MODERNISE *That Valve Portable*

By V. T. Rolfe

NO DOUBT MANY READERS HAVE BUILT THEMselves transistor receivers, but there must be many more who have portable receivers using valves. Some of these receivers will use the 50mA series of B7G valves, whilst some of the older models may use the Octal based 1.4V series. It is the purpose of the present article to give some hints on how these receivers may be modernised to use the 25mA series of B7G valves, and in many cases this will result in a substantial reduction in the battery consumption. Apart from the reduction in heater current, there is also some saving in the current drawn from the h.t. battery.

The modification of receivers using battery valves in *series chains* is not recommended, as the redesign of a 50mA chain to use 25mA valves is quite involved and the heaters of these valves must operate within close limits. In any case, such receivers are normally intended for mains/battery operation and therefore battery economy is not of such importance.

Table I gives a list of valves likely to be incorporated in battery portables. To simplify the text, only the Mullard type numbers are used wherever possible. For example, when the DK91 is mentioned the remarks will apply equally to equivalent types given in the above table (1C1, 1R5, X17). The Mazda 141 range is in general very similar to the D30 range except for the base and pin connections, so remarks on the D30 range apply to the 141 range also.

General Notes—Mechanical

Each stage will be considered in turn, as it is practical to either convert the whole set to the low consumption D96 range or to convert individual stages. Some readers may wish to modify the complete receiver, whereas others may find that one valve in their portable has ceased to function, and may wish to fit an up-to-date replacement either because the old valve is no longer available or may become obsolete in the near future.

Direct equivalents to the D96 series have not been included as the Mullard valves can be used as plug-in replacements in these cases. In replacing other B7G valves (column C in Table I) there are no mechanical problems. The circuit changes necessary will be dealt with later.

In replacing valves in column A or B, the question of a new valveholder arises. There are several methods of overcoming this:

(*a*) The old valveholder can be removed from the chassis and replaced by an aluminium plate holding the new B7G valveholder. This is the best solution.
(*b*) The new valveholder can be mounted on top of the old octal valveholder (taken from the old valve) and appropriate connections made (gl pin to g1 pin, etc.).
(*c*) As in (*b*) but pin 1 connected to pin 1, pin 2 to pin 2, etc., the under-chassis connections being changed as required.
(*d*) In some cases it may be possible, where a paxolin valveholder is fitted, to connect short wires to the B7G type and "plug-in" to the octal valveholder, soldering the short wires to the octal connectors (see Fig. 1).

Of these four methods, (*a*) is preferable, but if this is not possible, either (*c*) or (*d*) should be used. If (*b*) is used, wires must be crossed in the adaptor and this is liable to lead to instability. There is also the possibility of mistakes being made in wiring the adaptor. These are far less likely with (*c*) or (*d*). Some thought should be given to the best orientation.

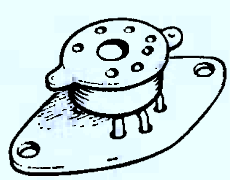

Fig. 1. Method of mounting a B7G over a paxolin octal valveholder

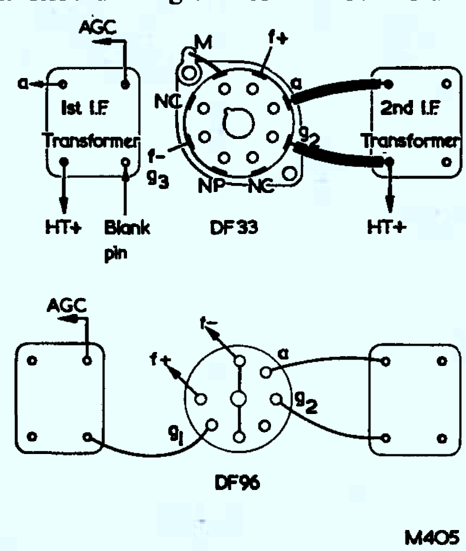

Fig. 2. A DF96 used in place of a DF33 type valve

TABLE I
Valves Used in Portable Receivers

	Mazda Octal Range A	Octal Range B	B7G Types 50mA C	B7G Types 25mA D
Frequency Changer	FC141	DK32, 1A7GT	DK91, 1C1, 1R5, X17 DK92, 1C2, 1AC6, X18	DK96
I.F. Amplifier	SP141	DF33, 1N5GT	DF91, 1F3, 1T4, W17	DF96
Det. A.F. Amplifier	H141D	DAC32, 1H5GT HD14	DAF91, 1FD9, 1S5, ZD17 1U5	DAF96
Output Valve	Pen 141	DL33, 3Q5GT, N16 DL35, 1C5G, N14	DL92, 1P10, 3S4, N17 DL94, 1P11, 3V4, N19 DL91, 1S4	DL96

TABLE II
Comparison of Output Valves

Valve Type	Pen 141	DL33	DL35	DL91 DL92		DL94	DL96		
Va	82	85	83	67.5	82	85	64	85	V
Vg2	82	85	83	67.5	82	85	64	85	V
Vg1	8.1	−5	−7	+7	−8.2	−5	−3.3	−5.2	V
Vin (r.m.s.)	4.9	3.5	5	5.5	6.3	3.5	2.5	3.4	V
Ia	5.0	7	7	7.2	10	6.9	3.5	5	mA
Ig2	1.0	0.8	1.6	1.5	2.2	1.5	0.65	0.9	mA
Ik	6.0	7.8	8.6	8.7	12.2	8.4	4.15	5.9	mA
Ra	10	9	9	5	5.5	10	15	13	kΩ
Pout	210	250	200	180	320	250	100	200	mW
Transformer Ratio*	57:1	55:1	55:1	40:1	42:1	57:1	70:1	65:1	

* For 3Ω Speaker.

Valve manufacturers usually arrange pin connections so that the input pin (g1) and the output pin (*a*) are on opposite sides of the valve. The valveholder should be orientated to give the shortest possible lead lengths to these two pins. A typical example is given in Fig. 2, which shows a DF96 used in place of a DF33. In this case, the grid lead was previously brought out to the top cap. It will sometimes be found that this connection is also brought out to a connection on the base of the i.f. transformer, or alternatively there is a blank pin on the base. The can should be removed and the connection re-routed to the underside of the chassis.

General Notes—Electrical

The D96 range of valves is designed for operation from a h.t. line not greater than 90V. Some of the earlier types will operate from higher voltages, up to a maximum of 120V. No portable receivers exist with 120V batteries, but if a table model receiver using a 120V battery is modified, dropping resistors must be fitted or the battery changed to ensure that any D96 valves that are used are not subjected to this voltage.

One portable receiver, the Burgoyne "Playboy", employs 45V h.t. batteries. The manufacturers' data for the D96 series does not contain characteristics or operating conditions at 45V, and performance under these conditions cannot therefore be guaranteed.

The Output Stage

The operating conditions of the output valves listed in Table I are given in Table II. From this table the principal differences between the types can readily be seen. In all cases the operating conditions should be changed to correspond as closely as possible to those given for the DL96. It will be noticed that the sensitivity of the DL96 is slightly higher than the other valves, but the output power is slightly lower. These differences are not, however, serious. A more serious difference is the higher value of optimum load required for the DL96.

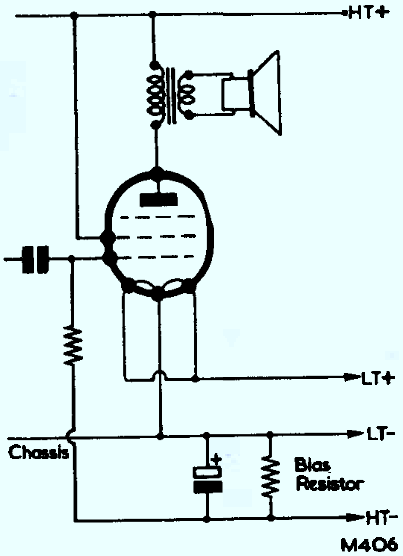

Fig. 3. Total h.t. current flows through the bias resistor, the voltage derived being used as bias for the output valve. Changing the valve will result in change of the total h.t. current. (See text)

If possible it would be advisable to change the load, but in the majority of cases this cannot be done economically, and some mismatch will take place. With a battery voltage of 90V and with a load of 9kΩ, the DL96 can be expected to give an output of about 150mW at 10% distortion, instead of the 200mW shown in the table. With a 67.5V battery the optimum load for the DL96 is 15kΩ, whereas the DL91 or DL92 (and equivalents) have a 5kΩ load under these conditions. In these circumstances, the mismatch would cause a considerable drop on the already low output of 100mW, and on the face of it such a substitution could not be recommended, unless of course the load can be altered by using a different ratio transformer, or changing the speaker to one having a higher impedance. In a receiver modified by the writer, however, the Marconiphone P17B, it was found that the DL92 was biased back to reduce the h.t. drain. Under these conditions the optimum load is higher and the output lower. In this receiver the load was estimated to be 13.5kΩ and the output about 70mW. The load was close to the 15kΩ required for the DL96 in this case, so the modification was carried out and proved successful.

Valve	Base Type	1	2	3	4	5	6	7	8	TC
DAC32	International Octal	M	f+	a	NC	ad	NP	f−	NC	g
DAF91	B7G	f−, g3	NP	ad	g2	a	g1	f+	—	—
DAF96	B7G	f−, g3	IC	ad	g2	a	g1	f+	—	—
DF33	International Octal	M	f+	a	g2	NC	NP	f−, g3	NC	g1
DF91	B7G	f−, g3	a	g2	NP	f−, g3	g1	f+	—	—
DF96	B7G	f−, g3	a	g2	IC	f−, g3	g1	f+	—	—
DK32	International Octal	M	f+	a	g3, g5	g1	g2	f−	NC	g4
DK91	B7G	f−, g5	a	g2, g4	g1	f−, g5	g3	f+	—	—
DK92	B7G	f−	a	g2	g1	g4	g3	f+, g5	—	—
DK96	B7G	f−	a	g2	g1	g4	g3	f+, g5	—	—
DL33	International Octal	NC	f+	a	g2	g1	NP	f−	fct, g3	—
DL35	International Octal	NC	f+	a	g2	g1	NP	f−, g3	NC	—
DL91	B7G	f−, g3	a	g1	g2	f−, g3	a	f+	—	—
DL92	B7G	f−	a	g1	g2	fct, g3	a	f+	—	—
DL94	B7G	f−	a	g2	NC	fct, g3	g1	f+	—	—
DL96	B7G	f−	a	g2	NC	fct, g3	g1	f+	—	—
FC141	Mazda Octal	f	NC	a	g2	g1	M	g3, g5	f	g4
H141D	Mazda Octal	f−	NP	a	NC	ad	M	NP	f+	g
Pen141	Mazda Octal	f−	NP	a	g2	g1	NC	NP	f+	—
SP141	Mazda Octal	f−	NP	a	g2	NC	M	NP	f+	g1
1U5	B7G	f−, g3	a	g2	ad	NC	g1	f+	—	—

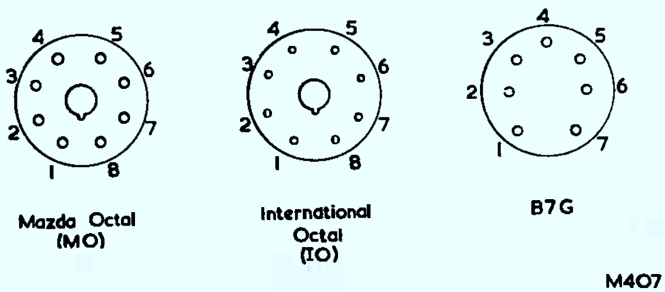

Fig. 4. Valve base connections

TABLE III
Comparison of A.F. Valves

	H141D	DAF91				DAF96		
Vb	82	67.5	67.5	90	90	64	85	V
Ra	0.47	0.47	1	0.47	1	1	1	MΩ
Rg2	—	1.8	3.9	1.8	3.9	2.7	2.7	MΩ
Rg1	4.7	10	10	10	10	10	10	MΩ
Rg1 of output valve	2.2	1.0	2.2	1.0	2.2	2.2	2.2	MΩ
Gain	35	55	71	66.5	90	57	65	
Ik	65	112	58	166	83.7	60	85	μA

TABLE IV
Comparison of I.F. Amplifiers

	SP141	DF33	DF91		DF96		
Va	83	90	67.5	90	64	85	V
Vg2	83	90	67.5	67.5	64	64	V
*Rg2	0	0	0	16	0	39	kΩ
Vg1	0	0	0	0	0	0	V
Ia	1.55	1.2	3.4	3.5	1.65	1.65	mA
Ig2	0.5	0.3	1.5	1.4	0.55	0.55	mA
gm	750	750	875	900	750	750	μA/V
Ik	1.65	1.5	4.9	4.9	2.2	2.2	mA

* Rg2 is sometimes common to the i.f. valve and frequency changer (see text).

TABLE V
Comparison of Frequency Changers

	FC141	DK32	DK91		DK92	DK96		
Voltages								
Anode (Va)	90	90	67.5	90	85	64	85	V
Screen-grid	45	45	} 67.5	67.5	60	64	68	V
Osc. anode	90	90			30	35	35	V
Osc. grid (r.m.s.)	—	—	—	—	4	4	4	V
Currents								
Anode (Ia)	0.55	0.6	1.4	1.6	0.7	0.55	0.6	mA
Screen-grid	0.6	0.7	} 3.2	3.2	0.15	0.12	0.14	mA
Osc. anode	1.2	1.2			1.6	1.6	1.5	mA
Osc. grid (Ig1)	35	35	250	250	100	85	85	μA
Total (Ik)	2.4	2.5	5	5	2.55	2.45	2.4	mA
gc	250	250	280	300	325	275	300	μA/V

When replacing the DL91 or DL92, any screen-grid dropping resistor and decoupling capacitor which is fitted can be removed. The only other change necessary is the bias. The bias is normally obtained in these receivers by a resistor connected between the h.t. negative and l.t. negative leads. The total h.t. current flows through this resistor, and the voltage derived is used as bias for the output valve (Fig. 3). Changing the output valve will cause a change in the total h.t. current and will therefore necessitate a change in bias resistor. The value of this resistor is given by

$$R = \frac{Vg1}{I\ tot}$$

The value of Vg1 for the DL96 is 5.2V (with a 90V battery) and 3.3V (with a 67.5V battery). The value of I tot will depend upon the valve complement,

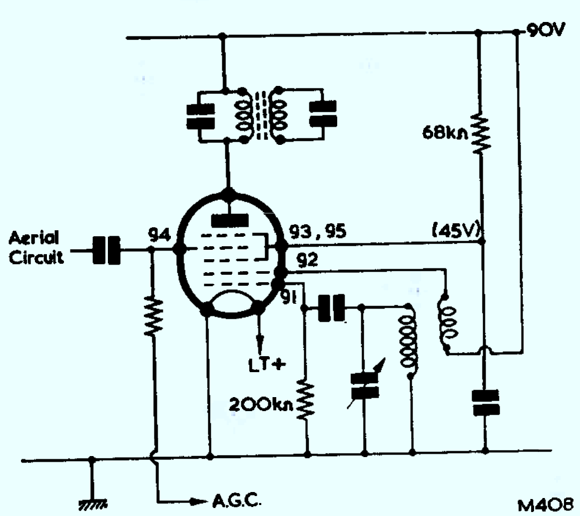

Fig. 5. Circuit using a DK32 valve

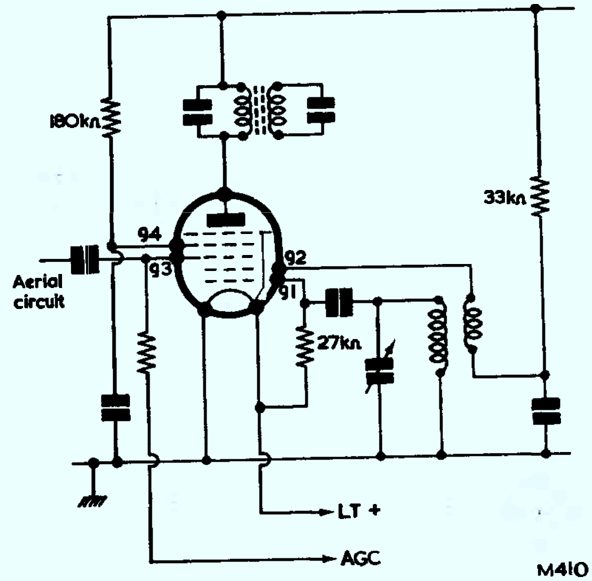

Fig. 7. Circuit using a DK92 valve

and can be obtained by adding the cathode currents given in Tables II to V.

The DL96 has the same pin connections as the DL94. The pin connections of the DL92 and DL91 differ. The connections for all these valves are given in Fig. 4.

Voltage Amplifying Stage

Table III compares the operating conditions of the DAF96 with the earlier DAF91 and equivalents. With similar anode loads, the DAF96 gives a gain reduction of about 25%. Where the DAF91 is used with a 470kΩ load however, the gain of the DAF96 with a 1MΩ load will be comparable. The base connections of both valves are the same. The 1U5 has identical characteristics to the DAF91, but different pin connections. (See Fig. 4.) The only circuit change necessary is to change the screen-grid dropping resistor to 2.7MΩ.

No operating conditions are given for the DAC32 or its equivalents. With a μ of 65, a voltage gain of about 35 can be expected. The μ of the DAF96 triode connected is only 16, so it is not possible to use it triode strapped as a replacement. It is therefore necessary to provide a screen-grid resistor and capacitor and use the valve as a pentode. This gives a 50% increase in the stage gain and greatly improves the sensitivity of the receiver. The grid lead should be re-routed under the chassis as mentioned previously.

The I.F. Amplifier

Table IV gives a comparison of the i.f. amplifier

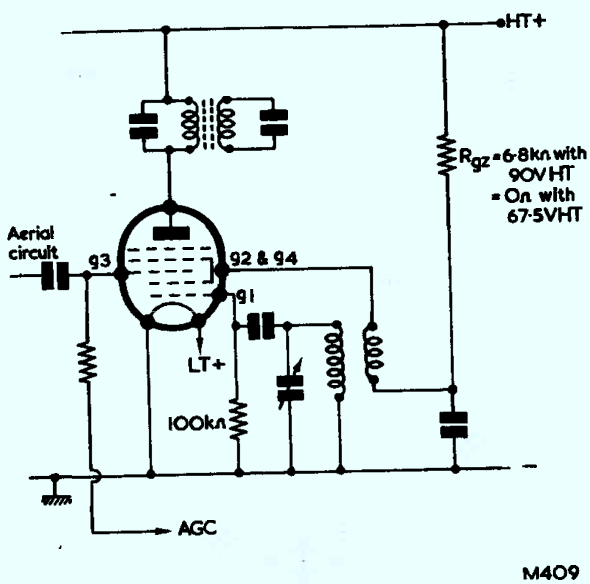

Fig. 6. Circuit using a DK91 valve

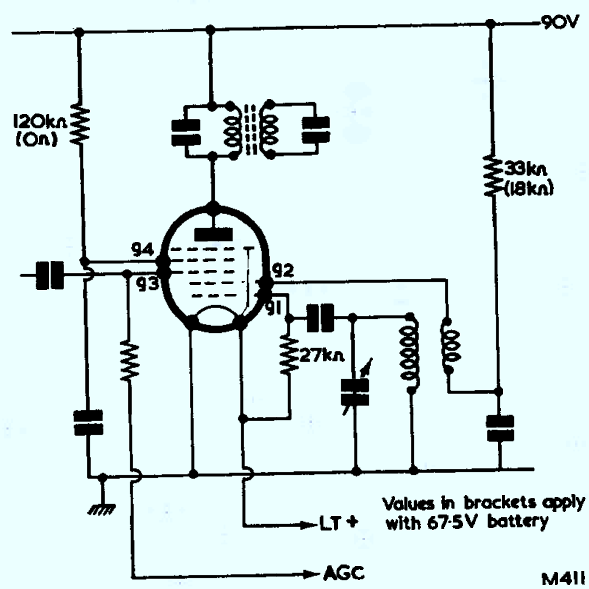

Fig. 8. Circuit using a DK96 valve

valves which may be encountered in portable receivers. When replacing the DF91 with the DF96 the screen-grid dropping resistor should be changed. In some receivers, particularly those using a DK91 frequency changer (or equivalent) a common resistor is used to feed the screen-grids of the frequency changer and i.f. valve. In such cases the most straightforward method is to use separate resistors for each screen grid, but some economy may be effected by using a common one. The value is given by:

$$Rg2 = \frac{Bb-Vg2}{Ig2(a)+Ig2(b)}$$

Where Vb is the battery voltage, Vg2 the required screen-grid voltage, and (g2(*a*), Ig2(*b*) the screen-grid currents of the i.f. valve and frequency changer. These will depend on the valves used, and can be obtained from Tables IV and V. After the valve has been changed, the i.f. transformer may need re-alignment.

The Frequency Changer

Table V lists the operating conditions of the various frequency changer valves. Modification of this part of the circuit is far more critical than any other stage. The situation is complicated by the fact that these valves have different electrode arrangements, and the circuit used with each type differs. Typical circuits for the DK32, DK91, DK92 and DK96 are shown in Figs. 5 to 7.

The simplest method of describing the substitutions is to deal with each type in turn, commencing with the DK92. The electrode structure of the DK96 is similar to the DK92, and the pin connections are identical. Only one circuit change is necessary: The value of the screen dropping resistor should be changed from 180kΩ to 120kΩ. The DK96 should not, however, be used in receivers with a short-wave band, as its short-wave performance is inferior to the DK92.

In the DK91, the screen-grid (g4) and the oscillator anode (g2) are strapped internally. This also implies a change in the pin connections (see Fig. 4). The conversion slope (gc) is very similar to the DK96.

The changes necessary are as follows:

(*a*) Disconnect pin 5 from the circuit, and if necessary complete the filament circuit via pin 1.

(*b*) Change the oscillator anode resistor to the correct value for the DK96. (18kΩ at 67.5V, 33kΩ at 90V.)

(*c*) Connect a 120kΩ resistor from h.t. + to pin 5, and a 0.1μF capacitor from pin 5 to earth.

(If the receiver uses a 67.5V battery, these two components will not be required. It is then sufficient to connect pin 5 directly to the h.t. line.)

(*d*) Replace the 100kΩ resistor between pin 4 and chassis with a 27kΩ resistor between pin 4 and pin 7. (f+.)

In the DK32, g4 is the signal grid and g3+g5 form the screen grid. The screen-grid dropper is usually 68kΩ and must be changed to 120kΩ. The oscillator anode is normally fed direct from the h.t. line (via the anode winding), and it will be necessary to fit a 33kΩ resistor and a 0.1μF decoupling capacitor. The oscillator grid leak should also be removed and a 27kΩ resistor connected between g1 and f+.

LARGE RELAY STATION ORDER FROM THE B.B.C.

The British Broadcasting Corporation has awarded a third contract to Marconi's for the supply of a considerable quantity of television and f.m. sound radio transmitter and translator equipments. These will be used by the B.B.C. as relay stations in areas of poor reception, in continuance of the Corporation's plan for as nearly as possible 100 per cent satisfactory coverage throughout the British Isles.

The contract covers the supply of 10 watt translator drivers and transmitter equipments, as well as 100 watt and 500 watt amplifiers. This new order brings the total number of units purchased by the B.B.C. up to 118.

Relay stations receive a main station transmission at a position of good signal strength, amplify it and retransmit it on a different channel into the area of poor reception. Since the equipments normally have to operate with the receiving and transmitting aerials in close proximity, a sophisticated form of design is necessary to prevent interaction between the retransmitted signal and the receiver.

At such stations all equipments are in duplicate, with one 10 watt driver in operation and one on standby, with automatic changeover in the event of failure of the operational equipment. The driver feeds a pair of amplifiers usually operating in parallel, but at some stations operating on an either/or basis; thus if one of these should fail, the service continues until the fault is rectified.

The equipment ordered by the B.B.C. is a specially designed version of standard equipment which has been supplied by Marconi's to overseas customers, including Sweden, Norway, Canada, Venezuela, Lebanon, Kenya, and Gibraltar. Because the British 405-line television system uses amplitude-modulated sound, cross-talk is a greater problem than is the case with frequency-modulated sound systems and special circuit precautions have to be taken on this account.