NOTES FOR THE USE OF AVO CT160 VALVE TEST METER FROM THE UK MILITARY MANUAL AP117L-0101-1(Pt.2), ALSO KNOWN AS BR1171(13)B.

CAUTION

RADIO ACTIVE VALVES of British make are marked with a symbol similar to that shown above. Radio active valves manufactured in the U.S.A. are marked with a symbol of the same shape but with the colour image reversed on a magenta background. These symbols supersede an earlier warning mark of a $\frac{1}{4}$ inch orange band. ALL SUCH VALVES ARE POTENTIALLY DANGEROUS AND MUST BE TREATED WITH CARE. Detailed instructions for the handling and disposal of radio active valves are published in current Defence Council Instructions.

GUIDANCE NOTES ON THE CORRECT INTERPRETATION OF VALVE RESULTS

1. The Valve Tester CT160 is a useful instrument provided that its indications are correctly interpreted. Without regard to the function of a valve in its circuit however, it is not possible to devise a simple method of "go - no go" indication that is completely reliable. In general, if this tester shows a valve to be good by the routine go - no go tests the valve will function properly in circuit; if the tester indicates a poor performance then the valve is the most likely cause of a circuit fault. The limitations of such valve tests are considered in the following paragraphs.

2. The green-white-red sectors of the meter scale may be used for reading "percentage goodness" although no direct calibration marks for this are shown. Because the full scale deflection is about 130% of nominal slope, the 100% slope indication is in the centre of the word GOOD where there is a black line across the green sector whilst the 70% slope is just above the lower end of the green scale. Above the coloured scale there are gradations, 0.1, 0.5, 1 mA/V, provided for measuring a slope less than 1 mA/V. These can be used as a "percentage goodness" scale by relating the 0.1 position with 10%, 0.5 with 50% and 1 mA/V with 100%. Percentages above 100 can be estimated from the knowledge that f.s.d. is approximately 130%. After balancing the anode current to zero, the SET mA/V control should be turned until the nominal slope (obtained from data tables) is set adjacent to the pointer. Percentage goodness can then be read off as stated previously.

3. It must be noted that variation in the mutual conductance of a <u>new</u> valve may cause the pointer to lie anywhere within the green sector. For a valve with mutual conductance of a nominal value given in the data tables the pointer should rest at the 100% position on the green scale. A valve should be rejected only when the pointer is clearly within, or below, the red sector. Should the pointer lie in the white sector the indication represents possible failure but, because of the relative inaccuracy of the CT160 compared with laboratory test facilities, the valve should not be thrown away immediately. In a certain circuit the valve may be satisfactory and its use for this specific purpose should be considered.

4. Users of the valve tester should study the following points.

(a) The instrument is intended to give a go - no go indication measured to a particular limit. Sometimes this limit may be very close to that at which the valve just functions properly in a certain circuit.

(b) Some circuits will still function, though perhaps not well, even when a valve is almost useless as indicated on the CT160. Thus,

(i) a multi stage amplifier with one valve giving negligible amplification may still pass some signal;

(ii) an oscillator in which loop gain is normally very high may still oscillate;

(iii) a stabilising or limiting valve will not seem faulty when the prevailing circuit conditions do not call for the correction normally afforded.

(c) A few circuits will not function properly even though the tester shows the valves to be good. The tester may be faulty but it is more likely that the circuit is faulty elsewhere, or has design peculiarities, and requires a valve of above average performance to work properly. Examples are:

(i) an oscillator in which the loop gain is just unity when using an above-average valve;

(ii) a pulse circuit in which the electrode potentiometer or bias levels are such that the circuit operation is critical.

Thus the valve tester readings may mislead and if the fault symptoms are such that the valve is suspect then, even though the CT160 indicates a good valve, it is worth trying a better valve. Note the relative goodness to the average figures of the valve in question before removing it from the group of components under suspicion. A wrong elimination can entail considerable delay in finding a fault.

(d) Pulse circuits often use valve parameters such as grid-to-screen mutual conductance, or the suppressor grid cut-off potential (e.g. Miller stage). These parameters are not usually defined by the valve data and are not readily tested by the CT160.

(e) Class A push-pull circuits require pairs of valves that are balanced for mutual conductance and anode current. Usually a tolerance of $\pm$ 10% is permitted, any unbalance being countered by pre-set adjustments of the circuit. Reference should be made to the handbook for the equipment to determine how exacting are the requirements.

(f) When measuring mutual conductance it must be remembered that this reading varies with cathode current and the measured value may not be the same as that existing under circuit conditions. The equipment designer is responsible for ensuring that a circuit will work correctly using valves with parameters (such as mutual conductance) lying within wide limits. These limits are of the order of $\pm$ 35% of the nominal value given in the valve data tables. A "used" valve is still serviceable if a mutual conductance of 50% of nominal value is indicated on test, i.e. if the reading is in the white or green sectors.

(g) There are two methods of testing heater cathode insulation. With the heater hot and isolated from cathode, an ohmmeter can be connected between the elements to measure the insulation. If the cathode is made negative with respect to the heater, then thermal emission from any part of the heater that is affected by the cathode is suppressed by the effective negative bias. (Consider the cathode as the "anode" of a directly-heated diode). This connection is the preferred test for heater-cathode insulation.

If the ohmmeter is connected such that the cathode is positive with respect to the heater (as in CT160 heater-cathode tests), then thermal emission can also contribute to a "low" heater-cathode insulation.

The readings of insulation taken on CT160 must be carefully interpreted with a knowledge of the circuit that the valve is to work in. If it has a few volts bias due to a small cathode resistor, e.g. r.f. or i.f. amplifier, a heater-cathode insulation of even 50k or 100k can be discounted.

In a.f. amplifiers such as low-level microphone amplifiers etc., hum troubles may occur. With pulse circuits where the cathode may be an active element (cathode follower, cathode coupled amplifier, grounded grid amplifier etc.,) a low heater-cathode insulation (due to either ohmic resistance, emission, or a culmination of both,) may cause trouble. Therefore, considering the valve circuit, it may be that a valve with poor heater cathode insulation can be exchanged for one in another part of an equipment where the cathode potential is near earth.

5. In fault finding one should not rely solely on valve tester measurement but should make a proper check of voltage levels, signal amplitudes and waveforms throughout the faulty unit.

6. The CT160 is based on a patented system whereby half-wave a.c. pulses are used in place of stabilised d.c. supplies. This enables the supply to be a simple tapped transformer circuit with the virtue of very low source impedance of the supply. Theoretically zero source impedance is needed in order to achieve a true static measurement of mutual conductance etc.

7. In practice the transformer, cut-out coil and metering resistances add up to some few hundred ohms resistance. This order of source resistance is negligible for most valves but a few types are coming into service that have very low a.c. impedances (Ra). Examples are:-

CV2984 = CV5008 = civilian Type 6080 CV2975 = civilian Type EL84
CV4079 = civilian Type A2293 CV5077 = civilian Type PL81

These low Ra valves are not tested to static test conditions but under dynamic conditions because the source impedance of the power supply is no longer negligible. As a result the mutual conductance figures may be low by a factor of one half to one quarter of the nominal value. This effect is a design limitation of the CT160 that cannot be eliminated by modification of the instrument. It applies to any valve that has an a.c. impedance lower than about 400 ohms.

ABBREVIATIONS USED IN THIS BOOK

D, DD, DDD - Diodes.
DT, DDT, DP, DDP - Valve with another electrode assembly in addition to the diode.
H - Heptode or Hexode.
N - Nonode.
O - Octode.
P - Pentode or Tetrode, PP - Double Pentode or Double Tetrode.
T - Triode, TT - Double Triode, TH - Triode Heptode, or Triode Hexode.
TP - Triode Pentode.
R - Rectifier, RR - Full-wave Rectifier.
TI - Tuning Indicator (magic eye).
CCR - Cold Cathode Rectifier.
+ - Appearing among ROLLER SELECTOR switch numbers, refers to third diodes in triple diodes. Refer to Volume 1, Part 1, Chapter 3, Section headed "Instructions for Testing Specific Valve Types" for full test procedure.
() - Where brackets appear around stated heater voltage thus (5) it indicates that heater voltage given in Data columns has been uprated to allow for voltage drop at valve base, due to high heater current taken by the particular valve.

NOTES REFERRED TO IN VALVE DATA REMARKS COLUMN

A The heater/cathode lead identified with red marking should be connected to Pin No. 1.

B The grid top cap is situated over Pins No. 7 and 8.

C This valve does not fit special valveholders supplied, and roller selector Data will depend on connections made to valve electrodes.

D Pin No. 1 on the flat pinch type of base is the lead adjacent to the coloured blob which identifies the anode connections, the remaining pins being directly numbered across the base from Pin No. 1.

E Alternative test figures are given for use when valve shows signs of back emission from anode to G_3. This phenomenom can be recognised by the anode current apparently decreasing as the valve heats.

G Valves on the B8D base when leads are cut, should be tested either by insertion in a B8D Adaptor, or leads lengthened and tested in the same way as those with flexible leads, by using the special 9 clip valveholder.

H Tests on tuning indicators should not be made until the resistor value (Ra), indicated in the remarks column, has been inserted across the link(s) on valve panel.

J Use special 9 clip valveholder.

K The grid top cap is situated over Pins 4 and 5.

L Anode 1 is situated over Pins 2 and 3, anode 2 is situated over Pins 7 and 8.

M To test valves with B7A bases, use adaptor, electron tube 5935-99-972-9810.

P Minimum slope figure.

Q Class B valve check for balance of both halves.

R Insulation tests only.

S Same remarks as note H, but add both sections to be tested.

T Check both sections of valve for balance.

U Red line indicates top cap anode.

V The CV number has been allocated to a pair of valves which must be checked for matching.

W Insulation checks only can be supplied to this valve.

X Low Ra Valve. Refer to paragraph 7 of Guidance Notes on the correct interpretation of valve results.

ABBREVIATED OPERATING INSTRUCTIONS FOR TEST SET, ELECTRONIC VALVE CT160

The brief notes which follow are intended as a guide to the operator who has already studied, and is familiar with, the full operating instructions given in Volume 1, Part 1, Chapter 3 of B.R.1771(13)A.

SETTING OF INSTRUMENT

1.(1) Check coarse mains voltage setting of MAINS VOLTAGE SELECTOR panel and, if necessary, re-set for supply voltage.

(2) Set CIRCUIT SELECTOR to SET ~.

(3) Set ELECTRODE SELECTOR to A_1.

(4) Set heater volts and associated toggle switch to value indicated in Valve Data.

(5) Set ANODE VOLTS, SCREEN VOLTS, NEG GRID VOLTS, and ANODE CURRENT switches to value indicated in Valve Data.

(6) Set ROLLER SELECTOR switch to Code Number given in the Valve Data and check that the links on the top panel are firmly connected.

(7) Connect mains lead to instrument and supply.

(8) Switch on, allow a few moments for instrument to warm up, and adjust rotary MAINS VOLTAGE SELECTOR until the meter needle lies in the black zone marked "~".

ALL VALVES

2.(1) Insert valve and if necessary, connect "Top Cap Lead" between valve and appropriate socket in TOP CAP CONNECTOR PANEL.

(2) Set CIRCUIT SELECTOR to H/CONT to check heater continuity.

(3) Set CIRCUIT SELECTOR to A/R and using successive settings of ELECTRODE SELECTOR at A_1, A_2, D_1, D_2, check electrode insulation, with the valve cold, between anodes and the remaining electrodes strapped together.

(4) Set CIRCUIT SELECTOR to S/R and set ELECTRODE SELECTOR switch to A_1 to check insulation, with the valve cold, between screen and all other electrodes (except diodes) strapped together.

(5) Set CIRCUIT SELECTOR to CH/R and ELECTRODE SELECTOR to A_1 or D_1 and D_2 to check, with valve hot, insulation between heater/cathode and all other electrodes strapped together.

(6) Set CIRCUIT SELECTOR and ELECTRODE SELECTOR to C/H to check, with valve hot, insulation between heater and cathode (for indirectly heated valves).

TRIODES, DOUBLE TRIODES, DIODE TRIODES, PENTODES, DOUBLE PENTODES, DIODE PENTODES AND TETRODES, IN SIMILAR COMBINATION

3. Set ELECTRODE SELECTOR to A_1 and CIRCUIT SELECTOR to TEST.

Should the protective relay operate, switch off and check for incorrect setting of ROLLER SWITCH or electrode voltages. If these are correct and the relay continues to buzz when the instrument is switched on, the valve is probably "soft" and the test should proceed no further.

To check relative goodness of valve in conjunction with coloured comparison scale

4.(a) Using recommended anode current

(1) Do not alter ANODE CURRENT controls, but adjust NEG GRID VOLTS control until meter reads zero.

(2) Slowly rotate SET mA/V control to SET ZERO position and make any final adjustment to zero, using fine ANODE CURRENT control.

(3) Continue rotation of SET mA/V control to expected value of mA/V (meter needle should rise).

(4) Comparative "goodness" of valve will now be shown by position of needle on coloured scale.

(b) Using recommended negative grid voltage

(1) Do not alter NEG GRID VOLTS control, but adjust ANODE CURRENT controls until meter reads zero.

(2) Slowly rotate SET mA/V control to SET ZERO position and make any final adjustment to zero, using fine ANODE CURRENT control.

(3) Continue rotation of SET mA/V control to expected value of mA/V (meter needle should rise).

(4) Comparative "goodness" of valve will now be shown by position of needle on coloured scale.

To check valve by direct reading of mutual conductance

5.(a) Using recommended anode current

(1) Do not alter ANODE CURRENT controls, but adjust NEG GRID VOLTS control until meter reads zero.

(2) Slowly rotate SET mA/V control to SET ZERO position and make any final adjustment to zero, using fine ANODE CURRENT control.

(3) Continue rotation of SET mA/V control until meter needle reaches calibration line in centre of "good" zone.

(4) Read actual value of mutual conductance from SET mA/V dial. This figure can be compared with that given in Valve Data.

(b) Using recommended negative grid volts

(1) Do not alter NEG GRID VOLTS control, but adjust ANODE CURRENT controls until meter reads zero.

(2) Slowly rotate SET mA/V control to SET ZERO position and make any final adjustment to zero, using fine ANODE CURRENT control.

(3) Continue rotation of SET mA/V control until meter needle reaches calibration line in centre of "good" zone.

(4) Read actual value of mutual conductance from SET mA/V dial. This figure can be compared with that given in the Valve Data.

To check valves having a mutual conductance less than 1 mA/V

6. Since the SET mA/V dial is not calibrated below 1 mA/V, it is not possible to check on the coloured comparison scale, valves having an expected mutual conductance less than 1 mA/V. Such valves are checked by direct measurement of mutual conductance using the procedure as in Paragraph 5 with the exception that the mA/V dial is rotated to the 1 mA/V position and the actual value for mutual conductance (being less than 1 mA/V) is read on the meter scale calibrated 0.1 - 1 mA/V.

For valves with more than one electrode assembly, having set up for any difference in electrode voltages, repeat appropriate test with ELECTRODE SELECTOR at A_2.

Gas Test

7. Set CIRCUIT SELECTOR to GAS, and ELECTRODE SELECTOR to A_1. Gas current will now be directly indicated in μA.

DIODES AND RECTIFIERS

8. Proceed as in Sections 1 and 2, then with the CIRCUIT SELECTOR at position TEST, ELECTRODE SELECTOR at D_1 and using inner ring of figures, set the right-hand ANODE CURRENT control to the load figure specified in Valve Data. The comparative "goodness" of a valve is shown by the position of the needle on coloured scale.

Load reading is per anode. Check full-wave rectifiers and double diodes with ELECTRODE SELECTOR at D_1 and D_2 respectively.

Check signal diodes at 1 mA loading unless otherwise specified in data.

B7A VALVES

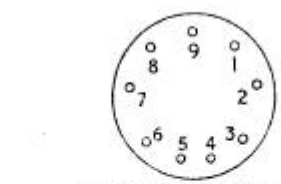
9. Valves with B7A bases are tested by means of Adaptor, 5935-99-972-9810 Electron Tube Socket plugged into the A08 standard valveholder of the CT160. Connect top cap pin (if any), using normal lead, and proceed with the appropriate test.

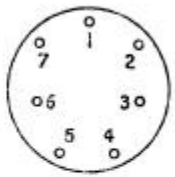
USE OF SUBSTITUTE VALVES

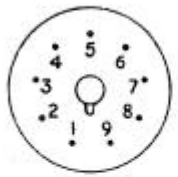
1. When stocks of certain electronic valves are approaching exhaustion and cannot be replaced from new production consideration is given to the use of substitute valves which are more readily available.

2. Details of alternative valves, and any modifications to radio equipment that their use may entail, are promulgated in B.R.1917(1)(A) and B.R.1917(S) in the section entitled "Valve Replacements".

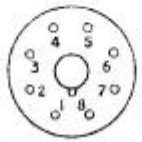
3. A demand for a valve will be met as long as stocks exist. When stocks are exhausted the substitute will be issued in lieu. Reference should then be made to B.R.1917 to determine the use of the substitute and subsequent demands should be raised only for the substitute valve.


BRITISH NINE PIN (B9)


BRITISH SEVEN PIN (B7)


B9G


'P' TYPE BASE (8SC)


INTERNATIONAL OCTAL (AC8)

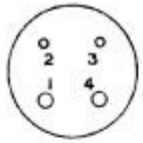

AMERICAN SIX PIN (UX6)


BRITISH 4/5 PIN (B5&B4)


AMERICAN FIVE PIN (UX5)


MAZDA OCTAL (MO8)


AMERICAN SMALL SEVEN PIN (SM7)


AMERICAN FOUR PIN (UX4)


AMERICAN LOCTAL (B8B or B8G)


SUB MINIATURE 8 PIN (B8D)


HIVAC FOUR PIN (SM4)


HIVAC FIVE PIN (SM5)


AMERICAN SEVEN PIN (UX7)


B7G


B9A


B3G


B8A

DIAGRAM OF PIN CONNECTIONS FOR STANDARD VALVE HOLDERS

(viewed from underside of Valve holder)

AP 1771(13)B Part 2 Orig/Issue1

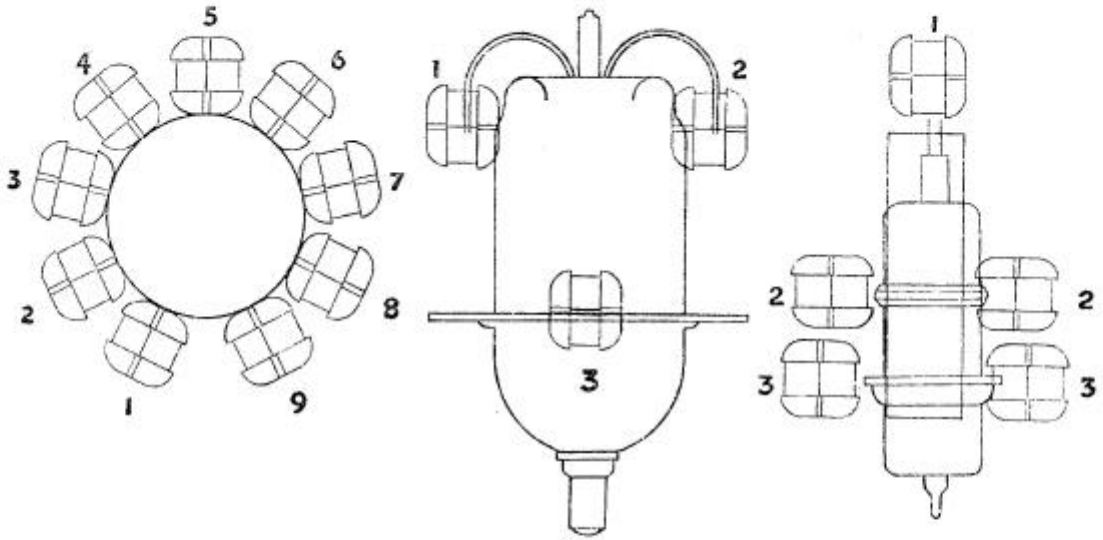


DIAGRAM OF SPECIAL VALVE HOLDERS

(showing pin connections viewed from above).

What follows in the manual is 106 pages of valve set up data for the CT160 which I have not scanned!