

VOLUME INDICATORS

KS-16652

KS-16653

KS-16654

1. GENERAL

1.01 This section is issued to provide "A" series holders with a practice covering the KS-1662, KS-16653 and KS-16654 types of Volume Indicators.

1.02 This section consists of the attached Section E47.154.

Attachment:
Section E47.154

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1. GENERAL

1.01 This section describes the KS-16652, List 1, and List 2, the KS-16653, List 1, and the KS-16654, List 1 Volume Indicators. These new instruments supersede the 752A, B, and C, 753D, E, and F, and the 754A, B, and C indicators. As no general replacement of the units now in use is contemplated, Section E47.153 describing the older volume indicators is not being cancelled at this time.

1.02 The basic unit is the KS-16652, List 1 assembly with an illuminated meter and the KS-16652, List 2 with a nonilluminated meter. This unit incorporates the three circuits of the 752A, B, and C Volume Indicators and will be the replacement for them in future installations. The circuits and the ranges available are described below. Fig. 1 shows the appearance of the unit.

1.03 The KS-16653, List 1 Volume Indicator is a portable instrument consisting of the KS-16652 List 2 (nonilluminated) basic indicator unit and a portable housing equipped with input jacks. This instrument, shown in Fig. 2, replaces the 753D, E, and F Volume Indicators.

1.04 The KS-16654, List 1 Volume Indicator is intended for rack mounting and consists of the basic KS-16652, List 1 unit assembled on a flat panel and equipped with a back cover. The

unit requires approximately 5-1/4 inches height on a standard 19-inch relay rack. A 12-volt or 24-volt supply is required for the meter lamps. This unit replaces the 754A, B, and C Volume Indicators and is shown in Fig. 3.

1.05 These volume indicators are intended for measurements on a high impedance bridged basis (7500 ohm) or in a terminating condition (600 ohm). A three-position switch permits setting up the following impedance and sensitivity ranges.

SWITCH POSITION	INPUT IMPEDANCE	VU RANGE
HIGH IMP	7500 ohms	+ 4 to +26
+20	7500 ohms	+24 to +46
600 ohms	600 ohms	- 6 to +16

The vu ranges above are for a deflection of the meter to the "0 vu" mark. The use of the full meter scale would extend these ranges 3 db above and 20 db below these ranges. The meters are so made, however, that the most accurate range is between scale readings of -4 and +3 vu and whenever possible measurements should be made in this region of the scale.

2. VOLUME MEASUREMENT

2.01 These volume indicators are intended primarily for the measurement of speech or music volume or the level of a nonsinusoidal signal at a given point in a circuit. Such measurements made in vu are valid only when read in a prescribed manner on a standard vu meter having closely controlled dynamic characteristics and calibrated so that the volume indicator reads 0 vu (algebraic sum of meter needle deflection and volume indicator attenuator setting) when it is bridged across a 600-ohm circuit terminated in 600 ohms in which 1 milliwatt of 1000-cycle power is flowing.

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2.02 The actual dynamic characteristic of a standard volume indicator is such that when a steady sine wave is suddenly impressed the meter will reach 99 per cent of its steady state reading in 0.3 seconds and overswing the steady state value by at least 1.0 but not more than 1.5 per cent. It should be noted that when used to measure the level of speech or music the indication in vu is not a true measure of average power, the meter being too slow to indicate true peak power and too fast to give a true indication of average power.

2.03 For steady state sine-wave power the readings of the instrument in vu are numerically equal to the level in dbm (for the case of a 1000-cycle test signal in a 600-ohm circuit). Therefore the volume indicator may be used for many types of transmission measurements where the range of the meter and its accuracy are considered adequate.

2.04 In all cases the indicated level of the signal in vu is the algebraic sum of the meter pointer reading and the setting of the associated attenuator on the volume indicator assembly. (Add 20 for the "+20" position or subtract 10 for the "600 OHMS" position). This indicated level is correct only when the circuit impedance at the bridging point is 600 ohms or when the circuit is terminated by the volume indicator with the switch in the "600-ohm" position. When the meter is bridged across points of other impedance the indicated level must be corrected by an amount equal to $10 \log 600/Z$ where Z is the impedance at the point of measurement. When Z is greater than 600 ohms this correction is negative, that is, the indicated level is higher than the true level. For circuits of less than 600 ohms the meter indicates a level lower than the true level. Whenever possible the use of this correction should be avoided by measuring at a 600-ohm circuit point or, where permissible, terminating the circuit in 600 ohms.

2.05 When a volume indicator is used for either single frequency level measurement or for speech or music volume measurement it is desirable to hold the meter pointer as near "0 vu" as possible by adjustment of the attenuator. In single frequency measurement it is especially desirable to keep the pointer indication between +2 and -2 vu. When so used an accuracy of ± 0.5 db should be obtained for any step of the

attenuator and at any frequency between 35 and 10,000 cycles.

2.06 When used for single frequency measurement from 10,000 cycles to about 16,000 cycles the indicator sensitivity may fall off from 0.5 to 1.0 db and special calibration is required if greater accuracy is needed. For use, however, in volume measurement on circuits transmitting frequencies up to 16 kc, this error is usually not noticeable due to the small amount of power usually present at these frequencies in most program material.

2.07 In the use of the volume indicator for measuring the level of speech or program material, some judgment is required to properly interpret the rapid deflections or kicks of the pointer. For speech or similar material where the successive peaks are of more or less the same value the attenuator should be adjusted to bring the maximum peaks up as close as possible to the 0 vu point but such that generally none of these peaks exceeds 0 vu. When so adjusted and the level observed for a period of a minute or more a sufficient number of peaks will usually occur within 0.5 vu of the maximum to permit a definite adjustment of the attenuator. The meter is so damped that over swings above 0 vu due to the meter itself should rarely occur and for this reason the proper adjustment is such that very few peaks should give readings above zero. In most material, however, some major peak or peaks will occasionally occur which will exceed this value and should be neglected.

2.08 In using the volume indicator for program transmission measurements where the material is less constant and both peak and average material level varies considerably, the volume reading that is of most importance is the maximum peak volume which should not exceed a particular predetermined value. In some cases it may be necessary to monitor program levels at low level points in a circuit or network. In these cases, an amplifier with known fixed gain or one with calibrated gain steps will be required between the bridging point and the volume indicator.

2.09 In some cases the volume indicator may be used as a monitor along a circuit merely to be sure that peak level at that point never exceeds a predetermined level. In this case

the attenuator may be preset so that a "0 vu" meter reading will represent this maximum level. With such an adjustment the majority of the indicated peaks will be considerably below this level and the average material may be too low to give any accurate meter indication.

3. CIRCUIT DESCRIPTION

3.01 The KS-16652 Volume Indicator unit is a component part of both the KS-16653 portable instrument and the KS-16654 rack mounted unit so that the electrical circuits of all volume indicators of this type are identical with only the following exceptions.

- (a) Input jacks are supplied in the KS-16653 unit.
- (b) The KS-16653 instrument utilizes the non-illuminated meter type of basic unit (KS-16652, List 2) and the wiring for the meter lamps is therefore omitted.

3.02 The schematic circuit of the KS-16652 basic unit is shown in Fig. 4. The three-position switch permits the instrument to be used as a high impedance bridging indicator in either of two ranges (Paragraph 1.05) or as a terminating instrument of 600-ohm impedance. Figs. 4A, 4B, and 4C show in a simplified manner the circuit in each of the three switch positions.

3.03 In the HIGH IMP position (Fig. 4A) the circuit consists of a 2800-ohm fixed resistor, an adjustable 1200-ohm calibrating resistor (R11), the T-type attenuator, and the meter. The 1200-ohm calibrating resistor (R13) (see Part 4) compensates for variations in individual meters and resistors. A mechanical adjustment (not shown) is also available on the meter to adjust the pointer for a no-current zero.

3.04 This external resistance of approximately 3600 ohms (assuming that 800 ohms of the 1200-ohm adjustable calibrating resistor is used) in series with the 3900-ohm attenuator-meter combination presents the line bridging impedance of approximately 7500 ohms. The attenuator has one step of 0 loss and 11 steps of 2 db each (plus an "off" position) permitting an adjustable loss of 0 to 22 db ahead of the meter. Since the sensitivity of the meter used is such that a level of +4 vu is required for the meter

needle to deflect to the 0 vu mark the zero loss step of the attenuator is marked +4 on the dial plate. Thus the algebraic sum of the meter reading and the attenuator setting will give the true level at the line terminals and permits a "0 vu" reference meter reading for a volume range of from +4 to +26 vu (numerically equal to dbm for single frequency measurements). By use of the full meter scale, single-frequency measurements of from -16 to +29 vu are theoretically possible but in order to utilize only the more readable and most accurate range of the meter volume readings between 0 and +29 vu should be considered with the 2 AR KEY UNIT in the HIGH IMP position. (This will confine readings to the -4 to +3 portion of the meter scale.)

3.05 With this key in the "+20" position the circuit is as shown in Fig. 4B. The circuit is the same as the "HIGH IMP" position except that the 20 db pad (3160/3160/787-ohm resistors) is connected ahead of the meter-attenuator combination. Operation and impedance are identical with the HIGH IMP position except that levels 20 db higher may be measured.

3.06 The circuit of the instrument in the "600 OHMS" position is shown in Fig. 4C. In this case the input is connected to the meter circuit thru a repeating coil that serves as a step-up transformer. The 1400-ohm resistor across the transformer primary is such that the circuit presents a 600-ohm input impedance. The four 51-ohm resistors are included or strapped out as required to adjust the circuit so that the gain provided by the transformer is exactly 10 db. The 270-ohm resistor, normally strapped out, is used only in the calibration procedure described in Part 4. Reading of the instrument with the key in the "600 ohms" position is identical to the HIGH IMP position except that 10 db is subtracted from the algebraic sum of the meter and attenuator readings. This results in a measurable level range of from -6 to +16 vu for a 0 vu meter deflection or a practical single frequency range of about -10 db to +19 db.

4. CALIBRATION AND TESTING

4.01 When the volume indicator, with the switch in either the "HIGH IMP" or "+20" position, is bridged across a 600-ohm circuit a loss of about 0.3 db is caused in the thru circuit. Two methods of calibration of the in-

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strument are used, conveniently designated Method A and Method B. Method A is usually employed when the instrument is to be connected to the circuit temporarily for purposes of making only a single, isolated measurement. When calibrated in this way the level indicated will be the level actually at that point with the indicator removed but not exactly the level on the circuit while the measurement is being made. This is the method normally used and is the method used for the initial calibration of the indicators when supplied. When, however, a circuit is to be permanently equipped with a volume indicator, Method B should be used so that the indicated meter level will be the actual circuit level with the indicator connected.

4.02 Method A: A source of 1000-cycle test power of 600-ohm impedance terminated in 600 ohms is adjusted to deliver 4 db above 1 milliwatt (+4 dbm). The volume indicator with the key in the HIGH IMP position is then connected across the 600-ohm termination. With the attenuator set to +4, adjust the resistor R11 (controlled by a screw driver adjustment on front of panel) until the meter reads 0 vu.

4.03 Method B: First connect the volume indicator (HIGH IMP key position) across the 600-ohm termination mentioned in 4.02 above. Then adjust the source of test power to deliver a +4 dbm level to the termination *with the volume indicator* bridged on. With the attenuator set to +4 adjust the resistor R11 (controlled by a screw driver adjustment on front of panel) until the meter reads 0 vu.

4.04 In those cases where an accurate source of +4 dbm test power is not available the above calibration may be made at some other level. If, for instance, a properly calibrated standard 0 dbm test power source is used, the meter of the volume indicator should be adjusted to read -4 vu (with attenuator at +4). Calibration at 0 vu, however, is generally more desirable because of the greater meter scale expansion at that point and because in general most single frequency measurements are made at the 0 vu mark on the meter scale.

4.05 The following checks and measurements may be of assistance in searching for the location of trouble in the instrument but should not be required in its normal use and calibration

unless the meter or some circuit component has been replaced.

(a) **Bridging Loss:** The bridging loss of the volume indicator across a 600-ohm circuit with the switch in either the HIGH IMP or +20 positions should be between 0.3 and 0.5 db for any attenuator setting at any frequency from 35 to 10,000 cycles.

(b) **Attenuator:** Each step of the attenuator R13 (except the first), when measured between the correct impedances should be 2.0 ± 0.2 db at any frequency from 35 to 10,000 cycles.

(c) **20 Db Pad:** The 20 db pad inserted in the "+20" switch position should measure $20 \text{ db} \pm 0.3$ db throughout the frequency range.

(d) **600-Ohm Sensitivity:** Operation of the volume indicator in the 600-ohm condition as a terminating instrument should provide an increased sensitivity of exactly 10 db so that no change should be required in the calibrating resistor from its HIGH IMP adjustment. This 10 db gain may be adjusted by strapping out one or more of the four 51-ohm resistors shown in Fig. 4C. Should it be necessary to change this strapping the adjustment may be made as follows:

The volume indicator should first be calibrated in the HIGH IMP position as covered in Paragraph 4.02 or 4.03. If Method B (4.03) is used, remove the strap around the 270-ohm resistor. A source of test power of 600-ohm impedance is terminated in 600 ohms and adjusted to deliver a +4 dbm level to the termination. The volume indicator key is then operated to the "600 ohms" position, and the 600-ohm test termination removed. With the attenuator set on +10 the tapped resistor is then strapped until the meter reads as closely as possible to 0 vu.

(e) **Frequency Characteristic:** The volume indicator should not deviate from the 1000-cycle reading by more than 0.5 db for any setting of the attenuator from 35 to 10,000 cycles. In the range up to 16,000 cycles, variations up to 1.0 db may be present in the "600-ohm" position.

(f) *Dynamic Characteristic:* A single frequency sinusoidal voltage of any frequency between 35 and 10,000 cycles and sufficient amplitude to give a reference volume reading of 0 vu should, when suddenly applied, cause the needle to reach 99 per cent of this deflection in 0.3 seconds ± 10 per cent and then overswing reference deflection by at least

1.0 per cent and not more than 1.5 per cent. The time for the pointer to come to rest after removal of the voltage should not be far different from the response time.

4.06 A list of the major components used in the KS-16652, List 1 and List 2 Volume Indicators is included in Fig. 4.

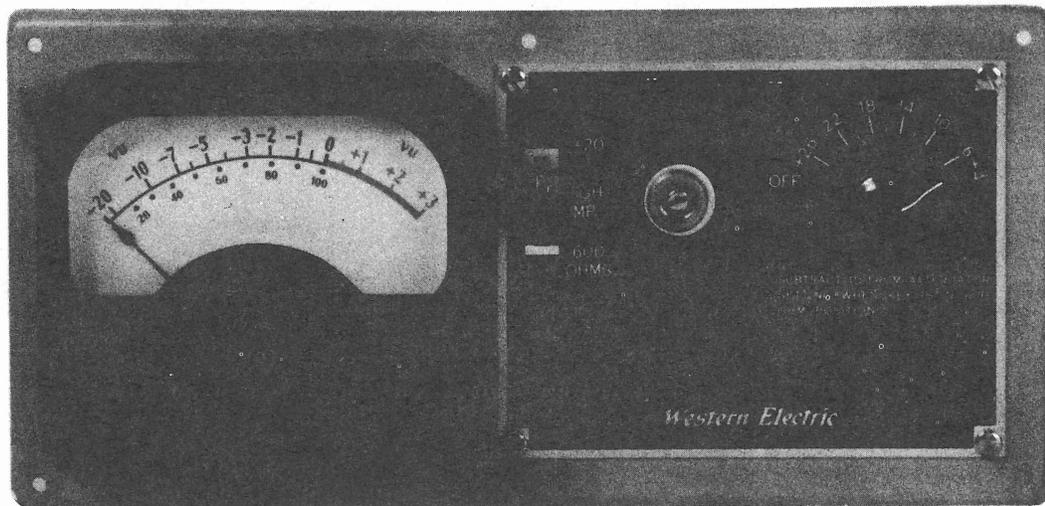


Fig. 1 - KS-16652, List 1 or List 2 Volume Indicator

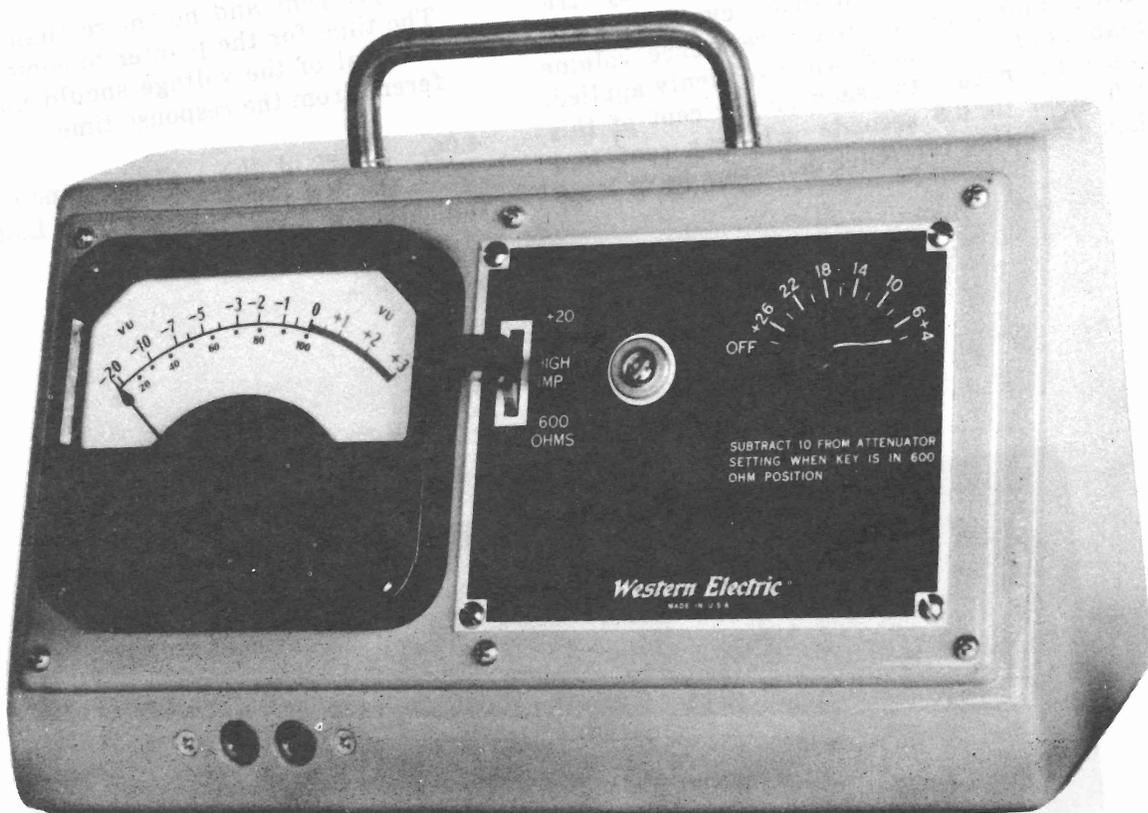


Fig. 2 - KS-16653, List 1 Volume Indicator



Fig. 3 - KS-16654, List 1 Volume Indicator

PARTS LIST

- Meter — KS-16652 List 1 — WECo, KS-8208 List 6 or List 7
- Meter — KS-16652 List 2 — WECo, KS-8207 List 4 or List 5
- R1 — IRC Type WW3J — 1400 ohm
- R2 — WL Vitrohm Type 241 — 2800 ohm
- R3,R4 — WL Vitrohm Type 241 — 3160 ohm
- R5 — WL Vitrohm Type 241 — 787 ohm
- R6,R7,R8,R9 — IRC Type BW — 0.5 watt — 51 ohm ± 5%
- R10 — IRC Type BW — 1 watt — 270 ohm ± 5%
- R11 — IRC Potentiometer Type 2W — 1200 ohm
- R12 — WL Vitrohm Type 241 — 100 ohm
- R13 — Potentiometer — Tech. Lab. SGL Type 800
3900/3900 ohm, 2 db steps
- S1 — WECo Type 2AR Key Unit
- T1 — WECo KS-16682, L1 Repeating Coil
- TB1 — Terminal Board, B187303

(IRC = International Resistance Co., WL = Ward Leonard,
WECo = Western Electric Company)

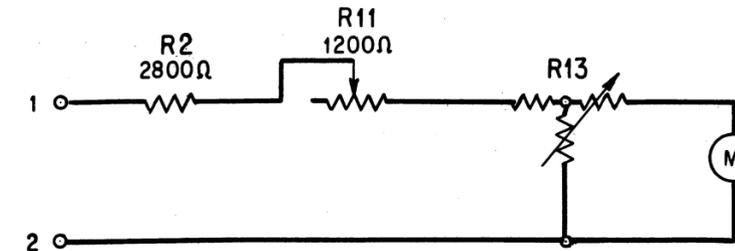
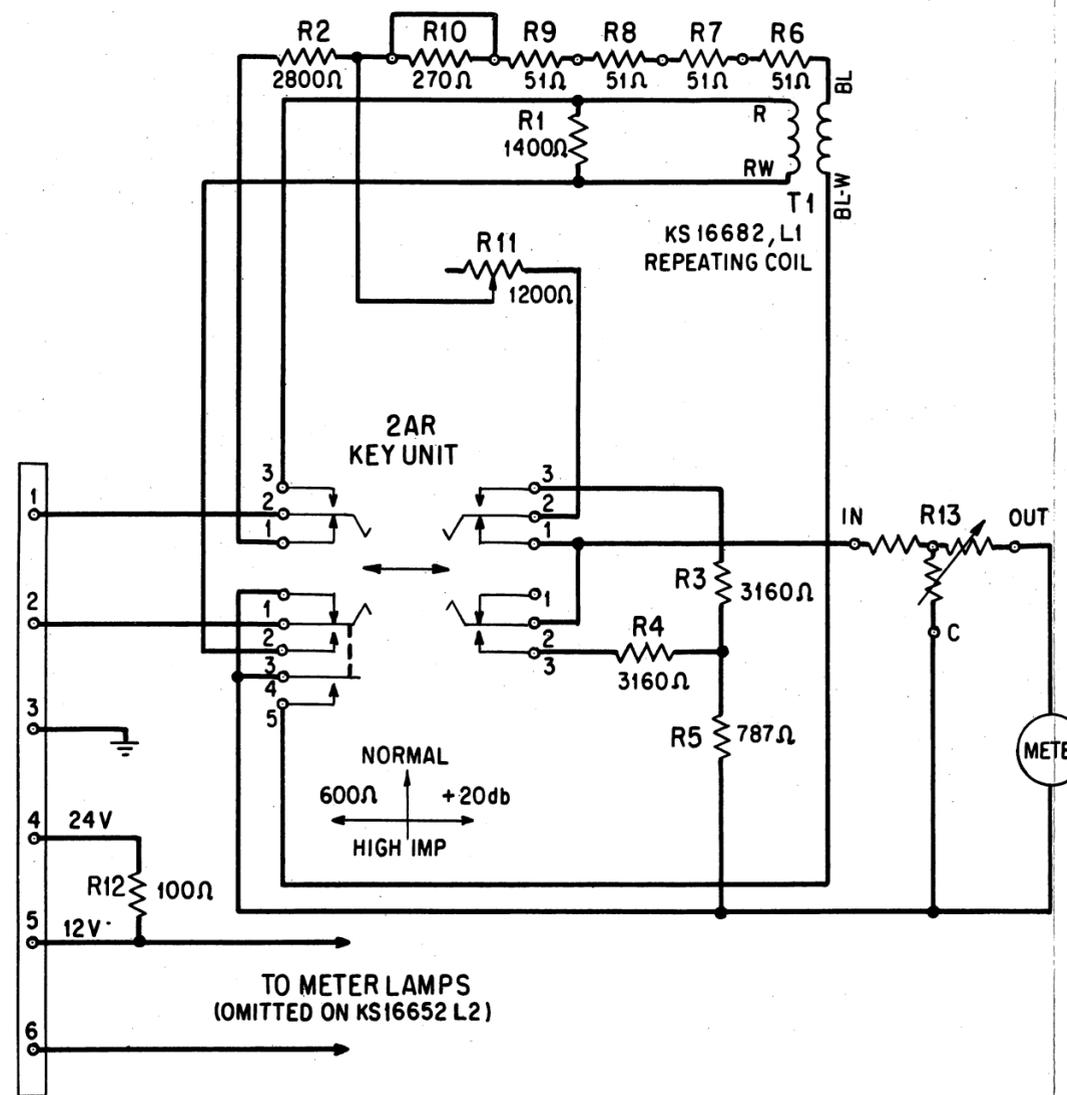


FIG. 4A - SIMPLIFIED SCHEMATIC - HIGH IMPEDANCE KEY POSITION

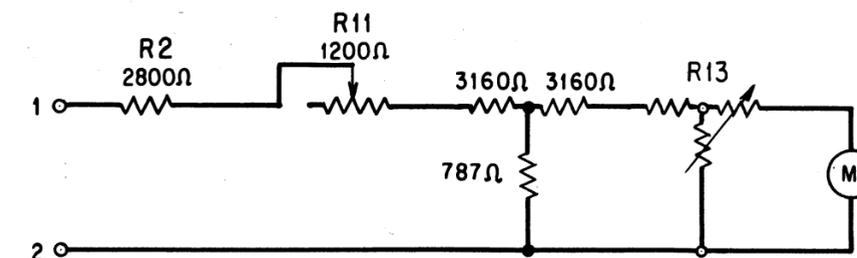


FIG. 4B - SIMPLIFIED SCHEMATIC - + 20db KEY POSITION

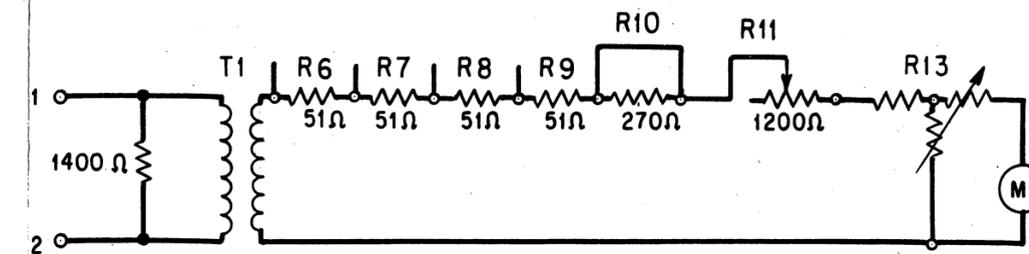


FIG. 4C - SIMPLIFIED SCHEMATIC - 600 OHMS KEY POSITION

Fig. 4 - Schematic — KS-16652,
L1 and L2 Volume Indicators