Figure 1-1. Type 1232-P1 RF Mixer.

TYPE 1232-P1
RF MIXER

SPECIFICATIONS

Frequency Range: 70 kc to 10 Mc. (Can be used up to 60 Mc, with care in the selection and identification of local-oscillator frequencies.)
I-F Output Frequencies: Switch-selected to 20 kc or 100 kc.
Bandwidth: 0.8 kc in 20-kc position, 10 kc in 100-kc position with a 20-kilohm output load (TYPE 1232-P1 RF Mixer alone).
Sensitivity: (Open-circuit voltage from 50-ohm source, equivalent to noise level.) Typically 1 microvolt from 70 kc to 150 kc; 0.4 microvolt from 150 kc to 10 Mc.
Input Impedance: Approximately 200 ohms.
Output Impedance: Approximately 20,000 ohms.
Dimensions: Diameter 2¼, length 6¾ inches (58 by 175 mm).
Net Weight: 1 pound (0.5 kg).

U. S. Patent Notice: 2,548,457.

SECTION **1**

INTRODUCTION

1.1 PURPOSE.

The Type 1232-P1 RF Mixer is a sensitive crystal mixer intended primarily as an accessory to the Type 1232-A Tuned Amplifier and Null Detector. As such, it extends the frequency range of the detector to 10 Mc,* thus permitting its use with General Radio rf impedance bridges. In this application, separate rf and local-oscillator sources are required. The instrument combination is also useful as a wide-range heterodyne receiver with excellent harmonic rejection.

When the frequency of the local oscillator is swept, the combination can be used as a spectrum analyzer, with an oscilloscope display. It can also be used as a sensitive level indicator in other rf measurements, including those of attenuation, leakage, and filter stop-band response.

1.2 DESCRIPTION.

The unit comprises a semiconductor diode, a tuned i-f output transformer, a microammeter, and associated filter circuits, all completely enclosed to provide optimum rf shielding.

All terminals are 50-ohm, Type 874 coaxial connectors; two are attached to short lengths of flexible cable.

A built-in 500-μa meter continuously monitors the level of local-oscillator drive supplied to the mixer.

Two i-f output frequencies, selectable by a slide switch on the side of the case, provide a wide (70-kc to 10-Mc) frequency capability.

The compact, lightweight unit may be plugged directly into an rf instrument fitted with a Type 874 connector, such as found on General Radio equipment, and it is equipped with a broad mounting foot to support it when used directly on a test bench. The foot is drilled to permit permanent screw mounting where desired.

Table 1-1 lists and describes operator controls, connectors, and indicators for the Type 1232-P1. (See also Figure 1-1.)

*Can be used up to 60 Mc, with care in the selection and identification of local-oscillator frequencies.

TABLE 1-1
CONTROL, CONNECTORS, INDICATOR

REF	TYPE	FUNCTION
INPUT Connector	Type 874 coaxial, locking, 50-ohm	Connects to rf signal source or to bridge detector terminals.
OUTPUT Connector	Type 874 coaxial, 50-ohm	Connects to input of detector/ indicator.
LOCAL OSC Connector	Type 874 coaxial, 50-ohm	Connects to local-oscillator rf source.
Meter M101	Dc microammeter, 0 - 500-μa movement	Indicates local-oscillator drive level.
Switch S101 "20 KC-100 KC"	SPST slide type	Selects filter for appropriate i-f signal at output.

SECTION **2**

OPERATING PROCEDURE

2.1 GENERAL.

The Type 1232-P1 requires an external rf source to function as a local oscillator, plus an external indicator for its i-f output. The equipment setup shown in Figure 2-1 is typical and procedures given in this section will be predicated upon it. However, the instrument is not restricted to this configuration, and may be combined with other generating and indicating instruments with equivalent capabilities. Other test setups making use of the RF Mixer are given in Section 3.

2.2 LOCAL OSCILLATOR REQUIRED.

A source covering the frequency range indicated and capable of producing 1 volt across a 300-ohm load is required. See Table 2-1 for recommended types.

2.3 INDICATOR REQUIRED.

A sensitive and selective amplifying indicator, capable of operating at 20 kc and 100 kc, and possessing an input impedance of at least 20,000 ohms, is required.

2.4 OPERATING PROCEDURES.

The following procedures should be observed in most applications (see also Section 3):

a. Connect the equipment as shown in Figure 2-1. Type 1232-P1 connections are as follows:

(1) INPUT coaxial connector to bridge detector terminal, either directly or by means of a Type 874-R22LA Patch Cord. Tighten locking nut to prevent rf leakage.

(2) LOCAL OSC coaxial cable to local-oscillator output (Type 874-Q9 Adaptor required with Type 1210-C oscillator).

(3) OUTPUT coaxial cable to null-detector input. *Do not add extra lengths of cable when unit is used in 100-kc position.*

NOTE

Input must always be connected before adjusting local oscillator drive (step f).

b. Set the mixer's i-f switch to:

(1) "20 KC" for test frequencies below 500 kc;

(2) "100 KC" for test frequencies above 500 kc.

c. Set the null-detector tuning to 20 kc or 100 kc to correspond to the i-f switch position.

d. Apply power to the generator and set to the measurement frequency. Allow for warm-up time.

e. Apply power to the local oscillator and tune to the generator frequency plus 20 kc or 100 kc, depending upon selection made in step b above. Allow for warm-up time.

NOTE

Make sure that the local oscillator is tuned to give the fundamental of the rf and not a harmonic.

f. Adjust the local oscillator to obtain an output reading on the mixer meter, in accordance with paragraph 2.5.

g. Increase the generator output until the null-detector meter (in the LINEAR mode) reads mid-scale. The null-detector system is now properly adjusted and ready for use. Occasionally, check that the oscillator tuning is peaked, since drift (or pulling) of the generator or local oscillator can occur. Use of the pads recommended in Figure 2-1 should control, if not eliminate, this difficulty. However, if extreme sensitivity is required, the pads may have to be removed.

For economy of local-oscillator sources, the mixer may be operated at a harmonic of the required local-oscillator frequency. Conversion efficiency, somewhat reduced in this case, can be augmented by operating the mixer with higher local-oscillator drive.

2.5 LOCAL-OSCILLATOR DRIVE ADJUSTMENT.

The drive from the local oscillator should be set to a level sufficient to give a 200-μa indication on the mixer meter when the i-f selector switch is in the "100-KC" position. The meter marking is oversize at this value for convenience.

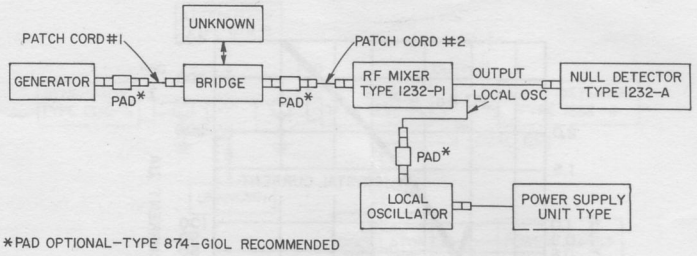

Figure 2-1. R-F bridge test set-up utilizing Type 1232-P1.

When the mixer is used in the "20 KC" i-f output mode, the drive-level requirement for the local oscillator varies with frequency. The relationship is shown in Figure 2-2. To determine the correct level at test frequencies above 70 kc, from the "CRYSTAL CURRENT" curve read the required meter indication on the right-hand scale corresponding to the test frequency in kilocycles given on the abscissa.

At lower-frequency extremes for 20-kc i-f operation (and to some extent for 100-kc), direct local-oscillator feedthrough causes a spurious reading on the Type 1232-A and reduces sensitivity. For this reason, lower values of drive are recommended, as shown in Figure 2-2. At the higher frequencies, feedthrough is negligible and crystal currents ≥ 200 μa can be used. In measuring filter stop-band attenuation, crystal currents of 400-500 μa are recommended for greatest linearity. However, operation at higher values applies only when local-oscillator turn-on does not appreciably raise the output indication above the residual noise level.

When the source impedance of the r-f bridge is very low, a few ohms or less, difficulty may be experienced in obtaining sufficient crystal-current indication because of excessive loading. Insertion of a Type 874-G3 Fixed Attenuator, or equivalent pad, between the bridge and the INPUT connector on the mixer alleviates this by raising the impedance closer to 50 ohms and thereby reducing the shunt load.

TABLE 2-1

EQUIPMENT RECOMMENDED

R-F BRIDGE WITH TYPE 1232-P1

(See Figure 2-1)

FREQUENCY RANGE	BRIDGE TYPE	GENERATOR		UNIT LOCAL OSCILLATOR		PATCH CORD†	
		TYPE	RANGE	TYPE	RANGE	#1-TYPE	#2-TYPE
20-300 kc	716-C*	1330-A	20-300 kc	1210-C	20-320 kc	874-R34	874-R34
50 kc-5 Mc	916-AL*	1330-A	50 kc-5 Mc	1210-C 1211-C	30-500 kc 500 kc-5.1 Mc	874-R34 874-R22A	874-R34
100 kc-5 Mc	716-CS1*	1330-A	100 kc-5 Mc	1210-C 1211-C	80-500 kc 500 kc-5.1 Mc	874-R34	874-R34
400 kc-10 Mc	1606-A**	1330-A	400 kc-10 Mc	1210-C 1211-C	380-500 kc 500 kc-50 Mc	874-R34 874-R22A	874-R22A

*Use Type 1232-A directly at 50 and 100 kc.

**Useful to 60 Mc with Type 1215-C Unit Oscillator as L.O.

† Type 874-R22A required throughout if pads used.
Type 874-R22LA recommended for low R-F leakage.

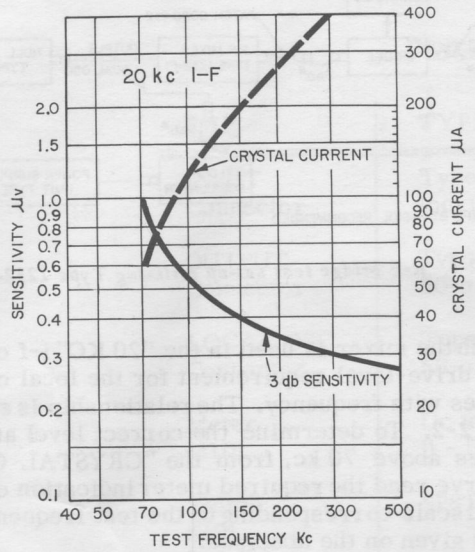

Figure 2-2. Mixer crystal current indications and input sensitivity.

2.6 LOCAL-OSCILLATOR SIDEBAND NOISE.

Power-supply ripple, line noise, and microphonics can amplitude or frequency modulate the local-oscillator carrier. Generally, the amplitudes of the sidebands above 15 kc are sufficiently small so that they are not detected by the mixer. Identification of such modulation as a cause of sensitivity loss (the modulation causes a spurious output indication) can be made above 500 kc by noting whether the spurious readings increase with increased local-oscillator drive. At lower frequencies, the modulation indication cannot be distinguished from carrier feedthrough.

When it is not convenient to reduce this modulation within the local oscillator itself by the obvious means, e.g., by better filtering, line filters, or vibration isolation, these sidebands can be eliminated by the direct introduction of a filter in the signal path. A series resonant circuit in series with the LOCAL OSC connection should give adequate results for measurement frequencies below 500 kc, at least. This filter can be installed in a Type 874-X Insertion Unit for convenience; the smallest practical value of capacitance should be employed.

SECTION 3

APPLICATIONS

3.1 GENERAL.

In addition to its use as a null detector with rf impedance bridges, this versatile instrument combination can be used as a general-purpose heterodyne receiver and as a level indicator for various rf measurements.

3.2 USE AS A HETERODYNE RECEIVER.

The combination of the Type 1232-P1 RF Mixer with the Type 1232-A Tuned Amplifier and Null Detector and a stable local oscillator can be used as a heterodyne receiver with sensitivity of 1 microvolt or better over a continuous frequency range of from 70 kc to 10 Mc (see the curve marked "3-db SENSITIVITY" in Figure 2-2 for typical values). The values on the left-hand ordinate denote the change in signal input required for a 3-db change in output indication at frequencies from 70 to 500 kilocycles. An output of not less than 1 volt from the Type 1232-A is available in addition to the meter indication.

3.3 USE IN ATTENUATION MEASUREMENT.

The equipment setup shown in Figure 3-1 permits attenuation or insertion-loss measurements on rf elements by the substitution method at frequencies up to 10 Mc. Loss measurements up to 140 db can be made with source power of 100 mw by the insertion of combinations of Type 874-GL Fixed Attenuators of appropriate value, or by means of a calibrated, variable attenuator. For convenience of connection, small networks can be mounted in the coaxial Type 874-X Insertion Unit.

The procedures are as follows (refer to paragraph 2.4 for routine procedures relative to the rf mixer and to the appropriate manuals for other instruments):

a. Arrange the equipment as shown in Figure 3-1 (attenuation standard in the circuit); apply power and allow for warm-up.

b. With METER switch on Type 1232-A in LINEAR position, adjust GAIN control to get full-scale indication on meter, i.e., 0 db.

c. Remove attenuation standard and replace with rf element to be measured. Observe resultant meter reading on Type 1232-A; for greater accuracy adjust the precision variable attenuator, if used, to obtain the same reading.

NOTE

If meter reading goes off DB scale, the standard attenuator will have to be adjusted in value.

3.4 OTHER RF MEASUREMENTS.

Similar procedures may be employed for rf leakage, cross talk and filter stop-band response measurements.

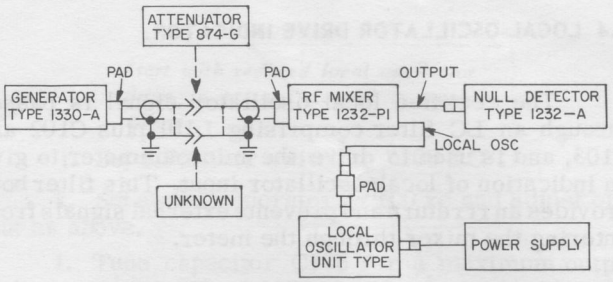

Figure 3-1. Attenuation test set-up (70 kc - 10 Mc) utilizing Type 1232-P1.

SECTION 4

THEORY OF OPERATION

4.1 GENERAL.

The Type 1232-P1 RF Mixer is a simple diode-type unit intended primarily for operation between 70 kc and 10 Mc but useful up to 60 Mc. The i-f output is switch-selectable at either 20 kc or 100 kc, and the level of local-oscillator current can be monitored by a built-in meter. A block diagram of the unit appears in Figure 4-1, and a detailed schematic diagram is shown in Figure 5-2.

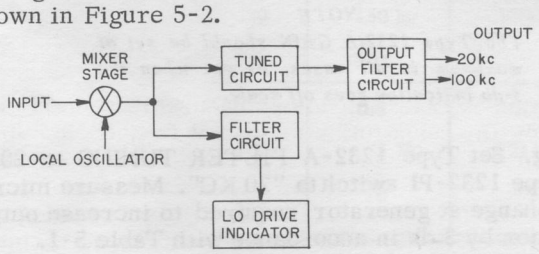

Figure 4-1. Functional diagram of Type 1232-P1 RF Mixer.

4.2 DIODE CONVERSION.

The diode mixer is basically a conversion device which combines two high-frequency signals to produce a third, low-frequency signal. The characteristic of the diode that permits this effect is the nonlinearity of its voltage - current relation, or of its conductance-voltage relation. Figure 4-2 shows a typical diode static conductance-voltage relation.

The diode in operation acts as a load for the signal source, and the load conductance is dependent on the instantaneous voltage applied to the diode by the local oscillator. Therefore, the local oscillator modulates the diode conductance, and when a signal is applied, a multiplication of the two ac voltages occurs.

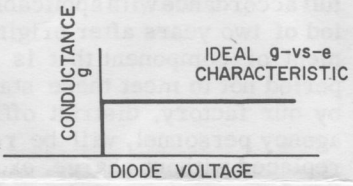

Figure 4-2. Conductance vs voltage for mixer diode.

As a result of this multiplication (and this can be shown by the simple multiplication of two sines or cosines), the output current contains the sum and difference of the local oscillator and signal frequency. The difference frequency is usually chosen for amplification.

Conversion loss in diode CR101 is approximately 6 db. This can be reduced by operating with larger local-oscillator drive, but the noise level increases because of diode excess noise, local-oscillator-noise-sideband feedthrough, or local-oscillator carrier feedthrough.

Typical oscillators develop sufficient drive across diode CR101 without, at the same time, shunting the 200-ohm (open-circuit) input impedance of the mixer.

4.3 TUNED CIRCUIT.

The i-f current out of the mixer diode flows through the primary of transformer T101, which has a relatively high Q and provides a large amount of rejection for strong local-oscillator signals. This feature prevents saturation of the low-level input circuits of the i-f amplifier and also prevents spurious output indications that would otherwise result from direct local-oscillator feedthrough.

The signal is stepped up in the transformer by a factor of 10. The transformer is resonated by means of a ferrite slug core and a variable capacitor, C106. The capacitance of the short length of cable attached to the OUTPUT is part of the tuning of the transformer, but is significant only for the 100-kc i-f.

4.4 LOCAL-OSCILLATOR DRIVE INDICATOR.

The rectified local-oscillator signal is passed through an LC filter comprising L101 plus C102 and C103, and is used to drive the microammeter to give an indication of local-oscillator input. This filter both provides an rf return and prevents external signals from entering the mixer through the meter.

4.5 RF SHIELDING.

Circuit elements are mounted on an etched-circuit board enclosed in an aluminum cylinder to which is appended, in a separate compartment, the meter housing. In addition, double-braid coaxial cable is used on all signal leads. As a result, the mixer is completely shielded from rf leakage, thus preventing spurious null-balance indications.

SECTION 5

SERVICE AND MAINTENANCE

5.1 WARRANTY.

General Radio warrants that each new instrument sold by us is free from defects in material and workmanship, and that, properly used, it will perform in full accordance with applicable specifications for a period of two years after original shipment. Any instrument or component that is found within the two-year period not to meet these standards after examination by our factory, district office, or authorized repair agency personnel, will be repaired, or, at our option, replaced without charge, except for tubes or batteries that have given normal service.

5.2 SERVICE.

The two-year warranty stated above attests the quality of materials and workmanship in our products. When difficulties do occur, our service engineers will assist in any way possible. If the difficulty cannot be eliminated by use of the following service instructions, please write or phone our Service Department, giving full information of the trouble and of steps taken to remedy it. Be sure to mention the serial and type numbers of the instrument.

Before returning an instrument to General Radio for service, please write to our Service Department or nearest district office, requesting a Returned Material Tag. Use of this tag will ensure proper handling and identification. For instruments not covered by the warranty, a purchase order should be forwarded to avoid unnecessary delay.

5.3 SENSITIVITY CHECK.

Check RF Mixer sensitivity and overall operation as follows:

a. Connect Type 1232-P1 to Type 1232-A INPUT by means of mixer OUTPUT cable; use no extension cables.

b. Set Type 1232-A controls as follows:

FILTER FREQUENCY:	See Table 5-1
METER:	LINEAR
GAIN:	Maximum

c. Connect a calibrated signal generator with a 50-ohm source impedance to the INPUT of the mixer, set at frequencies listed in Table 5-1, at approximately 2-μv output. General Radio Type 1001-A, or equivalent, is recommended.

d. Connect (via LOCAL OSC cable) a local oscillator (refer to Table 5-1 for appropriate type) and set to frequencies given (plus 20 kc or 100 kc as required).

e. Adjust local-oscillator output to produce the crystal currents given for each frequency.

f. At each test frequency, reduce the signal generator output to zero, then slowly increase it to obtain a 3-db increase in the Type 1232-A output.

NOTE

The Type 1232-A GAIN should be set at maximum in all cases, except when the 3-db indication goes off scale.

g. Set Type 1232-A FILTER TUNING to 20 kc and Type 1232-P1 switch to "20 KC". Measure microvolts change at generator required to increase output indication by 3 db in accordance with Table 5-1.

h. Set Type 1232-A FILTER TUNING to 100 kc and Type 1232-P1 to "100 KC". Measure as in step g.

5.4 TROUBLE ANALYSIS (Refer to Table 5-2).

If the Type 1232-P1 fails to meet the minimum sensitivity standards called for in paragraph 5.3, retain essentially the same test setup and perform the analysis given below to isolate the defect. Consult paragraph 5.6 if interior access is required.

5.5 TUNING ADJUSTMENTS.

If trouble analysis (Table 5-2) shows a need to adjust T101 and/or C106, remove the shield enclosures as described in paragraph 5.6 and perform the following procedures (refer to Table 5-3):

a. Connect Type 1232-A INPUT by means of mixer OUTPUT cable; use no extension cables.

b. Set Type 1232-A controls as follows:

FILTER FREQUENCY:	FLAT
METER:	LINEAR
GAIN:	Approx maximum

c. Connect Type 1001-A (or any signal generator covering from 15 kc to 10 Mc) to INPUT of mixer. Use a 50 to 200-ohm source impedance.

d. Connect a Type 1211-C local oscillator to the mixer LOCAL OSC cable.

e. Tune local oscillator to about 10 Mc (serves only to bias crystal at this frequency.

f. Adjust oscillator output to produce about 300-μa as indicated on mixer meter.

g. Set RF Mixer switch to "20 KC".

h. Set signal generator to 20 kc and adjust output to obtain about mid-scale reading with the Type 1232-A set to maximum GAIN.

i. Tune transformer T101 by means of its slug for a maximum output indication on the Type 1232-A. The peak should occur within ±0.3 kc, maximum, of 20 kc.

CAUTION

Start with reduced local oscillator drive to prevent crystal or meter damage.

j. Set RF Mixer switch to "100 KC".

k. Set signal generator to 100 kc and adjust output as above.

l. Tune capacitor C106 for a maximum output indication on the Type 1232-A. The peak should occur within +0 kc, -15 kc, of 100 kc.

m. Recheck 20-kc tuning and trim transformer if center frequency is changed.

5.6 DISASSEMBLY (See Figure 5-1).

To disassemble the RF Mixer in order to gain access to the secondary controls and adjustments (Table 5-3) or replace defective detail parts, proceed as follows:

a. Remove screws holding the cover on the meter end of the mixer.

b. Pull the meter and cover loose so that the two leads attached to the meter are accessible.

TABLE 5-1

TEST FREQUENCIES AND OUTPUT INDICATIONS

Mixer I-F kc	Test Frequency	Local Oscillator Type*	Mixer Crystal Current μa	Generator Output Increase for 3 db Change μv
	70		25	1.0
20	150 kc	1330-A	100	0.4
	500		200	0.4
	0.5		200	0.4
100	3 Mc	1211-C	200	0.4
	10		200	0.4

*Or equivalent.

TABLE 5-2

TROUBLE ANALYSIS FOR TYPE 1232-P1

INDICATION	PROBABLE CAUSE	REMEDY
No output	Defective diode or other detail part, or wiring.	Perform point-to-point resistance check using Figure 5-2, and repair or replace part.
Sensitivity low	T101/C106 out of adjustment.	Adjust for maximum (refer to paragraph 5.5).
No local-osc. drive indication	a. Low impedance at INPUT shunting local oscillator.	Insert 3-db pad ahead of INPUT. If condition persists, proceed to b.
	b. M101 or associated wiring defective.	Repair or replace.

c. Remove the two screws from the connector end of the mixer.

d. Remove the screws holding the slide switch on the side of the mixer and push the switch so that the finger tab is clear of the housing.

e. Grasp the housing firmly in one hand and the rigid air-line connector in the other and gently pry apart.

f. Slide the connector etched-circuit board assembly out of the housing until the slug adjustment on transformer T101 at the far end of the board is accessible.

NOTE

It may be necessary to feed some of the meter lead into the housing in order to be able to draw the assembly out sufficiently.

5.7 REASSEMBLY.

Reassembly procedures are the reverse of disassembly procedures with the following additions:

(1) Dress the leads of S101 so that they have a slight spring effect tending to push the finger tab against the wall of the housing. When the switch is aligned with the opening in the wall, the finger tab will push through once the assembly is properly positioned in the housing.

(2) Grasp the finger tab of the switch with a needle-nose plier while inserting and tightening the attaching screws.

NOTE

The mixer is properly reassembled when the engravings on the connector end are level and right-reading with respect to the instrument mounting foot.

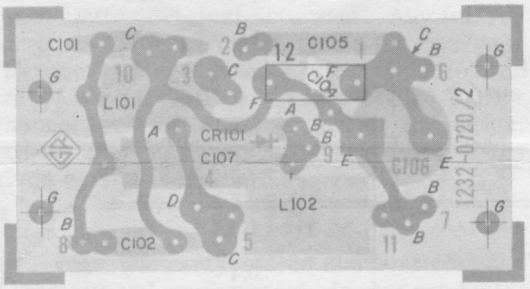

Figure 5-1. Etched-circuit board for Type 1232-P1.

TABLE 5-3

SECONDARY CONTROLS AND ADJUSTMENTS

(See Figure 5-1)

REF	LOCATION	FUNCTION
T101	Internal, top rear of etched-circuit board.	Screw-driver adjustment to peak output circuit.
C106	Internal, on etched-circuit board	Screw-driver trimmer to peak output circuit.

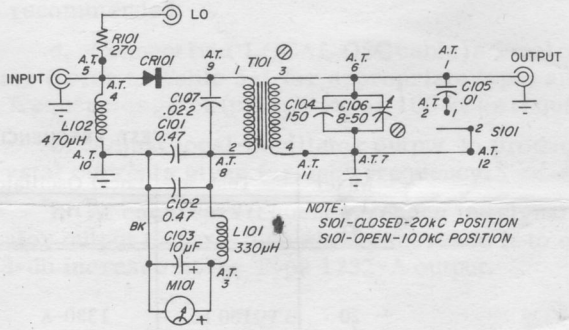

Figure 5-2. Type 1232-P1 R-F Mixer.

PARTS LIST

REF NO.	DESCRIPTION	PART NO.
C101	Capacitor, Ceramic, 0.47 μf +80 -20%, 12 dcwv	4428-4479
C102	Capacitor, Ceramic, 0.47 μf +80 -20%, 12 dcwv	4428-4479
C103	Capacitor, Electrolytic, 10 μf +100 -10%, 25 dcwv	4450-3800
C104	Capacitor, Mica, 150 pf ±10%, 500 dcwv	4620-1050
C105	Capacitor, Plastic, 0.01 μf ±5%, 100 dcwv	4860-7700
C106	Capacitor, Trimmer, 8-50 pf	4910-1170
C107	Capacitor, Plastic, 0.022 μf ±5%, 100 dcwv	4860-7888
CR101	Diode, Semiconductor, Type 1N118A	6082-1006
L101	Inductor, Choke, 330 μh ±10%	4300-4300
L102	Inductor, Choke, 470 μh ±10%	4300-4890
M101	Meter, 0-500 μa dc	5730-1376
R101	Resistor, Composition, 270 Ω ±5%, 1/4 w	6099-1275
S101	Switch, Slide	1232-2230
T101	Transformer, Audio, Adjustable	7910-0770

G E N E R A L R A D I O C O M P A N Y

WEST CONCORD, MASSACHUSETTS, USA