



BULLETIN

CX-330, CX-331 and CX-332

TWO VOLT FILAMENT TUBES

This group of new and improved battery operated tubes includes a general purpose tube (CX-330), a power output tube (CX-331) and a screen grid tube (CX-332). All three are of the high vacuum type and employ a strong coated type filament. The filament in each type has been carefully designed to take as little power as possible, consistent with satisfactory operating performance. These tubes are particularly suited for use in radio receivers operating either from dry cells or from a storage battery where economy of filament current drain is important.

FILAMENT OPERATING DATA

In order to keep the filament voltage of these tubes within their safe operating range (1.8 to 2.2 volts), two methods are herewith described. The first and preferred method is by use of a rheostat and filament voltmeter connected permanently in the circuit. As these tubes will usually be operated with their filaments in parallel, the size of the rheostat required with various tube combinations and batteries is shown in Table 1. The other method is to make use of a fixed resistance of correct value to limit the voltage to a maximum safe value of 2.2 volts at the peak battery voltage. As the battery is being used the tubes will be operated through their operating range of 2.2 to 1.8 volts. Care must be taken, however, to check the socket voltage with a good quality voltmeter while making the initial installation. Table 2 shows the size of fixed resistor to be used with various tube combinations.

Each of these tubes is discussed in detail as follows:

CX-330

GENERAL PURPOSE TUBE

The CX-330 is a new general purpose tube designed to operate in battery receivers where economy of filament consumption is important. It may be used as a detector or amplifier and has an appearance similar to the CX-299, but has electrical characteristics which are considerably better. By using the CX-330 with the CX-331 (power tube) and CX-332 (screen grid tube) it is possible to construct a modern radio receiver having screen grid R.F. amplification and a power output stage.



DIMENSIONS

Maximum Overall Length	4¼"
Maximum Overall Diameter	1⅜"

BASE

The new small CX type base is employed on this tube. This base has the same maximum diameter as the base used on CX-299 and CX-220 tubes but instead of the tapered shell a straight side shell is used. This new style base was developed for the slightly larger bulb size employed for CX-331. The standard pin dimensions and connections are employed.

AVERAGE CHARACTERISTIC CURVES

(Pages 63 and 64)

Filament Characteristic—Fig. 7 shows the change of filament current with various filament voltages.

Plate Characteristics—Fig. 9 shows the relation between plate current and plate voltage at various bias voltages.

Mutual Characteristics—Fig. 8 shows a family of grid voltage-plate current curves at various plate voltages.

Dynamic Characteristics—Fig. 10 shows the effect of plate current upon the amplification factor, mutual conductance and plate resistance.

Output Characteristic—Fig. 11 shows the undistorted power output obtainable at various load resistances.

CX-332

SCREEN GRID TUBE



The CX-332 is a new screen grid tube designed for use as a radio frequency amplifier or detector in battery operated receivers where economy of filament consumption is important. This tube used with the others of the new "Two Volt Filament" type, makes possible the construction of a most modern type of receiver operating with much greater economy than has heretofore been possible when using batteries.

The amplification factor of the CX-332 is 580 and the control grid to plate capacity is 0.020 mmf. This high amplification factor and low control grid to plate capacitance makes possible a high voltage amplification per stage.

FILAMENT

The CX-332 has a coated filament which operates at a normal voltage of 2.0 volts and a current of 60 milliamperes. The filament should be operated in accordance with the data specified on page 50.

PLATE, CONTROL GRID AND SCREEN GRID

The plate of this new screen grid tube is of circular construction, being similar to that used in the CX-322, while the control grid is spiral shaped and has its terminal *on the top* of the bulb. This control grid is electrostatically shielded from the plate by the introduction of an extra electrode called the screen grid.

The maximum recommended plate voltage for the CX-332 is 135 volts. At this voltage with a screen grid voltage of 67.5 and a proper grid bias of -3.0 volts, the average plate current is 1.4 milliamperes.

Circuit Recommendations

AS AN R.F. AMPLIFIER

Stable operation of this screen grid tube in circuits designed to give maximum gain per stage requires separation of the input and output circuit elements. Internal shielding of the screen makes neutralization of the plate to grid capacity unnecessary. However, the high amplifying ability of this tube makes it essential to prevent external coupling between circuit elements if the full capabilities of the tube are to be obtained. In general, with multi-stage amplifier circuits, it is necessary to use complete stage shielding including all the components of each stage. It is particularly necessary to shield the control-grid circuit from the plate circuit.

The use of filters in all leads entering the stage shields may be necessary in high gain amplifiers to reduce coupling in external parts of the circuits. In the construction of filters for the screen circuit, a by-pass condenser should be provided to keep the impedance from screen to ground as low as possible.

In general, properly designed radio-frequency transformers are preferable to impedances for inter-stage coupling. If, however, impedance coupling is used, the grid resistance should not exceed 2.0 megohms.

AS A DETECTOR

The CX-332 may be used as a detector providing the audio amplification is comparatively low in order to prevent microphonic disturbances. The audio gain permissible depends on the type of cabinet, speaker design, and power output capabilities of the power output tubes. In any circuit a cushion type socket is recommended. The following operating conditions are suggested:

Screen Grid Voltage	67.5	45
Control Grid Bias Voltage	-6	4.0
Plate Load Resistor	100000	100000

The Plate Battery Supply Voltage may be either 135 or 157.5 volts.

In addition to its recommended application as a screen grid-radio-frequency amplifier this new tube may be employed in experimental circuits wherever a double grid, four-electrode tube is desired.

In circuits designed for CX-322, the CX-332 may be substituted providing the filament and grid circuit voltages are altered to conform to the requirements of this new tube. A typical circuit diagram using the CX-332 as an R.F. amplifier is shown in Fig. 19.

OPERATING CONDITIONS

Filament Voltage	2.0 volts
Filament Current	0.06 amperes
Plate Voltage	135 volts
Control Grid Voltage	-3 volts
Screen Grid Voltage	67.5 volts

AVERAGE CHARACTERISTICS

Amplification Factor	580
Mutual Conductance	505 micromhos
Plate Resistance	1150000 ohms
Plate Current	1.4 milliamperes
Grid-Plate Capacitance	0.020 mmf.
Input Capacitance	6.0 mmf.
Output Capacitance	11.0 mmf.

DIMENSIONS

Maximum Overall Length $4\frac{11}{16}"$ to $5\frac{1}{4}"$
 Maximum Overall Diameter $1\frac{13}{16}"$

BASE

Standard CX (no side pin).

AVERAGE CHARACTERISTIC CURVES

(Pages 65 and 66)

Filament Characteristics—Fig. 12 shows the change of filament current with various filament voltages.

Inter-Electrode Characteristics—Figs. 13, 14 and 15 show the relations existing between the plate, control grid and screen grid by means of the following curves:

Plate Voltage—Plate Current	Fig. 14
Plate Voltage—Screen Grid Current . . .	Fig. 14
Control Grid Voltage—Plate Current . . .	Fig. 13
Control Grid Voltage—Screen Grid Current .	Fig. 13
Screen Grid Voltage—Plate Current . . .	Fig. 15
Screen Grid Voltage—Screen Grid Current .	Fig. 15

Dynamic Characteristics—Figs. 17 and 18 show the effect of control grid and screen grid voltage (respectively) upon the amplification factor, mutual conductance and plate resistance of the CX-332.

Detection Characteristics—Fig. 16 shows the relation between the radio frequency input and the audio frequency output, for several percentages of modulation.

TABLE I

Rheostat Values for Two Volt Filament Tubes—(Minimum)

Number of CX-330's or CX-332's	Two Dry Cells (3.0V.)		Two Edison Cells (2.8V.)	
	1 CX-331	2 CX-331's	1 CX-331	2 CX-331's
1	6 ohms	5 ohms	5 ohms	3 ohms
2	5 "	3 "	4 "	2.5 "
3	4 "	3 "	3 "	2 "
4	3 "	2 "	2.5 "	1.8 "
5	3 "	2 "	2 "	1.5 "
6	2.5 "	2 "	1.8 "	1.5 "
7	2 "	1.5 "	1.5 "	1.3 "

TABLE II

Fixed Resistance Values for Two Volt Filament Tubes

Number of CX-330's or CX-332's	Two Dry Cells (3.0V.)		Two Edison Cells (2.8V.)	
	1 CX-331	2 CX-331's	1 CX-331	2 CX-331's
1	4.2 ohms	2.5 ohms	3.2 ohms	1.9 ohms
2	3.2 "	2.1 "	2.4 "	1.6 "
3	2.6 "	1.8 "	1.9 "	1.4 "
4	2.2 "	1.6 "	1.6 "	1.2 "
5	1.9 "	1.4 "	1.4 "	1.1 "
6	1.6 "	1.3 "	1.2 "	1.0 "
7	1.5 "	1.2 "	1.0 "	0.9 "

NOTE: No resistances are needed when using a single cell storage battery