

752, 753 and 754
TYPES OF VOLUME INDICATORS

1. GENERAL:

- 1.01 This section is issued to provide "A" series holders with a practice covering the 752, 753 and 754 types of Volume Indicators.
- 1.02 This section consists of the attached Section E47.153.

Attachment:
Section E.47.153

752, 753 AND 754-TYPES OF VOLUME INDICATORS

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1. GENERAL

1.01 This section is based on material prepared by the Bell Telephone Laboratories, Incorporated, and describes a new volume indicator which is provided in a number of different mechanical arrangements, which are referred to as the 752, 753 and 754-types of volume indicators. This new device has resulted from a development, the main purpose of which was to provide a satisfactory means for reading volume with an instrument which would be relatively cheap and require little maintenance, and which would be acceptable to the

broadcasting companies as well as the Bell System. A new reference for volume measurements is defined, and a new terminology for expressing volumes in "vu" with respect to the new reference is explained. The calibration and use of the new instruments to give readings on the new basis is also covered.

1.02 A complete volume indicator of the new type consists essentially of a meter used as an indicating device and certain control arrangements for changing the sensitivity. As in the l-type volume indicators, volume levels are read from the settings of the adjustable controls necessary to cause the meter to deflect to an arbitrary scale point marked "0." Its input impedance 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, certain of the volume indicators described below are provided with a coil so that the instrument may be used as a 600-ohm termination for the circuit being measured, in which condition it has increased sensitivity.

1.03 Actually the coded volume indicators include assemblies of equipment on panels but do not include the meter which is furnished separately. However, in this section the term "volume indicator" will be used in the general sense to include the complete instrument with the meter, except for the detailed descriptions of the volume indicators themselves in Part 2.

1.04 The 752-type volume indicator consists of a subassembly which incorporates a number of apparatus units mounted on a 5" x 10-1/2" brass panel provided with an aluminum-gray finish. A designation plate, photo-etched in black with chromium trim, is fastened on the front of the subassembly. The 753-type consists of this subassembly mounted in a non-magnetic metal housing for portable use. The 754-type consists of this same subassembly mounted on a 5-1/4" x 19" brass panel (aluminum-gray finish) arranged for relay rack mounting. Each of these types of volume indicators is made with three different circuit arrangements: Code A is the simplest arrangement with only an adjustable attenuator and a zero corrector; Code B is an arrangement like Code A modified with a repeating coil and a key for optional use of the coil to give a 10 db increase in sensitivity and a 600-ohm input impedance; and Code C is the same as Code A except that it is arranged with a key for inserting a 20 db pad when desired. The following table shows for easy reference the essential features of the various arrangements of the new types of volume indicators.

Type	Size	Mounting	Code	Circuit
752	5"x10-1/2"	Subassembly	A	Attenuator only
753	5"x10-1/2"	Housed	B	Repeating coil additional
754	5-1/4"x19"	Relay Rack	C	20 db pad ad- ditional

1.05 Photographs are attached (Pages 104 and 105) which show front and rear views of the 754B panel with meter. These are representative of the general appearance of the new volume indicators.

1.06 The meter used as the indicating device is a copper-oxide milliammeter (Weston Type 30). The meter is provided in four different forms:

KS-8207 - non-illuminated "A scale."
 KS-8208 - illuminated "A scale."
 KS-8217 - non-illuminated "B scale."
 KS-8218 - Illuminated "B scale."

Note: These are the Weston Electrical Instrument Company's scale designations and are discussed in Part 2(C).

The copper-oxide rectifier used in this meter is of the full-wave type and is so used that the meter readings correspond approximately with the rms value of the input wave. The dynamic characteristics specified and the scales selected for use with this meter are the result of an extended series of tests in which various broadcasting representatives participated and represent a design which is expected to be generally acceptable to the communications field. The scale is thought to be a substantial improvement in ease of making measurements over the scales used in former devices. The dynamic characteristics, which are much the same as those of the 1E, 1G and 700A types of volume indicators, will permit of greater accuracy and consistency of volume measurements than was obtainable with the older types of volume indicators in extensive use such as the 203 and 518 types. These features will be discussed later in the description of the volume indicator.

1.07 The 752, 753 and 754 types of volume indicators contain no vacuum tubes and require no amplification to measure volumes covering a range from +4 vu* to +26 vu* (see below). The assemblies including the coil can measure volumes as low as -6 vu.* The assemblies including the 20 db pad can read volumes as high as +46 vu.* The only external connections required for these volume indicators are the input leads, except that in order to light the lamps in the illuminated type meters a battery supply circuit must be furnished. The lamps used are Mazda No. 47, 6.3-volt lamps requiring a current of 0.15 ampere each. These are normally arranged in series for the KS-8208 Meter and in parallel for the

KS-8218 Meter. By rearrangement of the wiring of the lamps inside the meter case, either connection can be made for either meter.

1.08 Volume level in a circuit is defined by the indication on a particular instrument, known as a volume indicator, having definite characteristics and used in a specified manner. The adoption of a new volume indicator as a standard, therefore, automatically involves a change in the definition of reference volume. In measuring volume with the new volume indicators, 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 defined as that level which will give a zero reading (1) on a volume indicator which has the characteristics described below and which is so calibrated that it reads zero on 1 milliwatt of 1000-cycle power in a 600-ohm resistance. The characteristics of the instrument are an important feature of this definition.

Except for measurements with sine wave power, zero volume level does not correspond to 1 milliwatt or any other specific value of power. The use of the instrument across any other impedance than 600 ohms will require correction, as described later.

1.09 In order to avoid more cumbersome terms, such as "db above (or below) zero volume level" and confusion with several previous standards, volume readings obtained with the new instrument will be designated as so many "vu," numerically equal to the number of db above (or below) the new zero volume level.

1.10 These volume indicators may be used for certain transmission measurements where their range and accuracy are adequate. For such measurements the term "vu" may be used, but it is not intended that levels measured on other types of meters should be reported in terms of vu unless such instruments are equivalent to the new ones.

*These values are for the normal deflections of the meters to the scale point marked "0 vu." Taking into account the whole scale of the meter, these ranges are extended to volumes which are 20 vu lower than, and 3 vu higher than, the figures given in the text. The term vu is explained in Paragraph 1.09.

(1) 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 sensitivity of the meter is such that a sine wave power of 4 db above 1 milliwatt in 600 ohms deflects to the arbitrary zero point on its scale. Therefore, the lowest setting of the sensitivity control is marked +4 and, with this setting, zero volume is read at -4 on the meter scale.

2. DESCRIPTION OF VOLUME INDICATORS**(A) Circuit Features**

2.01 The 752, 753 and 754-type volume indicators of the same letter code have the same circuit since they use the same subassembly (752 type) and differ only in the mounting arrangements, which will be covered later. Although the meter used with any particular volume indicator is not included as a part of the coded panel and is supplied separately, the schematic circuits shown here will include the meter so that the complete circuit as used in operation will be evident. The circuits as shown include arrangements for wiring to the lamps of the illuminated type meters. This wiring and an associated resistance are provided on all assemblies, but are not used when non-illuminated meters are used in the panel.

2.02 752A, 753A and 754A Circuit: The schematic circuit for these volume indicators is shown on Drawing ES-853656, page 100. The input impedance is between 7200 and 7900 ohms. Terminals 1 and 2 are used as the input of the volume indicator and a 2800-ohm resistance (R2) and a 1200-ohm slide wire (P1) are connected in series with the meter (M1). An adjustable T-type attenuator (A1) is inserted in the circuit between P1 and the meter. P1 is used during calibration to adjust the sensitivity of the volume indicator to be correct for the particular meter used with the panel. The total resistance (R2 + P1) provided in this way is in the order of 3300 to 3600 ohms, depending on which method of calibration (described later) is used. The impedance as seen from the 3900-ohm meter or attenuator is approximately 3900 ohms so that the A1 attenuator is of 3900 ohms impedance. The attenuator switch has 13 positions. One of these is an "off" position, and the other 12 permit adjustment of the attenuator loss from 0 to 22 db, inclusive, in steps of 2 db. The corresponding designations on the dial plate for these 12 positions are from +4 to +26, +4 corresponding to zero loss. (This is because the sensitivity of the volume indicator meter is such that a volume of +4 vu is required to produce a deflection to the "0 vu" point on the meter scale when there is no loss in the attenuator, as explained more fully in Part 4.) The arrangements are such that turning the attenuator knob in a clockwise direction will increase the readings on the meter. The "Off" position is provided at the extreme left of the dial (beyond the +26 position) and with the attenuator on this step the circuit to the meter is short-circuited.

2.03 The lamp circuit is brought out as indicated on terminals 8, 9 and 10. When a 24-volt supply is employed, it is connected to terminals 8 and 10 and the lamps in the meter are connected in series.

This arrangement connects the 80-ohm resistance (R3) in series with the two lamps and provides the proper voltage for the lamps. When a 12-volt supply is used, it is connected to terminals 9 and 10 with the lamps connected in series. This arrangement puts the two lamps (in series) directly across the power supply. When a 6-volt supply is used, it is connected to terminals 9 and 10 but the lamps are then arranged to be in parallel.

2.04 The operation of this circuit is fairly evident and hardly needs discussion. The function of the attenuator is to control the sensitivity of the complete instrument so that a convenient scale reading can be obtained on the meter, as described later.

2.05 752B, 753B and 754B Circuit: These volume indicators, which include a step-up repeating coil (T1) and a key (K1) for optional use of this coil, are shown schematically on Fig. 1 of Drawing ES-853657, page 101.

2.06 When the key is in the normal or the "HIGH IMP." position, as shown in Fig. 1, the circuit is identical with that described above for the A panels. This is shown by the simpler Fig. 2 of the drawing.

2.07 When the key is operated to the "600-OHMS" position, the fixed resistance (R2 and 270-ohm part of R4 when used) is removed from the circuit and the repeating coil with its associated resistances is inserted between the input terminals and the rest of the circuit. The resistance R4 connected in series on the high side of the transformer consists of two parts. The 270 ohms (shown strapped out on the drawing) is used only in a special method of calibration as considered later in Part 3. The remainder of the resistance is used to provide zero to 200 ohms in steps of 50 ohms for adjusting the circuit so that the step-up provided by the coil is exactly 10 db. A 1400-ohm resistance (R1) is shunted across the input of the transformer. The simplified circuit with this position of the key is shown in Fig. 3 of the drawing. The input impedance under these conditions is 600 ohms and the sensitivity of the device has been increased 10 db. The shield of the transformer is connected to the panel.

2.08 752C, 753C and 754C Circuit: The complete circuit of these volume indicators is shown schematically on Fig. 1 of Drawing ES-853658, page 102. Here a key (K1) is provided so that a 20 db pad (resistances R5, R6 and R7) can be used, if desired, to extend the range to higher volumes.

2.09 When the key is in the normal or "0" position, as shown in Fig. 1, the circuit is identical with that of the A code volume indicators and is shown in simple form by Fig. 2 of the drawing.

2.10 When the key is operated to the "+20" position, a 20 db, 3900-ohm, T-type pad is inserted ahead of the A1 attenuator. The simplified circuit for this condition is shown in Fig. 3 of the drawing.

(B) Equipment Arrangements

2.11 The 752A volume indicator consists of a subassembly on a non-magnetic panel 5" x 10-1/2". This panel is finished in aluminum-gray and is provided at the left hand and with the necessary hold and drillings for mounting any of the four types of meters which is necessary to complete the instrument. 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 is slotted for screwdriver adjustment from the front through a hole in the panel. The terminal block for external connections is mounted so that it is back of the meter. A non-magnetic designation plate, photo-etched in black with chromium trim, is mounted at the right in front of the attenuator to provide the proper designations for the steps of the attenuator.

2.12 The 752B volume indicator is a similar subassembly except that it includes the key, repeating coil and associated resistances and the subpanel is designated to indicate the input impedance for the two key positions. A note on the designation plate beneath the attenuator instructs the operator to "SUBTRACT 10 FROM THE ATTENUATOR SETTING WHEN KEY IS IN THE 600-OHM POSITION."

2.13 The 752C volume indicator consists of a subassembly similar to the 752A except that it includes the 20 db pad and its associated key and the designation plate is designated for the two key positions.

2.14 The 753A, 753B and 753C volume indicators consist of the 752A, 752B and 752C instruments, respectively, mounted in non-magnetic metal housings and are intended for portable use or for mounting on a desk or monitor position.

2.15 The 754A, 754B and 754C volume indicators consist of the 752A, 752B and 752C subassemblies, respectively, mounted in 5-1/4" x 19" non-magnetic panels arranged for relay rack mounting. These panels are also finished in aluminum-gray. Each panel is provided with a rear dust cover, on the inside of which is a circuit label showing the circuit arrangement for that particular assembly.

(C) Meters Used in Volume Indicators

2.16 Four meters are available, one of which must be mounted in the above volume indicator panels to make a complete instrument for use as a volume indicator. These are specified as KS-8207, KS-8208,

KS-8217 and KS-8218 Meters. All of these are special Weston "Volume Level Indicators."

2.17 The KS-8207 Meter (Model 802) is provided with the A scale and is non-illuminated.

2.18 The KS-8208 Meter (Model 862) is provided with the A scale and has provision for illuminating the scale by means of two Mazda No. 47, 6.3-volt, 0.15-ampere lamps. This meter is normally supplied with the lamps connected in series. These lamps are mounted in the front cover of the meter, which can be removed for replacement of the lamps or modification of the lamp connections to a parallel arrangement, if required. (The front cover of the meter can be removed from the front of the volume indicator panel without taking the meter out of the panel.)

2.19 The KS-8217 Meter (Model 802) is provided with the B scale and is non-illuminated.

2.20 The KS-8218 Meter (Model 862) is provided with the B scale and has provision for illuminating the scale the same as the KS-8208 meter discussed above, except that this meter is normally supplied with the lamps in parallel.

2.21 In all other respects these meters are the same except that the illuminated type meters have a slightly different front appearance and use different drillings for mounting the meter. A general description which applies to all four meters follows: The approximate overall meter dimensions are 4-1/4" x 3-15/16" on the face and 1-3/4" or 2-1/16" (for models 802 and 862, respectively) deep, the terminals project about 1/2" from the back of the meter. Each is of the semi-flush mounting type, mounting in a round hole 3-3/8" to clear, with the fronts of the two models projecting approximately 3/4" and 1", respectively, in front of the panels on which they are mounted. The meter case is black bakelite with that portion of it which projects in front of the panel finished in aluminum-gray. The glass used in the front of the meter is provided with a mask (also aluminum-gray) to cover the bottom portion of the pointer. The top of the masked portion is concentric with the scale arc on the meter card and has a radius about 7/8" less than the radius of the scale arc.

2.22 Two scales are provided for use in these meters and these are shown on Drawing ES-853659, Page 103. In Fig. 1 is shown the so-called "A scale," which emphasizes the vu markings. In Fig. 2 is shown the "B scale," which emphasizes the voltage or per cent. scale. Both scales are arbitrary and not related to the sensitivity of the meter.

2.23 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 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 of the meter will come to 99 per cent. of the steady-state deflection at the zero vu point in 0.3 second on the first upswing, and also the overswing of the pointer will be between 1 per cent 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. These meters should not, therefore, be mounted on steel panels.

2.24 A meter reading of zero vu 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 zero point on the vu scale is uniform within 0.2 vu of the 1000-cycle value over the frequency range of 35 to 10,000 cycles and is uniform within 0.5 vu over the frequency range of 25 to 16,000 cycles.

2.25 The harmonic distortion on a through 600-ohm circuit is small and can generally be neglected. It is not more than the harmonic distortion equivalent to 0.2 per cent. rms when the meter in series with 3600 ohms is bridged across that circuit and a scale reading of zero vu is obtained for any single sinusoidal frequency between 35 and 5,000 cycles.

2.26 The meter is capable of withstanding an overload equivalent to 10 times the zero vu voltage for at least 0.5 second, without injury to the meter or effect on its calibration. It is capable of withstanding a continuous overload equivalent to 5 times the zero vu voltage.

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

3. CALIBRATION AND CHECK TESTS

3.01 The type of volume indicator covered in this section is not tested in the shop with any particular meter inasmuch as the meter is supplied separately. When the volume indicator has been installed and the meter which is to be used with it has been connected into the circuit, the instrument should be calibrated so that the proper indications will be given. It will also be advisable to make certain other initial

tests on the assembly to check the attenuator and various characteristics of the device. In the case of the 752B, 753B or 754B volume indicator, which includes a repeating coil for increasing the sensitivity of the instrument, a further initial adjustment is required. After these initial tests have been made and the instrument found to be satisfactory, the only subsequent adjustment that need be made is that of the slide wire (P1) during calibration.

(A) 1000-Cycle Calibration

3.02 Two methods of calibrating the volume indicator* are given below, which differ from each other in the allowance made for the 0.3 db loss which the volume indicator causes to through transmission when bridged across a 600-ohm circuit.

3.03 Method A is the method which will usually be employed, and is applicable whenever the volume indicator is to be used on a separate program bridge outlet or is to be patched to a through line only while the volume is being read, i.e., when it is not to be permanently connected across a through circuit.

Method A

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 set on step +4, and the slide wire (P1) adjusted until a reading of 0 vu is obtained on the meter.

3.04 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 the true level on the through line. Or, in those cases where a volume measurement is desired on a line not normally equipped with a volume indicator, the reading obtained on this circuit by means of a 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.

3.05 Method B should be used in those cases where the volume indicator is to be permanently connected across a

*For the B-type volume indicator, the key should be in the "HIGH IMP." position for these methods of calibration. (See Part 3(E).)

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.

Method B

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 is set on step +4 and the slide wire (P1) adjusted until a reading of 0 vu is obtained on the meter

3.06 In either of the above methods of calibration, some other value of calibrating power may be used if it is more convenient. For example, if 1 milliwatt were used, the slide wire is adjusted so that a reading of -4 vu is obtained on the meter with the attenuator on step +4. However, the 1-milliwatt calibration is not recommended if the volume indicator is to be used for precise transmission measurements (see Part 4 (B)) near the "0 vu" point on the meter, because of possible small inaccuracies in the scale.

(B) Check of Bridging Loss

3.07 The bridging loss of the volume indicator (except for the B type when arranged for 600 ohms impedance) across a circuit of 600 ohms impedance in each direction for any setting of the attenuator should be between 0.3 and 0.5 db at any frequency from 35 to 10,000 cycles.

(C) Check of Attenuator

3.08 To check the steps of the attenuator, the volume indicator may be bridged across 600 ohms and 1000-cycle power supplied to it.* With the attenuator set on "+4" sufficient power is supplied to give a reading of 0 vu on the meter. The attenuator is then increased in successive steps and the power supplied increased in 2 db steps for each change of the attenuator. Under these conditions the meter reading for each attenuator setting should be between +0.2 vu and -0.2 vu.

(D) Check of the 20 db Pad (Type C)

3.09 With the volume indicator bridged across 600 ohms, 1000-cycle power is supplied* so that with the attenuator on step +4 the meter will read 0 vu. Then

*For these tests an amplifier will be required which is capable of delivering without distortion 26 db above 1 milliwatt of single frequency power.

with the key thrown to insert the 20 db pad, the 1000-cycle power is increased by 20 db. The meter reading should be between +0.3 vu and -0.3 vu.

(E) Adjustment of B-Type Volume Indicators

3.10 In the B-type volume indicator, an additional adjustment is provided to compensate initially for slight inaccuracies in the transformer. 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 "A - 1000-Cycle Calibration" will be accurate with the transformer cut either out or in.

3.11 This adjustment is made by making connection to the proper point of the tapped resistor associated with the transformer. Before making this adjustment the volume indicator should be calibrated and checked with key thrown to "HIGH IMP.", as described above, except that if Method B is used for the calibration 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 put in the 600-ohm condition and substituted for the 600-ohm termination. With the attenuator set on +10 the tapped resistor is adjusted until a reading is obtained as closely as possible to 0 vu. In making this adjustment the slide wire resistance should not be disturbed.

This adjustment, when once made, need not be changed unless the meter used in the volume indicator is replaced.

3.12 By this means, 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 level into this 600 ohms. Also, if the instrument is used to terminate a circuit by means of throwing the key to the 600-ohm position, the instrument can be used to read volumes as well as 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 instrument no longer provides the termination for the circuit and that this must be supplied in some other way.

(F) Check of Frequency Characteristic

3.13 With the same circuit connections as used to calibrate the volume indicator, the testing power should be changed in frequency and the meter readings noted. The amount of power supplied to the 600-ohm termination should be kept constant for all frequencies. An amount of power should preferably be used to give a reading of 0 vu on the meter. For any frequency from 35 to 10,000 cycles the meter reading should not change from that obtained for 1000 cycles by more than 0.4 vu for any setting of the attenuator.

3.14 In the case of the Type B models when the key is thrown to the 600-ohm position, the deviation from the 1000-cycle reading for any frequency from 35 to 10,000 cycles for any attenuator setting should not be greater than 0.5 vu.

(G) Check of Dynamic Characteristic of Meter

3.15 The dynamic characteristic of the meter may be checked as follows: With the volume indicator properly connected to a circuit, the input power should be adjusted to give a steady meter reading of 0 vu. (The step setting of the attenuator or the key position, if provided, is not important.) The input voltage should then be interrupted, and suddenly reapplied without change in amount after the needle has come to rest. The needle should not overswing the 0 vu point by more than 0.2 vu and should come to rest, of course, finally on 0. This test can be made conveniently when calibrating the volume indicator in accordance with the above instructions. A convenient method of suddenly applying the voltage is simply to remake the connection with a patch cord which has been removed from the calibrating circuit.

4. USE OF VOLUME INDICATORS

4.01 The 752, 753 and 754 types of 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, of course, 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 one 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 (i.e., attenuator setting plus scale deflection), plus or minus values indicating gains or losses, respectively. The B-type volume indicator is provided with a step-up coil which in ef-

fect increases the sensitivity of the device 10 db and which provides an input impedance of 600 ohms. This arrangement is intended primarily for use in transmission measurements but when arranged in this way it can also be used for volume measurements if the termination provided by the set is allowable.

4.02 The volume indicator, when properly calibrated and used in the manner described below, gives a direct reading on a circuit terminated in 600 ohms. For a termination of some other impedance (either artificial or by the through circuit itself), the reading in vu should be corrected by a number corresponding to the db value equivalent to a current ratio of $\sqrt{\frac{600}{Z}}$

where Z is the impedance of the terminating circuit. Where 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.

4.03 The sensitivity of the meter used in the volume indicator may drift from time to time over a range not exceeding ± 0.5 db so that recalibration of the instrument may be required occasionally when maximum accuracy is desired.

4.04 In the Bell System the principal uses of volume indicators are to read volumes or to make transmission measurements. In reading volumes, the purpose may be to determine the volume level of speech, particularly on message circuits, or to check the volume on circuits used for program transmission. In the latter case, the volume indicator may be used to determine if the program material as received or delivered is within the proper level limits, or it may be used for "peak checking" during the transmission of the program. These various uses of volume indicators are discussed in the following paragraphs.

(A) For Volume Readings

4.05 The technique of using the instrument for volume measurements is generally similar to that for previous types of volume indicators. That is, the sensitivity is adjusted by means of the attenuator until the meter indication is as near the 0 point 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 indications are exactly 0, and in that case the volume level shown by the attenuator setting may be corrected by adding or subtracting the deviations from 0 shown by the meter indications. As explained earlier, the meter sensitivity is such that a volume level of

+4 vu is required to cause the meter to indicate at the arbitrary 0 point, so that the lowest attenuator step (actually zero loss in the attenuator) is marked "+4 VU."

4.06 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 rule or procedure which will give uniform results with different observers. It should be possible to obtain readings of volume levels with an accuracy of ± 1 vu.

4.07 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 point, but it also is to be 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.)

4.08 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 of 0 vu, 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 over swings due to the meter itself will not occur. It is for this reason that no peaks are intentionally allowed to exceed the 0 vu point. 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 type volume indicators.

4.09 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 to effectively increase the sensitivity of the volume indicator as covered below under 4(D).

4.10 For a monitor along the circuit interested in maintaining the transmission of the program at the proper level, his greatest concern is that with his volume indicator adjusted in advance to a sensitivity to give a maximum reading of 0 vu on the meter scale for the proper level at the particular point at which the volume indicator is connected to the circuit, the major peaks of the program do not exceed this reading. With such a procedure it follows that, for a considerable portion of the time, indications on his meter will be such as to give readings considerably below this value.

4.11 In checking transmission from point to point along the circuit during service, a method of "peak checking" by the coordinated observations of a number of observers at various points along the circuit, on the peak readings obtained by them on the same program peaks 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 observer can report his maximum meter deflections immediately to the other as they occur 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 rms type.) The difference in the readings of the two instruments for a dozen or so peak observations is an indication of the condition of the circuit between observers as regards transmission.

(B) For Transmission Measurements

4.12 When used for transmission measurements, the volume indicator with its high input impedance (which is the case for all except the B-type instrument with the key thrown to the 600-ohm impedance position), 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 (Paragraph 3.03), except that if the volume indicator is normally bridged across the circuit at this point Method B (Paragraph 3.05) will be advisable.

4.13 Since the sensitivity-frequency characteristic of the volume indicator is quite flat, ordinarily no correction need be made for it when making a transmission-frequency run. However, if more accurate results are required than are indicated by the frequency characteristic given in Part 3 above, 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.

4.14 The reading is obtained by adding algebraically the attenuator setting and the exact steady-state reading of the pointer on the meter scale. Although indicated in vu such readings give directly the transmission in db above or below one milliwatt.

4.15 The vu scale of the meter is reasonably accurate but due to the contraction of the vu 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.

4.16 In the B-type model 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, as indicated on the name plate should be reduced by the number 10 to obtain the true reading.

4.17 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.

(C) Use Above 8000 Cycles

4.18 These volume indicators have in general reasonably flat sensitivity-frequency characteristics up to 16,000 cycles.

Consequently, for the purpose of reading volume on circuits transmitting up to 16,000 cycles, these volume indicators, adjusted as already described, will give satisfactory results for normal transmission. Although the sensitivity of the instrument adjusted as outlined above may fall off somewhat for the higher frequencies, the volume reading will not be affected inasmuch as the amount of power in the transmitted material within the range above 8,000 cycles is generally so small that it has little effect on the volume reading even if the sensitivity-frequency characteristic is flat over the whole range.

4.19 However, if the instrument is to be used for transmission measurements above 8,000 cycles, it should be kept in mind that the sensitivity may fall off from the 1000-cycle value as much as 0.5 db (1 db for B-type when coil is used) in the range up to 16,000 cycles so that if greater accuracy than this is required, corrections for the desired frequencies should be predetermined and applied to give the true reading or the instrument should be calibrated to give true readings at each frequency desired for measurement.

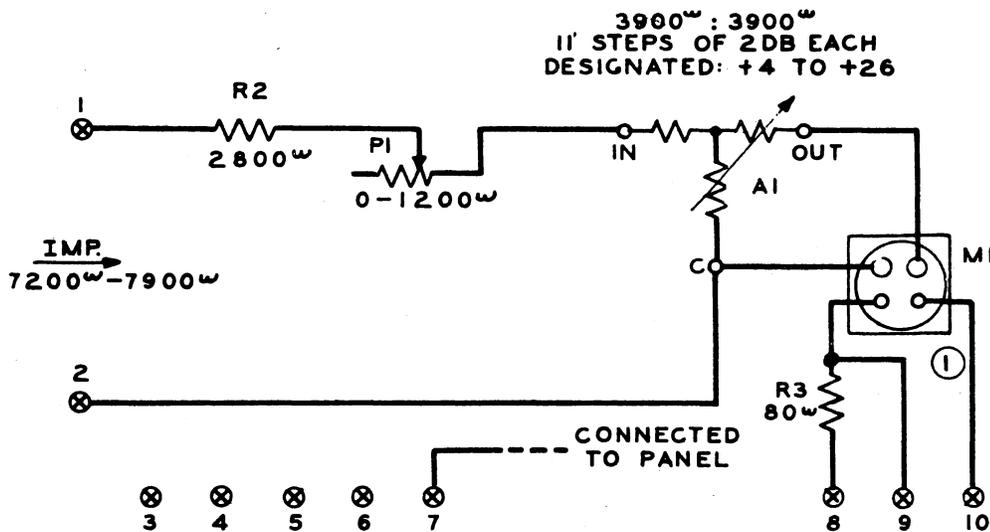
(D) Increased Sensitivity

4.20 As already pointed out, these volume indicators are not provided with amplification but have sufficient sensitivity for reading, at the 0 vu point of the scale, volumes of +4 vu or steady state powers of 4 db above 1 milliwatt. The type B model 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 as used 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.

5. DRAWINGS AND PHOTOGRAPHS ATTACHED

<u>Title</u>	<u>Drawing</u>	<u>Page</u>	<u>Title</u>	<u>Drawing</u>	<u>Page</u>
Schematic Circuit of 752A, 753A and 754A Volume In- dicators	ES-853656	100	Schematic Circuits of 752C, 753C and 754C Vol- ume Indicators	ES-853658	102
Schematic Circuits of 752B, 753B and 754B Vol- ume Indicators	ES-853657	101	Meter Scales	ES-853659	103
			Photograph - Front View - 754B, Volume Indicator		104
			Photograph - Rear View with Cover Removed - 754B Volume Indicator		105

752A, 753A, AND 754A VOLUME INDICATORS SCHEMATIC CIRCUIT DIAGRAM



LEGEND: ⊗ -TERMS. ON P250833 TERM. STRIP.
 R2-I.R.C. TYPE NAB RESISTANCE.
 R3-I.R.C. TYPE AB RESISTANCE.
 PI-I.R.C. TYPE VW VOLUME CONTROL.
 A1-DAVEN W.E. 80-1 ATTENUATOR
 MI-KS-8207, KS-8208, KS-8217, OR KS-8218 METER.(NOT INCLUDED AS PART OF CODED PANEL; MUST BE ORDERED SEPARATELY)

NOTES:

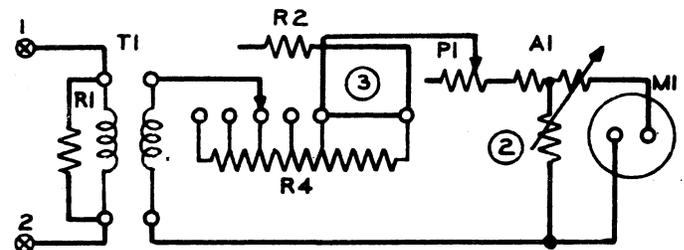
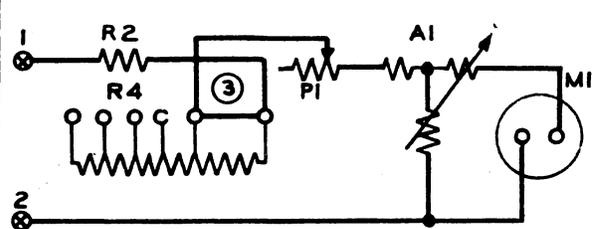
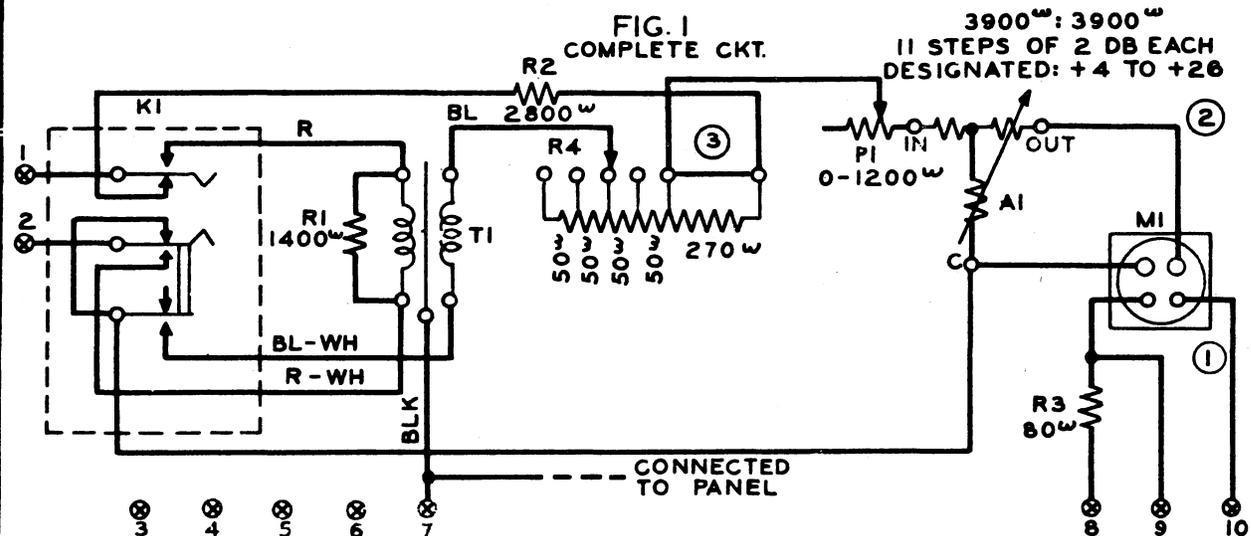
①

THESE TERMS ARE PROVIDED ONLY ON KS-8208 AND KS-8218 METERS. R3 AND WIRING TO TERMS. 8,9,AND 10 ARE PROVIDED ON ALL PANELS. FOR ILLUMINATED METERS, CONNECT AS FOLLOWS:

POWER SUPPLY AVAILABLE	USE TERMS.	LAMPS IN	CURRENT
24 VOLT	8 AND 10	SERIES	0.15AMP.
12 VOLT	9 AND 10	SERIES	0.15AMP.
6 VOLT	9 AND 10	PARALLEL	0.30AMP.

BELL TELEPHONE LABORATORIES, INC.

ES-853657

S.B. 4-4-39
S.B. 4-25-39752B, 753B, AND 754 B VOLUME INDICATORS
SCHEMATIC CIRCUIT DIAGRAMS

LEGEND: ⊗ - TERMS. ON P250833 TERM. STRIP.

R1-I.R.C. TYPE NAB RESISTANCE.

R2-I.R.C. TYPE NAB RESISTANCE.

R3-I.R.C. TYPE AB RESISTANCE

R4-I.R.C. TYPE MW3 RESISTANCE

PI-I.R.C. TYPE VW VOLUME CONTROL.

AI-DAVEN W.E. 80-1 ATTENUATOR

TI-W.E. 170A REP. COIL (IMP. RATIO - 420 ω : 2160 ω)

KI-W.E. 2 CL KEY UNIT. (2 POSITION, LEVER TYPE)

MI-KS-8207, KS-8208, KS-8217, OR KS-8218 METER (NOT

INCLUDED AS PART OF CODED PANEL; MUST BE ORDERED SEPARATELY.)

NOTES:

- ① THESE TERMS ARE PROVIDED ONLY ON KS-8208 AND KS-8218 METERS. R3 AND WIRING TO TERMS 8, 9, AND 10 ARE PROVIDED ON ALL PANELS. FOR ILLUMINATED METERS CONNECT AS FOLLOWS:

POWER SUPPLY AVAILABLE	USE TERMS.	LAMPS IN	CURRENT
24 VOLT	8 AND 10	SERIES	0.15 AMP.
12 VOLT	9 AND 10	SERIES	0.15 AMP.
6 VOLT	9 AND 10	PARALLEL	0.30 AMP.

- ② SUBTRACT 10 FROM ATTENUATOR SETTING WHEN KEY IS IN "600 OHMS" POSITION.
- ③ REMOVE THIS STRAP IF METHOD B IS USED FOR CALIBRATION.

752C, 753C, AND 754C VOLUME INDICATORS SCHEMATIC CIRCUIT DIAGRAMS

FIG. 1
COMPLETE CKT.

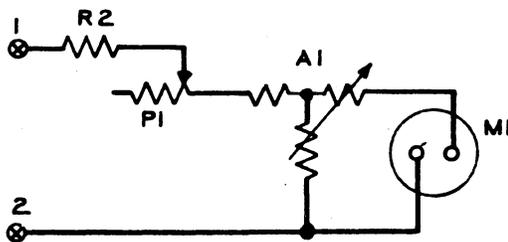
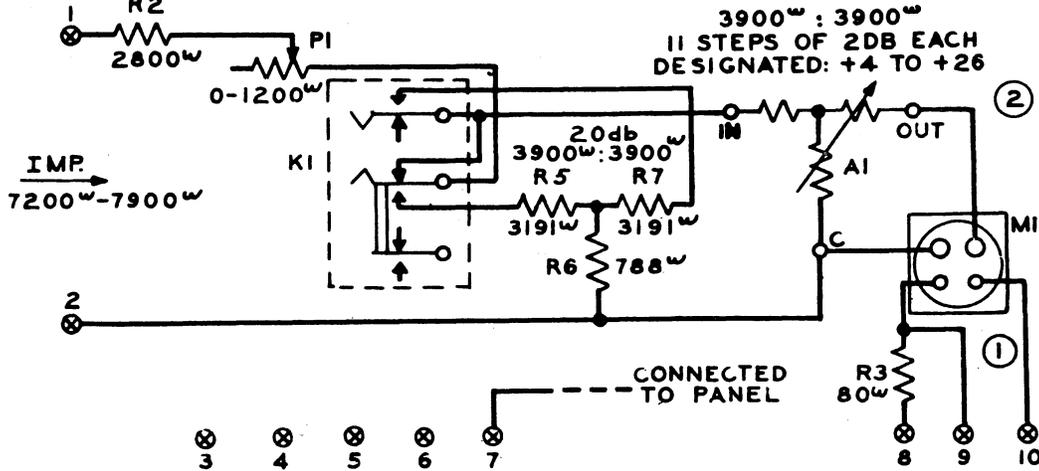


FIG. 2
SIMPLIFIED SCHEMATIC
WITH KI IN
NORMAL OR "0" POSITION

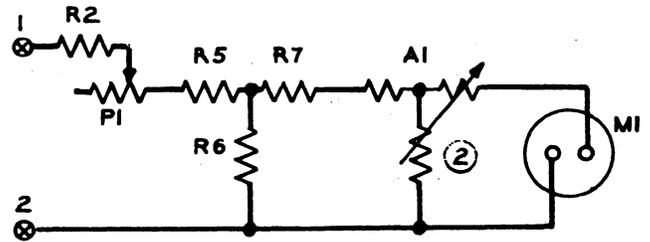


FIG. 3
SIMPLIFIED SCHEMATIC
WITH KI IN
OPERATE OR "+20" POSITION

LEGEND: ⊗ - TERMS. ON P-250833 TERM. STRIP.
R2 - I.R.C. TYPE NAB RESISTANCE.
R3 - I.R.C. TYPE AB RESISTANCE.
R5, R6, R7 - I.R.C. TYPE NAB RESISTANCES.
PI - I.R.C. TYPE VW VOLUME CONTROL.
A1 - DAVEN W.E. 80-1 ATTENUATOR.
KI - W.E. 2CL KEY UNIT (2 POSITION, LEVER TYPE)
MI - KS-8207, KS-8208, KS-8217, OR KS-8218 METER (NOT INCLUDED AS PART OF CODED PANEL; MUST BE ORDERED SEPARATELY)

NOTES:

①

THESE TERMS ARE PROVIDED ONLY ON KS-8208 AND KS-8218 METERS. R3 AND WIRING TO TERMS. 8, 9, AND 10 ARE PROVIDED ON ALL PANELS. FOR ILLUMINATED METERS, CONNECT AS FOLLOWS:

POWER SUPPLY AVAILABLE	USE TERMS.	LAMPS IN	CURRENT
24 VOLT	8 AND 10	SERIES	0.15 AMP.
12 VOLT	9 AND 10	SERIES	0.15 AMP.
6 VOLT	9 AND 10	PARALLEL	0.30 AMP.

②

ADD 20 TO ATTENUATOR SETTING WHEN KEY IS IN "+20" POSITION.

METER SCALES

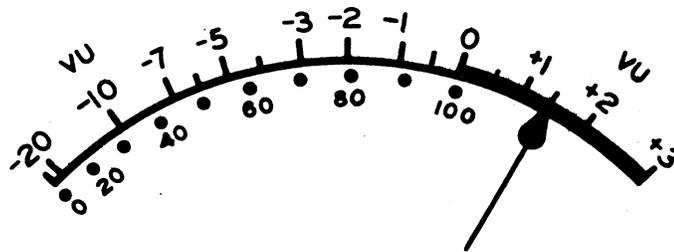


FIG. 1
"A SCALE"

USED ON KS8207 AND KS8208 METERS

SCALE CARD IS OF BUFF POST CARD STOCK.
 ALL SCALE MARKINGS AND DESIGNATIONS TO THE
 LEFT OF AND INCLUDING THE "0" VU AND "100"
 MARKINGS, TOGETHER WITH THE ASSOCIATED PORTION
 OF THE SCALE ARC, ARE IN BLACK.
 THE REMAINING SCALE MARKINGS, DESIGNATIONS, AND
 THE THICK PORTION OF THE SCALE ARC ARE IN RED.

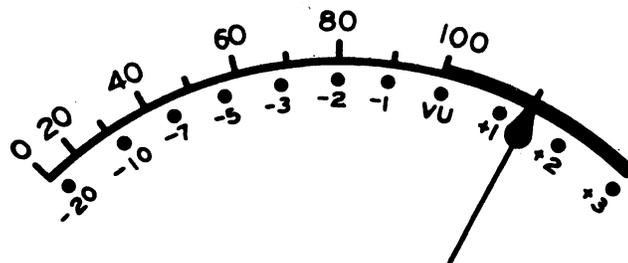


FIG. 2
"B SCALE"

USED ON KS8217 AND KS8218 METERS

SCALE CARD IS OF BUFF POST CARD STOCK.
 THE THIN PORTION OF THE SCALE ARC, AND
 THE DIVISIONS AND DESIGNATIONS ABOVE IT, INCLUDING THE
 "0" AND "100" MARKS AND DESIGNATIONS, ARE IN BLACK.
 THE THICK PORTION OF THE SCALE ARC AND
 ALL VU MARKINGS AND DESIGNATIONS ARE IN RED

