Western Electric

754A and 754B VOLUME INDICATORS

Instruction Bulletin No. 933P

754A AND 754B VOLUME INDICATORS

The Western Electric 754A and 754B Volume Indicators include improved volume indicator meters which in combination with other circuit elements to be described later have been standardized for the measurement of volume levels in circuits of 600 ohms impedance in speech-input equipments for radio broadcasting, public-address and similar installations, and program line transmission services. Measurements in circuits of impedance other than 600 ohms may also be made provided a correction is applied to the indicated readings.

A complete volume indicator of the new type consists of a meter, used as the indicating device, and associated control elements such as an attenuator for changing the volume range, an adjusting resistance, and, in the case of the 754B Volume Indicator, a repeating coil and associated resistors for increasing the sensitivity. Actually, the coded volume indicators both include the necessary apparatus assembled and wired on a brass mounting panel, but not the meter, which is ordered and shipped as a separate item. The reason for this is that any one of three models of the meter may be used as required in the particular instance, the volume indicator assembly being designed to accommodate any of these models.

This volume indicator has resulted from a development of the Bell Telephone Laboratories in cooperation with the major broadcasting systems and the Long Lines Department of the American Telephone and Telegraph Company, the main purpose of which was to provide a standard means for reading volumes with a meter of controlled electrical and dynamic characteristics. The input impedance of the 754A Volume Indicator is nominally 7500 ohms so that the instrument may be used as a bridging device on circuits of ordinary impedances such as 600 ohms. However, the 754B Volume Indicator is provided with a transformer and a transfer key, for use either as a bridging device of 7500 ohms impedance, or as a transformer-coupled 600-ohm termination for the circuit being measured. In addition to translation to 600 ohms impedance the transformer connection increases the sensitivity of the instrument by 10 db.

In measuring volume with the new indicator, a new standard reference level has been adopted in accordance with the following definition:

> Zero or reference volume level in a 600-ohm circuit is that level which will give a zero reading on a volume indicator which has the characteristics described below, and which is so calibrated that it reads zero for one milliwatt (0.001 watt) of 1,000-cycle sine-wave power in a 600-ohm resistance. *The use of the instrument across any impedance other than 600 ohms will require correction.*
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> The reading of the volume indicator is the setting of the sensitivity control to which is added algebraically the scale reading of the meter if the

latter is not zero. The meter sensitivity is such that a sine-wave power of 4 db above 1 milliwatt in 600 ohms deflects to the reference point of the meter scale. Therefore, the lowest setting of the sensitivity control (attenuator) is marked +4, and with this setting zero volume is read at —4 on the meter scale.

In order to avoid cumbersome terms such as "db above (or below) zero volume level," and confusion with several previous standards, volume readings obtained with the new indicator are designated as so many "vu" (numerically equal to the number of db above or below the new zero volume level). It is not intended, however, that volume levels measured on other types of meters be reported or designated in terms of vu unless such instruments are equivalent to the new ones.

The 754A and 754B Volume Indicators contain no vacuum tubes and require no amplification to measure volumes covering a range from —6 vu to +26 vu. The only external connections required are the input leads, except where illuminated type meters are used, in which case an external power-supply of the proper voltage must be furnished for meter scale illumination. Two lamps, Mazda No. 47, 6-8 volts, 0.15 ampere each, are used in each of the illuminated style meters. By rearrangement of the lamp wiring inside the meter case, either series or parallel connections of the lamps may be made depending upon the available voltage and capacity of the external supply.

Description

The 754A Volume Indicator consists of a sub-assembly, coded 752A Volume Indicator, incorporating a number of apparatus units mounted on a 5 by 10½ inch brass panel finished in aluminum gray on the front and aluminum on the back. The sub-assembly is mounted in a 5¼ by 19 inch brass mounting panel of aluminum gray finish on the front and aluminum finish on the back and arranged for relay rack or equipment-cabinet mounting. An aluminum-finished dust cover is also provided, on the inside of which is a circuit label of the equipment.

A photo-etched designation plate finished in black with chromium designations and trim is fastened on the front of the sub-assembly which provides space and mounting holes for a meter of the model selected for the particular application. The apparatus units are mounted on the back of the panel with the attenuator shaft extending through to the front for its knob. The shaft of the slide-wire adjusting resistance also extends through to the front and is slotted for screwdriver adjustment from the front of the panel. A terminal strip is provided at the back for the external connections which consist of two input terminals, a ground connection and three terminals for external power supply (6, 12 or 24 volts) to the dial-illuminating lamps of the meter.

The 754B Volume Indicator is similar in appearance and construction to

the 754A Volume Indicator except that a repeating coil, several resistors, and a transfer key are added to the sub-assembly, for increased sensitivity and translation to 600 ohms impedance. The sub-assembly for the 754B Volume Indicator is coded 752B Volume Indicator. In this assembly the photo-etched designation plate includes a key slot and associated designations "HIGH IMP" and "600 OHMS," corresponding to the key lever positions, as well as a statement of directions for interpreting the volume level readings when the instrument is used as a 600-ohm circuit termination.

A detailed description of the circuit elements of the 754A and 754B Volume Indicators is given under the heading "CIRCUIT FEATURES."

The meter used as an indicating device is a rectifier-type milliammeter of special design. It is provided in three different models consisting of two scale markings with illuminated or non-illuminated dials as follows:

KS-8207	Non-illuminated	"A" scale
KS-8208	Illuminated	"A" scale
KS-8218	Illuminated	"B" scale

The meter "A" and "B" scales are illustrated in Figures 1 and 2 respectively. The "A" scale emphasizes vu markings above the line of the meter arc, the 0 vu or 100 mark of the meter scale being at a position such that approximately two-thirds of the available scale length is utilized. Scale markings in vu extend from the 0 vu or 100 mark down the scale (left) to —20 which is just above the meter zero, and up the scale (right) to +3. A secondary scale known as the arbitrary voltage or per cent scale is shown in smaller figures below the line of the meter indicating arc. This scale is graduated in percentage figures up to the 100 mark which corresponds to the 0 vu mark.

In the "B" scale meter the vu and the percentage scales described above are reversed in position along the line of the pointer arc, the 0 to 100 scale being located in larger figures above the line.

The illuminating lamps in the KS-8208 Meter are normally connected in series, for operation from 12 volts (0.15 ampere) external power supply. The lamps in the KS-8218 Meter are provided in parallel connection for operation from 6-volt 0.3-ampere power supply but may be connected in series by rearrangement of the wiring inside the meter case for use with a 12-volt supply.

Each meter is of the semi-flush type, mounting in a round hole with the meter front projecting approximately ¾ to 1 inch in front of the mounting panel. The meter case is black bakelite with that portion of it which projects in front of the panel finished in aluminum gray.

In all other respects the three models of the meter are the same except that the illuminated types have a slightly different front appearance, and use different drillings for mounting. Mounting holes are provided for either of the meter

types, and meter mounting screws are furnished with the volume-indicator assembly.

The meters are of the copper-oxide rectifier milliammeter type and are so designed that they will have the proper dynamic characteristics when the external impedance of the circuit as seen from the meter is in the order of 3900 ohms. This requires that an external resistance (included on the panels but not provided with the meter) of approximately 3600 ohms be used in the circuit in series with the meter. When used in this way the dynamic characteristics of the meter are such that the pointer will come to 99 per cent of steady-state deflection at the 0 vu or 100 mark of the scale in 0.3 second on the first up-swing, and also the over-swing of the pointer will be between 1 and 1.5 per cent of the steady state deflection. *The meter will not have these characteristics if magnetic material is closer than about 2 inches to the meter movement. It is important therefore that these meters be mounted in non-ferrous metal panels and so located in an equipment bay or other assembly that the demagnetizing effect of adjoining steel panels is reduced to a minimum.*

A scale deflection to the 0 vu or 100 mark is obtained when 1.228 volts (4 db above the voltage corresponding to 1 milliwatt in 600 ohms) is applied across it in series with a 3600-ohm resistance. The meter sensitivity at the 0 vu or 100 mark of the scale is uniform within 0.2 vu of the 1,000-cycle value over the frequency range of 35 to 10,000 c.p.s. and is uniform within 0.5 vu over the frequency range of 25 to 16,000 c.p.s.

Harmonic distortion introduced by this device is not more than the distortion equivalent to 0.2 per cent r.m.s. when the meter in series with 3600 ohms is bridged across a 600-ohm circuit and a scale reading at the 0 vu or 100 mark is obtained for any single sine-wave frequency between 35 and 5,000 c.p.s.

The meter will stand an overload equivalent to 10 times the voltage required for a scale reading at the 0 vu or 100 mark for at least 0.5 second without injury to the meter and without effect on its calibration. It is capable of withstanding a continuous overload equivalent to 5 times the voltage required for a reading at the 0 vu or 100 mark on the scale.

The meter is provided with a zero adjustment for setting the pointer to zero on the per cent scale when no current is flowing.

CIRCUIT FEATURES

Although the meter used with the particular volume indicator is not included as part of the coded panel for the reason previously noted, the schematic circuits and wiring diagrams shown in Figures 3 and 4 include meters in order that the complete circuit as used in operation may be evident. The circuit diagrams also include terminals and wiring for the lamps of the illuminated meters. This wiring and the associated resistance designated R3 are provided on the sub-assemblies but are not used when non-illuminated meters are installed in the panel.

754A Volume Indicator

The 754A Volume Indicator is designed for use as a bridging instrument of approximately 7500 ohms impedance for the measurement of volume levels from +4* to +26 vu in circuits of 600 ohms impedance. Its bridging loss in a 600-ohm terminated circuit is 0.4 db maximum.

*These values are for the normal deflections of the meter to the scale point marked "0 vu" and "100," which is the reference point of the meter scale for all measurements of program material. For sine-wave signals of constant amplitude such as used in transmission tests and measurements, the volume ranges indicated above are extended to take into account the entire meter scale for volumes 20 vu lower and 3 vu higher than the figures.

The schematic circuit and the wiring diagram of the 754A Volume Indicator are shown in Figure 3. The impedance at the input terminals 1 and 2 is between 7200 and 7900 ohms and is made up of a 2800-ohm fixed resistance R2, a 1200-ohm slide-wire P1, and a meter M1 in series. An adjustable T-type attenuator A1 is inserted in the circuit between P1 and the meter. P1 is used during calibration to adjust the volume-indicator sensitivity for the particular meter used in the panel. The total resistance (R2 + P1) provided in this way is in the order of 3300 to 3600 ohms, depending upon the method of calibration to be described later. The impedance seen from the meter which is of 3900 ohms internal impedance, or from the attenuator A1, is approximately 3900 ohms and the attenuator is therefore designed for 3900 ohms impedance. The attenuator contains thirteen positions starting with the "OFF" at the extreme left, followed by eleven steps of 2 db attenuation each, with decreasing attenuation from 22 db to 0 db for clockwise rotation from left to right. The corresponding designations on the photoetched designation plate are from +26 (left) to +4, the latter corresponding to 0 db attenuation. (The +4 designation for the zero loss position of the attenuator is so marked because as previously explained, the sensitivity of the meter is such that a volume of +4 vu is required to produce a deflection to the 0 vu or 100 mark of the meter scale.) In the "OFF" position of attenuator A1 the connections to the meter are short-circuited.

The power circuit for the meter lamps is brought out as indicated on terminals 8, 9 and 10. When a 24-volt power supply is employed it is connected to terminals 8 and 10 and the lamps in the meter should be connected in series; when a 12-volt supply is used it is connected to terminals 9 and 10, the lamps being connected in series as before; when a 6-volt supply is used it is connected to terminals 9 and 10, and the meter lamps should then be connected in parallel.

With the series connection of the lamps the approximate current drain from the external voltage source is 0.15 ampere, while in the parallel arrangement of the lamps 0.3 ampere current is required for illumination.

754B Volume Indicator

The 754B Volume Indicator is intended for use as a high-impedance bridging instrument, or as a 600-ohm termination for the circuit being measured.

The schematic circuit and the wiring diagram of the 754B Volume Indicator are shown on Figure 4.

This circuit is basically the same as that of the 754A Volume Indicator except that a key-controlled coil and associated resistances have been added for increased sensitivity and 600 ohms input impedance.

When the key is in the normal position, marked "HIGH IMP" on the designation plate attached to the front of the panel, the circuit is identical with that of the 754A Volume Indicator just described.

When the key is operated to the "600 OHMS" position, the fixed resistance R2 and the 270-ohm part of R4—when used—are removed from the circuit and the repeating coil and associated resistances R1 and tapped sections of R4 are inserted between input terminals 1 and 2 and the rest of the circuit. Resistance R4, connected in series on the high-impedance side of transformer T1 as shown, consists of two parts: the 270-ohm section (shown strapped out on the drawing) is used only in a special method of calibration to be considered later, while the remainder of the resistance is used to provide series resistance from 0 to 200 ohms in 50-ohm steps for adjusting the circuit so that the voltage step-up provided by the coil is exactly 10 db. The transformer shield is connected to the panel ground terminal 7. A 1400-ohm resistance R1 is connected across the transformer input winding.

The input impedance of the circuit under these conditions is 600 ohms and the sensitivity has been increased 10 db. Directions for interpreting the volume indicator readings under these conditions are given on the designation plate as follows: "SUBTRACT 10 FROM THE ATTENUATOR SETTING WHEN KEY IS IN 600 OHM POSITION."

INSTALLATION

A terminal strip, designated "TS1," is provided at the back of each of the volume-indicator assemblies for external connections as follows:

TERMINAL NUMBERS AND CONNECTIONS FOR 754A, AND 754B VOLUME INDICATORS

Terminal Numbers	*External Connections*	
1 and 2	Input	
3, 4, 5, 6	Not used	
7	Ground	
8 and 10	24 volts 0.15 ampere	External Power Supply (See Note below)
9 and 10	6 volts 0.3 ampere or 12 volts 0.15 ampere	External Power Supply (See Note below)

NOTE: External power supply of the voltage indicated is required for dial illumination of the KS-8208 or KS-8218 Meter if used in the volume indicator assembly, but is not required if the KS-8207 Meter is used.

The lamps in the KS-8208 Meter are normally connected in series, and the lamps in the KS-8218 Meter are connected in parallel. Meter lamps may be connected either series or parallel as required for the particular voltage supply available, by removing the front cover of the meter case which is held in place by two screws.

If 12 or 24 volts supply is used the lamps in the KS-8218 Meter should be connected in series. For 6 volts the meter lamps should be connected in parallel.

D-c or a-c power supply may be utilized, *except that the use of a-c power is not recommended for this purpose in the case of installations employing low level, high gain amplifiers.*

Further information on meter lamps, including detailed instructions for replacement of lamps when required, is given under the heading "MAINTENANCE."

In the case of speech-input equipments for radio broadcasting, and in public-address and similar installations, shielded twisted-pair copper conductors should be used for the external connections to the volume indicator, the shields to be securely grounded either at the volume indicator ground terminal or at some other point in the system, depending upon the particular installation; in any case, the volume indicator panel itself should be grounded at terminal 7 by means of

an external ground wire connecting directly to the system ground. The power-supply leads to terminals 8 and 10 or terminals 9 and 10 of the volume indicator when required, should be of such size that the potential drops in the conductors when current is flowing do not reduce the terminal voltage at the volume indicator panel below 22 volts in the case of the 24-volt supply, 11 volts for the 12-volt supply, or approximately 5.5 volts for the nominal 6-volt supply.

The volume indicator meter is susceptible to magnetic fields in its immediate vicinity and for this reason it is recommended that the panel be located in the relay rack or equipment cabinet as far removed as practicable from the influence of strong magnetic fields generated in the immediate vicinity of power amplifiers, rectifiers or apparatus of a similar nature. In installations where it is desired to use the meter proper as an extension indicator on a control desk or console remote from the volume-indicator panel, the meter should be mounted in a non-magnetic panel or other structure in such a manner that magnetic materials are at least 2 inches away from its moving parts, and the meter connections at the volume-indicator panel extended by means of twisted-pair shielded conductors to the remote position. A meter blank is available upon order for use on the volume-indicator panel when the meter is removed for external use as indicated.

CALIBRATION

When the volume indicator and meter have been installed as described, the instrument should be calibrated so that the proper indications will be given. In the instructions which follow, two standard methods of calibration are outlined. In addition, an alternative method of calibration is described for use with the ordinary 60-cycle a-c power supply in cases where a single-frequency 1000-cycle sine-wave source is not available; however, for accurate results an electronic a-c voltmeter or a rectifier-type voltmeter capable of approximately 2 per cent accuracy will be required for this alternative calibration.

Standard methods of calibrating the volume indicator differ from each other in the allowance made for the 0.3-0.4 db loss which the volume indicator causes to through transmission when bridged across a 600-ohm circuit. In the case of the 754B Volume Indicator the key should be in the normal "HIGH IMP" position for this calibration.

Method A

This method of calibration is applicable whenever the volume indicator is to be used on a separate program bridge outlet or is to be patched to the through line only while the volume is being read; that is, the volume indicator is not to be permanently connected across the through circuit.

A sending source having approximately a 600-ohm impedance is adjusted to deliver 4 db above 1 milliwatt of 1000-cycle power into a 600-ohm resistance termination. The volume indicator is then connected across the

termination, the attenuator A1 set on step +4, and the slide-wire P1 adjusted until a reading at the 0 vu or 100 mark is obtained on the meter.

Readings on the volume indicator calibrated in this way indicate the level which would exist in the 600 ohms with the volume indicator disconnected rather than the level in the 600 ohms with the instrument bridged across it. Thus with the volume indicator connected to a program bridge outlet which has been lined up to have the same level as the through line the volume indicator reading obtained with the above calibration will indicate true level on the through line; or, in those cases where a volume measurement is desired on a line not normally equipped with the volume indicator, the reading obtained on this circuit by means of the volume indicator calibrated as above and patched temporarily to this circuit will give the true level on this circuit for the condition when the volume indicator has been removed.

Method B

This method should be used in cases where the volume indicator is to be permanently connected across a through circuit. In this method compensation is made for the bridging loss of the volume indicator (about 0.3 db) so that the readings obtained represent the volume levels in the circuit while the volume indicator is connected.

A sending source having approximately a 600-ohm impedance is adjusted to deliver 4 db above 1 milliwatt of 1000-cycle power into a 600-ohm resistance termination *when the volume indicator is bridged across it.* The attenuator A1 is set on step 4 and the slide-wire P1 adjusted until a reading at the 0 vu or 100 mark is obtained on the meter.

Alternative Calibration

In installations where a source of 1000-cycle power is not readily obtainable the volume indicator may be calibrated from low-voltage 60-cycle a-c power used for filament or heater supply in associated amplifiers, using an ordinary wire-wound potentiometer of 25,000 ohms total resistance for adjustment of the voltage applied across terminals 1 and 2 of the volume indicator. (In order to protect the amplifier or the system from which the 60-cycle source is obtained, a fuse should be connected in the temporary circuit as near as practicable to the source of the a-c voltage, and the connecting circuit including the fuse and the potentiometer should be carefully insulated from ground and from accidental contact with adjoining metal surfaces.) In this calibration a test voltmeter of the electronic or rectifier type is used to measure the 60-cycle sine-wave voltage at the volume-indicator input terminals, and the slide-wire P1 adjusted to obtain the proper deflection of the meter. Calibration in accordance with either Method A or Method B already described may be made in this manner, the method of calibration used being dependent upon the manner in which the volume indicator is

to be employed in measuring program volume; in either case the key of the 754B Volume Indicator should be operated to its normal center position, marked "HIGH IMP," before making this calibration.

In calibrating from the 60-cycle power supply, the slide-wire P1 should be adjusted to obtain a deflection to the 0 vu or 100 mark on the meter scale with a voltage of 1.228 r.m.s. volts impressed across input terminals 1 and 2 of the volume indicator, and the attenuator A1 set at its +4 position. This value of 1.228 volts sine-wave represents a power level of +4 vu (4 db above 0.001 watt) in 600 ohms. Calibration of the instrument at higher values of impressed voltage may be made if desired by changing the setting of the attenuator A1, the slide-wire P1 being adjusted as before to obtain a meter deflection to the 0 vu or 100 mark. For example, doubling the impressed voltage to 2.46 volts is equivalent to an increase of 6 vu in power level—under these conditions the attenuator should be operated to its +10 position before calibration by adjustment of P1; in like manner, with sine-wave voltages of 4.92 or 9.84 volts, the corresponding attenuator settings should be +16 or +22, respectively.

Adjustment of 754B Volume Indicator

In the 754B Volume Indicator an additional adjustment is provided; when this adjustment is properly made, as described below, the gain in sensitivity due to the transformer is made exactly 10 db so that the same adjustment of the slide-wire described above under Method A will be accurate with the transformer cut either out or in.

This adjustment is made by making connection to the proper point of the tapped resistor R4 associated with the transformer. Before making this adjustment the volume indicator should be calibrated and checked with key K1 thrown to "HIGH IMP" as described above, except that if Method B is used the strap should be removed from the 270-ohm resistance, so that the fixed series resistance becomes 3070 ohms. (In any case, operation of the key to the 600-ohm position removes the total fixed resistance from the circuit.) The tapped resistor should be adjusted as follows:

> A sending source having 600 ± 5 ohms impedance is adjusted to deliver 1 milliwatt of 1000-cycle power into a 600-ohm termination. The volume indicator, properly calibrated and checked as above, is then put in the 600-ohm condition by operation of the key K1, and substituted for the 600-ohm termination. With the attenuator set on +10 the tapped resistor is adjusted until a reading as close as possible to the 0 vu or 100 mark on the meter is obtained. *In making this adjustment the slide-wire resistance* P1 *should not be disturbed.*

This adjustment when once made need not be changed unless the meter used in the volume indicator is replaced. With this adjustment of the tapped

resistor fixed, subsequent calibration of the instrument may be made by using the above procedure and adjusting the slide-wire to get the proper reading.

Under these conditions, regardless of the method of calibration of the instrument for the high-impedance condition the volume indicator will provide an approximate 600-ohm termination and give the true value into this 600 ohms. Also if the instrument is used to terminate a circuit by throwing the key to the 600-ohm position the instrument can be used to read volumes as well as to make transmission measurements. However, if when used in this way it is found necessary to remove the transformer from the circuit by throwing the key to the high-impedance condition in order to read higher volumes, *it must be remembered that the volume indicator no longer provides the 600-ohm termination for the circuit and that this must be supplied in some other way.*

NOTE: The sensitivity of the meter used in the volume indicator may change with time over a range not exceeding ± 0.5 db so that recalibration of the instrument as outlined may be required occasionally when maximum accuracy is desired.

OPERATION

The 754A and 754B Volume Indicators have been designed to be direct reading when bridged across a circuit terminated in 600 ohms resistance. The instrument is intended primarily for volume measurement but inasmuch as it is calibrated by means of single-frequency steady-state power it can be used for making single-frequency transmission or level measurements if the accuracy and range of the volume indicator are sufficient for the purpose. When using the instrument for transmission measurements where a sending power of 1 milliwatt is employed the loss (or gain) is indicated directly in db, the number of db being numerically the same as the reading of the volume indicator in vu; that is, the attenuator setting plus the scale deflection, plus or minus values indicating gains or losses, respectively. The 754B Volume Indicator is provided with a step-up coil which in effect increases the sensitivity of this device 10 db and provides an input impedance of 600 ohms. *Because of its low input impedance with key* K1 *at the "600 OHMS" position the 754B Volume Indicator cannot be used as a bridging indicator across a circuit terminated in 600 ohms.*

The volume indicator when properly calibrated and used in the manner described gives a direct reading on a circuit terminated in 600 ohms. For a termination of some other impedance the reading in vu should be corrected by a number corresponding to the db value equivalent to a current ratio of $\sqrt{600/z}$, where z is the impedance of the terminating circuit. When z is greater than 600 ohms the correction should be subtracted from the actual indication of the instrument, that is, the true reading will be lower than the actual reading. When z is less than 600 ohms, the reverse is true.

The technique of using the instrument for volume measurements is generally similar to that employed with previous volume indicators, that is, the sensitivity is adjusted by means of the attenuator until the meter indication is as near the 0 vu or 100 mark as possible and the volume level is then read from the designations on the attenuator dial plate. Since the attenuator has steps of 2 db it may not be possible to adjust it so that the meter deflects exactly to the 0 vu or 100 mark on the scale. In that case the volume level shown by the attenuator setting may be corrected by adding or subtracting the deviations of the meter indications from the 0 vu or 100 mark on the scale. As explained earlier, the meter sensitivity is such that a volume level of +4 vu is required to cause the meter to deflect to the arbitrary 0 vu or 100 mark on its scale so that the lowest attenuator step (actually zero loss in the attenuator) is marked +4 vu.

Music and speech are of a rapidly varying character and the meter pointer of the volume indicator responds to them in a series of "KICKS" or deflections of varying amplitude. Some judgment is required to interpret indications of this sort, and this will now be briefly discussed with the purpose of stating a procedure which should give uniform results with different observers. When this procedure is followed it should be possible to obtain readings of volume levels with an accuracy of ± 1 vu.

For a type of material where the successive major peaks are of more or less the same value, such as speech from a steady talker, an adjustment of the attenuator should be made with the intention of bringing the maximum peaks indicated on the meter up to the 0 vu or 100 mark, but it also is the intention that none of these peaks should exceed the 0 vu point. It is suggested that, for this type of material, observations be made for a period of one minute or so to determine the volume at that time. (All of the maximum peaks occurring during this period will not, of course, give identical indications on the meter, but generally a sufficient number of peaks will occur within 0.5 vu of the maximum so that a definite adjustment of the attenuator can be readily made.)

Although an observer may be very conscientious in making an adjustment of the attenuator in accordance with the above suggestion, it will be found that in bringing the peaks up to give readings at the 0 vu or 100 mark on the meter scale, some major peak or peaks will occasionally occur which will exceed this value and these may be neglected. It will be noted that the meter movement is more nearly critically damped than in previous volume indicators, so that overswings due to the meter itself will not occur. It is for this reason that no peaks are intentionally allowed to exceed the 0 vu or 100 mark in adjusting the new volume indicator. Consequently, it is expected that a much more accurate measurement will be obtained and there will be a closer correlation between two observers than with former types of volume indicators.

In using the volume indicator for program transmission, where the material is less steady and is varying considerably from time to time and over a wide volume range, the volume reading that is of most importance is the maximum volume, which should not exceed a particular predetermined value. In some cases, particularly where the program material is received for transmission over a network, it may be necessary to determine if the volume is below some predetermined value. To do this an amplifier will be required as discussed later to increase the sensitivity of the volume indicator.

In the case of a monitor along the circuit his greatest concern is that the major peaks of the program do not exceed the 0 vu or 100 mark with the volume indicator adjusted to the proper sensitivity for the point at which it is connected to the circuit. For a considerable portion of the time of course his meter will give readings considerably below this value.

In checking transmission from point to point along the circuit during service, a method of "peak checking" by a number of observers will be of value. This can probably best be done between two observers at a time. A means of ready communication between the observers is essential so that one can report his maximum meter deflections immediately to the other, while the latter compares these reports with his observations of his instrument on the same program, peak for peak. The two instruments have been previously adjusted to give identical readings on the same material if the circuit between them is in proper condition. (This is practicable with the new volume indicators which are of the r.m.s. type). The difference in the readings of the two instruments for a dozen or so peak observations is an indication of the transmission condition of the circuit between observers.

The volume indicator may be used for making transmission loss (or gain) and transmission level measurements. (It is assumed in the following that the nominal circuit impedance is 600 ohms where measurements are required.) When used for transmission measurements, the volume indicator with its high input impedance is essentially a level indicating device and is, of course, subject to the same limitations as any level measuring set. That is, to obtain a true reading of the transmission at that point, correction for the circuit impedance will be required if the actual impedance of the circuit is other than 600 ohms. If it is allowable during the measurement, it will be simpler to terminate the circuit in 600 ohms and bridge the volume indicator across it so that the reading obtained will be the true reading in a 600-ohm termination. This will avoid the necessity for impedance correction. When used in this way, the volume indicator should be calibrated by Method A previously described, except that if the volume indicator is normally bridged across the circuit at this point Method B will be advisable.

Since the sensitivity-frequency characteristic of the volume indicator is practically flat, ordinarily no correction need be made for it when a transmission-

frequency run is made. However, if more accurate results are required than are indicated by the frequency characteristic just given, it will, of course, be necessary to correct for the frequency characteristics of the volume indicator or calibrate the instrument for the particular frequency or frequencies of interest.

The vu scale of the meter is reasonably accurate, but due to the contraction of the scale at its lower end, it will be advisable, when possible, to adjust the sensitivity of the instrument by means of the attenuator knob so that meter readings will be confined to the portion of the scale between —2 and +2 vu.

In the 754B Volume Indicator the key can be thrown to the 600-ohm position for those cases where it is necessary to read powers somewhat less than +4 vu or 4 db above one milliwatt. *In this position the volume indicator has 600 ohms input impedance and is used to terminate the circuit directly, and any other termination which may be present for this purpose should be removed from the circuit.* In using the volume indicator in this manner the sensitivity has been increased 10 db so that the attenuator setting indicated on the nameplate should be reduced by the number 10 to obtain the true reading.

The volume indicator used in accordance with the above instructions will give a receiving accuracy of ± 0.5 vu (or db) for any step of the attenuator and any position of the key for any frequency from 35 to 10,000 cycles. By calibrating the instrument for the particular setting and the particular frequency used in measuring, the receiving accuracy can be made about ± 0.2 vu.

As already pointed out, these volume indicators are not provided with amplification but have sufficient sensitivity for reading, at the 0 vu or 100 mark on the meter scale, volumes of +4 vu or steady state powers of 4 db above 1 milliwatt. The 754B Volume Indicator can be used to measure values 10 db less than this if a 600-ohm termination is allowable. If it is required to use these instruments for lower values, an auxiliary amplifier may be used between the instrument and the point of application to the circuit to raise the level for measurement and in effect increase the sensitivity of the volume indicator. If a bridging connection is desired, the input impedance of the amplifier should be high enough so that the bridging loss will not be excessive. For a terminating connection the input impedance of the amplifier should be 600 ohms. The gain of the amplifier must be known and this value in db subtracted from the indicated reading of the volume indicator to give the true level at the point of application of the amplifier. In general, the gain of the amplifier can be set in advance at some convenient value to bring the level up into the range of the volume indicator so that normal variations of the observed material will not necessitate changing the gain of the amplifier. However, in some cases where wide ranges of volume must be measured, an amplifier with calibrated gain steps will be found convenient.

MAINTENANCE

The 754A and 754B Volume Indicators include no vital expendable parts and therefore require no special attention other than occasional recalibration at intervals of three to six months and the normal routine maintenance check of connections and inspection to insure that the contacts of the attenuator, and the key in the case of the 754B Volume Indicator, are clean and in good working order.

The illuminating lamps in the KS-8208 and KS-8218 Meters have a normal average life of 3000 hours when operated with 6.3 volts at the respective lamp terminals. Operation at higher voltages definitely shortens the useful life of the lamps and makes necessary more frequent replacement. *It is important therefore that the voltage of the external power supply to the volume indicators at terminals 8-10 or 9-10 when required be maintained as nearly as practicable at the values indicated under "INSTALLATION."*

In replacing the lamps of the KS-8208 or KS-8218 Meter the meter front cover should be removed by taking out two screws at the left and right sides of the meter zero adjustment. The lamps can then be removed by relieving the pressure on the larger of two contact springs associated with each lamp socket. In placing a new lamp in the socket, care should be taken to assure that the lamp prongs rest in the correct positions in the socket and that the electrical contacts are completed at the base and side of the lamp.

The attenuator will require occasional cleaning and lubrication to obtain long life and smooth operation, and the following procedure is recommended:

1. The contact studs and contact rings should be kept free from more than a trace of visible tarnish and from accumulations of dirt and lubricant.

2. Ordinarily, the cleaning of studs and rings with a piece of clean chamois or lintless cloth (such as KS-2423 Cloth), using heavy pressure, will suffice.

3. If excessive tarnish is still visible on studs or rings, this should be burnished off with Aloxite Cloth No. 320, backed by a small wood block so as to present a flat surface; this will require removal of the brush assembly, by removing the two small machine screws in its insulating plate, so as to avoid the deposit of abrasive particles between the brush leaves; the contact surfaces of the brush leaves may also be burnished lightly while the assembly is removed.

4. Unnecessary burnishing should be avoided, in order to prolong the life of the parts.

5. After cleaning or burnishing, the contact rings and studs should always be lubricated with a light but visible film of unmedicated petrolatum or vaseline (such as W. E. Co. No. 57997), wiping off any excess with a soft lintless cloth.

6. The star-wheel or detent should be lubricated lightly with vaseline; this can be applied most conveniently with the end of a clean toothpick when the brush assembly is removed.

If case replacements are required they should be ordered from the nearest distributor. Orders should specify the apparatus designations shown on the schematic and wiring diagram, as well as the code numbers given in the apparatus lists furnished with each equipment.

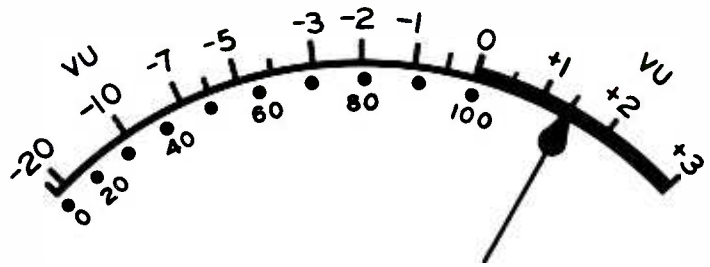

FIGURE 1—*"A" Scale Used on KS8207 and KS8208 Meters*

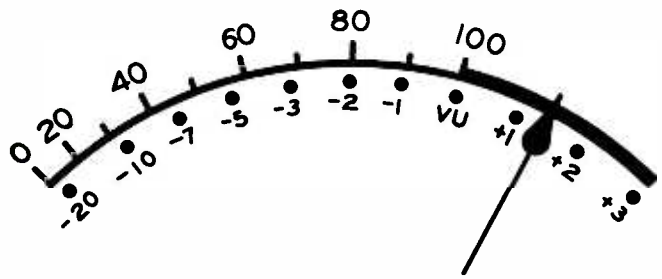

FIGURE 2—*"B" Scale Used on KS8218 Meter*

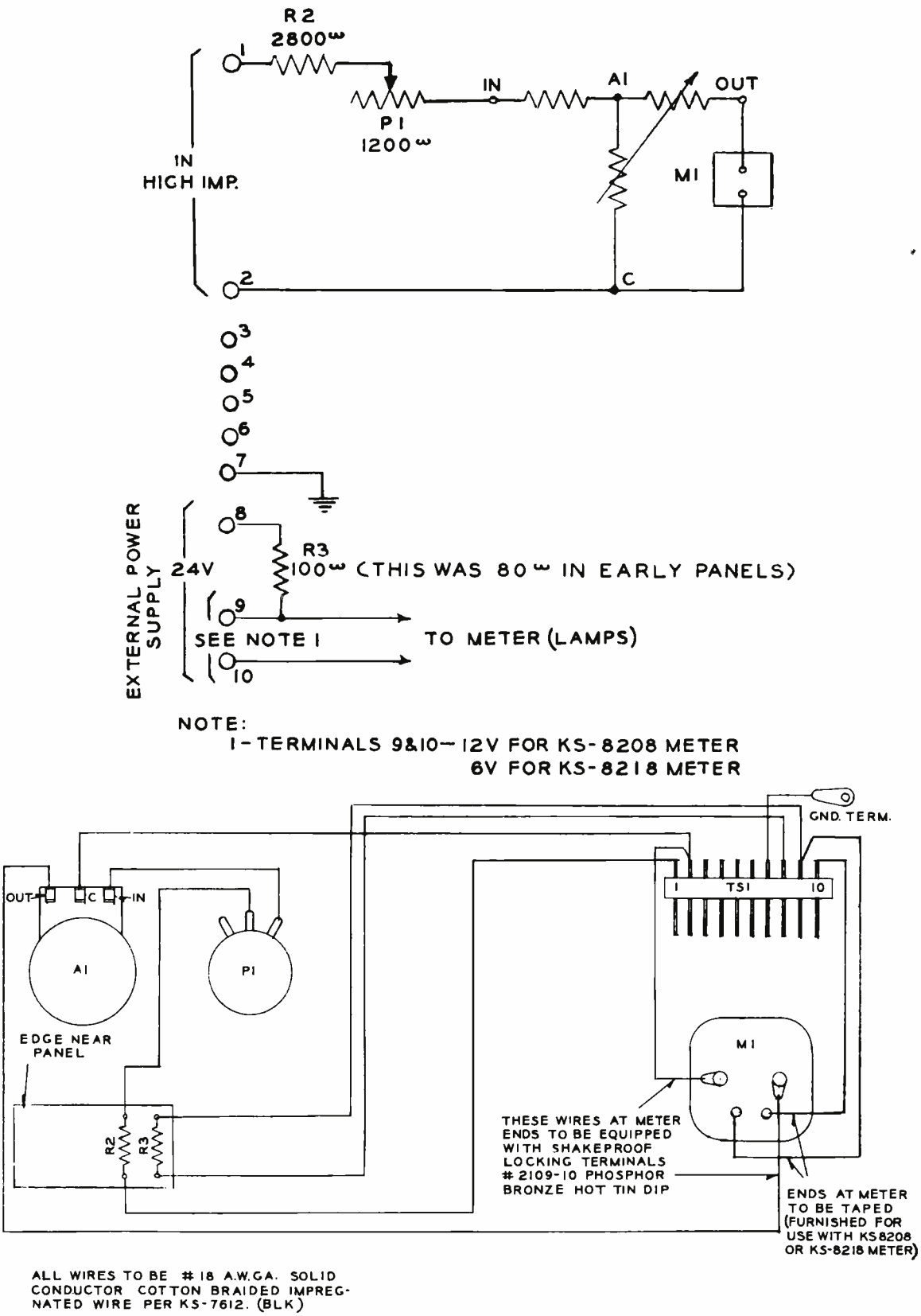

FIGURE 3—*Schematic and Wiring Diagrams of 754A Volume Indicator*

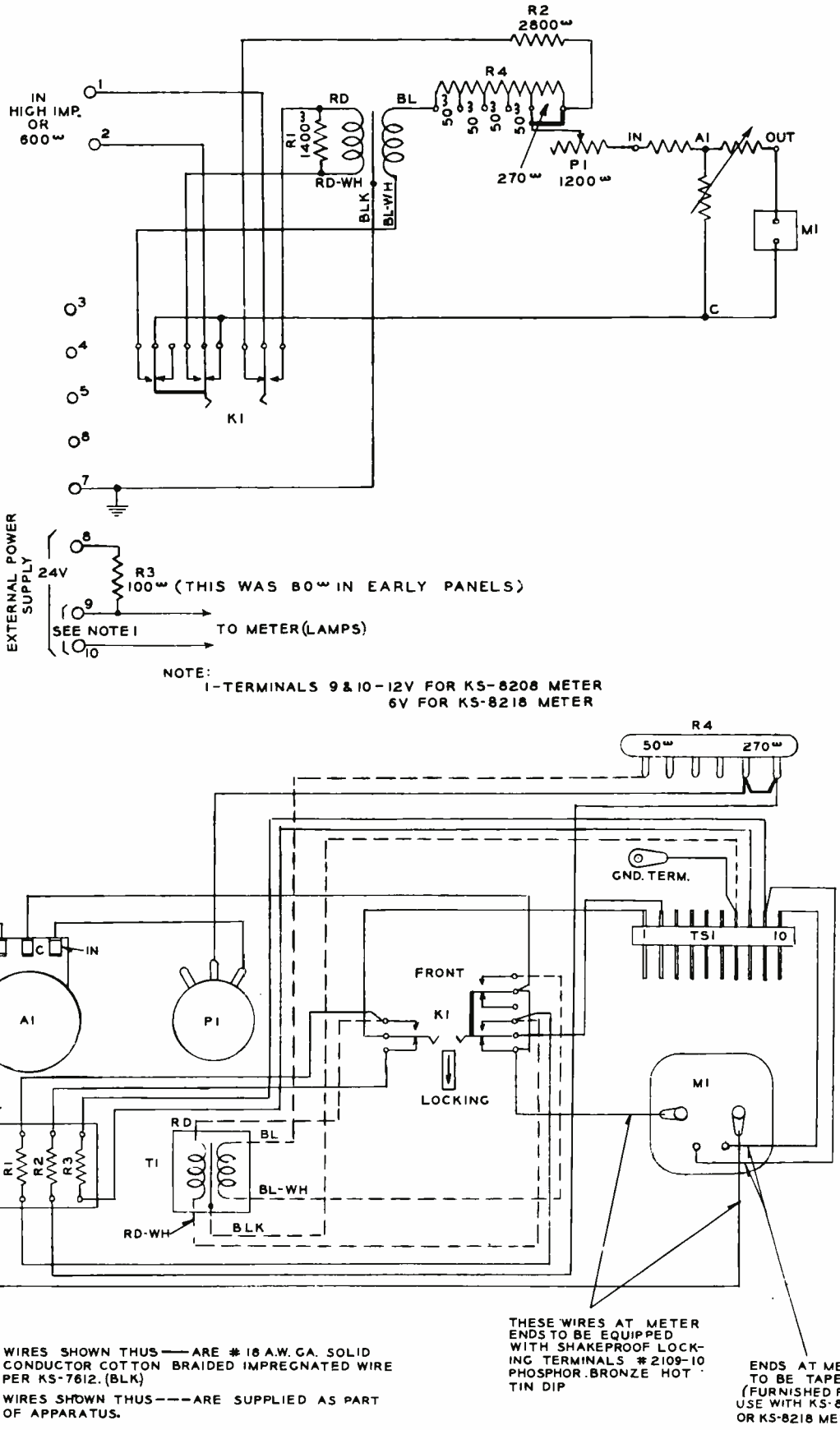

FIGURE 4—*Schematic and Wiring Diagrams of 754B Volume Indicator*

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