SECTION 15

PORTABLE AMPLIFIER DETECTOR PAD/9

General Description

The PAD/9 is basically a portable version of the AD/4, but has a slightly different circuit and provides some additional facilities. The range of level measurement extends from −75 db to +10 db approximately, and the input impedance can be switched to either 30 kilohms or 600 ohms. There is no provision for operating from batteries, but a built-in mains unit is included, and the instrument is self-calibrating from the 50-c/s supply.

Circuit Description (Fig. 22)

General

The circuit comprises three pentode stages, *RC*-coupled, with transformer input and a 0/0·5-mA meter at the output. Level measurements are carried out with the aid of calibrated potentiometers included in the grid circuits of the first and second stages, the potentiometers being adjusted to bring the meter reading to the region of a fixed point on the scale.

The connection to the input transformer, TR1, is via a jack (with alternative screw terminals) and a 3-position key. One position of the key connects the jack and terminals directly to TR1 primary, where as the impedance ratio is 3 : 1, an input impedance of 30 kilohms is reflected from the 10-kilohm potentiometer P/65P across the secondary terminals. In the second key position, the 610-ohm resistor R32 is connected across TR1 primary, reducing the input impedance to 600 ohms. The third position of the key connects a 50-c/s voltage at +10 db to the input; this voltage is derived from a calibrating circuit which will be described later.

The P/65P has 5-db tappings with a maximum loss of 60 db to cover the range of input levels from +10 to −50 db; it has also an *Off* position. The P/65P slider is taken to V1 grid via the anti-parasitic resistor R1.

The coupling from V1 anode to V2 grid is through capacitor C3, switch SW C and the 100-kilohm potentiometer P/64P, which has 0·5-db tappings with a range of 5 db. The P/64P acts as a fine control and also extends the coverage of the instrument down to −55 db.

In the position of SW C marked *Normal*, the signal reaching the P/64P is attenuated ·20 db by the potential divider formed by R7, and R9 in parallel with the P/64P, while in the position marked *−20*, R7 and R9 are taken out of circuit, so increasing the sensitivity of the instrument by 20 db and allowing the measurement of levels down to −75 db.

Between V2 and V3 is the *Adjust Sensitivity* control, R17, which is used in conjunction with the calibrating circuit to standardise the gain of the instrument before taking level measurements.

To minimise non-linearity, current negative feedback is applied to V1, V2 and V3 via the cathode-circuit resistors R6, R15 and R24. A flat frequency response is obtained by suitable adjustment of the combinations C5-R8, C9-R16 and C15-R26, which are effective in the ranges 30 c/s-1 kc/s, 1-10 kc/s and 10-15 kc/s respectively.

Meter Circuit

The anode of V3 is taken to the meter circuit in parallel with the anode load and an *Output Listen* jack with 200-kilohm series resistor for use with headphones. The meter rectifier is a Westinghouse 1-mA instrument type. The meter itself is a 0·5-mA Sangamo Weston Model S.20 with a 0-db calibration mark at 80 per cent of full-scale deflection, and additional markings corresponding to ±1 db. Intermediate points on the scale are also marked at ±0·5 db, allowing readings to be estimated with care to within 0·1 db.

Calibrating Circuit,

This consists essentially of the potential divider formed by R28 and the neon V5 connected between one side of the h.t. winding and the centre-tap on mains transformer TR 2. The stabilised 50-c/s voltage across the neon is further divided by the chain R29, R30, R31. The voltage developed between the variable tapping on R30 and TR 2 centre-tap is applied as a calibrating signal to TR 1 primary via the *Cal. +10* position of the input key.

Mains Unit

The 50-c/s mains supply enters the equipment via a 3-pin plug and lead and the 2-pole *On/Off* switch SW A. A 1-amp fuse is fitted and a neon indicator-lamp is provided to show when the supply is on. The mains transformer primary can be switched to 210, 230 or 250-volt tappings, which may be reduced by 10 volts in each instance by changing the internal strap. An h.t. supply at 275 volts is provided via the rectifier V4 and smoothing components L1, C16, C17. The 6·3-volt heater winding for V1-V3 is bridged by R33, which has a variable tapping to earth for hum suppression. V4 heater is supplied from a separate 4-volt winding.

2. Before proceeding further, wait for at least ten minutes, to give time for the instrument to attain stability.

Hum Adjustment

3. Set the coarse calibrated control to *Off*, and the fine calibrated control to 0. Set the 20-db switch to −20.
4. With the aid of a screwdriver, rotate the pre-set *Hum* control until a minimum meter deflection is obtained.

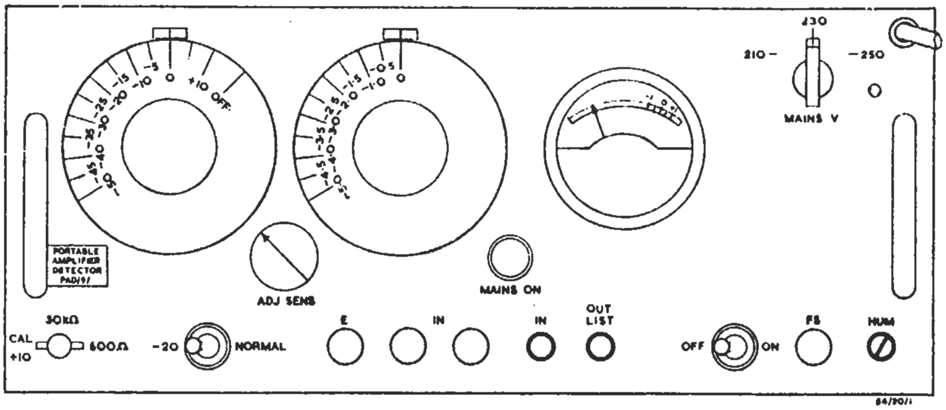

Fig. 15.1 PAD/9 Face Panel
Drawing No. ESK 1305

Mechanical Construction

The instrument is constructed in a sheet-aluminium case with overall dimensions of 6⅞ in. by 14¾ in. by 10½ in. approximately. Its total weight is 21 lb.

The mains fuse and all controls except the *Calibrate* adjustment are mounted on the face panel (Fig. 15.1), which is protected for transport by a detachable hinged lid fastened by trunk-catches. A support bar is provided at each end of the face panel to allow the instrument to be inverted for maintenance without damage to the controls. A 9-ft mains lead emerges through a bushed hole in the panel, and can be held for transport by clips inside the lid.

A carrying handle is provided at one end of the body. Rubber feet are fitted at the other end, and also on the base.

Operating Procedure

Switching On

1. Set the *Mains Voltage Selector* to the required position, and switch on the mains. The neon indicator-lamp should now light.

Calibration at Base

5. Set the coarse control to + 10, leaving the fine control on 0.
6. Set the 20-db switch to *Normal*, throw the input key to *600 Ω*, and apply tone at a level of + 10 db to the input jack from a source of frequency around 1 kc/s. (The impedance of the source itself is not important, provided that it delivers an accurate + 10 db into 600 ohms.)
7. Vary the setting of the *Adjust Sensitivity* control until the meter pointer comes to rest opposite the 0-db mark on the scale.

NOTES :—(i) It is to be stressed that the validity of the calibration depends entirely upon the accuracy of the + 10-db level obtained from the tone source, and if the latter is not provided with an output meter some other means of checking its output level must be found.

(ii) Should a source of + 10-db level not be available an accurate zero-level source may be used, but the coarse control on the PAD/9 should then be set to 0 instead of + 10 during operation 5, and restored to + 10 prior to operation 8.

(iii) Although a CAL/1 unit can conveniently be used for checking the accuracy of the tone-source level against a P.P.M., the 50-c/s output obtained from this unit should not be used directly to calibrate the PAD/9.

8. Throw the input key to *Cal. + 10*, and adjust the *Calibrate* control inside the instrument until a meter reading of 0 is again obtained. Note that the neon tube V5 (also inside the instrument) is liable to shake loose in transit, and as this can introduce serious calibration errors, it is important to check that the neon is screwed tightly home.

Calibration in the Field

9. First carry out operations 1 and 5 as already given. Then throw the input key to *Cal. + 10*, and set the *Adjust Sensitivity* control for a meter reading of 0.

Measuring Tone Levels

10. First calibrate the instrument as described under operation 9.
11. Set the input key to 600Ω or 30 kΩ as required.
12. Apply the tone which it is desired to measure.
13. Adjust the two calibrated controls to bring the meter pointer as nearly as possible to calibration mark 0 on the scale.
14. (a) If the meter reading is within ± 1 db of the calibration mark, proceed to operation 15.
    (b) If the meter reads more than 1 db high, the tone level is more than + 11 db, and is outside the range of the instrument.
    (c) If the meter reads more than 1 db low, set the left-hand control temporarily to − 30, throw the 20-db switch to − 20, and repeat operation 13.
    (d) If after operation 14(c) the meter reading is still more than 1 db low, the tone level is below − 76 db, and is outside the range of the instrument.
15. The tone level as obtained from 14(a) will be equal to the algebraic sum of the readings of the two calibrated controls and the meter. If the 20-db switch is thrown to − 20, as in 14(c), it will be necessary to subtract a further 20 db from the figure so obtained. A typical calculation might be as follows:

L.H. Control	*R.H. Control*	*Meter Reading*	*20-db Switch*		*Tone Level*
− 40	− 2·5	+ 0·2	− 20	=	− 62·3

NOTE.—To reduce risk of damage to the measuring circuit, the controls should always be handled in such a manner as to cause the meter pointer to approach the calibrated part of the scale from *below*.

Valve Data

Valve	*Anode Current mA*	*Screen Current mA*	*Heater Volts*	*Heater Amps*
Stage 1 EF 50	1·6	0·5	6·3	0·3
Stage 2 EF 50	1·6	0·5	6·3	0·3
Stage 3 EF 50	3·3	1·0	6·3	0·3
Rectifier UU6			4·0	1·4

Supplies

Mains supply, 200-250 volts 50 c/s a.c.

H.T. supply, 275 volts 8·5 mA.

L.T. supplies, 6·3 volts 0·9 amp, and 4·0 volts 1·4 amps a.c.

General Data

Impedances

Input $Z = 600\ \Omega$ or 30 kΩ

Input Level

− 75 db to + 10 db.

Calibrated Potentiometers

Type	*Resistance*	*No. of Studs*	*Loss per Stud*
P/64P	100 kΩ	11	0·5 db
P/65P	10 kΩ	14	5 db

Modifications to PAD/9 (Fig. 23)

Scope of Modifications

The modifications to be described have been carried out on all PAD/9 instruments in use by Lines Department and by S.E.T.'s mobile maintenance teams. The amended circuit is shown in Fig. 23.

The principal results of the changes are:

(a) Some increase in the stability of meter readings in the presence of mains-voltage variations, and improved protection of the meter against overload signals by the use of anode-bend current limiting.

(b) Provision of facilities for using a PPM/6 in conjunction with the PAD/9 for such applications as noise measurement.

A disadvantage resulting from (a) is a 10-db reduction in the sensitivity of the PAD/9 when used alone. It should also be mentioned that, except for special applications, the stability of the standard unmodified instrument is normally perfectly adequate, as illustrated by the following figures, which give average variations of PAD/9 meter readings when the supply voltage is varied over the range of 250/200 volts with the mains switch set to 230 and 1-kc/s tone at zero level applied.

Mains Volts	*Meter Reading Variations: db*	
	Standard PAD/9	*Modified PAD/9*
250	+0·6	+0·3
240	+0·3	+0·15
230	0	0
220	−0·3	−0·1
210	−0·7	−0·3
200	−1·1	−0·35

Stability Improvements and Meter Protection

Stability has been improved mainly by making the circuit a closer approach to that of the AD/4. (See Section 1). Changes under this heading include an increase in the amount of current feedback applied to V1, due to the omission of the cathode-circuit by-pass capacitor, and re-arrangement of the meter circuit to bring the meter within a feedback loop between V3 and V2, the meter therefore measuring feedback current instead of output voltage. The *Adjust Sensitivity* control is placed in V2 cathode circuit, and is thus also within the feedback loop. The *Output Listen* jack which was in parallel with the meter circuit is removed.

A Metrosil disk is connected in V3 anode circuit to reduce long-term drift resulting from mains-voltage variations; the value of the smoothing capacitor, C13, is increased to 326 μF, thus reducing short-term level variations due to mains surges, which are unaffected by the Metrosil disk, since this latter is temperature-operated and is consequently a slow-acting device. To provide adequate anode-bend current limiting, the valve is now triode-connected; as a result, the maximum meter current on overload signals is only 1·5 times that for normal full-scale deflection, in contrast to 5 times the normal full-scale current before the change.

The input-key connections are rewired so as to reduce the number of series break contacts in the low-impedance path. This is to guard against possible high contact resistance which could introduce serious errors in measurement.

Since the increase in feedback and the triode connection of V3 together cause a drop in gain of 10 db, the switched gain-control circuit between V1 and V2 is modified so as to produce a 10-db change instead of one of 20 db. The two ranges of the instrument thus become:

(1) +10 db to −55 db.
(2) 0 db to −65 db.

An additional 1 db in either direction is still obtainable by using the ±1-db markings on the meter scale.

Use of PPM/6

A jack is fitted between V2 and V3 to enable the amplifier portion of the PAD/9 together with the calibrated controls to be used in conjunction with a PPM/6, the facilities obtainable with the combination being equivalent to those provided by a TPM/3. Although the high-impedance input of the PPM/6 is used, the connection affects the readings of the PAD/9 internal meter, and to prevent mistakes auxiliary contacts are provided on the jack which when a plug is inserted automatically short-circuit the internal meter.

The signal applied to the PPM/6 is at zero level when the calibrated controls are both at 0 db and the 10-db switch is set to maximum gain, thus giving direct readings from the P.P.M. and the attenuator dials. The switch is now labelled *T.P.M. Normal and Amp. Det. −10 db* in this position and *Amp. Det. Normal* in its other position.

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