scope pattern shows 0° phase shift.

5. With front panel Phase Switch at 180° scope pattern shows 180° phase shift, ± 1°.

6. With front panel Phase Switch at 0° check operation of the front panel ± 1° Phase Switch. (To measure 1° on the scope Lissajous pattern, set the vertical and horizontal gain for a 3 cm by 3 cm display. Then increase the vertical and horizontal gain by a factor of 10. With this pattern, a 1° phase shift results in an opening of 1/2 cm in the Lissajous.

7. Connect scope, oscillator, and counter as shown in Figure 1B and replace Q11 in socket.



Setup for checking 9960 Hz deviation and 90°, 270°, phase shift.

Fig. 1B

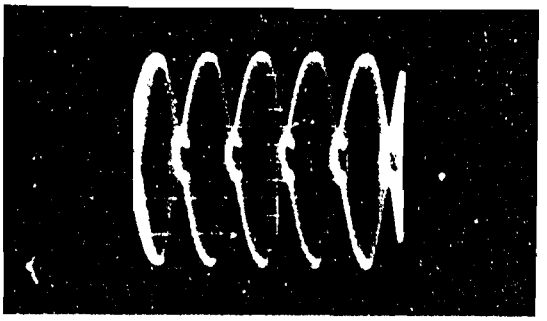


Fig. 2B

8. Turn T-27B Phase Switch to 90° and set external audio oscillator to 9960 Hz.

9. Carefully adjust R14 (9960 Hz Freq. Adj.) for stationary pattern on scope as shown in Fig. 2B. (Adjust external audio oscillator amplitude to make lobes in pattern clearly evident.)

10. Adjust R12 (FM Deviation) for 5.1 lobes as shown in the figure. This corresponds to ± 480 Hz deviation.

11. Adjust R6 (Quad. Phase Adjust) so the lobes overlap indicating 90° phase shift. Operate ± 1° Phase Switch on front panel and note change in overlap condition of scope pattern.

12. With T-27B Phase Switch at 270° the lobes should overlap as in step 10, ± 2°.

(To maintain a stationary pattern requires that both 9960 Hz generator frequencies be identical. It may be necessary to readjust the external audio oscillator to compensate for slight frequency drift.)

4.5 MIXER AMPLIFIER ADJUSTMENT:

1. Connect scope to TP10 and adjust R15 (Mixer adj.) for equal amplitudes of 30 Hz and 9960 Hz as shown in Fig. 3B.

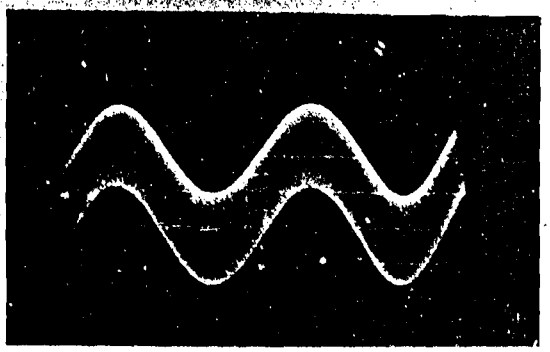


Fig. 3B

2. Adjust R16 (Amp. Gain) to eliminate clipping.

4.6 MODULATOR AND R. F. SECTION:

NOTE: A threaded plastic lock is used in coils L1 and L2. To adjust these coils remove the locks with a screwdriver and restore them after adjustments have been made.

1. Extend T-27B antenna and connect D. C. scope input and VTVM to TP11. Connect ground lead of scope and VTVM to TP1.

2. Adjust L1 for maximum D. C. output and signal linearity at TP11.

3. Adjust L2 for maximum D. C. output and signal linearity at TP11.

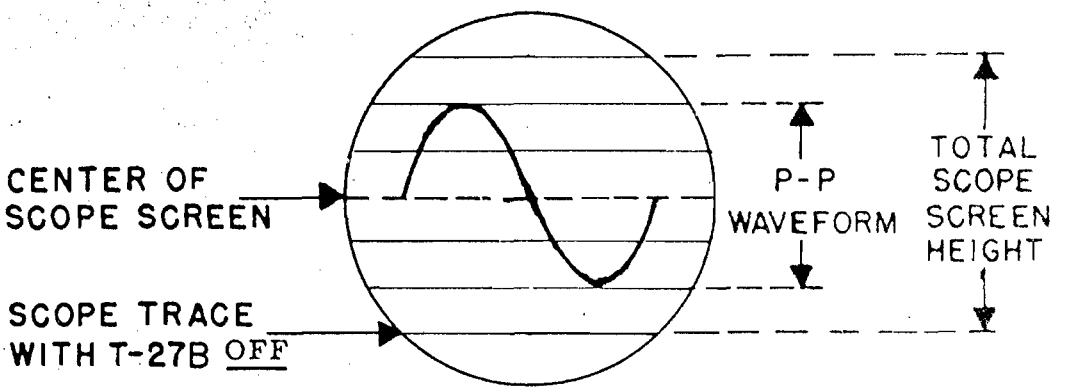
4. Make approximate adjustment of % modulation as follows:

   a. Leave scope as in step 1.

   b. With T-27B power switch off, position scope trace to bottom of screen.

   c. Turn on T-27B. Adjust scope gain so center of waveform is at center of scope screen. (Recheck position of scope trace with T-27B off.)

   d. Calculate % modulation. This is equal to 100 times peak-to-peak wave-form divided by total scope screen height. See Fig. 4B.



$$\% \text{ MODULATION} = \frac{\text{P - P Waveform X 100}}{\text{Total Scope Screen Height}} = \frac{400}{6} = 66.6\%$$

FIG. 4B

e. Adjust R17 (% Modulation Adj.) for 80% modulation. This is actually about 60% modulation, due to voltage drop in the detector diode CR7.

f. If % modulation is too high, adjust R16 (Amp. Gain.)

5. The D. C. voltage measured at TP11 should now be greater than 0.6V and the R. F. voltage measured at the base of the antenna should be greater than 0.5Vrms. (Use Sampling Voltmeter to measure R.F.)

6. For accurate % modulation measurements, couple the % Modulation meter to the T-27B antenna through a 1 inch loop, remove transistor Q8 to eliminate 30 Hz signal and adjust % modulation for 30% as measured on the modulation meter.

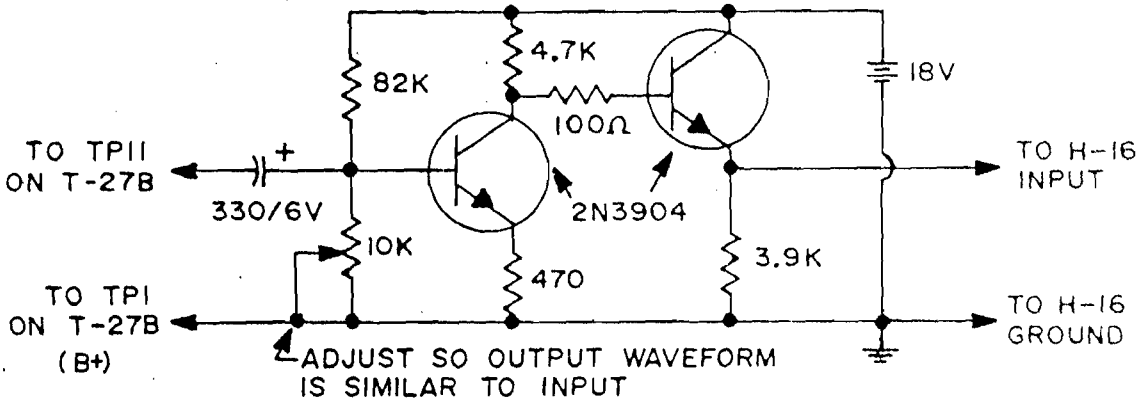
7. Replace Q8 and connect scope to TP10. At this point the 30 Hz and 9960 Hz signal should be of equal amplitude. If they are not equal, readjust R15 (Mixer adj.) and repeat step 6.

NOTE: The AFM1% Modulation meter falls off at 30 Hz so a measurement of % modulation at 30 Hz would be inaccurate. A measurement of the combined VOR signal would also be inaccurate since the AFMI does not respond accurately to the high frequency and low duty cycle of the VOR signal.

8. Check output frequency by coupling the counter to the T-27B antenna through a 1 inch loop. (Remove transistor Q15 to eliminate spurious counts caused by modulation.)

4.7 FINAL PHASE SHIFTER ADJUSTMENT:

1. The ARC H-16 Course Checker can be used to adjust 0° and check the accuracy of the 180° and ± 1° bearing directly out of the built-in detector. To do this, a low phase-shift amplifier is required to drive the H-16 Course Checker. A schematic for such an amplifier is shown in Fig. 5B.



CAUTION: DO NOT CONNECT T-27B GROUND TO H-16 GROUND

FIG. 5B

2. Connect T-27B, low phase-shift amplifier and H-16 as shown in Fig. 5B. There is a basic difference of 0.7° between 0° VOR as measured with a Collins Zifor and as measured with an ARC H-16A. VOR's in private aircraft are usually set to ARC 0°, while airline equipment is usually set to Zifor 0°. Settings are given below for both types of 0°.

   Set T-27B Phase Switch at 0° "TO" (Amp. introduces 180° inversion). Set up H-16 front panel controls as described in the H-16 Instruction Book. Switch H-16 to measure 180° and adjust R5 (0° Phase Adj.) on T-27B for 0° on the H-16 meter. (To calibrate for Zifor Zero adjust R5 for + 0.7° on the H-16 meter.)

4. Operate ± 1° Phase Switch and note that H-16 meter deviates plus and minus 1°.

5. Set T-27B Phase Switch at 180° "TO" (Amp. introduces 180° inversion). Set up H-16 front panel controls as described in the H-16 Instruction Book. Switch H-16 to measure 0° "TO" and read 0° on the H-16 meter. (+0.7° for Zifor Zero.)

   Note: With the T-27B Phase Switch at 0° "TO" the specified accuracy is ± 0.5°. The accuracy with the T-27B Phase Switch at 180° "TO" can be brought to ±0.5° by adjusting R5 to split the error at 0° and 180°.

6. To adjust the 90° and 270° positions of the T-27B, radiate the signal from the T-27B antenna into the antenna of a Test Bench receiver of known accuracy.

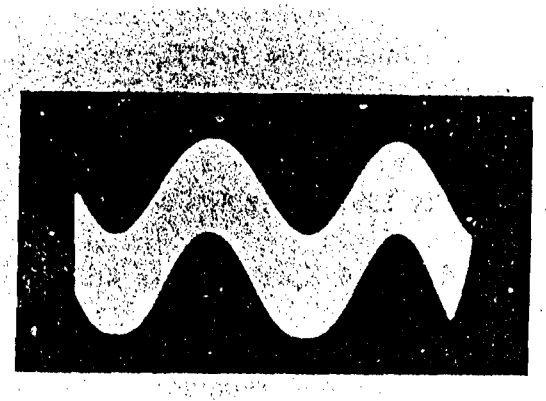
7. Set VOR Test Bench receiver to 108.0 MHz and 90° "TO".

8. Set T-27B to 90° "TO" and adjust R6 "Quad. Phase Adj." pot to center receiver needle.

9. Switch T-27B to 270° "TO". Leave VOR receiver at 90° "TO". Adjust R4 "Level-Balance" pot to center receiver needle.

10. Steps 8 and 9 are interacting so they must be repeated until the required accuracy is obtained.

11. Switch T-27B and VOR receiver to 270° "TO" as a final check of accuracy at 270° "TO".



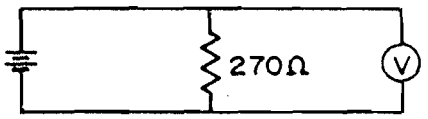
T-27B detector output signal. 8ms/cm Horizontal. .43V/cm Vertical.

FIG. 6B

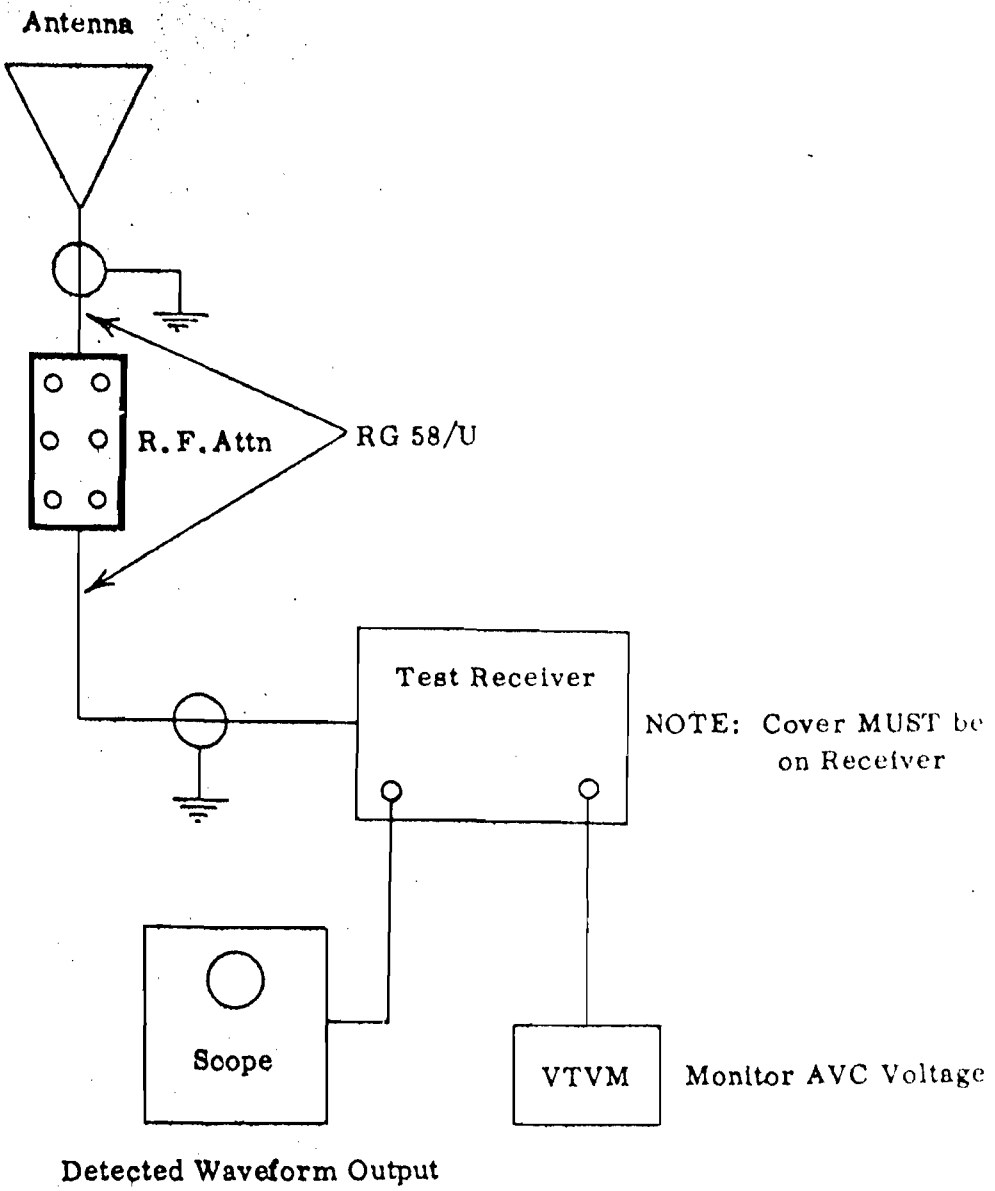
IMPORTANT NOTE: The same equipment should be used to calibrate the T-27B as is used to "bench test" the aircraft receivers. This will minimize the possibility of problems caused by tolerances in test equipment specifications.

When the ramp test set is checked against a test bench receiver the output from the ramp test set may be sufficient to overload the receiver. In this case an attenuator can be placed in the cable from the receiver antenna. The attenuation should be sufficient to insure that the receiver is not being overloaded. The input to the receiver can be determined by first measuring the A.V.C. voltage of the test receiver with the ramp test set turned on. Then feed a signal generator equipped with a calibrated attenuator into the receiver and determine what value of signal is required to achieve the same A.V.C. voltage as before.

NOTE: In some cases it has been observed that brand new batteries have been found defective. Therefore it is recommended that all new batteries be checked under load before operation. They can be checked in the circuit shown:



If the voltage falls rapidly (0.4V or more) in 5 minutes the battery should be considered defective.



TYPICAL TEST RECEIVER SET-UP

SECTION 5
TEST EQUIPMENT AND TOOLS

5.1 INSTRUMENTS REQUIRED:

ARC Model H-16 Standard Course Checker or Equivalent
VTVM
Oscilloscope D. C. 100 kHz or more
Electronic Counter
Distortion Analyzer
% Modulation Meter. Radiometer AFM 1 or equivalent
D.C. power supply Adjustable 5-20 V
Broadband Sampling Voltmeter HP Model 3406A or equivalent
VOR Receiver
Navcom Signal Generator TIC type T-12A e/w T-12-1A VHF Com/Nav Plug-in unit or equivalent

The radiation pattern of the ramp tester is affected by its metal case. For this reason it is recommended that the final adjustments be made with the unit placed in a test case which has been drilled to allow access to the necessary adjustments. A pre-drilled case is available from TIC and is identified as a "T-30A/T-30B Test Jig".

T-27B VOR MAIN CHASSIS

ITEM	DESCRIPTION	CIRCUIT DESIGNATION	QTY	TIC PART #
1	ANTENNA TIC DWG. NO. T-27A-60-5-A	A1	1	TA-2-A
2	BATTERY EVEREADY #222	BT1 thru BT4 Incl.	4	TB-8
3	" CLIP ASSEMBLY FOR 4 BATTERIES		1	TC-181-A
4	CAPACITOR FIXED MYLAR TUBULAR 0.0047 μF 100V 10% CORNELL-DUBILIER WMF1D47	C38	1	TC-101
5	CLIP KEYSTONE 80		4	TH-10
6	INDUCTOR FIXED ANTENNA TIC MFR.	L4	1	TC-205C
7	KNOB NOBEX 1-503	VARIABLE	1	TK-15
8	" NOBEX 1-504D	SELECTOR	1	TK-16
9	METER EMICO 802 PWR	M1	1	TM-7
10	RESISTOR VARIABLE COMPOSITION 10K ALLEN-BRADLEY RV6NAYSD103A (TIC MOD.)	R54	1	TP-66
11	SWITCH ROTARY GRAYHILL 50CD36-01-2-5N (TIC MOD.)	S3	1	TS-75
12	" TOGGLE ARROW-HART & HEGEMAN TG-3-M	S2	1	TS-77
13	" " ARROW-HART & HEGEMAN TM-3-M	S4	1	TS-78
14	" " ARROW-HART & HEGEMAN TM-6-M	S1	1	TS-81

T-27B PRINTED CIRCUIT BOARD

ITEM	DESCRIPTION	CIRCUIT DESIGNATION	QTY	TIC PART #
1	CAPACITOR FIXED DIPPED MICA 100 pF 5% SANGAMO DM155F101J	C25, C36	2	TC-49
2	" " " " 470 pF 5% SANGAMO DM195F471J	C11	1	TC-50-A
3	" " " " 2.2K pF 5% SANGAMO DM195F222J	C24	1	TC-53
4	" " " " 3K pF 5% SANGAMO DM195F302J	C21, C22	2	TC-53-A
5	" " CERAMIC DISC 47 pF CENTRALAB DD470	C32, C34	2	TC-77
6	" " " " 470 pF CORNELL - DUBILIER BYZ601ZU471P	C26 thru C29 Incl., C33	5	TC-90
7	" " " " 1K pF ERIE TECHN. PROD. 801	C1, C20	2	TC-94
8	" " " 0.1 μF 25V SPRAGUE 5C023104X250B3	C5, C6, C39	3	TC-122
9	" " " 0.47 μF 50V SPRAGUE 7C023474X0500E	C19	1	TC-139
10	" " MICA 5 pF CM15C050J	C35	1	TC-11
11	" " " 33 pF CM15C330J	C30, C31	2	TC-17
12	" ELECTROLYTIC TANTALUM 330 μF 6V SPRAGUE 196D337X0006MA3	C3	1	TC-174
13	" " " 100 μF 10V SPRAGUE 196D107X0010LA3	C10	1	TC-168
14	" " " 220 μF 10V SPRAGUE 196227X0010MA3	C16	1	TC-173-1
15	" " " 15 μF 15V SPRAGUE 196D156X0015JE3	C12, C13	2	TC-152

T-27B PRINTED CIRCUIT BOARD

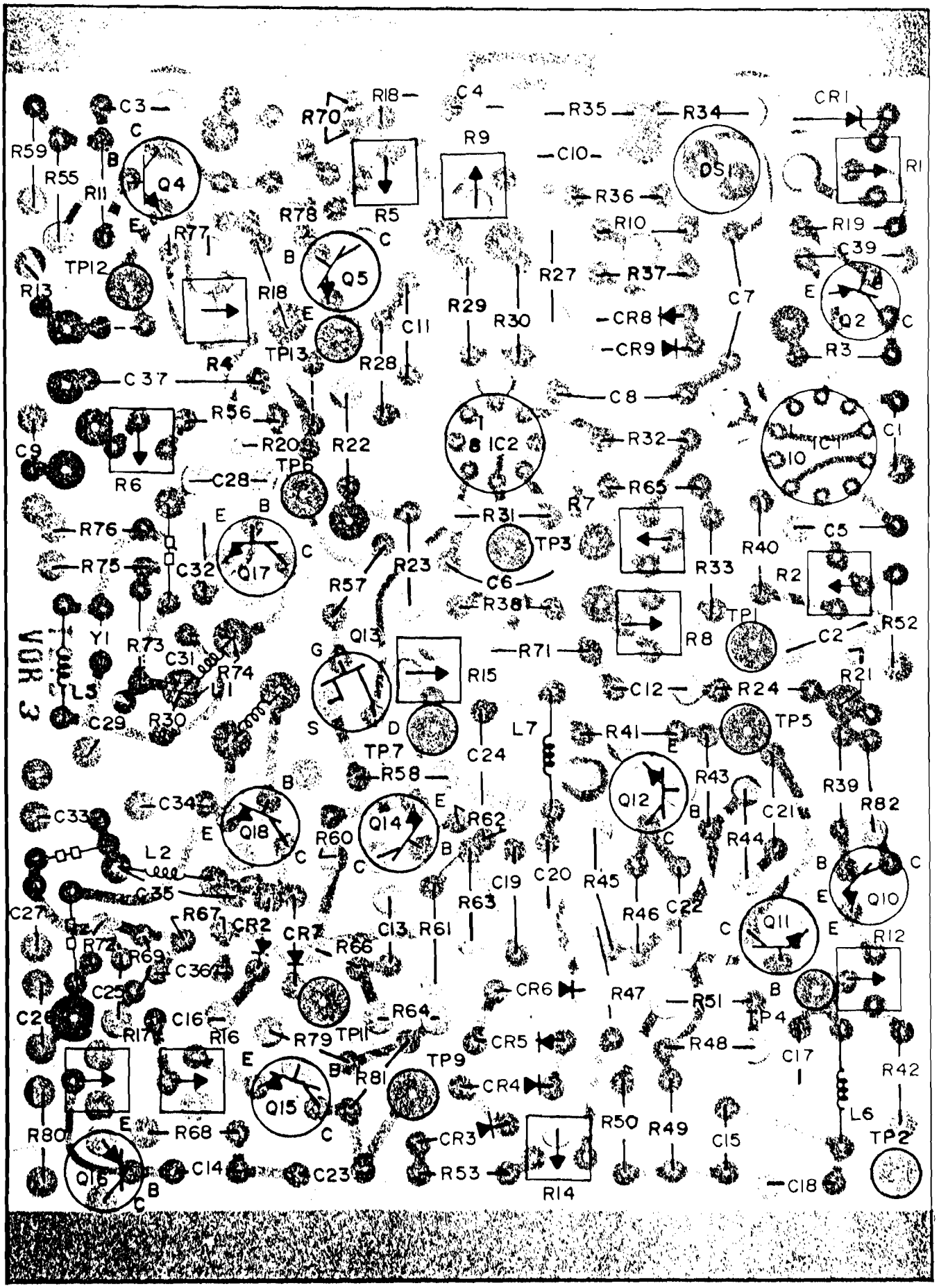
ITEM	DESCRIPTION	CIRCUIT DESIGNATION	QTY	TIC PART #
16	CAPACITOR ELECTROLYTIC TANTALUM 68 µF 15V SPRAGUE 196D686X0015LA3	C14, C23	2	TC-166
17	" " " 22 µF 25V SPRAGUE 196D226X0025LA3	C2	1	TC-156
18	" " " 33 µF 25V SPRAGUE 196D336X0025LA3	C15	1	TC-161
19	" FIXED POLYCARBONATE 0.0047 µF 50V 5% TRW X440	C17, C18	2	TC-100-A
20	" " " 0.015 µF 50V 5% TRW X440	C4	1	TC-106-A
21	" " " 0.039 µF 50V 5% TRW X440	C9	1	TC-113-A
22	" " " 0.22 µF 50V 5% TRW X463UW	C37	1	TC-131
23	" " PARY-L 0.047 µF 50V KEMET KC4702FK50J	C7, C8	2	TC-114-B
24	CRYSTAL 54.0 MHz TIC-55 PIEZO 6082291	Y1	1	TC-269
25	DIODE SILICON 1N87A	CR2 thru CR6 Incl., CR7	6	TD-7
26	" SILICON 1N4148	CR8, CR9	2	TD-19A
27	" ZENER 1N959B 8.2V	CR1	1	TD-13
28	INDUCTOR FIXED 1 µH CRAMER 190-1	L5	1	TC-196
29	" " 150 µH STANWYCK DINK 150,000	L6, L7	2	TC-200
30	" VARIABLE OSCILLATOR TIC MFR.	L1	1	TC-204B
31	" " AMPLIFIER - DOUBLER TIC MFR.	L2	1	TC-204A

ITEM	DESCRIPTION	CIRCUIT DESIGNATION	QTY	TIC PART #
32	INSERT LOCKING CAMBRIDGE THERMIONIC CORP. #2208-1	(Used on L1 & L2)	2	TI-5
33	INTEGRATED CIRCUIT MOTOROLA MC1469G	IC1	1	TMC1469G
34	" " RCA CA3078T	IC2	1	TCA3078T
35	LAMP SYLVANIA 913	DS1	1	TL-2-A
36	RESISTOR FIXED COMPOSITION 100Ω 1/4W 10% ALLEN-BRADLEY CB1011	R11,19,39,57,62,78	6	TR-145
37	" " " 150Ω 1/4W 10% ALLEN-BRADLEY CB1511	R76	1	TR-146-A
38	" " " 220Ω 1/4W 10% ALLEN-BRADLEY CB2211	R42	1	TR-148
39	" " " 1K 1/4W 10% ALLEN-BRADLEY CB1021	R13,R74,R81	3	TR-155
40	" " " 1.5K 1/4W 10% ALLEN-BRADLEY CB1521	R43,R53,R75	3	TR-157
41	" " " 1.8K 1/4W 10% ALLEN-BRADLEY CB1821	R67,R69	2	TR-158
42	" " " 2.7K 1/4W 10% ALLEN-BRADLEY CB2721	R47	1	TR-160
43	" " " 3.9K 1/4W 10% ALLEN-BRADLEY CB3921	R22,58,60,73	4	TR-162
44	" " " 4.7K 1/4W 10% ALLEN-BRADLEY CB4721	R37,R38	2	TR-163

T-27B PRINTED CIRCUIT BOARD

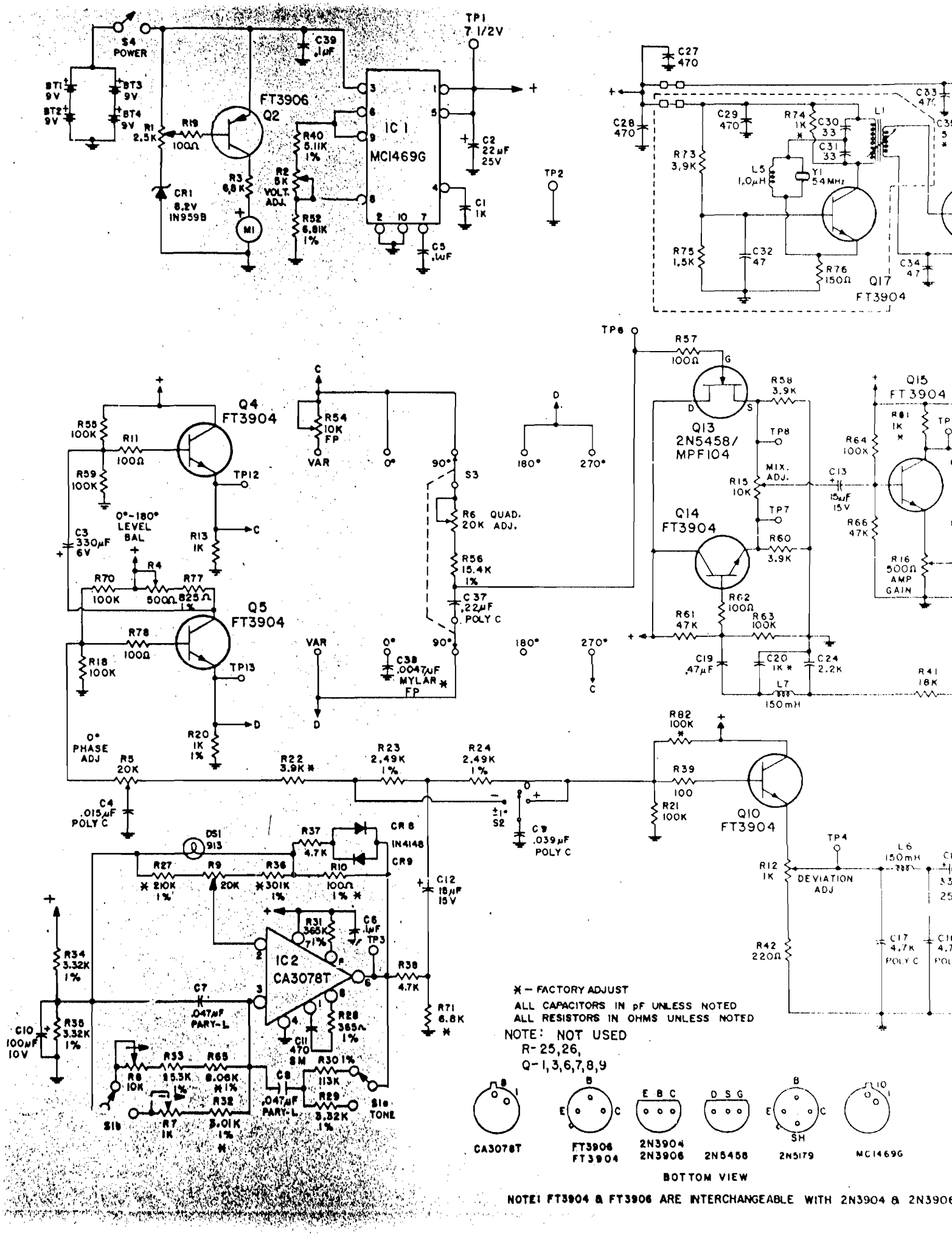
ITEM	DESCRIPTION	CIRCUIT DESIGNATION	QTY	TIC PART #
45	RESISTOR FIXED COMPOSITION 5.6K 1/4W 10% ALLEN-BRADLEY CB5621	R46	1	TR-164
46	" " " 6.8K 1/4W 10% ALLEN-BRADLEY CB6821	R3, R71, R79	3	TR-165
47	" " " 10K 1/4W 10% ALLEN-BRADLEY CB1031	R72	1	TR-167
48	" " " 12K 1/4W 10% ALLEN-BRADLEY CB1231	R80	1	TR-168
49	" " " 18K 1/4W 10% ALLEN-BRADLEY CB1831	R41	1	TR-170
50	" " " 47K 1/4W 10% ALLEN-BRADLEY CB4731	R61, R66	2	TR-175
51	" " " 100K 1/4W 10% ALLEN-BRADLEY CB1041	R18, 21, 55, 59, 63, 64, 68, 70, 82	9	TR-179
52	" " METAL FILM 100Ω 1% RN55C	R10	1	
53	" " " " 365Ω 1% RN55C	R28	1	
54	" " " " 825Ω 1% RN55C	R77	1	
55	" " " " 1K 1% RN55C	R20	1	
56	" " " " 2.49K 1% RN55C	R23, R24	2	
57	" " " " 3.01K 1% RN55C	R32	1	
58	" " " " 3.32K 1% RN55C	R29, R34, R35	3	
59	" " " " 6.81K 1% RN55C	R40, R52	2	
60	" " " " 8.06K 1% RN55C	R65	1	
61	" " " " 15.4K 1% RN55C	R56	1	
62	" " " " 33.2K 1% RN55C	R48, 49, 50, 51	4	
63	" " " " 46.4K 1% RN55C	R44, R45	2	
64	" " " " 102K 1% RN55C	R33	1	

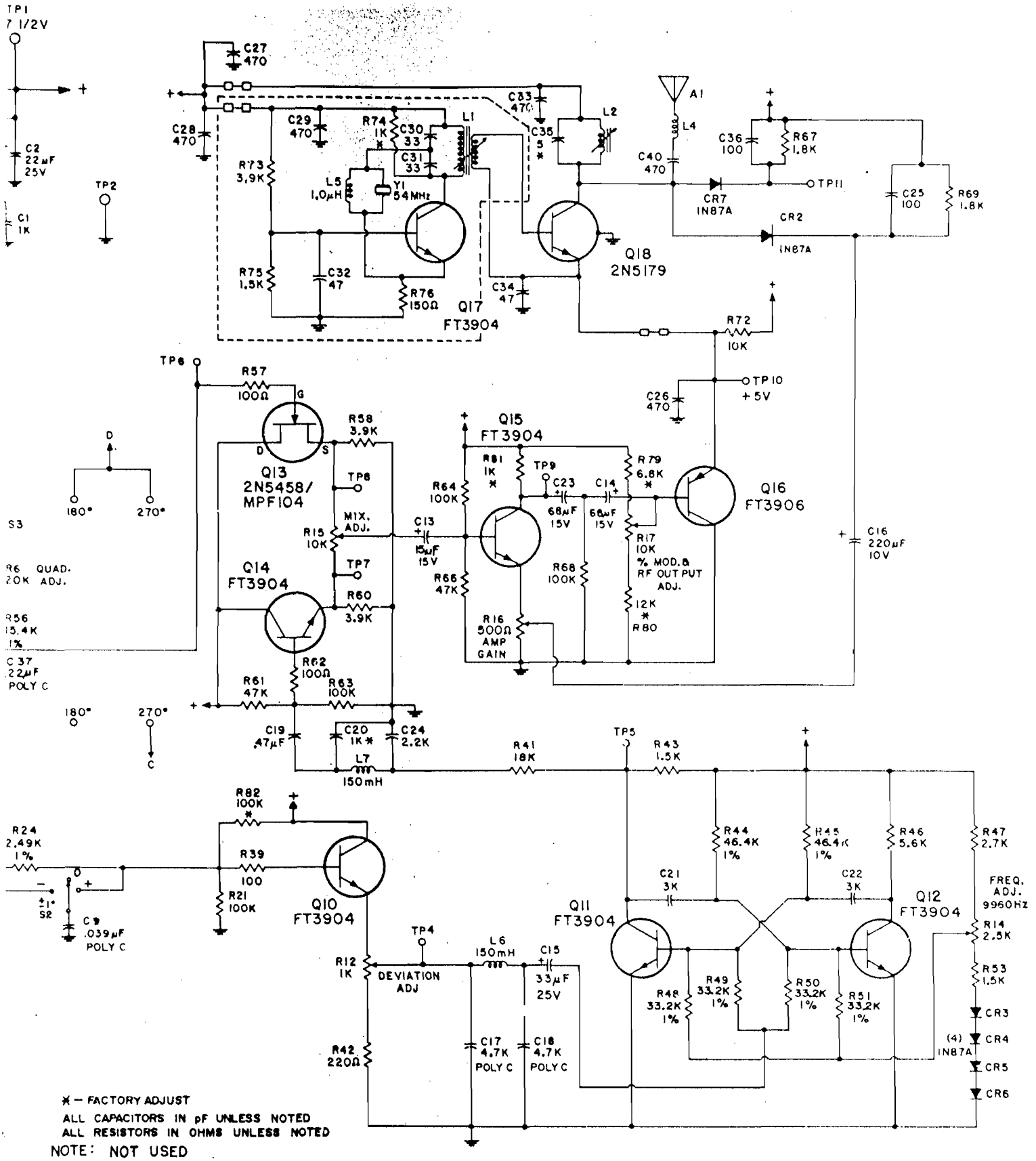
ITEM	DESCRIPTION	CIRCUIT DESIGNATION	QTY	TIC PART #
65	RESISTOR FIXED METAL FILM 113K 1% RN55C	R30	1	
66	" " " " 210K 1% RN55C	R27	1	
67	" " " " 301K 1% RN55C	R36	1	
68	" " " " 365K 1% RN60C	R31	1	TR-114-B
69	VAR VARIABLE CERMET 500Ω ALLEN-BRADLEY ZV5011	R4, R16	2	TP-38-A
70	" " " 1K ALLEN-BRADLEY ZV1021	R7, R12	2	TP-41-A
71	" " " 2.5K ALLEN-BRADLEY ZV2521	R1, R14	2	TP-54-A1
72	" " " 5K ALLEN-BRADLEY ZV5021	R2	1	TP-55-A1
73	" " " 10K ALLEN-BRADLEY ZV1031	R8, R15, R17	3	TP-65-A
74	" " " 20K ALLEN-BRADLEY ZV2031	R5, R6, R9	3	TP-73-A
75	SOCKET INTEGRATED CIRCUIT BARNES 131-55022-084	XIC2	1	TS-42-C
76	" " " BARNES 631-26012-102	XIC1	1	TS-42-C-1
77	" TRANSISTOR INDUSTRIAL ELECTRONIC HARDWARE MPT 4003-1 NYLON	XQ2, XQ4, XQ5 XQ10 thru XQ17 Incl.	11	TS-34
78	" " INDUSTRIAL ELECTRONIC HARDWARE MPT 4004-1 NYLON	XQ18	1	TS-35
79	TRANSISTOR 2N5179 NPN SILICON	Q18	1	TT-36
80	" FAIRCHILD SEMICONDUCTOR FT3904 or 2N3904 NPN SILICON	Q4, 5, 10, 11, 12, 14, 15, 17	8	TT-32
81	" FAIRCHILD SEMICONDUCTOR FT3906 or 2N3906 PNP SILICON	Q2, Q16	2	TT-33
82	" FET 2N5458/MPF104	Q13	1	TT-17



T-27B-5-8

SOLDER SIDE VIEW


S4 POWER
BT1 9V
BT2 9V
BT3 9V
BT4 9V
R1 2.5K
R19 100Ω
FT3906 Q2
CR1 8.2V 1N959B
R3 6.8K
M1
R2 5K VOLT. ADJ.
R40 5.11K 1%
R52 6.81K 1%
IC 1 MC1469G
C39 .1μF
TP1 7 1/2V
C2 22μF 25V
C1 1K
C5 .1μF
TP2
C27 470
C28 470
C29 470
R74 1K *
C30 33
C31 33
L1
R73 3.9K
L5 1.0μH
Y1 54 MHz
R75 1.5K
C32 47
R76 150Ω
Q17 FT3904
C34 47
TP6
R57 100Ω
Q13 2N5458/ MPF104
R58 3.9K
TP8
MIX. ADJ.
R15 10K
TP7
Q14 FT3904
R60 3.9K
R62 100Ω
R61 47K
R63 100K
C19 .47μF
C20 1K *
C24 2.2K
L7 150mH
R41 18K
Q15 FT3904
R64 100K
R66 47K
R16 500Ω AMP GAIN
C13 15μF 15V
Q4 FT3904
R55 100K
R11 100Ω
R59 100K
TP12
0°-180° LEVEL BAL
C3 330μF 6V
R13 1K
R4
R70 100K
R77 500Ω 825Ω 1%
Q5 FT3904
R78 100Ω
R18 100K
TP13
R20 1K 1%
0° PHASE ADJ
R5 20K
C4 .015μF POLY C
R54 10K FP
VAR
0°
90°
180°
270°
S3
R6 QUAD. 20K ADJ.
R56 15.4K 1%
C37 .22μF POLY C
C38 .0047μF MYLAR * FP
R22 3.9K *
R23 2.49K 1%
R24 2.49K 1%
S2
C9 .039μF POLY C
R82 100K *
R39 100
R21 100K
Q10 FT3904
TP4
R12 1K
DEVIATION ADJ
L6 150mH
C17 4.7K POLY C
R42 220Ω
DS1 913
R37 4.7K
CR8 IN4148
CR9
R27 * 210K 1%
R9 20K
R36 * 301K 1%
R10 100Ω 1% *
C12 18μF 15V
R31 365K 1%
C6 .1μF
TP3
IC2 CA3078T
R38 4.7K
R71 6.8K *
R34 3.32K 1%
R35 3.32K 1%
C10 100μF 10V
C7 .047μF PARY-L
R28 365Ω 1%
C11 470 8M
R30 1% 113K
R33 R65 8.06K * 1%
R8 10K
R32 3.01K 1% *
R7 1K
C8 .047μF PARY-L
R29 3.32K 1%
S1a TONE
S1b
* — FACTORY ADJUST
ALL CAPACITORS IN pF UNLESS NOTED
ALL RESISTORS IN OHMS UNLESS NOTED
NOTE: NOT USED
R-25,26,
Q-1,3,6,7,8,9
CA3078T
FT3906 FT3904
2N3904 2N3906
2N5458
2N5179
MC1469G
BOTTOM VIEW
NOTE: FT3904 & FT3906 ARE INTERCHANGEABLE WITH 2N3904 & 2N3906



* — FACTORY ADJUST

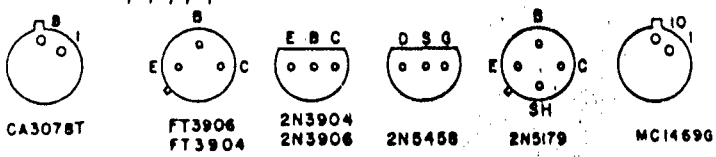
ALL CAPACITORS IN pF UNLESS NOTED

ALL RESISTORS IN OHMS UNLESS NOTED

NOTE: NOT USED

R-25,26,

Q-1,3,6,7,8,9



BOTTOM VIEW

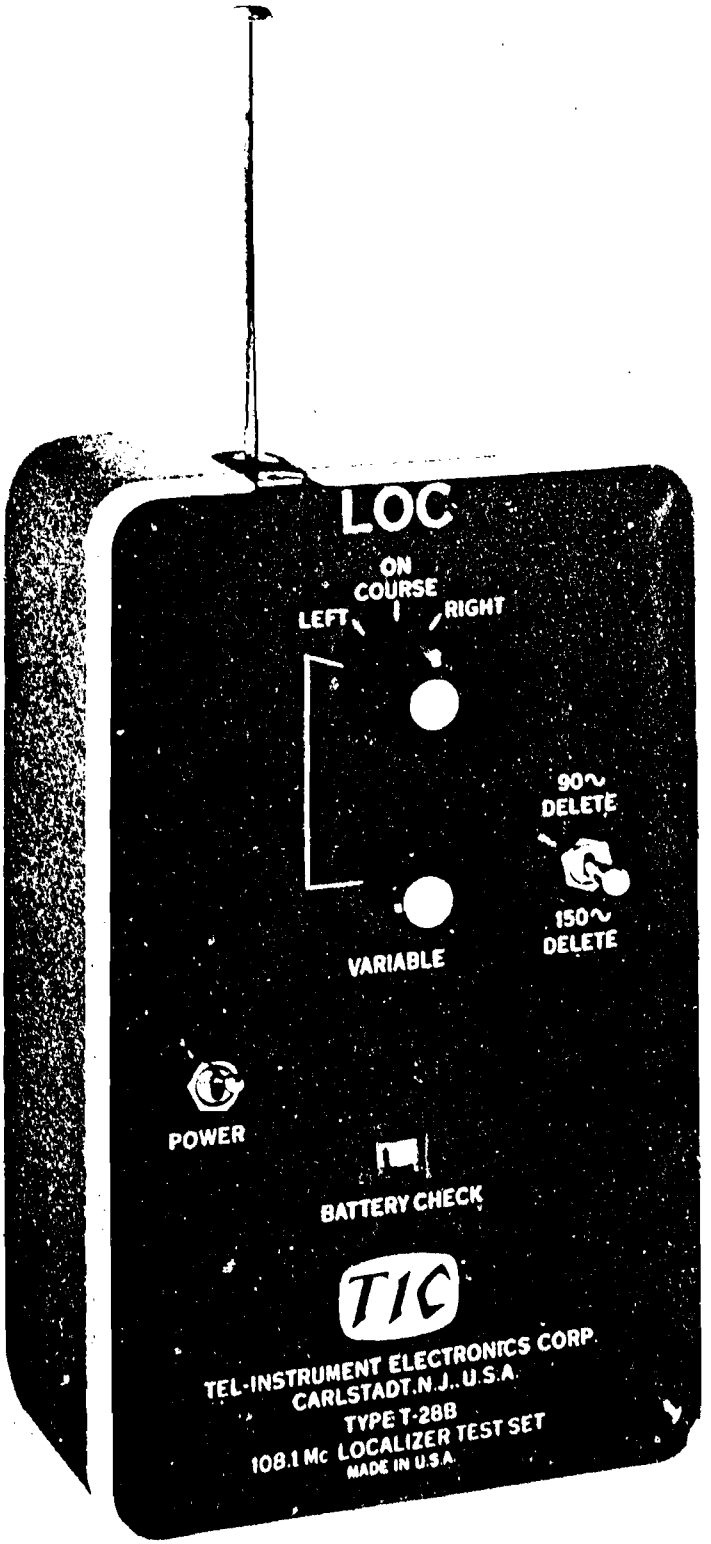
NOTE: FT3904 & FT3906 ARE INTERCHANGEABLE WITH 2N3904 & 2N3906 RESPECTIVELY

VOR RAMP TESTER

T-27B-50-1-C

ISSUE 1	DATE 4-19-72	
" 2	" 8-17-72	ECO 894
3	2-15-74	ECO 931
4	4-19-74	ECO 936

PART IV
T-28B
LOCALIZER TEST SET



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ADDENDUM FOR THE TYPE T-28B

LOCALIZER TEST SET

To provide improved performance of the Type T-28B LOCALIZER TEST SET, the following changes have been approved by the Tel-Instrument Electronics Corp. Engineering Department.

1. On the schematic, drawing No. T-28B-50-1-C, make the following corrections:

   A. Change the designation of CR3 and CR5 from 1N487 to 1N4148.

   B. Change the issue from 2 to 3 dated 5/29/73, ECO 921.

2. On the PRINTED CIRCUIT BOARD parts lists, change as follows:

   A. Item 18: Change in the DESCRIPTION, 1N487 to 1N4148; in the TIC PART #, change TD-9 to TD-19-A.

ECO 921, 5/29/73 NOTE: The implementation of this ECO is not mandatory. It should be accomplished only if either CR3 or CR5 require replacement. The 1N4148 diode is more readily available and less expensive than the 1N487.

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1. On the schematic, drawing No. T-28B-50-1-C, make the following corrections:

   A. In the antenna circuit, insert capacitor C37 between the lower end of L6 and the junction of CR8, C2, L4 and the collector of Q15. C37 is a 470 pF capacitor.

   B. Change the issue from 3 to 4 dated 2/15/74, ECO 931.

2. On the MAIN CHASSIS parts list change as follows:

   A. Add a new Item 3A to the parts list between Items 3 and 4 as follows: DESCRIPTION, CAPACITOR FIXED CERAMIC DISC 470 pF CENTRALAB DD471; CIRCUIT DESIGNATION, C37; QTY, 1; TIC PART #, TC-89.

ECO 931, 2/15/74 Effectivity, T-28B, S/N 514S and up; T-30B and T-30B/B, S/N 905 and up and T-30B-S301, T-30B-S303 and T-30B-S304, S/N 909 and up.

1. On the schematic T-28B-50-1-C, make the following additions:

   A. Add 150 pF DISC capacitor C37 from base of Q10 to ground and C38 from base of Q11 to ground. The base of Q10 is TP6, base of Q11 is TP7.

   B. Change the issue from 4 to 5 dated 3-4-75, ECO 960.

2. On the PRINTED CIRCUIT BOARD parts list change as follows:

   A. Add a new item 2A to the parts list between Items 2 and 3 as follows: Description, CAPACITOR FIXED CERAMIC DISC 150 pF 10% 1KV CENTRALAB DD151; CIRCUIT DESIGNATION, C-37, C-38; QTY, 2; TIC PART #, TC-84.

ECO 960, 3-4-75 Effectivity, T-29B, S/N 540S and up; T-30B and T-30B/B, S/N 1045 and up and T-30B-S301, T-30B-S303 and T-30B-S304, S/N 1035 and up.

SECTION I
DESCRIPTION

1.1 GENERAL:

The T-28B LOC Ramp Test is a miniature LOC transmitter. It generates "Left", "Right" and "On Course" signals on the 108.1 MHz localizer channel. It also includes a control which is continuously adjustable from extreme "Left" to extreme "Right".

A 54.05 MHz crystal controlled oscillator is fed to an amplifier-doubler which delivers 108.1 MHz to the antenna. The 108.1 MHz carrier is amplitude modulated with the mixed 90 Hz and 150 Hz Localizer signals.

A temperature compensated unijunction transistor relaxation oscillator drives a multivibrator whose output is a 30 Hz square wave. The square wave locks the 90 Hz and 150 Hz LC oscillators whose amplitude is temperature compensated. A resistor network mixes the 90 Hz and 150 Hz signals in the proper ratio to give the course indication selected by the front panel controls.

Four 9 volt batteries in series-parallel supply 18 volts to a voltage regulator and metering circuit which delivers $7\frac{1}{2}$V as long as the battery voltage remains above $9\frac{1}{2}$ volts. When the battery voltage falls below $9\frac{1}{2}$ volts the meter falls to the red scale indicating that the batteries must be replaced.

SECTION 2
OPERATION

2.1 GENERAL

Tune the aircraft receivers to 108.10 MC. Extend the 4" antenna of the T-28B LOC test set. Note the four operating controls on the front panel:

1. On-Off Power Switch
2. LOC Four Position Course Switch
3. LOC Variable Knob
4. Delete Switch

ON-OFF POWER SWITCH - Spring return:

The Power On-Off Switch is spring loaded so that it must be held "ON" in order to operate the unit in any of its functions.

LOC FOUR POSITION COURSE SWITCH - Consisting of the following function:

On course, left of course, right of course and variable. The physical layout of the panel is such that when the course knob is turned left the LOC indicator swings left, and conversely right when turned right. The deflection left or right is 150 μa or last dot on all indicators. This permits checks of all types of indicators whether two, three or five dot references are used. The variable position on the course switch references a potentiometer with a line pointing to the potentiometer knob. The dot on the knob, when lined up with the reference line, is the approximate "On Course" position for ready reference. Turning the knob either left or right results in a variable left or right indicator deflection of from center to approximately 185 μa each side. This function permits checkout of indicator "Hang-Up" on full deflection.

LOC DELETE SWITCHES - Spring return:

With the T-28B course selector set to "On Course", the flag should appear on a properly operating receiver when either the 90 Hz or 150 Hz modulation is deleted. This assumes that the R.F. carrier is modulated 20% by the individual audio signals.

If the modulation of the T-28B is actually 21% or 22%, or if the receiver has been calibrated with a generator whose actual modulation is only 18% or 19%, the flag may not appear when the above test is made. Under these conditions, the flag check can be made at a reduced R. F. level by sliding in the T-28B antenna so that it extends about 1 inch from the case.

This method can be used until the T-28B modulation can be readjusted to agree with the generators being used to bench calibrate the receivers. When this is done, the "Right" and "Left" course adjustments must also be made. The procedure is outlined on pages 4-4 to 4-7 of the T-28B Instruction Manual.

RETRACT THE ANTENNA AFTER THESE CHECKS HAVE BEEN MADE.

SECTION 3
THEORY OF OPERATION

3.1 POWER SUPPLY:

The power supply consists of four 9 volt batteries connected in series-parallel to supply 18 volts to the battery voltage regulator (Q1, Q3, and Q4). Q3 and Q4 form a differential amplifier which compares a portion of the output voltage at the base of Q4 with the voltage across the Zener diode, CR1 at the base of Q3. The base current for the series regulator Q1 is supplied by Q3. Any increase in the output voltage results in a decrease in Q3 collector current and a corresponding decrease in Q1 collector current. This results in a decrease in output voltage. Conversely, a decrease in output voltage results in an increase in Q1 collector current. Thus Q1 acts as a variable resistance which maintains the output voltage constant. D. C. voltage control R2 adjusts the output of the regulator to 7½V.

The collector-emitter voltage of Q1 is applied to the base-emitter of Q2. If the battery voltage exceeds the regulator output voltage by 1½ V or more, the voltage across Q1 is sufficient to forward bias Q2 and the Battery Check meter reads in the white scale due to Q2 collector current. When the battery voltage no longer exceeds the output voltage by approximately 1½V, Q2 collector current falls and the Battery Check meter reads in the red scale indicating that the batteries must be replaced.

Through the action of the voltage regulator a drop in battery voltage from 18V to 9V results in a drop in output voltage of less than 0.1V.

3.2 PULSE GENERATOR AND MULTIVIBRATOR:

A unijunction transistor, Q5, is used in a relaxation oscillator circuit to generate 60 pps. The timing circuit (C9, R14, and R15) is adjusted to produce the required 60 pps. The discharge of C9 into the emitter of Q5 produces sharp negative pulses at B1. Resistor R16 and potentiometer R17 in B2 of Q5 compensate for changes in Rbb (From B1 to B2) with temperature and maintain the frequency constant at 60 pps.

The negative pulses at B1 are coupled through C12 and C13 to the bases of Q6 and Q7, which form a bistable multivibrator. At an input of 60 pps, the output of the multivibrator is a 30 Hz square wave.

The negative pulses at B1 are coupled through C12 and C13 to the bases of Q6 and Q7, which form a bistable multivibrator. At an input of 60 pps, the output of the multivibrator is a 30 Hz square wave.

3.3 90 Hz AND 150 Hz LC OSCILLATORS

Transistors Q8 and Q9 are the 90 Hz and 150 Hz LOC oscillators, respectively. With the exception of the tank circuits (L1, C3, and L2, C4) the two oscillators are identical so the operation of the 90 Hz oscillator will be described.

The tank circuit L1, C3, is tuned to 90 Hz and the secondary of L1 is connected in the emitter of Q8 to supply the necessary positive feedback to maintain oscillation. Potentiometer R34 in the emitter circuit adjusts the gain of Q8 and the amount of control exercised by the 30 Hz sync signal.

The diode, CR5, across the tuned circuit limits the amplitude of the signal across the tank and maintains the level constant with temperature.

The 30 Hz square wave which is applied to the base of Q8 and Q9 locks every third cycle and every fifth cycle of the 90 Hz and 150 Hz oscillator respectively, so that they maintain the proper phase relationship.

When the front panel Delete switch S2 is operated it shorts out the secondary of L1 or L2 and oscillation stops.

3.4 90 Hz AND 150 Hz MIXER AND AMPLIFIER

The 90 Hz signal across the secondary of L1 is applied to the base of amplifier Q10. R38 adjusts the gain of Q10.

The 150 Hz signal across the secondary of L2 is applied to the base of amplifier Q11, whose gain is adjusted by R26.

The outputs at the collectors of Q10 and Q11 are mixed in potentiometer R30 (Front Panel Control) which can be adjusted for varying ratios of 90 Hz and 150 Hz. Potentiometers R27, R28, and R29 are connected in series across the front panel control R30. R28 is set for equal amounts of 90 Hz and 150 Hz and R27 and R29 are set for a fixed ratio of 90 Hz and 150 Hz. Front panel switch S3 is used to select one of the preset ratios or the continuously variable control. The signal selected by S3 is applied through C23 to the base of amplifier Q12. The gain of Q12 is adjusted by R44 and the output is fed to the modulator through C24.

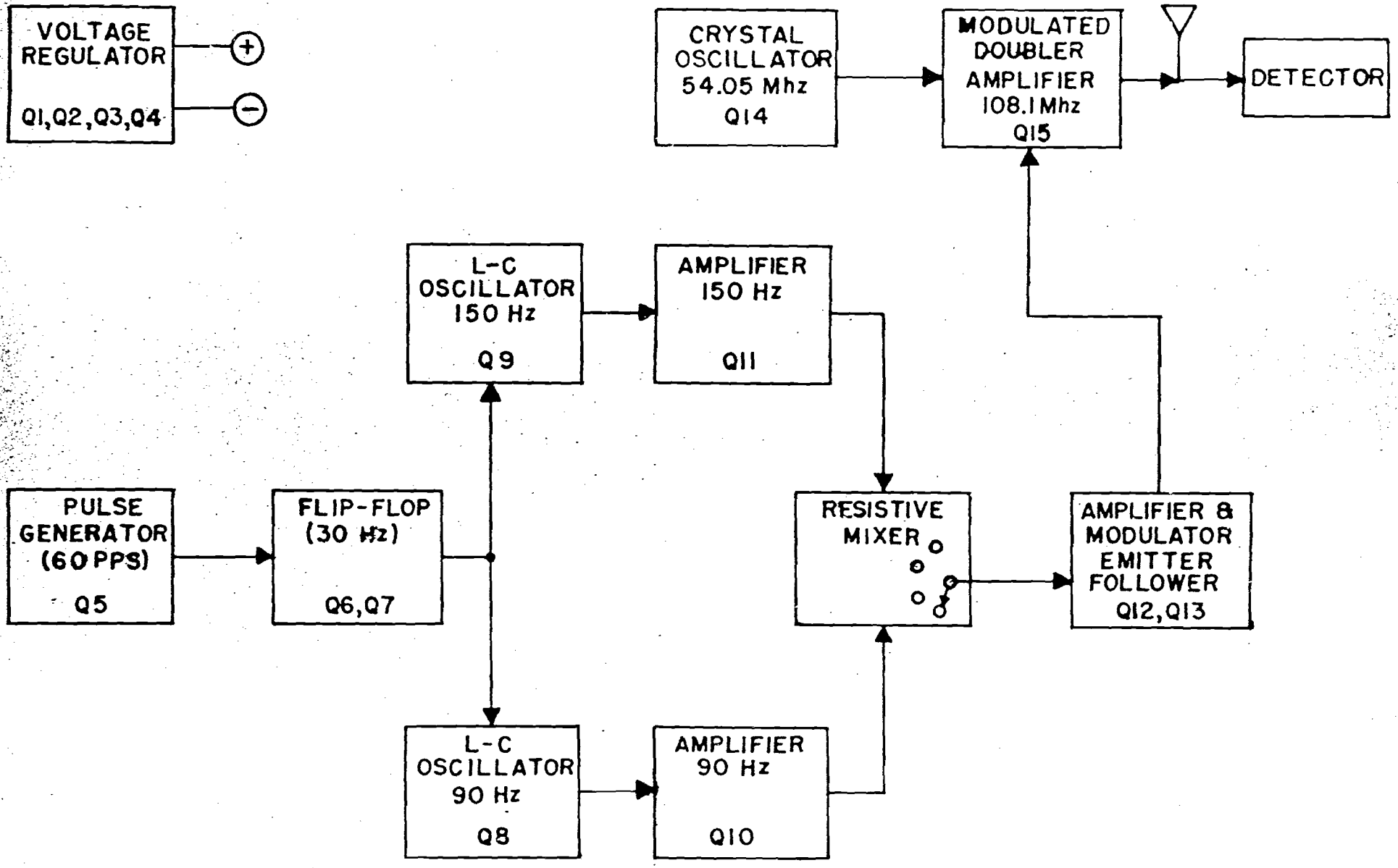
3.5 MODULATOR AND R. F. CIRCUITS:

Transistor Q14 is a Colpitts-type crystal oscillator. The tank circuit (L3, C27, and C28) in the collector is tuned to 54.05 MHz. The crystal Y1, operates in the series resonant mode and provides a low impedance feedback path to the emitter to sustain oscillation.

The secondary winding of L3 is coupled to the base of the modulated amplifier-doubler, Q15. This transistor is normally cut off and is turned on by the positive peaks of the oscillator signal. The tank circuit (L4, C2) in the collector of Q15 is tuned to the second harmonic of the crystal oscillator to achieve doubling.

The emitter of Q15 is returned to ground through the modulator, Q13. This transistor is an emitter follower whose base voltage consists of a D. C. voltage determined by the setting of R13 and the amplified 90 Hz and 150 Hz signals, resulting in a varying D. C. voltage at its emitter. This varying voltage modulates the collector currents of the the amplifier-doubler, Q15.

The diode, CR8, is a built-in detector which is used when adjusting the R. F. circuits.



BLOCK DIAGRAM

T-28B-3-4

SECTION 4
TROUBLE SHOOTING AND MAINTENANCE

4.1 MAINTENANCE:

This unit should require very little maintenance other than replacement of batteries. In order to replace the batteries, remove the unit from the case by taking out the four screws underneath the case. Lift off the battery connector board (use a screwdriver if necessary) and replace the batteries. CAUTION: Be sure to observe correct polarity.

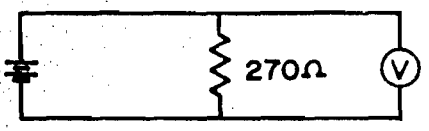
If a unit should become inoperative isolate the defective section by following the procedures outlined as indicated in the adjustments below. After the defective section has been found, replace the associated transistors taking care to insert them correctly into their sockets. If new transistors do not correct the trouble and it becomes necessary to unsolder components, great care should be exercised to avoid damaging the printed circuit board. When troubleshooting the unit, refer to the block diagram and "Theory of Operation" section.

To remove the circuit board for service, consult Figures 1Ca and 1Cb.

Remove the four screws marked "A", unsolder the lead to the antenna, and slide the board out.

To replace the antenna, unscrew the teflon stop from the end of the antenna and pull the antenna out. Insert the replacement antenna and screw it into the teflon stop. See Figure 1Cb.

IMPORTANT NOTE: In some cases it has been observed that brand new batteries have been found to be defective. Therefore it is recommended that all new batteries be checked under load before operation. They can be tested in the circuit shown:



If the voltage falls rapidly (0.4V or more) in 5 minutes the battery should be considered defective.

CAUTION: When removing the linkage between the LOC and GS power switches loosen the set screws to avoid breaking the switch levers. An Allen wrench is supplied for this purpose.

LOC

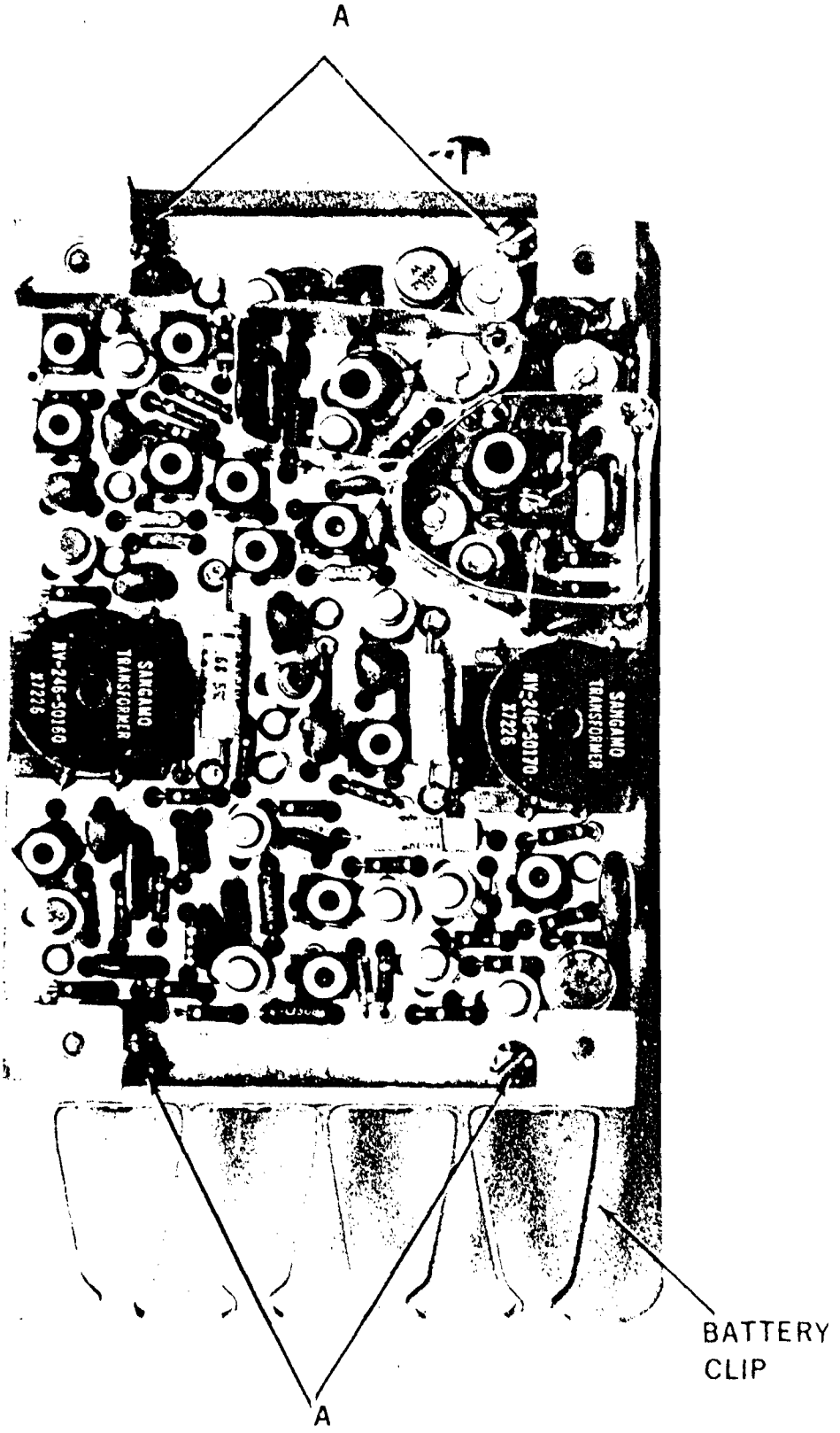


Figure 1Ca

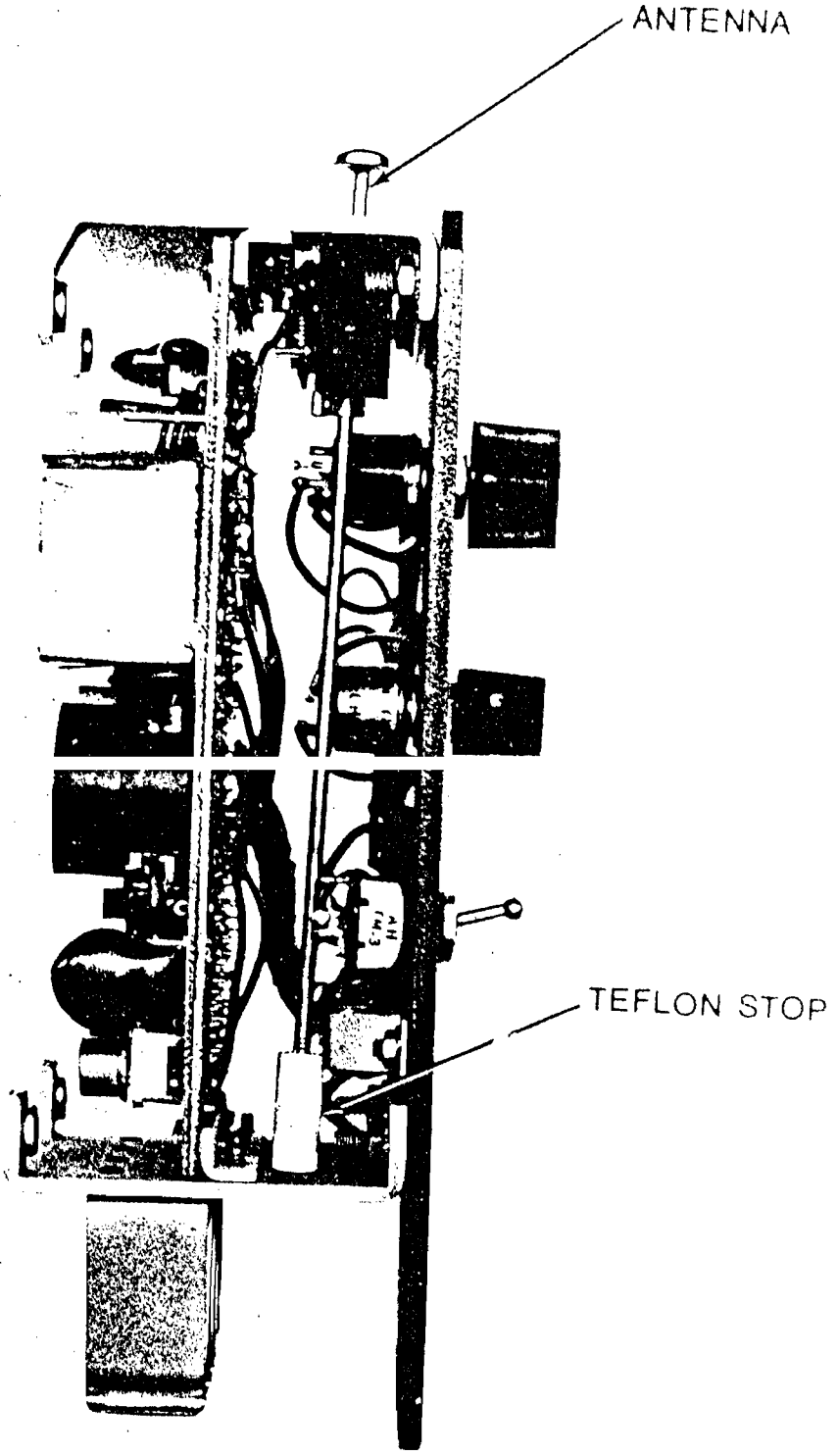


Figure 1Cb

4.2 VOLTAGE REGULATOR ADJUSTMENT:

1. Set D. C. power supply to 18V and connect to T-28B in place of batteries.

2. Turn on T-28B and adjust R2 (D. C. Voltage Control) for $7\frac{1}{2}$ V across TP2 and TP3. (To increase R.F. output this voltage can be increased to $8\frac{1}{2}$ V with resulting decrease in battery life.)

3. Reduce D. C. supply voltage slowly while monitoring Battery Check meter and voltage across TP2 and TP3. Voltage at this point should not fall more than 1% and input voltage should be less than $9\frac{1}{2}$ V before the Battery Check meter falls to the red scale.

4.3 30 Hz GENERATOR ADJUSTMENT:

1. Remove unijunction transistor Q5, D5K1, from socket and measure its interbase resistance, Rbb (from B1 to B2) with an ohm-meter.

2. Connect ohm meter from B2 to ground (Q5 out of socket) and adjust R17 (Temp. Comp. adj.) so measured resistance is $\frac{Rbb}{6}$.

3. Restore Q5 and connect scope and counter to TP4. Adjust R15 (freq. adj.) so signal at TP4 is a 30 Hz square wave.

4.4 AUDIO OSCILLATOR ADJUSTMENT:

1. Remove Q5 from socket and connect scope and counter to TP7.

2. Adjust R22 (150 Hz Feedback Adj.) to the point where feedback is just sufficient to sustain full amplitude oscillation. See Fig. 1B.

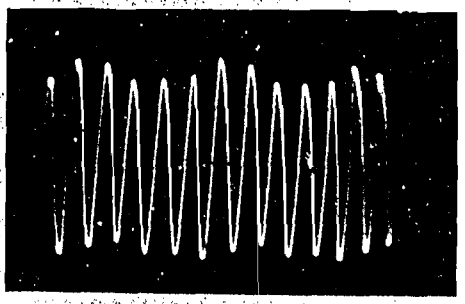


Fig. 1B

3. Adjust frequency to 148 Hz with L2. If L2 has insufficient range, tailor factory adjust capacitor C4 as necessary to reach 148 Hz. Note: If the signal amplitude at TP7 is insufficient to operate the counter, connect it to TP11, throw Delete switch to delete 90 Hz, and adjust R26 (150 Hz Amp. Adj.) for sufficient signal to operate the counter.

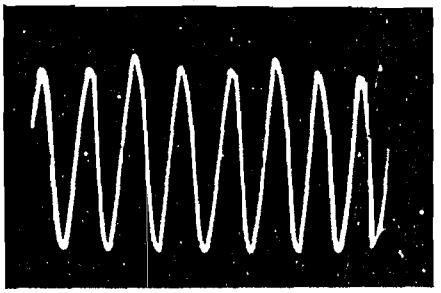


Fig. 2B

4. Connect scope and counter to TP6 and adjust R34 (90 Hz Feedback Adj.) to the point where feedback is just sufficient to sustain full amplitude oscillation.

5. Adjust frequency to 88 Hz with L1. If L1 has insufficient range, tailor factory adjust capacitor C3 as necessary to reach 88 Hz. Note: If the signal amplitude at TP6 is insufficient to operate the counter connect it to TP12, throw Delete switch to delete 150 Hz, and adjust R38 (90 Hz Amp. Adj.) for sufficient signal to operate the counter.

6. Connect scope and A.C. VTVM to TP11. Throw Delete switch to delete 90 Hz and adjust R26 (150 Hz Amp. Adj.) for approximately 0.1 Vrms.

7. Connect scope and A.C. VTVM to TP12. Throw Delete switch to delete 150 Hz and adjust R38 (90 Hz Amp. Adj.) for same amplitude as in Step 6.

8. Connect scope to TP8. Turn course switch to "On Course", set R28 (On Course Adj.) at mid-range and adjust R44 (% Modulation Adj.) for maximum signal without clipping. If necessary, reduce gain of 90 Hz and 150 Hz amplifiers, by adjusting R26 and R38.

9. The mixed 90 Hz and 150 Hz signal at TP8 is not phase-locked. Restore Q5. The signal at TP8 should now lock in phase.

10. Repeat Steps 6, 7 and 8.

11. With scope connected to TP8, throw Delete switch to delete 90 Hz. Signal should appear as in Fig. 1B. Throw Delete switch to delete 150 Hz and signal should appear as in Figure 2B.

12. With Delete switch in neutral position compare waveform at TP8 with Figure 3B. The balanced minor peaks indicate the correct phase relationship of the 90 Hz and 150 Hz signals. If the minor peaks are not balanced adjust L1 slightly to bring the peaks into balance.

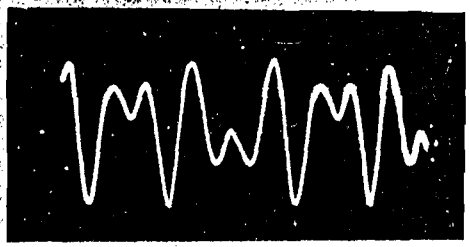


Fig. 3B

4.5 MODULATOR AND R. F. SECTION:

NOTE: A threaded plastic lock is used in coils L3 and L4. To adjust these coils remove the locks with a screwdriver and restore them after adjustments have been made.

1. Extend T-28B antenna and connect D. C. scope input and VTVM to TP10. Connect ground lead of scope and VTVM to TP2. (If the external power supply and scope have a common ground through the power cable, the power supply must be floated or a short circuit will result. Batteries may be substituted as a power source.)

2. Adjust L3 for maximum D. C. output and signal amplitude at TP10.

3. Adjust L4 for maximum D. C. output and signal linearity at TP10. Check output frequency by coupling counter to T-28B through a one inch loop. (Remove transistor Q12 to eliminate spurious counts caused by modulation.) Replace Q12 after measurement.

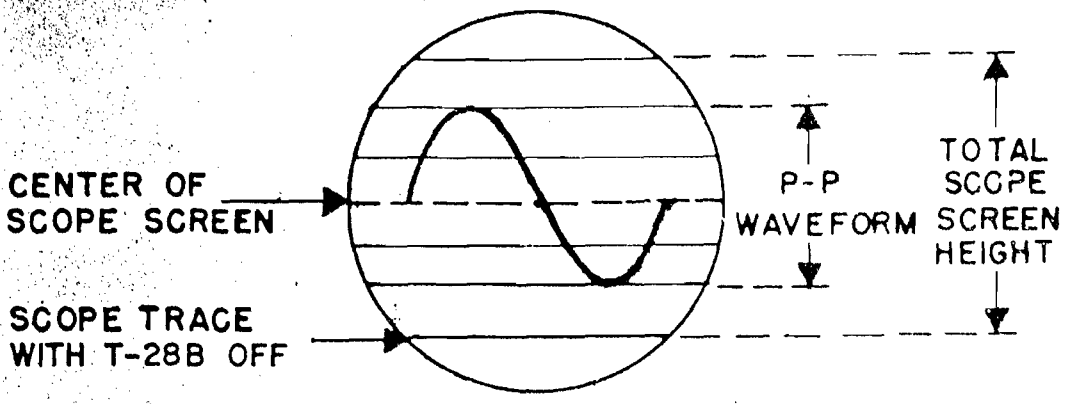
4. Make preliminary adjustment of % modulation as follows:

   a. Leave scope and VTVM as in Step 1.

   b. With T-28B power switch off, position scope trace to bottom of screen.

   c. Set Course Switch to "On Course", R28 (On Course Adj.) to mid-range, Delete Switch to Delete 90 Hz, and turn on T-28B. Adjust scope gain so center of waveform is at center of scope screen. (Recheck position of scope trace with T-28B off.)

d. Calculate % modulation. This is equal to 100 times peak-to-peak waveform divided by total scope screen height. See Fig. 4B.



$$\% \text{ MODULATION} = \frac{\text{P-P Waveform} \times 100}{\text{Total Scope Screen Height}} = \frac{400}{6} = 66.6\%$$

Fig. 4B

e. Adjust R44 (% Modulation Adj.) and R13 (R. F. output) for 30% modulation and D. C. output at TP10 greater than 0.6V. This is actually about 20% modulation, due to voltage drop in the detector diode, CR8.

f. Throw Delete Switch to Delete 150 Hz and adjust R38 (90 Hz Amp Adj.) for 30% modulation as in step e.

g. Return Delete Switch to neutral and observe waveform at TP10. If clipping is evident, readjust R44 (% Modulation Adj.) to eliminate clipping, and readjust R13 (R. F. Output) for correct modulation in step e and f.

5. The R. F. voltage measured at the base of the antenna should be greater than 0.5 Vrms. (Use Sampling Voltmeter to measure R. F.)

6. Final adjustment of % modulation and d.d.m.:

a. Radiate signal from T-28B into short antenna connected to I.L.S. Calibrator R. F. input jack and switch calibrator to measure d.d.m.

b. With T-28B Course Switch at "On Course" adjust R28 (On Course Adj.) for 0 d.d.m. on the I.L.S. Calibrator. If zero deviation can-

not be obtained by adjusting R28 it indicates that the 90 Hz and 150 Hz levels are unbalanced. To correct this, set R28 at mid-range and adjust R38 (90 Hz Amp. Adj.) for zero deviation current on Test Bench receiver with Ramp Test Set switched to "On Course" position.

c. Switch I. L. S. Calibrator to measure % modulation and adjust R44 (% Mod. Adj.) for 20% modulation.

d. Recheck step b.

e. Set T-28B Course Switch to "Left" and adjust R27 (Left Course Adj.) for 0.155 d.d.m.

f. Set T-28B Course Switch to "Right" and adjust R29 (Right Course Adj.) for 0.155 d.d.m.

7. Alternate method for adjusting % modulation and d.d.m.:

If an I. L. S. Calibrator is not available the T-28B can be calibrated against a TIC Type T-12A Nav/Com Generator or a Collins 479S-3 Signal Generator and a H. P. 211A R. F. Generator using a receiver as a transfer standard.

a. Equip the receiver with meters to measure flag current and deviation current.

b. Calibrate the receiver against the bench standards. (Flag current is a measure of % modulation and its value at 0 d.d.m. should be used to calibrate the T-28B.)

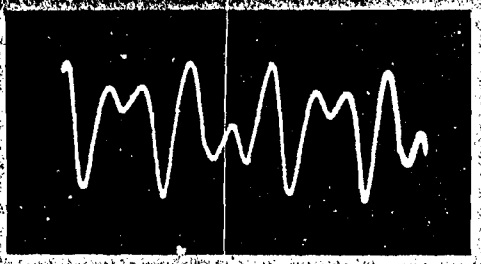
c. Radiate the T-28B into the receiver antenna and adjust R28 (On Course Adj.) for 0 deviation current with T-28B Course Switch set to "On Course".

d. Set T-28B Course Switch to "On Course" and adjust R44 (% Modulation Adj.) for the same flag current as measured in step b.

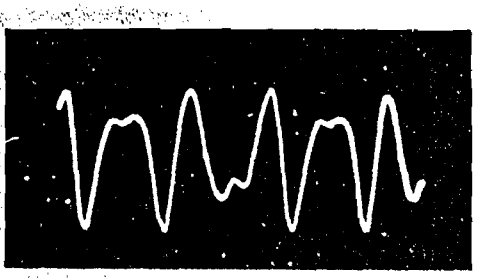
e. Recheck step c.

f. Set T-28B Course Switch to "Left" and adjust R27 (Left Course Adj.) for 150 μa.

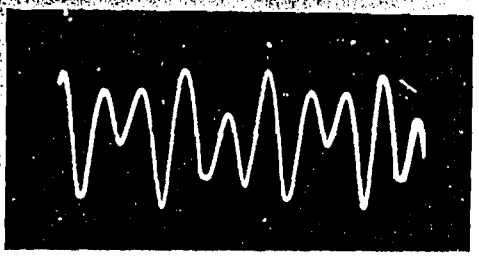
g. Set T-28B Course Switch to "Right" and adjust R29 (Right Course Adj.) for 150 μa.



a



b



c

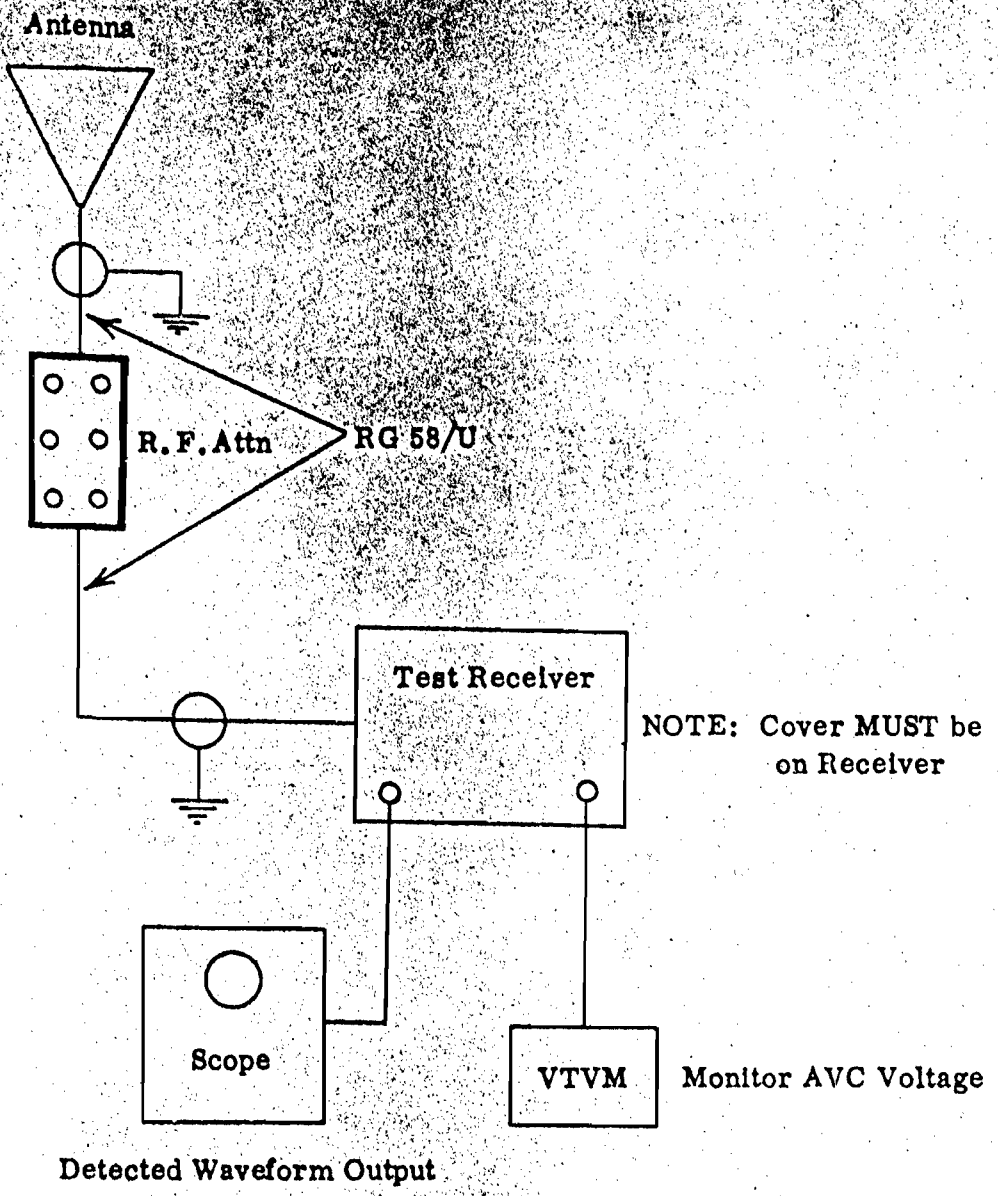
T-28B detector signal. 8 ms/cm Horizontal. 0.5V/cm Vertical.

a. On Course
b. Needle Right
c. Needle Left

FIG. 5B

IMPORTANT NOTE: The same test equipment should be used to calibrate the T-28B as is used to "bench test" the aircraft receivers. This will minimize the possibility of problems caused by tolerances in test equipment specifications.

When the ramp test set is checked against a test bench receiver the output from the ramp test set may be sufficient to overload the receiver. In this case an attenuator can be placed in the cable from the receiver antenna. The attenuation should be sufficient to insure that the receiver is not being overloaded. The input to the receiver can be determined by first measuring the A.V.C. voltage of the test receiver with the ramp test set turned on. Then feed a signal generator equipped with a calibrated attenuator into the receiver and determine what value of signal is required to achieve the same A.V.C. voltage as before.



TYPICAL TEST RECEIVER SET-UP

T-286-4-8

SECTION 5
TEST EQUIPMENT AND TOOLS

5.1 INSTRUMENTS REQUIRED:

VTVM A. C. and D. C.
D. C. power supply adjustable 5-20V.
Electronic counter H.P. Model 524B or equivalent.
Oscilloscope D.C. - 100 kHz or more.
Broadband Sampling Voltmeter H. P. Model 3406A or equivalent.
I. L. S. Calibrator Wayne Kerr Type N100 or equivalent.
LOC Receiver.
Nav/Com Signal Generator TIC Type T-12A e/w T-12-1A VHF Com/Nav Plug-in unit or equivalent.

The radiation pattern of the ramp tester is affected by its metal case. For this reason it is recommended that the final adjustments be made with the unit placed in a test case which has been drilled to allow access to the necessary adjustments. A pre-drilled case is available from TIC and is identified as a "T-30A/T-30B Test Jig".

T-28B LOCALIZER

MAIN CHASSIS

ITEM	DESCRIPTION	CIRCUIT DESIGNATION	QTY	TIC PART #
1	ANTENNA TIC DWG. NO. T-27A-60-5-A	A1	1	TA-2-A
2	BATTERY EVEREADY #222	BT1 thru BT4 Incl.	4	TB-8
3	" CLIP ASSEMBLY FOR 4 BATTERIES		1	TC-181-A
4	CLIP KEYSTONE 80		4	TH-10
5	INDUCTOR FIXED ANTENNA TIC MFR.	L6	1	TC-205C
6	KNOB NOBEX 1-503	VARIABLE	1	TK-15
7	" NOBEX 1-504D	SELECTOR	1	TK-16
8	METER EMICO 802 PWR	M1	1	TM-7
9	RESISTOR VARIABLE COMPOSITION 10K ALLEN-BRADLEY RV6NAYSD103A (TIC MOD.)	R30	1	TP-66
10	SWITCH ROTARY GRAYHILL 50CD36-01-2-4N (TIC MOD.)	S3	1	TS-74
11	" TOGGLE ARROW-HART & HEGEMAN TG-3-M	S2	1	TS-77
12	" " ARROW-HART & HEGEMAN TM-3	S1	1	TS-79

T-28B LOCALIZER

PRINTED CIRCUIT BOARD

ITEM	DESCRIPTION	CIRCUIT DESIGNATION	QTY	TIC PART #
1	CAPACITOR FIXED DIPPED MICA 100 pF 5% SANGAMO DM155F101	C32	1	TC-49
2	" " CERAMIC DISC 47 pF CENTRALAB DD470	C30, C31	2	TC-77
3	" " " " 470 pF CORNELL-DUBILIER BYZ601ZU471P	C33 thru C36 Incl. C26, C29	6	TC-90
4	" " " " 1K pF ERIE TECHN. PROD. 801	C10 thru C13 Incl.	4	TC-94
5	" " " 0.22 µF 50V SPRAGUE 7C023224X0500D	C19	1	TC-132
6	" " " 0.47 µF 50V SPRAGUE 7C023474X0500E	C14, C15	2	TC-139
7	" " MICA 10 pF CM15C100J	C2	1	TC-12
8	" " " 33 pF CM15E330J	C27, C28	2	TC-17
9	" ELECTROLYTIC TANTALUM 330 µF 6V SPRAGUE 196D337X0006MA3	C25	1	TC-174
10	" " " 100 µF 10V SPRAGUE 196D107X0010LA3	C16, 17, 18, 20, 21, 22, 23, 24	8	TC-168
11	" " " 15 µF 15V SPRAGUE 196D156X0015JE3	C8	1	TC-152
12	" " " 150 µF 15V SPRAGUE 196D157X0015MA3	C7	1	TC-172
13	" FIXED POLYCARBONATE 0.22 µF 50V 5% TRW X463UW	C3, C9	2	TC-131
14	" " " 0.47 µF 50V 5% TRW X463UW	C4	1	TC-138
15	" " " 0.68 µF 50V 5% TRW X463UW	C3	1	TC-141
16	CRYSTAL 54.05 MHz TIC-55	Y1	1	TC-275
17	DIODE SILICON 1N87A	CR8	1	TD-7
18	" SILICON 1N487	CR3, CR5	2	TD-9
19	" ZENER 1N705A or 1N5230B 4.8V	CR1	1	TD-10

T-28B LOCALIZER

PRINTED CIRCUIT BOARD

ITEM	DESCRIPTION	CIRCUIT DESIGNATION	QTY	TIC PART #
20	INDUCTOR FIXED 1 μH CRAMER 190-1	L7	1	TC-196
21	" VARIABLE AMPLIFIER-DOUBLER TIC MFR.	L4	1	TC-205B
22	" VARIABLE OSCILLATOR TIC MFR.	L3	1	TC-205A
22A	INSERT LOCKING CAMBRIDGE THERMIONIC CORP. # 2208-1 (used on L3 & L4)		2	TI-5
23	RESISTOR FIXED COMPOSITION 47Ω 1/4W 10% ALLEN-BRADLEY CB4701	R7	1	TR-142
24	" " " 150Ω 1/4W 10% ALLEN-BRADLEY CB1511	R48	1	TR-146-A
25	" " " 220Ω 1/4W 10% ALLEN-BRADLEY CB2211	R18	1	TR-148
26	" " " 1K 1/4W 10% ALLEN-BRADLEY CB1021	R1,R45	2	TR-155
27	" " " 1.2K 1/4W 10% ALLEN-BRADLEY CB1221	R20,R32	2	TR-156
28	" " " 1.5K 1/4W 10% ALLEN-BRADLEY CB1521	R40,R47	2	TR-157
29	" " " 1.8K 1/4W 10% ALLEN-BRADLEY CB1821	R50	1	TR-158
30	" " " 2.2K 1/4W 10% ALLEN-BRADLEY CB2221	R53	1	TR-159
31	" " " 2.7K 1/4W 10% ALLEN-BRADLEY CB2721	R8,R11	2	TR-160
32	" " " 3.3K 1/4W 10% ALLEN-BRADLEY CB3321	R21,R33	2	TR-161
33	" " " 3.9K 1/4W 10% ALLEN-BRADLEY CB3921	R6,R46	2	TR-162
34	" " " 4.7K 1/4W 10% ALLEN-BRADLEY CB4721	R5,R51,R52	3	TR-163
35	" " " 8.2K 1/4W 10% ALLEN-BRADLEY CB8221	R4	1	TR-166

T-28B LOCALIZER

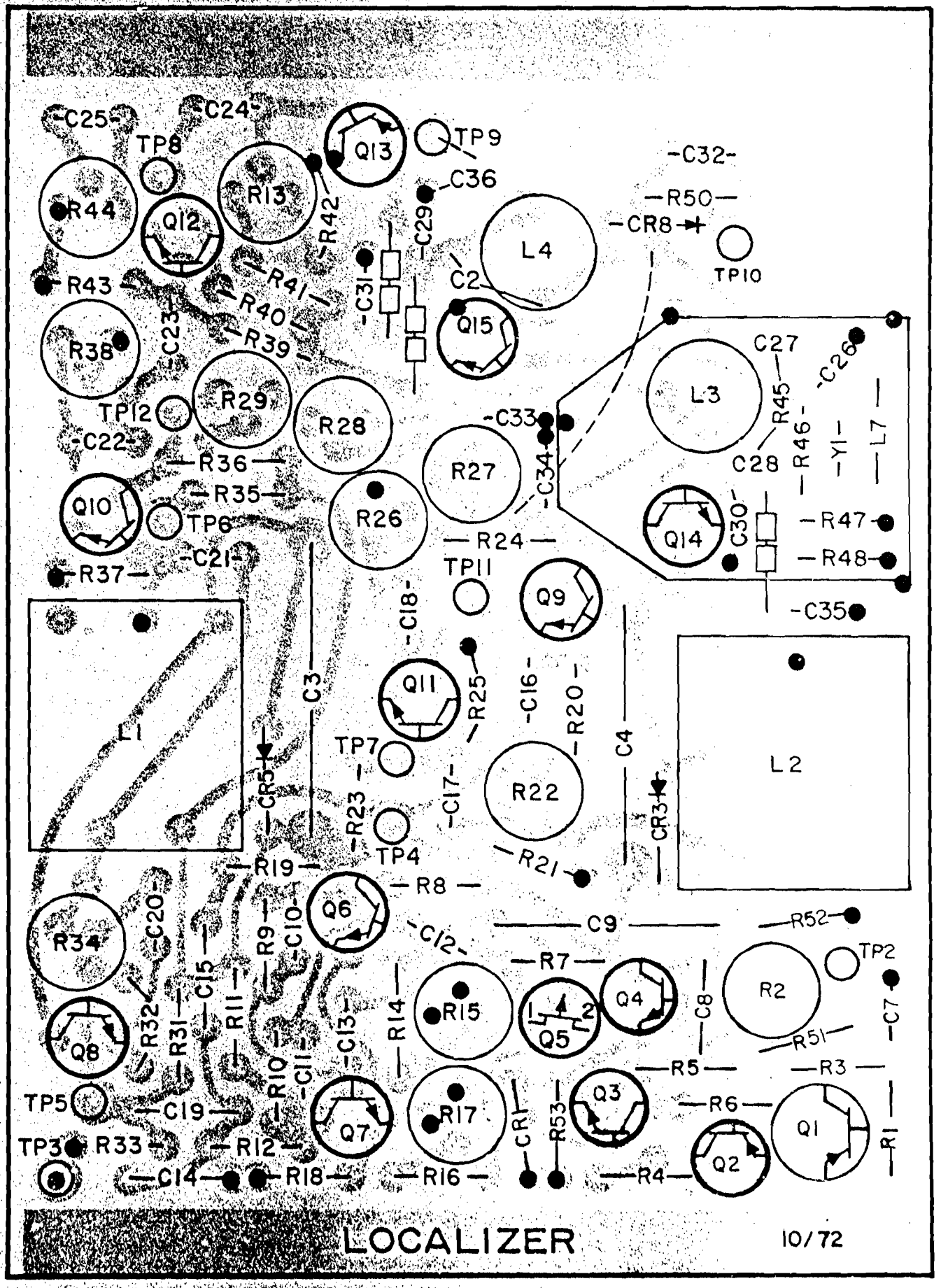
PRINTED CIRCUIT BOARD

ITEM	DESCRIPTION					CIRCUIT DESIGNATION	QTY	TIC PART
36	RESISTOR	FIXED	COMPOSITION	10K 1/4W 10%	ALLEN-BRADLEY CB1031	R19,R31	2	TR-167
37	"	"	"	12K 1/4W 10%	ALLEN-BRADLEY CB1231	R41,R42	2	TR-168
38	"	"	"	22K 1/4W 10%	ALLEN-BRADLEY CB2231	R25,R37	2	TR-171
39	"	"	"	27K 1/4W 10%	ALLEN-BRADLEY CB2731	R12	1	TR-172
40	"	"	"	47K 1/4W 10%	ALLEN-BRADLEY CB4731	R43	1	TR-175
41	"	"	"	68K 1/4W 10%	ALLEN-BRADLEY CB6831	R9,R10	2	TR-177
42	"	"	"	82K 1/4W 10%	ALLEN-BRADLEY CB8231	R23,R35	2	TR-178
43	"	"	"	150K 1/4W 10%	ALLEN-BRADLEY CB1541	R39	1	TR-181
44	"	"	"	180K 1/4W 10%	ALLEN-BRADLEY CB1841	R3	1	TR-181-A
45	"	"	METAL FILM	825Ω 1%	RN60C	R16	1	TR-90-B
46	"	"	" "	2.49K 1%	RN60C	R24,R36	2	TR-94
47	"	"	" "	95.3K 1%	RN60C	R14	1	TR-26-A
48	RESISTOR	VARIABLE	CERMET	250Ω	ALLEN-BRADLEY ZV2511	R44	1	TP-32
49	"	"	"	1K	ALLEN-BRADLEY ZV1021	R17,R28	2	TP-41-A
50	"	"	"	2K	ALLEN-BRADLEY ZV2021	R22,26,34,38	4	TP-50-A
51	"	"	"	5K	ALLEN-BRADLEY ZV5021	R27,R29	2	TP-55-A1
52	"	"	"	10K	ALLEN-BRADLEY ZV1031	R2,R13	2	TP-65-A
53	"	"	"	20K	ALLEN-BRADLEY ZV2031	R15	1	TP-73-A

T-28B LOCALIZER

PRINTED CIRCUIT BOARD

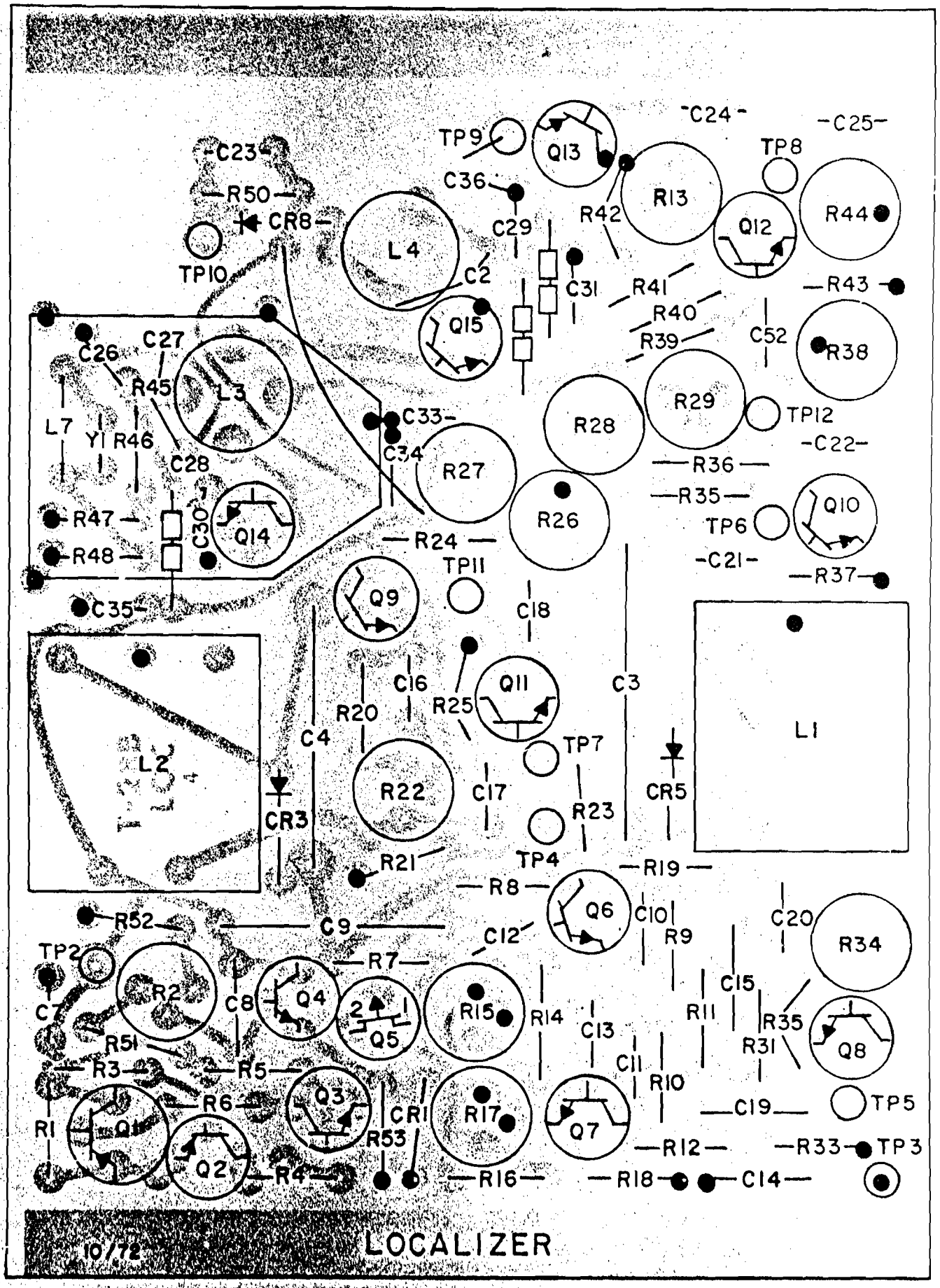
ITEM	DESCRIPTION	CIRCUIT DESIGNATION	QTY	TIC PART #
54	SOCKET TRANSISTOR INDUSTRIAL ELECTRONIC HARDWARE MPT 4003-1 NYLON	XQ2 thru XQ14	13	TS-34
55	" " INDUSTRIAL ELECTRONIC HARDWARE MPT 4004-1 NYLON	XQ15	1	TS-35
56	" " INDUSTRIAL ELECTRONIC HARDWARE MPT 6003-1 NYLON	XQ1	1	TS-36
57	TRANSISTOR 2N4037 PNP SILICON	Q1	1	TT-34
58	" 2N5179 NPN SILICON	Q15	1	TT-36
59	" FAIRCHILD SEMICOND. FT3904 or 2N3904 NPN SILICON	Q3, Q4, Q6 thru Q12, Q14	10	TT-32
60	" FAIRCHILD SEMICOND. FT3906 or 2N3906 PNP SILICON	Q2, Q13	2	TT-33
61	" UNIJUNCTION D5K1 SILICON	Q5	1	TT-16
62	TRANSFORMER 2.3H SANGAMO NV-246-50170	L2	1	TC-224-B
63	" 3.5H SANGAMO NV-246-50160	L1	1	TC-224-A



COMPONENT SIDE VIEW

CHASSIS GND ●

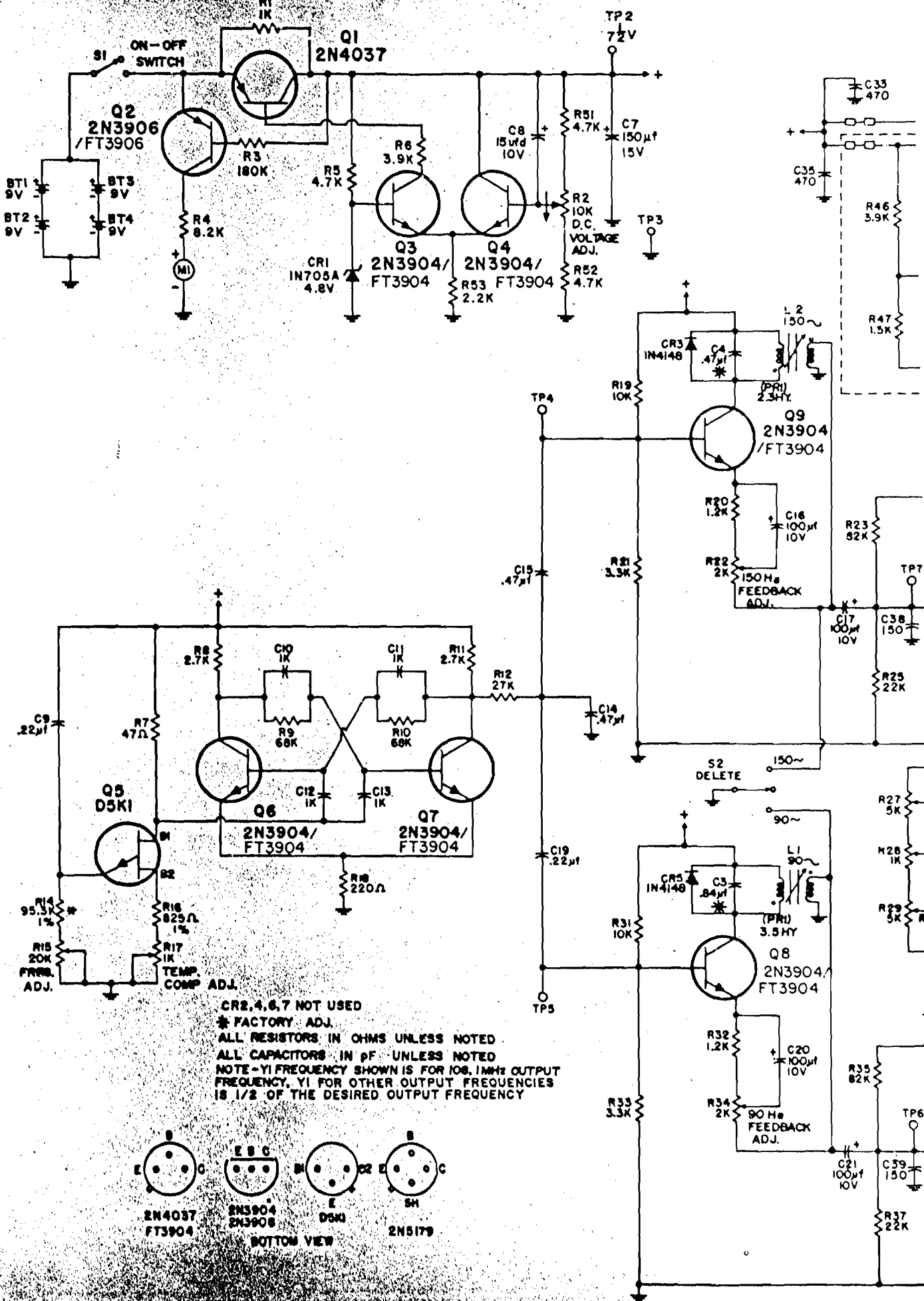
T-28B-5-7



● CHASSIS GND

SOLDER SIDE VIEW

T-28B-5-8


R1 1K
Q1 2N4037
S1 ON-OFF SWITCH
Q2 2N3906 /FT3906
R3 180K
R4 8.2K
BT1 9V
BT2 9V
BT3 9V
BT4 9V
M1
R5 4.7K
R6 3.9K
Q3 2N3904/ FT3904
Q4 2N3904/ FT3904
CR1 IN705A 4.8V
R53 2.2K
C8 15 ufd 10V
R51 4.7K
C7 150 µf 15V
R2 10K D.C. VOLTAGE ADJ.
R52 4.7K
TP2 7½V
TP3
C33 470
C35 470
R46 3.9K
R47 1.5K
L2 150~
CR3 IN4148
C4 .47µf
(PRI) 2.3HY
R19 10K
TP4
Q9 2N3904 /FT3904
R20 1.2K
C16 100µf 10V
R22 2K 150 Hz FEEDBACK ADJ.
R21 3.3K
C15 .47µf
R23 82K
TP7
C17 100µf 10V
C38 150
R25 22K
R8 2.7K
C10 1K
C11 1K
R11 2.7K
R12 27K
C14 .47µf
C9 .22µf
R7 47Ω
R9 68K
R10 68K
C12 1K
C13 1K
Q5 D5K1
Q6 2N3904/ FT3904
Q7 2N3904/ FT3904
R18 220Ω
R14 95.3K 1%
R16 825Ω 1%
R15 20K FREQ. ADJ.
R17 1K TEMP. COMP ADJ.
S2 DELETE
150~
90~
C19 .22µf
L1 90~
CR5 IN4148
C3 .84µf
(PRI) 3.5HY
R31 10K
Q8 2N3904/ FT3904
R27 5K
R28 1K
R29 5K
R32 1.2K
C20 100µf 10V
R34 2K 90 Hz FEEDBACK ADJ.
R33 3.3K
R35 82K
TP6
C21 100µf 10V
C39 150
R37 22K
TP5
CR2,4,6,7 NOT USED
* FACTORY ADJ.
ALL RESISTORS IN OHMS UNLESS NOTED
ALL CAPACITORS IN pF UNLESS NOTED
NOTE - Y1 FREQUENCY SHOWN IS FOR 108.1 MHz OUTPUT FREQUENCY. Y1 FOR OTHER OUTPUT FREQUENCIES IS 1/2 OF THE DESIRED OUTPUT FREQUENCY
B E C
2N4037 FT3904
E B C
2N3904 2N3906
B1 B2 E
D5K1
B C
SH
2N5179
BOTTOM VIEW

PART V
T-29B
GLIDE SLOPE TEST SET

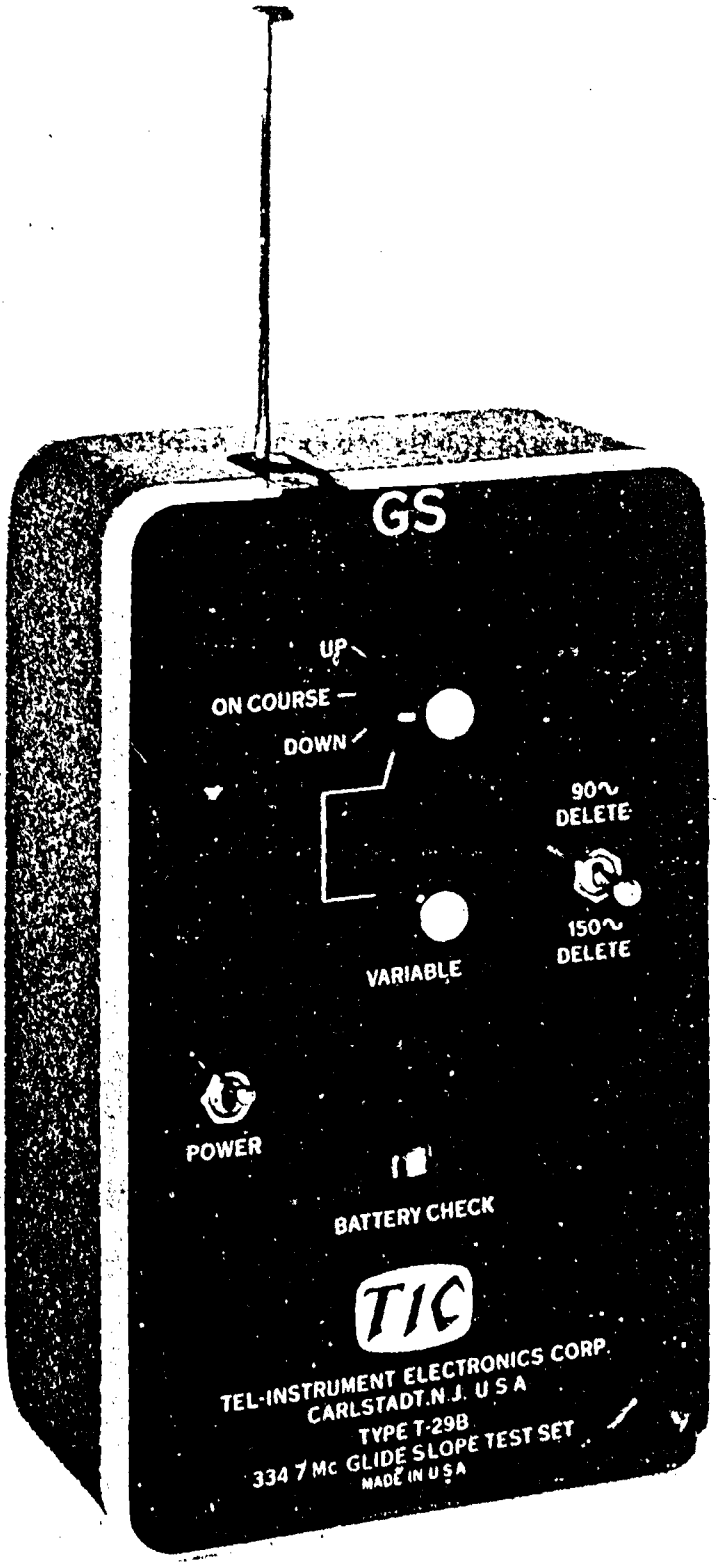


TABLE OF CONTENTS

SECTION I
DESCRIPTION

1.1 GENERAL

The T-29B G. S. Ramp Test is a miniature G.S. transmitter. It generates "UP", "Down" and "On Course" signals on the 334.7 MHz G. S. channel. It also includes a variable control which is continuously adjustable from extreme "Up" to extreme "Down".

An 83.675 MHz crystal controlled oscillator is fed to an amplifier-doubler, followed by a second amplifier-doubler, which delivers 334.7 MHz to the antenna. The 334.7 MHz carrier is amplitude modulated with the mixed 90 Hz and 150 Hz Localizer signals.

A temperature compensated unijunction transistor relaxation oscillator drives a multivibrator whose output is a 30 Hz square wave. The square wave locks the 90 Hz and 150 Hz LC oscillators whose amplitude is temperature compensated. A resistor network mixes the 90 Hz and 150 Hz signals in the proper ratio to give the course indication selected by the front panel controls.

Four 9 volt batteries in series-parallel supply 18 volts to a voltage regulator and metering circuit which delivers 7½ V as long as the battery voltage remains above 9 volts. When the battery voltage falls below 9 volts the meter falls to the red scale indicating that the batteries must be replaced.

SECTION 2
OPERATION

2.1 GENERAL:

Tune the aircraft receivers to 108.10 MC. This will automatically index the corresponding GS channel of 334.7 MC. Extend the 4" antenna of the T-29B GS test set. Note the four operating controls on the front panel:

1. On-Off Power Switch
2. GS Four Position Course Switch
3. GS Variable Knob
4. Delete Switch

ON-OFF POWER SWITCH - Spring return:

The Power On-Off Switch is spring loaded so that it must be held "ON" in order to operate the unit in any of its functions.

GS FOUR POSITION COURSE SWITCH - Consisting of the following function:

On course, up, down, and variable. The physical layout of the panel is such that when the course knob is turned down, the GS indicator swings down, and conversely up when turned up. The deflection up or down is 150 μa or last dot on all indicators. This permits checks of all types of indicators whether two, three, or five dot references are used. The variable position on the course switch references a potentiometer with a line pointing to the potentiometer knob. The dot on the knob, when lined up with the reference line, is the approximate "On Course" position for ready reference. Turning the knob either left or right results in a variable up or down indicator deflection of from center to approximately 185 μa each side. This function permits checkout of indicator "Hang-Up" on full deflection.

GS DELETE SWITCHES - Spring return:

With the T-29B course selector set to "On Course", the flag should appear on a properly operating receiver when either the 90 Hz or 150 Hz modulation is deleted. This assumes that the R. F. carrier is modulated 40% by the individual audio signals.

If the modulation of the T-29B is actually 42% or 44%, or if the receiver has been calibrated with a generator whose actual modulation is only 36% or 38%, the flag may not appear when the delete test is made. Under these conditions, the flag check can be made at a reduced R. F. level by sliding in the T-29B antenna so that it protrudes about 1 inch from the case.

This method can be used until the T-29B modulation is readjusted to agree with the generator used to bench calibrate the receivers. When this is done, the "UP" and "DOWN" course adjustments must also be made. The procedure is outlined on page 4-6 of the T-29B Instruction Manual.

RETRACT THE ANTENNA AFTER THESE CHECKS HAVE BEEN MADE.

SECTION 3
THEORY OF OPERATION

3.1 POWER SUPPLY:

The power supply consists of four 9 volt batteries connected in series-parallel to supply 18 volts to the battery voltage regulator (Q1, Q3, and Q4). Q3 and Q4 form a differential amplifier which compares a portion of the output voltage at the base of Q4 with the voltage across the Zener diode, CR1 at the base of Q3. The base current for the series regulator Q1 is supplied by Q3. Any increase in the output voltage results in a decrease in Q3 collector current and a corresponding decrease in Q1 collector current. This results in a decrease in output voltage. Conversely, a decrease in output voltage results in an increase in Q1 collector current. Thus Q1 acts as a variable resistance which maintains the output voltage constant. D. C. voltage control R2 adjusts the output of the regulator to 7½ V.

The collector-emitter voltage of Q1 is applied to the base-emitter of Q2. If the battery voltage exceeds the regulator output voltage by 1½ V or more, the voltage across Q1 is sufficient to forward bias Q2 and the Battery Check meter reads in the white scale due to Q2 collector current. When the battery voltage no longer exceeds the output voltage by approximately 1½ V, Q2 collector current falls and the Battery Check meter reads in the red scale indicating that the batteries must be replaced.

Through the action of the voltage regulator a drop in battery voltage from 18V to 9V results in a drop in output voltage of less than 0. 1V.

3.2 PULSE GENERATOR AND MULTIVIBRATOR:

A unijunction transistor, Q5, is used in a relaxation oscillator circuit to generate 60 pps. The timing circuit (C9, R14, and R15) is adjusted to produce the required 60 pps. The discharge of C9 into the emitter of Q5 produces sharp negative pulses at B1. Resistor R16 and potentiometer R17 in B2 of Q5 compensate for chages in Rbb (From B1 to B2) with temperature and maintain the frequency constant at 60 pps.

The negative pulses at B1 are coupled through C12 and C13 to the bases of Q6 and Q7, which form a bistable multivibrator. At an input of 60 pps, the output of the multivibrator is a 30 Hz square wave.

3.3 90 Hz AND 150 Hz LC OSCILLATORS:

Transistors Q8 and Q9 are the 90 Hz and 150 Hz LOC oscillators, respectively. With the exception of the tank circuits (L1, C1, and L2, C2) the two oscillators are identical so the operation of the 90 Hz oscillator will be described.

The tank circuit L1, C1, is tuned to 90 Hz and the secondary of L1 is connected in the emitter of Q8 to supply the necessary positive feedback to maintain oscillation. Potentiometer R34 in the emitter circuit adjusts the gain of Q8 and the amount of control exercised by the 30 Hz sync signal.

The diode, CR5, across the tuned circuit limits the amplitude of the signal across the tank and maintains the level constant with temperature.

The 30 Hz square wave which is applied to the base of Q8 and Q9 locks every third cycle and every fifth cycle of the 90 Hz and 150 Hz oscillator respectively, so that they maintain the proper phase relationship.

When the front panel Delete switch S2 is operated it shorts out the secondary of L1 or L2 and oscillation stops.

3.4 90 Hz AND 150 Hz MIXER AND AMPLIFIER:

The 90 Hz signal across the secondary of L1 is applied to the base of amplifier Q10. R38 adjusts the gain of Q10.

The 150 Hz signal across the secondary of L2 is applied to the base of amplifier Q11, whose gain is adjusted by R26.

The outputs at the collectors of Q10 and Q11 are mixed in potentiometer R30 (Front Panel Control) which can be adjusted for varying ratios of 90 Hz and 150 Hz. Potentiometers R27, R28, and R29 are connected in series across the front panel control R30. R28 is set for equal amounts of 90 Hz and 150 Hz and R27 and R29 are set for a fixed ratio of 90 Hz and 150 Hz. Front panel switch S3 is used to select one of the preset ratios or the continuously variable control. The signal selected by S3 is applied through C23 to the base of amplifier Q12. The gain of Q12 is adjusted by R44 and the output is fed to the modulator through C24.

3.5 MODULATOR AND R. F. CIRCUITS:

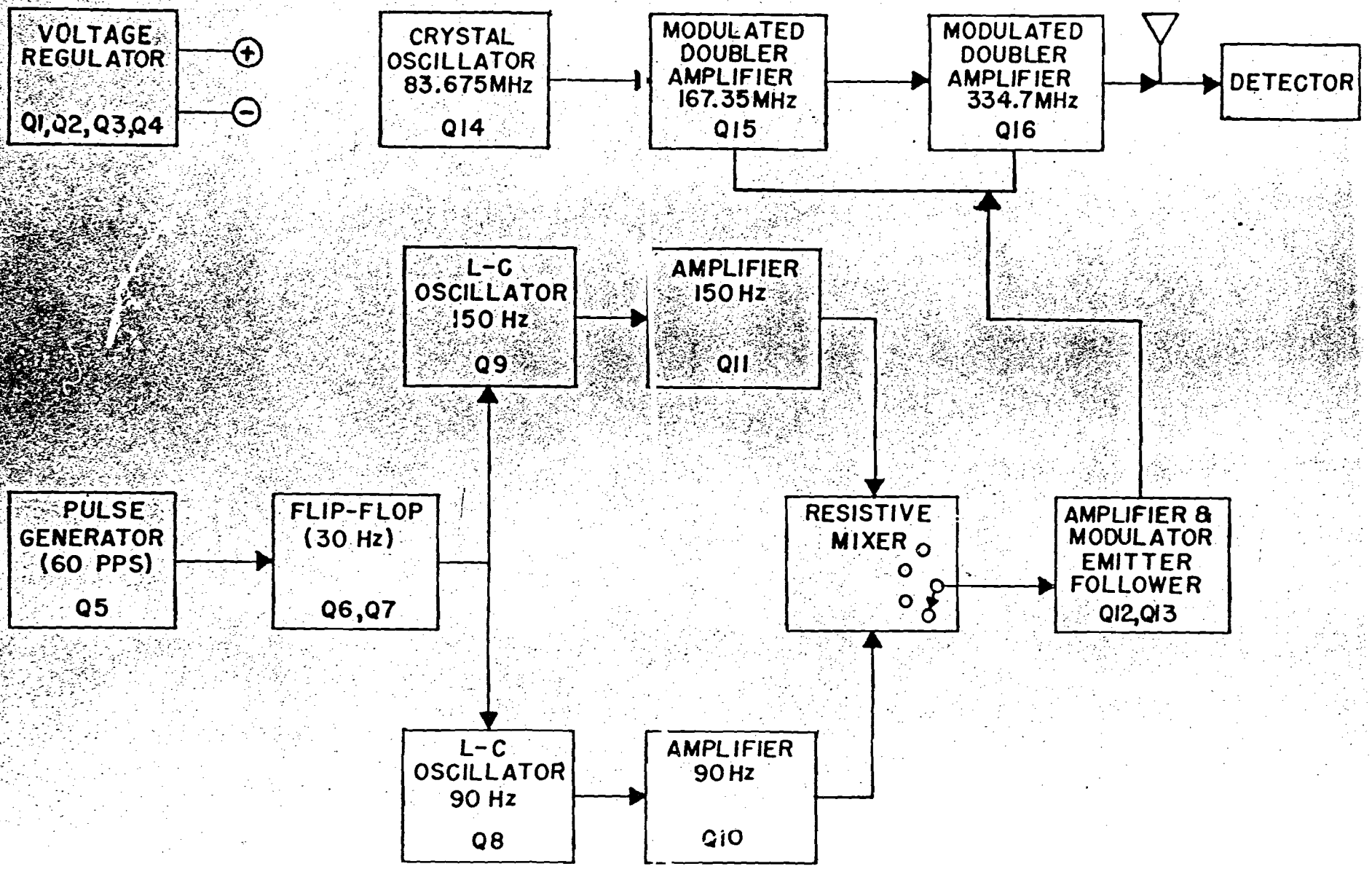
Transistor Q14 is a Colpitts-type crystal oscillator. The tank circuit L3, C3, C29, and C30 tune the collector to 83.675 MHz. The crystal, Y1, operates in the series resonant mode and provides a low impedance feedback path to the emitter to sustain oscillation.

The oscillator output is coupled to the base of the modulated amplifier-doubler Q15. This transistor is normally cut off and is turned on by the positive peaks of the oscillator signal. The tank circuit (L4, C4) in the collector of Q15 is tuned to the second harmonic of the crystal oscillator to achieve doubling.

The doubler output is coupled to the base of the second modulated amplifier-doubler, Q16. The collector of Q16 is tuned to the fourth harmonic of the crystal oscillator (334.7 MHz) by L5, C5 and C40. The antenna is connected to a low impedance point of the output tank.

The emitters of Q15 and Q16 are returned to ground through the modulator, Q13. This transistor is an emitter follower whose base voltage consists of a D. C. voltage determined by the setting of R13, and the amplified 90 Hz and 150 Hz signals, resulting in a varying D. C. voltage at its emitter. This varying voltage modulates the collector currents of the two amplifier-doublers, Q15 and Q16.

The series tuned trap (L9, C6) from antenna to ground is tuned to the fourth harmonic of the crystal oscillator to eliminate spurious radiation. The diode CR8, is a built-in detector which is used when adjusting the R. F. circuits.



BLOCK DIAGRAM

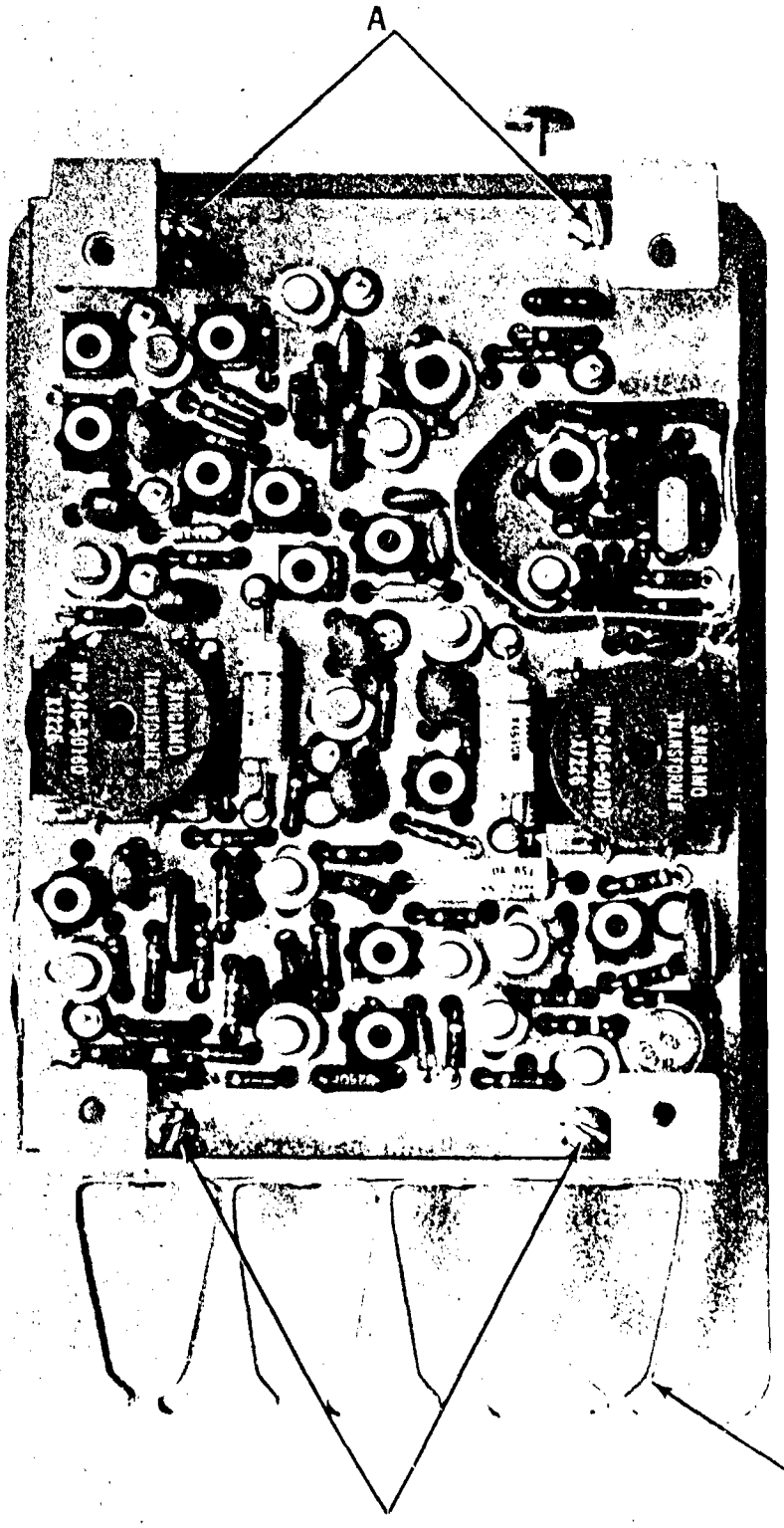


Figure 1Ca

SECTION 4
TROUBLE SHOOTING AND MAINTENANCE

4.1 MAINTENANCE:

This unit should require very little maintenance other than replacement of batteries. In order to replace the batteries, remove the unit from the case by taking out the four screws underneath the case. Lift off the battery connector board (use a screwdriver if necessary) and replace the batteries.
CAUTION: Be sure to observe correct polarity.

If a unit should become inoperative isolate the defective section by following the procedures outlined as indicated in the adjustments below. After the defective section has been found, replace the associated transistors taking care to insert them correctly into their sockets. If new transistors do not correct the trouble and it becomes necessary to unsolder components, great care should be exercised to avoid damaging the printed circuit board. When troubleshooting the unit, refer to the block diagram and "Theory of Operation" section.

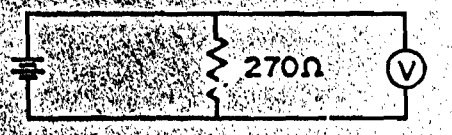
To remove the circuit board for service, consult Fig. 1Ca & 1Cb.

Remove the four screws marked "A" unsolder the lead to the antenna, and slide the board out.

To replace the antenna, unscrew the teflon stop from the end of the antenna and pull the antenna out. Insert the replacement antenna and screw it into the teflon stop. See Fig. 1Cb.

CAUTION: When removing the linkage between the LOC and GS power switches loosen the set screws to avoid breaking the switch levers. An Allen wrench is supplied for this purpose.

IMPORTANT: In some instances brand new batteries have been found to be defective. Therefore it is recommended that all new batteries be checked under load before installation. They can be tested in the circuit shown:



If the voltage falls rapidly (0.4V or more) in 5 minutes the battery should be considered defective.

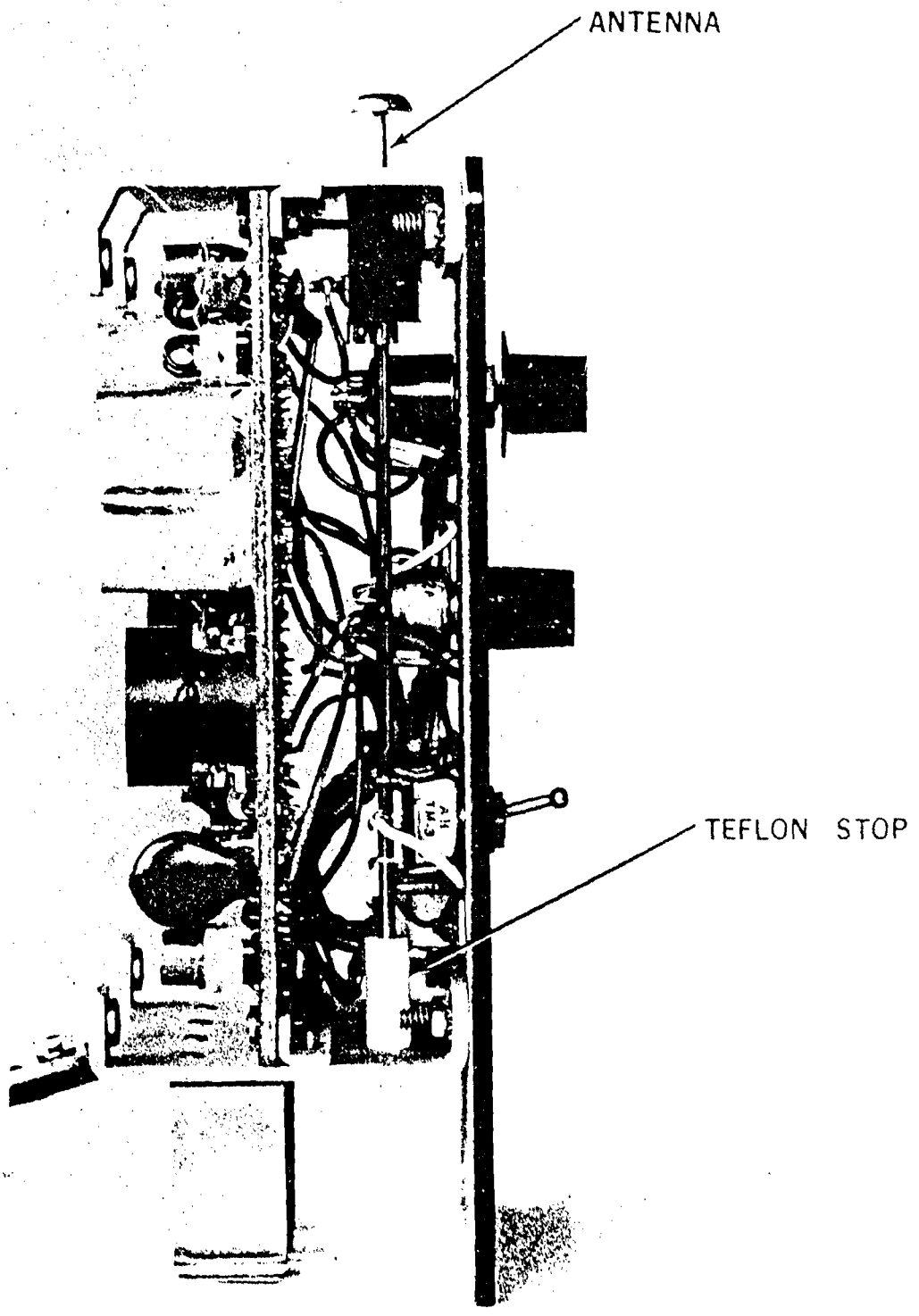


Figure 1Cb

T-29B-4-1.2

4.2 VOLTAGE REGULATOR ADJUSTMENT:

1. Set D. C. power supply to 18V and connect to T-29B in place of batteries.

2. Turn on T-29B and adjust R2 (D. C. voltage control) for 7½ V across TP2 and TP3. (To increase R. F. output this voltage can be increased to 8½ V with resulting decrease in battery life.

3. Reduce D. C. supply voltage slowly while monitoring Battery Check meter and voltage across TP2 and TP3. Voltage at this point should not fall more than 1% and input voltage should be less than 9½ V before the Battery Check meter falls to the red scale.

30 Hz GENERATOR ADJUSTMENT:

1. Remove unijunction transistor Q5, D5K1, from socket and measure its interbase resistance, Rbb (from B1 to B2) with an ohmmeter.

2. Connect the ohmmeter from B2 to ground (Q5 out of socket) and adjust R17 (Temp. Comp. Adj.) so measured resistance is $\frac{Rbb}{6}$.

3. Restore Q5 and connect scope and counter to TP4. Adjust R15 (Freq. adj.) so signal at TP4 is a 30 Hz square wave.

4.3 AUDIO OSCILLATOR ADJUSTMENT:

1. Remove Q5 from socket and connect scope and counter to TP7.

2. Adjust R22 (150 Hz Feedback Adj.) to the point where feedback is just sufficient to sustain full amplitude oscillation. See Fig. 1B.

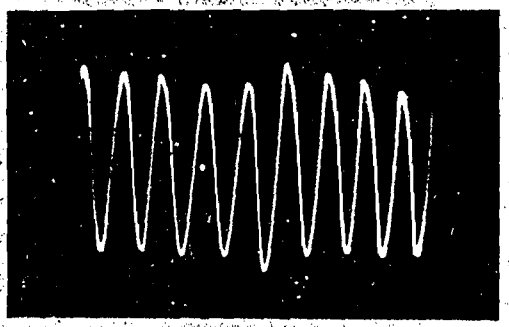


Fig. 1B

3. Adjust frequency to 148 Hz with L2. If L2 has insufficient range, tailor factory adjust capacitor C4 as necessary to reach 148 Hz. Note: If the signal amplitude at TP7 is insufficient to operate the counter, connect it to TP11, throw Delete switch to delete 90 Hz, and adjust R26 (150 Hz Amp. Adj.) for sufficient signal to operate the counter. See Fig. 2B.

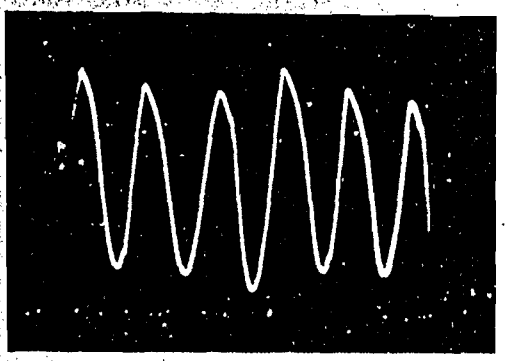


Fig. 2B

4. Connect scope and counter to TP6 and adjust R34 (90 Hz Feedback Adj.) to the point where feedback is just sufficient to sustain full amplitude oscillation.

5. Adjust frequency to 88 Hz with L1. If L1 has insufficient range, tailor factory adjust capacitor C3 as necessary to reach 88 Hz. Note: If the signal amplitude at TP6 is insufficient to operate the counter connect it to TP12, throw Delete switch to delete 150 Hz, and adjust R38 (90 Hz Amp. Adj.) for sufficient signal to operate the counter.

6. Connect scope and A.C. VTVM to TP11. Throw Delete switch to delete 90 Hz and adjust R26 (150 Hz Amp. Adj.) for approximately 0.1 Vrms.

7. Connect scope and A.C. VTVM to TP12. Throw Delete switch to delete 150 Hz and adjust R38 (90 Hz Amp. Adj.) for same amplitude as in Step 6.

8. Connect scope to TP8. Turn course switch to "On Course", set R28 (On Course Adj.) at mid-range and adjust R44 (% Modulation Adj.) for maximum signal without clipping. If necessary, reduce gain of 90 Hz and 150 Hz amplifiers, by adjusting R26 and R38.

9. The mixed 90 Hz and 150 Hz signal at TP8 is not phase-locked. Restore Q5. The signal at TP8 should now lock in phase. See Fig. 3B.

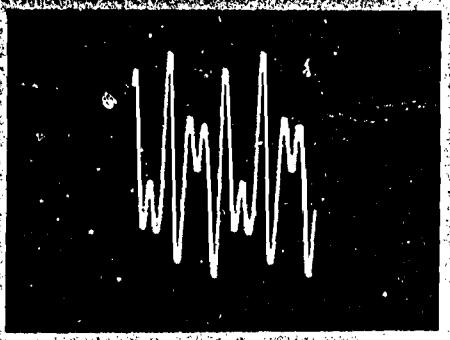


Fig. 3B

10. Repeat Steps 6, 7 and 8.

11. With scope connected to TP8, throw Delete switch to delete 90 Hz. Signal should appear as in Fig. 1B. Throw Delete switch to delete 150 Hz and signal should appear as in Figure 2B.

12. With Delete switch in neutral position compare waveform at TP8 with Figure 3B. The balanced minor peaks indicate the correct phase relationship of the 90 Hz and 150 Hz signals. If the minor peaks are not balanced adjust L1 slightly to bring the peaks into balance.

4.4 MODULATOR AND R. F. SECTION:

1. Extend T-29B antenna and connect D. C. scope input to TP10.

2. Connect VTVM from TP9 to ground and adjust R13 (R. F. Output) for minimum D. C. voltage, then connect VTVM to TP10.

3. Adjust the oscillator tuning capacitor C3 for maximum total current as indicated on external D. C. supply.

4. Adjust first doubler tuning capacitor C4 for maximum total current as indicated on external D. C. supply.

5. If signal appears at TP10, adjust output tuning capacitor C5 for maximum signal and optimum modulation linearity. If there is no signal at TP10, adjust the capacitor for maximum total current as in steps 3 and 4.

6. Adjust 418 MHz trap tuning capacitor C6 for maximum signal at TP10.

7. Touch up all tuning capacitors if necessary for maximum signal and modulation linearity at TP10.

8. Check output frequency by coupling counter to T-29B through 1 inch loop. (Remove transistor Q12 to eliminate spurious counts caused by modulation.) Replace Q12 after measurement.

9. Make preliminary adjustment of % modulation as follows:

a. Leave scope and VTVM as in step 1.

b. With T-29B power switch off, position scope trace to bottom of screen.

c. Set Course Switch to "On Course", R28 (On Course Adj.) to mid-range, Delete Switch to Delete 90 Hz and turn on T-29B. Adjust scope gain so center of waveform is at center of scope screen. (Recheck position of scope trace with T-29B off.)

d. Calculate % modulation. This is equal to 100 times peak-to-peak waveform divided by total scope screen height. See Fig. 4B.

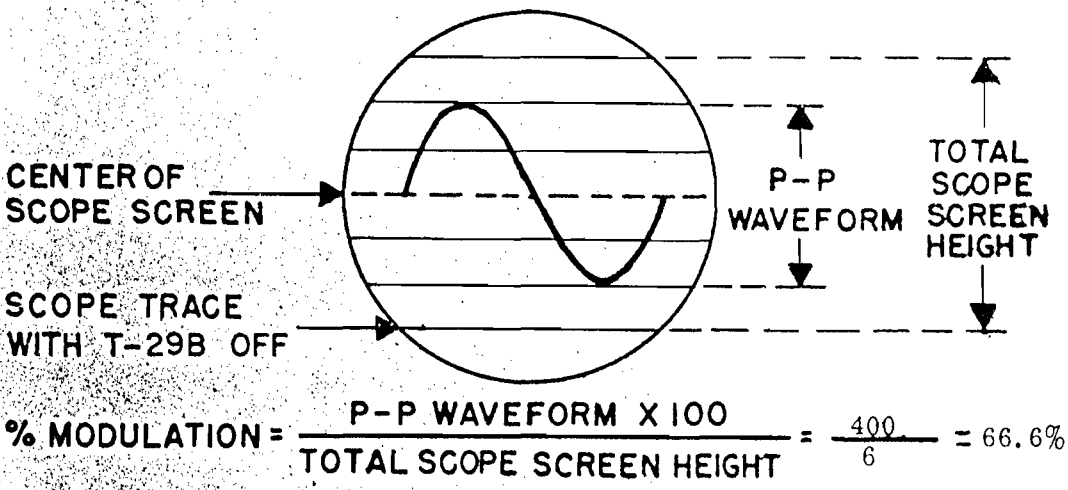


FIG. 4B

e. Adjust R44 (% Modulation Adj.) and R13 (R.F. output) for 50% modulation and D. C. output at TP10 greater than 0.3V. This is actually about 40% modulation due to voltage drop in the detector diode, CR8.

f. Throw Delete Switch to Delete 150 Hz and adjust R38 (90 Hz Amp. Adj.) for 50% modulation as in step e.

g. Return Delete Switch to neutral and observe waveform at TP10. If clipping is evident, readjust R44 (% Modulation Adj.) to eliminate clipping, and readjust R13 (R.F. Output) for correct modulation in steps e and f.

10. The R. F. voltage measured at the base of the antenna should be greater than 0.4 Vrms. (Use Sampling Voltmeter to measure R. F.)

11. Final adjustment of % modulation and d.d.m.:

a. Radiate signal from T-29B into short antenna connected to ILS Calibrator R.F. input jack and switch calibrator to measure d.d.m.

b. With T-29B Course Switch at "On Course" adjust R23 (On Course Adj.) for 0 d.d.m. on the ILS Calibrator. If zero deviation cannot be obtained by adjusting R28 it indicates that the 90 Hz and 150 Hz levels are unbalanced. To correct this, set R28 at mid-range and adjust R38 (90 Hz Amp. Adj.) for zero deviation current on Test Bench receiver with Ramp Test Set switched to "On Course" position.

c. Switch ILS Calibrator to measure % modulation and adjust R44 (% mod. Adj.) for 40% modulation.

d. Recheck step b.

e. Set T-29B Course Switch to "UP" and adjust R27 (Up Course Adj.) for 0.175 d.d.m.

f. Set T-29B Course Switch to "Down" and adjust R29 (Down Course Adj.) for 0.175 d.d.m.

12. Alternate method for adjusting % Modulation and d.d.m.:

If an ILS Calibrator is not available, the T-29B can be calibrated against a TIC Type T-12A Nav Com Generator or a Glide Slope Signal Generator, Boonton Type 232-A using a receiver as a transfer standard.

a. Equip the receiver with meters to measure flag current and deviation current.

b. Calibrate the receiver against the bench standards. (Flag Current is a measure of % modulation and its value at 0 d.d.m. should be used to calibrate the T-29B.)

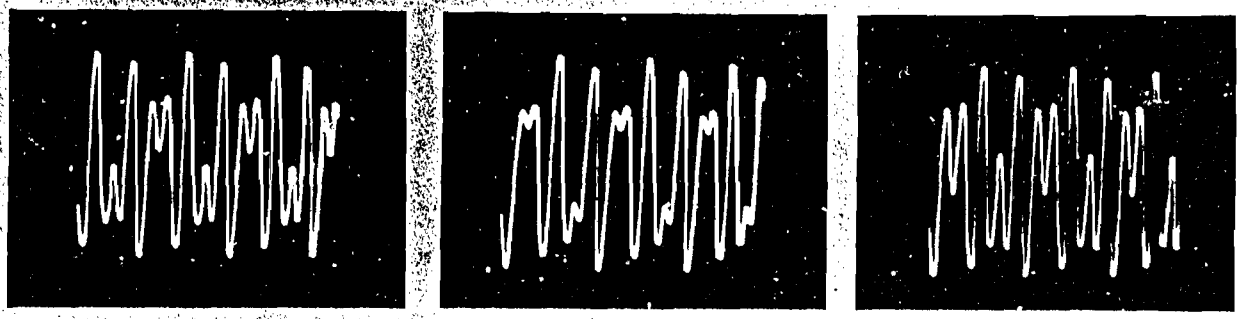
c. Radiate the T-29B into the receiver antenna and adjust R28 (On Course Adj.) for 0 deviation current with T-29B Course Switch set to "On Course".

d. Set T-29B Course Switch to "On Course" and adjust R44 (% Mod. Adj.) for the same flag current as measured in step b.

e. Recheck step c.

f. Set T-29B Course Switch to "UP" and adjust R27 (UP Course Adj.) for 150 μa.

g. Set T-29B Course Switch to "Down" and adjust R29 (Down Course Adj.) for 150 μa.



a b c

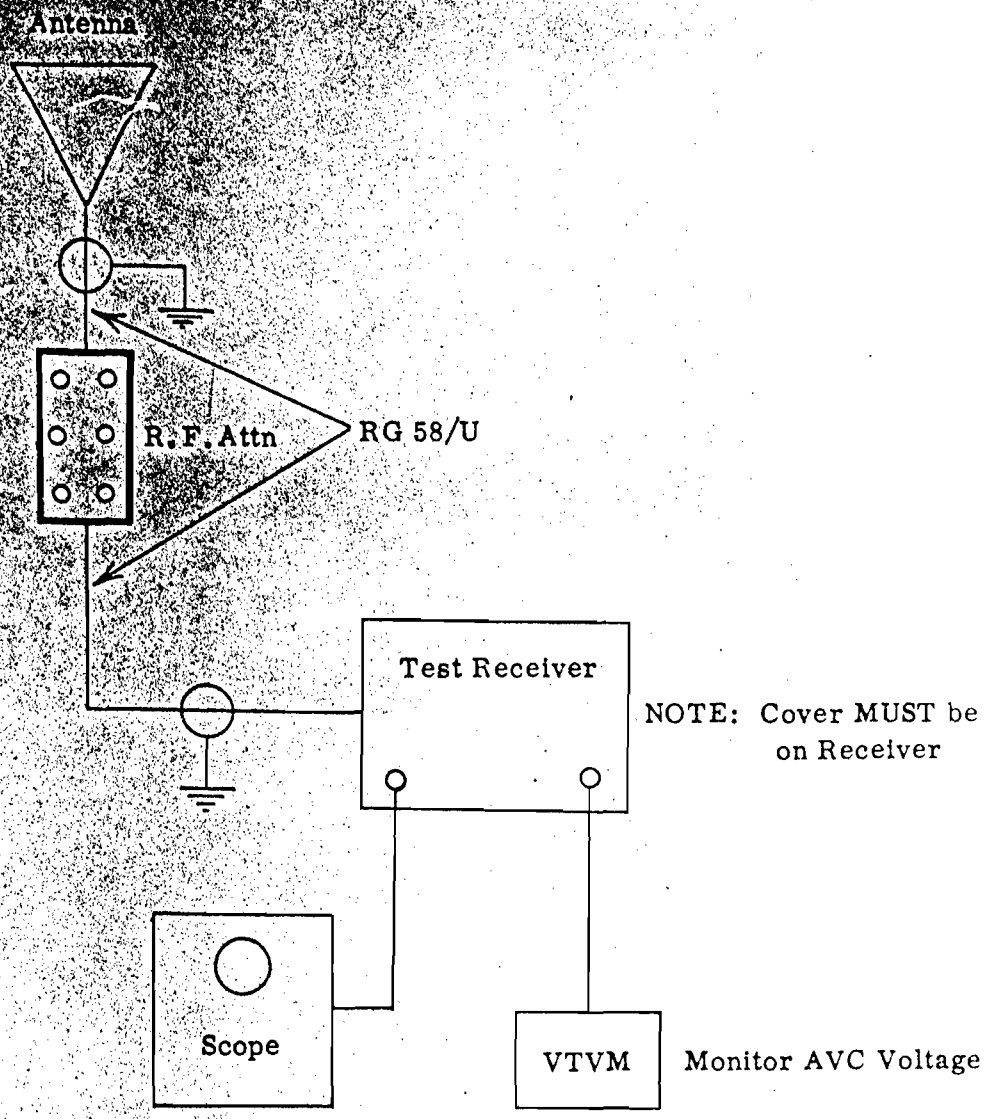
T-29B detector output signal. 17 ms/cm Horizontal. 0.22V/cm Vertical.

a. On Course
b. Needle down
c. Needle up

Fig. 5B

IMPORTANT NOTE: The same test equipment should be used to calibrate the T-29B as is used to "bench test" the aircraft receivers. This will minimize the possibility of problems caused by tolerances in test equipment specifications.

When the ramp test set is checked against a test bench receiver the output from the ramp test set may be sufficient to overload the receiver. In this case an attenuator can be placed in the cable from the receiver antenna. The attenuation should be sufficient to insure that the receiver is not being overloaded. The input to the receiver can be determined by first measuring the A.V.C. voltage of the test receiver with the ramp test set turned on. Then feed a signal generator equipped with a calibrated attenuator into the receiver and determine what value of signal is required to achieve the same A.V.C. voltage as before.



TYPICAL TEST RECEIVER SET-UP

T-29B GLIDE SLOPE

MAIN CHASSIS

ITEM	DESCRIPTION	CIRCUIT DESIGNATION	QTY	TIC PART #
1	ANTENNA TIC DWG. NO. T-27A-60-5-A	A1	1	TA-2-A
2	BATTERY EVEREADY #222	BT1 thru BT4 Incl.	4	TB-8
3	" CLIP ASSEMBLY FOR 4 BATTERIES		1	TC-181-A
4	CLIP KEYSTONE 80		4	TH-10
5	KNOB NOBEX 1-503	VARIABLE	1	TK-15
6	" NOBEX 1-504D	SELECTOR	1	TK-16
7	METER EMICO 802 PWR	M1	1	TM-7
8	RESISTOR VARIABLE COMPOSITION 5K ALLEN-BRADLEY RV6NAYSD502A	R30	1	TP-61-A
9	SWITCH ROTARY GRAYHILL 50CD36-01-2-4N (TIC MOD.)	S3	1	TS-74
10	" TOGGLE ARROW-HART & HEGEMAN TG-3-M	S2	1	TS-77
11	" " ARROW-HART & HEGEMAN TM-3	S1	1	TS-79

T-29B GLIDE SLOPE

PRINTED CIRCUIT BOARD

ITEM	DESCRIPTION	CIRCUIT DESIGNATION	QTY	TIC PART
1	CAPACITOR FIXED DIPPED MICA 47 pF 5% SANGAMO DM155F470J	C40	1	TC-48
2	" TRIMMER 2-8 pF ERIE TECHN. PROD. 538-011-A	C5, C6	2	TC-60
3	" " 3-15 pF ERIE TECHN. PROD. 538-011-D	C3, C4	2	TC-61
4	" FIXED CERAMIC DISC 47 pF CENTRALAB DD470	C33, C36, C38	3	TC-77
5	" " " " 470 pF CORNELL-DUBILIER BYZ601ZU471P	C26, C27, C28, C31, C34, C35, C37, C39	8	TC-90
6	" " " " 1K pF ERIE TECHN. PROD. 801	C10 thru C13 Incl.	4	TC-94
7	" " " 0.22 µF 50V SPRAGUE 7C023224X0500D	C19	1	TC-132
8	" " " 0.47 µF 50V SPRAGUE 7C023474X0500E	C14, C15	2	TC-139
9	" " MICA 15 pF CM15E150J	C29, C30	2	TC-14
10	" ELECTROLYTIC TANTALUM 330 µF 6V SPRAGUE 196D337X0006MA3	C25	1	TC-174
11	" " " 100 µF 10V SPRAGUE 196D107X0010LA3	C16, C17, C18, C20, C21, C22, C23, C24	8	TC-168
12	" " " 15 µF 15V SPRAGUE 196D156X0015JE3	C8	1	TC-152
13	" " " 150 µF 15V SPRAGUE 196D157X0015MA3	C7	1	TC-172
14	" FIXED POLYCARBONATE 0.22 µF 50V 5% TRW X463UW	C1, C9	2	TC-131
15	" " " 0.47 µF 50V 5% TRW X463UW	C2	1	TC-138
16	" " " 0.68 µF 50V 5% TRW X463UW	C1	1	TC-141
17	CRYSTAL 83.675 MHz TIC-56	Y1	1	TC-276
4A	CAPACITOR FIXED CERAMIC DISC 150 pF 10% 1KV CENTRALAB	C-41, C-42	2	TC-84

T-29B GLIDE SLOPE

PRINTED CIRCUIT BOARD

ITEM	DESCRIPTION	CIRCUIT DESIGNATION	QTY	TIC PART #
18	DIODE SILICON 1N87A	CR8	1	TD-7
19	" SILICON 1N4148	CR3, CR5	2	TD-19-A
20	" ZENER 1N705A or 1N5230B 4.8V	CR1	1	TD-10
21	INDUCTOR FIXED 1 μH CRAMER 190-1	L6, L7, L8	3	TC-196
22	" " OSCILLATOR TIC MFR.	L3	1	TC-207A
23	" " 1ST AMPLIFIER-DOUBLER TIC MFR.	L4	1	TC-207B
24	" " 2ND AMPLIFIER-DOUBLER TIC MFR.	L5	1	TC-207C
25	" " R.F. TRAP TIC MFR.	L9	1	TC-207C
26	RESISTOR FIXED COMPOSITION 47Ω 1/4W 10% ALLEN-BRADLEY CB4701	R7	1	TR-142
27	" " " 150Ω 1/4W 10% ALLEN-BRADLEY CB1511	R47	1	TR-146-A
28	" " " 220Ω 1/4W 10% ALLEN-BRADLEY CB2211	R18	1	TR-148
29	" " " 470Ω 1/4W 10% ALLEN-BRADLEY CB4711	R48, R52	2	TR-151
30	" " " 1K 1/4W 10% ALLEN-BRADLEY CB1021	R1, R49, R51	3	TR-155
31	" " " 1.2K 1/4W 10% ALLEN-BRADLEY CB1221	R20, R32	2	TR-156
32	" " " 1.5K 1/4W 10% ALLEN-BRADLEY CB1521	R40, R46	2	TR-157
33	" " " 1.8K 1/4W 10% ALLEN-BRADLEY CB1821	R50	1	TR-158
34	" " " 2.2K 1/4W 10% ALLEN-BRADLEY CB2221	R53	1	TR-159

T-29B GLIDE SLOPE

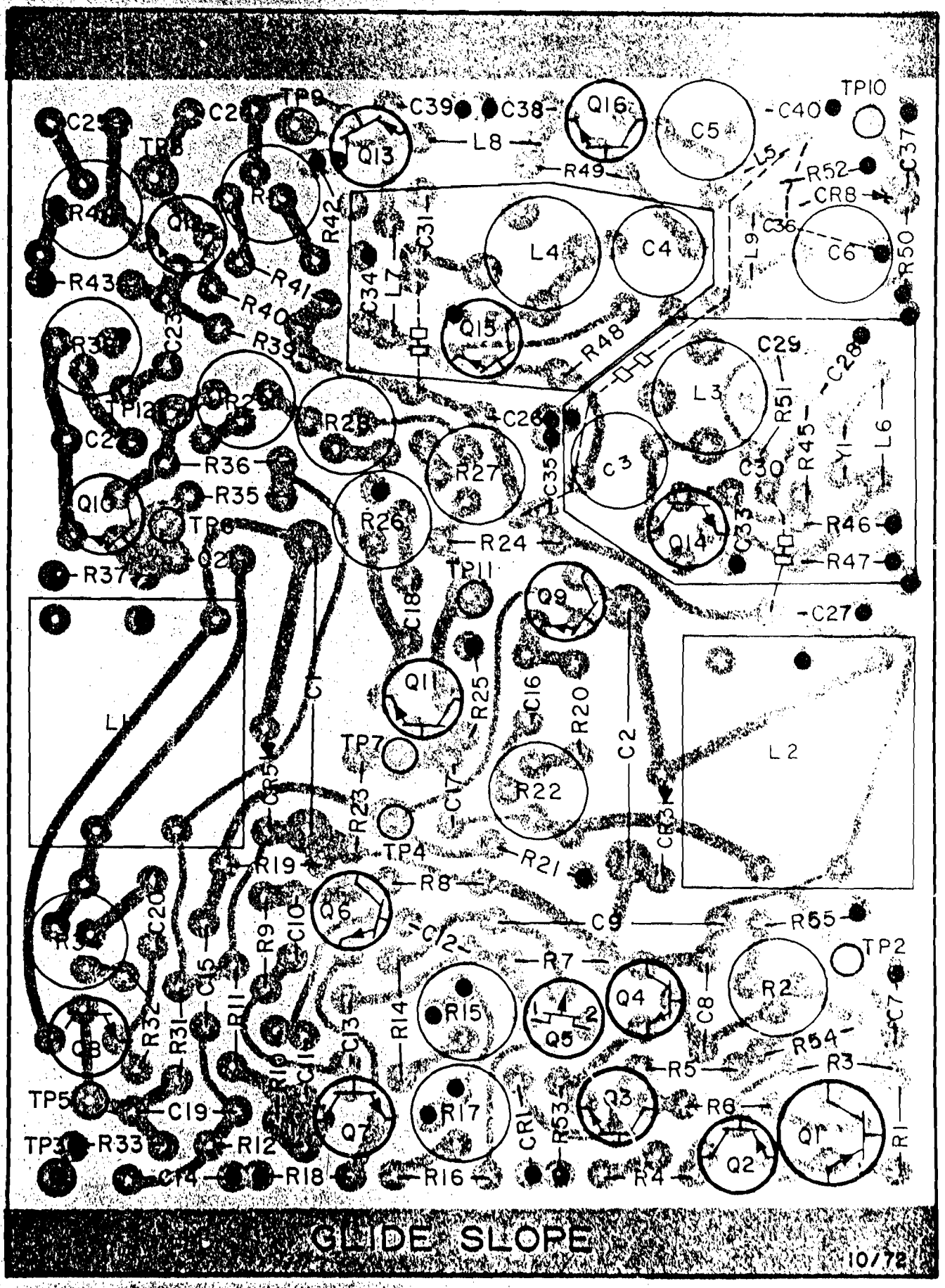
PRINTED CIRCUIT BOARD

ITEM	DESCRIPTION				CIRCUIT DESIGNATION	QTY	TIC PART #
35	RESISTOR	FIXED COMPOSITION	2.7K 1/4W 10% ALLEN-BRADLEY CB2721		R8,R11	2	TR-160
36	"	"	3.3K 1/4W 10% ALLEN-BRADLEY CB3321		R21,R33	2	TR-161
37	"	"	3.9K 1/4W 10% ALLEN-BRADLEY CB3921		R6,R42,R45	3	TR-162
38	"	"	4.7K 1/4W 10% ALLEN-BRADLEY CB4721		R5,R54,R55	3	TR-163
39	"	"	8.2K 1/4W 10% ALLEN-BRADLEY CB8221		R4	1	TR-166
40	"	"	10K 1/4W 10% ALLEN-BRADLEY CB1031		R19,R31	2	TR-167
41	"	"	22K 1/4W 10% ALLEN-BRADLEY CB2231		R25,R37,R41	3	TR-171
42	"	"	27K 1/4W 10% ALLEN-BRADLEY CB2731		R12	1	TR-172
43	"	"	47K 1/4W 10% ALLEN-BRADLEY CB4731		R43	1	TR-175
44	"	"	68K 1/4W 10% ALLEN-BRADLEY CB6831		R9,R10	2	TR-177
45	"	"	82K 1/4W 10% ALLEN-BRADLEY CB8231		R23,R35	2	TR-178
46	"	"	150K 1/4W 10% ALLEN-BRADLEY CB1541		R39	1	TR-181
47	"	"	180K 1/4W 10% ALLEN-BRADLEY CB1841		R3	1	TR-181-A
48	"	"	METAL FILM	825Ω 1% RN60C	R16	1	TR-90-B
49	"	"	" "	2.49K 1% RN60C	R24,R36	2	TR-94
50	"	"	" "	95.3K 1% RN60C	R14	1	TR-26-A

T-29B GLIDE SLOPE

PRINTED CIRCUIT BOARD

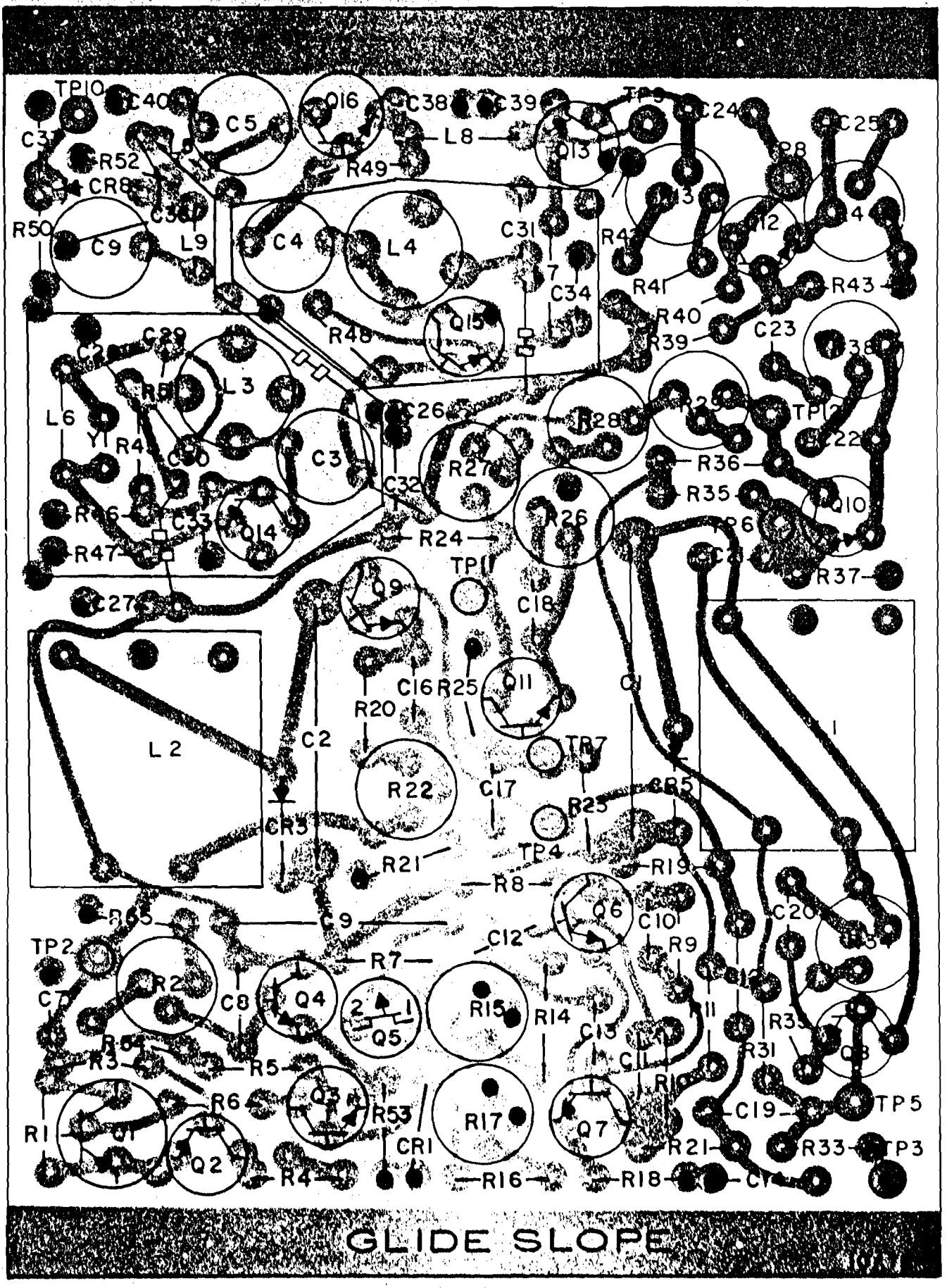
ITEM	DESCRIPTION					CIRCUIT DESIGNATION	QTY	TIC PART #
51	RESISTOR	VARIABLE	CERMET	250Ω	ALLEN-BRADLEY ZV2511	R44	1	TP-32
52	"	"	"	500Ω	ALLEN-BRADLEY ZV5011	R28	1	TP-38A
53	"	"	"	1K	ALLEN-BRADLEY ZV1021	R17	1	TP-41-A
54	"	"	"	2K	ALLEN-BRADLEY ZV2021	R22, R26, R27, R29, R34, R38	6	TP-50-A
55	"	"	"	10K	ALLEN-BRADLEY ZV1031	R2, R13	2	TP-65-A
56	"	"	"	20K	ALLEN-BRADLEY ZV2031	R15	1	TP-73-A
57	SOCKET	TRANSISTOR			INDUSTRIAL ELECTRONIC HARDWARE MPT 4003-1 NYLON	XQ2 thru XQ14	13	TS-34
58	"	"			INDUSTRIAL ELECTRONIC HARDWARE MPT 4004-1 NYLON	XQ15	1	TS-35
59	"	"			INDUSTRIAL ELECTRONIC HARDWARE MPT 6003-1 NYLON	XQ1, XQ16	2	TS-36
60	TRANSISTOR	2N3866	NPN	SILICON		Q16	1	TT-31-A
61	"	2N4037	PNP	SILICON		Q1	1	TT-34
62	"	2N5179	NPN	SILICON		Q15	1	TT-36
63	"	FAIRCHILD SEMICOND. FT3904 or 2N3904 NPN SILICON				Q3, Q4, Q6 thru Q12 Incl., Q14	10	TT-32
64	"	FAIRCHILD SEMICOND. FT3906 or 2N3906 PNP SILICON				Q2, Q13	2	TT-33
65	"	UNIJUNCTION D5K1		SILICON		Q5	1	TT-16
66	TRANSFORMER	2.3H	SANGAMO		NV-246-50170	L2	1	TC-224-B
67	"	3.5H	SANGAMO		NV-246-50160	L1	1	TC-224-A



● CHASSIS GND

COMPONENT SIDE VIEW

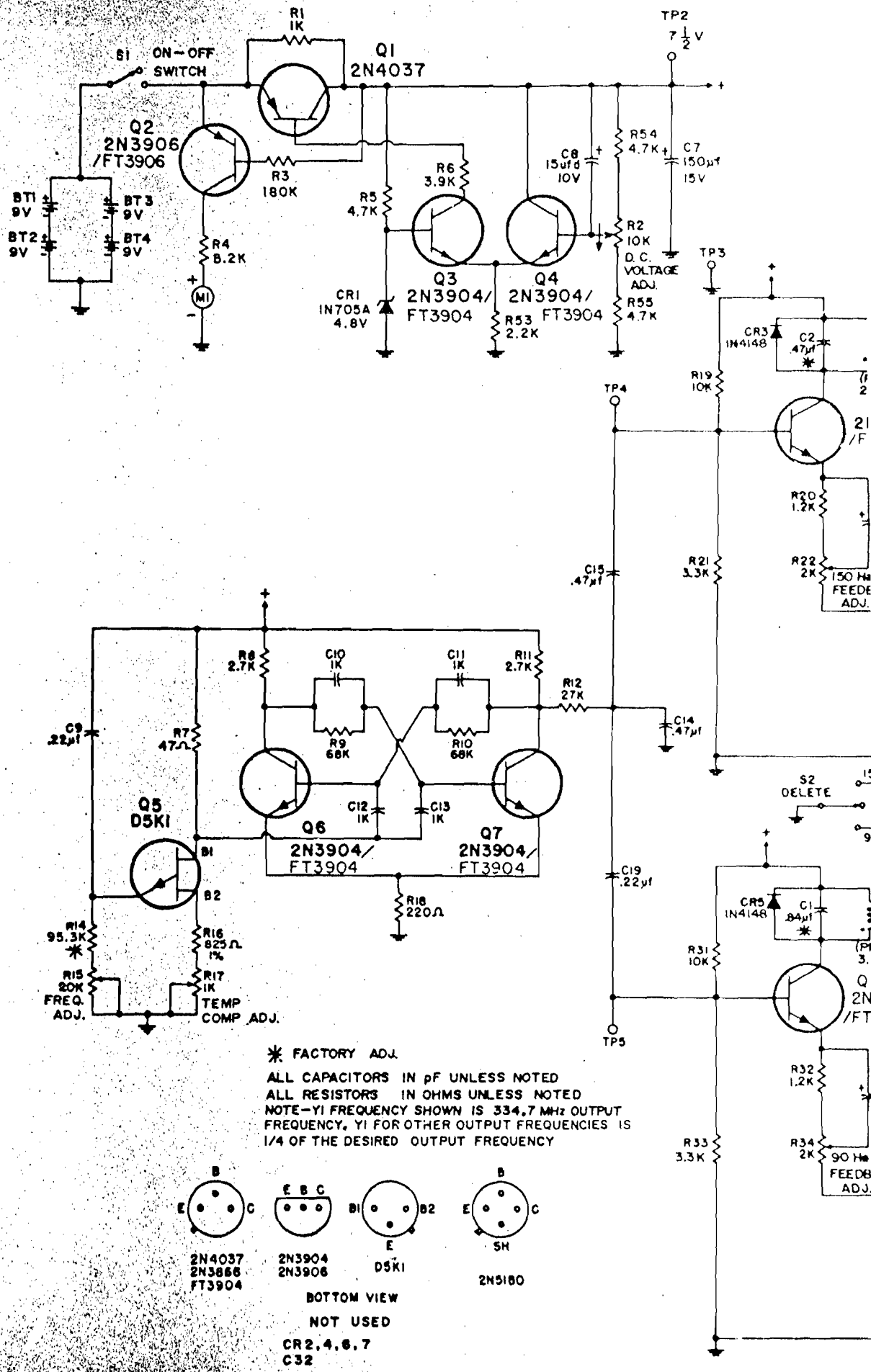
T-298-5-7

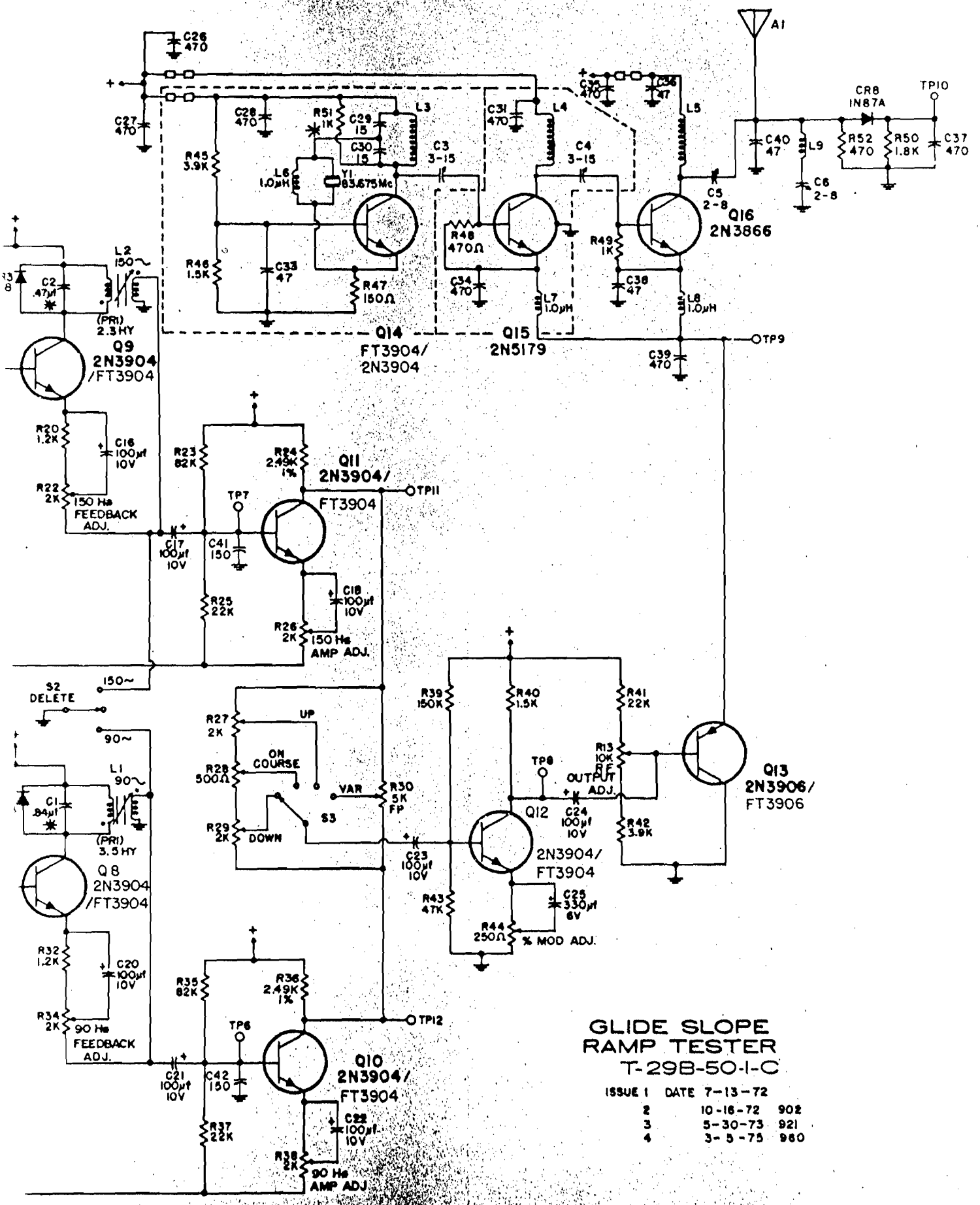


T-29B-5-8

SOLDER SIDE VIEW

CHASSIS GND


R1
1K
S1 ON-OFF SWITCH
Q1
2N4037
TP2
7½ V
Q2
2N3906
/FT3906
R3
180K
BT1
9V
BT2
9V
BT3
9V
BT4
9V
R4
8.2K
M1
R5
4.7K
R6
3.9K
C8
15ufd
10V
R54
4.7K
C7
150µf
15V
R2
10K
D.C. VOLTAGE ADJ.
R55
4.7K
CR1
IN705A
4.8V
Q3
2N3904/
FT3904
Q4
2N3904/
FT3904
R53
2.2K
TP3
CR3
IN4148
C2
.47µf
R19
10K
TP4
R20
1.2K
R21
3.3K
R22
2K
C15
.47µf
R8
2.7K
C10
1K
C11
1K
R11
2.7K
R12
27K
C14
.47µf
C9
.22µf
R7
47Ω
R9
68K
R10
68K
Q5
D5K1
B1
B2
C12
1K
C13
1K
Q6
2N3904/
FT3904
Q7
2N3904/
FT3904
R18
220Ω
C19
.22µf
S2
DELETE
CR5
IN4148
C1
.84µf
R31
10K
R14
95.3K
R16
825Ω
1%
R15
20K
FREQ. ADJ.
R17
1K
TEMP COMP ADJ.
TP5
R32
1.2K
R33
3.3K
R34
2K
90 Hz
FEEDB
ADJ.
* FACTORY ADJ.
ALL CAPACITORS IN pF UNLESS NOTED
ALL RESISTORS IN OHMS UNLESS NOTED
NOTE-YI FREQUENCY SHOWN IS 334.7 MHz OUTPUT FREQUENCY. YI FOR OTHER OUTPUT FREQUENCIES IS 1/4 OF THE DESIRED OUTPUT FREQUENCY
B
E
C
2N4037
2N3866
FT3904
E B C
2N3904
2N3906
B1
B2
E
D5K1
B
E
C
SH
2N5180
BOTTOM VIEW
NOT USED
CR2,4,6,7
C32



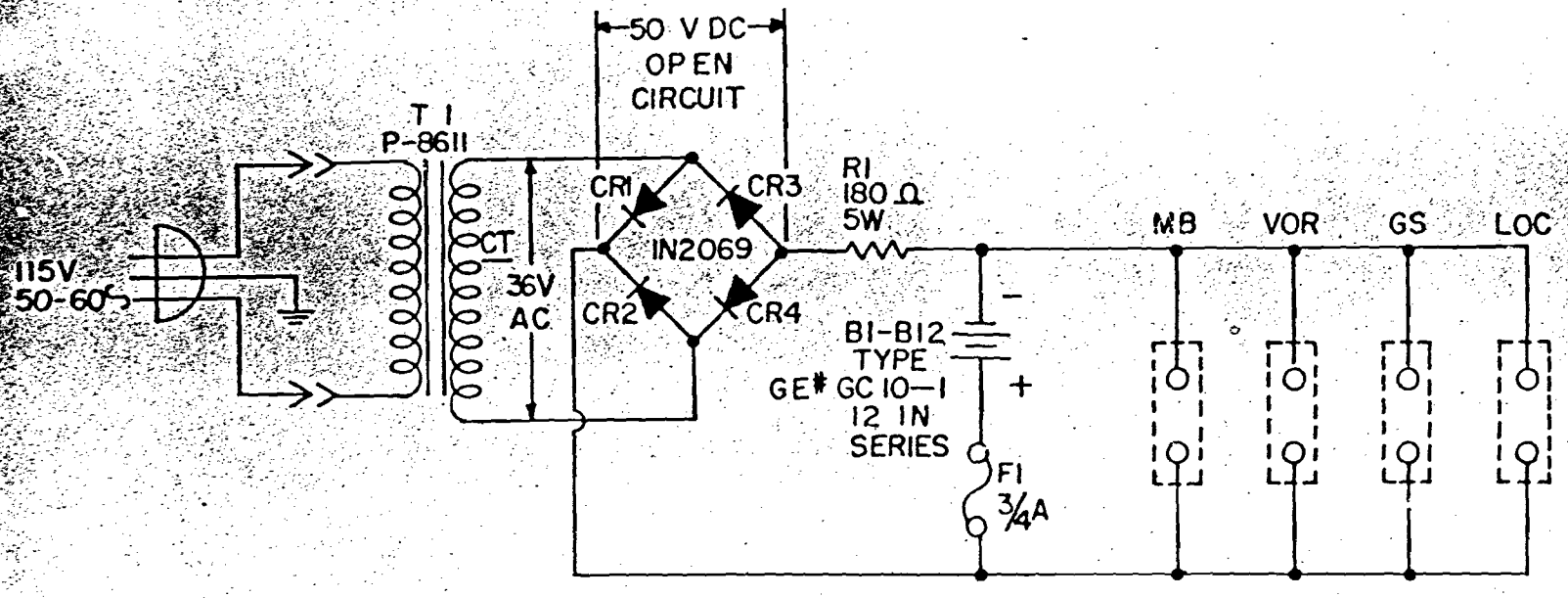
GLIDE SLOPE RAMP TESTER
T-29B-50-1-C

ISSUE	DATE	
1	7-13-72	
2	10-16-72	902
3	5-30-73	921
4	3-5-75	960

T-30B/B VOR/ILS RAMP TEST SET

BATTERY CHARGER

ITEM	DESCRIPTION	CIRCUIT DESIGNATION	QTY	TIC PART #
1	BATTERY GE 41B001AA72 OR GOULTON TYPE R-125 SIZE RR	B1 thru B12 Incl.	12	TB-7-A
2	CLIP BATTERY WORKMAN L-9		4	TC-181
3	CORD LINE BELDEN 17258-S 8' #18-3 TYPE SVT		1	TL-7
4	DIODE 1N2069	CR1 thru CR4 Incl.	4	TD-16
5	FUSE 3/4A LITTLEFUSE 276.750	F1	1	TF-21-A
6	RECEPTACLE POWER SOCKET SWITCHCRAFT AC3G		1	TR-1
7	RESISTOR 180Ω 5W OHMITE STYLE 995-5B	R1	1	TR-186
8	TRANSFORMER STANCOR P-8611	T1	1	TT-15-B



ISS.	CODE	DATE
1		12-31-69

SCALE-

MATERIAL- SIZE

ALUM- _____
STEEL- _____
BRASS- _____
SYNTHANE- _____
OTHER- _____
_____

FINISH-

- ☐ CD 8 33 M&W LACQUER
- ☐ COPPER FLASH - NICKEL
- ☐ NATURAL
- ☐ TIC SLATE GREY
- ☐ 512 AIRCRAFT GREY
- ☐ AS SPECIFIED

TOLERANCE - UNLESS SPECIFIED
DECIMAL - ± .010
ANGULAR - ± 1/2°
FRACTIONAL - ± 1/64
ALL BENDS 1/32R INSIDE

BATTERY CHARGER

DWG. NO. T-30AB-50-1-A

ENG.	DRN.	CHK'D.	APP.
	[illegible]		

TEL-INSTRUMENT
ELECTRONICS CORP.
728 GARDEN ST., CARLSTADT, N.J.

T-308-2

FORM 101A