# RA-1593-A AMPLIFIER AND RA-1594-A CONTROL UNIT

## TECHNICAL INFORMATION BULLETIN

Westrex

# RA-1593-A AMPLIFIER & RA-1594-A CONTROL UNIT

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# *Westrex Corporation*

HOLLYWOOD DIVISION

# TECHNICAL INFORMATION BULLETIN
# OPERATING AND MAINTENANCE INSTRUCTIONS
# FOR
# RA-1593-A AMPLIFIER & RA-1594-A CONTROL UNIT

## 1.0 Use

The RA-1593-A Amplifier and RA-1594-A Control Unit in combination provide a compressor-limiter amplifier for general sound recording applications.

## 2.0 Illustrations



## 3.0 General Data

### 3.1 General Features

(a) High degree of balance-stability against "Thump".

(b) Distortion less than one per-cent on compressed characteristics.

(c) Adjustable compression slope and threshold with peak-chopping at end of compression range.

(d) "De-essing" equalization.

### 3.2 Characteristics

| | |
|---|---|
| Gain: | 70 db (in uncompressed condition) |
| Input Impedance: | 600 ohms, balanced or unbalanced |
| Output Impedance: | 600 ohms, unbalanced |
| Distortion: | Less than 1% with or without compression up to a maximum compression point of approximately +29 dbm, at which level peak chopping occurs. |
| Frequency Characteristic: | Flat within ±0.5 db from 50 to 15,000 cps. |
| Output Noise Level: | Approximately —50 dbm (in uncompressed condition) |
| Compression Characteristics: | |
| Compression: | 10:5 |
| | 20:10 |
| | 30:15 |
| | 10:3 |
| | 20:6 |
| Limiting: | 10:1 |
| | 20:2 |
| | Compression-Limiting out |




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## 3.0 General Data (Continued)

| | |
|---|---|
| Attack and Release Time: | Attack, 1.5 milliseconds<br>Release, 25, 50, 100, 200 and 500 milliseconds |
| Equalization: (De-essing) | Zero or up to 10 db at 10 kc high-frequency equalization in compression control circuit in 2-db steps. |
| Metering: | Compression Meter 0-15 db. Circuit provided for extension compression meter. |
| Controls: | |
| RA-1594-A: | Compression Characteristic (D2)<br>Release Time (D-1)<br>H-F Equalization (D3)<br>Meter Zero Adjust (P-1) |
| Power Required: | 44 milliamperes at 275 volts dc.<br>1.2 amperes at 12.6 volts dc.<br>(May be supplied by RA-1479-C Power Supply) |
| Mounting: | |
| RA-1593-A: | Mounts on 8¾" dished chassis or on mounting straps and secured with two Camloc fasteners. Plug-connected to associated circuitry. |
| RA-1594-A: | Intended for mounting in a control-panel area and may be remote from the amplifier. |
| Dimensions: | |
| RA-1593-A: | 8¾" high; 6" wide; 5⅜" deep. |
| RA-1594-A: | 8¾" high; 4¼" wide; 3¾" deep. |
| Weight: | |
| RA-1593-A: | 6 lbs. |
| RA-1594-A: | 2½ lbs. |

## 4.0 Description

The RA-1593-A Amplifier consists of a three-stage push-pull program amplifier and a control amplifier. The operating controls are in the RA-1594-A Control Unit, which may be located 25 feet or more from the RA-1593-A Amplifier. The components contained in the control unit are also available in kit form as the P-94119 Kit for those applications where the customer wishes to mount the controls on his own control panel and in his own arrangement. Figure 1 is a view of the RA-1593-A Amplifier and Figure 2 is a view of the RA-1594-A Control Unit.

Figure 3 shows the schematic circuit of the amplifier. Two remote-cutoff pentodes are used in the first stage of the program circuit and the various types of compression and limiting are obtained by varying the d-c grid bias of these tubes. Distortion is less than one per-cent under all conditions below peak chopping.

Two potentiometers P-1 and P2 are provided within the amplifier for obtaining dynamic balance beyond the compression stage to minimize transients, generally referred to as thumps, resulting from the compression of steep-wavefront signals. The RA-1605-A Test Oscillator has been designed to facilitate this adjustment of balance and its use is recommended.

Peak chopping is provided by grid limiting in the output stage and occurs at an output level of approximately +29 dbm.

The control amplifier contains a two-stage voltage amplifier with feedback. The second stage is transformer coupled to a 12AL5 twin diode which is used as a full-wave rectifier. The d-c output voltage from the twin diode is fed into the grid circuit of the variable-gain stage of the program amplifier. An additional amplifier stage is bridged across the output of the twin diode to drive the meter (or meters) which indicates the amount of reduction in gain (compression) in db. The operating controls for the control amplifier, and the compression meter are located in the RA-1594-A Control Unit. The controls function in circuits having sufficiently low impedance so that the

## 4.0 Description (Continued)

control unit may be mounted at a distance from the amplifier.

Figure 4 shows the schematic circuit of the RA-1594-A Control Unit. The interconnections with the RA-1593-A Amplifier are also indicated.

The resistors on section B of the selector switch D2 provide selection of the input level to the control amplifier. This section of the switch affects the compression slope and the threshold at which compression starts. The resistors on section A of switch D2 provide selection of the amount of back bias on the diode, which affects the threshold at which compression starts. The ranges of compression and limiting available are shown in a box in Figure 4 and they also appear on the control panel. As an example, with switch D2 on compression step 5, the upper 20-db input range is compressed into a 6-db output range and the compression meter will indicate approximately 14 db gain reduction at the upper end of the compression slope where peak chopping begins.

The compression meter, reading 0 to 15-db compression (or gain reduction), is located in the control unit together with a zero-adjusting potentiometer. A similar meter may be located remote from the control unit as indicated in Note 1 in Figure 4. The meter is coded, Westrex P-93812 Compression Meter.

The attack time in the control circuit is approximately 1.5 milliseconds in all cases. The release time may be selected over the range of 25, 50, 100, 200 and 500 milliseconds by setting selector switch D-1, which connects condensers of different capacity across the load circuit of the twin diode.

High-frequency equalization (de-essing) is obtained by the selector switch D3 which connects different capacity values across the cathode resistor R34 in the input stage of the control amplifier. Five steps of 2 db each of increased equalization at 10 kc in the control circuit are provided in addition to the flat characteristic. An increase in equalization increases the sensitivity of the compressor to high-frequency signals.

## 5.0 Installation

The RA-1593-A Amplifier is intended to be mounted on a dished chassis or mounting straps, secured by two Camloc fasteners, and plug-connected to the associated circuitry.

A P-94577 Plug-and-Hood Assembly for terminating the incoming cable form and two Camloc receptacles are furnished as loose parts with the amplifier.

The RA-1594-A Control Unit is intended for mounting in a control-panel area and may be located 25 feet or more from its associated RA-1593-A Amplifier. The interconnections between the control unit and amplifier are shown in Figure 4. Shielded twisted wiring should be used as shown. The coaxial line shown at terminals 9 and 2 of TS-1 may be Beldon No. 8221 PEC Cable or equivalent for lines up to 15 feet between the units. For separations of 15 to 30 feet, Beldon No. 8254 (RG62U) is recommended. Connections to a remote extension compression meter are also shown in Figure 4.

The power requirements are given in Section 3 and may be furnished by an RA-1479-C Power Supply or from the system power supply. It should be noted that the vacuum-tube heaters require direct current.

The input and output circuits are left floating and are expected to pick up ground from the circuits with which they are connected.

### 5.1 Associated Equipment

Separate input and output attenuators should be provided external to the amplifier. The amount of attenuation provided will depend on the application of the equipment. The various operations in sound picture recording studios will be adequately accommodated with a 60-db input attenuator having 30 2-db steps and an output attenuator having 30 1-db steps.

### 5.2 Preliminary Tests

The performance of an amplifier and its associated control unit is to a certain extent de-

## 5.0 Installation (Continued)

pendent on the characteristics of the set of tubes mounted in the amplifier. Adjustments are provided within the control unit to compensate for variation in characteristics among tubes. A control unit and the amplifier and tubes which were associated together at the time of production test are generally shipped as a unit to the customer to eliminate the need for adjustment at the time of installation. However, the adjustment of the two potentiometers P-1 and P2 in the amplifier should be verified for minimum "thump" during compression, before the equipment is put into operation. The method of adjustment is described in Section 7.1. This adjustment should be repeated from time to time as may be found necessary. The output level of the amplifier at which peak chopping starts should be determined as noted in Section 7.0, and the value noted for reference. In the event the compression characteristics or thresholds are in question, the testing procedure outlined in Section 7.3 should be employed.

## 6.0 Operation

The amount and type of compression or limiting which can be employed depends on the dynamic range in the incoming program material and that of the medium to which the program is being applied. The choice of release time will depend on the program material and the type of recording to be made, for example variable area, variable density or magnetic. When recording high-level rapid speech, it may be found desirable to use a short release time in order that the amplifier can return to normal gain before the next syllable occurs. An equalization or de-essing characteristic is used generally only with speech and the amount used will vary with the compression ratio and with the characteristics of the voice of the speaker.

After selecting the desired compression or limiting characteristic, the release time and equalization characteristic, the external output attenuator should be set so that peak chopping occurs at the desired level relative to the 100-per-cent modulation point of the recorder. In variable-area applications, peak chopping will be set normally at one or two db below the modulator overload. In variable-density systems, peak chopping may be set 6 to 8 db above the modulator overload, and in magnetic recording systems it may be set 8 to 12 db above overload. The external input attenuator should then be adjusted so that full modulation and the desired amount of compression, as indicated respectively on the external output volume indicator and on the compression meter, are obtained. When operating with program material, the reading on the compression meter will not necessarily represent the exact instantaneous amount of compression being obtained, because of the rapid attack and release time of the control circuit and the relatively slow ballistic characteristic of the meter. This is similar to the situation which exists with a volume-indicator meter.

## 7.0 Maintenance

Except for routine testing, maintenance adjustments are not generally required except when tube replacement occurs. The determination of the peak-chopping level should be included in routine testing, and may be checked by the use of a distortion meter, oscilloscope or headphones. Likewise the checking of the mechanical and electrical zero adjustments of the compression meter should be a routine matter. With power off, the meter needle should be adjusted to read 15 by means of the screw on the meter case. The amplifier power should then be turned on and the equipment should be allowed to stabilize for several minutes. With no input and with the compression selector switch in the "Off" position, the screwdriver-operated potentiometer shaft just below the meter case should be adjusted so that the meter needle is at the zero point at the right end of the scale. The needle will remain essentially on this point for any position of the compression selector switch with no input to the amplifier. Occasionally a fractional-db reading will be found on the 30:15 and 20:10 settings. This is due to a slight amount of leakage current through some 12AL5 tubes, and may be disre-

## 7.0 Maintenance (Continued)

garded unless it reaches the order of a db or more, in which case the 12AL5 tube should be replaced. If a studio does not plan to change from one compression ratio to another at frequent intervals and plans to use a ratio which shows a slight deviation from zero, the error can be corrected by the zero-setting potentiometer.

### 7.1 Amplifier Balance

Two adjustments are provided within the amplifier for balancing the circuitry beyond the compression stage to minimize thump. These adjustments are shown as P-1 and P2 in Figure 3. The following method provides a very close balance of this amplifier and is recommended:

(a) Connect the output of a 20,000-cycle oscillator to the amplifier input circuit and provide means for keying the output of the oscillator on for an interval of about one second and off for the same interval. The RA-1605-A Oscillator is designed to provide an automatically keyed test signal for this balance adjustment and may be obtained on separate order. The sending level should be sufficient to take the amplifier into 3 to 4 db of compression and still stay safely below the peak-chopping level. A compression ratio of 20:6 is satisfactory for this adjustment.

(b) Terminate the output of the amplifier in a 200-ohm series resistor followed by a 4 mf shunt condenser and either a loudspeaker monitor circuit or a volume indicator.

(c) P-1 and P2 should be set first in their approximate mid-positions and then adjusted alternately as the 20,000 cycle signal is keyed on and off, to get a minimum thump in the output circuit. Since P-1 and P2 do not have end stops, their mid-position may be determined by rotating their screwdriver controls 25 turns in one direction and then 12 turns in the reverse direction. With a properly balanced amplifier, and under the test conditions, the deflection on a volume indicator set at +4 dbm can be reduced to approximately $\frac{1}{16}$".

### 7.2 Meter Calibration

The calibration of the compression meter should be checked after a tube replacement. The following procedure is recommended:

(a) Check that the meter needle reads 15 with the power off and that it reads zero with the power on with the compression selector switch in the off position and with no input to the amplifier. Also verify that the meter reads zero with no input and with the selector switch in the 30:15 position. If a reading of a db or more occurs the 12AL5 tube should be replaced.

(b) With the compression switch in the "Off" position, send a 1,000-cycle signal into the amplifier at an input level which produces an output level of +26 dbm, and note the input level.

(c) Set the compression selector switch to the 30:15 position and increase the input level until the output level again reads +26 dbm. Note the input level.

(d) Subtract the input reading obtained in (b) from the input reading obtained in (c). This difference is the reduction in gain caused by the control amplifier and represents the amount of compression. The reading on the compression meter should show this amount of compression. If it is not in agreement the following adjustment should be applied.

(e) Referring to Figure 4, adjust P2 to change the meter reading so that it conforms with the measured change in amplifier gain. A change in the setting of P2 will change the zero position of the needle as well as the meter reading. Accordingly, after each change of P2, the zero point must be reset by the use of P-1 before determining the actual meter reading.

### 7.3 Compression Ratio

The compression ratios should be checked after a replacement of tubes. Referring to Figure 4, it will be noted that the threshold of compression and the compression slopes, the latter being reciprocals of the compression ratios, are controlled by the two sections of switch D2. Section A of the switch contains fixed values

## 7.0 Maintenance (Continued)

of resistance which primarily affect the thresholds and which are not intended to be changed. Section B of the switch contains both fixed and variable resistors, the latter to be adjusted when necessary to correct the compression ratios and thresholds. The two sections of the switch function together to determine compression ratios and thresholds. In the case of Section B of the switch, increasing the resistance increases the compression ratio and at the same time lowers the threshold. When resistors in section B of D2 are adjusted properly, and with the fixed resistor values which have been established in section A, both the compression ratio and threshold will be approximately at the values specified for the switch setting. The compression characteristics are not exactly straight lines due to the inherent characteristics of the remote-cutoff pentodes, the deviation being greatest at the low-compression ratios such as 30:15.

The following procedure is recommended in making these adjustments:

(a) Provide a 1,000-cycle sending source and a gain set. Set the compression selector switch to the "Off" position. Adjust the input level until the output level is just below the peak-chopping point. This point should be determined accurately, since an error in the output reading will be magnified by the compression ratio in the subsequent input reading. Note the output level.

(b) Set the selector switch to the 10:5 compression-ratio position. Increase the input until the output level is the same as in (a), which is the level where peak chopping starts and note the input level and the reading of the compression meter.

(c) Reduce the input until the compression meter reads one db, and note the input and output levels.

(d) Subtract the input level in (c) from the input level in (b) and add 2 db. The result should be approximately 10 db and represents the input-level range over which compression occurs. Subtract the output level in (c) from the output level in (b) and add one db. The result should be approximately 5 db and represents the output-level range over which compression occurs. Thus it will be observed that the compression ratio is 10:5 and the threshold of compression is approximately 10 db below the input level at which peak chopping occurs.

It will be noted that the one-db compression point was used instead of the threshold point and the latter was obtained by extrapolation. Since the compression slope is 2:1, 2 db were added to the input and one db was added to the output. The determination of the exact threshold by measurement is complicated by the fact that the compression slope changes considerably in this region and the method described is both adequate and simple.

The 20:10 compression ratio is tested in a similar manner. These compression ratios are relatively stable and no correcting adjustments are provided.

The 30:15 compression ratio is checked in a similar manner, except in this case the variable resistor P3 is available to adjust the compression ratio and threshold. Increasing the resistance in P3 (clockwise rotation of the screwdriver-operated control) increases the compression ratio and lowers the threshold.

In checking the 10:3 and 20:6 compression ratios a minor variation of the foregoing procedure is used. After completing step (b), the input level is decreased until the compression meter reads 2 db. Then 3 db are added to the difference in input readings and one db is added to the difference in output readings, because the compression slopes are 3:1. In these instances the variable resistor P4 provides means for adjustment, and since it controls both compression ratios, the adjustment is a compromise for the best adjustment of the two.

In checking the 10:1 and 20:1 limiting, steps (a), (b) and (c) are repeated. After that one db is added to the input difference and nothing to the output difference since the correction for the latter is negligible.

The following is illustrative of the method of using this type of adjustment:

## 7.0 Maintenance (Continued)

With the compression off and sending a 1,000-cycle signal, peak chopping occurred at an output level of +29.5 dbm. With the selector switch on the 20:6 compression ratio, the input level was −34.2 dbm to bring the output level to +29.5 dbm, and the compression meter read 10.2 db. The input level was reduced until the compression meter read 2 db. Under this condition the input level was −46.5 dbm and the output level was +25.7 dbm. The difference in input levels was 12.3 db. Adding 3 db gave a value of 15.3 db. The difference in output levels was 3.8 db. Adding one db gave a value of 4.8 db. This showed the compression ratio to be 15.3:4.8 and the threshold to be 15.3 db below the peak-chopping point and these values were considered to be unsatisfactory.

To increase the compression range the screwdriver control on P4 was rotated 4½ turns clockwise to increase the resistance value and the test was repeated. The compression meter now read 12.5 db. The input levels were now −30.8 dbm and −47.4 dbm and their difference was 16.6 db, to which 3 db was added to give a value of 19.6 db. The output levels were +29.5 dbm and +24.5 dbm and their difference was 5.0 db, to which one db was added. This gave a compression ratio of 19.6:6.0 db and a threshold 19.6 db below the peak-chopping point. This was considered to be very satisfactory.

### 7.4 High-Frequency Equalization

The high-frequency equalization (de-essing) is obtained by increasing the gain of the control amplifier at the higher frequencies. This in turn increases the compression in the program amplifier when actuated by high-frequency signals. The equalization is peaked at 10,000 cycles and at this frequency the selector switch provides five 2-db steps of gain change in the control amplifier. The 2 db steps in gain in the control amplifier produce somewhat smaller steps in loss in the program amplifier, the exact amount being a function of the compression ratio employed. The following method of determining that the high-frequency equalization is functioning properly has been found to be satisfactory:

(a) Connect an oscillator and a gain set with the amplifier. Set the compression selector switch to the 20:6 position. Set the high-frequency selector switch to zero.

(b) Send a 10,000-cycle signal at a level which will produce an output level just below the peak-chopping point. Then as the high-frequency selector switch is advanced, the output level will drop approximately 1.5 db for each step the selector switch is advanced.

Figures 5 and 6 show the wiring digarams of the RA-1593-A Amplifier and RA-1594-A Control Unit.

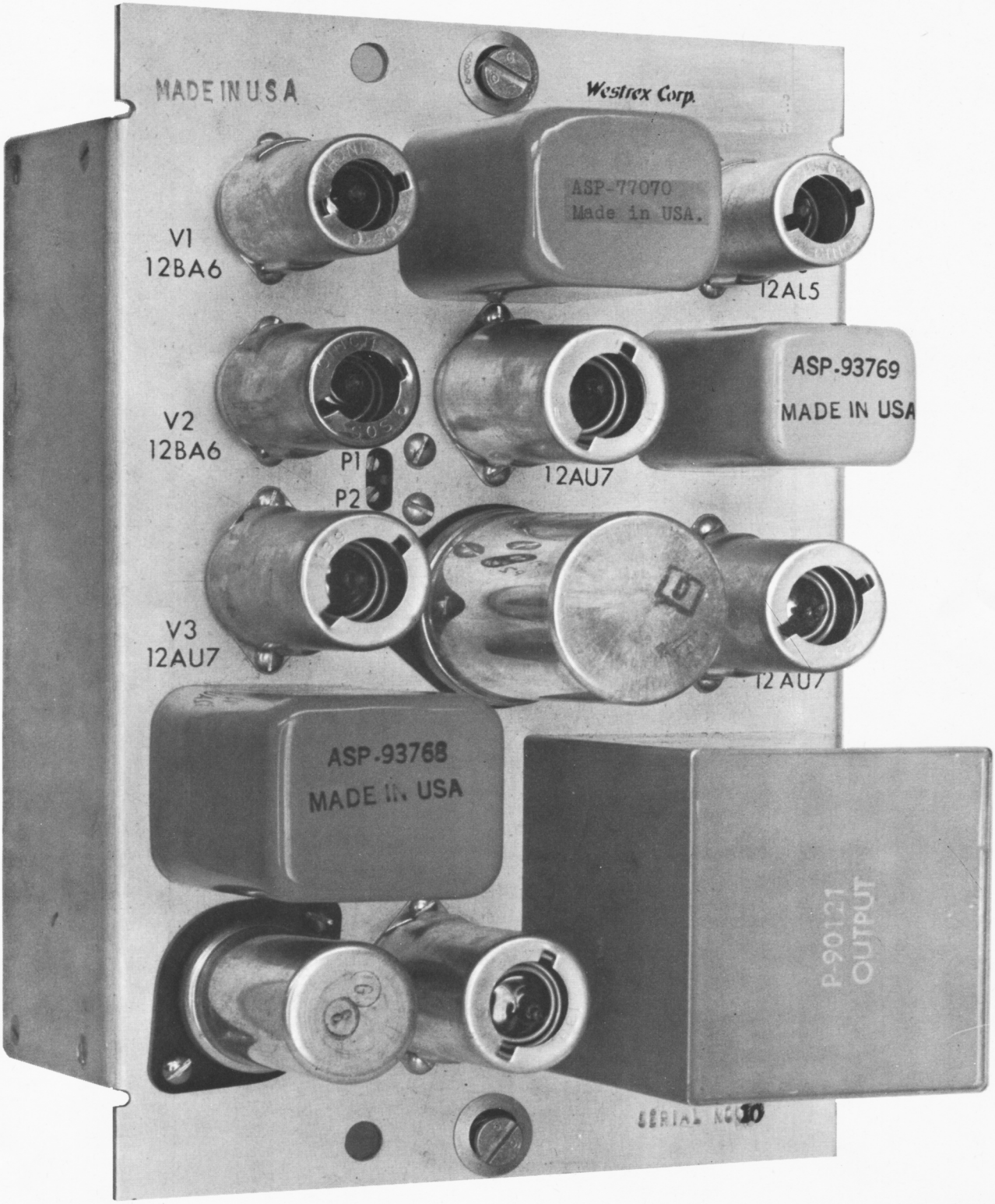



***Figure 1 View of RA-1593-A Amplifier***

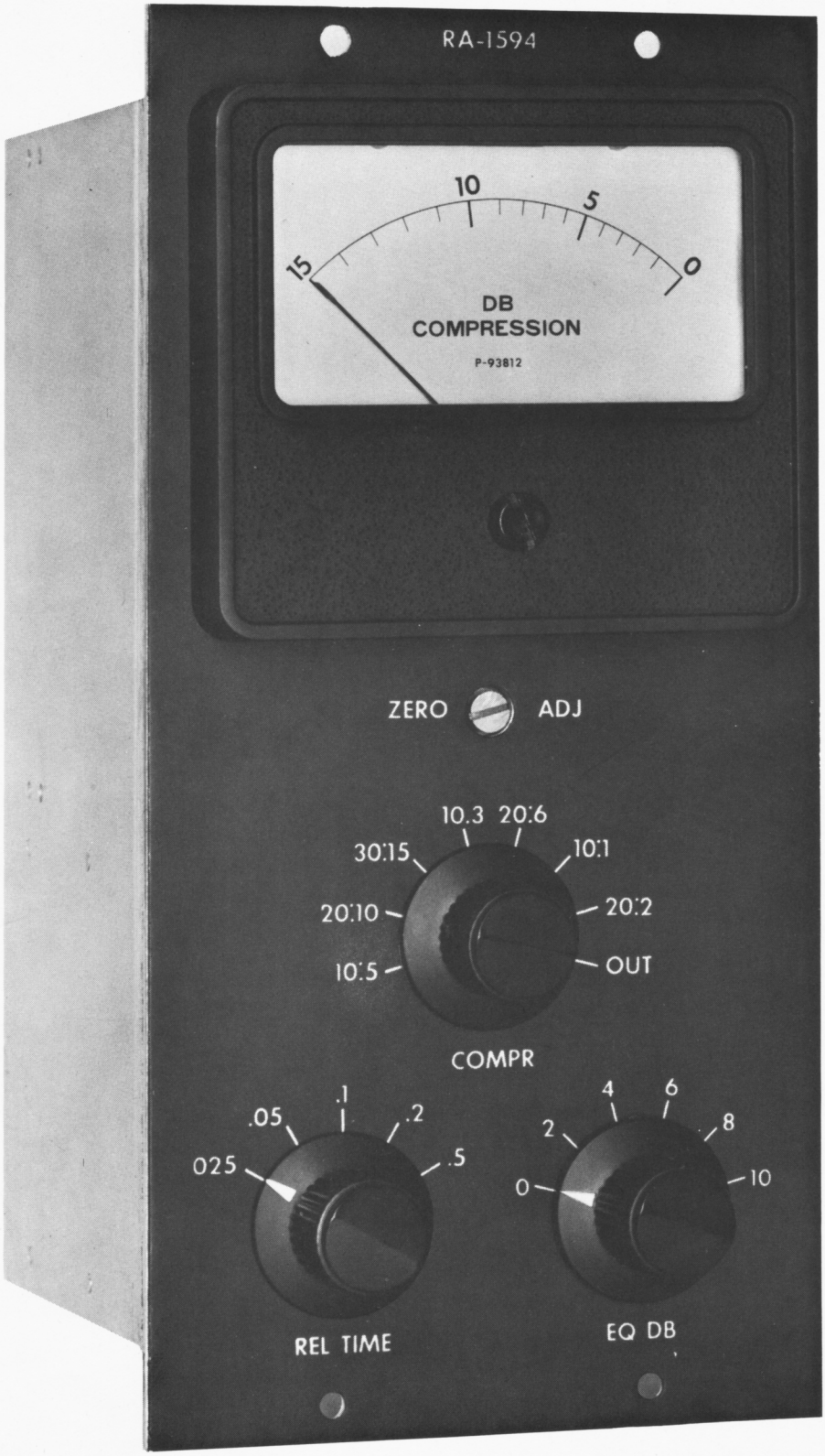
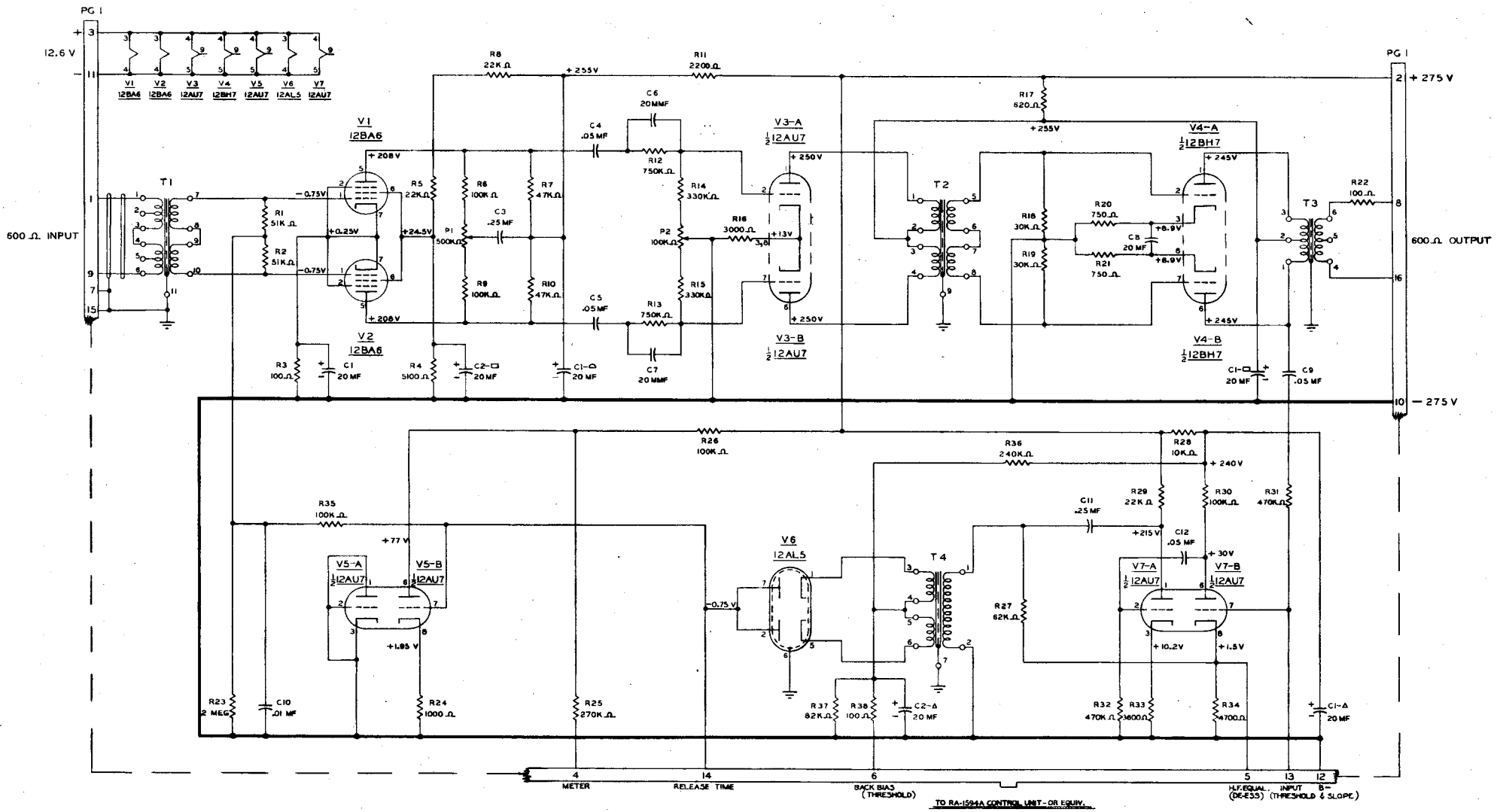


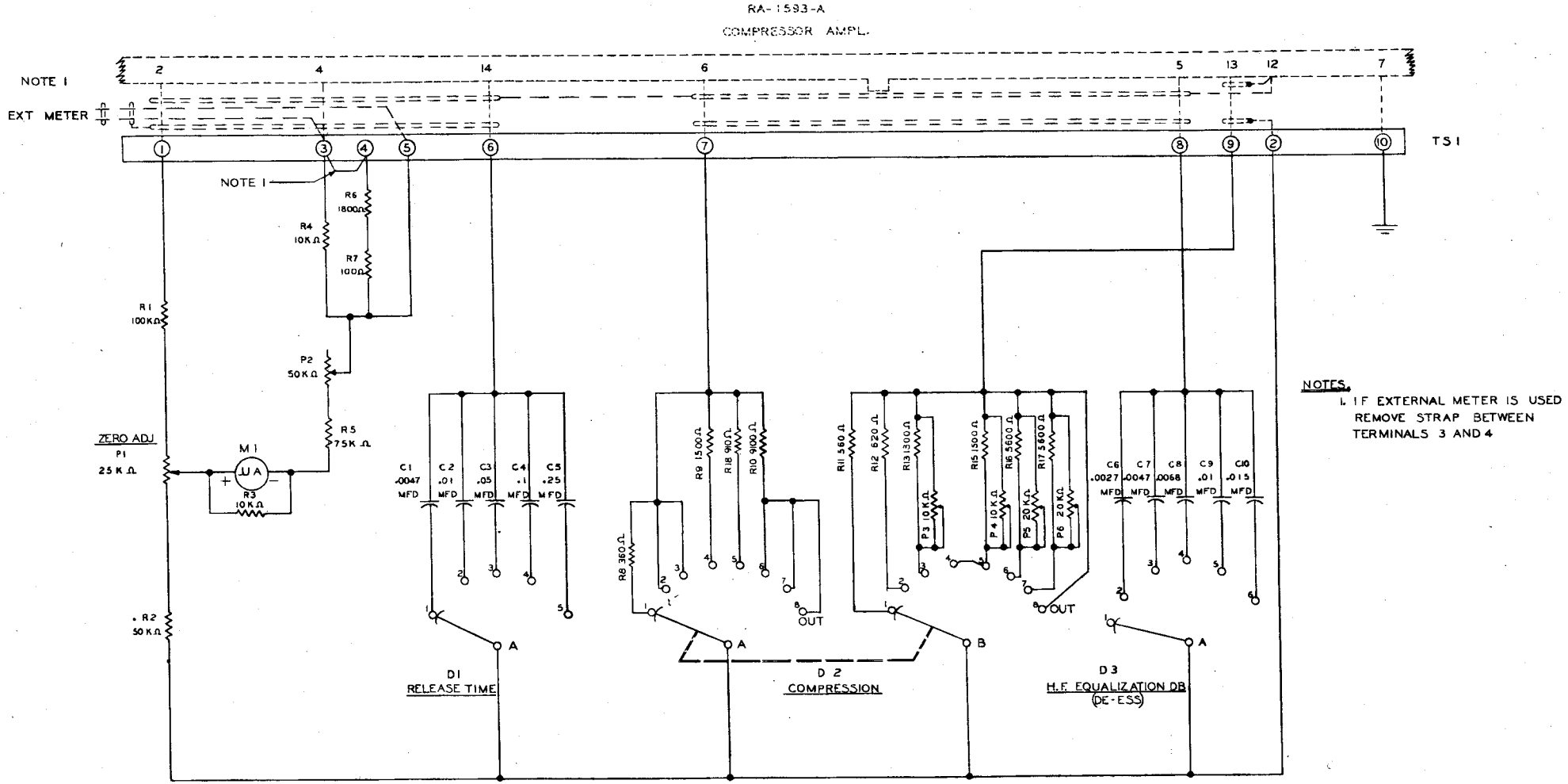

***Figure 2 View of RA-1594-A Control Unit***




NOTES

1—THE DC VOLTAGES SHOWN ARE MEASURED UNDER ZERO SIGNAL CONDITIONS WITH A HIGH IMPEDANCE VTVM

***Figure 3 Schematic Circuit of RA-1593-A Amplifier***




NOTES:
1. IF EXTERNAL METER IS USED REMOVE STRAP BETWEEN TERMINALS 3 AND 4

| RELEASE TIME | |
|---|---|
| STEP | (SEC.) |
| 1 | .025 |
| 2 | .05 |
| 3 | .1 |
| 4 | .2 |
| 5 | .5 |

| COMPRESSION | | | |
|---|---|---|---|
| STEP | RATIO | STEP | RATIO |
| 1 | 10:5 | 5 | 20:6 |
| 2 | 20:10 | 6 | 10:1 |
| 3 | 30:15 | 7 | 20:2 |
| 4 | 10:3 | 8 | OUT |

| HF EQUALIZATION DB | |
|---|---|
| STEP | 10KC |
| 1 | 0 DB |
| 2 | 2 |
| 3 | 4 |
| 4 | 6 |
| 5 | 8 |
| 6 | 10 |

***Figure 4 Schematic Circuit of RA-1594-A Control Unit***

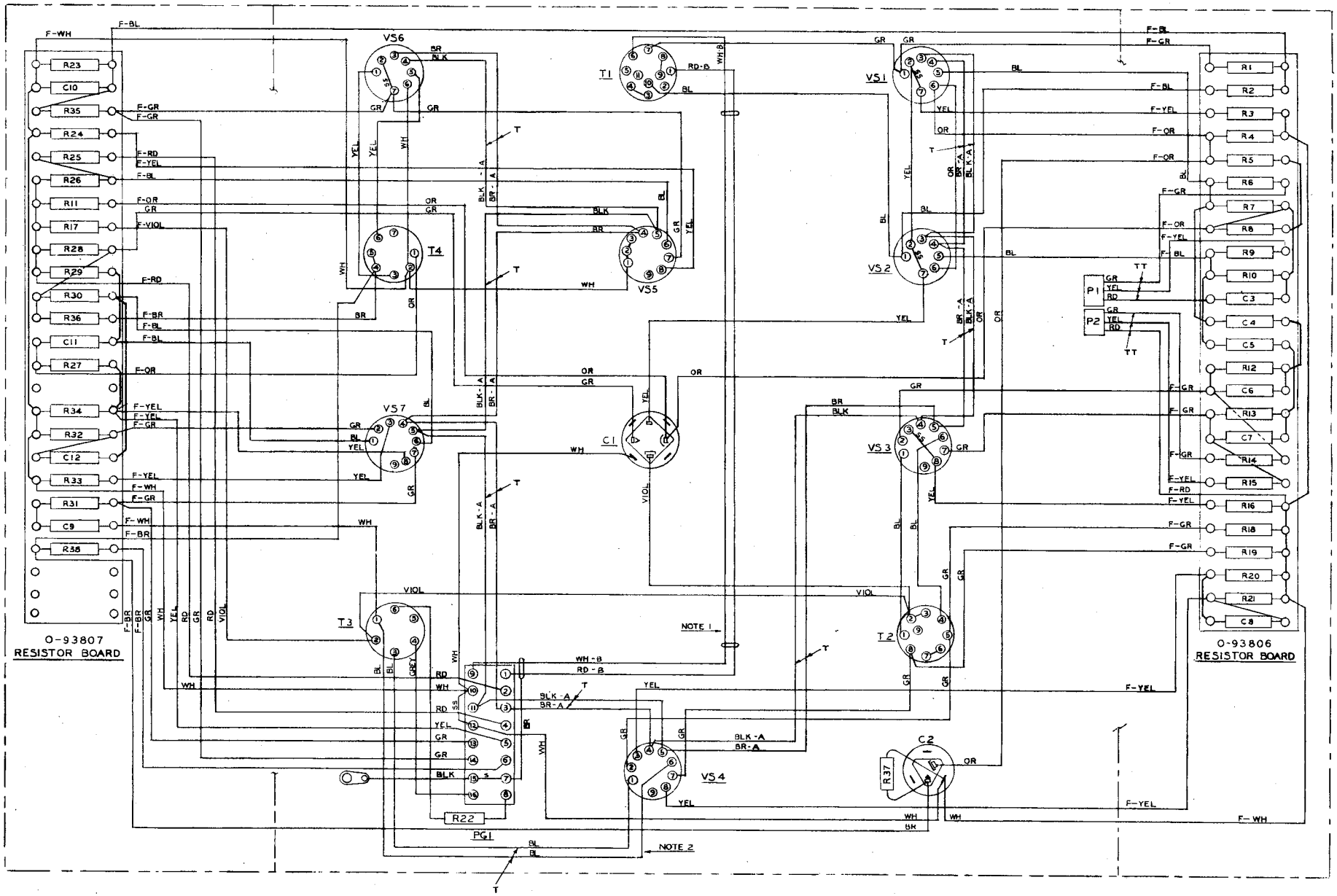



***Figure 5 Wiring Diagram of RA-1593-A Amplifier***

NOTES

1 - IF EXTERNAL METER IS USED REMOVE STRAP BETWEEN TERMINALS 3 AND 4.

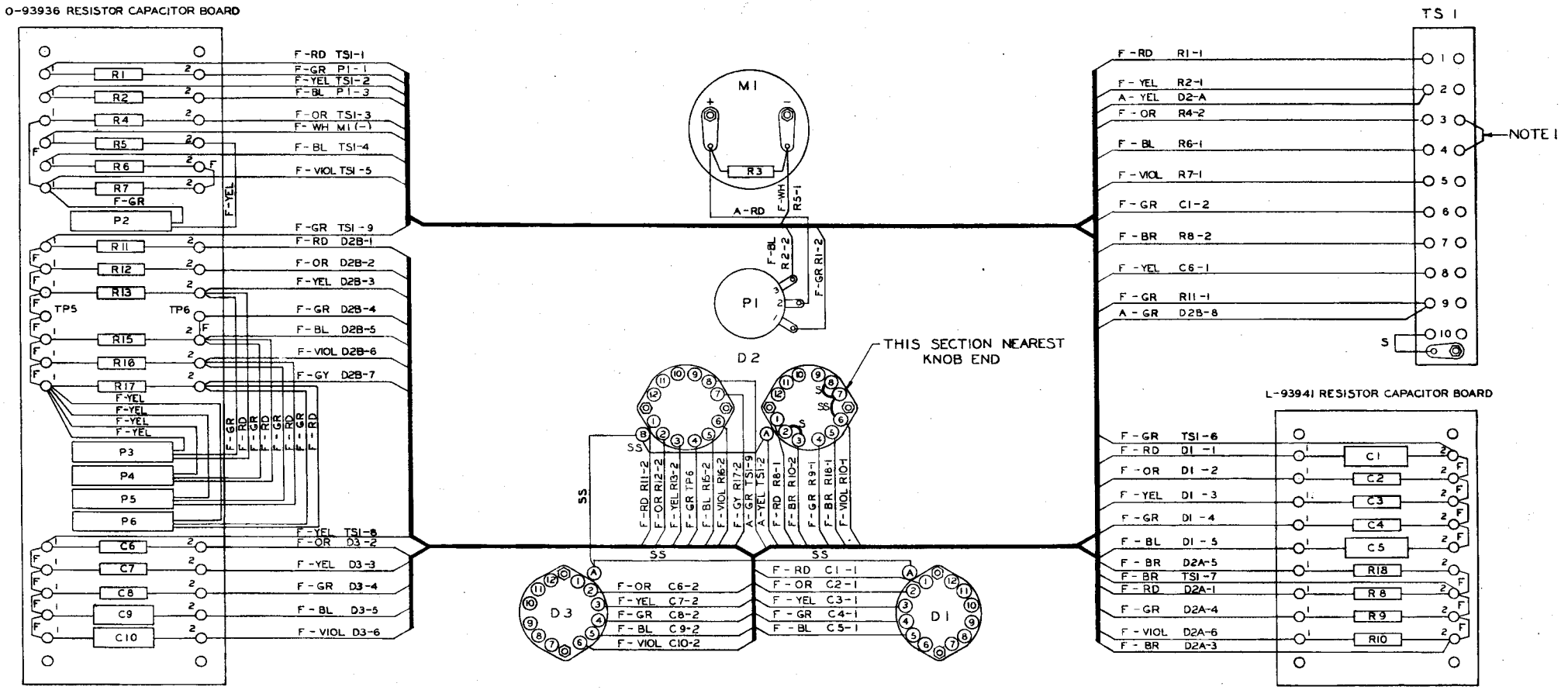



***Figure 6 Wiring Diagram of RA-1594-A Control Unit***