The RCA RADIOTRON MANUAL

TECHNICAL SERIES
No. R-10

Price 25 cents

RCA Radiotron

UX-120

POWER AMPLIFIER

The '20 is a three-electrode, high-vacuum, power amplifier tube designed for operation from dry-cells. It is intended for use in the last audio stage of dry-battery-operated receivers using the '99 and/or '22.

CHARACTERISTICS

Filament Voltage (D. C.)		3.0-3.3	Volts
Filament Current		0.125-0.132	Ampere
Plate Voltage	90	135 *max.*	Volts
Grid Voltage	−16.5	−22.5	Volts
Plate Current	3.0	6.5	Milliamperes
Plate Resistance	8000	6300	Ohms
Amplification Factor	3.3	3.3	
Mutual Conductance	415	525	Micromhos
Load Resistance	9600	6500	Ohms
Undistorted Power Output	45	110	Milliwatts
Grid-Plate Capacitance		4.1	μμf.
Grid-Filament Capacitance		2.0	μμf.
Plate-Filament Capacitance		2.3	μμf.
Maximum Overall Length			4 1/8"
Maximum Diameter			1 3/16"
Bulb (See page 42, Fig. 1)			T-8
Base			Small 4-Pin

INSTALLATION

The **base** pins of the '20 fit the standard four-contact socket. The socket should be installed to operate the tube in a vertical position. For socket connections, see page 39, Fig. 1.

The **filament** in this tube is designed for operation with three No. 6 dry-cells connected in series. In multi-tube receivers the use of six or nine No. 6 dry-cells connected in series-parallel to give 4.5 volts will decrease the current drain per cell and give a more stable source of filament power. If storage battery operation is preferred, a four-volt storage battery may be used. In any case, a filament rheostat should be provided to maintain the voltage applied to the filament within the stated range.

APPLICATION

For **power amplifier** service, the '20 will give greatest power output when operated at a plate voltage of 135 volts and the corresponding grid bias of −22.5 volts. At 90 volts on the plate and with a corresponding grid bias of −16.5 volts, good quality of reproduction may be obtained at a lower level of power output.

In receivers employing tubes of the 3.3 volt filament type, the use of the '20 in the output stage will be found desirable.

RCA Radiotron

UY-224-A

SCREEN GRID RADIO-FREQUENCY AMPLIFIER

The '24-A is a screen grid amplifier tube containing a 2.5 volt uni-potential heater-cathode which permits operation from alternating current. This tube is recommended for use primarily as a radio-frequency amplifier in carefully shielded circuits especially designed for it. The '24-A may also be used as a screen grid detector or audio amplifier.

CHARACTERISTICS

Heater Voltage (A. C. or D. C.)		2.5	Volts
Heater Current		1.75	Amperes
Plate Voltage*	180	250	Volts
Grid Voltage	−3	−3	Volts
Screen Voltage	90	90 *max.*	Volts
Plate Current	4	4	Milliamperes
Screen Current		Not over 1/3 of plate current	
Plate Resistance	400000	600000	Ohms
Amplification Factor	400	615	
Mutual Conductance	1000	1025	Micromhos
Effective Grid-Plate Capacitance		0.01 *maximum*	μμf.
Input Capacitance		5.0	μμf.
Output Capacitance		10.0	μμf.
Overall Length			$4\frac{25}{32}$" to $5\frac{1}{32}$"
Maximum Diameter			$1\frac{13}{16}$"
Bulb (See page 42, Fig. 11)			S-14
Cap			Small Metal
Base			Medium 5-Pin

* Maximum plate voltage = 275 volts.

INSTALLATION

The **base** pins of the '24-A fit the standard five-contact socket. The socket may be installed to operate the tube in any position. For socket connections, see page 39, Fig. 9.

The **heater** of the '24-A is intended for operation from a 2.5 volt winding of the power transformer. The voltage applied to the heater terminals should be the rated value of 2.5 volts under conditions of operating load and average line voltage.

The **cathode connection** to the heater should be made (1) to the movable arm of a potentiometer connected across the heater winding of the power transformer, or (2) to a mid-tapped resistor across the heater winding, or (3) to the mid-point of the heater winding itself. Recommended practice is to have no voltage difference between heater and cathode. If this practice is not followed, the heater may be made negative by not more than 45 volts.

The positive **screen voltage** for the '24-A may be obtained from a fixed or variable tap on a voltage divider across the high voltage supply, or across a portion of the supply.

Complete **shielding** in all stages of the circuit is necessary if maximum gain per stage is to be obtained.

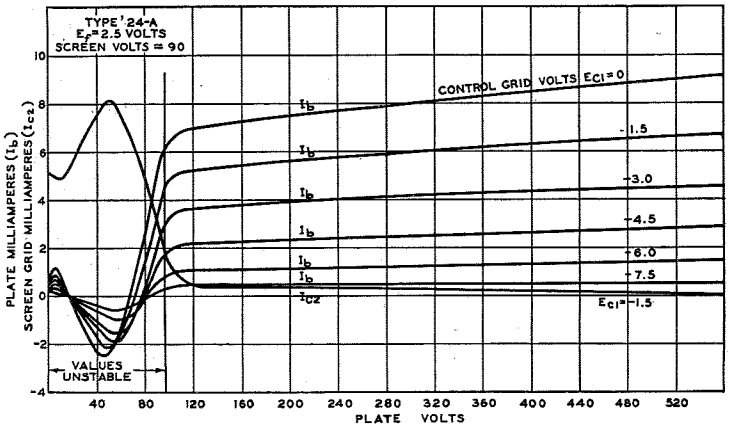
APPLICATION

As a **radio-frequency amplifier,** the '24-A should be operated at the voltages given under CHARACTERISTICS. Plate voltage and screen voltage are not critical. In general, properly designed radio-frequency transformers are preferable to inter-stage coupling impedances, especially in cases where a high impedance B-supply may cause oscillation below radio frequencies.

As a **detector,** the '24-A may be operated either with grid leak and condenser or with grid bias (see page 16). For grid bias detection suitable operating conditions are: plate supply voltage of 275 volts applied through a plate coupling resistor of 250000 ohms, a positive screen voltage of 20 to 45 volts, and a negative grid bias (approximately 5 volts) so adjusted that a plate current of 0.1 milliam-pere is obtained with no a-c input signal. For grid leak and condenser detection, suitable operating conditions are: plate supply voltage 275 volts applied through a plate coupling resistor of 250000 ohms, a positive screen voltage of 20 to 45 volts, a grid leak of 2 to 5 megohms, and a grid condenser of 0.00025 μf.

As a screen grid **audio-frequency amplifier** in resistance coupled circuits, the '24-A may be operated under the following conditions: plate supply voltage 250, grid bias −1 volt, screen voltage 25 volts, plate current 0.5 milliampere (approxi-mate), plate load resistor 0.1 to 0.25 megohm, and a grid resistor of 0.25 to 2.0 megohms.

AVERAGE PLATE CHARACTERISTICS



RCA Radiotron

UY-227

DETECTOR, AMPLIFIER

The '27 is a three-electrode general purpose tube containing a 2.5 volt heater-cathode of the equi-potential type which permits operation from alternating current.

CHARACTERISTICS

HEATER VOLTAGE (A. C. or D. C.)				2.5	Volts
HEATER CURRENT				1.75	Amperes
PLATE VOLTAGE*	90	135	180	250	Volts
GRID VOLTAGE	−6	−9	−13.5	−21	Volts
PLATE CURRENT	2.7	4.5	5.0	5.2	Milliamperes
PLATE RESISTANCE	11000	9000	9000	9250	Ohms
AMPLIFICATION FACTOR	9	9	9	9	
MUTUAL CONDUCTANCE	820	1000	1000	975	Micromhos
GRID-PLATE CAPACITANCE			3.3		μμf.
GRID-CATHODE CAPACITANCE			3.5		μμf.
PLATE-CATHODE CAPACITANCE			3.0		μμf.
MAXIMUM OVERALL LENGTH					$4\frac{11}{16}$"
MAXIMUM DIAMETER					$1\frac{13}{16}$"
BULB (See page 42, Fig. 8)					S-14
BASE					Medium 5-Pin

* Maximum plate voltage = 275 volts.

INSTALLATION

The **base** pins of the '27 fit the standard five-contact socket. The socket may be mounted to hold the tube in any position. For socket connections, see page 39, Fig. 8.

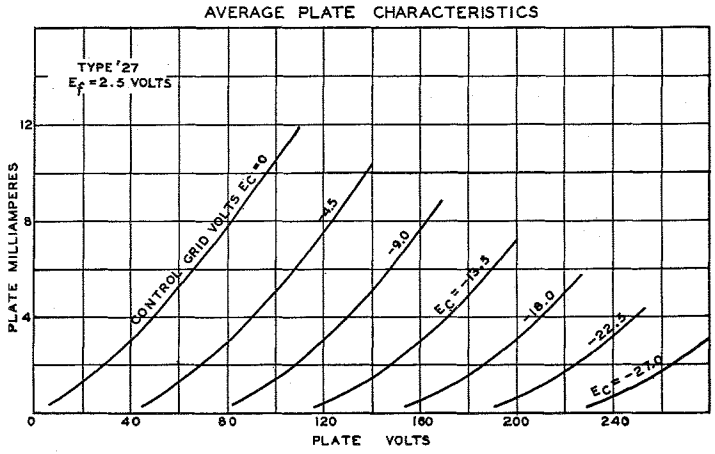
The **heater** of the '27 is intended for operation from a 2.5 volt winding of the power transformer. The voltage applied to the heater terminals should be the rated value of 2.5 volts under conditions of operation and average line voltage.

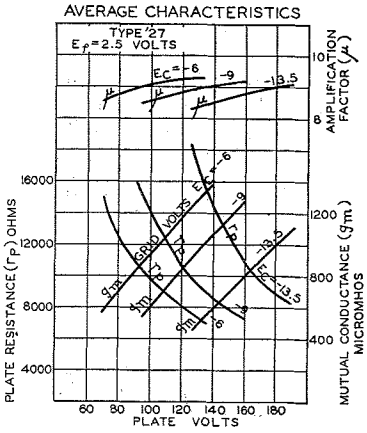
The **cathode connection** to the heater should be made (1) to the movable arm of a potentiometer connected across the heater winding of the power transformer, or (2) to a mid-tapped resistor across the heater winding, or (3) to the mid-point of the heater winding itself. Recommended practice is to have no potential difference between heater and cathode. If this practice is not followed, the heater may be biased preferably negative, but allowably positive, with respect to the cathode by not more than 45 volts.

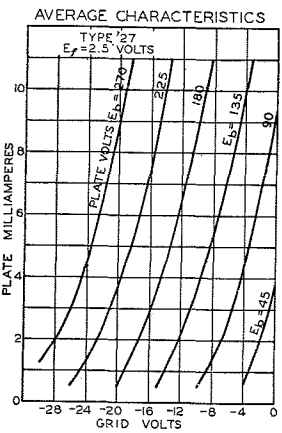
APPLICATION

As an **amplifier,** the '27 is applicable to the audio- or the radio-frequency stages of a receiver. Recommended plate and grid voltages are shown under CHARACTERISTICS.

As a **detector,** the '27 may be operated either with grid leak and condenser or with grid bias. The recommended plate voltage for grid leak and condenser detections is 45 volts (see page 16). A grid leak of from 1 to 5 megohms used with a grid condenser of 0.00025μf. is suitable. For grid bias detection, a plate voltage of 250 volts or less may be used. The corresponding grid bias should be adjusted so that the plate current when no signal is being received is approximately 0.2 milliampere. For the conditions of 250 volts on plate and transformer coupling, the grid bias will be approximately −30 volts.


AVERAGE PLATE CHARACTERISTICS
TYPE '27
E_f = 2.5 VOLTS
CONTROL GRID VOLTS EC=0
-4.5
-9.0
EC = -13.5
-18.0
-22.5
EC = -27.0
PLATE MILLIAMPERES
PLATE VOLTS
0
40
80
120
160
200
240
4
8
12


AVERAGE CHARACTERISTICS
TYPE '27
E_f = 2.5 VOLTS
AMPLIFICATION FACTOR (μ)
MUTUAL CONDUCTANCE (gm) MICROMHOS
PLATE RESISTANCE (r_p) OHMS
GRID VOLTS
PLATE VOLTS
60
80
100
120
140
160
180
4000
8000
12000
16000
400
800
1200
8
10


AVERAGE CHARACTERISTICS
TYPE '27
E_f = 2.5 VOLTS
PLATE MILLIAMPERES
PLATE VOLTS
GRID VOLTS
-28
-24
-20
-16
-12
-8
-4
0
2
4
6
8
10
270
225
180
135
90
45

RCA Radiotron

RCA-56

SUPER-TRIODE AMPLIFIER

The 56 is a three-electrode tube of the uni-potential heater-cathode type recommended for use as detector, amplifier, or oscillator in a-c receivers designed for it. This tube is characterized by its small overall size, its relatively low heater power consumption, its high mutual conductance, and its comparatively high amplification factor. The 56 is especially useful in resistance-coupled audio-frequency amplifiers.

CHARACTERISTICS

Heater Voltage (A. C. or D. C.)	2.5	Volts
Heater Current	1.0	Ampere
Plate Voltage	250 *max.*	Volts
Grid Voltage*	−13.5	Volts
Plate Current	5	Milliamperes
Plate Resistance	9500	Ohms
Amplification Factor	13.8	
Mutual Conductance	1450	Micromhos
Grid-Plate Capacitance	3.2	μμf.
Grid-Cathode Capacitance	3.2	μμf.
Plate-Cathode Capacitance	2.2	μμf.
Maximum Overall Length		4¼"
Maximum Diameter		1 9/16"
Bulb (See page 42, Fig. 6)		S-12
Base		Small 5-Pin

* If a grid coupling resistor is used, its maximum value should not exceed 1.0 megohm.

INSTALLATION

The **base** of the 56 is of the small five-pin type. Its pins fit the standard five-contact socket which may be installed to operate the tube either in a vertical or in a horizontal position. For horizontal operation, the socket should be positioned with its heater pin openings one vertically above the other. For socket connections, see page 39, Fig. 8.

The **heater** is designed to operate at 2.5 volts. The transformer winding supplying the heater circuit should be designed to operate the heater at this recommended value (as measured at the heater terminals) when rated voltage is applied to the primary of the power transformer operating under average load.

The **cathode** should be connected either to the mid-tap on the heater supply winding or to the mid-tap of a 50 ohm (approximate) resistor shunted across the winding. If this practice is not followed, the heater may be biased negative with respect to the cathode by not more than 45 volts. When the cathode is not connected directly to the heater in a-c receivers, attention should be given to keeping the impedance of the circuit between heater and cathode as low as possible. Unless this is done, hum may arise because of heater to cathode leakage.

APPLICATION

As an **amplifier,** the 56 is applicable either to radio-frequency or audio-frequency circuits. Recommended operating conditions for service using transformer coupling are given under Characteristics. For circuits utilizing resistance coupling, typical operating conditions are as follows: Plate supply voltage, 250 volts; grid bias voltage,

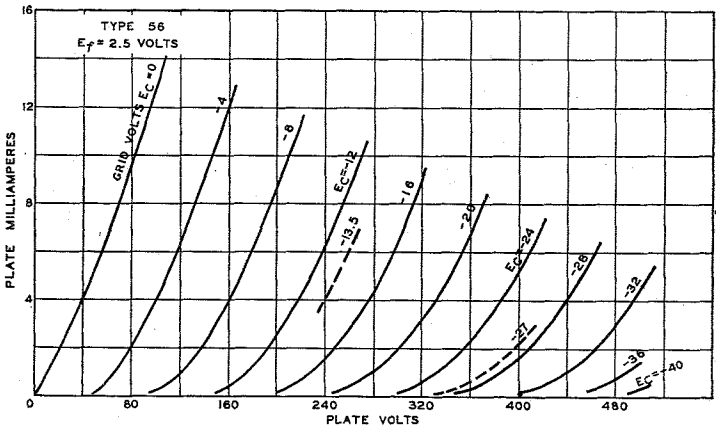
–9 volts (approximate); plate load resistor, 50000 to 100000 ohms; and plate current, 1 to 2 milliamperes.

As a **detector,** the 56 may be of the grid leak and condenser or grid bias type. The plate voltage for the grid leak and condenser method should be about 45 volts. A grid leak of from 1 to 5 megohms with a grid condenser of 0.00025 μf. is satisfactory. For the grid bias method of detection, the maximum plate supply voltage of 250 volts may be used together with a negative grid bias voltage of approximately 20 volts. The plate current should be adjusted to 0.2 milliampere with no a-c input signal voltage. The grid bias voltage may be supplied from the voltage drop in a resistor between cathode and ground. The value of this self-biasing resistor is not critical, 100000 to 150000 ohms being suitable. The higher value will permit the application of a larger input signal.

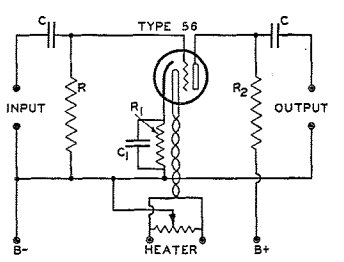
The 56 may be employed as a two-electrode detector preferably by connecting the plate to the cathode for the one electrode and using the grid for the other. With this arrangement, a-c input voltages as high as 40 volts RMS may be applied between grid and cathode.

As an **oscillator,** the 56 may be operated with a plate voltage of approximately 90 volts and zero grid bias. A lower value of plate voltage may be found desirable in some applications.

AVERAGE PLATE CHARACTERISTICS

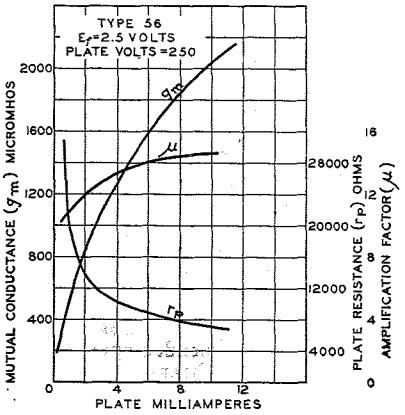


RESISTANCE-COUPLED A-F AMPLIFIER



R = GRID RESISTOR (1.0 MEGOHM, MAX.)
R_1 = SELF-BIASING RESISTOR (3000 OHMS)
R_2 = COUPLING RESISTOR (50000 TO 100000 OHMS)
C = COUPLING CONDENSER (0.1 μf. - 1.0 μf.)
C_1 = BY-PASS CONDENSER (4 μf.)

AVERAGE CHARACTERISTICS



RCA Radiotron

UX-171-A

POWER AMPLIFIER

The '71-A is a power amplifier tube of low output impedance for use in the output stage of audio-frequency amplifiers.

CHARACTERISTICS

Filament Voltage (D. C.)			5.0	Volts
Filament Current			0.25	Ampere
Plate Voltage	90	135	180 *max.*	Volts
Grid Voltage*	−16.5	−27	−40.5	Volts
Plate Current	12	17.5	20	Milliamperes
Plate Resistance	2250	1960	1850	Ohms
Amplification Factor	3	3	3	
Mutual Conductance	1330	1520	1620	Micromhos
Load Resistance	3200	3500	5350	Ohms
Undistorted Power Output	125	370	700	Milliwatts
Grid-Plate Capacitance		7.4		μμf.
Grid-Filament Capacitance		3.7		μμf.
Plate-Filament Capacitance		2.1		μμf.
Maximum Overall Length				$4\frac{11}{16}$"
Maximum Diameter				$1\frac{13}{16}$"
Bulb (See page 42, Fig. 8)				S-14
Base				Medium 4-Pin

* For operation on a-c filament supply, increase grid bias voltage 2.5 volts.

INSTALLATION

The **base** pins of this tube fit the standard four-contact socket. The socket should be installed so that the tube will operate in a vertical position. For socket connections, see page 39, Fig. 1.

The coated **filament** of the '71-A may be operated from a storage battery or from the a-c line through a step-down transformer. For operation of this tube from a storage battery, a fixed or variable resistor of suitable value is required to reduce the battery voltage to 5.0 volts across the filament terminals at the socket. Most satisfactory operating performance of the tube will be obtained at the rated filament voltage.

APPLICATION

Operating conditions are given under Characteristics for the use of this tube in the power output stage. With a d-c filament supply, the grid and the plate return should be made to the negative filament terminal.

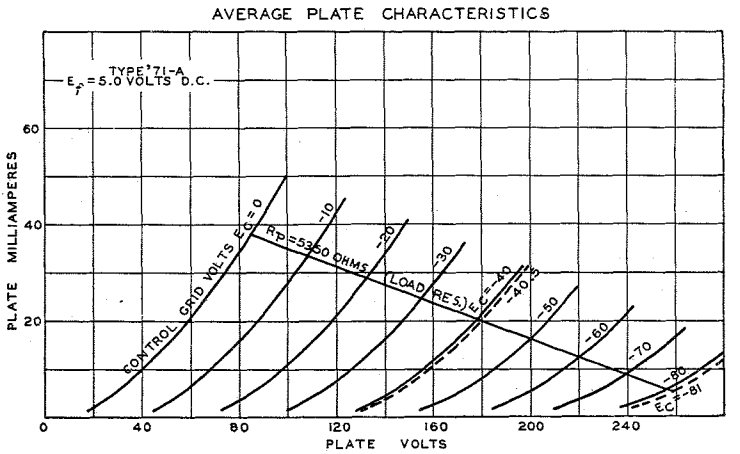
For a-c filament supply, the plate and the grid return should be brought either to a mid-tapped resistor of 20 to 40 ohms across the filament winding, or to a mid-tap of the filament winding. To prevent overloading and distortion, the recommended negative grid bias should always be used.

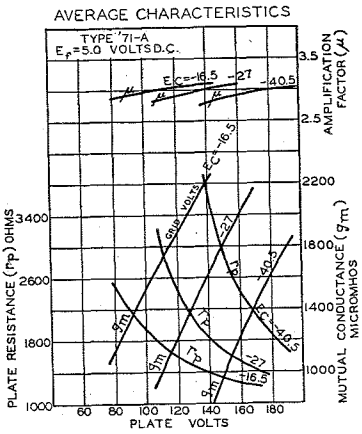
Grid bias for the '71-A may be obtained from a C-battery or by means of the voltage drop in a resistor connected in the negative plate return lead. This second method is known as the self-biasing method, since the plate current determines the

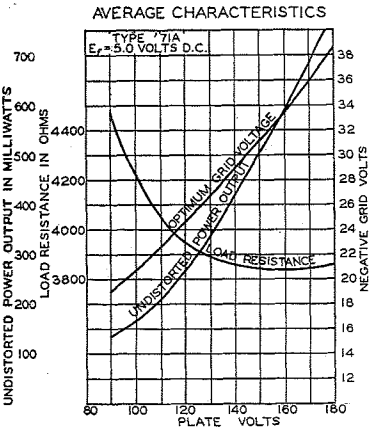
drop. It is not, however, generally applicable to battery operated receivers. The proper value of this resistor for a plate voltage of 180 volts is 2150 ohms; for a plate voltage of 135 volts, 1700 ohms; and for 90 volts, 1600 ohms.

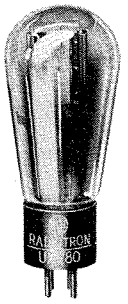
If more output is desired than can be obtained from a single '71, two '71's may be operated either in parallel or push-pull connection. See page 13. When two '71's are operated together in the same amplifier stage, the values of the self-biasing resistors will be approximately one-half the values given above for a single tube.

An **output device** should be used to transfer power to the winding of the reproducing unit.









RCA Radiotron

UX-280

FULL-WAVE RECTIFIER

The '80 is a full-wave rectifying tube intended for use in d-c power supply devices which operate from the a-c supply line.

CHARACTERISTICS

	FILAMENT VOLTAGE (A. C.)	5.0	Volts
	FILAMENT CURRENT	2.0	Amperes
1	A-C VOLTAGE PER PLATE (RMS)	350	Volts
	D-C OUTPUT CURRENT	125 *max.*	Milliamperes
2	A-C VOLTAGE PER PLATE (RMS)	400 *max.*	Volts
	D-C OUTPUT CURRENT	110 *max.*	Milliamperes
3*	A-C VOLTAGE PER PLATE (RMS)	550 *max.*	Volts
	D-C OUTPUT CURRENT	135 *max.*	Milliamperes
	MAXIMUM OVERALL LENGTH		5 5/8"
	MAXIMUM DIAMETER		2 3/16"
	BULB (See page 42, Fig. 10)		S-17
	BASE		Medium 4-Pin

* This rating is permissible only with filter circuits having an input choke of at least 20 henries.

INSTALLATION

The **base** pins of the '80 fit the standard four-contact socket which should be mounted preferably to hold the tube in a vertical position. If it is necessary to place the tube in a horizontal position, the socket should be mounted with both of the filament pin openings, either at the top or at the bottom. This precaution locates the filament plane vertical for most satisfactory performance. For socket connections, see page 39, Fig. 2. Provision should be made for free circulation of air around the bulb since it becomes quite hot during operation.

The coated **filament** of the '80 is designed to operate from the a-c line through a step-down transformer. The voltage applied to the filament terminals should be the rated value of 5.0 volts under operating conditions and average line voltage.

The approximate **d-c output voltage** of the '80 for various values of a-c input voltages may be obtained from the curves. For the d-c voltage available at the radio set, it is necessary to subtract the voltage drop across the filter from the value read from the curves.

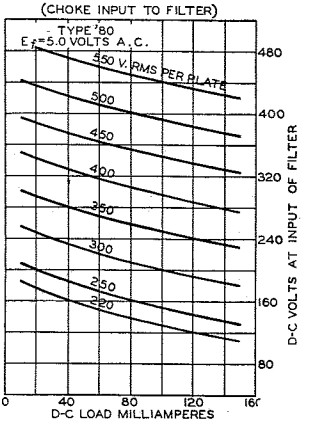
The **filter** may be of either the condenser-input or choke-input type. If an input condenser is used, consideration must be given to the instantaneous peak value of the a-c input voltage. The peak value is about 1.4 times the RMS value as measured by most a-c voltmeters. Filter condensers, therefore, especially the input condenser, should have a rating high enough to withstand the instantaneous peak value, if breakdown is to be avoided. When the input-choke method is used, the available d-c output voltage will be somewhat lower than with the input-condenser method for a given a-c plate voltage. However, improved regulation together with lower peak current will be obtained.

APPLICATION

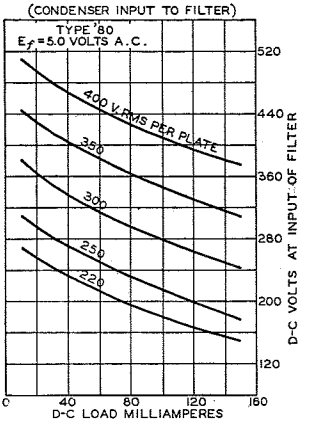
As a **full-wave rectifier,** the '80 may be operated with condenser-input or choke-input filter under conditions not to exceed the ratings given under CHARACTERISTICS.

As a **half-wave rectifier,** two '80's may be operated in a full-wave circuit with reasonable serviceability to deliver more d-c output current than can be obtained from one tube. For this use, the plates of each '80 are tied together at the socket. The allowable voltage and load conditions per tube are the same as for full-wave service.

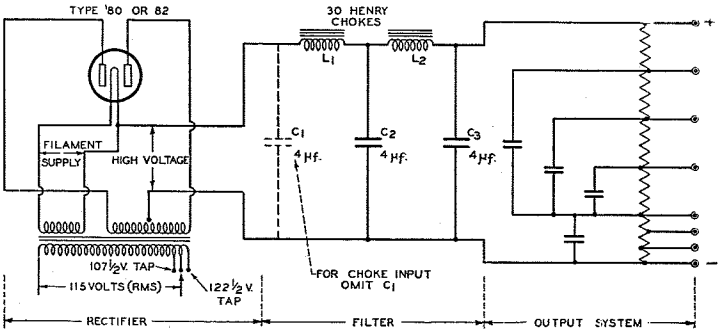
OUTPUT CHARACTERISTICS
(CHOKE INPUT TO FILTER)



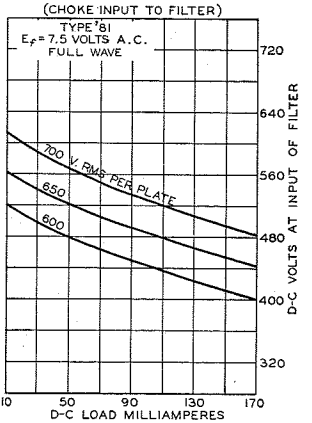
OUTPUT CHARACTERISTICS
(CONDENSER INPUT TO FILTER)



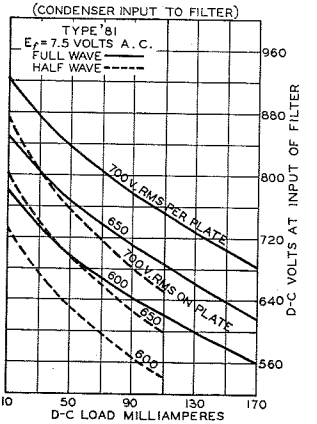
TYPICAL FULL-WAVE RECTIFIER CIRCUIT



OUTPUT CHARACTERISTICS
(CHOKE INPUT TO FILTER)



OUTPUT CHARACTERISTICS
(CONDENSER INPUT TO FILTER)



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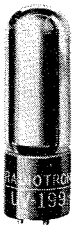

UV-199 AND UX-199

DETECTORS, AMPLIFIERS

The '99 types are three-electrode, general purpose tubes designed for dry-cell operation. The low power consumption of these tubes makes them applicable to portable receivers and services where power economy is important. The two types have different bases.

CHARACTERISTICS

FILAMENT VOLTAGE (D. C.)	3.0-3.3		Volts
FILAMENT CURRENT	0.060-0.063		Ampere
PLATE VOLTAGE	90 *max.*		Volts
GRID VOLTAGE	−4.5		Volts
PLATE CURRENT	2.5		Milliamperes
PLATE RESISTANCE	15500		Ohms
AMPLIFICATION FACTOR	6.6		
MUTUAL CONDUCTANCE	425		Micromhos
GRID-PLATE CAPACITANCE	3.3		μμf.
GRID-FILAMENT CAPACITANCE	2.5		μμf.
PLATE-FILAMENT CAPACITANCE	2.5		μμf.
	Type '99	*X-Type* '99	
MAXIMUM OVERALL LENGTH	3½"	4⅛"	
MAXIMUM DIAMETER	1 1/16"	1 3/16"	
BULB (See Figs. on page 42)	T-8 (Fig. 3)	T-8 (Fig. 1)	
BASE	Small 4-Nub	Small 4-Pin	

INSTALLATION

The **base** pins of the X-Type '99 fit the standard four-contact socket while the '99 fits only the small shell socket with bayonet slot. The socket should be installed so that the tubes will operate in a vertical position. Cushioning of the socket in the detector stage may be desirable if microphonic disturbances are encountered. For socket connections of X-Type '99 and of '99, see page 39, Fig. 1 and Fig. 10, respectively.

The **filaments** in these tubes are designed for operation with three No. 6 dry-cells connected in series. In multi-tube receivers the use of six or nine No. 6 dry-cells connected in series-parallel to give 4.5 volts will decrease the current drain per cell and give a more stable source of filament power. If storage-battery operation is preferred, a four-volt storage battery may be used. In any case, a filament rheostat should be provided so that the filament voltage can be adjusted to the recommended operating value.

APPLICATION

As **detectors,** '99's may be operated either with grid leak and condenser or with grid bias. The recommended plate voltage for the former method is 45 volts. A grid leak of from 1 to 5 megohms used with a grid condenser of 0.00025 μf. is satisfactory. The grid circuit return should be connected to the positive filament terminal. For grid bias detection the maximum plate voltage of 90 volts may be used with the corresponding negative grid bias of 10.5 volts. The grid bias should be adjusted so that the plate current is 0.2 milliampere with no a-c input signal.

As **amplifiers,** '99's are applicable to the audio- or the radio-frequency stages of a receiver. Recommended plate and grid voltages are shown under CHARACTERISTICS.