ELECTRON TUBES

RCA Application Note

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A Tube Complement for AC/DC AM/FM Receivers

This Note presents a complement of tubes including a rectifier for use in ac/dc radio receivers operating in the frequency-modulation (FM) and the standard broadcast (AM) bands. The complement consists of eight tubes, a sufficient number for achieving a desirable level of sensitivity in the FM band. The tubes all have a heater current of 150 milliamperes and are operated in series. The voltage of the heater string is almost exactly 117 volts, the proper design voltage for ac/dc receivers. Provision for a 6-volt panel lamp is included. The tube types recommended and their functions are tabulated below.

Type	*Heater Volts*	*AM Function*	*FM Function*
6BJ6	6.3	rf amplifier	rf amplifier
12BE6	12.6	converter	converter
6BJ6	6.3	if amplifier	if amplifier
6BJ6	6.3	-	if amplifier (driver)
12AL5	12.6	-	ratio detector
6AQ6	6.3	detector; af amplifier	af amplifier
35B5	35.0	output amplifier	output amplifier
35W4	32.0	rectifier; panel-lamp supply	rectifier; panel-lamp supply
	117.4		

Several of these tubes have features which make them particularly suitable for ac/dc FM/AM service. Type 12AL5 is recommended for the ratio detector type of circuit because of its high perveance and good balance between sections. Type 35W4 is recommended because its heater is tapped for the operation of a panel lamp and because it is capable of supplying the direct-current requirements of the tube complement.

The type 6BJ6 is well suited for rf amplifier service in the FM band because it has a high transconductance (3800 μmhos) and a low in-

TUBE DEPARTMENT
RADIO CORPORATION OF AMERICA, HARRISON, NEW JERSEY

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put conductance (275 μmhos). As an if amplifier, type 6BJ6 has the high transconductance necessary for FM service and the low grid-to-plate capacitance (0.0035 μμf max.) essential for FM and AM operation. Complete short-circuit input admittance data for this tube, taken at 100 megacycles, are given in Table I.

The control characteristics (transconductance, plate current, and screen current versus grid voltage) of the 6BJ6 show a sharper cutoff than most other remote-cutoff types. This cutoff characteristic was chosen in order to obtain a high transconductance at a moderate value of plate current. Although it reduces the maximum signal level which can be handled by a tube without cross-talk or rf distortion, signal levels at the input to the first tube, for receivers with self-contained antennas, do not generally become large enough to cause difficulty. When an outside antenna is used, however, it is recommended that the coupling from the antenna to the signal grid in the standard AM broadcast band be reduced to a suitable value. A preferred arrangement for maintenance of good signal-to-noise ratio is to use normal coupling between the antenna and the first tuned circuit, but to apply only part of the voltage developed in the tuned circuit to the control grid of the rf tube. A convenient way of doing this is to use a coupling capacitor between the tuned circuit and the control grid which is of the same order of magnitude as the input capacitance of the tube (4.5 μμf).

Table I

Short-Circuit Input Admittance Data at 100 Megacycles for Type 6BJ6

Operating Conditions:		
Plate Voltage	250	volts
Screen Voltage	100	volts
Control-Grid Voltage	-1	volt
Transconductance	3800	μmhos
Short-Circuit Input Capacitance:*		
Tube Operating	8.2	μμf
Tube Cutoff	6.6	μμf
Tube Cold	6.4	μμf
Capacitance Increase (cold to cutoff)	0.2	μμf
Capacitance Increase (cutoff to operating)	1.6	μμf
Short-Circuit Input Conductance:*		
Tube Operating	275	μmhos
Tube Cutoff	24	μmhos
Tube Cold	18	μmhos
Conductance Increase (cold to cutoff)	6	μmhos
Conductance Increase (cutoff to operating)	251	μmhos
Grid-to-Cathode Capacitance (measured at low frequency with tube cold)	2.6	μμf

* Data for tube and socket, as measured on admittance meter; socket capacitance, 0.8 μμf; socket conductance, 2.3 μmhos.