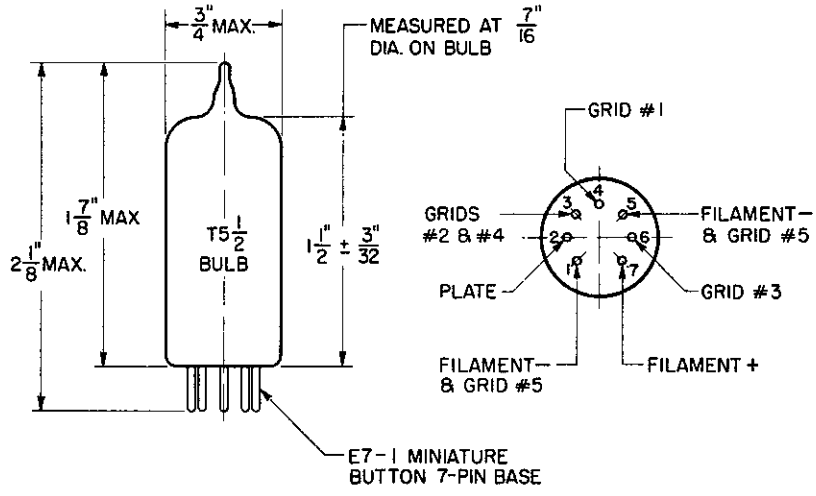
ADVANCE ELECTRON TUBE DATA SHEET

WESTERN ELECTRIC 400A ELECTRON TUBE

400A
MINIATURE
PENTAGRID
CONVERTER



CLASSIFICATION

Miniature Pentagrid Converter

MOUNTING

This tube may be mounted in any position

MAXIMUM RATINGS (Design Center Values)

Plate Voltage	135	volts
Grids #2 and #4 Voltage	135	volts
Cathode Current	7	milliamperes

OPERATING CONDITIONS AND CHARACTERISTICS

Filament Voltage	1.3	volts
Filament Current	200	milliamperes
Plate Voltage	90	volts
Grids #2 and #4 Voltage	45	volts
Grid #1 Resistor	100,000	ohms
Plate Current	0.9	milliampere
Cathode Current	2.7	milliamperes
Conversion Transconductance	230	micromhos

INTERELECTRODE CAPACITANCES (No Shield)

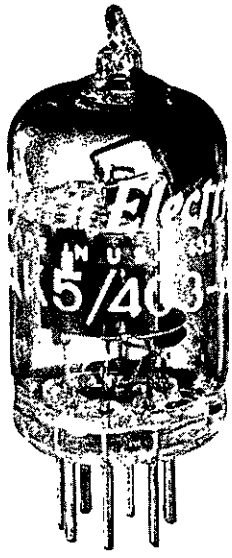
Grid #3 to All Other Electrodes	8.0	μμf
Plate to All Other Electrodes	8.0	μμf
Grid #3 to Plate	0.25	μμf

ISSUE 1 8-18-47

PRINTED IN U.S.A.

Western Electric

Western Electric



PENTODE
MINIATURE

Western Electric

DESCRIPTION

The 6AK5/403A* is a 7-pin miniature pentode having an indirectly heated cathode. It is designed for use in amplifier circuits at high and ultra high frequencies.

CHARACTERISTICS

Heater Voltage		6.3 volts
Plate Current	$E_b = E_{c2} = 120$ volts; Cathode-Bias Resistor = 200 ohms	7.5 milliamperes
Transconductance	$E_b = E_{c2} = 120$ volts; Cathode-Bias Resistor = 200 ohms	5000 micromhos

GENERAL CHARACTERISTICS

ELECTRICAL DATA

Heater Voltage, A-C or D-C	6.3 volts
Heater Current	175 milliamperes

Direct Interelectrode Capacitances	without external shield	with external shield (RMA #316)
Grid to Plate (maximum)	.019	*.010 uuf
Input	3.9	*4.0 uuf
Output	2.0	*2.9 uuf

MECHANICAL DATA

Cathode	Coated Unipotential
Bulb	T5½
Base	Miniature Button 7-pin
Mounting Position	Any

Dimensions and pin connections shown in outline drawing on Page 4

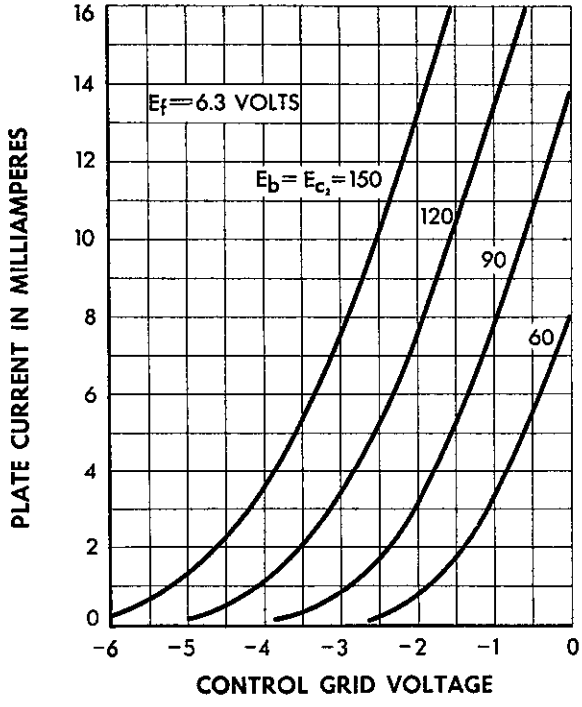
MAXIMUM RATINGS, Design-Center Values

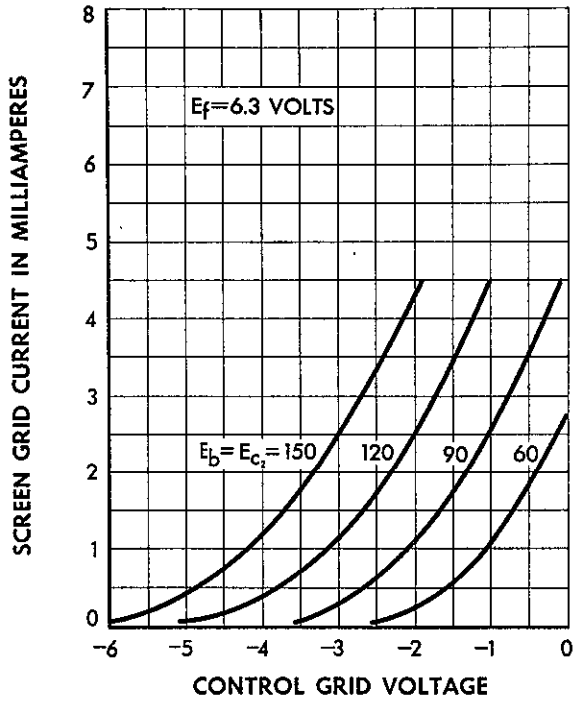
Plate Voltage	180 volts
Screen Grid Voltage	140 volts
Plate Dissipation	1.7 watts
Screen Grid Dissipation	0.5 watt
Cathode Current	18 milliamperes
Heater-Cathode Voltage	90 volts
Bulb Temperature	120 centigrade

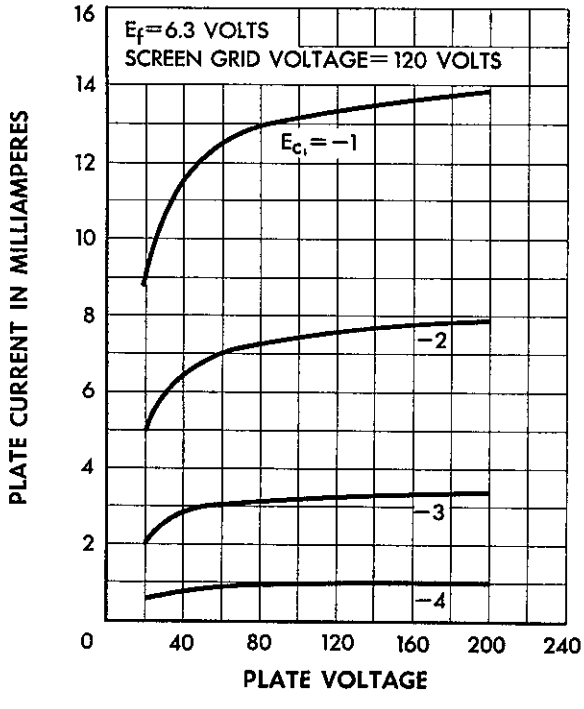
TYPICAL OPERATING CONDITIONS AND CHARACTERISTICS – CLASS A_1 AMPLIFIER

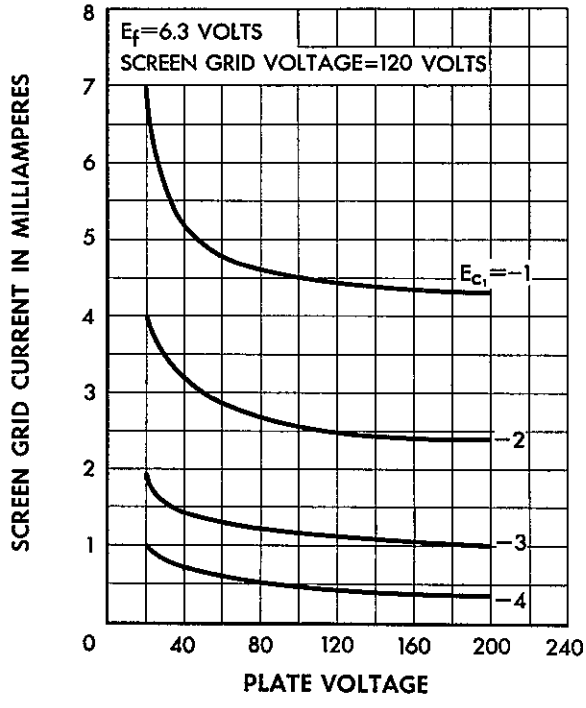
Plate Voltage	120	150	180	volts
Screen Grid Voltage	120	140	120	volts
Cathode-Bias Resistor	200	330	200	ohms
Plate Current	7.5	6.6	7.7	milliamperes
Screen Grid Current	2.5	2.1	2.4	milliamperes
Plate Resistance	0.30	0.40	0.45	megohm
Transconductance	5000	4500	5100	micromhos
Grid Voltage, Approximate, for Plate Current of 10 Microamperes	−6.8	−7.8	−6.9	volts

*External shield connected to cathode pins 2 and 7.


PLATE CURRENT IN MILLIAMPERES
16
14
12
10
8
6
4
2
0
E_f=6.3 VOLTS
E_b=E_{c_2}=150
120
90
60
−6
−5
−4
−3
−2
−1
0
CONTROL GRID VOLTAGE

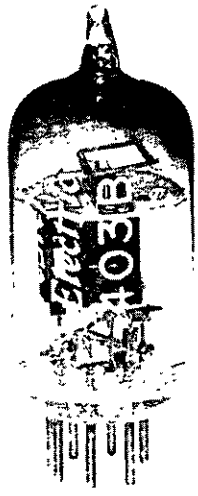

SCREEN GRID CURRENT IN MILLIAMPERES
8
7
6
5
4
3
2
1
0
E_f=6.3 VOLTS
E_b=E_{c_2}=150
120
90
60
−6
−5
−4
−3
−2
−1
0
CONTROL GRID VOLTAGE


PLATE CURRENT IN MILLIAMPERES
16
14
12
10
8
6
4
2
0
E_f=6.3 VOLTS
SCREEN GRID VOLTAGE=120 VOLTS
E_{c_1}=−1
−2
−3
−4
40
80
120
160
200
240
PLATE VOLTAGE


SCREEN GRID CURRENT IN MILLIAMPERES
8
7
6
5
4
3
2
1
0
E_f=6.3 VOLTS
SCREEN GRID VOLTAGE=120 VOLTS
E_{c_1}=−1
−2
−3
−4
40
80
120
160
200
240
PLATE VOLTAGE

ELECTRON TUBE DATA SHEET

WESTERN ELECTRIC 403 B ELECTRON TUBE



DESCRIPTION

The 403B is a 7 pin miniature pentode with an indirectly heated cathode. It is designed for use in amplifier circuits at high and ultra high frequencies.

CHARACTERISTICS

Heater Voltage		6.3	volts
Plate Current	$E_b = E_{c2}$ = 120 volts; Cathode Bias Resistor = 200 ohms	7.5	milliamperes
Transconductance		5000	micromhos

FILE: MINIATURE SECTION

© American Telephone and Telegraph Company 1962

GENERAL CHARACTERISTICS

Electrical Data

Heater Voltage, A-C or D-C (Note 1)		6.3	volts
Heater Current		150	milliamperes
Direct Interelectrode Capacitances	without external shield	with external shield (JEDEC #316)	
Grid to Plate (maximum)	.019	*.010	μμf
Input: g1 to (h+k+g2+g3+i.s.)	3.9	* 4.0	μμf
Output: p to (h+k+g2+g3+i.s.)	2.0	* 2.9	μμf

Mechanical Data

Cathode	Coated Unipotential
Bulb	T 5½
Base	Miniature Button 7 pin
Mounting Position	Any

Dimensions and pin connections shown in outline drawing on Page 4.

MAXIMUM RATINGS, Absolute System (Note 2)

Plate Voltage	200	volts
Screen Grid Voltage	155	volts
Plate Dissipation	1.85	watts
Screen Grid Dissipation	0.55	watt
Cathode Current	20	milliamperes
Heater Cathode Voltage	130	volts
Bulb Temperature	130	centigrade
Maximum Grid Circuit Resistance		
For Fixed Bias	1.0	megohm
For Cathode Bias	2.0	megohms

TYPICAL OPERATING CONDITIONS AND CHARACTERISTICS - Class A_1 Amplifier

Plate Voltage	120	150	180	volts
Screen Grid Voltage	120	140	120	volts
Cathode Bias Resistor (Note 3)	200	330	200	ohms
Plate Current	7.0	6.6	7.4	milliamperes
Screen Gird Current	2.2	2.1	2.1	milliamperes
Plate Resistance	0.30	0.40	0.45	megohm
Transconductance	5000	4500	5100	micromhos
Grid Voltage, Approximate, for Plate Current of 10 Microamperes	-6.8	-7.8	-6.9	volts

* External shield connected to cathode pins 2 and 7.

Note 1: For optimum tube life the heater voltage specified (6.3 volts) should be regulated to ±5%.

Note 2: In the "Absolute System" the maximum ratings specified are limiting values above which the serviceability of the device may be impaired from the viewpoint of life and satisfactory performance. Maximum ratings, as such, do not constitute a set of operating conditions and all values may not, therefore, be attained simultaneously.

Note 3: Operation with the control grid positive with respect to the cathode is not recommended.

←Indicates a change

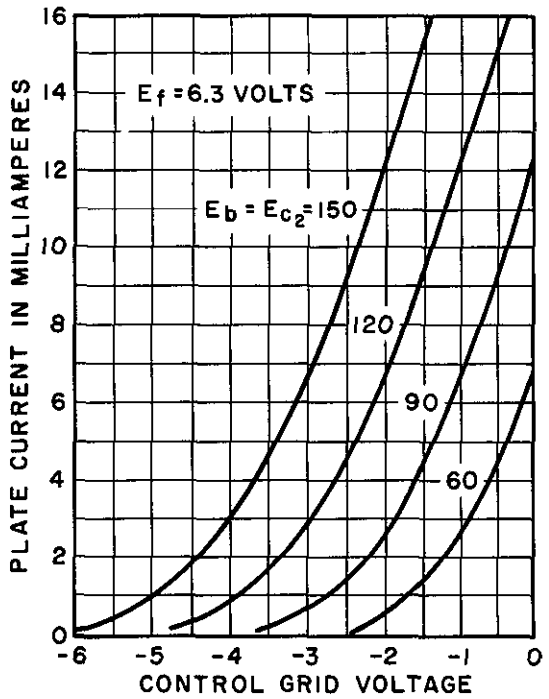


FIG. 1

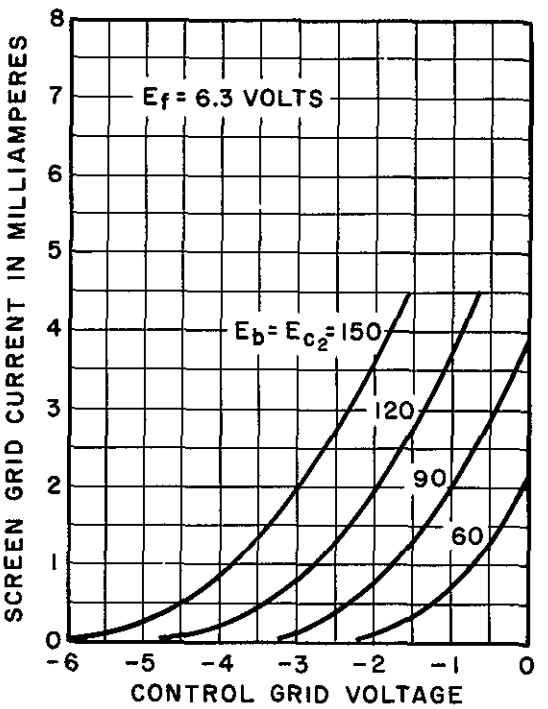


FIG. 2

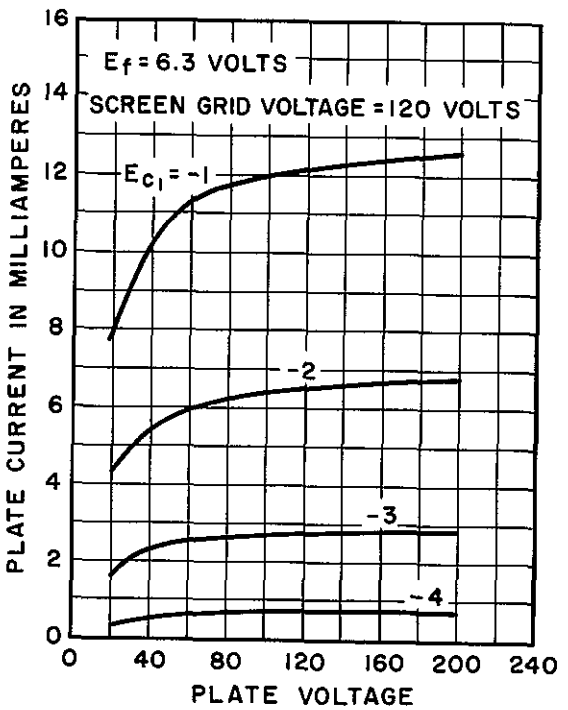


FIG. 3

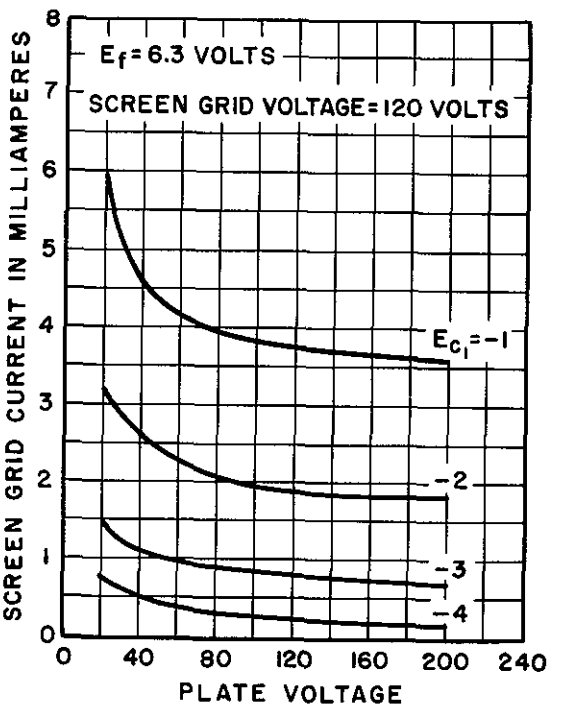


FIG. 4

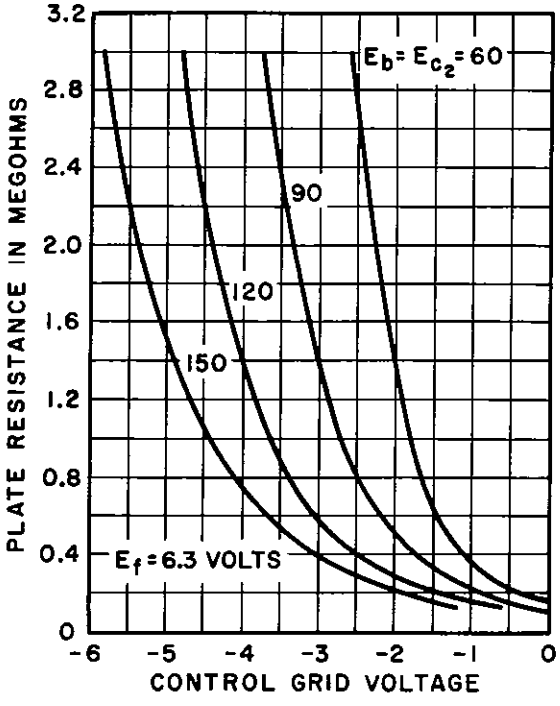


FIG.5

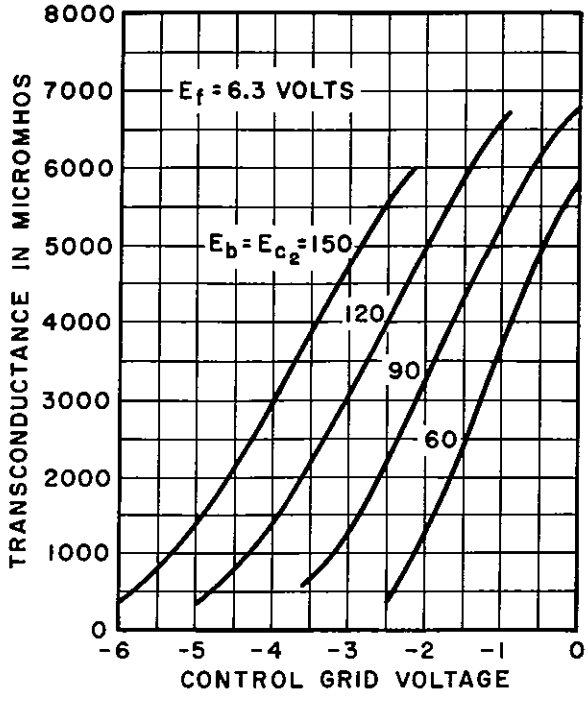
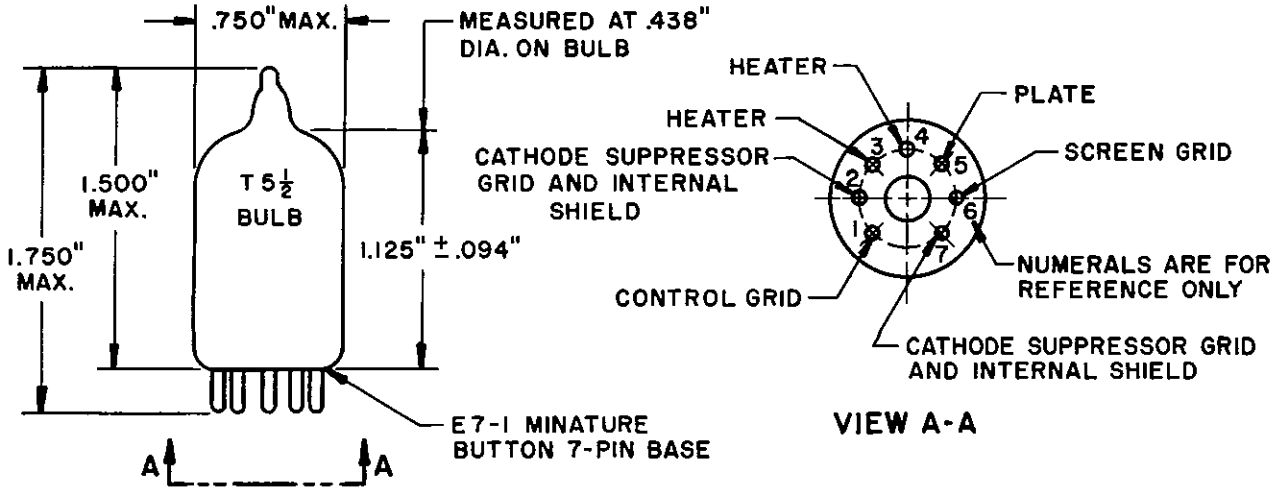


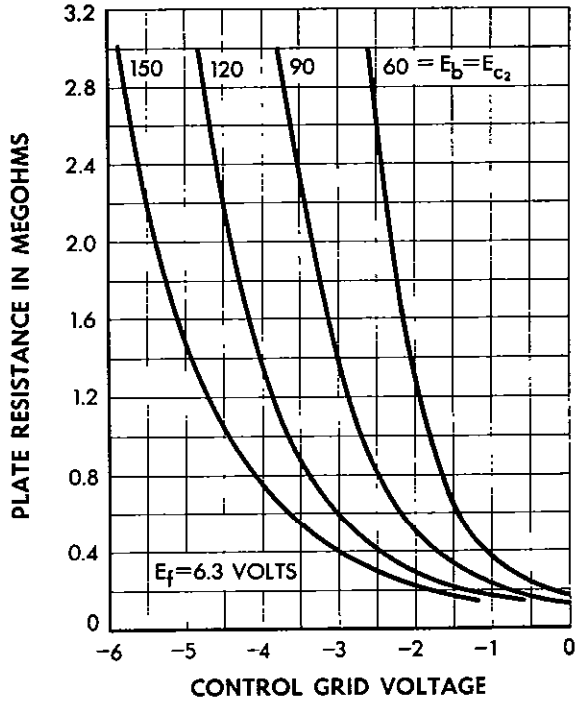
FIG. 6

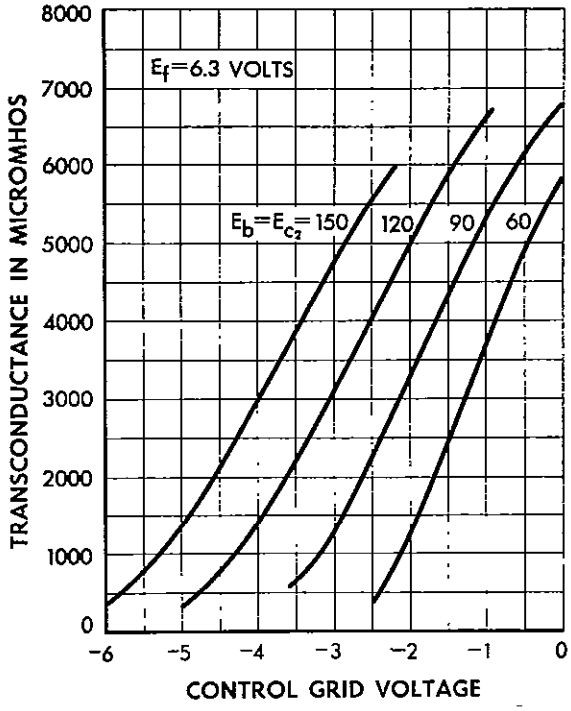


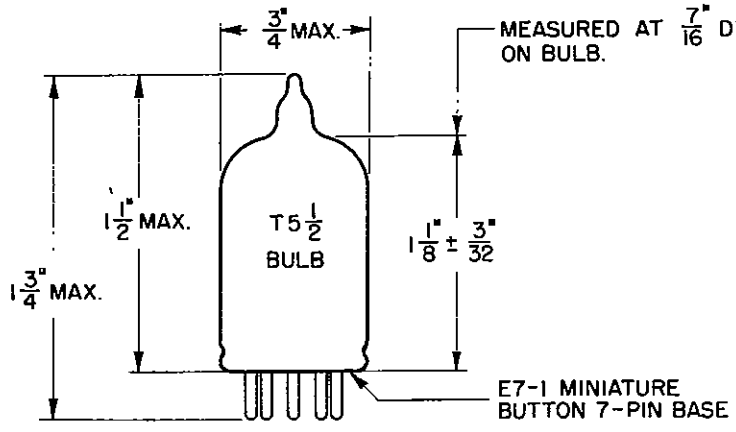
VIEW A-A

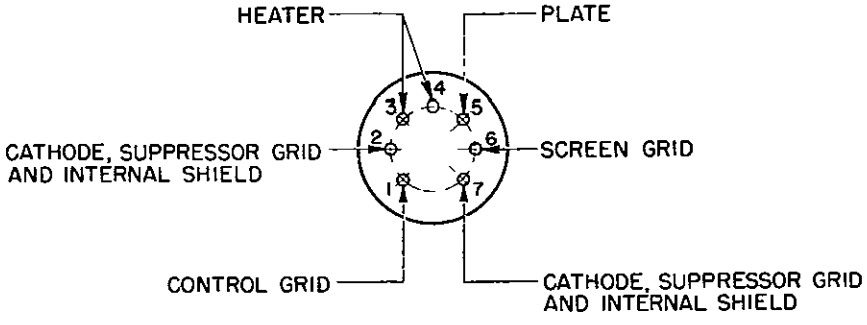
A development of Bell Telephone Laboratories, the research laboratories of the American Telephone and Telegraph Company and the Western Electric Company.

PRINTED IN U.S.A.









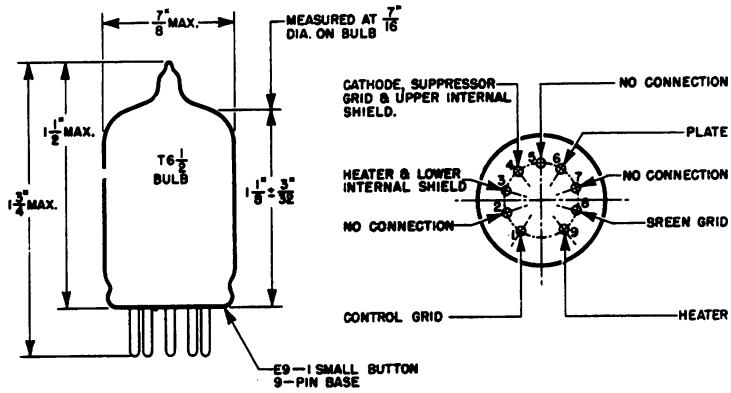
Western Electric

A development of Bell Telephone Laboratories, the research laboratories of the American Telephone and Telegraph Company and the Western Electric Company.

ADVANCE ELECTRON TUBE DATA SHEET

WESTERN ELECTRIC 5847/404A ELECTRON TUBE

5847/404A
MINIATURE PENTODE



DESCRIPTION

This tube is a miniature pentode of the unipotential cathode type. It is designed for use in high-gain amplifiers at high and ultra-high frequencies.

MAXIMUM RATINGS (Design Center Values)

Plate Voltage	180	volts
Screen-Grid Voltage	150	volts
Plate Dissipation	3	watts
Screen-Grid Dissipation	0.75	watt
Cathode Current	35	milliamperes
Heater-Cathode Voltage	50	volts
Grid Resistance	0.1	megohm
Bulb Temperature	120°	Centigrade

GENERAL CHARACTERISTICS

ELECTRICAL DATA

Heater Voltage, A-C or D-C	6.3	volts
Heater Current	300	milliamperes

Direct Interelectrode Capacitances

	Without External Shield	With External Shield (RMA #315)	
Grid to Plate, Maximum	.0 5	.0 4	μμf
Input	7.0	7.1	μμf
Output	2.5	2.9	μμf

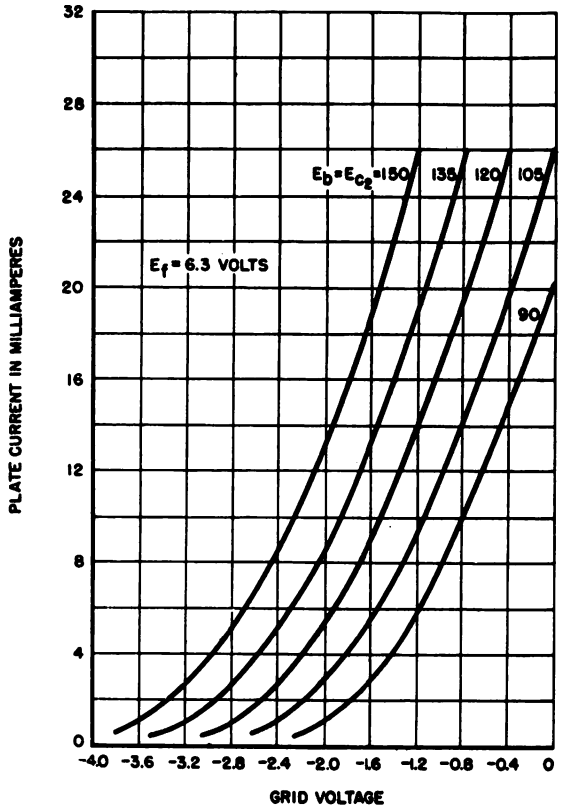
MECHANICAL DATA

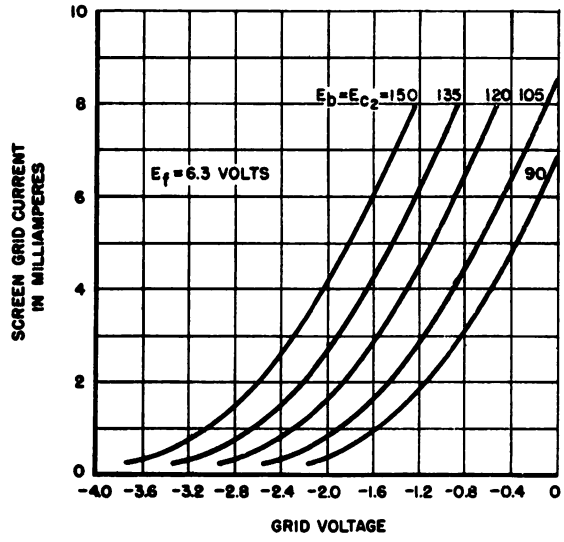
Cathode	Coated Unipotential
Bulb	T 6-1/2
Base	Small Button, 9-pin
Mounting Position	Any

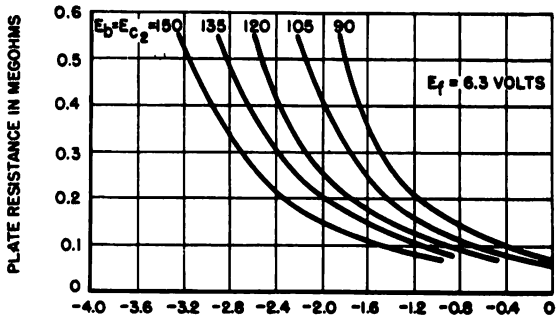
OPERATING CONDITIONS AND CHARACTERISTICS

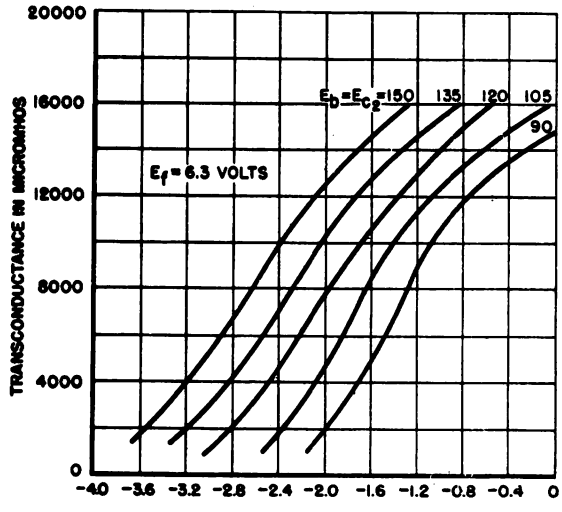
		*	
Plate Supply Voltage	150	160	volts
Screen-Grid Supply Voltage	150	160	volts
Control Grid Voltage	0	+8.5	volts
Plate Current	13	13	milliamperes
Screen-Grid Current	4.5	4.5	milliamperes
Cathode Resistor	110	600	ohms
Transconductance	12500	12500	micromhos

*Operating conditions to minimize gain variations due to supply voltage fluctuations.

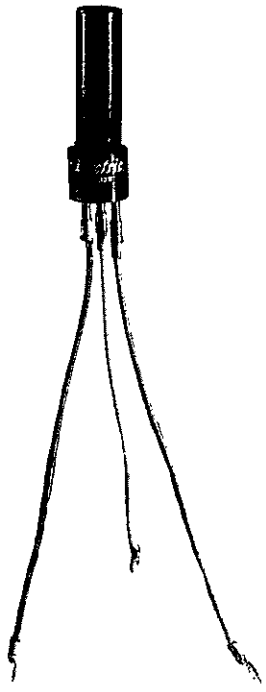

PLATE CURRENT IN MILLIAMPERES
32
28
24
20
16
12
8
4
0
$E_b=E_{c_2}$=150
135
120
105
90
E_f = 6.3 VOLTS
-4.0 -3.6 -3.2 -2.8 -2.4 -2.0 -1.6 -1.2 -0.8 -0.4 0
GRID VOLTAGE


SCREEN GRID CURRENT IN MILLIAMPERES
10
8
6
4
2
0
$E_b=E_{c_2}$=150
135
120
105
90
E_f = 6.3 VOLTS
-4.0 -3.6 -3.2 -2.8 -2.4 -2.0 -1.6 -1.2 -0.8 -0.4 0
GRID VOLTAGE


PLATE RESISTANCE IN MEGOHMS
0.6
0.5
0.4
0.3
0.2
0.1
0
$E_b=E_{c_2}$=150
135
120
105
90
E_f = 6.3 VOLTS
-4.0 -3.6 -3.2 -2.8 -2.4 -2.0 -1.6 -1.2 -0.8 -0.4 0


TRANSCONDUCTANCE IN MICROMHOS
20000
16000
12000
8000
4000
0
$E_b=E_{c_2}$=150
135
120
105
90
E_f = 6.3 VOLTS
-4.0 -3.6 -3.2 -2.8 -2.4 -2.0 -1.6 -1.2 -0.8 -0.4 0

OK for Plant & Dept use.
S. F. H. 6/15/0



COLD CATHODE

Western Electric

DESCRIPTION

The 405A is a three-electrode, inert-gas-filled, cold cathode tube for use primarily as a relay in communication circuits. It is also suitable for use in control circuits such as in triggering, counting or switching apparatus. This tube, because of its small size, flexible connector leads and ease in mounting, may be used to advantage in equipment where space is a factor.

MAXIMUM RATINGS

Peak Anode Voltage	.....	165 volts
Average Cathode Current	4	40 milliamperes
Average Life	10000	10 hours

MAXIMUM RATINGS, Absolute Values

Peak Anode Voltage	
Forward	165 volts
Inverse	165 volts
Forward Cathode Current	
Peak	40 milliamperes
Average	15 milliamperes
Averaging Time	1 second
Peak Inverse Anode Current	1 milliampere
Ambient Temperature Limits	−55 to +85 centigrade

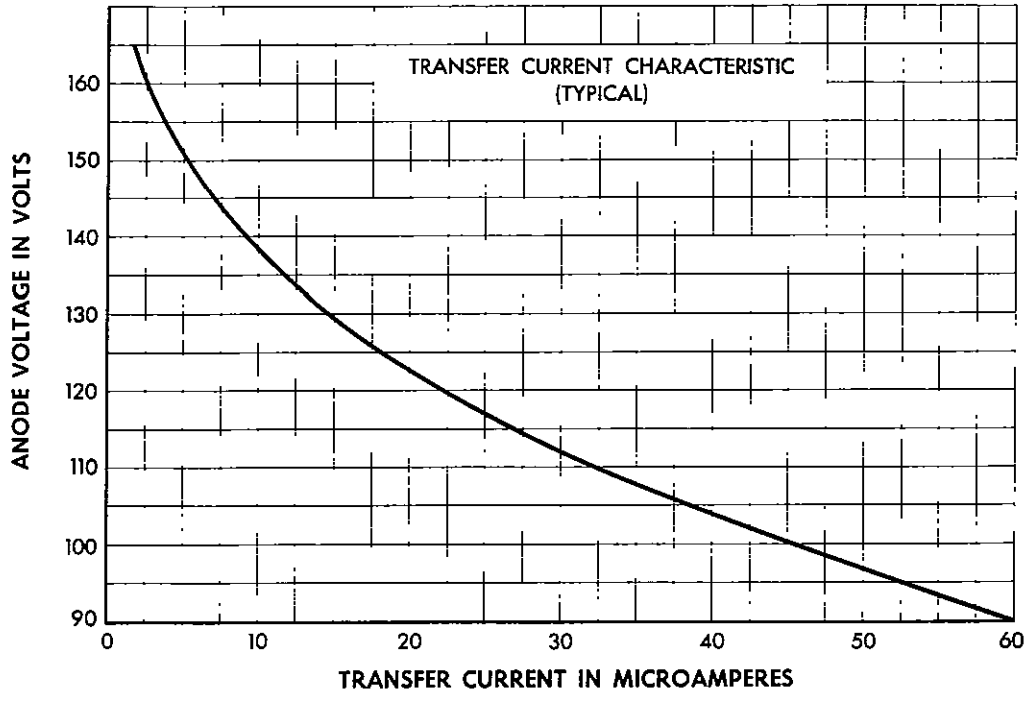
ELECTRICAL DATA

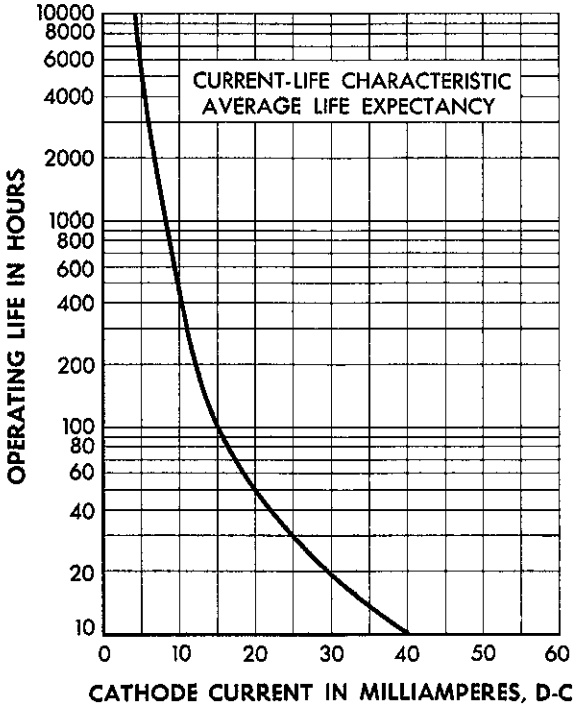
	Min.	Bogey	Max.	
Starter Breakdown Voltage*	67	75	89	volts
Starter Voltage Drop at 10 milliamperes	52	60	74	volts
Anode Voltage Drop at 10 milliamperes	66	75	90	volts
Required Transfer Current at 130 Anode Volts (D. C.)	50	...	...	microamperes
Deionization Time, Approximate				
Starter Gap	...	2	...	milliseconds
Main Gap	...	8	...	milliseconds

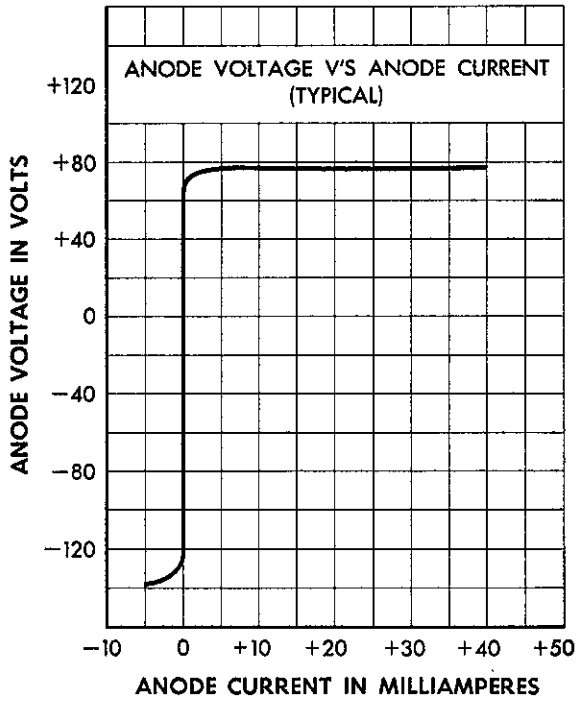
MECHANICAL DATA

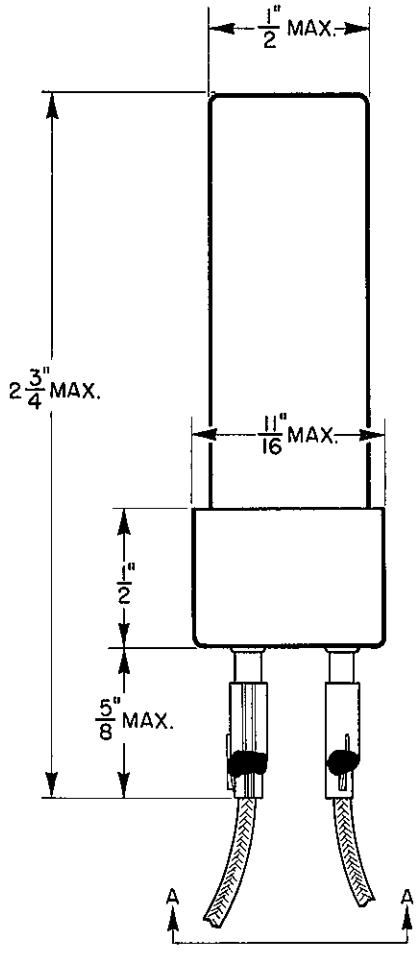
Mounting Position	Any
Net Weight, Approximate	0.4 ounce

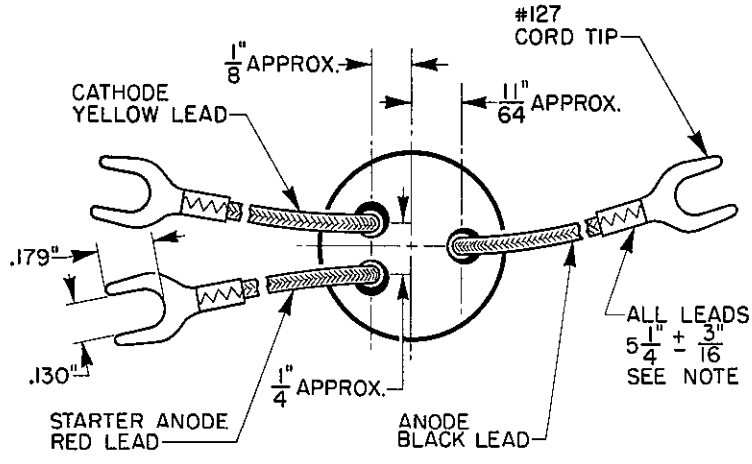
*Limits apply immediately after tube has conducted current. If tube has been idle, these values may be as much as 3 volts higher or lower.











VIEW A–A

NOTE: LEAD LENGTHS SPECIFIED REFER TO LENGTH FROM END OF BASE SHELL TO END OF SPADE.

Western Electric

A development of Bell Telephone Laboratories, the research laboratories of the American Telephone and Telegraph Company and the Western Electric Company.

1-D-50-4 PRINTED IN U. S. A. T-2651

ELECTRON TUBE DATA SHEET

WESTERN ELECTRIC 407A ELECTRON TUBE



DESCRIPTION

The 407A is a 9-pin miniature double triode with separate indirectly heated cathodes. It is designed for use in amplifier, mixer, oscillator, multivibrator and clamp circuits. The useful frequency range extends through the VHF range.

CHARACTERISTICS

		Parallel		Series	
Heater Voltage		20	or	40	volts
Plate Current per Section	E_b = 150 volts, E_c = -2.0 volts			8.2	milliamperes
Transconductance per Section	E_b = 150 volts, E_c = -2.0 volts			5500	micromhos

FILE: MINIATURE SECTION

© American Telephone and Telegraph Company, 1962

GENERAL CHARACTERISTICS

Electrical Data	Parallel	Series	
Heater Voltage, A-C or D-C (Note 1)	20	40	volts
Heater Current	100	50	milliamperes
Direct interelectrode Capacitances	without external shield	with external shield (JEDEC #315)	
Grid-to-Plate per Section	1.3	* 1.3	μμf
Input per Section	2.2	* 2.3	μμf
Output per Section	1.0	* 1.3	μμf
Plate-to-Plate	0.04	**0.03	μμf
Plate-to-Plate (maximum)	0.11	**0.10	μμf

Mechanical Data

Cathode	Coated unipotential
Bulb	T 6½
Base	Small button, 9-pin
Mounting Position	Any

Dimensions and pin connections shown in outline drawing on page 4.

MAXIMUM RATINGS, Absolute System (Note 2)

Values are for each section

Plate Voltage	330	volts
Plate Dissipation	1.6	watts
Plate Current	20	milliamperes
Heater Cathode Voltage	130	volts
Maximum Grid Circuit Resistance for		
Fixed Bias	1	megohm
Cathode Bias	2	megohm

TYPICAL OPERATING CONDITIONS AND CHARACTERISTICS - Class A_1 Amplifier

Values are for each section

Plate Voltage	150	150	volts
Grid Voltage	-2.0	-	volts
Cathode Resistor	-	240	ohms
Plate Current	8.2	8.2	milliamperes
Transconductance	5500	5500	micromhos
Amplification Factor	35	35	
Grid Voltage (Approximate) for Plate Current of 10 microamperes	- 8	-	volts

* Pin 5 and external shield (EIA #315) connected to cathode pin of section under test. Elements of other section grounded.

** Pin 5 and external shield (EIA #315) connected to ground with other elements.

→ Indicates a change

TYPICAL OPERATING CONDITIONS - Class AB_1 Amplifier

Plate Voltage	200	300	volts
Cathode Resistor (Cathodes Tied Together)	400	800	ohms
Peak A-F Grid-to-Grid Voltage	9.0	20	volts
Zero Signal Plate Current per Section	5.0	4.7	milliamperes
Maximum Signal Plate Current per Section	5.6	6.0	milliamperes
Load Impedance, Plate-to-Plate	30000	40000	ohms
Signal Power Output	0.40	0.95	watt
Total Harmonic Distortion Less Than	5	10	per cent

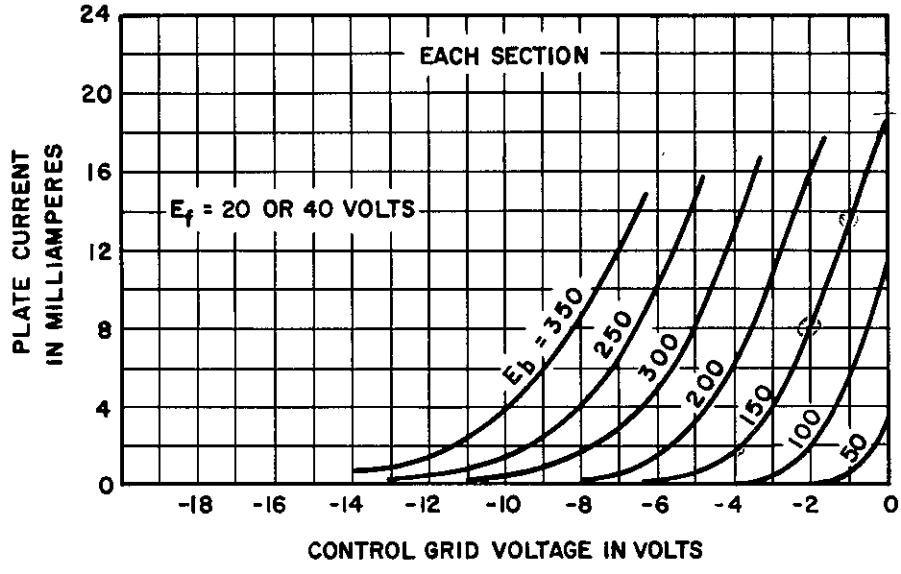


FIG. 1

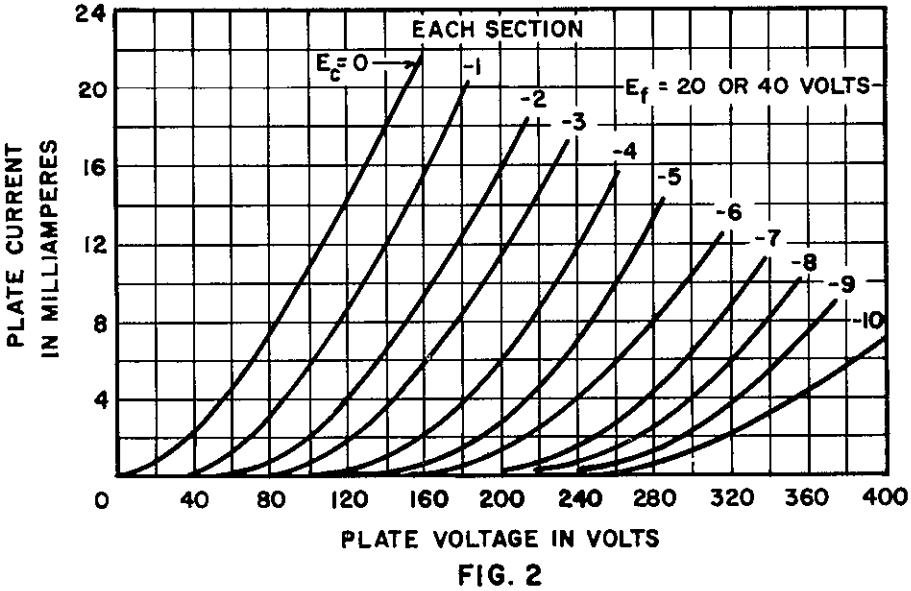


FIG. 2

Note 1: For optimum tube life the heater voltage specified (20 or 40 volts) should be regulated to ±5%.

Note 2: In the "Absolute System" the maximum ratings specified are limiting values above which the serviceability of the device may be impaired from the viewpoint of life and satisfactory performance. Maximum ratings, as such, do not constitute a set of operating conditions and all values may not, therefore, be attained simultaneously.

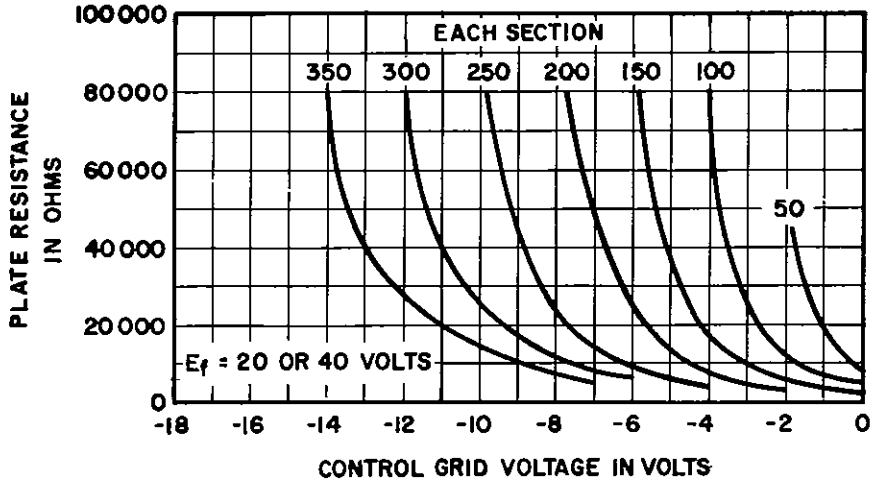


FIG. 3

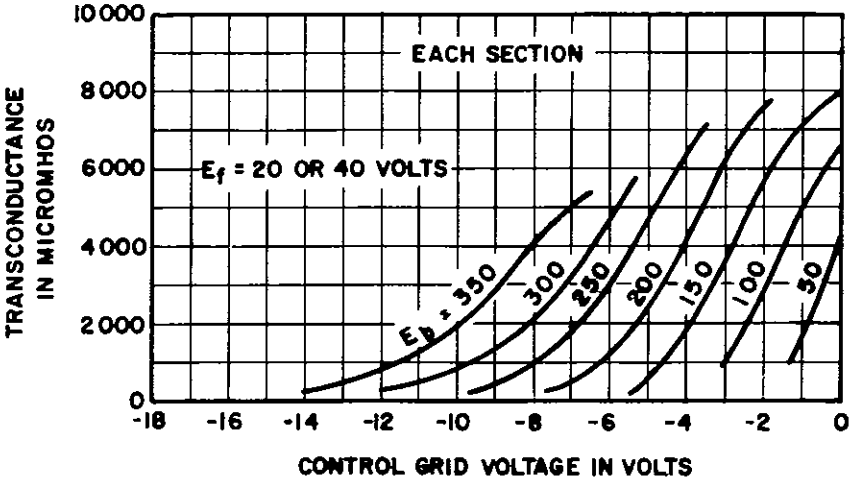
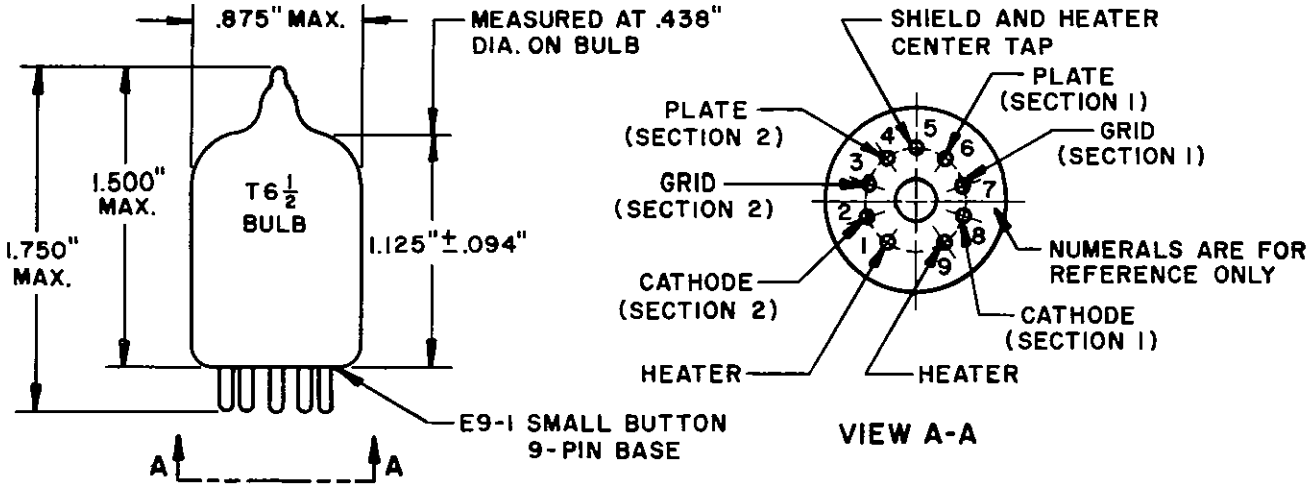


FIG. 4

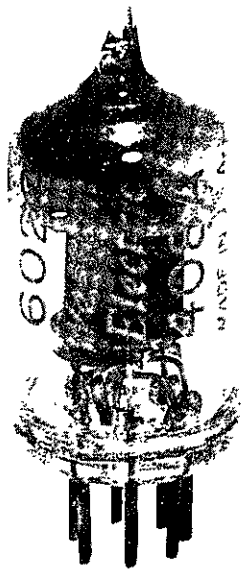


A development of Bell Telephone Laboratories, the research laboratories of the American Telephone and Telegraph Company and the Western Electric Company.

PRINTED IN U.S.A.

ELECTRON TUBE DATA SHEET

WESTERN ELECTRIC 408A* ELECTRON TUBE



DESCRIPTION

The 6028/408A* is a 7-pin miniature pentode having an indirectly heated cathode. It is designed for use in amplifier circuits at high and ultra high frequencies. It is also suitable for audio-frequency applications where exceptionally low microphonic noise is not a requirement.

CHARACTERISTICS

Heater Voltage		20 volts
Plate Current	$E_b = E_{c2}$ = 120 volts; Cathode-Bias Resistor = 200 ohms	7.5 milliamperes
Transconductance	$E_b = E_{c2}$ = 120 volts; Cathode-Bias Resistor = 200 ohms	5000 micromhos

GENERAL CHARACTERISTICS

ELECTRICAL DATA

Heater Voltage, A-C or D-C	20 volts
Heater Current	50 milliamperes

Direct Interelectrode Capacitances	without external shield	with external shield (RMA # 316)
Grid to Plate (maximum)	.019	*.010 uuf
Input	3.9	*4.0 uuf
Output	2.0	*2.9 uuf

MECHANICAL DATA

Cathode	Coated Unipotential
Bulb	T5 1/2
Base	Miniature Button 7-pin
Mounting Position	Any

Dimensions and pin connections shown in outline drawing on Page 5

MAXIMUM RATINGS, Design-Center Values

Plate Voltage	180 volts
Screen Grid Voltage	140 volts
Plate Dissipation	1.7 watts
Screen Grid Dissipation	0.5 watt
Cathode Current	18 milliamperes
Heater-Cathode Voltage[1]	120 volts
Bulb Temperature	120°centigrade

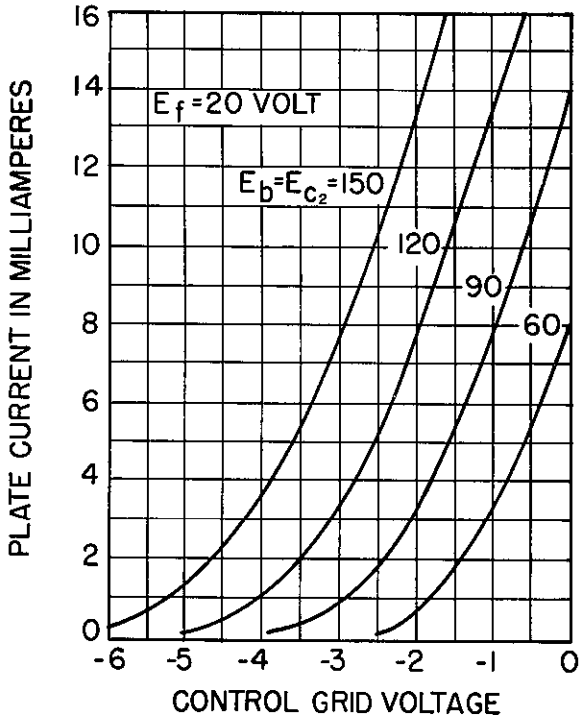
Maximum Grid Current Resistance for	
Fixed Bias	1.0 megohm
Cathode Bias	2.0 megohms

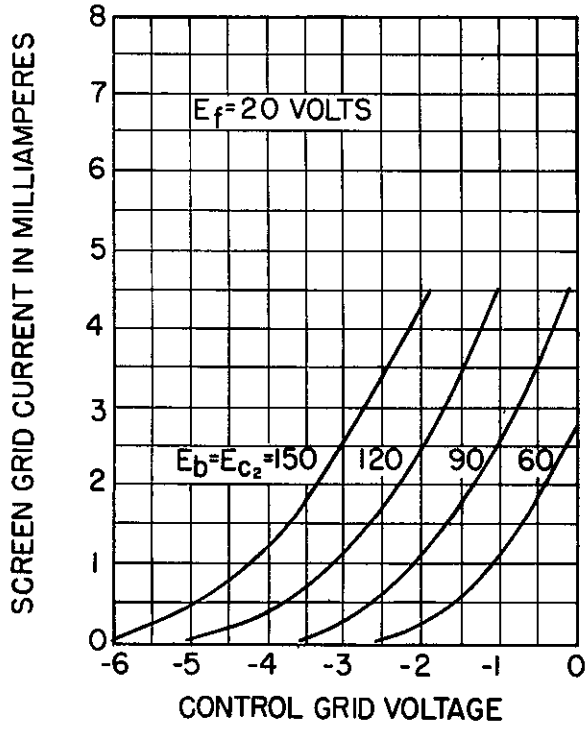
TYPICAL OPERATING CONDITIONS AND CHARACTERISTICS - CLASS A_1 AMPLIFIER

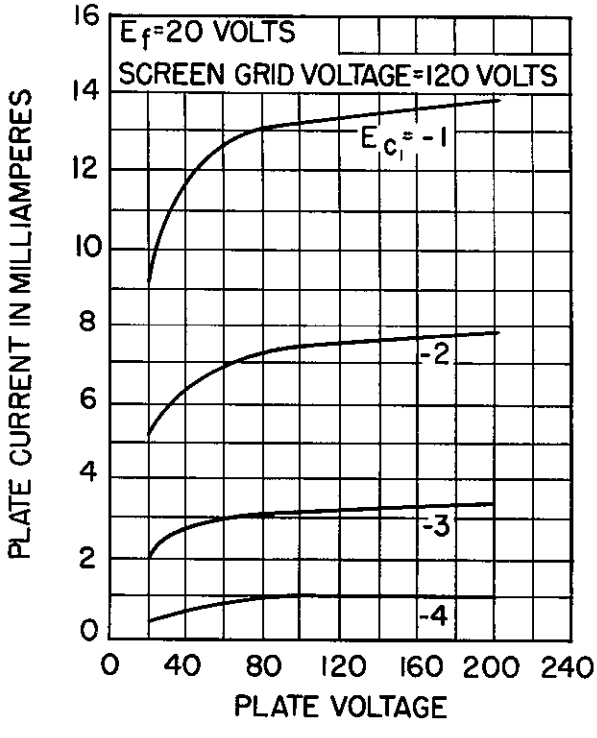
Plate Voltage	120	120 volts
Screen Grid Voltage	120	120 volts
Cathode-Bias Resistor	200	130 ohms
Peak A-F Grid Voltage	2.0	1.5 volts
Zero Signal Plate Current	7.5	9.4 milliamperes
Maximum Signal Plate Current	7.7	9.2 milliamperes
Zero Signal Screen Grid Current	2.5	3.2 milliamperes
Maximum Signal Screen Grid Current	3.3	3.9 milliamperes
Plate Resistance	0.30	0.25 megohm
Transconductance	5000	5600 micromhos
Load Resistance	15000	15000 ohms
Power Output	325	265 milliwatts
Total Harmonic Distortion	12	5.5 per cent
Grid Voltage, Approximate, for Plate Current of 10 Microamperes	-6.8	-6.8 volts

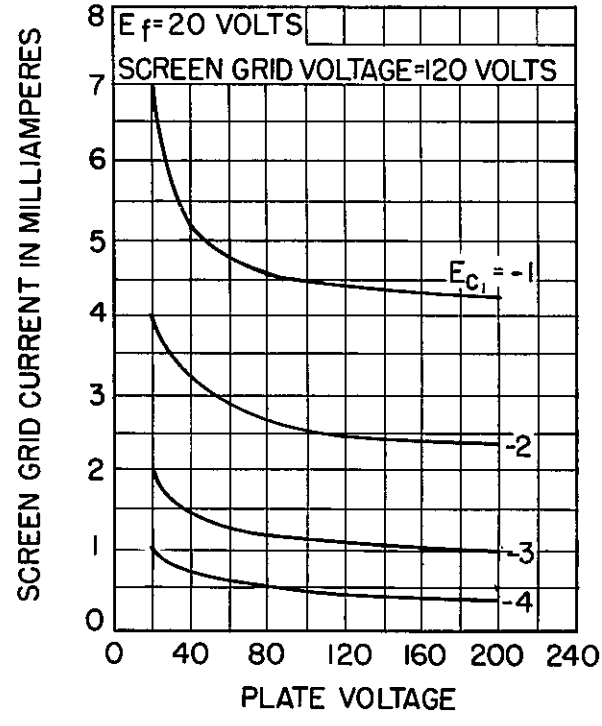
* External shield connected to cathode pins 2 and 7.

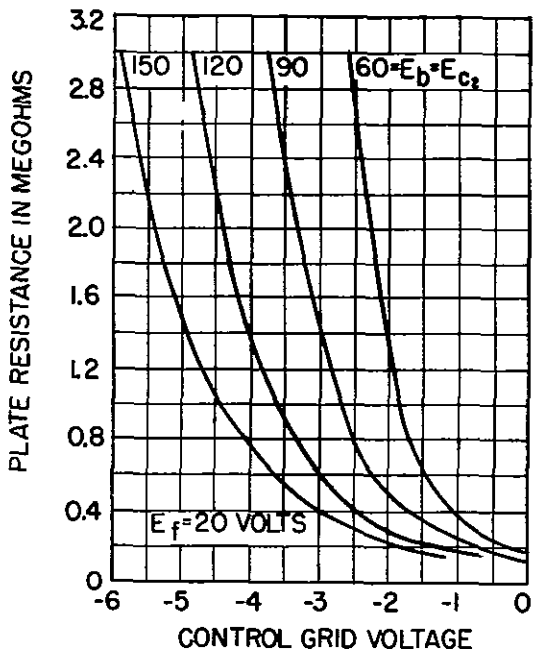
Note 1. For optimum tube life it is recommended that heater-cathode voltage should not exceed 90 volts.

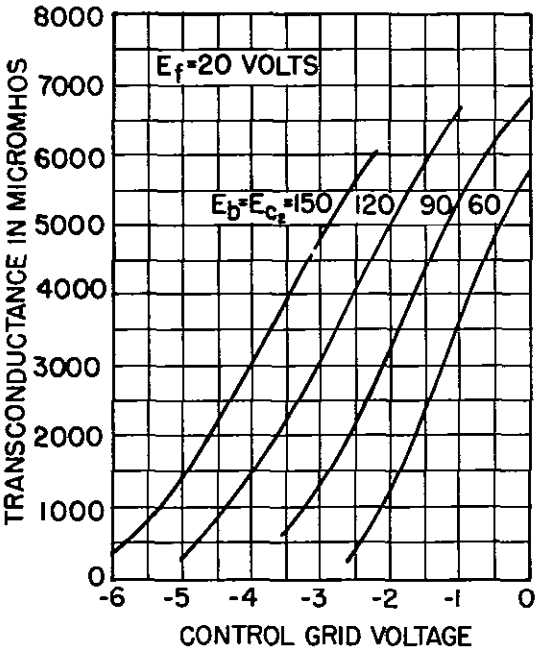

PLATE CURRENT IN MILLIAMPERES
16
14
12
10
8
6
4
2
0
E_f=20 VOLT
E_b=E_{c_2}=150
120
90
60
-6
-5
-4
-3
-2
-1
0
CONTROL GRID VOLTAGE

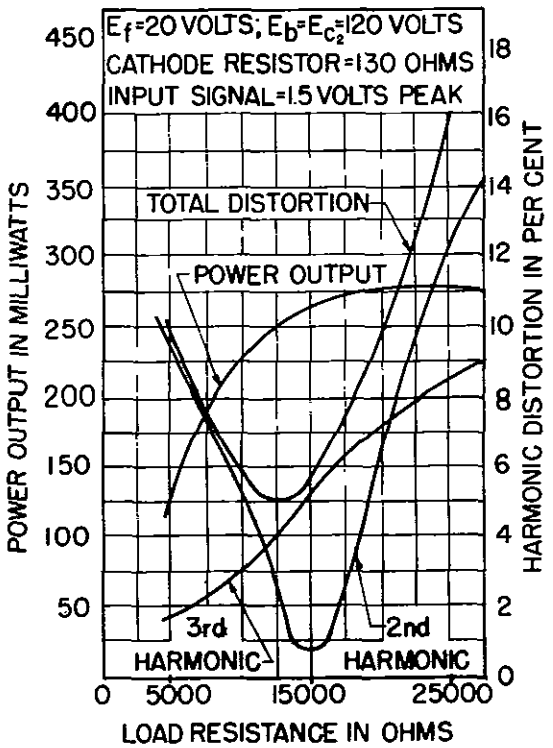

SCREEN GRID CURRENT IN MILLIAMPERES
8
7
6
5
4
3
2
1
0
E_f=20 VOLTS
E_b=E_{c_2}=150
120
90
60
-6
-5
-4
-3
-2
-1
0
CONTROL GRID VOLTAGE

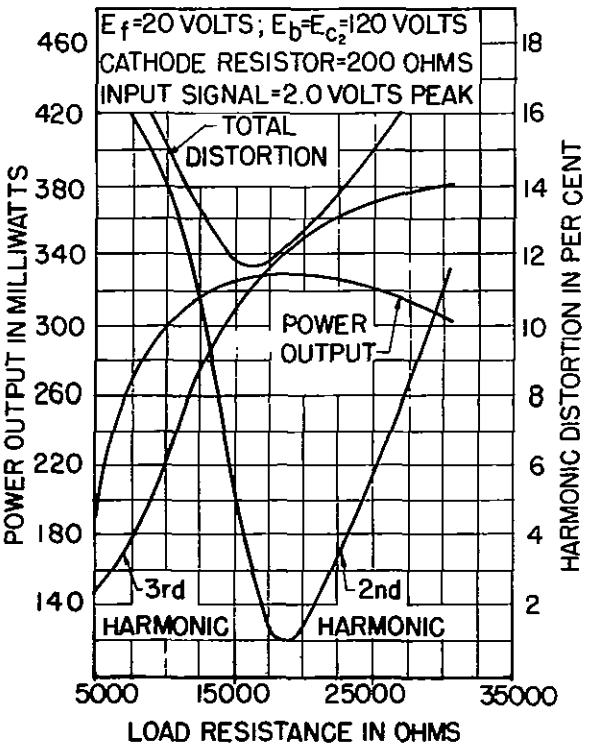

PLATE CURRENT IN MILLIAMPERES
16
14
12
10
8
6
4
2
0
E_f=20 VOLTS
SCREEN GRID VOLTAGE=120 VOLTS
E_{c_1}=-1
-2
-3
-4
0
40
80
120
160
200
240
PLATE VOLTAGE

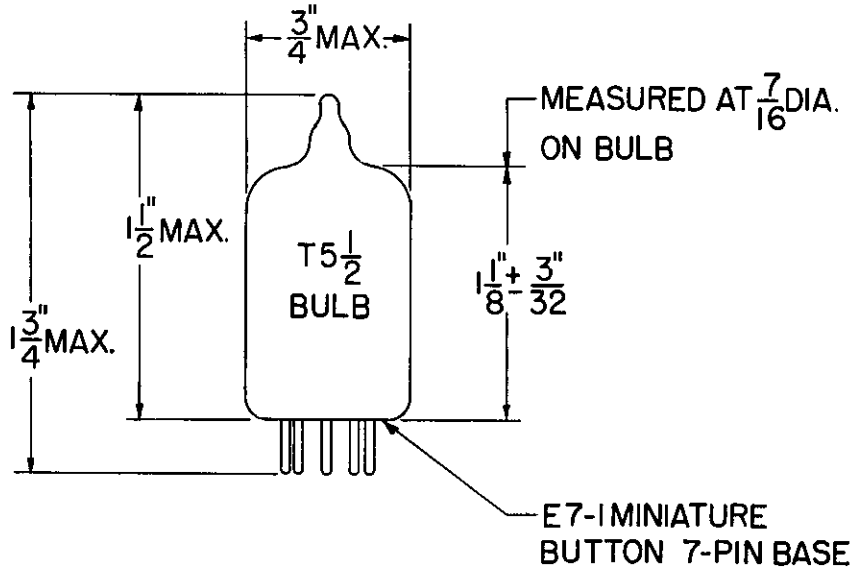

SCREEN GRID CURRENT IN MILLIAMPERES
8
7
6
5
4
3
2
1
0
E_f=20 VOLTS
SCREEN GRID VOLTAGE=120 VOLTS
E_{c_1}=-1
-2
-3
-4
0
40
80
120
160
200
240
PLATE VOLTAGE

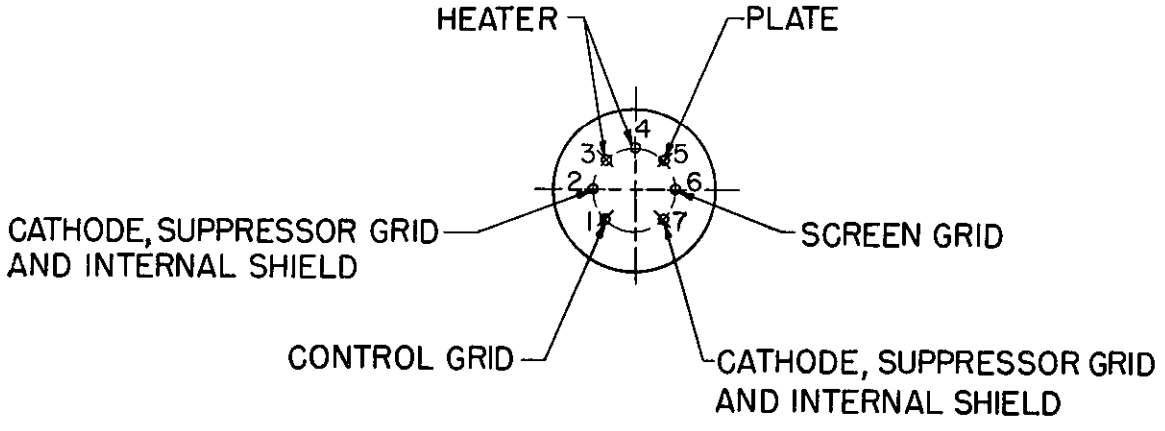

PLATE RESISTANCE IN MEGOHMS
3.2
2.8
2.4
2.0
1.6
1.2
0.8
0.4
0
150
120
90
60=Eb=Ec2
Ef=20 VOLTS
-6
-5
-4
-3
-2
-1
0
CONTROL GRID VOLTAGE


TRANSCONDUCTANCE IN MICROMHOS
8000
7000
6000
5000
4000
3000
2000
1000
0
Ef=20 VOLTS
Eb=Ec2=150
120
90
60
-6
-5
-4
-3
-2
-1
0
CONTROL GRID VOLTAGE


Ef=20 VOLTS; Eb=Ec2=120 VOLTS
CATHODE RESISTOR=130 OHMS
INPUT SIGNAL=1.5 VOLTS PEAK
POWER OUTPUT IN MILLIWATTS
450
400
350
300
250
200
150
100
50
TOTAL DISTORTION
POWER OUTPUT
3rd HARMONIC
2nd HARMONIC
HARMONIC DISTORTION IN PER CENT
18
16
14
12
10
8
6
4
2
0
0
5000
15000
25000
LOAD RESISTANCE IN OHMS


Ef=20 VOLTS; Eb=Ec2=120 VOLTS
CATHODE RESISTOR=200 OHMS
INPUT SIGNAL=2.0 VOLTS PEAK
POWER OUTPUT IN MILLIWATTS
460
420
380
340
300
260
220
180
140
TOTAL DISTORTION
POWER OUTPUT
3rd HARMONIC
2nd HARMONIC
HARMONIC DISTORTION IN PER CENT
18
16
14
12
10
8
6
4
2
5000
15000
25000
35000
LOAD RESISTANCE IN OHMS



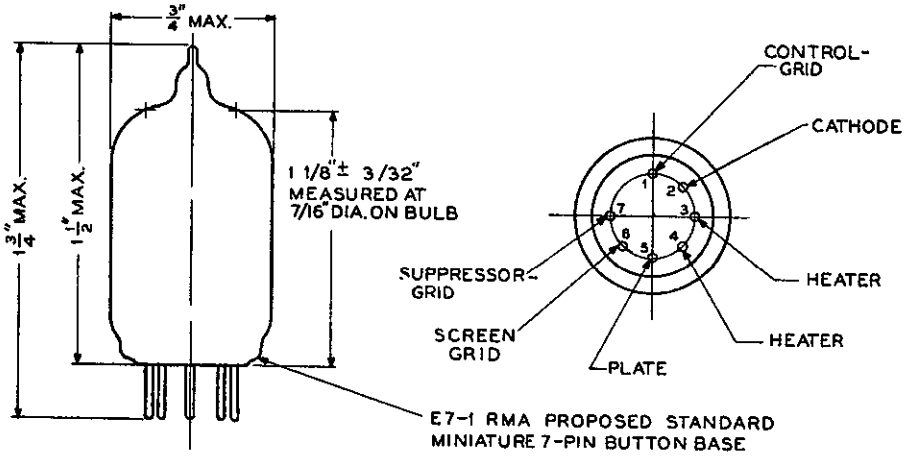


A development of Bell Telephone Laboratories, the research laboratories of the American Telephone and Telegraph Company and the Western Electric Company.

ADVANCE ELECTRON TUBE DATA SHEET

WESTERN ELECTRIC 6AS6/409A ELECTRON TUBE

6AS6/409A
MINIATURE PENTODE U.H.F.



CLASSIFICATION

The 6AS6/409A electron tube is a 7-pin miniature, triple-grid pentode with an indirectly heated cathode. It is intended for low power applications at high and ultra-high frequencies. The usual control-grid and the suppressor-grid can be used as independent control elements. The tube is suitable for use in gated amplifiers, gain controlled amplifiers, delay circuits, and mixers.

MOUNTING

The dimensions and arrangement of terminal connections are as shown above. The tube may be mounted in any position.

HEATER RATING

Heater voltage, a-c or d-c	6.3 volts
Nominal heater current	0.175 ampere

MAXIMUM RATINGS (Design-center values)

Plate voltage	180 volts
Screen voltage	140 volts
Positive suppressor voltage	27 volts
Plate dissipation	1.7 watts
Screen dissipation	0.75 watt
Cathode current	18 milliamperes
Heater-cathode voltage	90 volts
Bulb temperature	120°Centigrade

OPERATING CONDITIONS AND CHARACTERISTICS

Plate voltage	120	120 volts
Screen voltage	120	120 volts
Suppressor voltage	- 3	0 volts
Grid voltage	- 2	- 2 volts
Plate current	3.6	5.2 milliamperes
Screen current	4.8	3.5 milliamperes
Transconductance, control-grid	1850	3200 umhos
Transconductance, suppresor-grid	810	470 umhos

CONTROL-GRID PLATE CURRENT CUT-OFF CHARACTERISTICS

Plate voltage	120	volts
Screen voltage	120	volts
Suppressor voltage	0	volts
Nominal cut-off, control-grid	- 6	volts
Guaranteed cut-off, control-grid	-10	volts

SUPPRESSOR-GRID PLATE CURRENT CUT-OFF CHARACTERISTICS

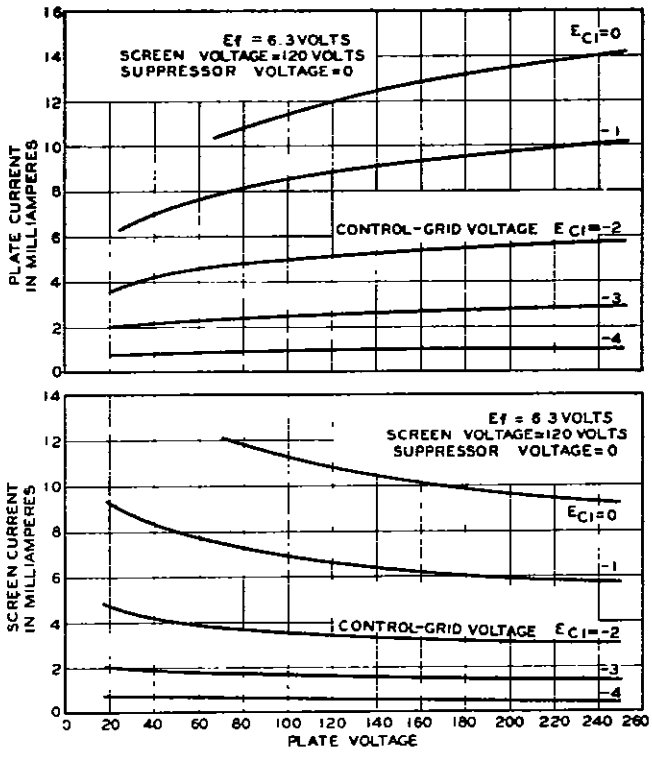
Plate voltage	120	120 volts
Screen voltage	120	60 volts
Grid voltage	- 2	0 volts
Nominal cut-off, suppressor-grid	-10	- 8 volts
Guaranteed cut-off, suppressor-grid	-15	-10 volts

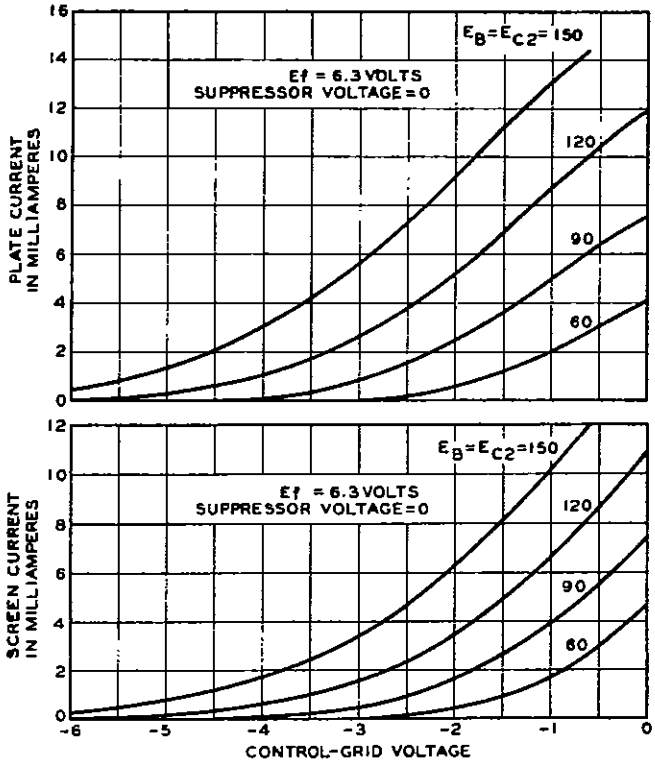
INTERELECTRODE CAPACITANCES (With JAN 1A No. 314 shield connected to cathode)

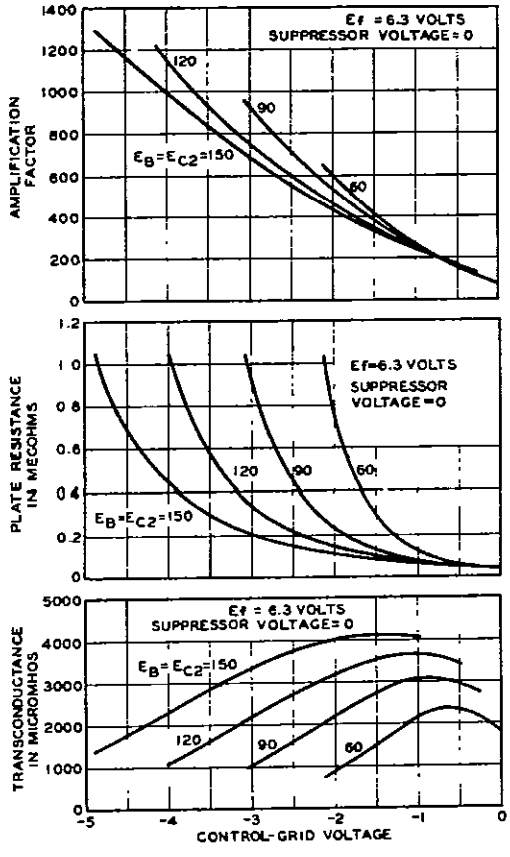
Control-grid to heater, cathode, screen and suppressor-grid	3.9 uuf
Plate to control-grid	0.01 uuf
Plate to heater, cathode, screen and suppressor-grid	3.0 uuf
Control-grid to suppressor-grid	0.1 uuf

Western Electric

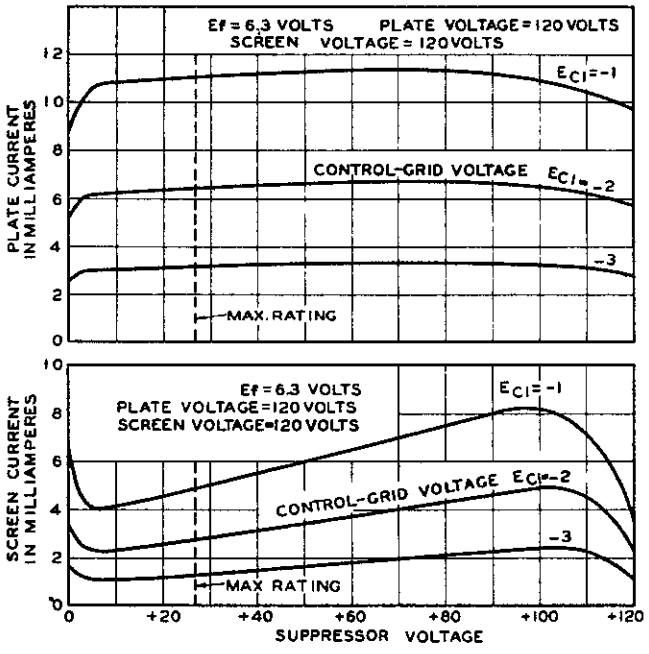
NORMAL PENTODE CHARACTERISTICS

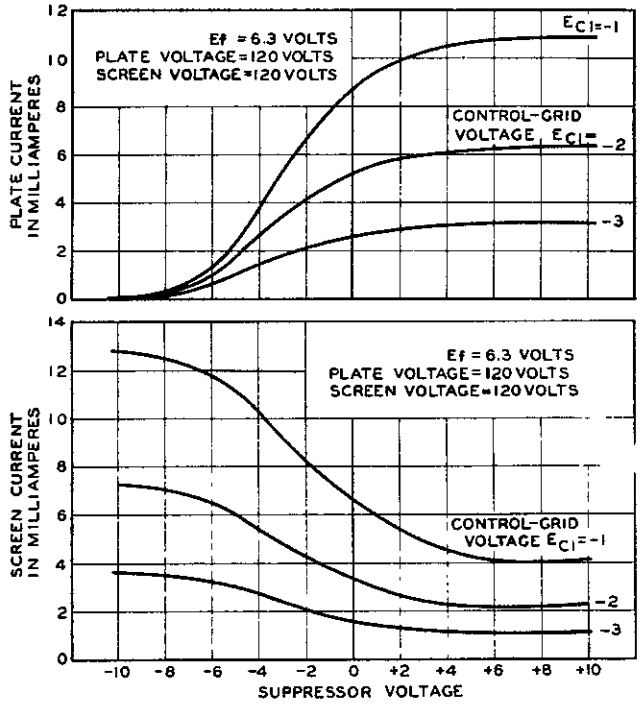


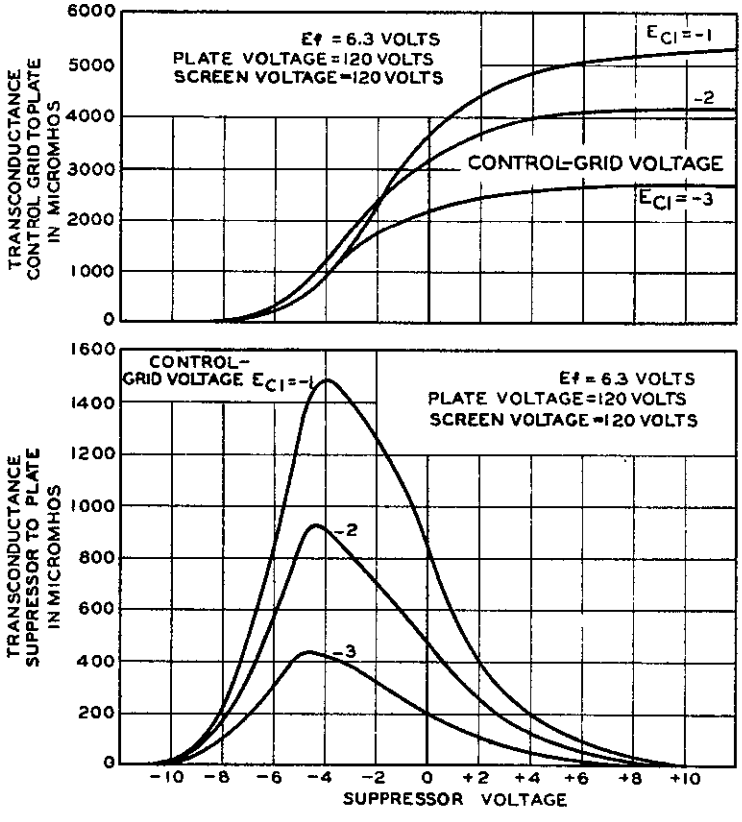




SUPPRESSOR – GRID CHARACTERISTICS

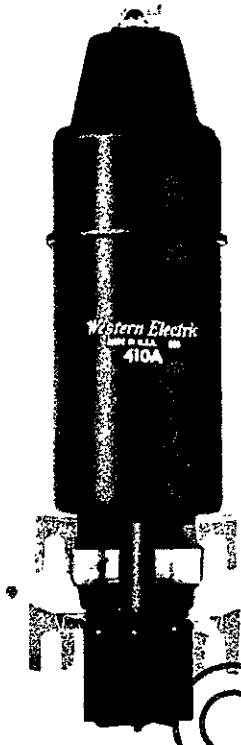






ELECTRON TUBE DATA SHEET

WESTERN ELECTRIC 410A ELECTRON TUBE



A&M ONLY

DESCRIPTION

The 410A is a three-electrode mercury-vapor thyratron with a negative control characteristic. This tube is designed for use in controlled rectifier or inverter circuits.

MAXIMUM RATINGS

Peak Anode Voltage	1500 volts
Average Cathode Current	8 amperes

FILE:THYRATRON SECTION

© American Telephone and Telegraph Company 1962

MAXIMUM RATINGS, ABSOLUTE VALUES

Peak Anode Voltage	
Inverse	1500 volts
Forward	1500 volts
Cathode Current	
Peak	32 amperes
Average	8 amperes
Surge (maximum duration 0.1 second)	320 amperes
Averaging Time	15 seconds
Negative Grid Voltage	
Before Conduction	500 volts
During Conduction	10 volts
Positive Grid Current, Average	
(Averaging time = one cycle)	0.25 ampere
Condensed Mercury Temperature Limits	+30 to +80 centigrade

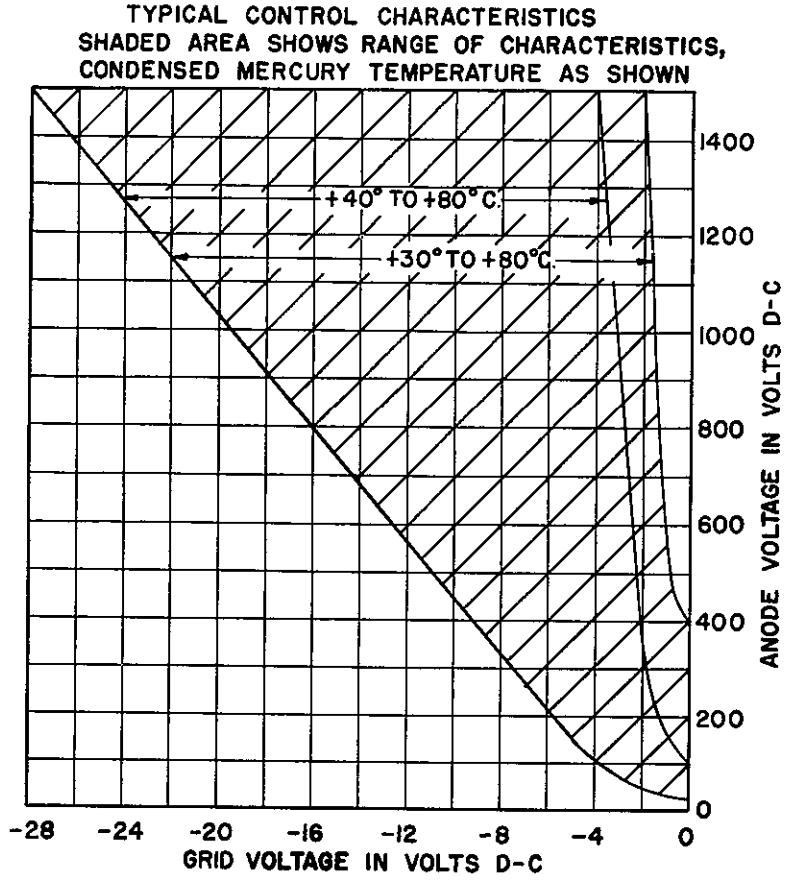
ELECTRICAL DATA

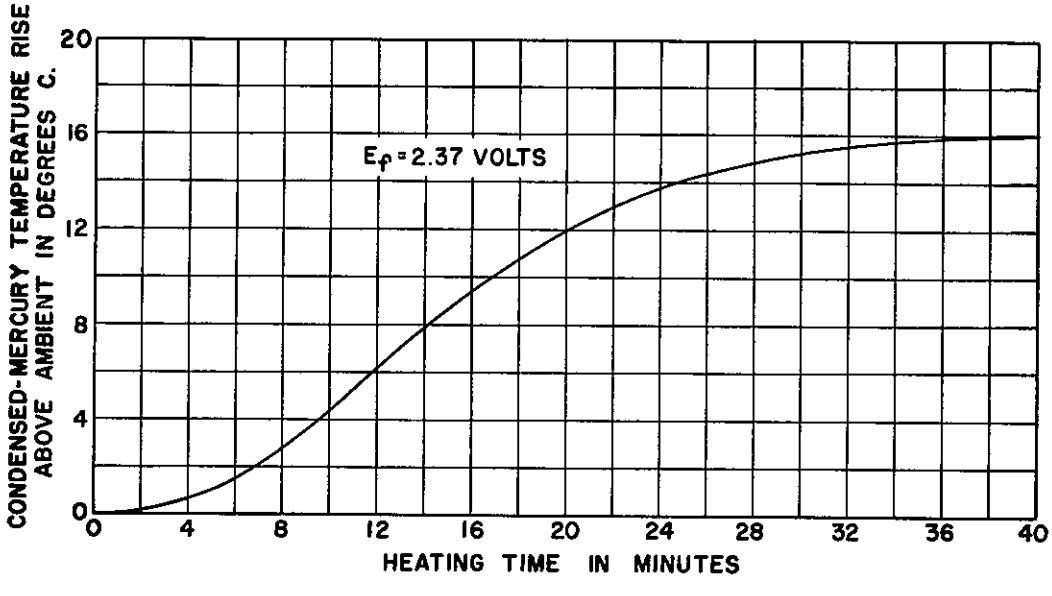
	Min.	Bogey	Max.	
Filament Voltage	2.37	2.5	2.62	volts
Filament Current at 2.5 volts	----	18	21	amperes
Filament Heating Time Required	60	----	----	seconds
Anode to Grid Capacitance	----	15	----	uuf.
Grid to Filament Capacitance	----	15	----	uuf.
Deionization Time, Approximate[1]				
E_{bb}=1500 volts; I_b=16 amperes; E_{cc}=-30 volts; THg=80C; Rg=50000 ohms	----	1500	----	microseconds
E_{bb}=500 volts; I_b=16 amperes; E_{cc}=-30 volts; THg=50C; Rg=50000 ohms	----	300	----	microseconds
Ionization Time, Approximate[2]				
E_{bb}=100 volts; THg=40C; Grid Overvoltage=5 volts	----	15	----	microseconds
E_{bb}=100 volts; THg=80C; Grid Overvoltage=25 volts	----	2	----	microseconds
Anode Voltage Drop	----	12	----	volts

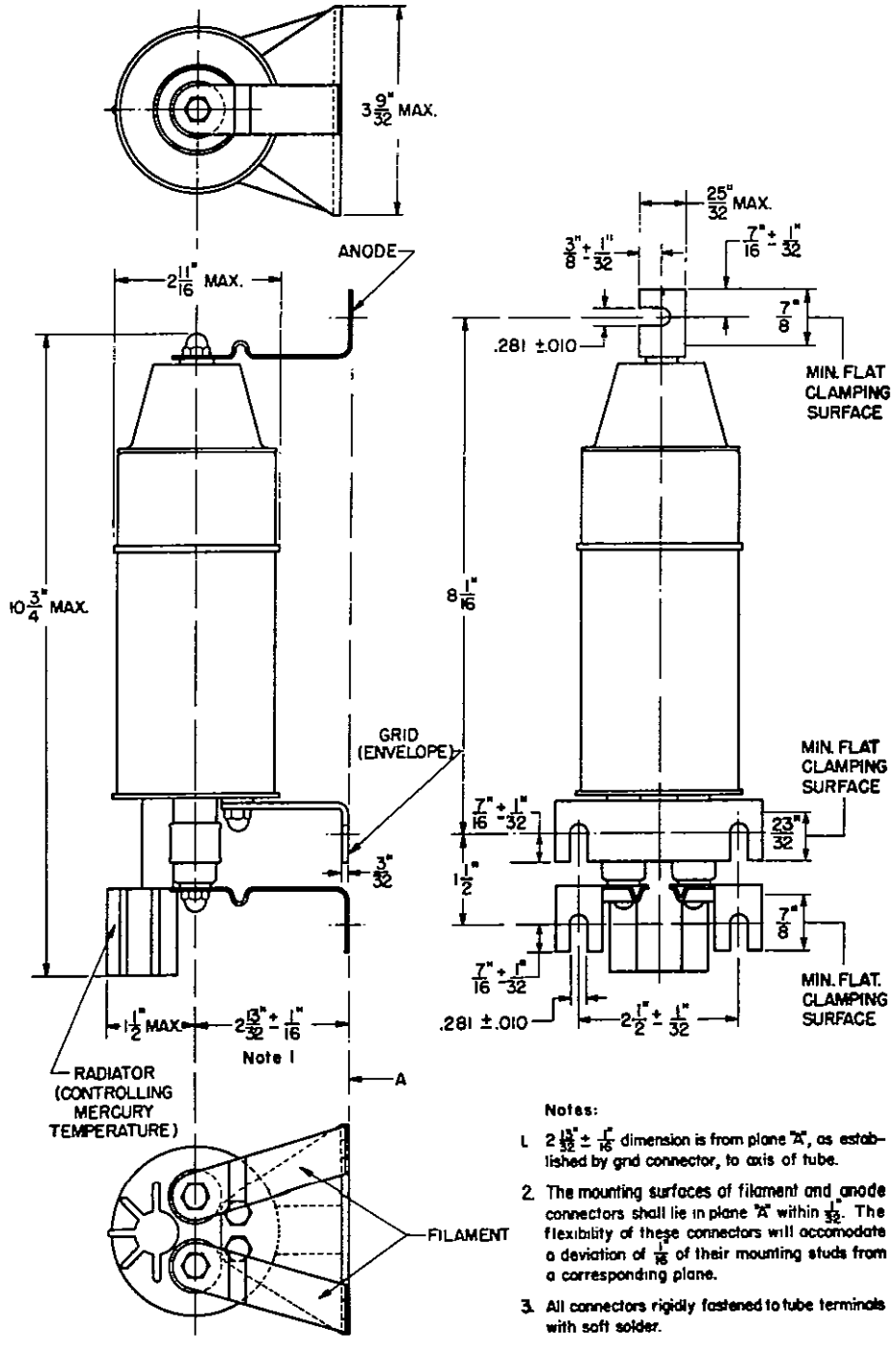
MECHANICAL DATA

Type of Cooling	Convection
Equilibrium Condensed Mercury Temperature Rise Above Ambient	
At Full Load (approximate)	28 Centigrade
At No Load (approximate)	16 Centigrade
Mounting Position	Vertical, filament terminals down
Net Weight, Approximate	1.8 pounds

1. Deionization time decreases with an increase in negative grid voltage or with a decrease in (a) condensed mercury temperature (THg) (b) grid resistance or (c) anode current immediately preceding the end of conduction.
2. Ionizatien time decreases with an increase in (a) anode voltage, (b) condensed mercury temperature (THg) or (c) grid overvoltage. Grid overvoltage is defined as the magnitude by which the applied voltage exceeds, in a positive direction, the critical grid voltage value. Critical grid voltage is the instantaneous value of grid voltage at the time when anode current starts to flow.


TYPICAL CONTROL CHARACTERISTICS
SHADED AREA SHOWS RANGE OF CHARACTERISTICS,
CONDENSED MERCURY TEMPERATURE AS SHOWN
+40° TO +80° C.
+30° TO +80° C.
1400
1200
1000
800
600
400
200
0
ANODE VOLTAGE IN VOLTS D-C
-28
-24
-20
-16
-12
-8
-4
0
GRID VOLTAGE IN VOLTS D-C


CONDENSED-MERCURY TEMPERATURE RISE ABOVE AMBIENT IN DEGREES C.
20
16
12
8
4
0
E_f = 2.37 VOLTS
0
4
8
12
16
20
24
28
32
36
40
HEATING TIME IN MINUTES



Notes:

1. $2\frac{13}{32}" \pm \frac{1}{16}"$ dimension is from plane "A", as established by grid connector, to axis of tube.
2. The mounting surfaces of filament and anode connectors shall lie in plane "A" within $\frac{1}{32}"$. The flexibility of these connectors will accomodate a deviation of $\frac{1}{16}"$ of their mounting studs from a corresponding plane.
3. All connectors rigidly fastened to tube terminals with soft solder.

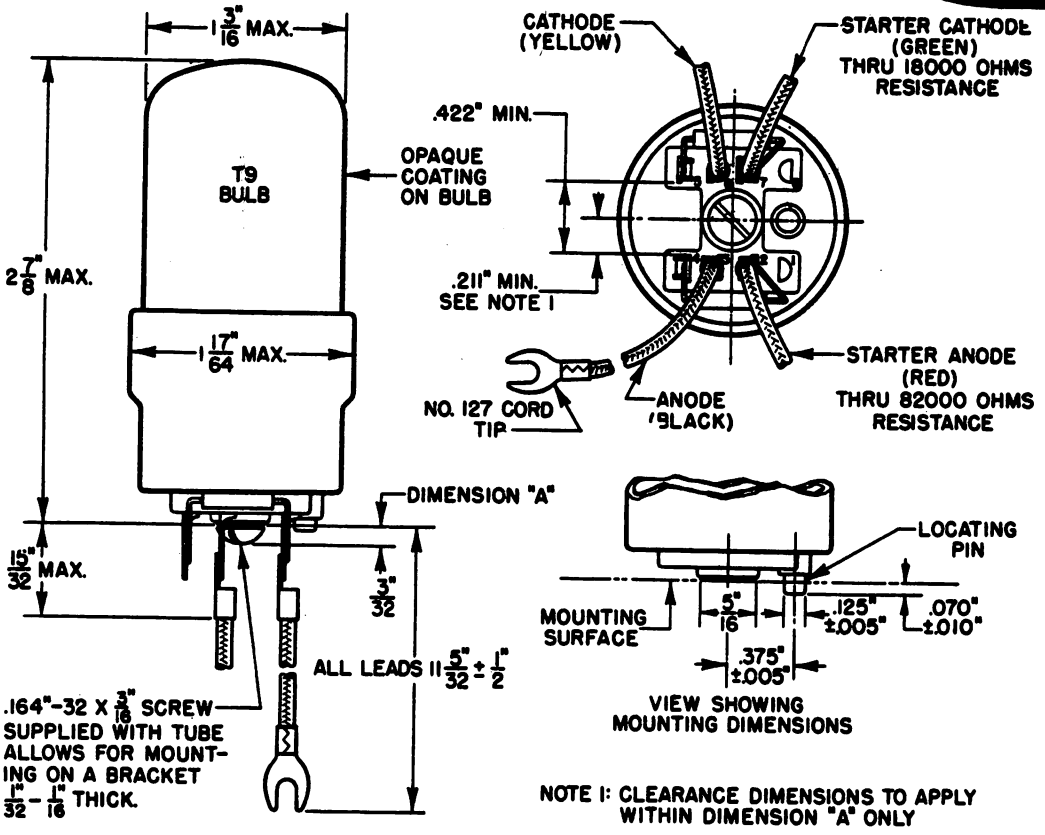
A development of Bell Telephone Laboratories, the research laboratories of the American Telephone and Telegraph Company and the Western Electric Company.

PRINTED IN U.S.A.

ADVANCE ELECTRON TUBE DATA SHEET

WESTERN ELECTRIC 411 A ELECTRON TUBE

411A
COLD CATHODE



DESCRIPTION

The 411A is a four-electrode, inert-gas-filled, cold cathode tube for use as a relay.

MAXIMUM RATINGS, Absolute Values

Maximum Peak Voltage, Forward or Inverse		
Anode to Cathode	180	volts
Anode to Starter Cathode	180	volts
Cathode to Starter Cathode	180	volts
Maximum Cathode Current		
Peak	100	milliamperes
Average	35	milliamperes
Maximum Averaging Time	2	seconds
Maximum Starter Cathode Current		
Peak	10	milliamperes
Average	3.5	milliamperes
Maximum Averaging Time	2	seconds
Maximum Peak Inverse Current		
Anode	5	milliamperes
Starter Anode	1	milliampere
Frequency	60	cycles/second
Ambient Temperature Limits	-40 to +80	centigrade

Electrical and Mechanical Data on reverse side

Western Electric

ELECTRICAL DATA

	Min.	Bogey	Max.	
Starter Breakdown Voltage	62	70	85	volts
Starter Voltage Drop at 3 Milliamperes	50	60	70	volts
Anode Voltage Drop at 20 Milliamperes	58	70	80	volts
Required Transfer Current at 110 Anode Volts D.C.*	600	....	....	*microamperes*
Required Negative Cathode Transfer Voltage**	45	....		volts
Deionization Time, Approximate				
Starter Gap	....	.05	....	milliseconds
Main Cap	....	5	....	milliseconds

MECHANICAL DATA

Mounting Position	Any
Net Weight, Approximate	1.3 ounces

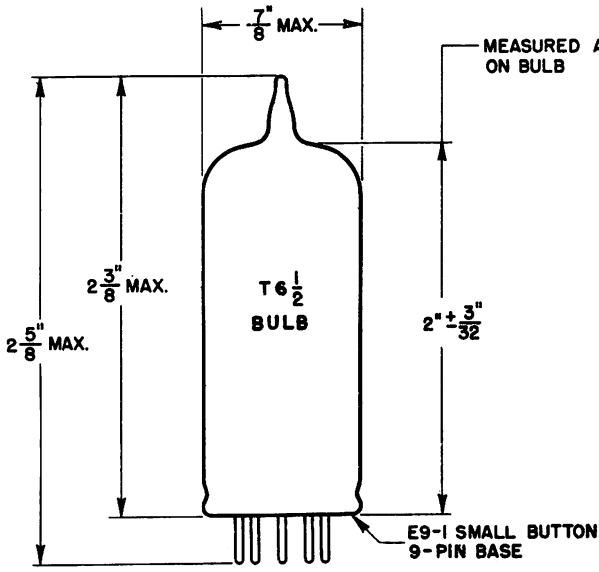
*To assure transfer of conduction from the starter anode - starter cathode gap to the anode - starter cathode gap.

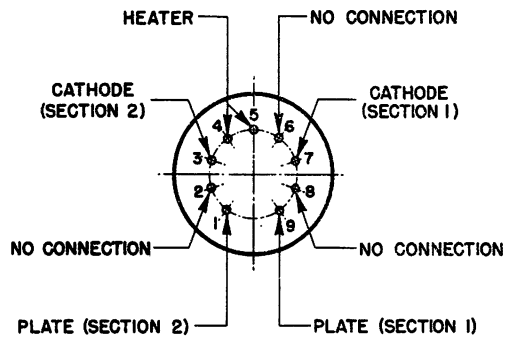
**To assure transfer of conduction from the anode - starter cathode gap to the anode - cathode gap with 1.0 milliampere flowing from anode to starter cathode. Voltage measured with respect to starter cathode.

ADVANCE ELECTRON TUBE DATA SHEET

WESTERN ELECTRIC 412A ELECTRON TUBE

412A
MINIATURE FULL-WAVE RECTIFIER





DESCRIPTION

Miniature Full-Wave Rectifier

MOUNTING

This tube may be mounted in any position

MAXIMUM RATINGS (Design Center Values)

Peak Inverse Voltage	1250	volts
Peak Plate Current per Plate	300	milliamperes
D-C Output Current	100	milliamperes
D-C Heater-Cathode Potential	450	volts

GENERAL CHARACTERISTICS

ELECTRICAL DATA

Heater Voltage	6.3	volts
Heater Current	1.0	ampere

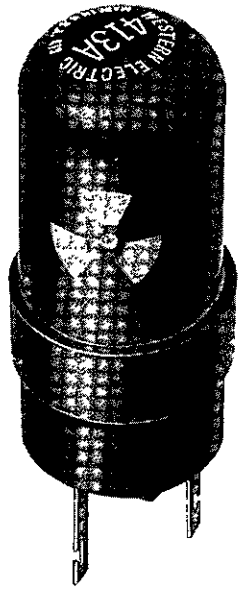
MECHANICAL DATA

Cathode	Coated Unipotential
Bulb	T 6-1/2
Base	Small button 9-pin

TYPICAL OPERATION WITH CONDENSER INPUT FILTER

A-C Plate Voltage per Plate (RMS)	300	volts
D-C Output Current	90	milliamperes
D-C Output Voltage at Input Filter, Approximate	340	volts
Total Effective Plate Supply Impedance per Plate	150	ohms
Filter Input Condenser	4	microfarads

ELECTRON TUBE DATA SHEET
WESTERN ELECTRIC 413A ELECTRON TUBE



DESCRIPTION

The 413A is a two-electrode inert-gas-filled cold cathode tube having a high current rating. In addition to its initial field of use in telephone message register circuits it is especially suitable also for use in control circuits such as in switching or pulse counting apparatus.

MAXIMUM RATINGS

Forward or Inverse Average Cathode Current	20	200 milliamperes
Average Life, Approximate.	10000	10 hours

MAXIMUM RATINGS, Absolute Values

Cathode Current [1]	
Peak, Forward or Inverse	200 milliamperes
Average, Forward or Inverse	70 milliamperes
Averaging Time	2 seconds
Ambient Temperature Limits	-55 to +85 centigrade

ELECTRICAL DATA, Throughout Life

	Min.	Bogey	Max.	
Anode Breakdown Voltage				
Forward	180	200	255	volts
Inverse	180	200	---	volts
Anode Voltage Drop, Forward or Inverse	55	62	75	volts
Ionization Time[2]	---	1	---	millisecond
Deionization Time, Approximate	---	2	---	milliseconds

MECHANICAL DATA

Mounting Position	Any
Net Weight, Approximate	1.2 ounces

Dimensions and pin connections shown in outline drawing on page 3.

Note 1: Sufficient resistance must be used in series with the tube to assure that the electrode currents do not exceed their maximum rated values.

Note 2: With 15 volts overvoltage (15 volts above anode breakdown voltage) when tube is in total darkness.

HANDLING

Western Electric cold cathode tubes contain a minute amount of radium bromide which is a radioactive material. The amount in most types is too small to require any special care in use, handling or disposal.

A few types contain a larger quantity of radium bromide in which the radium approximates that found on a luminous watch dial. These types bear a red three-bladed propeller-shaped symbol on the tube envelope. Instructions for handling such tubes are given below and also in Bell System Practices for Central Office maintenance.

Installations ordinarily require no precautions against radiation. However, quantities of the tubes should not be so installed, or so stored outside the shipping carton, that they will be within a few inches of personnel or in proximity to photographic film for extended periods of time. For example, however, a 40-hour week exposure at about one (1) foot from a bank of 500 tubes (covering an area of 20 inches x 45 inches) is well within the accepted tolerance limits for personnel. Reasonable care should be exercised in handling and disposal of broken tubes. In general, attention should be given to the following:

(a) Avoid breathing dust or vapors from broken tubes.

(b) Avoid contacting broken parts with bare hands.

(c) Use wet rag to pick up broken parts. Wrap broken parts in rag and tie securely so as to form a package. Thoroughly wash hands after disposal.

(d) Dispose of broken or defective tubes as they are taken out of service. One or two tubes at a time may be disposed of with normal waste material Accumulation of tubes in one concentrated area of the place of final disposition should be avoided.

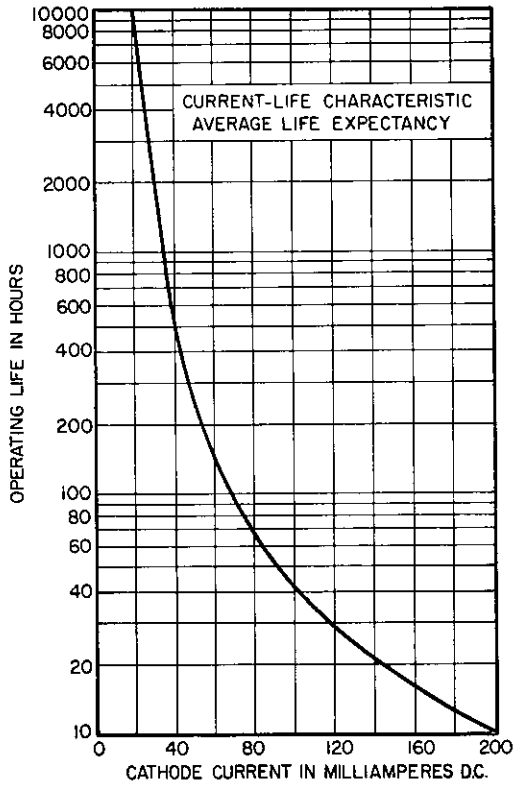


FIG 1

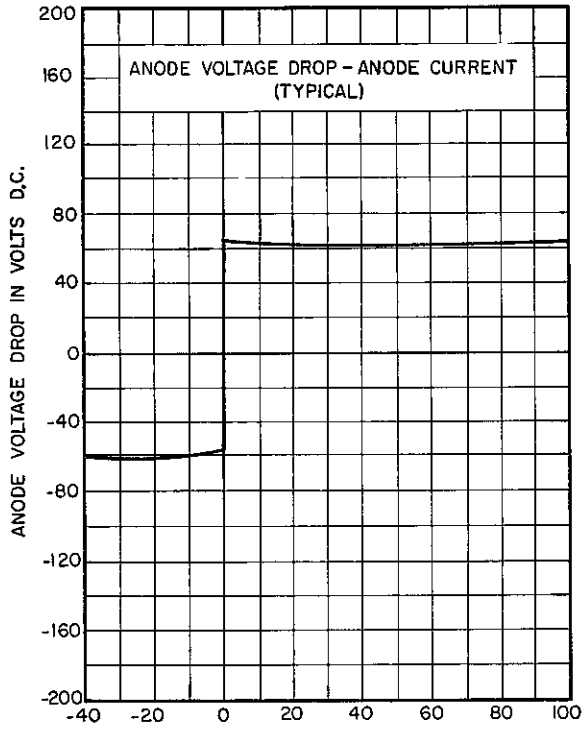
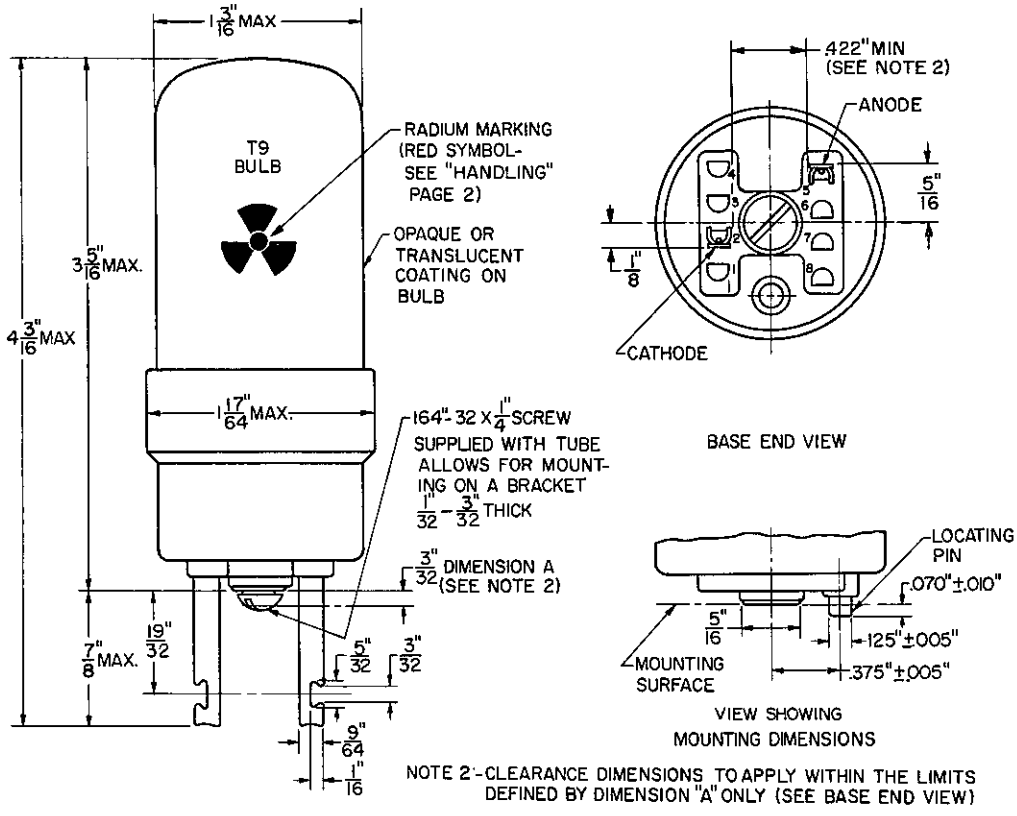
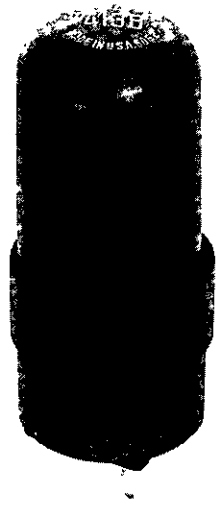


FIG. 2



NOTE 2-CLEARANCE DIMENSIONS TO APPLY WITHIN THE LIMITS DEFINED BY DIMENSION "A" ONLY (SEE BASE END VIEW)

ELECTRON TUBE DATA SHEET
WESTERN ELECTRIC 413B ELECTRON TUBE



DESCRIPTION

The 413B is a two-electrode inert-gas-filled cold cathode tube having a high current rating. In addition to its initial field of use in telephone message register circuits it is especially suitable also for use in control circuits such as in switching or pulse counting apparatus.

CHARACTERISTICS

Forward or Inverse Average Cathode Current	20	200	milliamperes
Average Life, Approximate	10000	10	hours

File: Cold Cathode Section

© American Telephone and Telegraph Company 1962

MAXIMUM RATINGS, Absolute System (Note 1)

Cathode Current (Note 2)		
Peak, Forward or Inverse	200	milliamperes
Average, Forward or Inverse	70	milliamperes
Averaging Time	2	seconds
Ambient Temperature Limits	-55 to +85	centigrade

ELECTRICAL DATA, Throughout Life

	Min.	Bogey	Max.	
Anode Breakdown Voltage				
Forward	180	200	255	volts
Inverse	180	200	-	volts
Anode Voltage Drop, Forward or Inverse	55	62	75	volts
Ionization Time (Note 3)	-	1	-	millisecond
Deionization Time, Approximate	-	2	-	milliseconds

MECHANICAL DATA

Mounting Position	Any
Net Weight, Approximate	1.2 Ounces

Dimensions and pin connections shown in outline drawing on page 3.

HANDLING

This tube contains a small amount of krypton-85 gas which is a by-product radioactive material. The amount of krypton-85 is less than five microcuries, which is too small an amount to require any special care in use.

Atomic Energy Commission regulations require that the individual tube carton for tubes containing by-product radioactive material be appropriately marked. The marking includes the statement that tube disposal should be in approved manner.

Approved instructions for disposal of tubes containing krypton-85 are as follows;

> Tubes to be disposed of should be broken or crushed in a well ventilated place releasing any resulting vapors to the outside atmosphere. The residual broken or crushed tubes should be disposed of in a normal public trash disposal system. Tubes should be disposed of at a rate of not more than 100 each week from any one location. Avoid breathing vapors from broken tubes.

Note 1: In the "Absolute System" the maximum ratings specified are limiting values above which the serviceability of the device may be impaired from the viewpoint of life and satisfactory performance. Maximum ratings, as such, do not constitute a set of operating conditions and all values may not, therefore, be attained simultaneously.

Note 2: Sufficient resistance must be used in series with the tube to assure that the electrode currents do not exceed their maximum rated values.

Note 3: With 15 volts overvoltage (15 volts above anode breakdown voltage) when tube is in total darkness.

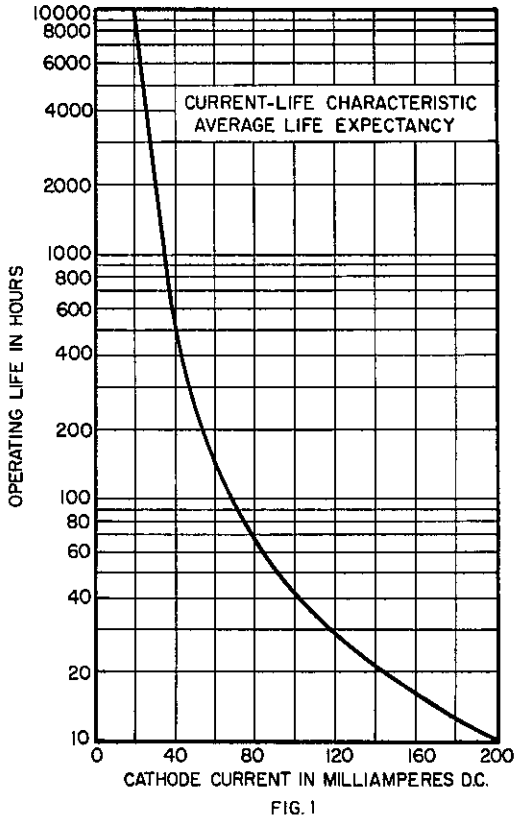


FIG. 1

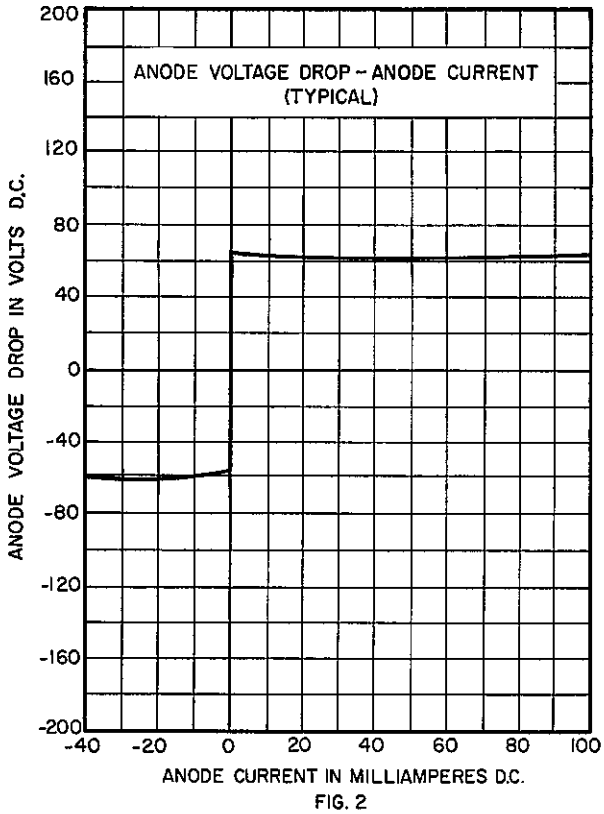
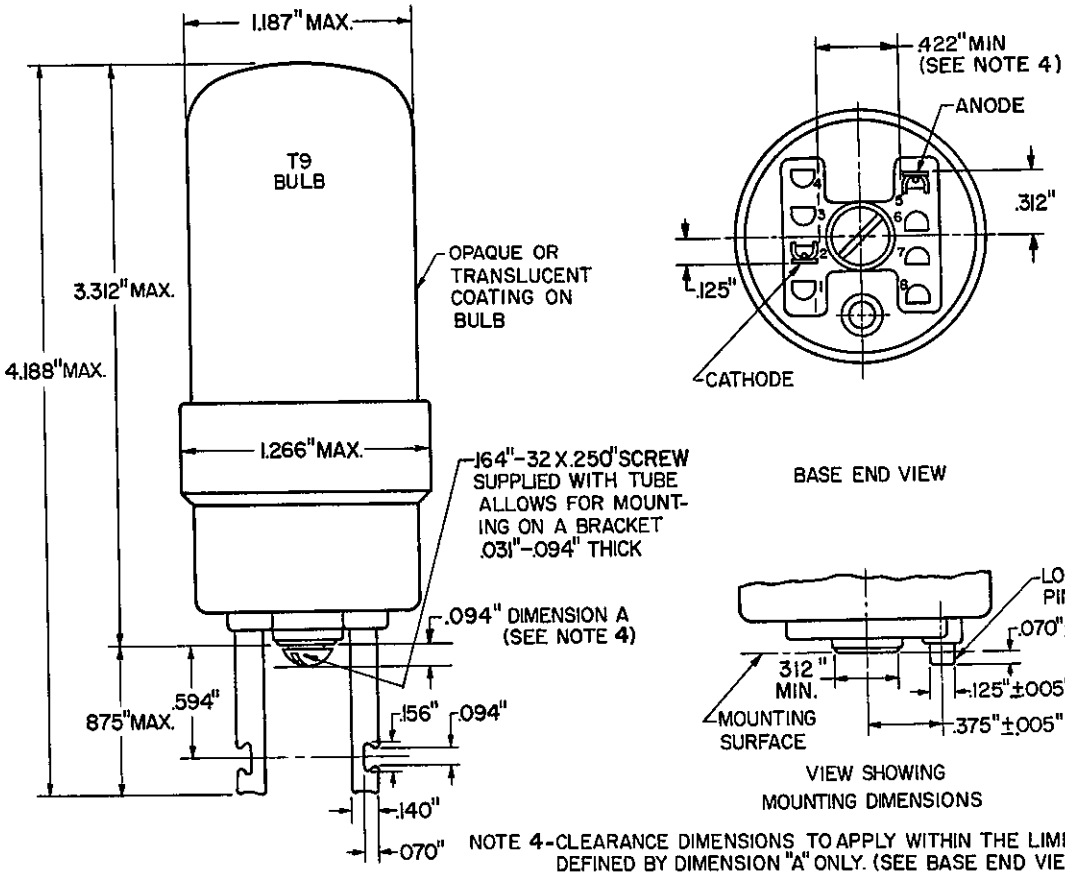


FIG. 2



NOTE 4-CLEARANCE DIMENSIONS TO APPLY WITHIN THE LIMITS DEFINED BY DIMENSION "A" ONLY. (SEE BASE END VIEW)

Western Electric Company

A development of Bell Telephone Laboratories, the research laboratories of the American Telephone and Telegraph Company and the Western Electric Company.

PRINTED IN U.S.A.

Western Electric

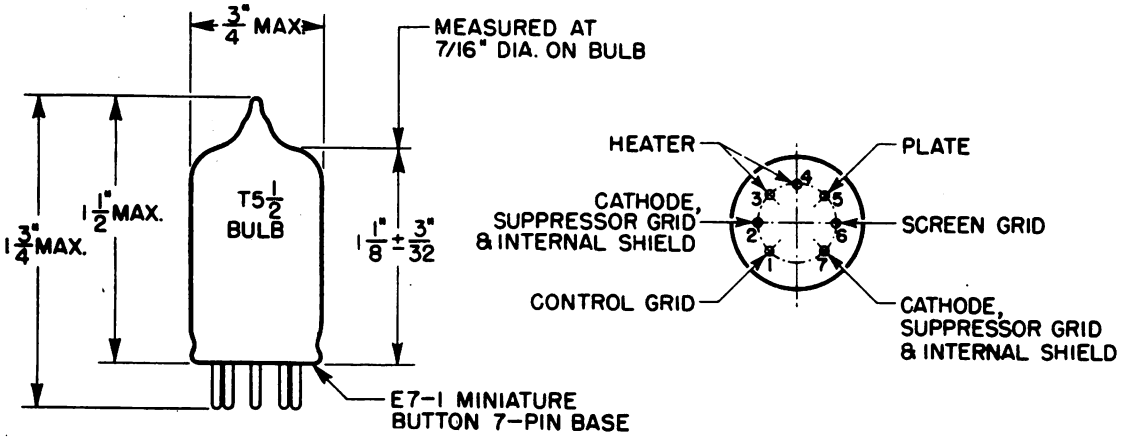
A development of Bell Telephone Laboratories, the research laboratories of the American Telephone and Telegraph Company and the Western Electric Company.

1-D-56-4 PRINTED IN U.S.A. T2739

ADVANCE ELECTRON TUBE DATA SHEET

WESTERN ELECTRIC 414A ELECTRON TUBE

414A MINIATURE PENTODE



DESCRIPTION

The 414A is a miniature pentode with an indirectly heated cathode.

MAXIMUM RATINGS (Design Center Values)

Plate Voltage	180	volts
Screen-Grid Voltage	140	volts
Plate Dissipation	1.7	watts
Screen-Grid Dissipation	0.5	watt
Cathode Current	18	milliamperes
Heater Cathode Voltage	90	volts
Bulb Temperature	120°	centigrade

GENERAL CHARACTERISTICS

ELECTRICAL DATA

Heater Voltage, A-C or D-C	6.3	volts
Heater Current	150	milliamperes

Direct Interelectrode Capacitances

	Without External Shield	With External Shield (RMA #31C)	
Plate to Grid, Maximum	0.02	*0.012	uuf
Input	4.1	*4.3	uuf
Output	2.0	*2.9	uuf

MECHANICAL DATA

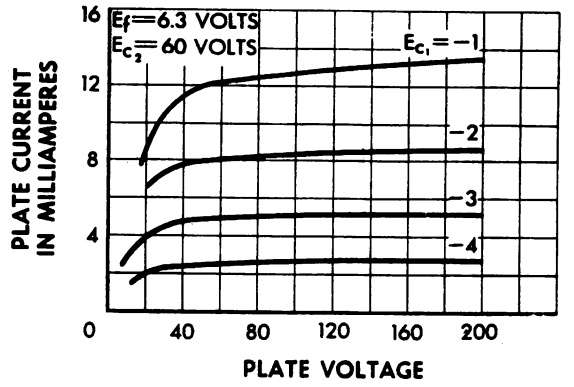
Cathode	Coated Unipotential
Bulb	T5-1/2
Base	Miniature Button, 7-pin
Mounting Position	Any

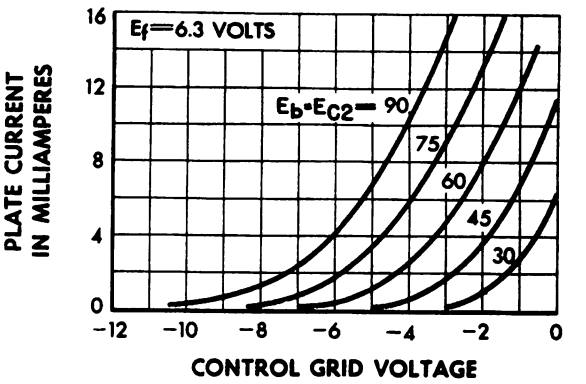
*External shield (RMA #31C) connected to cathodes-pins #2 and #7.

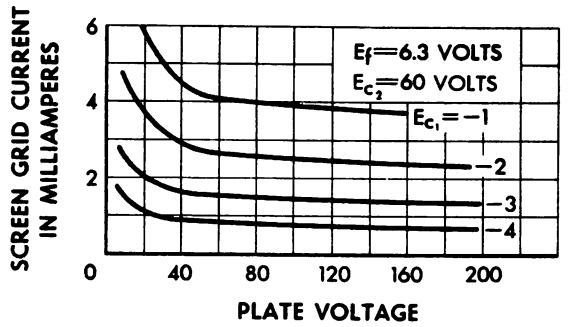
Operating Conditions and Characteristics on Reverse Side

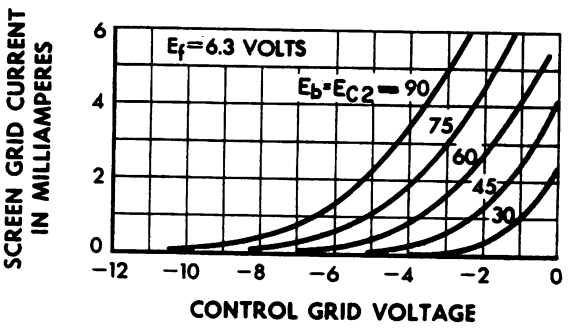
OPERATING CONDITIONS AND CHARACTERISTICS

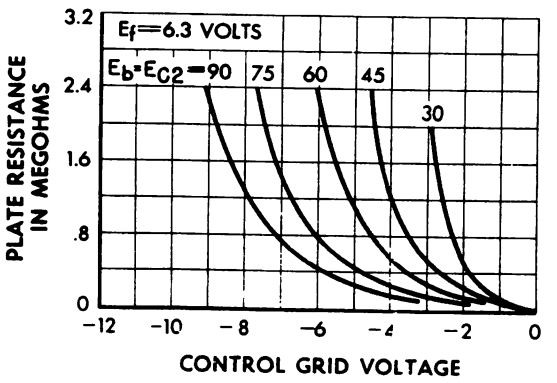
Plate Voltage	60	volts
Screen-Grid Voltage	60	volts
Cathode Resistor	510	ohms
Plate Current	4.3	milliamperes
Screen-Grid Current	1.5	milliamperes
Plate Resistance	0.35	megohm
Transconductance	2750	micromhos
Grid Voltage (approximate) for 10 Microamperes Plate Current	-9.5	volts

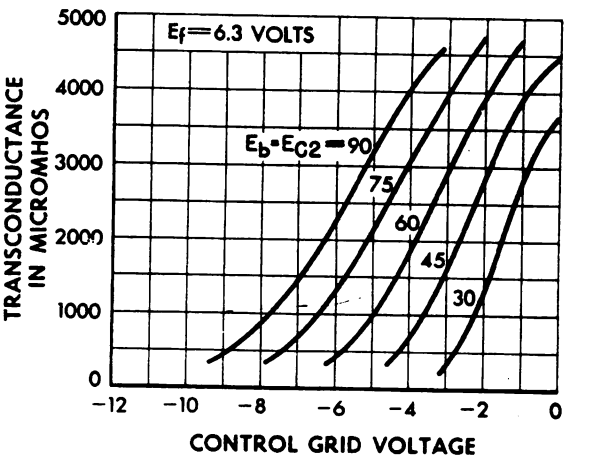










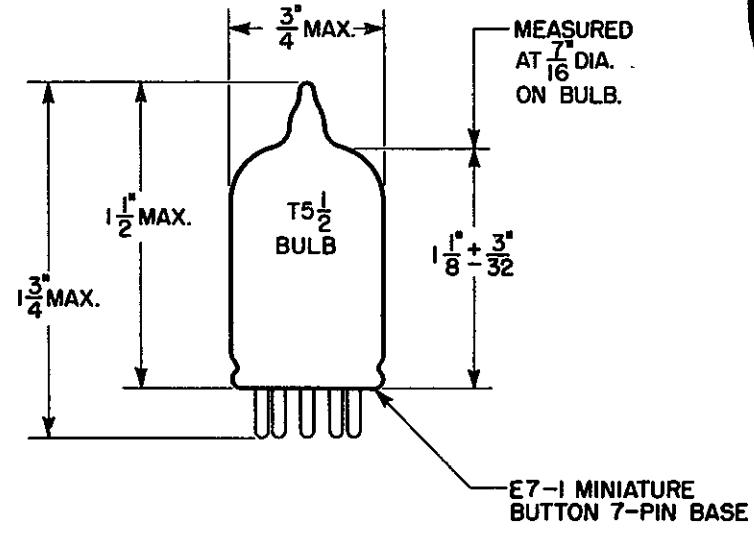


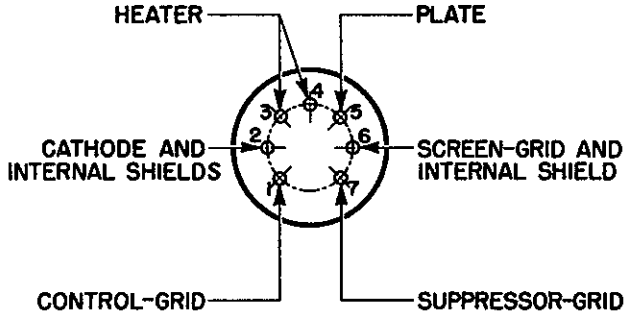
PRINTED IN U.S.A.

ADVANCE ELECTRON TUBE DATA SHEET

WESTERN ELECTRIC 415A ELECTRON TUBE

415A
MINIATURE PENTODE UHF





DESCRIPTION

Miniature Suppressor-Grid Pentode

MOUNTING

This tube may be mounted in any position.

HEATER RATING

Heater Voltage, A-C or D-C	6.3	volts
Nominal Heater Current	150	milliamperes

MAXIMUM RATINGS (Design Center Values)

Plate Voltage	180	volts
Screen-Grid Voltage	140	volts
Positive Suppressor-Grid Voltage	27	volts
Plate Dissipation	1.7	watts
Screen-Grid Dissipation	0.75	watt
Cathode Current	18	milliamperes
Heater-Cathode Voltage	90	volts
Bulb Temperature	120	centigrade

OPERATING CONDITIONS AND CHARACTERISTICS

Plate Voltage	120	120	volts
Screen-Grid Voltage	120	120	volts
Suppressor-Grid Voltage	-3	0	volts
Control-Grid Voltage	-2	-2	volts
Plate Current	3.6	5.2	milliamperes
Screen-Grid Current	4.8	3.5	milliamperes
Transconductance, Control-Grid	1850	3200	μmhos
Transconductance, Suppressor-Grid	810	470	μmhos

Western Electric

CONTROL-GRID PLATE CURRENT CUT-OFF CHARACTERISTICS

Plate Voltage	120	volts
Screen-Grid Voltage	120	volts
Suppressor-Grid Voltage	0	volts
Control-Grid Voltage (approximate) for Plate Current of 10 Microamperes	-7.5	volts

SUPPRESSOR-GRID PLATE CURRENT CUT-OFF CHARACTERISTICS

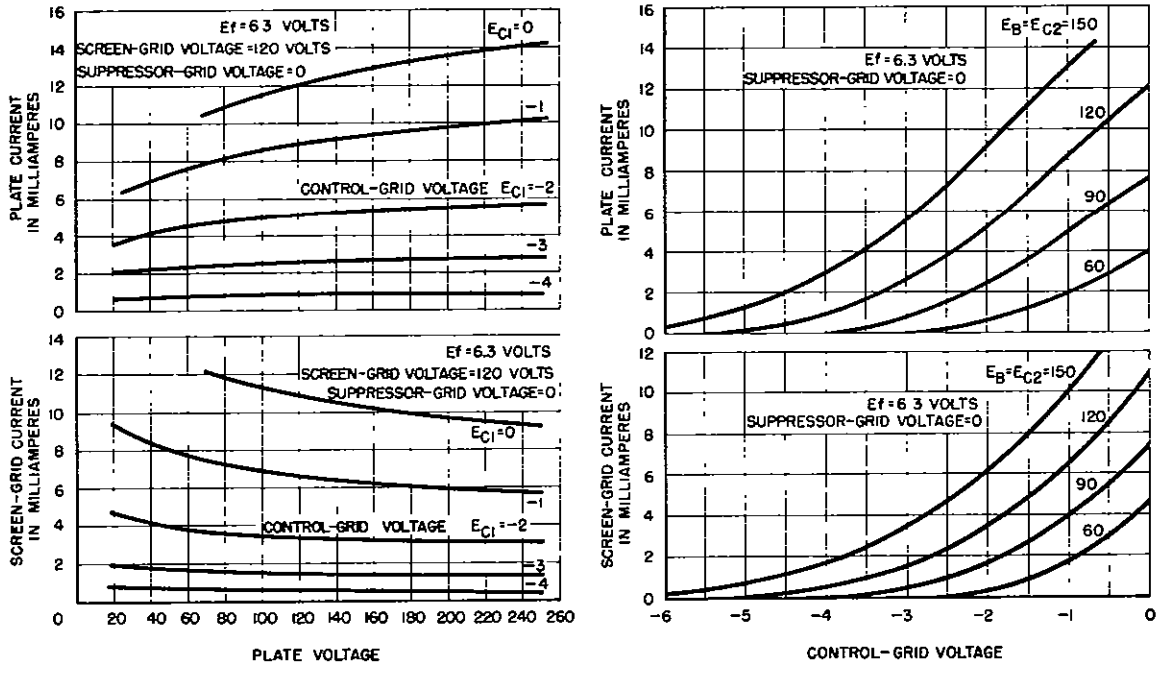
Plate Voltage	120	volts
Screen-Grid Voltage	120	volts
Control-Grid Voltage	-2	volts
Suppressor-Grid Voltage (Approximate) for Plate Current of 10 Microamperes	-10	volts

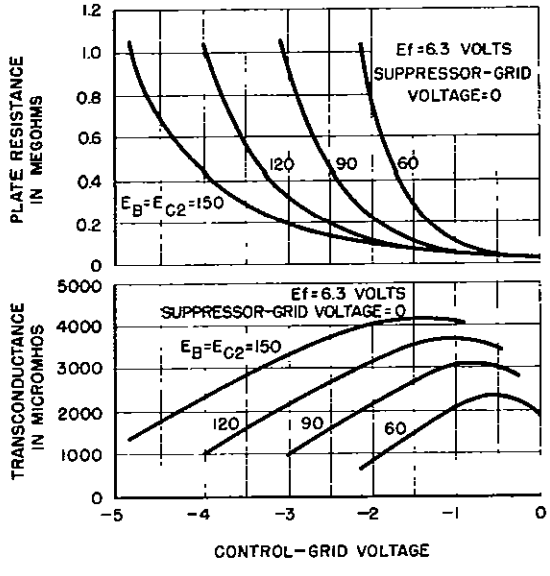
INTERELECTRODE CAPACITANCES (With RMA No. 316 Shield)

Plate to Control-Grid, Maximum	*0.014	µµf
Input (G1 to Heater, Cathode, G2 & G3)	*3.9	µµf
Output (Plate to Heater, Cathode, G2 & G3)	*3.0	µµf
Control-Grid to Suppressor-Grid	*0.1	µµf

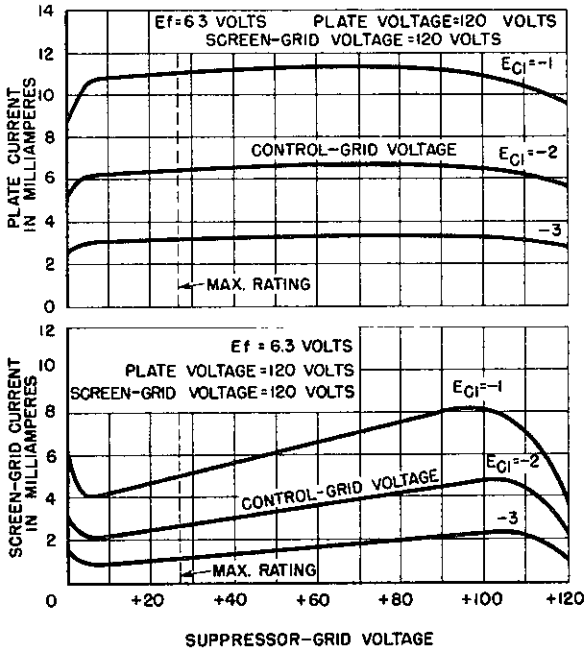
*External shield connected to cathode-pin #2.

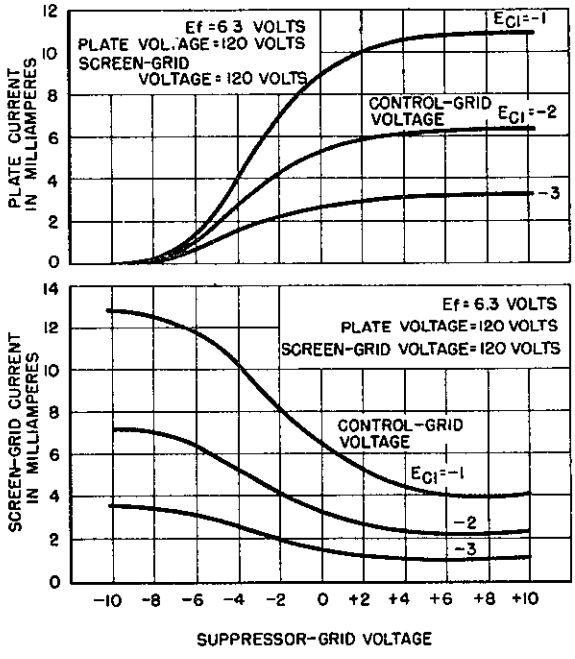
NORMAL PENTODE CHARACTERISTICS

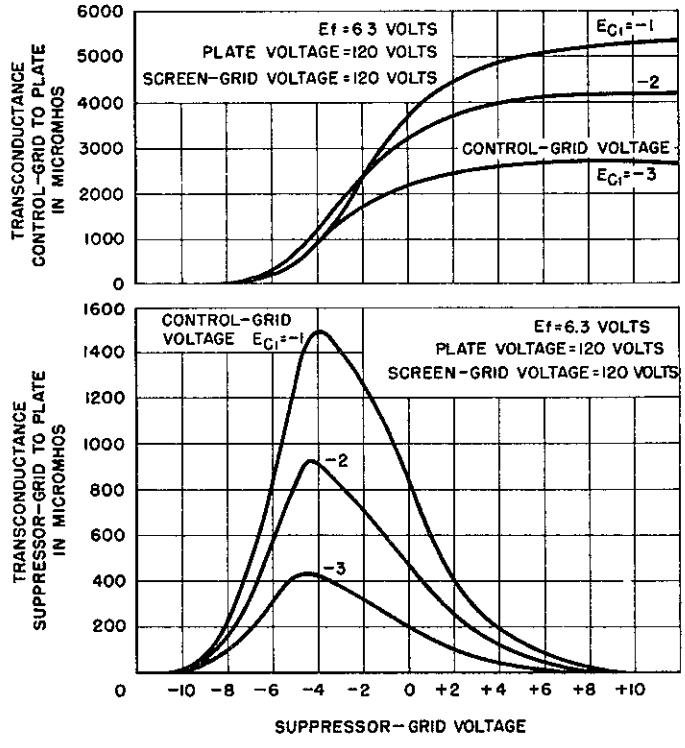




SUPPRESSOR-GRID CHARACTERISTICS







PRINTED IN U.S.A.

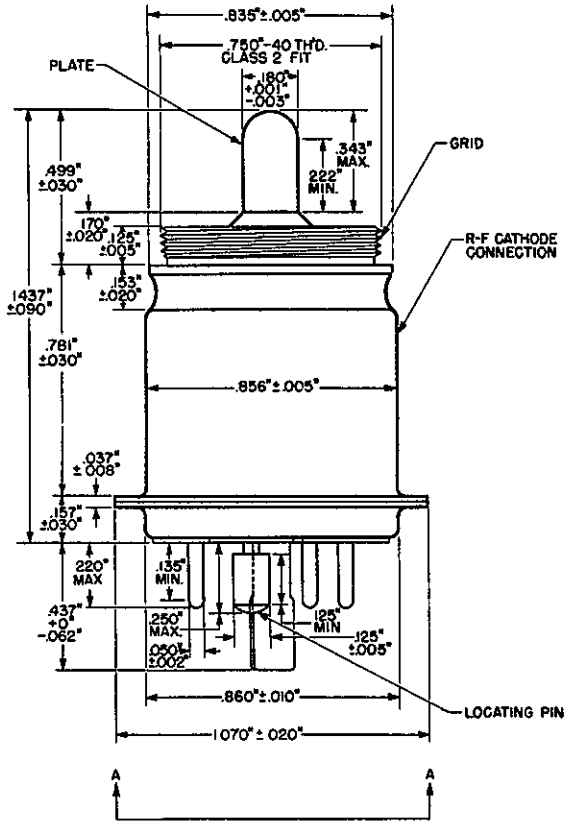
Western Electric

OK to send to Plant Dept. A.D.N. 7/25/49

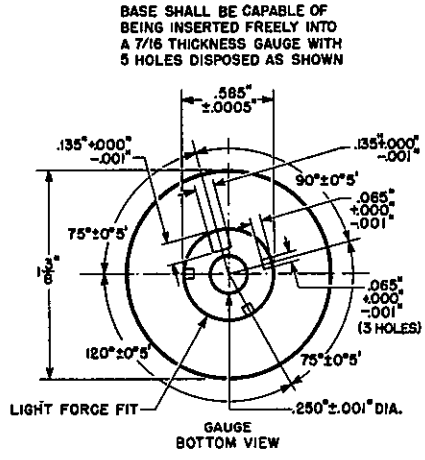
ADVANCE ELECTRON TUBE DATA SHEET

WESTERN ELECTRIC 416 A ELECTRON TUBE

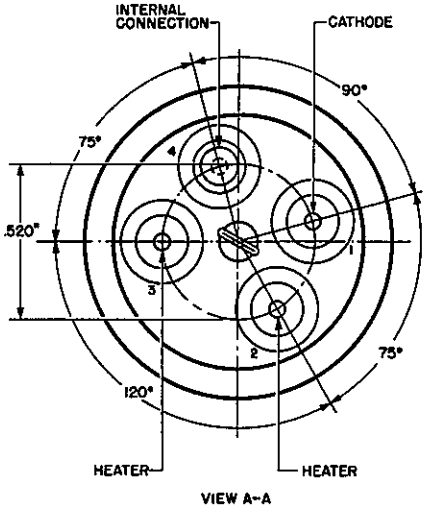
416 A
TRIODE
SHF



NOTE: SURFACES OF R-F CATHODE, GRID AND PLATE CONNECTIONS GOLD PLATED



GAUGE
BOTTOM VIEW



VIEW A-A

DESCRIPTION

The 416A is a disc-seal planar type triode designed for use as an amplifier or frequency multiplier at frequencies in the order of 4000 megacycles.

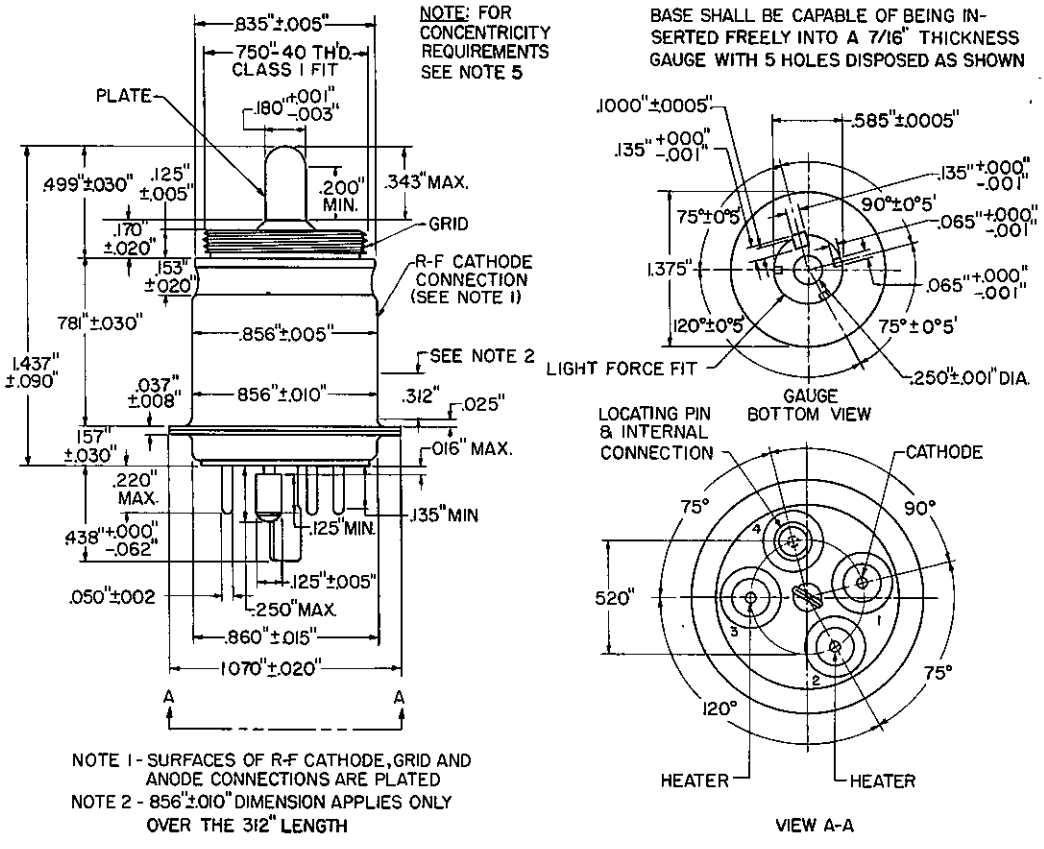
MAXIMUM RATINGS, ABSOLUTE VALUES

Plate Voltage	250	volts
Grid Voltage	+1.0	volt
Plate Current	33	milliamperes
Grid Current	10	milliamperes
Plate Dissipation	7.5	watts
Plate Seal Temperature	125°	Centigrade
Grid Seal Temperature	100°	Centigrade
Heater-Cathode Voltage	45	volts

Western Electric

ADVANCE ELECTRON TUBE DATA SHEET

WESTERN ELECTRIC 416B* ELECTRON TUBE



DESCRIPTION

The 6280/416B* is a planar type triode designed for use as an amplifier or frequency multiplier at frequencies in the order of 4000 megacycles.

CHARACTERISTICS

Heater Voltage	6.3 volts
Plate Voltage	200 volts
Frequency	4000 megacycles
Gain (50 milliwatts output)	9 decibels
Bandwidth (3 db down)	100 megacycles

GENERAL CHARACTERISTICS

ELECTRICAL DATA

	Min.	Bogey	Max.	
Heater Voltage(3)	---	6.3	---	volts
Heater Current	---	1.18	---	amperes
Amplification Factor	---	200	---	
Transconductance (I_b = 30 ma)	---	50000	---	micromhos
Direct Interelectrode Capacitances				
Grid to Plate	1.25	1.45	1.60	uuf
Grid to Shell(4)	8.5	11.2	17.0	uuf
Grid to Shell,(4) Hot (E_f=6.1 v; E_b=0 v)	7.6	8.7	10.3	uuf
Plate to Shell(4)	---	.019	.050	uuf
Cathode to Shell	30	42.5	57	uuf

MECHANICAL DATA

Cathode	Unipotential
Mounting Position	Any
Weight, Approximate	1 ounce
Socket (Equivalent to or)	KS14134

MAXIMUM RATINGS, ABSOLUTE VALUES

Plate Voltage	270 volts
Grid Voltage	+1.5 volts -15.0 volts
Plate Current	33 milliamperes
Grid Current	15 milliamperes
Plate Dissipation	7.5 watts
Plate Seal Temperature	150° Centigrade
Grid Seal Temperature	100° Centigrade
Heater-Cathode Voltage	45 volts

TYPICAL OPERATING CONDITIONS AND CHARACTERISTICS

Plate Voltage	200 volts
Plate Current	30 milliamperes
Bias Circuit	
Cathode Bias Resistor	260 ohms
Grid Supply Voltage	8 volts
Frequency	4000 megacycles
Gain (50 Milliwatts Output)	9 decibels
Gain (500 Milliwatts Output)	5 decibels
Band Width (3 db Down)	100 megacycles

Note (3): For optimum life, heater may be supplied from a source of 10.8 ± 0.2 volts through a circuit resistance of 4.16 ohms.

Note (4): Cathode connected to shell through cathode to shell capacitance.

Note (5): With the .750"-40 thread screwed into a guage having a thread with a .750"-40 class 1 fit, the .856", 1.070" and .180" diameters must fit in cylinders concentric with the .750"-40 thread and having diameters of .895" x .720" long; 1.135" x .157" long; and .210" x .375" long. Allowances for these tolerances must be made in any circuit design.

GENERAL CHARACTERISTICS

ELECTRICAL DATA

Heater Voltage	6.3	volts
Heater Current	1.85	amperes
Amplification Factor	300	
Transconductance (I_b = 30 ma)	50000	micromhos
Direct Interelectrode Capacitances		
Grid to Plate	1.25	μμf
Grid to Shell*	7.5	μμf
Plate to Shell*	0095	μμf
Cathode to Shell	42.5	μμf

*Cathode connected to shell through cathode to shell capacitance

MECHANICAL DATA

Cathode	Unipotential
Mounting Position	Any
Weight, Approximate	1 ounce

TYPICAL OPERATING CONDITIONS AND CHARACTERISTICS

Plate Voltage	200	volts
Plate Current	30	milliamperes
Plate Dissipation	6	watts
Cathode Bias Resistor	250	ohms
Grid Supply Voltage	8	volts
Frequency	4000	megacycles
Gain (50 Milliwatts Output)	9	decibels
Gain (500 Milliwatts Output)	3	decibels
Band Width (3 db Down)	100	megacycles

PRINTED IN U.S.A.

ELECTRON TUBE DATA SHEET

WESTERN ELECTRIC 417A ELECTRON TUBE



DESCRIPTION

The 417A is a 9-pin miniature triode with an indirectly heated cathode. It is intended primarily for grounded-grid operation in the input stage of broad band amplifiers.

CHARACTERISTICS

Heater Voltage	6.3	volts
Maximum Plate Voltage	200	volts
Amplification Factor	43	

FILE: MINIATURE SECTION

© American Telephone and Telegraph Company 1962

GENERAL CHARACTERISTICS

Electrical Data

Heater Voltage (Note 1)	6.3	volts
Heater Current	300	milliamperes
Direct Interelectrode Capacitances	(without external shield)	
Input (cathode to grid and heater)	9.0	$\mu\mu$f
Output (plate to grid and heater)	1.8	$\mu\mu$f
Plate to Cathode and Heater	0.48	$\mu\mu$f

Mechanical Data

Cathode	Coated unipotential
Bulb	T 6½
Base	Small button 9 pin
Mounting Position	Any

MAXIMUM RATINGS, Absolute System (Note 2)

Plate Voltage	200	volts
Plate Dissipation	4.5	watts
Cathode Current	40	milliamperes
Heater Cathode Voltage	55	volts
Bulb Temperature	130°	centigrade

TYPICAL OPERATING CONDITIONS AND CHARACTERISTICS

Plate Supply Voltage	130	150	volts
Grid Voltage (Note 3)	+7.5	-	volts
Cathode Resistor	360	62	ohms
Plate Current	23.0	22.5	milliamperes
Plate Resistance	1850	1700	ohms
Transconductance	25000	25000	micromhos
Amplification Factor	44	43	

Note 1: For optimum tube life the heater voltage specified (6.3 volts) should be regulated to ±5%.

Note 2: In the "Absolute System" the maximum ratings specified are limiting values above which the serviceability of the device may be impaired from the viewpoint of life and satisfactory performance. Maximum ratings, as such, do not constitute a set of operating conditions and all values may not, therefore, be attained simultaneously.

Note 3: Reference point for "Grid Voltage" is the negative end of the cathode resistor. Operation with the control grid positive with respect to the cathode is not recommended.

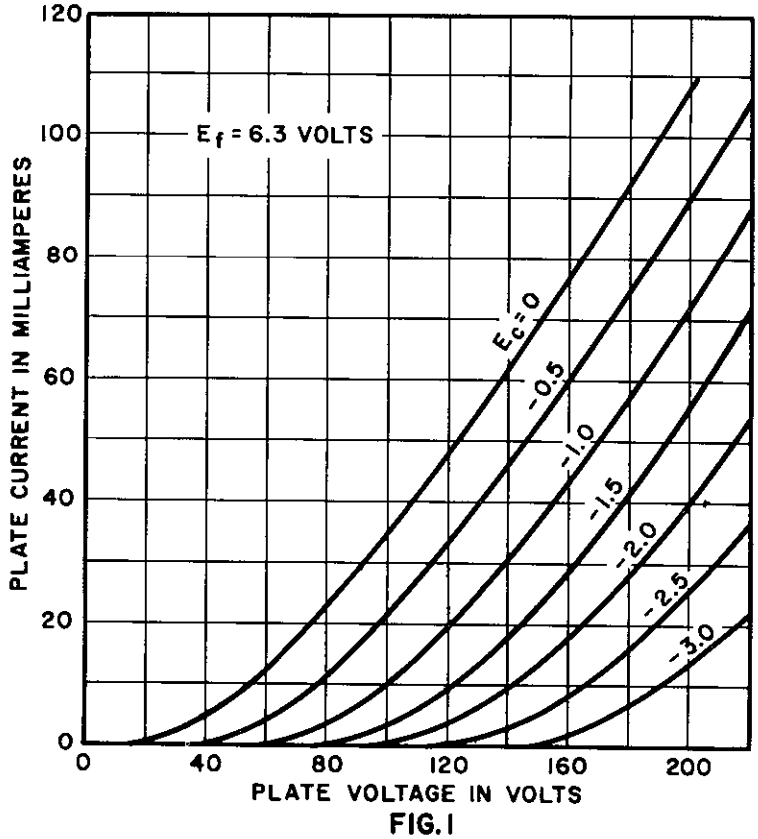


FIG. 1

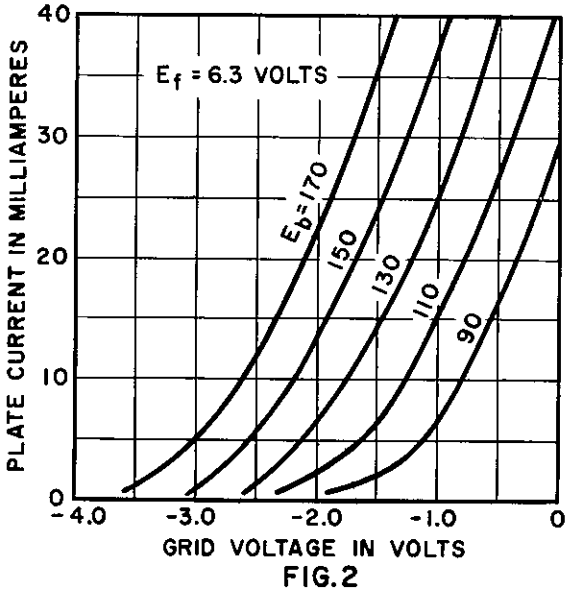


FIG. 2

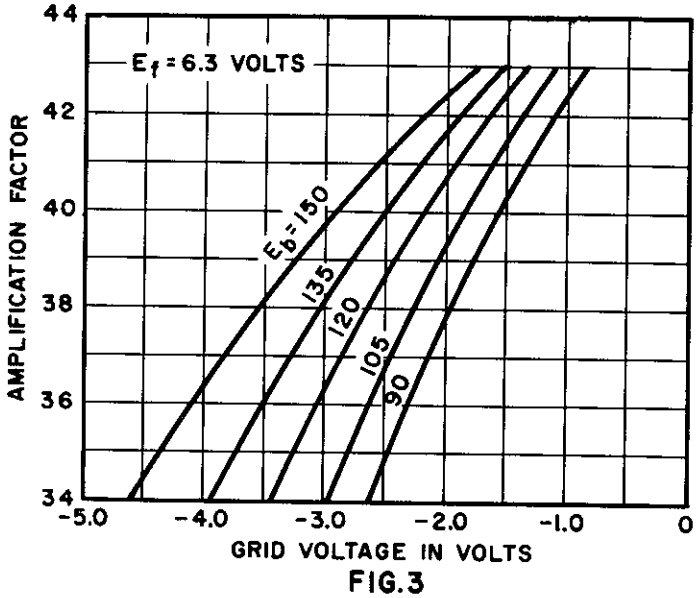


FIG. 3

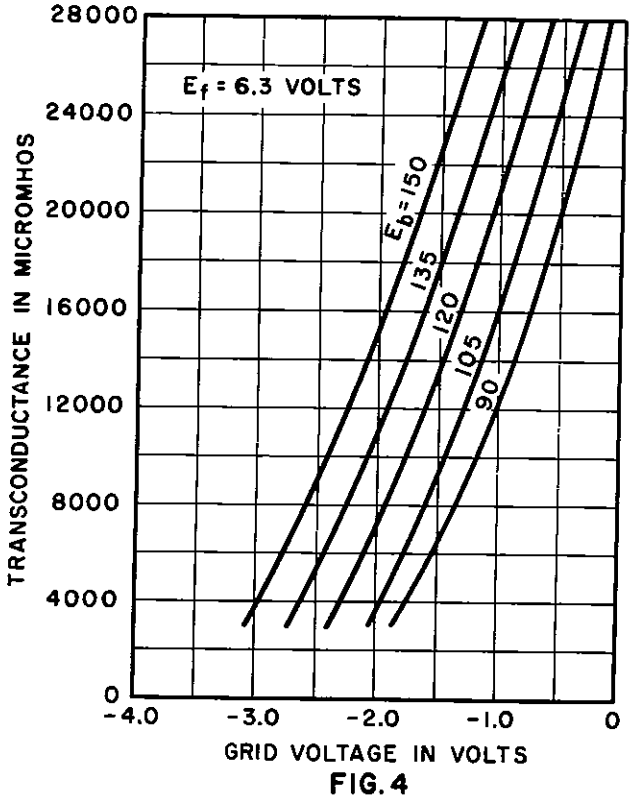


FIG. 4

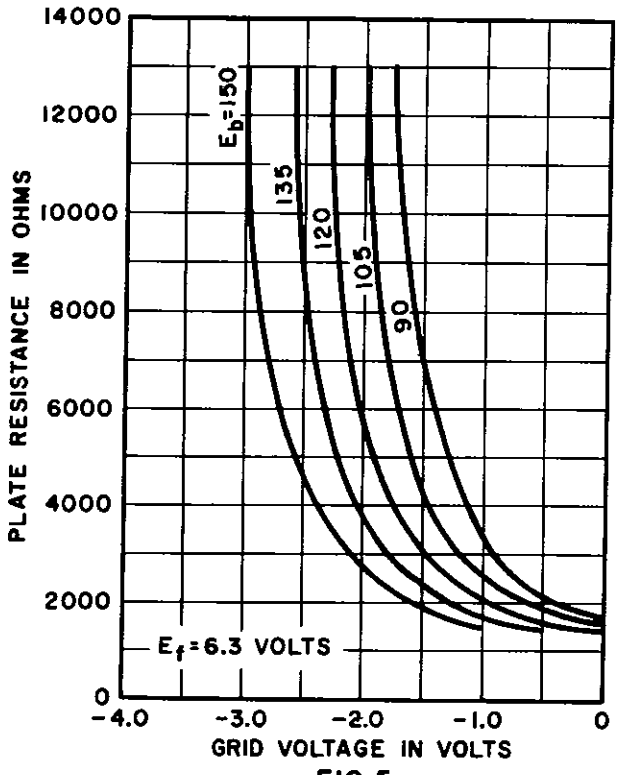
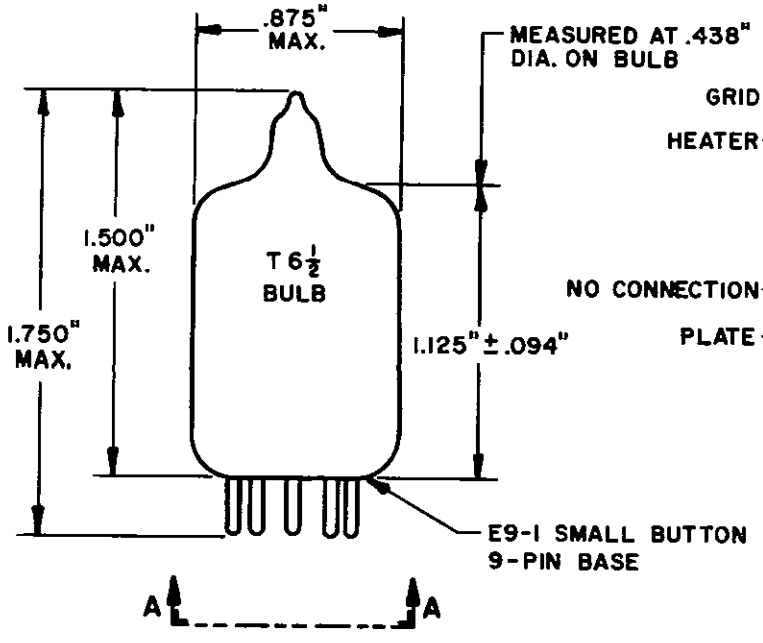
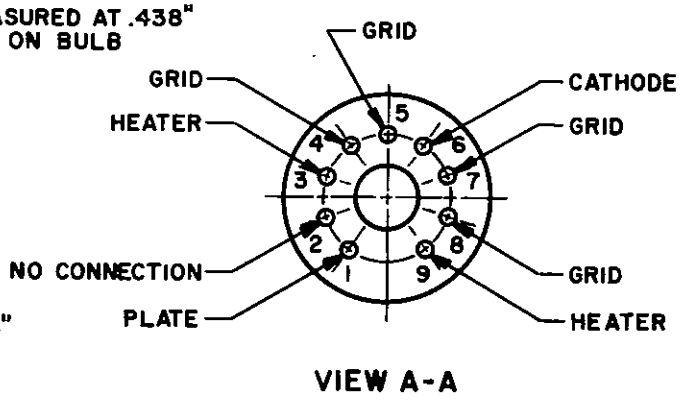


FIG. 5





VIEW A-A

A development of Bell Telephone Laboratories, the research laboratories of the American Telephone and Telegraph Company and the Western Electric Company.

PRINTED IN U.S.A.

AB46.418A
Issue 1 April 1956
A.T.&T. Co. Standard

ELECTRON TUBE DATA SHEET

WESTERN ELECTRIC 418A ELECTRON TUBE



DESCRIPTION

The 418A electron tube is an indirectly heated cathode type tetrode. This tube was designed primarily for use as a power output tube in broad-band video and intermediate-frequency amplifiers.

CHARACTERISTICS

Heater Voltage		6.3 volts
Cathode Current	(E_b = E_{c2} = 150 volts, E_{c1} = 0, R_k = 27 ohms)	70 milliamperes
Transconductance	(E_b = E_{c2} = 150 volts, E_{c1} = 0, R_k = 27 ohms)	26500 micromhos

File: General Purpose Section
Issue 2, 4-56

GENERAL CHARACTERISTICS

ELECTRICAL DATA

Heater Voltage	6.3 volts
Heater Current	0.6 ampere
Direct Interelectrode Capacitances	Without External Shield
Grid to Plate	0.055 μμf
Input: g1 to (h+k+g2+i.s)	15.0 μμf
Output: p to (h+k+g2+i.s)	2.8 μμf

MECHANICAL DATA

Cathode	Coated Unipotential
Bulb	T9
Base	See outline drawing page 4
Mounting Position	Any

Dimensions and pin connections shown in outline drawing on page 4

MAXIMUM RATINGS, Design Center Values

Plate Voltage	250 volts
Screen Grid Voltage	150 volts
Plate Dissipation	8.5 watts
Screen Grid Dissipation	3.0 watts
Control Grid Dissipation	see footnote *
Cathode Current	90 milliamperes
Heater-Cathode Voltage	90 volts
Bulb Temperature	130 centigrade

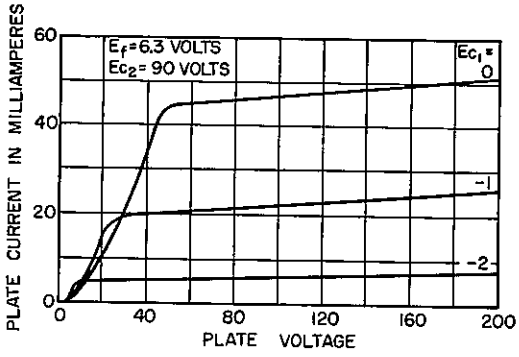
MAXIMUM CIRCUIT VALUES

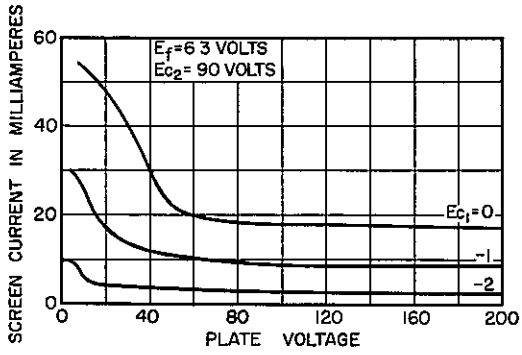
Grid Circuit Resistance:	
For Fixed Bias	0.05 megohm
For Cathode Bias	0.10 megohm

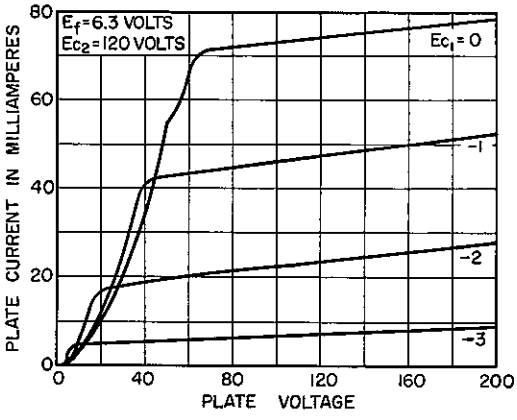
TYPICAL OPERATING CONDITIONS AND CHARACTERISTICS

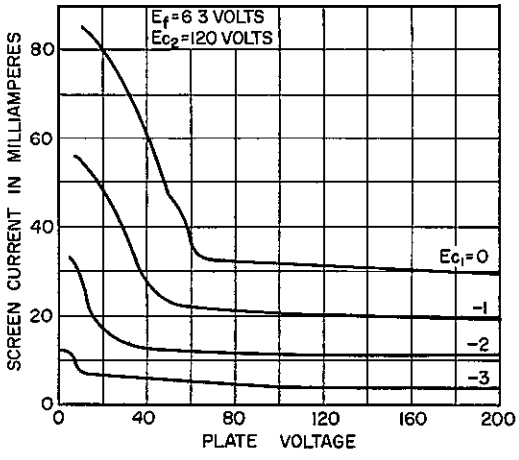
Plate Voltage	120	150	volts
Screen Grid Voltage	120	150	volts
Control Grid Voltage	-1.0	---	volts
Cathode Bias Resistor	---	27	ohms
Plate Current	47	50	milliamperes
Screen Grid Current	20	20	milliamperes
Plate Resistance	18000	18000	ohms
Transconductance	26500	26500	micromhos
Control Grid Voltage (approximate) for Plate Current of 10 microamperes	-9.5	---	volts

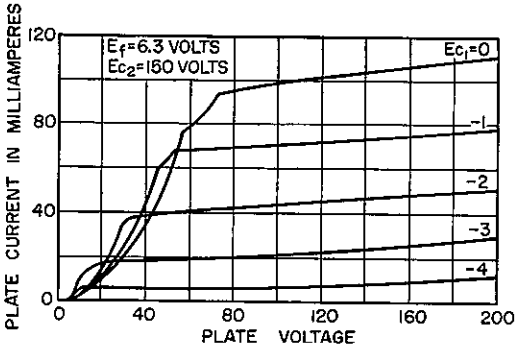
* Operation with the control grid positive with respect to the cathode is not recommended.

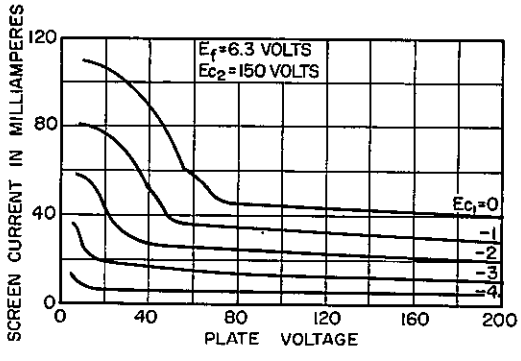

E_f=6.3 VOLTS
Ec_2= 90 VOLTS
Ec_1= 0
-1
-2
PLATE CURRENT IN MILLIAMPERES
PLATE VOLTAGE
0
20
40
60
0
40
80
120
160
200

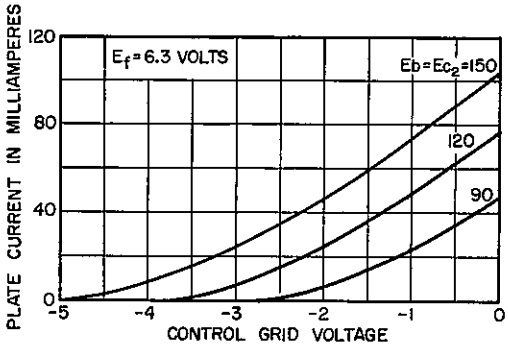

E_f=6.3 VOLTS
Ec_2= 90 VOLTS
Ec_1=0
-1
-2
SCREEN CURRENT IN MILLIAMPERES
PLATE VOLTAGE
0
20
40
60
0
40
80
120
160
200

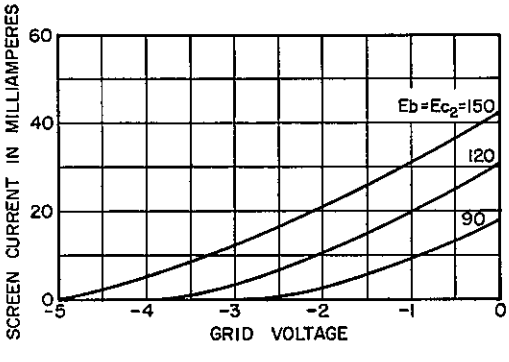

E_f=6.3 VOLTS
Ec_2=120 VOLTS
Ec_1= 0
-1
-2
-3
PLATE CURRENT IN MILLIAMPERES
PLATE VOLTAGE
0
20
40
60
80
0
40
80
120
160
200

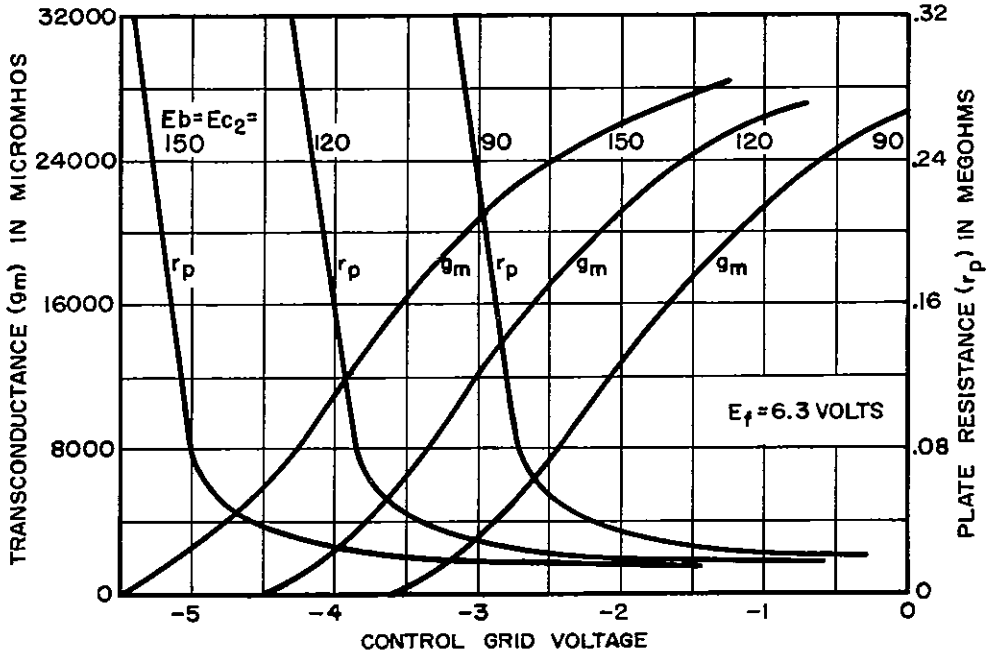

E_f=6.3 VOLTS
Ec_2=120 VOLTS
Ec_1=0
-1
-2
-3
SCREEN CURRENT IN MILLIAMPERES
PLATE VOLTAGE
0
20
40
60
80
0
40
80
120
160
200

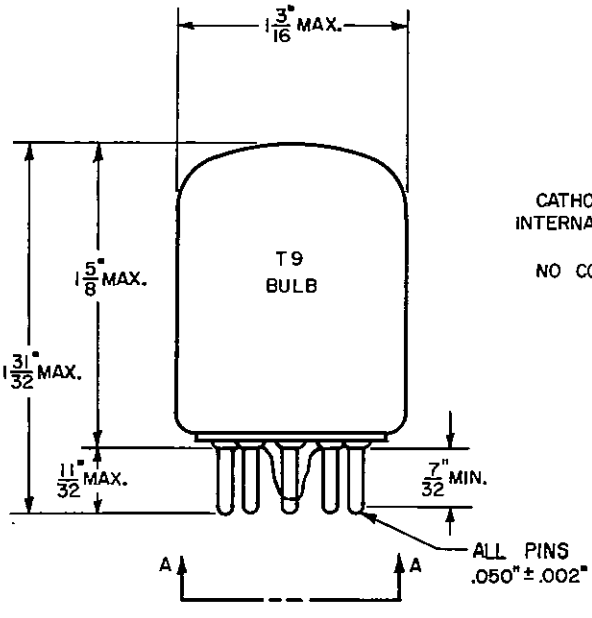

E_f=6.3 VOLTS
Ec_2=150 VOLTS
Ec_1=0
-1
-2
-3
-4
PLATE CURRENT IN MILLIAMPERES
PLATE VOLTAGE
0
40
80
120
0
40
80
120
160
200

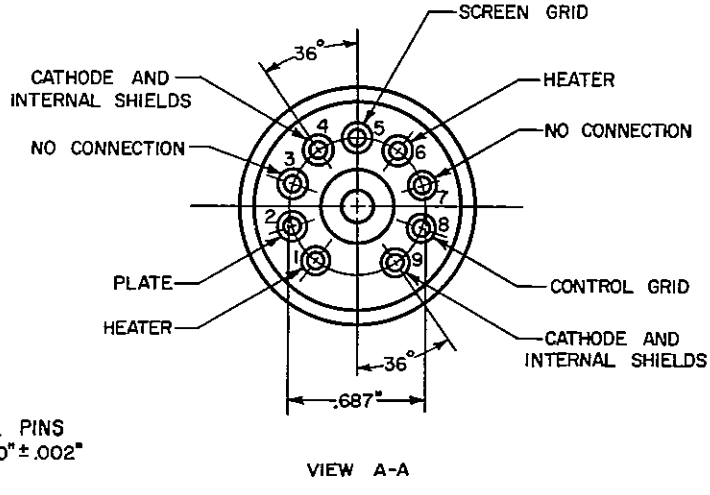

E_f=6.3 VOLTS
Ec_2=150 VOLTS
Ec_1=0
-1
-2
-3
-4
SCREEN CURRENT IN MILLIAMPERES
PLATE VOLTAGE
0
40
80
120
0
40
80
120
160
200


E_f=6.3 VOLTS
Eb=Ec_2=150
120
90
PLATE CURRENT IN MILLIAMPERES
CONTROL GRID VOLTAGE
0
40
80
120
-5
-4
-3
-2
-1
0


Eb=Ec_2=150
120
90
SCREEN CURRENT IN MILLIAMPERES
GRID VOLTAGE
0
20
40
60
-5
-4
-3
-2
-1
0



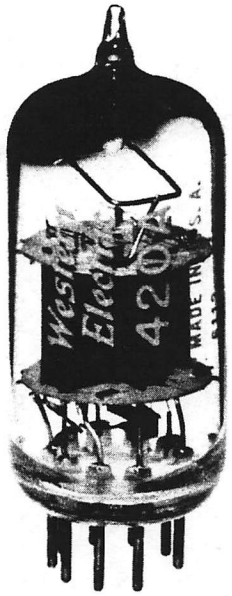




A development of Bell Telephone Laboratories, the research laboratories of the American Telephone and Telegraph Company and the Western Electric Company.

ELECTRON TUBE DATA SHEET

WESTERN ELECTRIC 420A ELECTRON TUBE



DESCRIPTION

→ The 420A electron tube is a double-triode having separate indirectly heated cathodes. The heater is center-tapped to permit operation from a 6.3 or 12.6 volt filament supply. This tube has been designed for use in d-c amplifier circuits where tube requirements include a high order of mechanical and thermionic stability as well as long life expectancy.

CHARACTERISTICS

Heater Voltage		6.3 volts
Plate Current (each section)	E_b = 110 volts; E_c = -0.6 volt	0.15 milliampere
Transconductance (each section)		500 micromhos

FILE: MINIATURE SECTION

→ Indicates a change

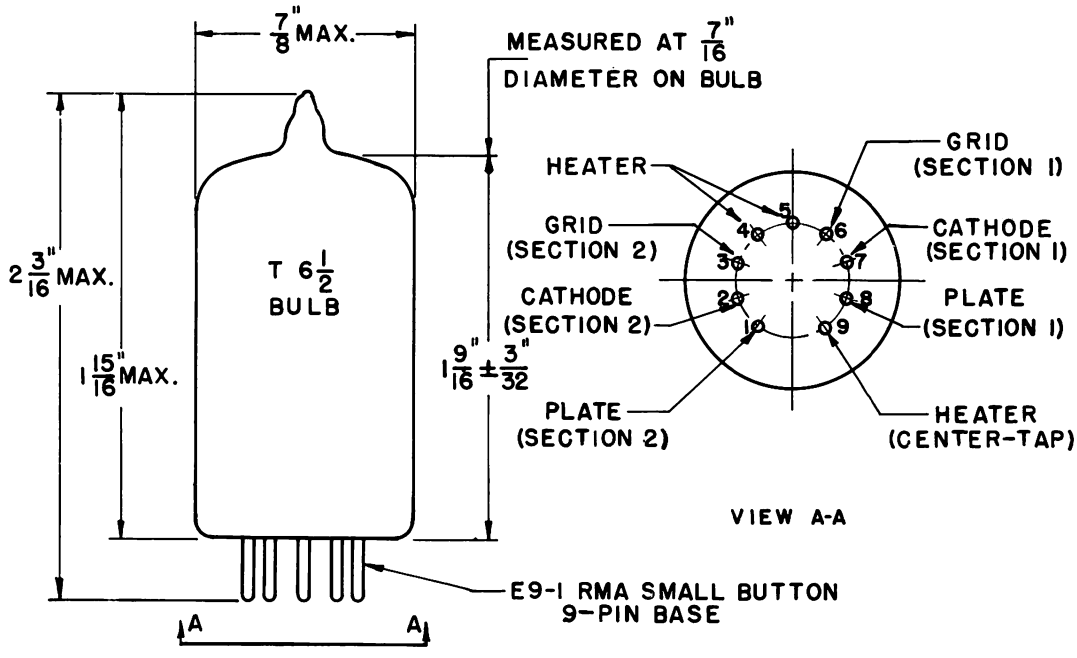
© American Telephone and Telegraph Company 1962

BELL SYSTEM PRACTICES
Transmission Engineering and Data
Electron Tube Data

SECTION AB46.420A
Issue 1, May 1951
A.T.& T. Co. Standard

ADVANCE ELECTRON TUBE DATA SHEET

WESTERN ELECTRIC 420A* ELECTRON TUBE



DESCRIPTION

The 5755/420A* is a double-triode amplifier tube having separate indirectly heated cathodes. The heater is center-tapped to permit operation from a 6.3 or 12.6 volt filament supply. This tube has been designed for use in d-c amplifier circuits where tube requirements include a high order of mechanical and thermionic stability as well as long life expectancy.

CHARACTERISTICS

Heater Voltage		6.3 volts
Plate Current (each section)	E_b=110 volts; E_c=-0.6 volt	0.15 milliampere
Transconductance (each section)		500 micromhos

5755/420A - PAGE 2

GENERAL CHARACTERISTICS

ELECTRICAL DATA

	Parallel	Series	
Heater Voltage	6.3	12.6	volts
Heater Current	360	180	milliamperes
Direct Interelectrode Capacitances	without external shield	with external shield (RMA #315)	
Grid to plate (each section)	1.4	(a) 1.4	uuf
Input (each section)	1.5	(a) 1.7	uuf
Output (Section #1)	0.8	(a) 1.5	uuf
Output (Section #2)	0.6	(a) 1.3	uuf
Plate 1 to Plate 2	0.9	(b) 0.8	uuf
Grid 1 to Plate 2	0.01	(b) 0.01	uuf
Grid 2 to Plate 1	0.01	(b) 0.01	uuf

MECHANICAL DATA

Cathode	Coated Unipotential
Bulb	T6-1/2
Base	Small Button 9-pin
Mounting Position	Any

Dimensions and pin connections shown in outline drawing on Page 4

MAXIMUM RATINGS, Design Center Values (Each Section)

Plate Voltage	225 volts
Plate Dissipation	0.9 watt
Plate Current	4 milliamperes
Heater-Cathode Voltage	70 volts

TYPICAL OPERATING CONDITIONS AND CHARACTERISTICS, D-C AMPLIFIER

(Values are for each section unless otherwise specified)

	(c)	
Heater Supply Voltage	12.6	volts
Heater Ballast Resistor	35	ohms
Plate Supply Voltage	310	volts
Cathode Bias Resistor (Cathodes tied together)	150,000	ohms
Plate Current	0.15	milliampere
Grid Current (max.)	10^{-9}	ampere
Plate Resistance	0.14	megohm
Load Resistance	0.9	megohm
Transconductance	500	micromhos
Amplification Factor	70	
Balance[1]	0.3	volt
Stability[2]	5	millivolts

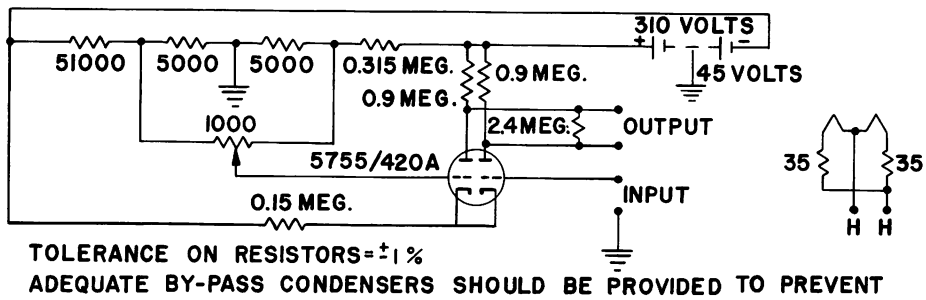
(a) With external shield #315 connected to cathode pin of section under test.

(b) With external shield #315 connected to ground with other elements.

(c) See circuit - Fig. 1

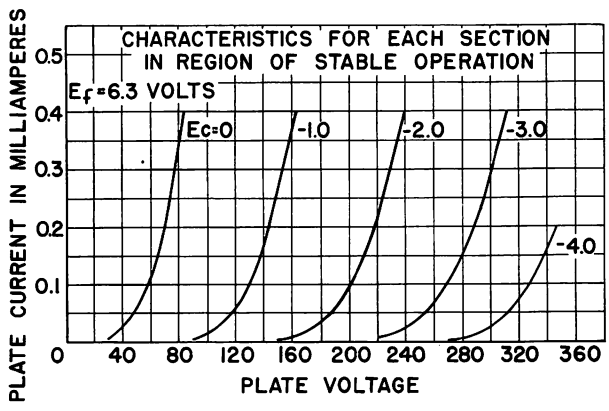
1. Balance is the condition obtained when grid voltages have been adjusted so that resulting plate current values are equal in both sections of the tube. Value shown above is the maximum grid voltage differential necessary to obtain balance.

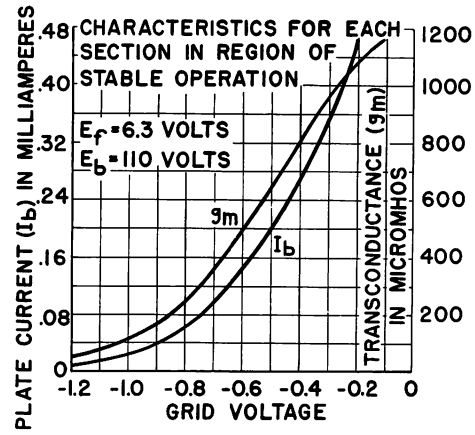
2. Stability is defined as the capability of the tube to maintain the condition of balance described in Note 1 in a circuit such as shown in Fig. 1. The arithmetical average value of input voltage change necessary to maintain balance for a production sample group of tubes will not be greater than the value given. This average value of input voltage change is determined over a 7-hour testing period immediately following a 9-hour circuit acclimation schedule. (A 5 millivolt change in input voltage is equivalent to a 0.26 volt change in the output voltage.)

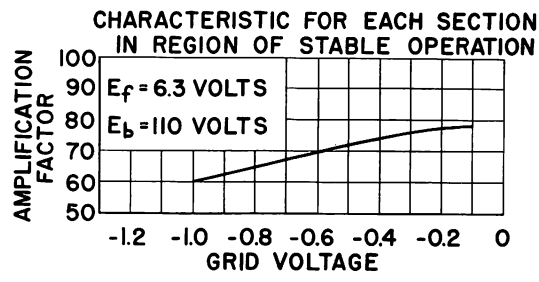


TOLERANCE ON RESISTORS = ±1 %
ADEQUATE BY-PASS CONDENSERS SHOULD BE PROVIDED TO PREVENT PARASITIC OSCILLATIONS.
THE BALLASTED HEATER CIRCUIT IS USED TO ESSENTIALLY CANCEL OUT VARIATIONS IN HEATER POWER DUE TO SMALL VARIATIONS IN HEATER RESISTANCE.

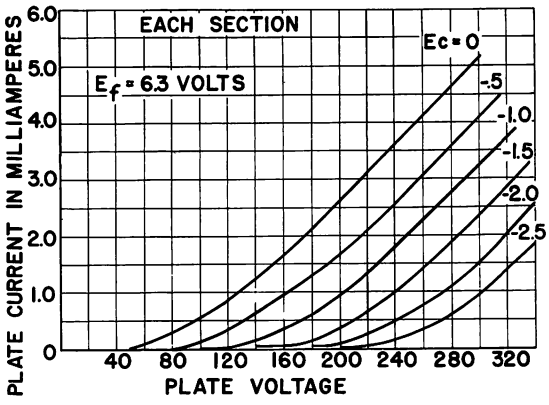
FIG. 1

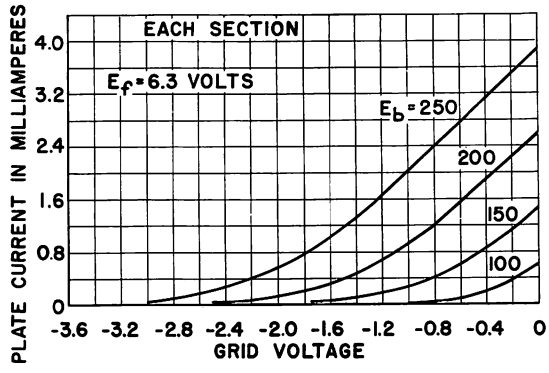


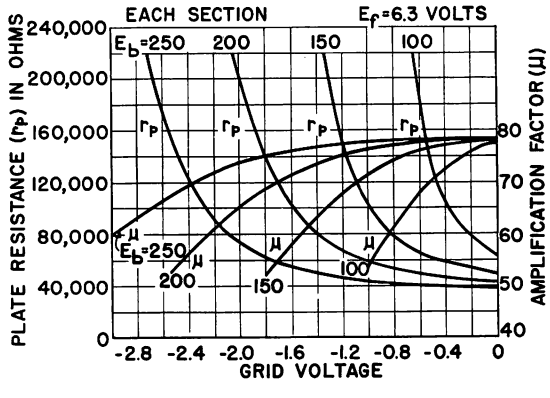


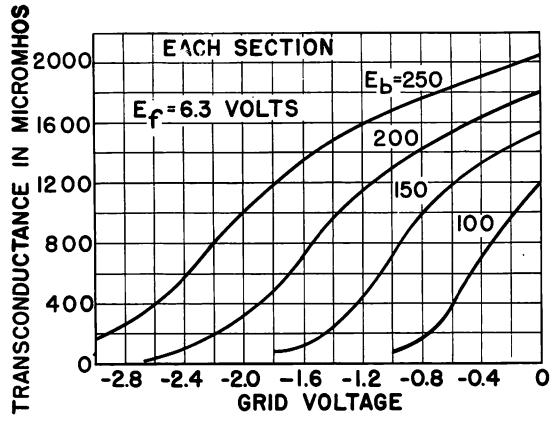


5755/420A - PAGE 4









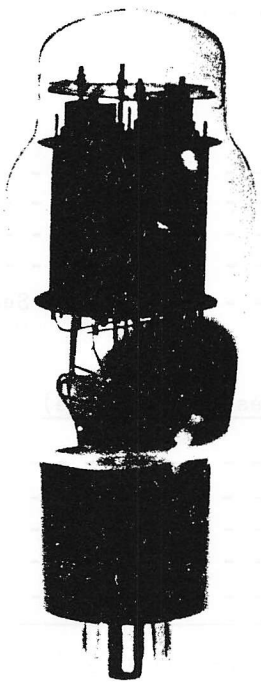
A development of Bell Telephone Laboratories, the research laboratories of the American Telephone and Telegraph Company and the Western Electric Company.

1-E-51-4

T-2696

ELECTRON TUBE DATA SHEET

WESTERN ELECTRIC 5998* ELECTRON TUBE



DESCRIPTION

The 5998/421A* is a double triode having separate indirectly heated cathodes. It is intended for use as a series tube in regulated rectifier circuits.

CHARACTERISTICS

Heater Voltage		6.3 volts
Plate Current per Section	E_{bb} - 110 volts;	125 milliamperes
Transconductance per Section	R_k - 65 ohms	20000 micromhos

GENERAL CHARACTERISTICS

ELECTRICAL DATA

Heater Voltage	6.3 volts
Heater Current	2.4 amperes

MECHANICAL DATA

Cathode	Coated Unipotential
Bulb	ST 16
Base	Medium 8-pin octal
Mounting Position	Any
Dimensions and Pin Connections	See Outline drawing page 4

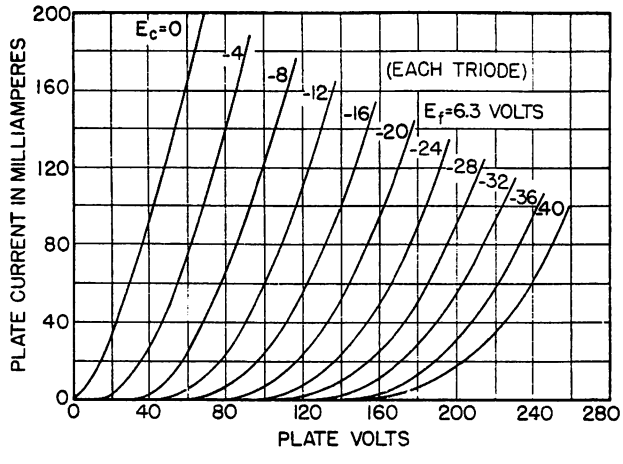
MAXIMUM RATINGS, Design-Center Values (Each Triode)

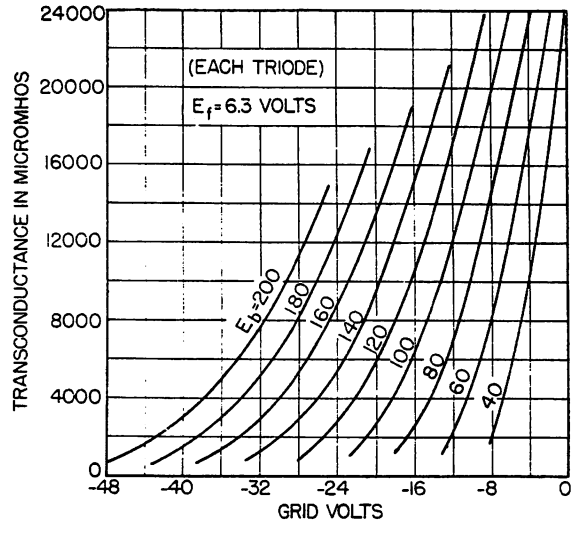
Plate Voltage	250 volts
Plate Dissipation	13 watts
Cathode Current	125 milliamperes
Heater-Cathode Voltage[1]	150 volts
Bulb Temperature[1]	200°Centigrade
Maximum Grid Circuit Resistance for Cathode Bias	0.1 megohm

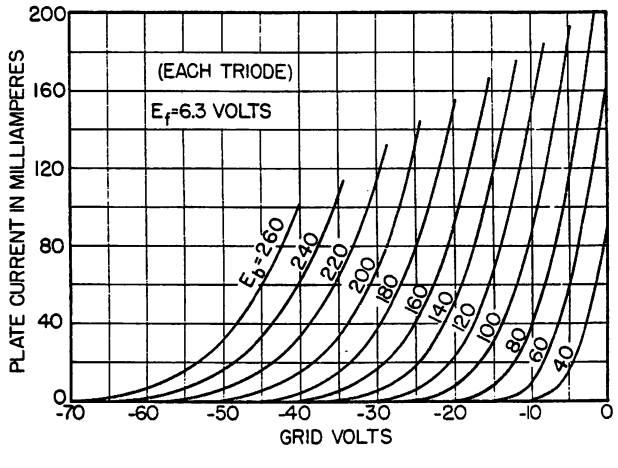
OPERATING CONDITIONS AND CHARACTERISTICS (Each Triode)

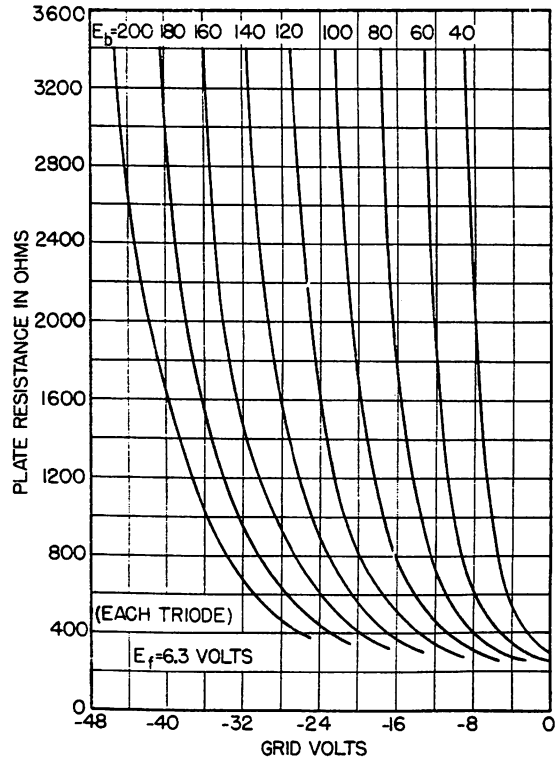
Plate Supply Voltage	110	110 volts
Cathode Bias Resistance	90	65 ohms
Plate Current	100	125 milliamperes
Amplification Factor	5.9	6.1
Plate Resistance	330	305 ohms
Transconductance	18000	20000 micromhos

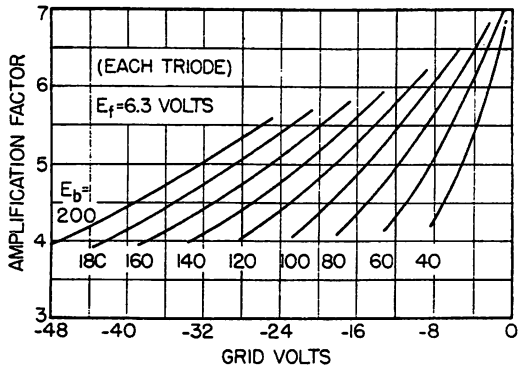
Note 1: For optimum life expectancy the heater-cathode voltage should not exceed 90 volts and forced-air cooling should be provided. The air flow should be sufficient to keep the bulb temperature below 150°C.

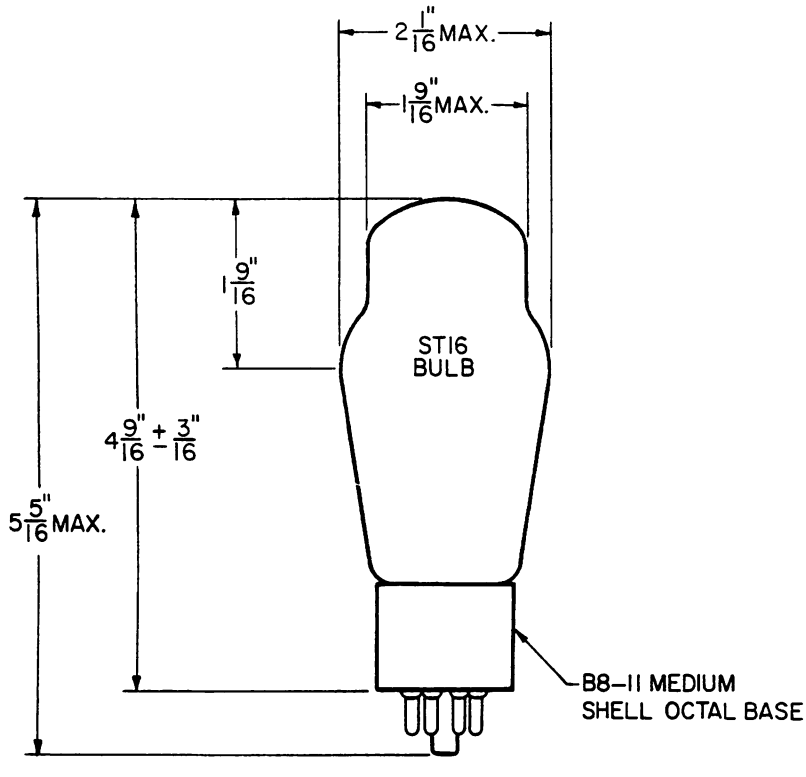

PLATE CURRENT IN MILLIAMPERES
PLATE VOLTS
(EACH TRIODE)
E_f=6.3 VOLTS
E_c=0
-4
-8
-12
-16
-20
-24
-28
-32
-36
-40
0
40
80
120
160
200
240
280

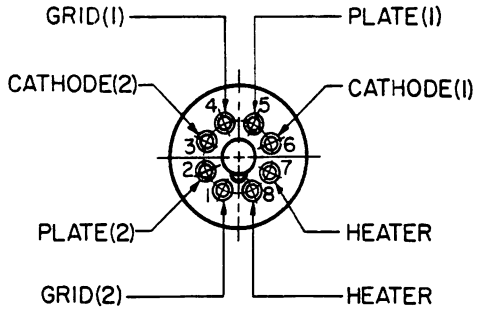

TRANSCONDUCTANCE IN MICROMHOS
GRID VOLTS
(EACH TRIODE)
E_f=6.3 VOLTS
E_b=200
180
160
140
120
100
80
60
40
-48
-40
-32
-24
-16
-8
0


PLATE CURRENT IN MILLIAMPERES
GRID VOLTS
(EACH TRIODE)
E_f=6.3 VOLTS
E_b=260
240
220
200
180
160
140
120
100
80
60
40
-70
-60
-50
-40
-30
-20
-10
0


PLATE RESISTANCE IN OHMS
GRID VOLTS
E_b=200 180 160 140 120 100 80 60 40
(EACH TRIODE)
E_f=6.3 VOLTS
-48
-40
-32
-24
-16
-8
0


AMPLIFICATION FACTOR
GRID VOLTS
(EACH TRIODE)
E_f=6.3 VOLTS
E_b=
200
180
160
140
120
100
80
60
40
-48
-40
-32
-24
-16
-8
0





A development of Bell Telephone Laboratories, the research laboratories of the American Telephone and Telegraph Company and the Western Electric Company

ELECTRON TUBE DATA SHEET

WESTERN ELECTRIC 422A ELECTRON TUBE



DESCRIPTION

The 422A is a double diode with indirectly heated cathodes. It is used as a full wave rectifier to supply direct current from an alternating current source.

CHARACTERISTICS

Heater Voltage	5 volts
Maximum Peak Inverse Voltage	1800 volts
Maximum D-C Output Current	400 milliamperes

FILE: RECTIFIER SECTION
ISSUE 2 9-52

GENERAL CHARACTERISTICS

ELECTRICAL DATA

Heater Voltage	5 volts
Heater Current	3 amperes

MECHANICAL DATA

Cathode	Coated unipotential
Bulb	ST16
Base	Medium Shell Octal
Mounting Position	Any

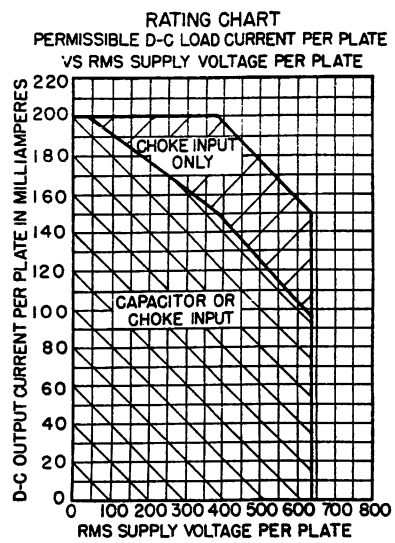
Dimensions and pin connections shown in outlined drawing on page 4.

RATINGS, Design-Center Values

Maximum Peak Inverse Voltage	1800 volts
Maximum Steady State Peak Plate Current per Plate	0.9 ampere
Maximum Transient Peak Plate Current per Plate	4 amperes
Maximum A-C Plate Supply Voltage per Plate	See rating chart
Maximum Steady State D-C Output Current per Plate	See rating chart
Minimum Effective Plate Supply Impedance per Plate	100 ohms
Tube Voltage Drop (at 300 milliamperes per plate)	26 volts
Maximum Bulb Temperature[1]	150 centigrade

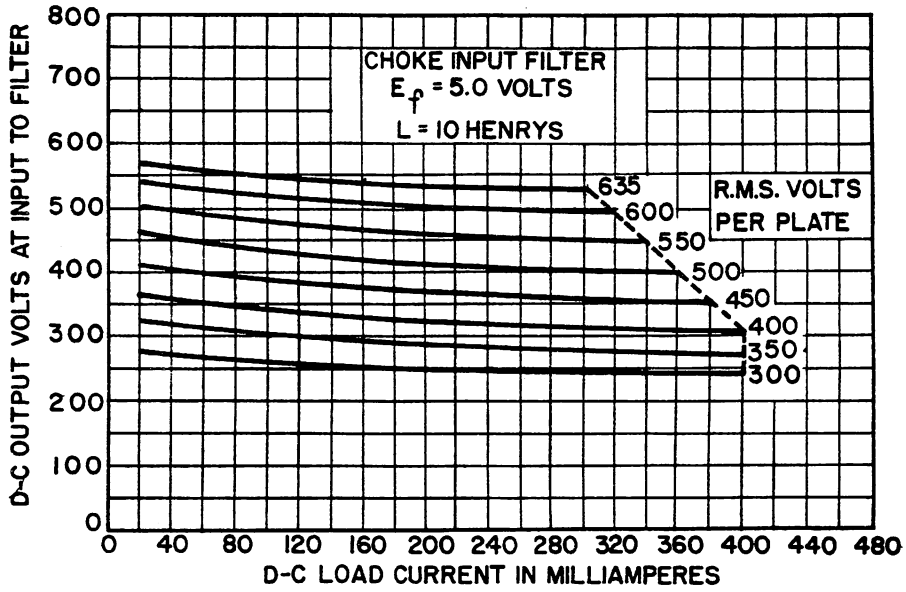
TYPICAL OPERATING CONDITIONS

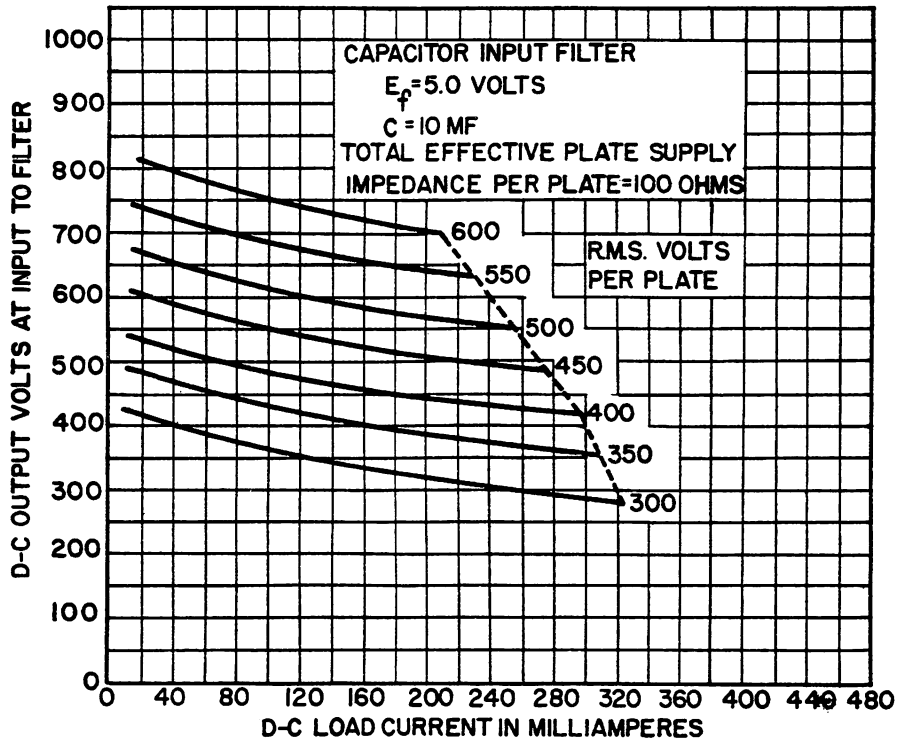
Full Wave Rectifier	Input To Filter	
	Capacitor	Choke
A-C Plate Supply Voltage per Plate	385	450 volts
Input Capacitor	10	--- microfarads
Input Choke (minimum)	---	10 henrys
Effective Plate Supply Impedance per Plate	100	--- ohms
D-C Output Current	300	350 milliamperes
D-C Output Voltage	395	360 volts



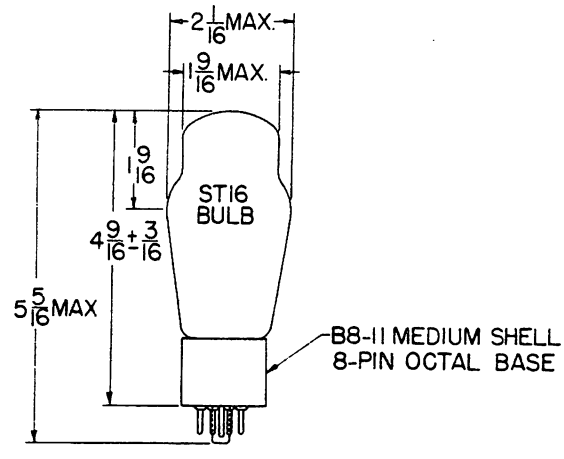
Note: Operating point for capacitor input to filter must be within the lower cross-hatched area designated "Capacitor or Choke Input" while that for choke input to filter must be at some point within either cross-hatched area.

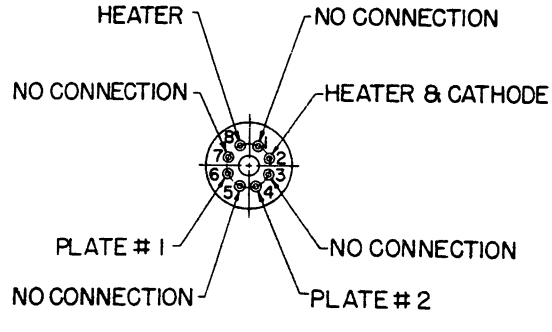
Note 1: Temperature limit given is that required to obtain optimum tube life. Forced-air cooling is necessary to meet this limit. Maximum permissible bulb temperature is 200 centigrade.

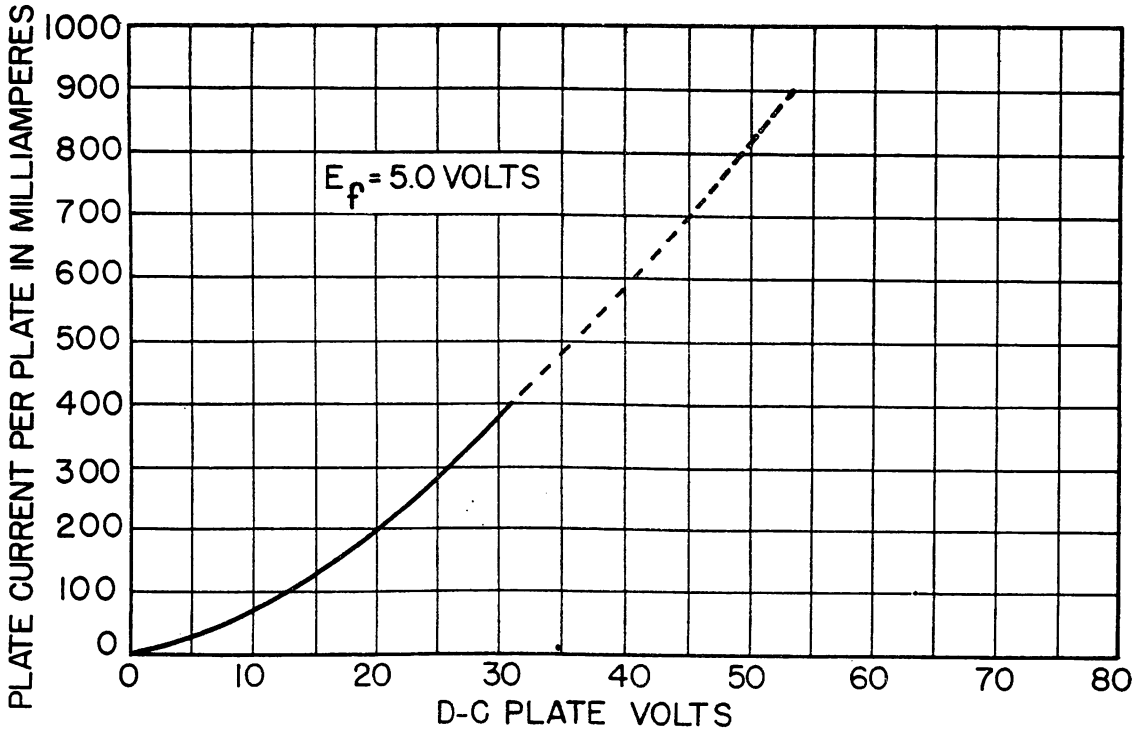




422A-Page 4







A development of Bell Telephone Laboratories, the research laboratories of the American Telephone and Telegraph Company and the Western Electric Company.

1-J-52-4

T2720

ELECTRON TUBE DATA SHEET

WESTERN ELECTRIC 423A* ELECTRON TUBE



DESCRIPTION

The 6140/423A* is a two-electrode inert-gas filled cold cathode tube designed primarily for use as a voltage reference tube. This tube has characteristics which are exceptionally stable with life and with variations in ambient temperature.

CHARACTERISTICS

Cathode Current	4 to 8 milliamperes
Anode Voltage Drop	100 volts
Regulation, Max. (4 to 6 Milliamperes D-C)	0.75 volt

RATINGS, Absolute Values

Cathode Current, Forward	
Maximum	8 milliamperes
Minimum	4 milliamperes
Maximum Inverse Anode Current	0.0 milliampere
Ambient Temperature Limits	-55 to + 60 centigrade

ELECTRICAL DATA

	Min.	Bogey	Max.	
Anode Breakdown Voltage	---	135	160	volts
Anode Voltage Drop at 6 Milliamperes (D-C)[1]	99	100	103	volts
Regulation (4 to 6 Milliamperes, D-C)	---	0.3	0.75	volt
Temperature Sensitivity of Anode Voltage Drop				
Anode Current, 4 Milliamperes (D-C)	---	-0.01	---	volt/c
Anode Current, 8 Milliamperes (D-C)	---	-0.02	---	volt/c
Fluctuation[2]	---	0.02	0.1	volt
Stability[3]	---	0.05	0.2	volt

MECHANICAL DATA

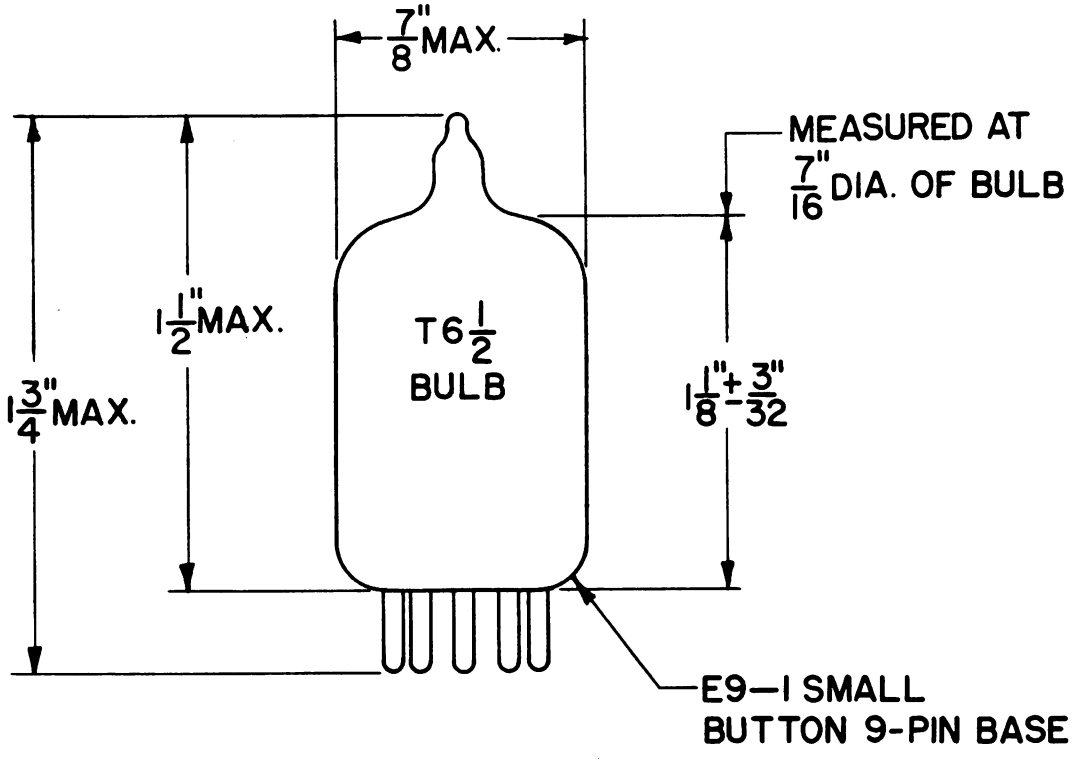
Mounting Position	Any
Net Weight, Approximate	0.3 ounce
Bulb	T 6-1/2
Base	Small Button 9-pin

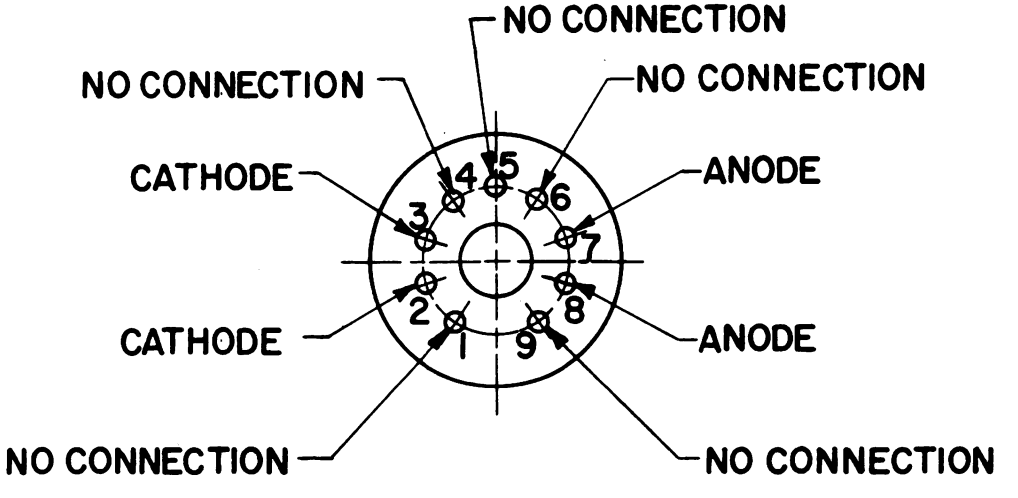
Note 1: These values are for new tubes. Anode voltage drop will stabilize within 3 minutes after starting. The stability characteristic should be considered during tube life.

Note 2: The anode voltage drop variation during a short period of time (one to ten minutes), with the tube operating at one value of current and temperature within its ratings, will not exceed the above stated maximum value.

Note 3: The drift of anode voltage drop over a period of 1000 hours, with the tube operating at one value of current and temperature within its ratings, will not exceed the above stated maximum value.

Note 4: Pins marked "NO CONNECTION" should not be connected to any portion of an external circuit. Failure to observe this precaution may result in improper operation of the tube.





SEE NOTE 4 ON PIN CONNECTIONS

Western Electric

1-L-52-4 PRINTED IN U.S.A. T2721

ELECTRON TUBE DATA SHEET

WESTERN ELECTRIC 423C ELECTRON TUBE



DESCRIPTION

The 423C is a two-electrode inert-gas filled cold cathode tube designed primarily for use as a voltage reference tube. This tube has characteristics which are exceptionally stable with life and with variations in ambient temperature.

CHARACTERISTICS

Cathode Current	4 to 8	milliamperes
Anode Voltage Drop	100	volts
Regulation at 4 to 6 milliamperes d-c (Note 5-page 3)	0.75	volt

File: Cold Cathode Section

© American Telephone and Telegraph Company 1962

RATINGS, Absolute System (Note 1)

Cathode Current, Forward		
Maximum	8	milliamperes
Minimum	4	milliamperes
Maximum Inverse Anode Current	0.0	milliampere
Ambient Temperature Limits	-55 to +60	centigrade

ELECTRICAL DATA, Throughout Life

	Min.	Bogey	Max.	
Anode Breakdown Voltage	-	135	160	volts
Anode Voltage Drop(E_{td}) at 6 Milliamperes (D-C) Note 2	99	100	103	volts
Regulation (4 to 6 Milliamperes, D-C) (Note 5)	-	0.3	0.75	volt
Temperature Sensitivity of Anode Voltage Drop				
Anode Current, 4 Milliamperes (D-C)	-	-0.01	-	volt/c
Anode Current, 8 Milliamperes (D-C)	-	-0.02	-	volt/c
Fluctuation (Note 3)	-	0.02	0.1	volt
Average Ionization Time (Note 4)	-	4.0	6.0	milliseconds

MECHANICAL DATA

Mounting Position	Any
Net Weight, Approximate	0.3 ounce
Bulb	T 6½
Base	Small Button 9 pin

Dimensions and connections shown in outline drawing on page 4.

LIFE DATA

Regulation (4 to 6 mAdc) after 1000 hours at 5 mAdc (Note 5)	See Figure 1
Drift in Anode Voltage Drop (E_{td}) in 1000 hours at 5 mAdc	See Figure 2

HANDLING

This tube contains a small amount of krypton-85 gas which is a by-product radioactive material. The amount of krypton-85 is less than five microcuries, which is too small an amount to require any special care in use.

Atomic Energy Commission regulations require that the individual tube carton for tubes containing by-product radioactive material be appropriately marked. The marking includes the statement that tube disposal should be in approved manner.

Approved instructions for disposal of tubes containing krypton-85 are as follows;

> **Tubes to be disposed of should be broken or crushed in a well ventilated place releasing any resulting vapors to the outside atmosphere. The residual broken or crushed tubes should be disposed of in a normal public trash disposal system. Tubes should be disposed of at a rate of not more than 100 each week from any one location. Avoid breathing vapors from broken tubes.**

Note 1: In the "Absolute System" the maximum ratings specified are limiting values above which the serviceability of the device may be impaired from the viewpoint of life and satisfactory performance. Maximum ratings, as such, do not constitute a set of operating conditions and all values may not, therefore, be attained simultaneously.

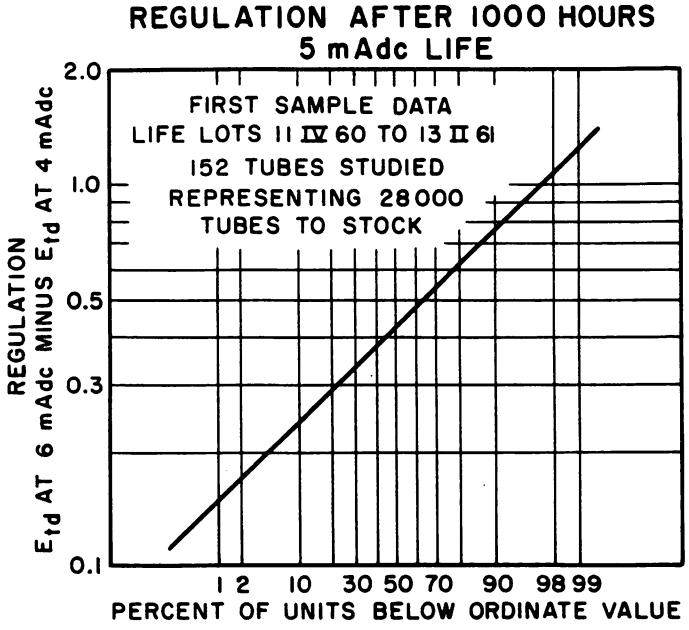


FIG. 1

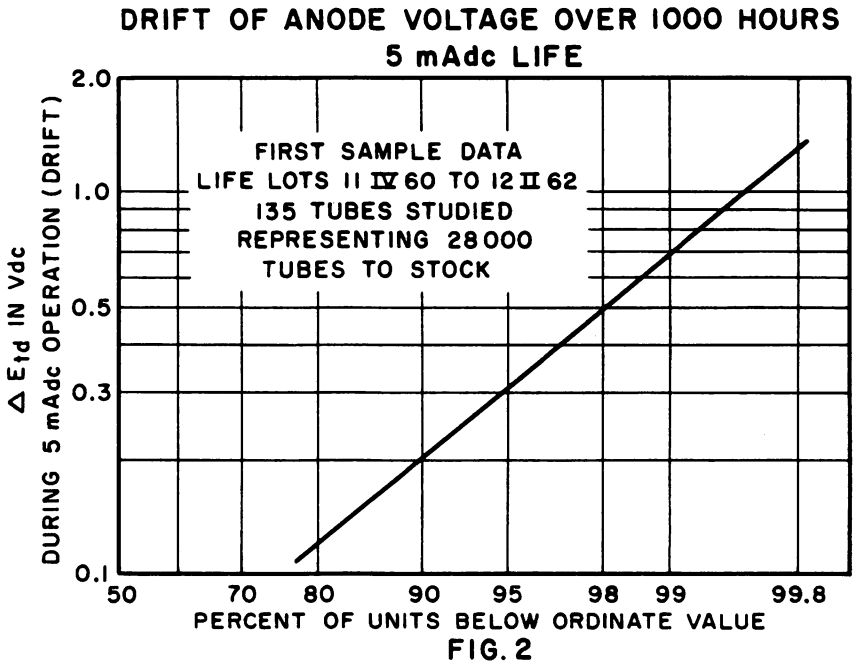


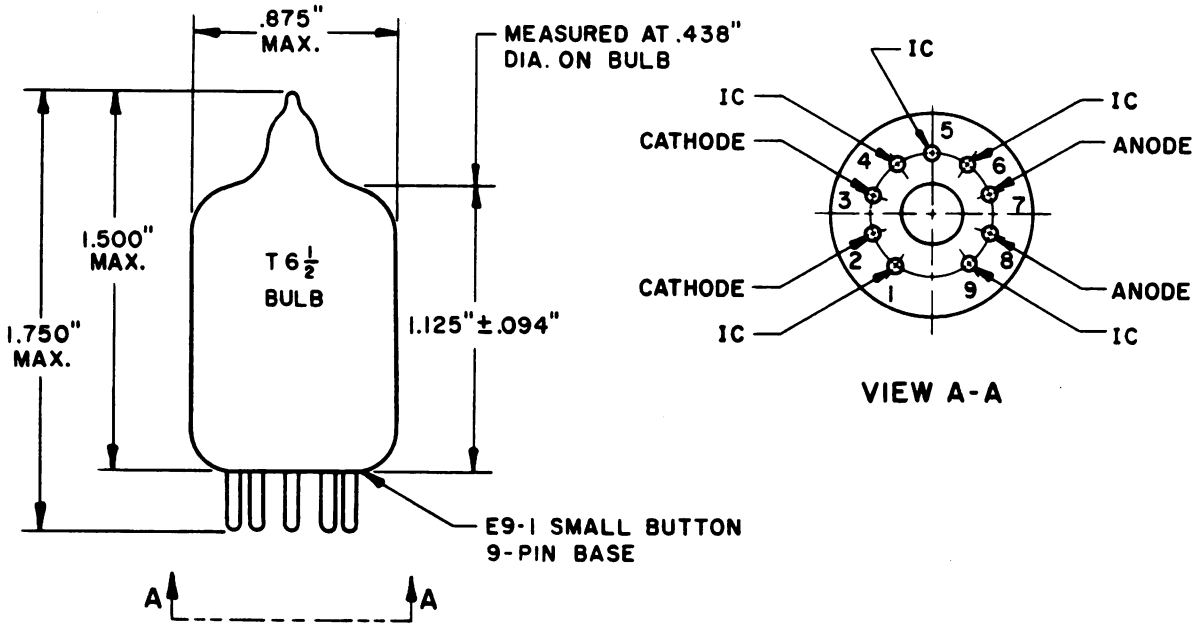
FIG. 2

Note 2: These values are for new tubes. Anode voltage drop will stabilize within 3 minutes after starting.

Note 3: The anode voltage drop variation during a short period of time (one to ten minutes), with the tube operating at one value of current and temperature within its ratings, will not exceed the above stated maximum value.

Note 4: With 15 volts overvoltage (15 volts above Anode Breakdown Voltage) with tube in total darkness. Average of 10 measurements taken at 1 second intervals.

Note 5: Regulation is defined to be Anode Voltage Drop (E_{td}) at 6 mAdc minus Anode Voltage Drop (E_{td}) at 4 mAdc.



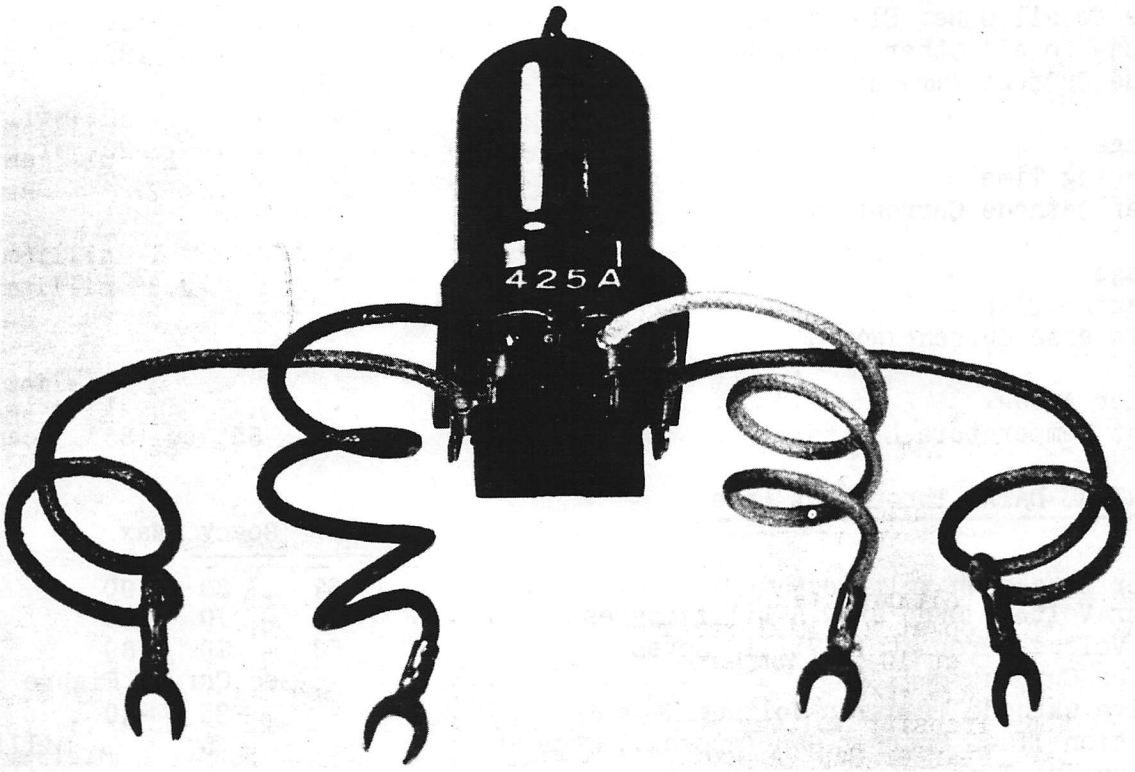
VIEW A-A

NOTE: PINS MARKED IC (INTERNAL CONNECTION) SHOULD NOT BE CONNECTED TO ANY PORTION OF AN EXTERNAL CIRCUIT. FAILURE TO OBSERVE THIS PRECAUTION MAY RESULT IN IMPROPER OPERATION OF THE TUBE.

A development of Bell Telephone Laboratories, the research laboratories of the American Telephone and Telegraph Company and the Western Electric Company.

PRINTED IN U.S.A.

ELECTRON TUBE DATA SHEET
WESTERN ELECTRIC 425A ELECTRON TUBE



DESCRIPTION

The 425A is a four-electrode, inert-gas filled cold cathode tube for use as a relay device. The tube is provided with an anode-cathode gap and a starter anode-starter cathode gap such that isolation of the control (starter gap) and controlled (main gap) portions of a circuit may be obtained.

This tube is designed with an integral special mounting bracket. It is available in an electrically equivalent, socket mounting form, as the 451A.

CHARACTERISTICS

Peak Anode Voltage	180	180	volts
Average Starter Cathode Current	0.7	7.0	milliamperes
Average Main Cathode Current	5.0	50	milliamperes
Average Life, Approximate	10000	10	hours

FILE: COLD CATHODE SECTION

←Indicates a change

© American Telephone and Telegraph Company 1962

MAXIMUM RATINGS, Absolute System (Note 1)

Peak Voltage, Forward or Inverse		
Anode to all Other Electrodes	180	volts
Cathode to all Other Electrodes	180	volts
→Cathode Current (Note 2)		
Peak	50	milliamperes
Average	20	milliamperes
Averaging Time	2	seconds
Starter Cathode Current (Note 2)		
Peak	7	milliamperes
Average	2.5	milliamperes
Averaging Time	2	seconds
→Peak Inverse Current (Note 2)		
Anode	5	milliamperes
Starter Anode	1	milliamperes
Ambient Temperature Limits	-55° to +85°	centigrade

ELECTRICAL DATA, Throughout Life

	Min.	Bogey	Max.	
Starter Breakdown Voltage (Note 3)	67	80	90	volts
Starter Voltage Drop at 2.5 Milliamperes	55	70	75	volts
Anode Voltage Drop at 10 Milliamperes	58	70	80	volts
→Transfer Current (Note 4)		See Curve, Figure 3, Page4		
Negative Cathode Transfer Voltage (Note 5)	-	-25	-40	volts
Ionization Time, Starter Gap (Approx.) (Note 6)	-	5	-	milliseconds
Deionization Time, Main Gap (Approx.)	-	1	-	millisecond

MECHANICAL DATA

Mounting (Note 7)	Any position	
New Weight, Approximate	0.7	ounce
Dimensions and Connections	See outline drawing on page 4	

HANDLING

This tube contains a small amount of krypton-85 gas which is a by-product radioactive material. The amount of krypton-85 is less than five microcuries, which is too small an amount to require any special care in use.

Atomic Energy Commission regulations require that the individual tube carton for tubes containing by-product radioactive material be appropriately marked. The marking includes the statement that tube disposal should be in approved manner.

Approved instructions for disposal of tubes containing krypton-85 are as follows;

> Tubes to be disposed of should be broken or crushed in a well ventilated place releasing any resulting vapors to the outside atmosphere. The residual broken or crushed tubes should be disposed of in a normal public trash disposal system. Tubes should be disposed of at a rate of not more than 100 each week from any one location. Avoid breathing vapors from broken tubes.

→Indicates a change

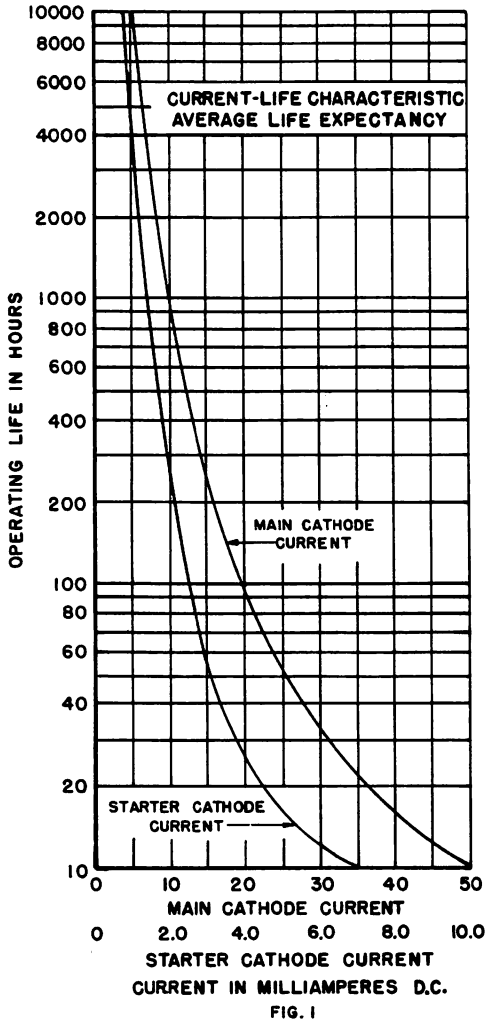


FIG. 1

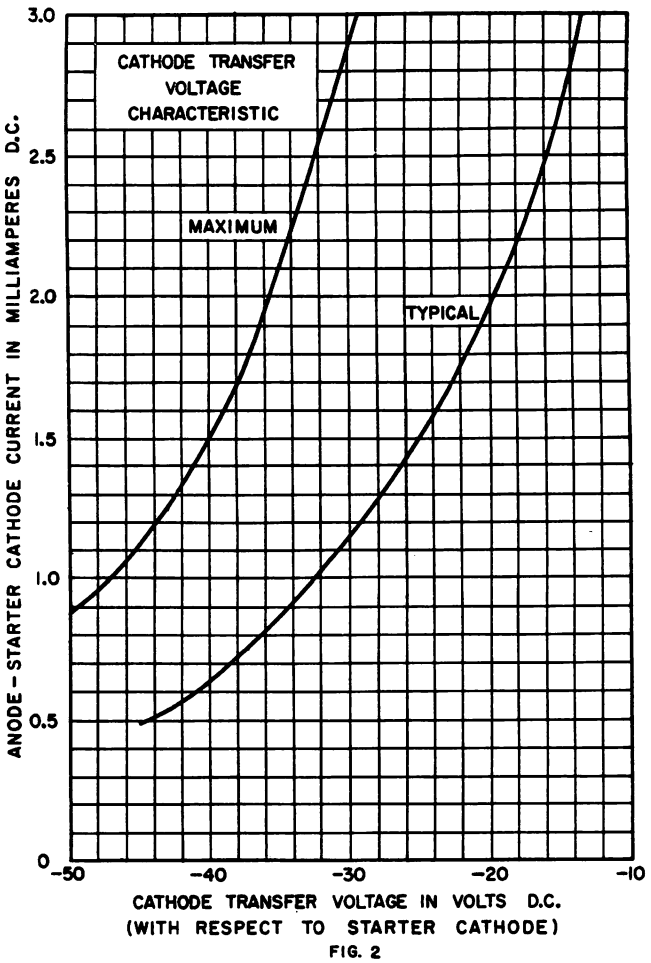


FIG. 2

Note 1: In the "Absolute System" the maximum ratings specified are limiting values above which the serviceability of the device may be impaired from the viewpoint of life and satisfactory performance. Maximum ratings, as such, do not constitute a set of operating conditions and all values may not, therefore, be attained simultaneously.

Note 2: Sufficient resistance must be used in series with the tube discharge paths to assure that the electrode currents do not exceed their maximum rated values. ◄

Note 3: Limits apply immediately after the tube has conducted current. These values may be initially as much as 3 volts higher or lower if the tube has been idle.

Note 4: To assure transfer of conduction from the starter anode-starter cathode gap to the anode-starter cathode gap.

Note 5: To assure transfer of conduction from the anode-starter gap to the anode-cathode gap with 1.5 milliamperes flowing from anode to starter cathode. Cathode voltage is measured with respect to starter cathode.

Note 6: With 15 volts starter overvoltage (15 volts above Starter Breakdown Voltage) and with the tube in total darkness.

Note 7: Tube is permanently mounted on plastic angle bracket. Pin connections are terminated in flexible connector leads.

→Indicates a change

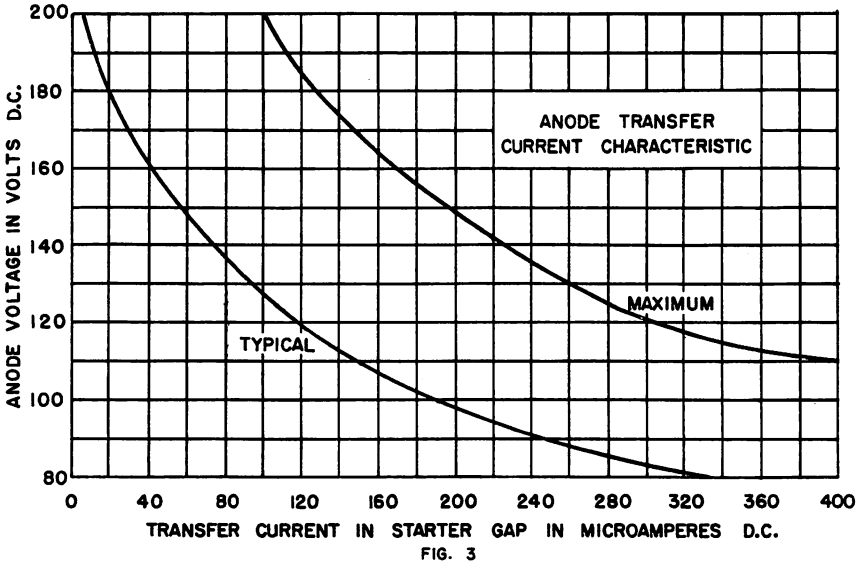
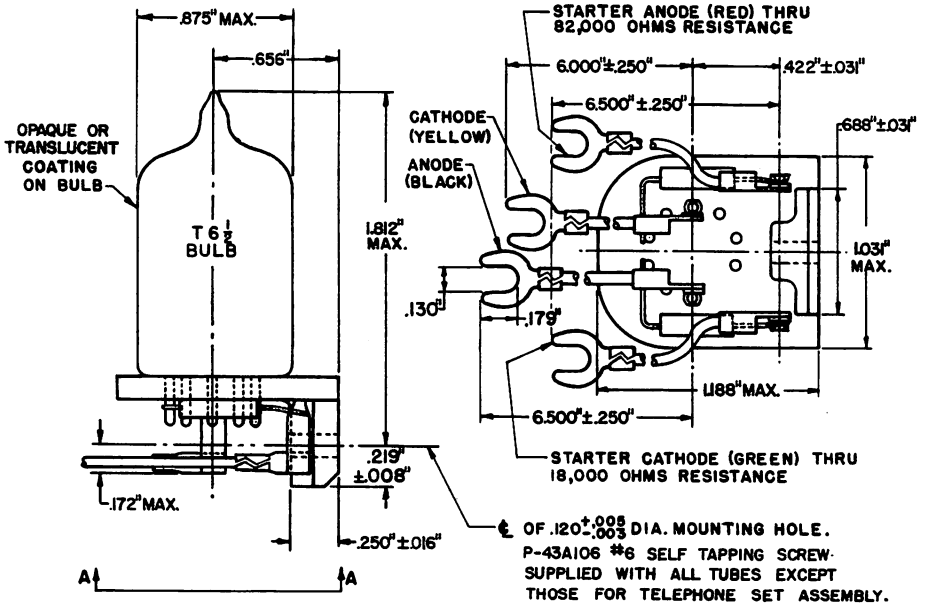


FIG. 3



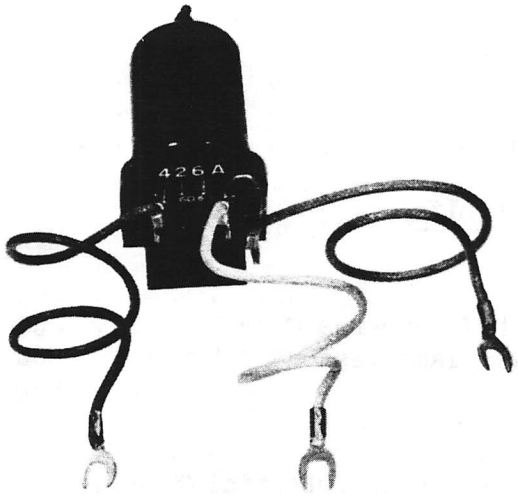
VIEW AA

A development of Bell Telephone Laboratories, the research laboratories of the American Telephone and Telegraph Company and the Western Electric Company.

PRINTED IN U.S.A.

ELECTRON TUBE DATA SHEET

WESTERN ELECTRIC 426A ELECTRON TUBE



DESCRIPTION

The 426A is a three-electrode inert-gas-filled miniature cold cathode tube for use in relay, voltage regulator or rectifier circuits. This tube is especially suitable for use in control circuits such as in triggering, counting or switching apparatus.

CHARACTERISTICS

Peak Anode Voltage		180	volts
Average Cathode Current	7.5	60	milliamperes
Average Life, Approximate	10000	10	hours

File: Cold Cathode Section

© American Telephone and Telegraph Company 1962

MAXIMUM RATINGS, Absolute System (Note 1)

Forward Peak Anode Voltage	180	volts
Forward Cathode Current (Note 2)		
Peak	60	milliamperes
Average	30	milliamperes
Averaging Time	2	seconds
Peak Inverse Current (Note 2)		
Anode	5	milliamperes
Starter	1	milliampere
Ambient Temperature Limits	-55 to +85	centigrade

ELECTRICAL DATA, Throughout Life

	Min.	Bogey	Max.	
Starter Breakdown Voltage	65	72	85	volts
Starter Voltage Drop at 3 Milliamperes (Note 3)	53	63	72	volts
Anode Voltage Drop at 10 Milliamperes (Notes 4 & 5)	63	69	75	volts
Transfer Current	See Figure 1, Page 3			
Ionization Time, Starter Gap (Note 6)	-	10	-	milliseconds
Deionization Time, Main Gap	-	6	-	milliseconds
Inverse Current at -120 Volts Anode Potential (Note 7)	-	-	3	milliamperes

MECHANICAL DATA

Mounting (Note 8)	Any Position
Net Weight	0.7 Ounce

Dimensions and connections shown in outline drawing on page 4.

HANDLING

This tube contains a small amount of krypton-85 gas which is a by-product radioactive material. The amount of krypton-85 is less than five microcuries, which is too small an amount to require any special care in use.

Atomic Energy Commission regulations require that the individual tube carton for tubes containing by-product radioactive material be appropriately marked. The marking includes the statement that tube disposal should be in approved manner.

Approved instructions for disposal of tubes containing krypton-85 are as follows;

> Tubes to be disposed of should be broken or crushed in a well ventilated place releasing any resulting vapors to the outside atmosphere. The residual broken or crushed tubes should be disposed of in a normal public trash disposal system. Tubes should be disposed of at a rate of not more than 100 each week from any one location. Avoid breathing vapors from broken tubes.

Note 1: In the "Absolute System" the maximum ratings specified are limiting values above which the serviceability of the device may be impaired from the viewpoint of life and satisfactory performance. Maximum ratings, as such, do not constitute a set of operating conditions and all values may not, therefore, be attained simultaneously.

Note 2: Sufficient resistance must be used in series with the tube to assure that the electrode currents do not exceed the maximum rated values.

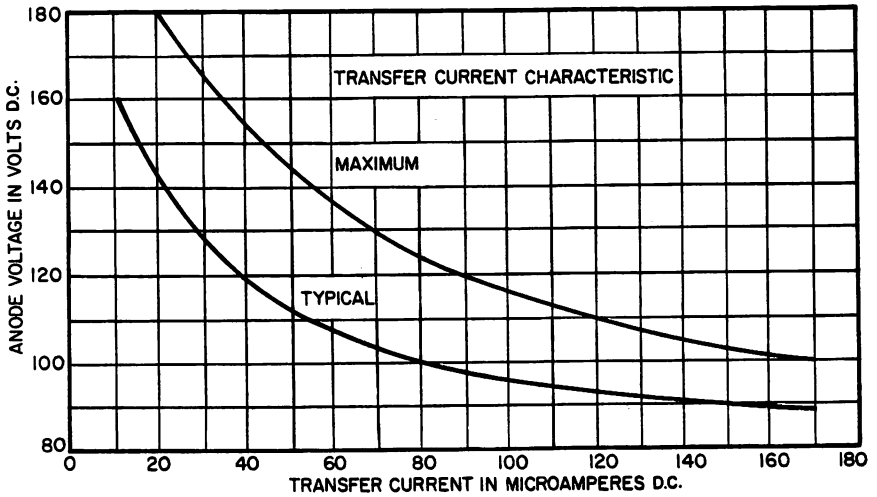


FIG. 1

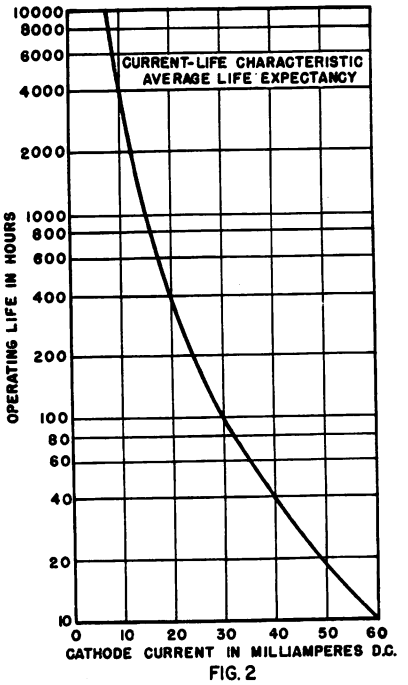


FIG. 2

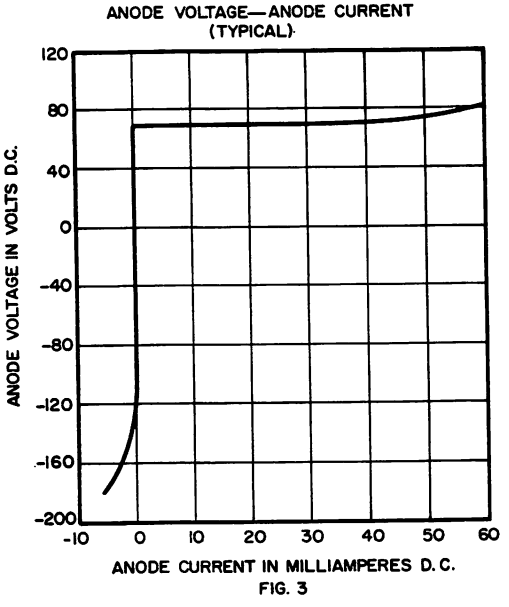


FIG. 3

Note 3: Starter voltage oscillations of approximately 1 to 10 kilocycles and 12 volts peak-to-peak will be present at starter current values below 0.05 milliampere.

Note 4: Approximately 95% of tubes will be within limits of ± 2.8 volts from the bogey value

Note 5: Anode voltage oscillations of approximately 5 to 20 kilocycles and 3 volts peak-to-peak will be present at anode currents within the ratings.

Note 6: With 15 volts starter overvoltage (15 volts above starter breakdown voltage) with tube in total darkness.

Note 7: Negative anode voltage applied through 8000 ohms. Starter connected to anode through 100,000 ohms.

Note 8: Tube is permanently mounted on a plastic angle bracket. Pin connection are terminated in flexible connector leads.

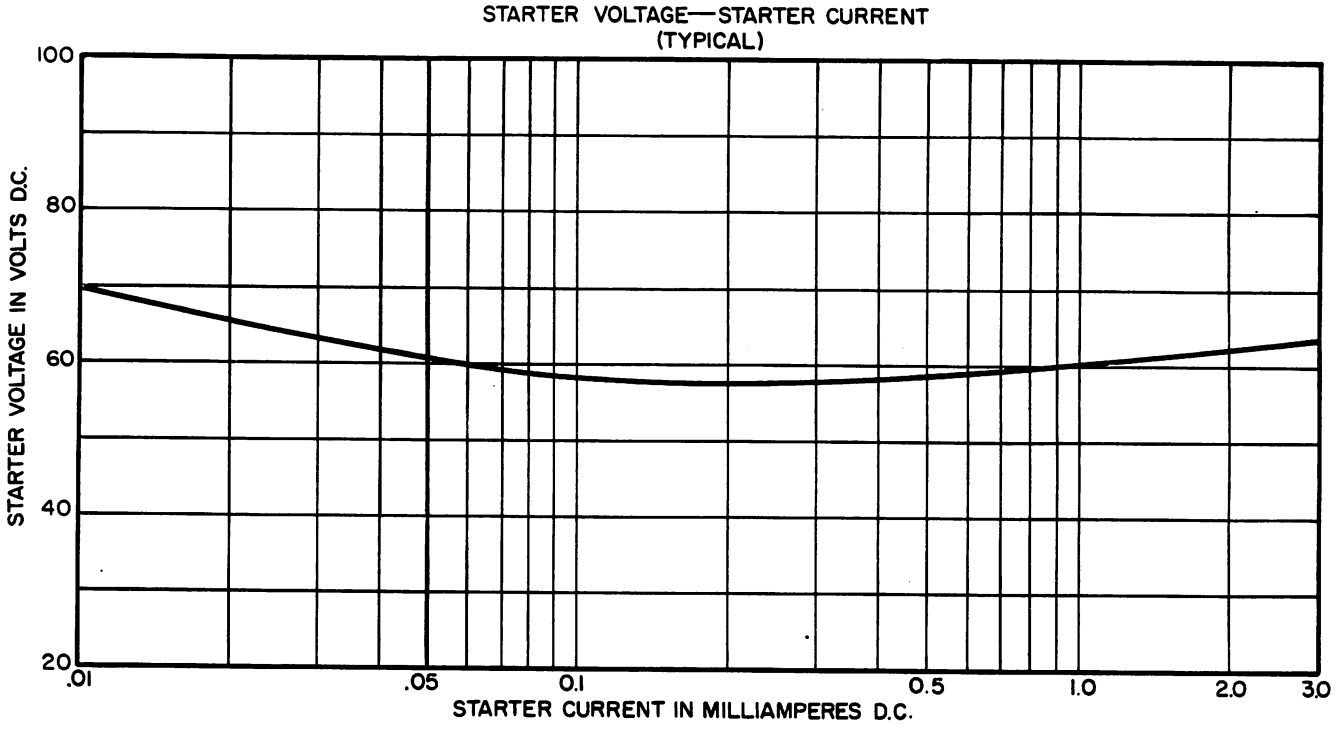
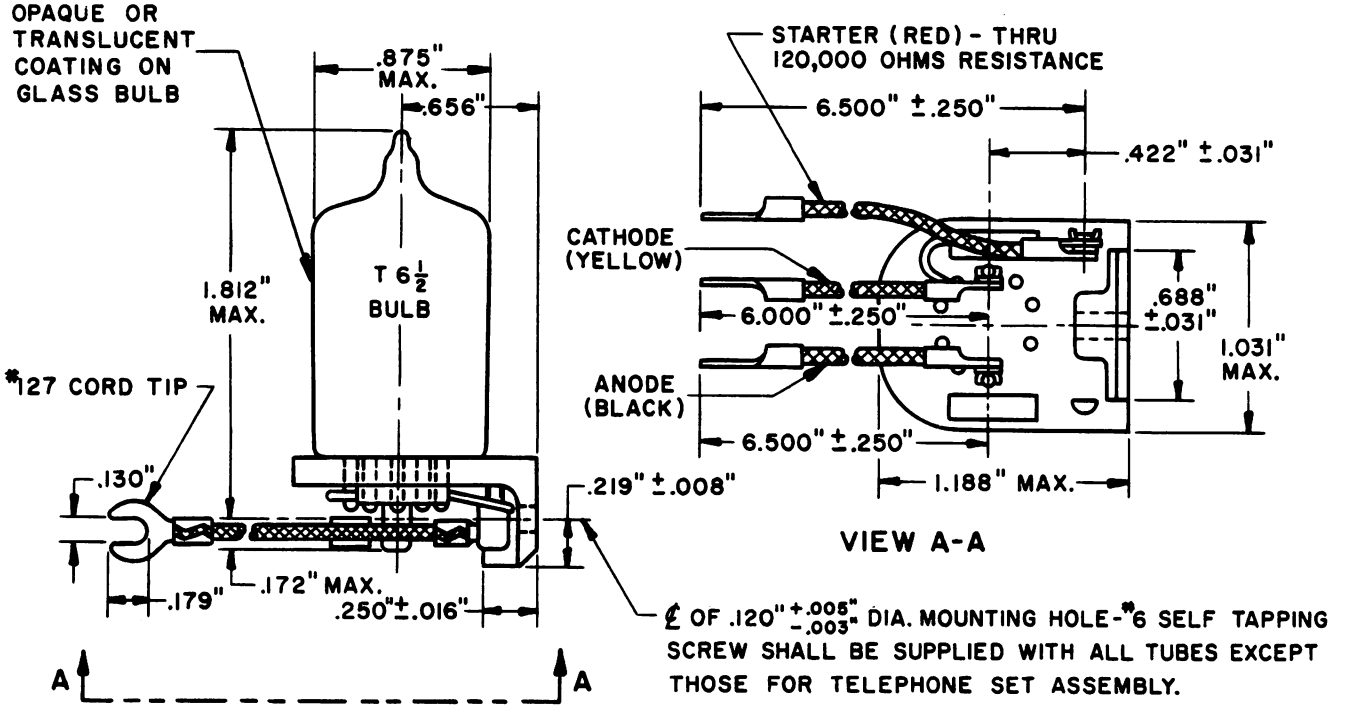


FIG. 4



A development of Bell Telephone Laboratories, the research laboratories of the American Telephone and Telegraph Company and the Western Electric Company.

PRINTED IN U.S.A.

ELECTRON TUBE DATA SHEET

WESTERN ELECTRIC 427A ELECTRON TUBE



DESCRIPTION

The 427A is a three-electrode inert-gas-filled cold cathode tube designed for use as a voltage regulator and has characteristics which are exceptionally stable with life and with variation in ambient temperature. The third electrode is primarily a starting element.

CHARACTERISTICS

Cathode Current	5 to 40	milliamperes
Anode Voltage Drop (E_{td})	100	volts
Regulation at 5 to 40 milliamperes d-c (Note 6)	±1.5	volts

File: Cold Cathode Section

© American Telephone and Telegraph Company 1962

RATINGS, Absolute System (Note 1)

Cathode Current, Forward	
Maximum	40 milliamperes
Minimum	5 milliamperes
Starter Current, Forward	
Maximum	5 milliamperes
Minimum (Note 2)	0.5 milliampere
Maximum Inverse Starter or Anode Current	0.0 milliampere
Ambient Temperature Limits	-55 to +85 centigrade

ELECTRICAL DATA

	Min.	Bogey	Max.	
Anode Breakdown Voltage	-	165	-	volts
Anode Voltage Drop (E_{td}) at 40 Milliamperes, (D-C) (Note 3)	99	100	103	volts
Regulation (5 to 40 Milliamperes, D-C) (Notes 4 & 6)	-	−0.3	±1.5	volts
Starter Breakdown Voltage	115	125	135	volts
Starter Voltage Drop at 5 Milliamperes, (D-C)	100	110	120	volts
Transfer Current	See Curve - Figure 1			
Temperature Sensitivity, Anode Voltage Drop				
Anode Current, 5 milliamperes (D-C)	-	−0.007	-	volt/c
Anode Current, 40 milliamperes (D-C)	-	−0.004	-	volt/c

LIFE DATA

Starter Breakdown Voltage (Max.) after 500 hours at 40 mAdc	135 volts
Regulation (5 to 40 mAdc) after 500 hours at 40 mAdc (Note 6)	See Figure 3, Page 4
Drift in Anode Voltage Drop (E_{td}) in 500 hours at 40 mAdc	See Figure 2 and Note 5

MECHANICAL DATA

Mounting Position	Any
Net Weight, Approximate	0.4 Ounce
Base	Small Button 9-pin
Bulb	T6-1/2

Dimensions and connections shown in outline drawing on page 4.

HANDLING

This tube contains a small amount of krypton-85 gas which is a by-product radioactive material. The amount of krypton-85 is less than five microcuries, which is too small an amount to require any special care in use.

Atomic Energy Commission regulations require that the individual tube carton for tubes containing by-product radioactive material be appropriately marked. The marking includes the statement that tube disposal should be in approved manner.

Approved instructions for disposal of tubes containing krypton-85 are as follows;

> Tubes to be disposed of should be broken or crushed in a well ventilated place releasing any resulting vapors to the outside atmosphere. The residual broken or crushed tubes should be disposed of in a normal public trash disposal system. Tubes should be disposed of at a rate of not more than 100 each week from any one location. Avoid breathing vapors from broken tubes.

Note 1: In the "Absolute System" the maximum ratings specified are limiting values above which the serviceability of the device may be impaired from the viewpoint of life and satisfactory performance. Maximum ratings, as such, do not constitute a set of operating conditions and all values may not, therefore, be attained simultaneously.

Note 2: The minimum starter current requirement applies only when the tube is operated for extended periods (hundreds of hours) between starting operations to assure maintaining starter breakdown and transfer current characteristics.

Note 3: These values are for new tubes. Anode voltage drop will stabilize within 3 minutes after starting.

Note 4: Continuous operation at a current value in the low portion of the operating range for an extended period (hundreds of hours) may result temporarily in regulation exceeding the stated values.

Note 5: The drift of anode voltage drop improves with operating life. After 1000-2000 hours operation the drift of anode voltage drop per 1000 hours will not exceed 0.3 volt.

Note 6: Regulation is defined to be Anode Voltage Drop (E_{td}) at 40 mAdc minus Anode Voltage Drop (E_{td}) at 5 mAdc.

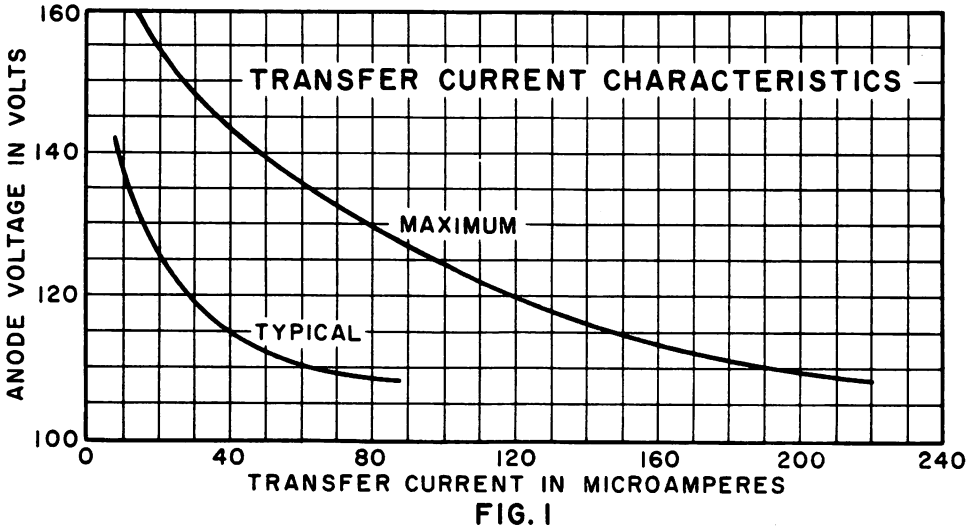


FIG. 1

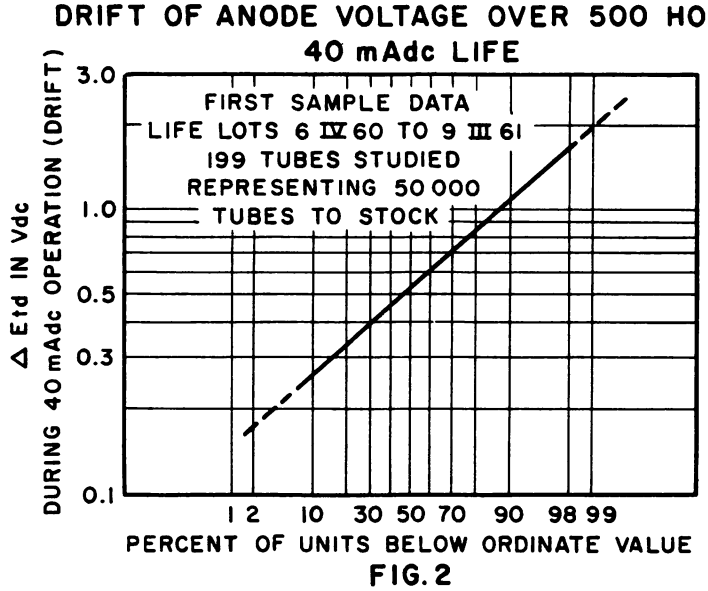


FIG. 2

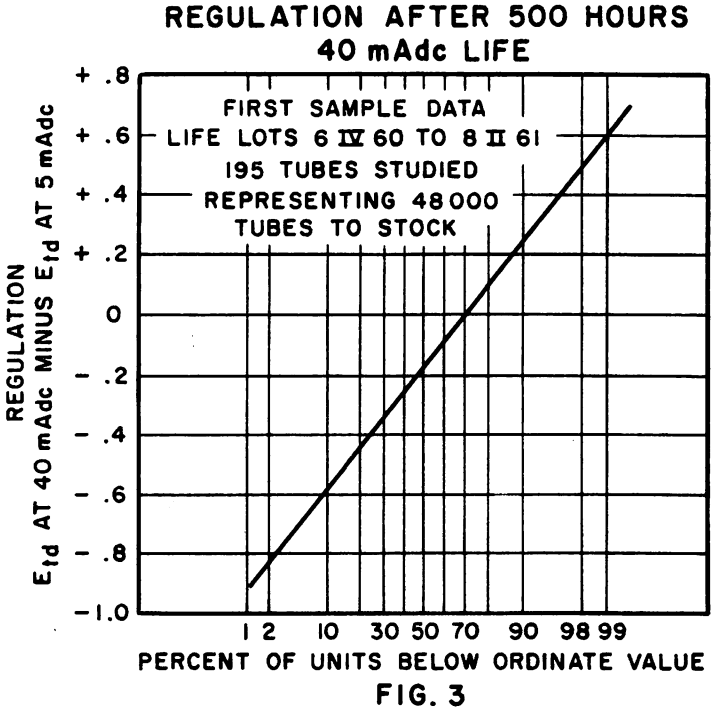
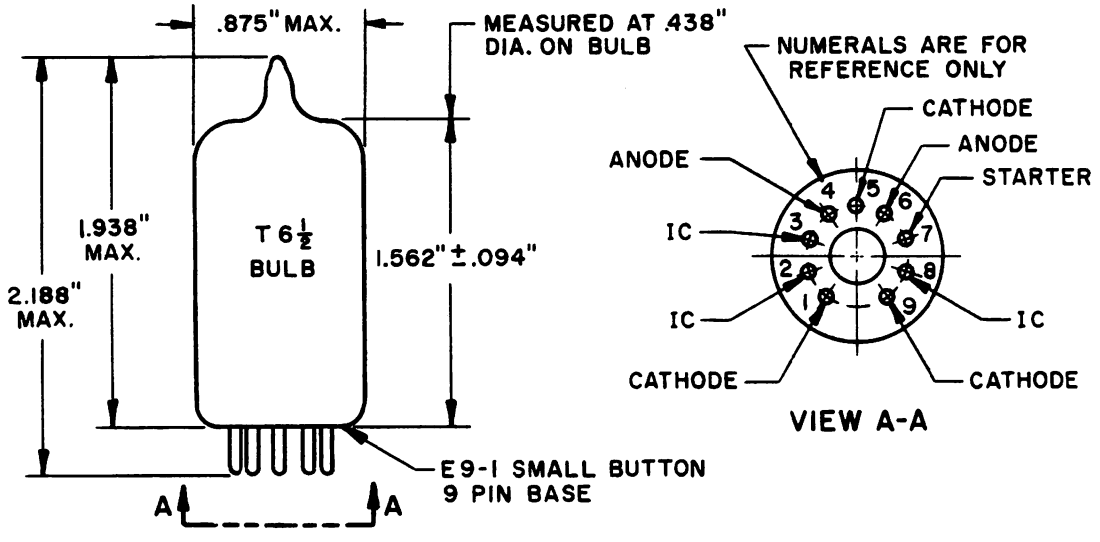


FIG. 3



NOTE: PINS MARKED IC (INTERNAL CONNECTION) SHOULD NOT BE CONNECTED TO ANY PORTION OF AN EXTERNAL CIRCUIT. FAILURE TO OBSERVE THIS PRECAUTION MAY RESULT IN IMPROPER OPERATION OF THE TUBE.

A development of Bell Telephone Laboratories, the research laboratories of the American Telephone and Telegraph Company and the Western Electric Company.

PRINTED IN U.S.A.

AB46.429A
Issue 3, February, 1961
A.T. & T. Co. Standard

ELECTRON TUBE DATA SHEET
WESTERN ELECTRIC 429A ELECTRON TUBE



DESCRIPTION

The 429A is a beam pentode of the indirectly heated cathode type. The tube was designed, initially, for use in the #2 and #9B Telegraph Service Board Circuits. It is also suitable for use as an audio-frequency amplifier.

CHARACTERISTICS

Heater Voltage		20 volts
Plate Current	E_{c1} = -3 volts, $E_b = E_{c2}$ = 130 volts	41 milliamperes
Transconductance	E_{c1} = -3 volts, $E_b = E_{c2}$ = 130 volts	6600 micromhos

File: General Purpose Section
Data Sheet Issue 3, 2-61

© American Telephone and Telegraph Company, 1961

GENERAL CHARACTERISTICS

ELECTRICAL DATA

Heater Voltage (Note 1)	20 volts
Heater Current	140 milliamperes
Direct Interelectrode Capacitances (without external shield)	
Grid to Plate (maximum)	1.5 μμf
Input	8.5 μμf
Output	5.0 μμf

MECHANICAL DATA

Cathode	Coated unipotential
Bulb	T9
Base	Button Stem 9-Pin
Mounting Position	Any

MAXIMUM RATINGS, Absolute System (Note 2)

Plate Voltage	275 volts
Screen Grid Voltage	150 volts
Plate Current	75 ma
Plate Dissipation	12.0 watts
Screen Grid Dissipation	2.0 watts
Heater-Cathode Voltage	130 volts
Bulb Temperature	130°Centigrade

MAXIMUM CIRCUIT VALUES

Grid Circuit Resistance:

For Fixed Bias	0.1 megohms
For Cathode Bias	0.3 megohms

TYPICAL OPERATING CONDITIONS AND CHARACTERISTICS

Plate Voltage	130 volts
Screen Grid Voltage	130 volts
Control Grid Voltage	-3 volts
Peak A-F Grid Voltage	3 volts
Zero Signal Plate Current	41 ma
Maximum Signal Plate Current	43 ma
Zero Signal Screen Grid Current	2.0 ma
Maximum Signal Screen Grid Current	3.5 ma
Transconductance (Note 3, See Page 4)	6600 umhos
Plate Resistance	37000 ohms
Load Resistance	5000 ohms

Note 1: For optimum life, the heater voltage should be regulated to within ± 2% of the rated value.

Note 2: In the "Absolute System" the maximum ratings specified are limiting values above which the serviceability of the tube may be impaired from the viewpoint of life and satisfactory performance. Maximum ratings, as such, do not constitute a set of operating conditions and all values may not, therefore, be attained simultaneously.

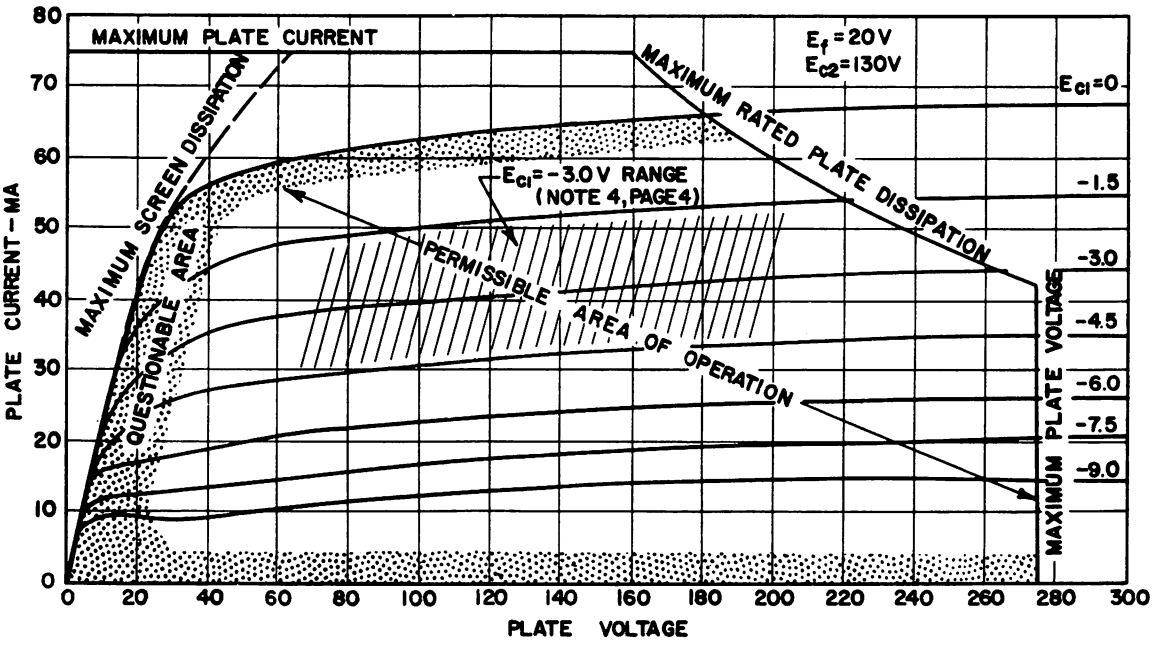


FIG. 1

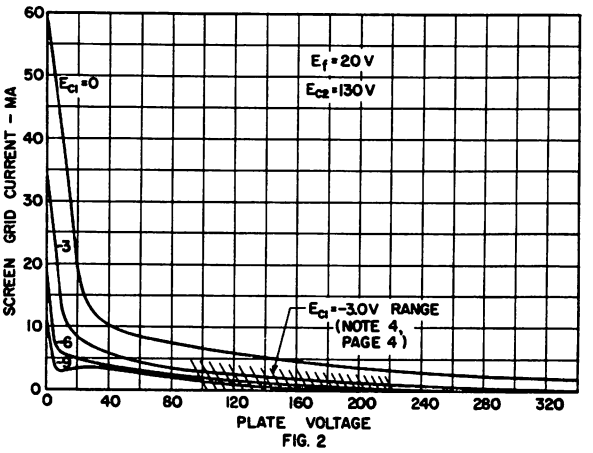


FIG. 2

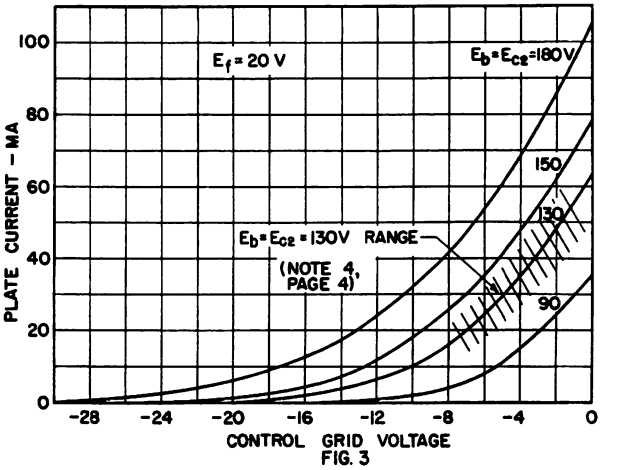


FIG. 3

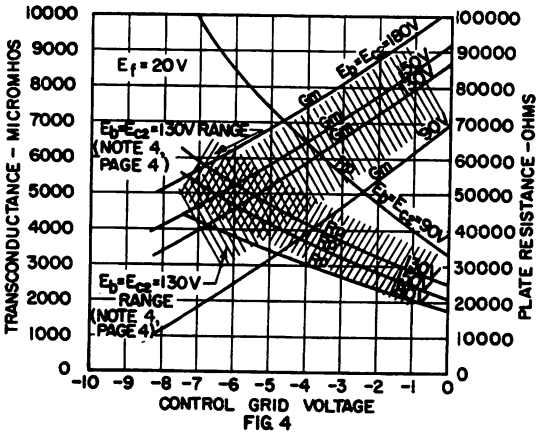


FIG. 4

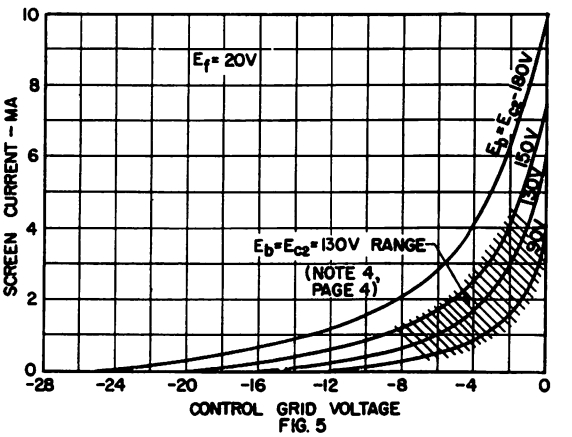
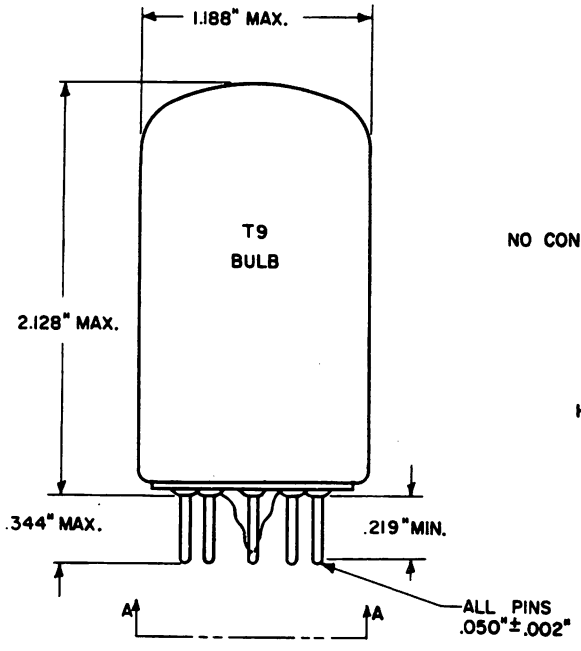
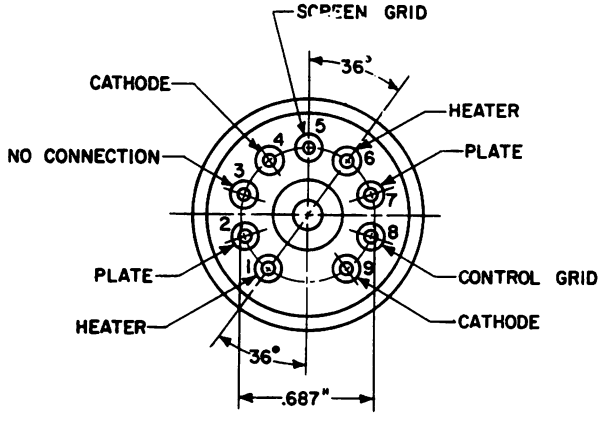


FIG. 5

→ Indicates a change





VIEW A-A

Note 3: The 429A tube is considered to have reached the end of useful life when one or more of the following conditions occur under the conditions shown: a) The transconductance decreases to 65% of the typical value shown, b) The change in transconductance exceeds 30% when the heater voltage is reduced 10%, c) The grid current exceeds 5 microamperes. To obtain optimum life the equipment should be capable of tolerating this order of tube parameter degredation.

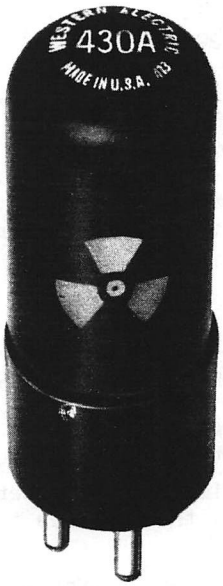
Note 4: These curves represent electrical characteristics exhibited by typical tubes. While it is expected that characteristics will be centered around the bogey values shown by the curves, individual tubes will deviate to some extent from these values. The shaded areas (unless stated otherwise) are intended to define the approximate limits of such deviation.

A development of Bell Telephone Laboratories, the research laboratories of the American Telephone and Telegraph Company and the Western Electric Company.

3-B-61 PRINTED IN U.S.A. T2742

AB46.430A
Issue 2, April 1956
A.T.&T. Co. Standard

ELECTRON TUBE DATA SHEET
WESTERN ELECTRIC 430A ELECTRON TUBE



DESCRIPTION

The 430A is a three-electrode, inert-gas-filled, cold cathode tube for use in relay, voltage regulator or rectifier circuits. This tube is mechanically and electrically identical to the 313C except that it has a much faster starter gap ionization time. The tube is especially suitable for use in fast switching circuits.

MAXIMUM RATINGS

Peak Anode Voltage		185 volts
Average Cathode Current	10	100 milliamperes
Average Life, Approximate	10,000	10 hours

MAXIMUM RATINGS, Absolute Values

Forward Peak Anode Voltage	185 volts
Forward Cathode Current[1]	
Peak	100 milliamperes
Average	35 milliamperes
Averaging Time	2 seconds
Inverse Peak Anode Current[1]	5 milliamperes
Ambient Temperature Limits	-55 to +85 centigrade

ELECTRICAL DATA, Throughout Life

	Min.	Bogey	Max.	
Starter Breakdown Voltage[2]	65	70	85	volts
Starter Voltage Drop at 20 Milliamperes	52	60	74	volts
Anode Voltage Drop at 20 Milliamperes	68	75	85	volts
Transfer Current	See curve - Fig. 3			
Ionization Time, Starter Gap[3]	...	0.07	0.20	milliseconds
Deionization Time, Approximate				
Starter Gap	...	3	...	milliseconds
Main Gap	...	10	...	milliseconds
Inverse Current at -120 Volts Anode Potential[4]	...	...	3	milliamperes

MECHANICAL DATA

Mounting Position	Any
Net Weight, Approximate	1 ounce

Dimensions and pin connections shown in outline drawing on page 4.

Note 1: Sufficient resistance must be used in series with the tube to assure that the electrode currents do not exceed their maximum rated values.

Note 2: Limits apply immediately after tube has conducted current. If the tube has been idle, these values initially may be as much as 3 volts higher or lower.

Note 3: With 15 volts starter overvoltage (15 volts above Starter Breakdown Voltage) with the tube in total darkness (See Fig. 4.)

Note 4: Negative anode voltage applied through 8000 ohms. Starter connected to anode through 100,000 ohms.

HANDLING

Western Electric cold cathode tubes contain a minute amount of radium bromide which is a radioactive material. The amount in most types is too small to require any special care in use, handling or disposal.

A few types contain a larger quantity of radium bromide in which the radium approximates that found on a luminous watch dial. These types bear a red three-bladed propeller-shaped symbol on the tube envelope. Instructions for handling such tubes are given below and also in Bell System Practices for Central Office maintenance.

Installations ordinarily require no precautions against radiation. However, quantities of the tubes should not be so installed, or so stored outside the shipping carton, that they will be within a few inches of personnel or in proximity to photographic film for extended periods of time. For example, however, a 40-hour week exposure at about one (1) foot from a bank of 500 tubes (covering an area of 20 inches x 45 inches) is well within the accepted tolerance limits for personnel. Reasonable care should be exercised in handling and disposal of broken tubes. In general, attention should be given to the following:

(a) Avoid breathing dust or vapors from broken tubes.

(b) Avoid contacting broken parts with bare hands.

(c) Use wet rag to pick up broken parts. Wrap broken parts in rag and tie securely so as to form a package. Thoroughly wash hands after disposal.

(d) Dispose of broken or defective tubes as they are taken out of service. One or two tubes at a time may be disposed of with normal waste material. Accumulation of tubes in one concentrated area of the place of final disposition should be avoided.

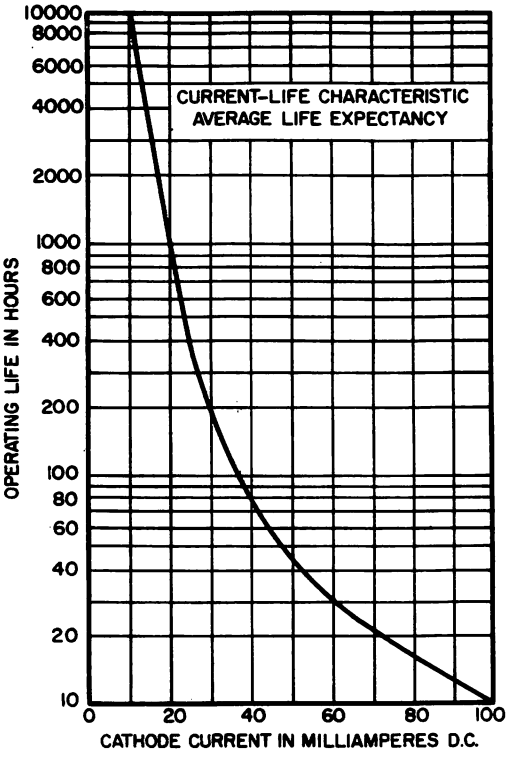


FIG. 1

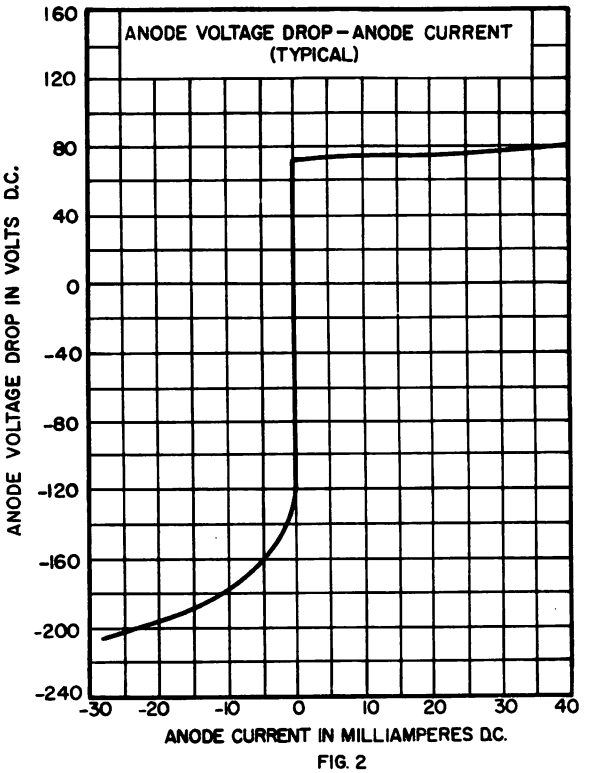


FIG. 2

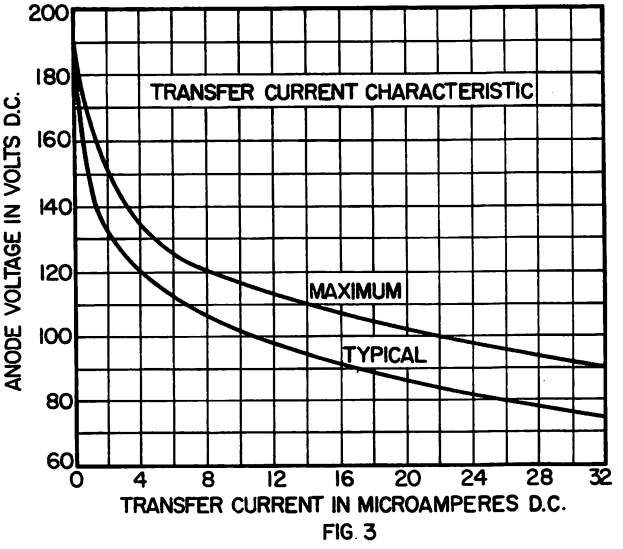


FIG. 3

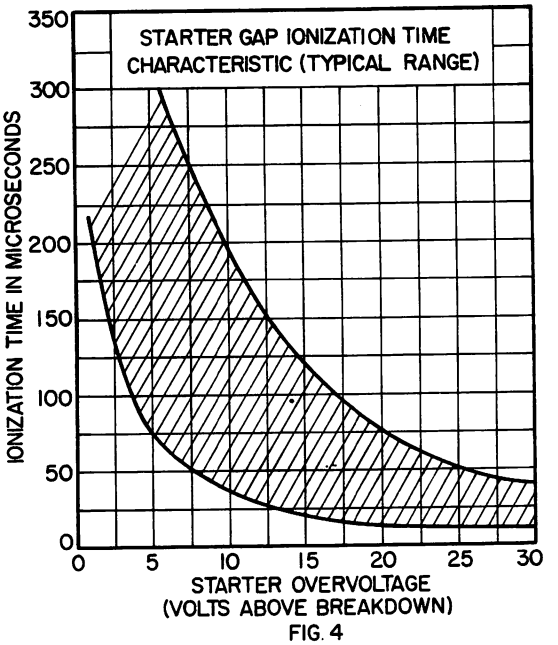
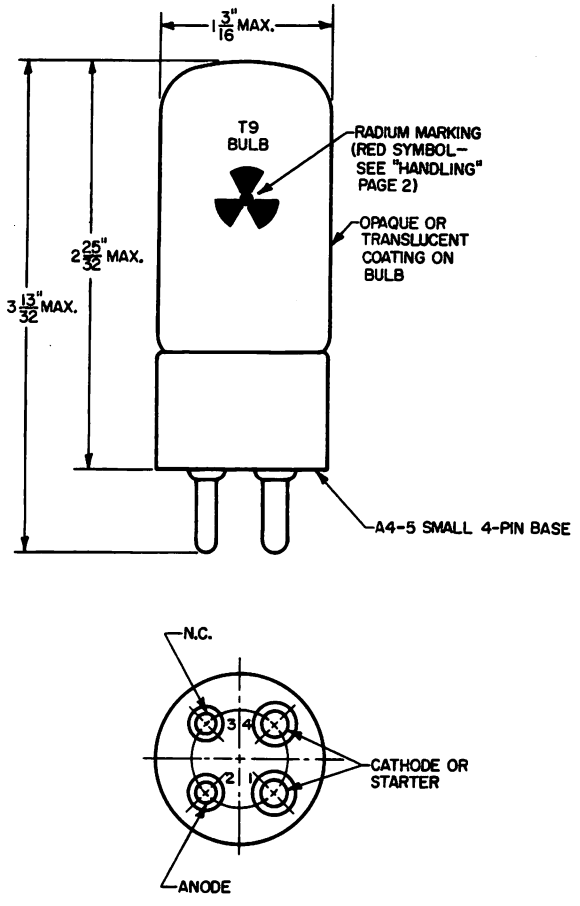


FIG. 4



A development of Bell Telephone Laboratories, the research laboratories of the American Telephone and Telegraph Company and the Western Electric Company.

ELECTRON TUBE DATA SHEET

WESTERN ELECTRIC 430B ELECTRON TUBE



DESCRIPTION

The 430B is a three-electrode, inert-gas-filled, cold cathode tube for use in relay, voltage regulator or rectifier circuits. This tube is mechanically and electrically identical to the 313C except that it has a much faster starter gap ionization time. The tube is especially suitable for use in fast switching circuits.

CHARACTERISTICS

Peak Anode Voltage		185	volts
Average Cathode Current	10	100	milliamperes
Average Life, Approximate	10,000	10	hours

File: Cold Cathode Section

© American Telephone and Telegraph Company 1962

MAXIMUM RATINGS, Absolute System (Note 1)

Forward Peak Anode Voltage	185	volts
Forward Cathode Current (Note 2)		
Peak	100	milliamperes
Average	35	milliamperes
Averaging Time	2	seconds
Inverse Peak Anode Current (Note 2)	5	milliamperes
Ambient Temperature Limits	-55 to +85	centigrade

ELECTRICAL DATA, Throughout Life

	Min.	Bogey	Max.	
Starter Breakdown Voltage (Note 3)	65	70	89	volts
Starter Voltage Drop at 20 Milliamperes	52	60	74	volts
Anode Voltage Drop at 20 Milliamperes	68	75	90	volts
Transfer Current	See curve - Fig. 3			
Ionization Time, Starter Gap (Note 4)				
Average (Note 5)	-	0.07	0.20	milliseconds
Maximum	See curve - Fig. 5, Page 4			
Deionization Time, Approximate				
Starter Gap	-	3	-	milliseconds
Main Gap	-	10	-	milliseconds
Inverse Current at -120 Volts Anode Potential (Note 6)	-	-	3	milliamperes

MECHANICAL DATA

Mounting Position	Any
Net Weight, Approximate	1 Ounce

Dimensions and pin connections shown in outline drawing on page 4.

HANDLING

This tube contains a small amount of krypton-85 gas which is a by-product radioactive material. The amount of krypton-85 is less than five microcuries, which is too small an amount to require any special care in use.

Atomic Energy Commission regulations require that the individual tube carton for tubes containing by-product radioactive material be appropriately marked. The marking includes the statement that tube disposal should be in approved manner.

Approved instructions for disposal of tubes containing krypton-85 are as follows;

> **Tubes to be disposed of should be broken or crushed in a well ventilated place releasing any resulting vapors to the outside atmosphere. The residual broken or crushed tubes should be disposed of in a normal public trash disposal system. Tubes should be disposed of at a rate of not more than 100 each week from any one location. Avoid breathing vapors from broken tubes.**

Note 1: In the "Absolute System" the maximum ratings specified are limiting values above which the serviceability of the device may be impaired from the viewpoint of life and satisfactory performance. Maximum ratings, as such, do not constitute a set of operating conditions and all values may not, therefore, be attained simultaneously.

Note 2: Sufficient resistance must be used in series with the tube to assure that the electrode currents do not exceed their maximum rated values.

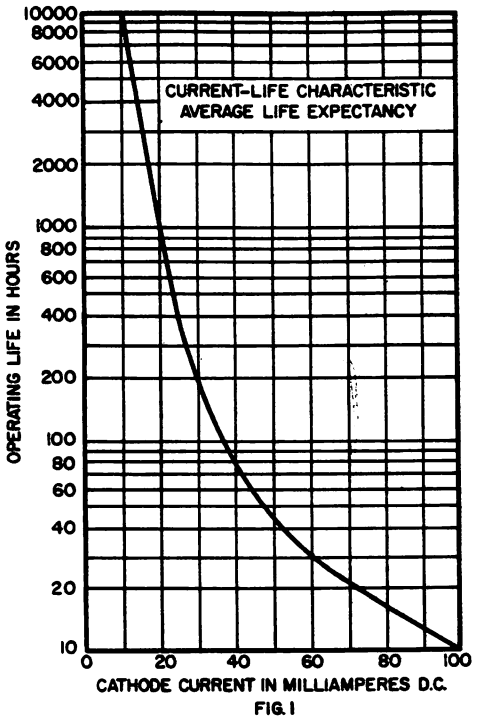


FIG. 1

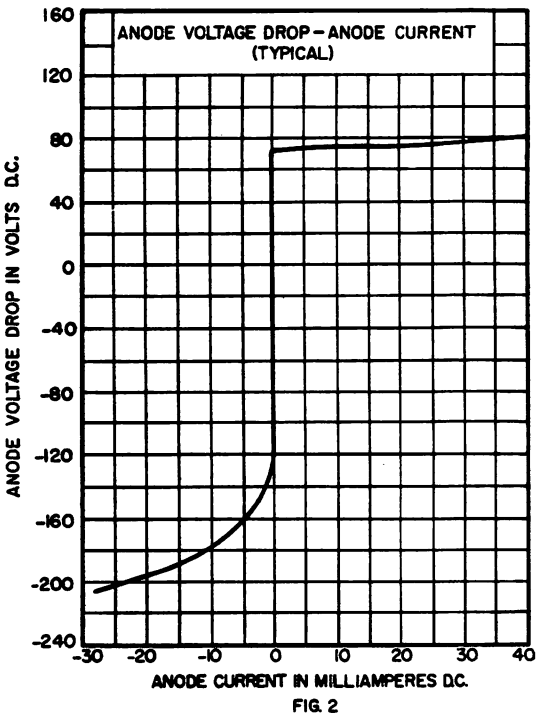


FIG. 2

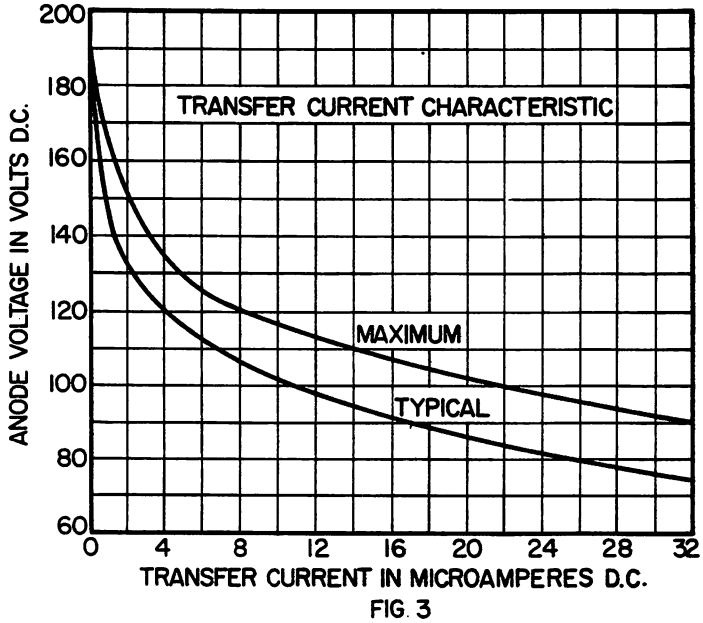


FIG. 3

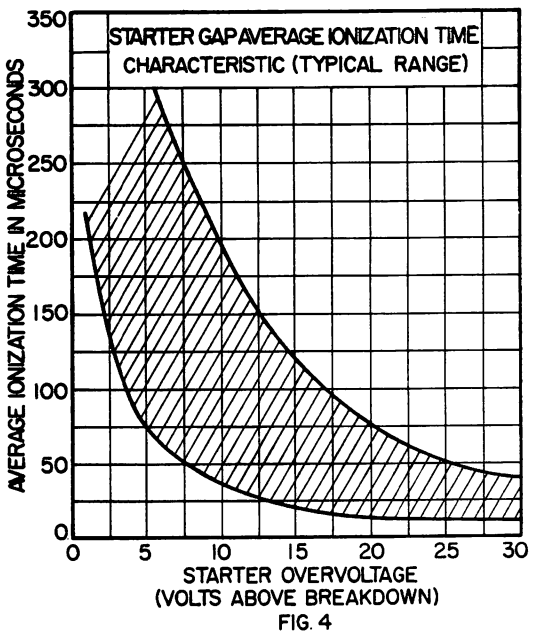


FIG. 4

Note 3: Limits apply immediately after tube has conducted current. If the tube has been idle, these values initially may be as much as 3 volts higher or lower.

Note 4: With 15 volts starter overvoltage (15 volts above Starter Breakdown Voltage) with the tube in total darkness (See Fig. 4.)

Note 5: Average of 10 measurements taken at 1 second intervals.

Note 6: Negative anode voltage applied through 8000 ohms. Starter connected to anode through 100,000 ohms.

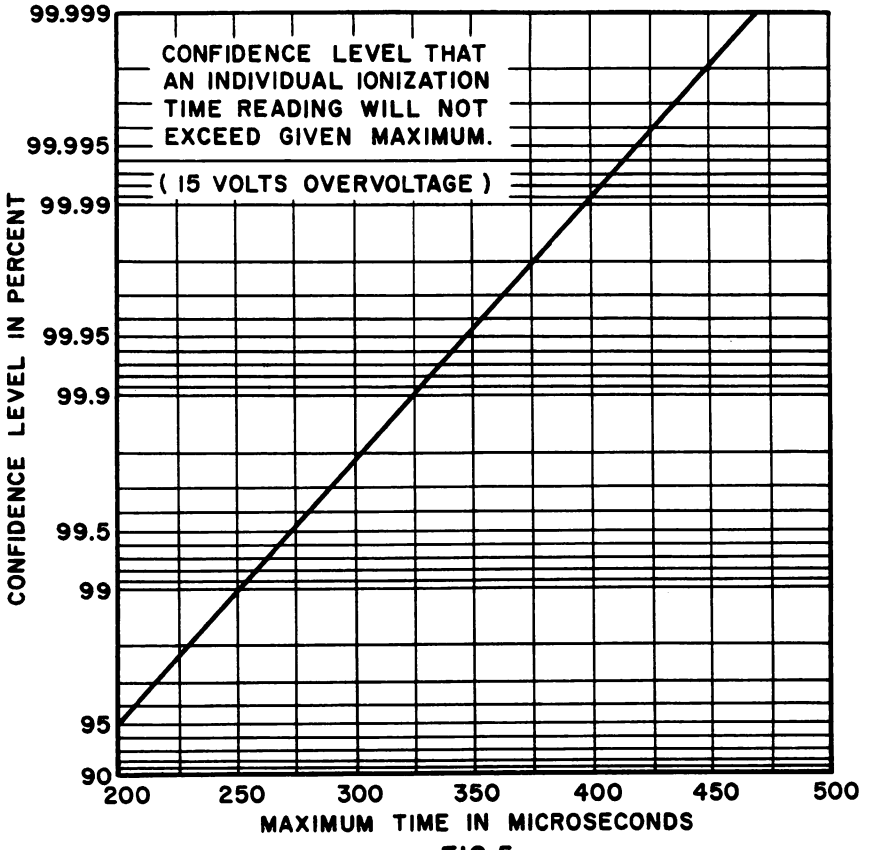
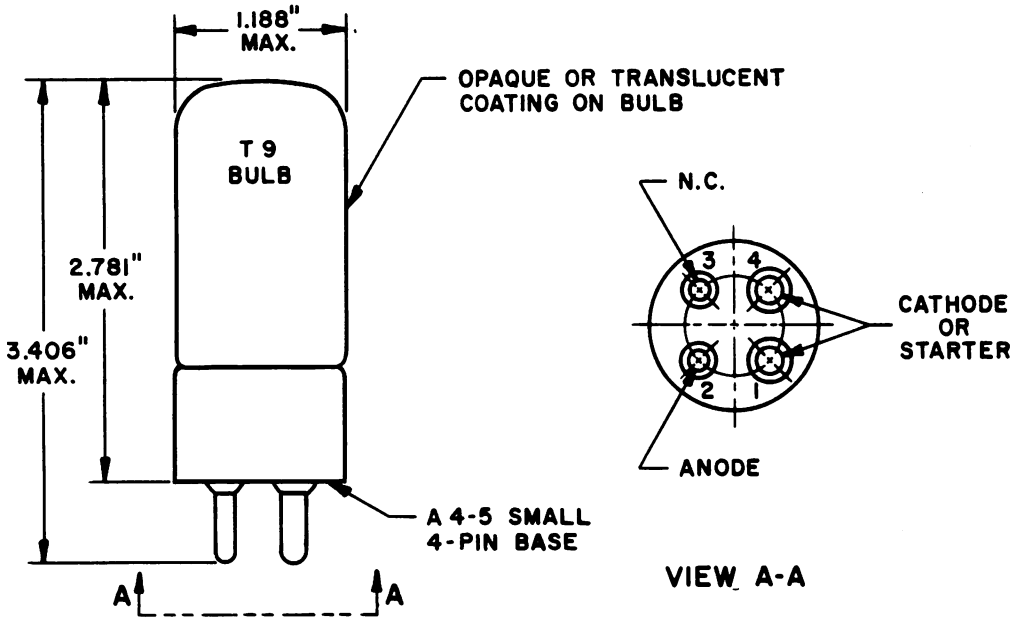


FIG.5

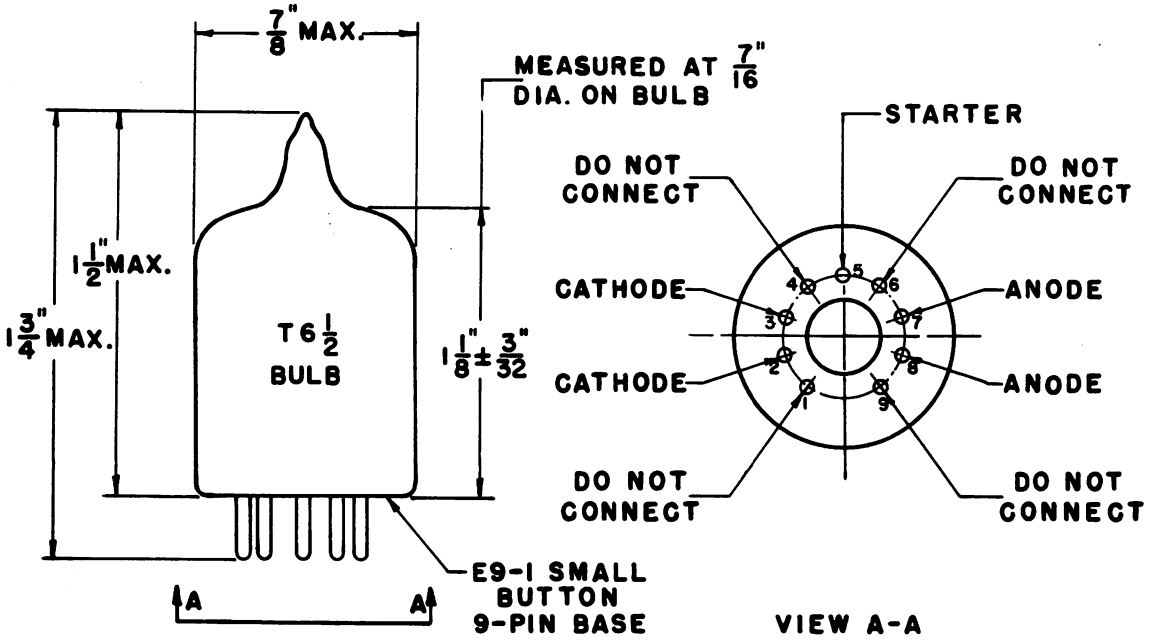


A development of Bell Telephone Laboratories, the research laboratories of the American Telephone and Telegraph Company and the Western Electric Company.

PRINTED IN U.S.A.

ADVANCE ELECTRON TUBE DATA SHEET

WESTERN ELECTRIC 432A ELECTRON TUBE



DESCRIPTION

The 432A is a three-electrode inert-gas filled cold cathode tube designed primarily for use as a voltage reference tube. This tube has exceptionally stable characteristics.

CHARACTERISTICS

Cathode Current	4 to 8 milliamperes
Anode Voltage Drop	100 volts
Regulation, Max. (4 to 6 Milliamperes D-C)	0.5 volt

FILE: COLD CATHODE SECTION
ISSUE 1, 9-50

RATINGS, Absolute Values

Cathode Current	
Maximum	8 milliamperes
Minimum	4 milliamperes
Maximum Inverse Starter or Anode Current	0.0 milliampere
Starter Current (Minimum)	0.2 milliampere
Ambient Temperature Limits	-55 to + 60 centigrade

ELECTRICAL DATA

	Min.	Bogey	Max.
Anode Breakdown Voltage	---	---	160 volts
Anode Voltage Drop at 6 Milliamperes (D-C)[1]	99	100	103 volts
Starter Breakdown Voltage	---	---	200 volts
Starter Voltage Drop	---	115	--- volts
Required Transfer Current at 110 Anode Volts	200	---	--- microamperes
Regulation (4 to 6 Milliamperes, D-C)	---	---	0.5 volt
Temperature Sensitivity of Anode Voltage Drop			
Anode Current, 4 Milliamperes (D-C)	---	-0.01	--- volt/c
Anode Current, 8 Milliamperes (D-C)	---	-0.02	--- volt/c
Fluctuation[2]	---	---	0.1 volt
Stability[3]	---	---	0.3 volt

MECHANICAL DATA

Mounting Position	Any
Net Weight, Approximate	0.3 ounce
Bulb	T 6-1/2
Base	Small Button 9-pin

Note 1: These values are for new tubes. The stability characteristic should be considered during tube life.

Note 2: The anode voltage drop variation during a short period of time (one to ten minutes), with the tube operating at one value of current and temperature within its ratings, will not exceed the above stated maximum value.

Note 3: The drift of anode voltage drop over a period of 1000 hours, with the tube operating at one value of current and temperature within its ratings, will not exceed the above stated maximum value.

A development of Bell Telephone Laboratories, the research laboratories of the American Telephone and Telegraph Company and the Western Electric Company.

ELECTRON TUBE DATA SHEET
WESTERN ELECTRIC 432B ELECTRON TUBE



DESCRIPTION

The 432B is a three-electrode inert-gas-filled cold cathode tube designed for use as a voltage reference tube. The third electrode is a starting element for use in circuits having insufficient voltage available for breakdown at the voltage reference point or requiring negligible overshoot of the reference voltage when starting. This tube is free of parasitic oscillations and has an exceptionally stable anode voltage drop characteristic.

CHARACTERISTICS

Cathode Current	4 to 8 milliamperes
Anode Voltage Drop	100 volts
Regulation, Max. (4 to 6 Milliamperes D-C)	0.75 volt

RATINGS, Absolute Values

Cathode Current[1]	
Maximum	8 milliamperes
Minimum[2]	4 milliamperes
Inverse Starter or Anode Current, Maximum	0.0 milliampere
Starter Current, Minimum[3]	0.2 milliampere
Ambient Temperature Limits	-55 to + 60 centigrade

ELECTRICAL DATA, Throughout Life

	Min.	Bogey	Max.	
Anode Breakdown Voltage	---	135	160	volts
Anode Voltage Drop at 6 Milliamperes (D-C)[4]	99	100	103	volts
Starter Breakdown Voltage	---	135	200	volts
Starter Voltage Drop at 0.2 ma	---	102	---	volts
Transfer Current at 110 Anode Volts	---	60	200	microamperes
Regulation (4 to 6 Milliamperes, D-C)	---	0.3	0.75	volt
Temperature Sensitivity of Anode Voltage Drop				
Anode Current, 4 Milliamperes (D-C)	---	-0.01	---	volt/c
Anode Current, 8 Milliamperes (D-C)	---	-0.02	---	volt/c
Fluctuation[5]	---	0.02	0.1	volt
Stability[6]	---	0.2	0.8	volt

MECHANICAL DATA, Throughout Life

Mounting Position	Any
Net Weight, Approximate	0.3 ounce
Bulb	T 6-1/2
Base	Small Button 9-pin
Dimensions and Connections	See outline drawing Page 3

Note 1: Sufficient resistance must be used in series with the tube to assure that electrode currents do not exceed their maximum rated values.

Note 2: The tube is capable of operating at current values below the rated "Minimum" value of 4 milliamperes in regulator applications where lower current is required, however, operation at values below 4 milliamperes for extended periods of time (hundreds of hours) may result in an increase in regulation.

Note 3: The minimum starter current requirement applies
(a) when tube is operated for extended periods (hundreds of hours) between starting operations to assure maintaining starter breakdown and transfer characteristics.
(b) to assure oscillation-free operation.

Note 4: These values are for new tubes. Anode voltage drop will stabilize within 3 minutes after starting. The stability characteristic should be considered during tube life.

Note 5: The anode voltage drop variation during a short period of time (one to ten minutes), with the tube operating at one value of current and temperature within its ratings, will not exceed the above stated maximum value.

Note 6: The drift of anode voltage drop over a period of 1000 hours, with the tube operating at one value of current and temperature within its ratings, will not exceed the above stated maximum value. Stability improves with operating life. After 1000-2000 hours operation the drift of anode voltage drop per 1000 hours will not exceed 0.3 volt.

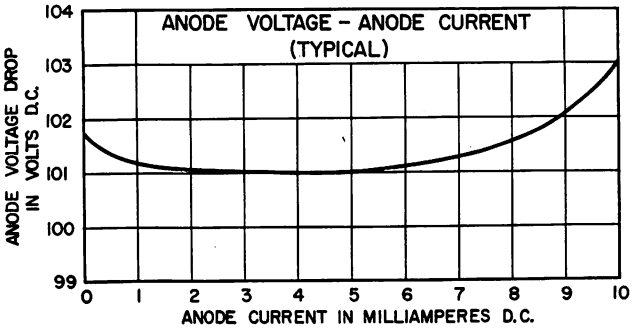


FIG. 1

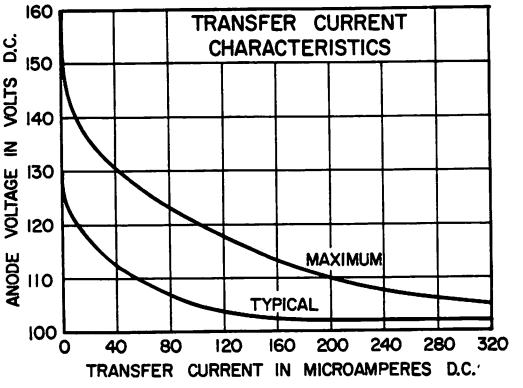
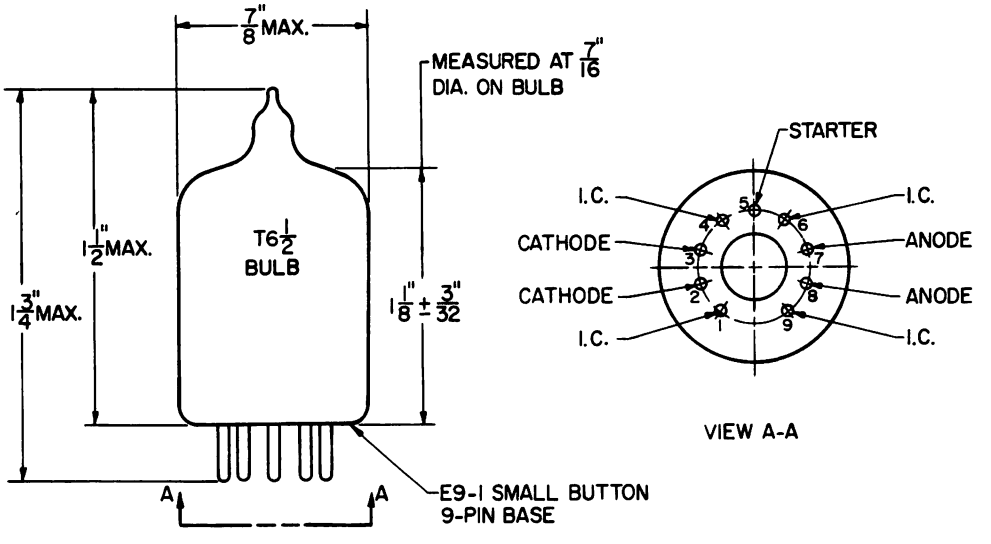


FIG. 2



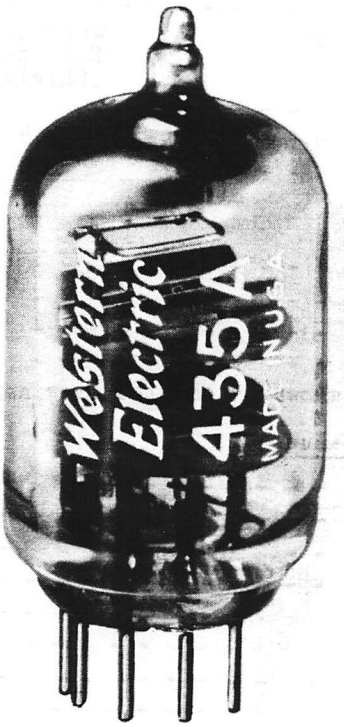
NOTE:- PINS MARKED I.C.(INTERNAL CONNECTION) SHOULD NOT BE CONNECTED TO ANY PORTION OF AN EXTERNAL CIRCUIT.

A development of Bell Telephone Laboratories, the research laboratories of the American Telephone and Telegraph Company and the Western Electric Company

Western Electric

ELECTRON TUBE DATA SHEET

WESTERN ELECTRIC 435A ELECTRON TUBE



DESCRIPTION

The 435A electron tube is a high figure of merit miniature tetrode with an indirectly heated cathode. It was designed primarily for the input amplifier of the L-3 tandem two stage amplifier.

CHARACTERISTICS

Heater Voltage		6.3 volts
Cathode Current	E_b = 190 volts; E_{c2} = 160 volts	14.3 milliamperes
Transconductance	E_{cc1} = +7.5 volts; R_k = 630 ohms	15500 micromhos

GENERAL CHARACTERISTICS

ELECTRICAL DATA

Heater Voltage		6.3 volts	
Heater Current		300 milliamperes	
Direct Interelectrode Capacitances	Without External Shield	With External Shield (RETMA #315)	
Grid to Plate (maximum)	.035	.030	uuf
Input	7.9	8.1	uuf
Output	2.9	3.3	uuf

MECHANICAL DATA

Cathode	Coated Unipotential
Bulb	T6 1/2
Base	Small Button 9 Pin
Mounting Position	Any

Dimensions and pin connections shown in outline drawing on page 4

MAXIMUM RATINGS, Design Center Values

Plate Voltage	190 volts
Screen Grid Voltage	160 volts
Plate Dissipation	3.0 watts
Screen Grid Dissipation	0.75 watt
Control Grid Dissipation	See footnote *
Cathode Current	36 milliamperes
Heater-Cathode Voltage	50 volts
Bulb Temperature	130 centigrade
Maximum Grid Circuit Resistance for	
Fixed Bias	0.05 megohm
Cathode Bias	0.10 megohm

TYPICAL OPERATING CONDITIONS AND CHARACTERISTICS

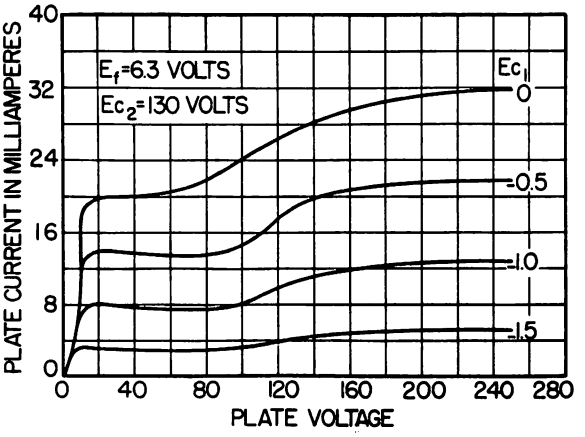
Plate Voltage	130	160	190 volts
Screen Grid Voltage	130	160	160 volts
Control Grid Voltage[1]	-1.0	-1.5	+7.5 volts
Cathode Bias Resistor	---	---	630 ohms
Plate Current	10.3	11.6	11.5 milliamperes
Screen Grid Current	3.8	4.3	2.8 milliamperes
Plate Resistance	13000	13000	65000 ohms
Transconductance	15300	15600	15500 micromhos
Control Grid Voltage (approximate) for Plate Current of 10 microamperes	-3.2	-3.9	---- volts
Modulation			
Second Order (2F)**	----	----	35 db
Third Order (3F)***	----	----	52 db
Load Resistance	----	----	270 ohms

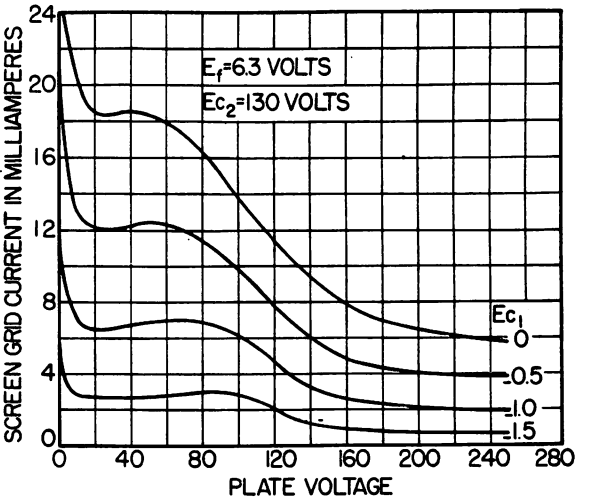
* Operation with the control grid positive with respect to cathode is not recommended.

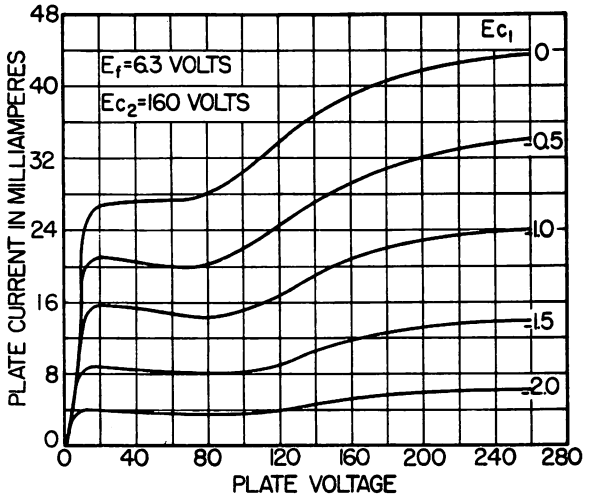
** Ratio of product to fundamental at output for 0.1 volt rms signal from grid to cathode.

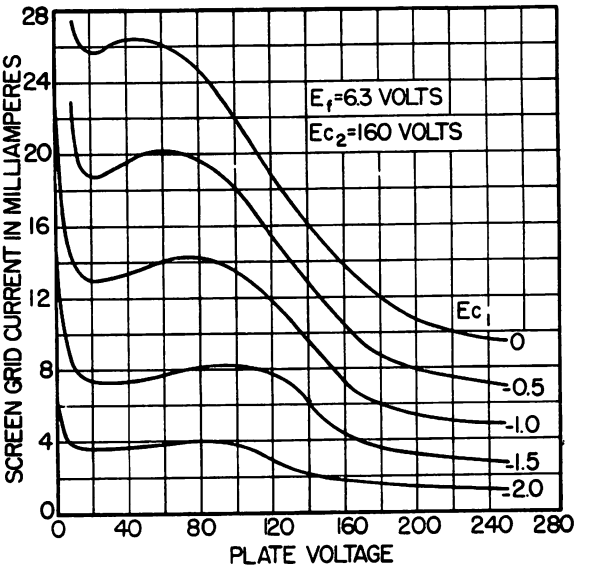
*** Ratio of product to fundemental at output for a 0.2 volt rms signal from grid to cathode.

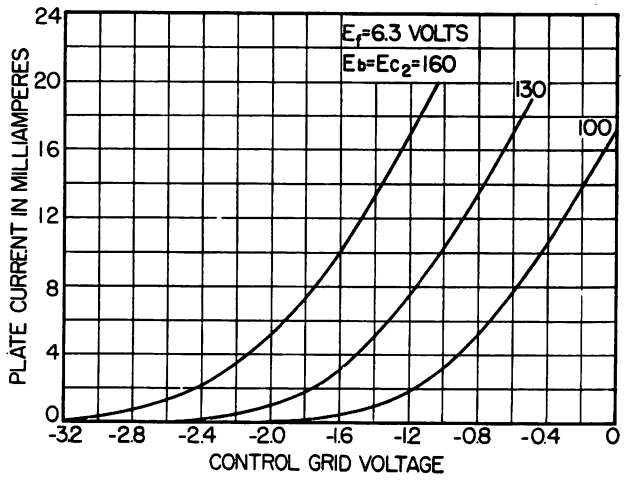
Note 1: Reference point for "Control Grid Voltage" is the negative end of the cathode bias resistor.

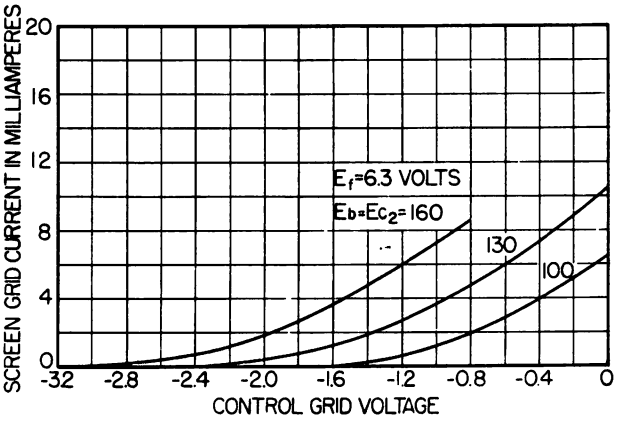

E_f=6.3 VOLTS
Ec_2=130 VOLTS
Ec_1
0
-0.5
-1.0
-1.5
PLATE CURRENT IN MILLIAMPERES
PLATE VOLTAGE
0 40 80 120 160 200 240 280
0 8 16 24 32 40

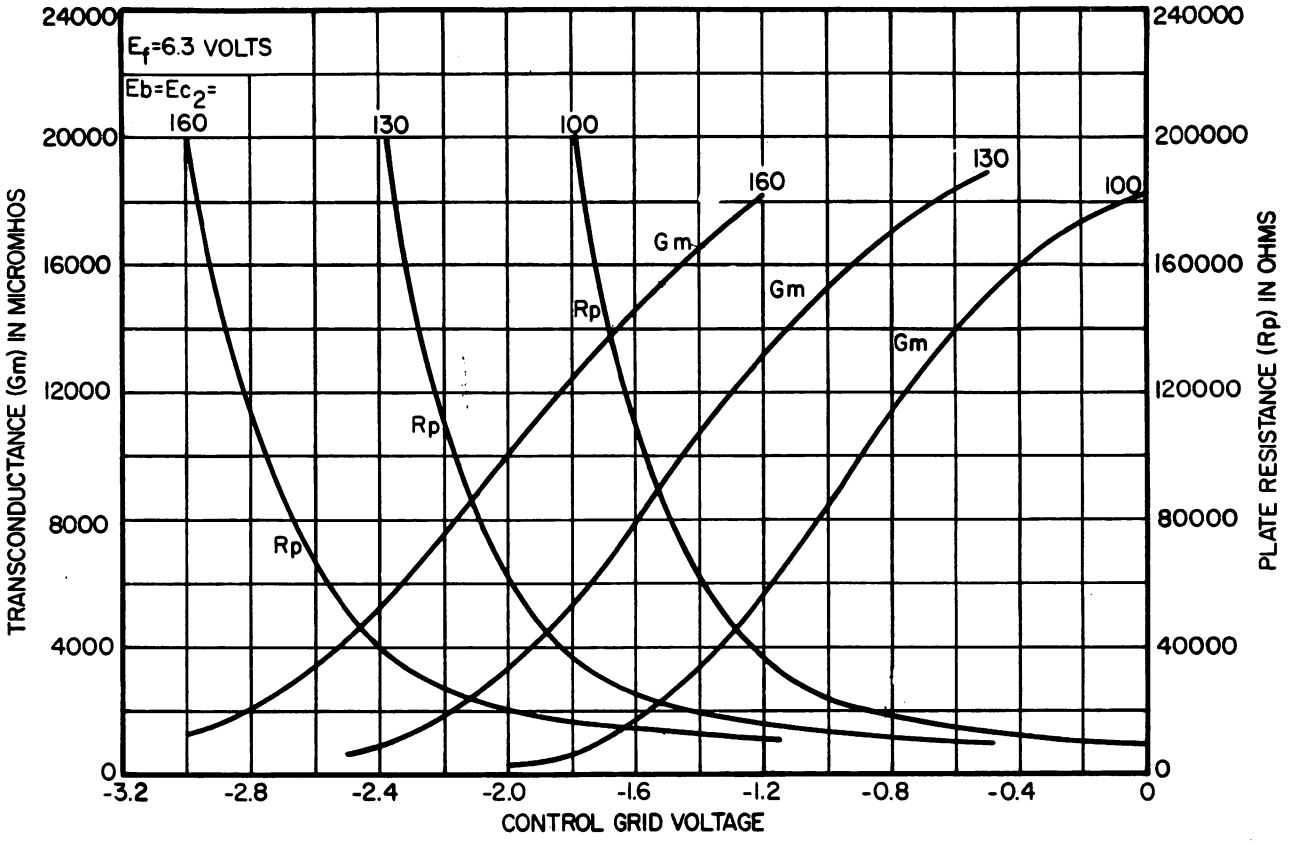

E_f=6.3 VOLTS
Ec_2=130 VOLTS
Ec_1
0
-0.5
-1.0
-1.5
SCREEN GRID CURRENT IN MILLIAMPERES
PLATE VOLTAGE
0 40 80 120 160 200 240 280
0 4 8 12 16 20 24

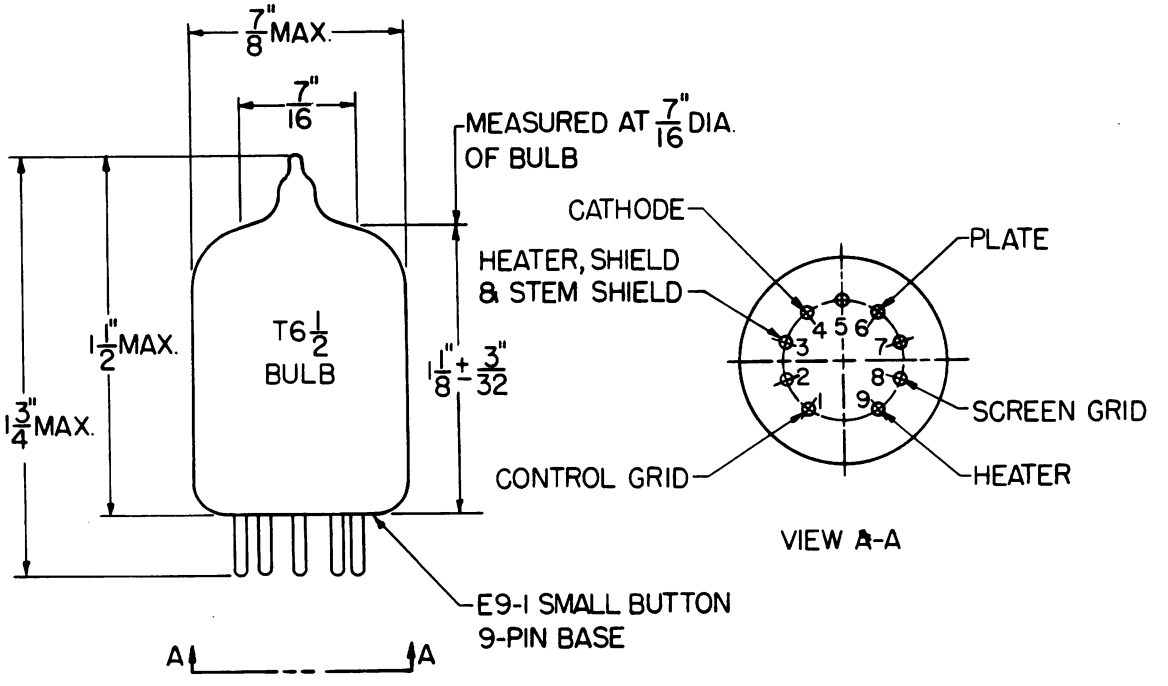

E_f=6.3 VOLTS
Ec_2=160 VOLTS
Ec_1
0
-0.5
-1.0
-1.5
-2.0
PLATE CURRENT IN MILLIAMPERES
PLATE VOLTAGE
0 40 80 120 160 200 240 280
0 8 16 24 32 40 48


E_f=6.3 VOLTS
Ec_2=160 VOLTS
Ec_1
0
-0.5
-1.0
-1.5
-2.0
SCREEN GRID CURRENT IN MILLIAMPERES
PLATE VOLTAGE
0 40 80 120 160 200 240 280
0 4 8 12 16 20 24 28


E_f=6.3 VOLTS
E_b=Ec_2=160
130
100
PLATE CURRENT IN MILLIAMPERES
CONTROL GRID VOLTAGE
-3.2 -2.8 -2.4 -2.0 -1.6 -1.2 -0.8 -0.4 0
0 4 8 12 16 20 24


E_f=6.3 VOLTS
E_b=Ec_2=160
130
100
SCREEN GRID CURRENT IN MILLIAMPERES
CONTROL GRID VOLTAGE
-3.2 -2.8 -2.4 -2.0 -1.6 -1.2 -0.8 -0.4 0
0 4 8 12 16 20


E_f=6.3 VOLTS
Eb=Ec2=
160
130
100
Gm
Rp
TRANSCONDUCTANCE (Gm) IN MICROMHOS
PLATE RESISTANCE (Rp) IN OHMS
CONTROL GRID VOLTAGE
24000
20000
16000
12000
8000
4000
0
240000
200000
160000
120000
80000
40000
-3.2
-2.8
-2.4
-2.0
-1.6
-1.2
-0.8
-0.4
0


7/8" MAX.
7/16"
MEASURED AT 7/16" DIA. OF BULB
T6 1/2 BULB
1 1/2" MAX.
1 3/4" MAX.
1 1/8" + 3/32"
CATHODE
HEATER, SHIELD & STEM SHIELD
PLATE
SCREEN GRID
CONTROL GRID
HEATER
VIEW A-A
E9-1 SMALL BUTTON 9-PIN BASE
A
A

ELECTRON TUBE DATA SHEET

WESTERN ELECTRIC 436A ELECTRON TUBE



DESCRIPTION

The 436A electron tube is a high figure of merit tetrode with an indirectly heated cathode. It was designed primarily for use in the L-3 amplifier. ←

CHARACTERISTICS

Heater Voltage		6.3	volts
Cathode Current	(E_b = 190 volts; E_{c2} = 160 volts	28.4	milliamperes ←
Transconductance	E_{cc1} = +7.5 volts; R_k = 315 ohms)	30000	micromhos

Note 1: In the "Absolute System" the maximum ratings specified are limiting values above which the serviceability of the device may be impaired from the viewpoint of life and satisfactory performance. Maximum ratings, as such, do not constitute a set of operating conditions and all values may not, therefore, be attained simultaneously.

Note 2: Reference point for Control Grid Voltage is the negative end of the cathode bias resistor.

File: General Purpose Section

Indicates a change ←

© American Telephone and Telegraph Company 1963

GENERAL CHARACTERISTICS

Electrical Data

Heater Voltage		6.3	volts
Heater Current		450	milliamperes
Direct Interelectrode Capacitances	Without External Shield	With External Shield (JEDEC #309)	
Grid to Plate (maximum)	.07	.06	μμf
Input: gl to (h+k+g2+i.s.)	14.0	14.2	μμf
Output: p to (h+k+g2+i.s.)	3.5	4.7	μμf

Mechanical Data

Cathode	Coated Unipotential
Bulb	T 9
Base	See outline drawing page 4
Mounting Position	Any

Dimensions and pin connections shown in outline drawing on page 4.

MAXIMUM RATINGS, Absolute System (Note 1, See Page 1)

Plate Voltage	210	volts
Screen Grid Voltage	175	volts
Plate Dissipation	5.0	watts
Screen Grid Dissipation	2.2	watts
Control Grid Dissipation	See footnote *	
Cathode Current	50	milliamperes
Heater-Cathode Voltage	55	volts
Bulb Temperature	130	centigrade
Maximum Grid Circuit Resistance for		
Fixed Bias	0.05	megohm
Cathode Bias	0.10	megohm

TYPICAL OPERATING CONDITIONS AND CHARACTERISTICS

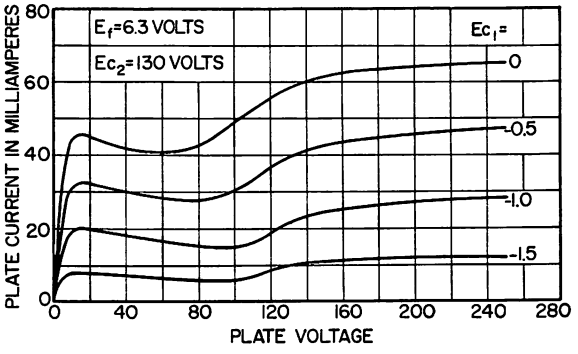
Plate Voltage	130	160	190	volts
Screen Grid Voltage	130	160	160	volts
Control Grid Voltage	-1.0	-1.75	-	volts
Control Grid Supply Voltage (Note 2, See Page 1)	-	-	+7.5	volts
Cathode Bias Resistor (Note 2, See Page 1)	-	-	315	ohms
Plate Current	21.5	18.8	20.2	milliamperes
Screen Grid Current	12.5	10.8	8.2	milliamperes
Plate Resistance	5000	5000	36000	ohms
Transconductance	30000	28000	30000	micromhos
Control Grid Voltage (approximate) for Plate Current of 10 microamperes	-3.7	-4.7	-	volts
Modulation				
Second Order (2F)**	-	-	-32	db
Third Order (3F)***	-	-	-54	db
Load Resistance	-	-	270	ohms

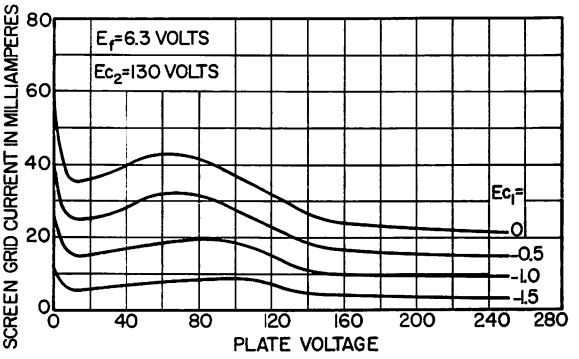
* Operation with the control grid positive with respect to cathode is not recommended.

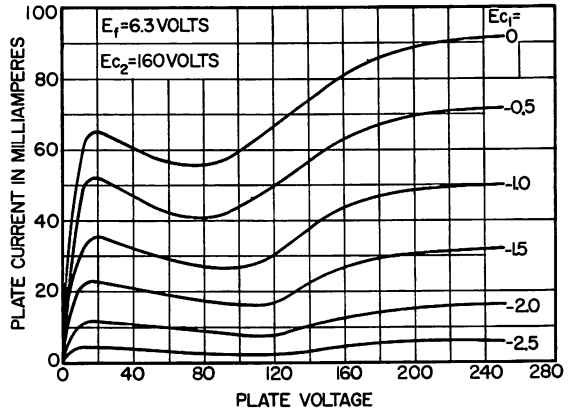
** Ratio of product to fundamental at output for 0.1 volt rms signal from grid to cathode.

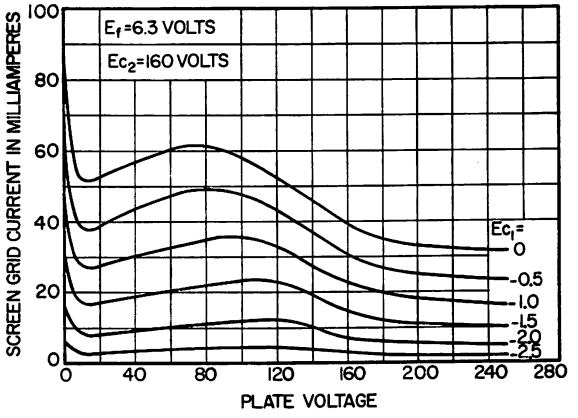
*** Ratio of product to fundamental at output for a 0.2 volt rms signal from grid to cathode.

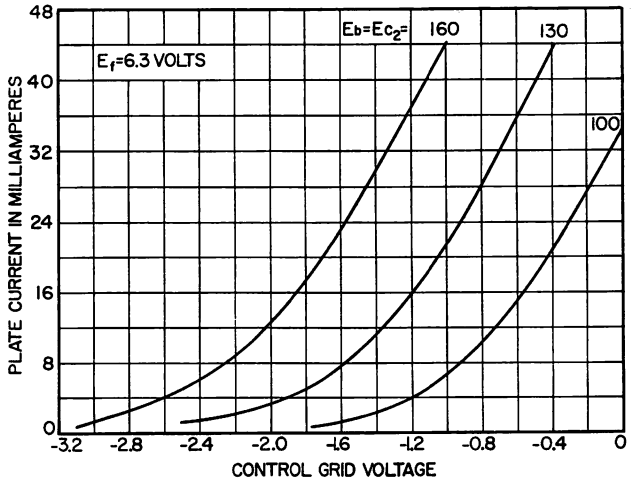
→ Indicates a change

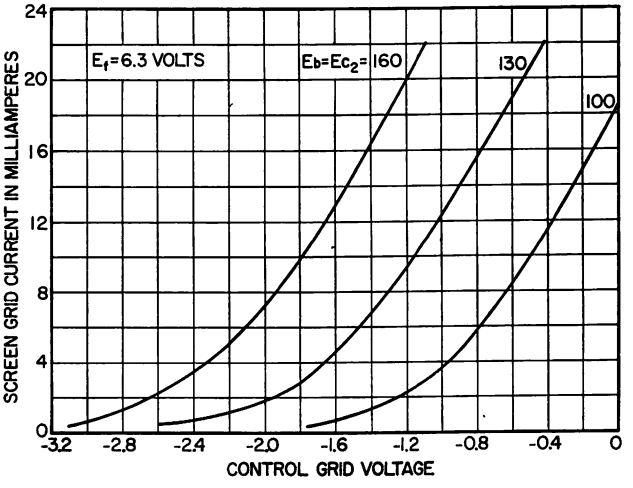

PLATE CURRENT IN MILLIAMPERES
80
60
40
20
0
E_f=6.3 VOLTS
Ec_2=130 VOLTS
Ec_1=
0
-0.5
-1.0
-1.5
0 40 80 120 160 200 240 280
PLATE VOLTAGE

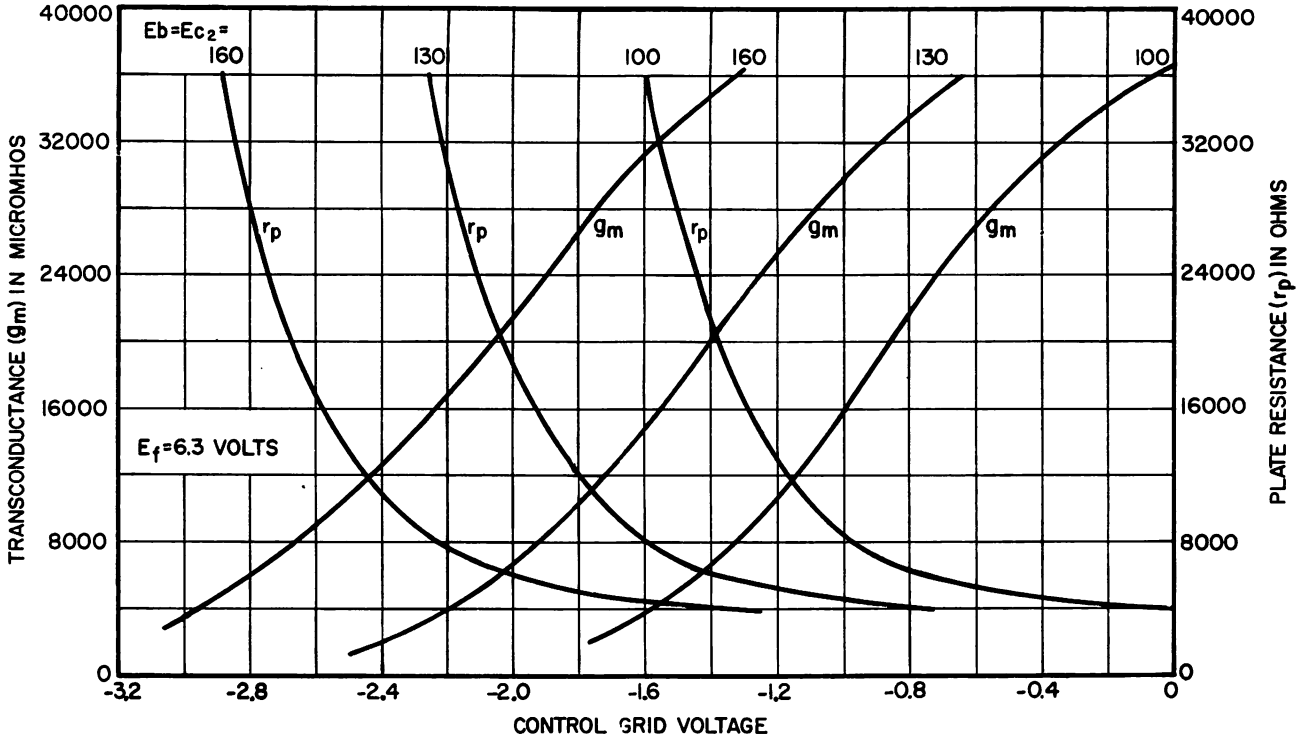

SCREEN GRID CURRENT IN MILLIAMPERES
80
60
40
20
0
E_f=6.3 VOLTS
Ec_2=130 VOLTS
Ec_1=
0
-0.5
-1.0
-1.5
0 40 80 120 160 200 240 280
PLATE VOLTAGE

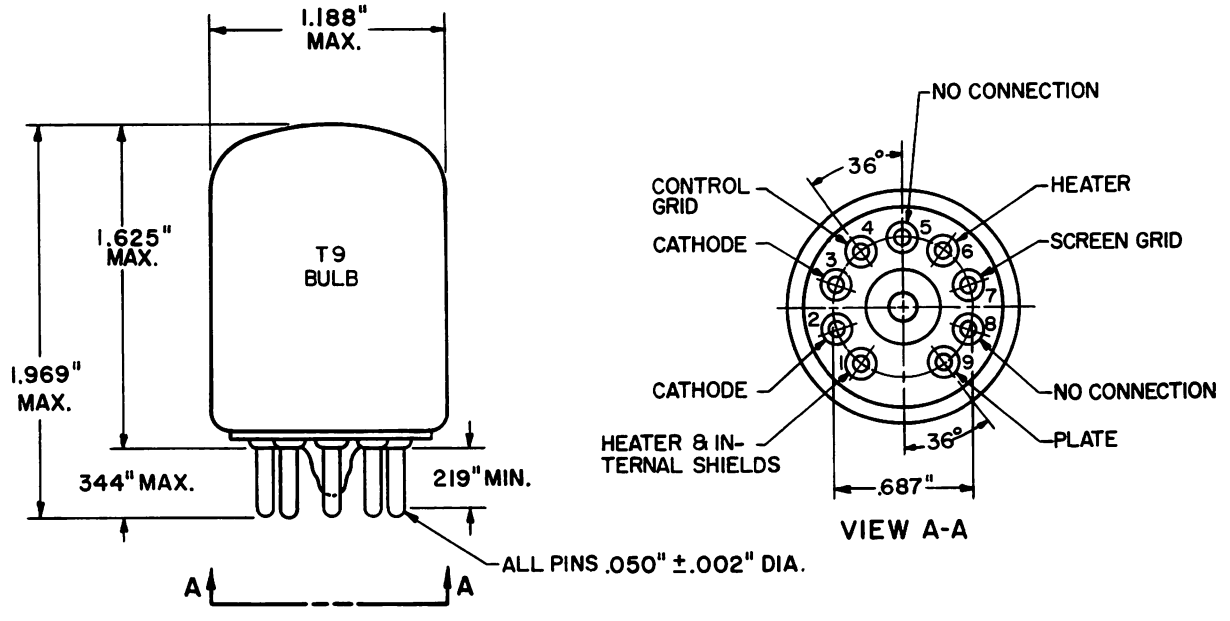

PLATE CURRENT IN MILLIAMPERES
100
80
60
40
20
0
E_f=6.3 VOLTS
Ec_2=160 VOLTS
Ec_1=
0
-0.5
-1.0
-1.5
-2.0
-2.5
0 40 80 120 160 200 240 280
PLATE VOLTAGE


SCREEN GRID CURRENT IN MILLIAMPERES
100
80
60
40
20
0
E_f=6.3 VOLTS
Ec_2=160 VOLTS
Ec_1=
0
-0.5
-1.0
-1.5
-2.0
-2.5
0 40 80 120 160 200 240 280
PLATE VOLTAGE


PLATE CURRENT IN MILLIAMPERES
48
40
32
24
16
8
0
E_f=6.3 VOLTS
Eb=Ec_2=
160
130
100
-3.2 -2.8 -2.4 -2.0 -1.6 -1.2 -0.8 -0.4 0
CONTROL GRID VOLTAGE


SCREEN GRID CURRENT IN MILLIAMPERES
24
20
16
12
8
4
0
E_f=6.3 VOLTS
Eb=Ec_2=160
130
100
-3.2 -2.8 -2.4 -2.0 -1.6 -1.2 -0.8 -0.4 0
CONTROL GRID VOLTAGE





A development of Bell Telephone Laboratories, the research laboratories of the American Telephone and Telegraph Company and the Western Electric Company.

PRINTED IN U.S.A.

ELECTRON TUBE DATA SHEET
WESTERN ELECTRIC 437A ELECTRON TUBE



DESCRIPTION

The 437A electron tube is a high figure of merit triode with an indirectly heated cathode. It was designed primarily for the output amplifier of the L-3 tandem two stage amplifier.

CHARACTERISTICS

Heater Voltage		6.3 volts
Cathode Current	E_b = 160 volts;	36.5 milliamperes
Transconductance	E_{ccl} = +7.5 volts; R_k = 262 ohms	46000 micromhos

File: General Purpose Section
Issue 1, 10-55

GENERAL CHARACTERISTICS

ELECTRICAL DATA

Heater Voltage	6.3 volts
Heater Current	450 milliamperes

Direct Interelectrode Capacitances	Without External Shield	With External Shield (RETMA #309)
Grid to Plate (maximum)	3.8	3.8 uuf
Input: g to (h+k+i.s.)	11.1	11.3 uuf
Output: p to (h+k+i.s.)	1.0	2.1 uuf

MECHANICAL DATA

Cathode	Coated Unipotential
Bulb	T9
Base	See outline drawing page 4
Mounting Position	Any

Dimensions and pin connections shown in outline drawing on page 4

MAXIMUM RATINGS, Design Center Values

Plate Voltage	250 volts
Plate Dissipation	7.0 watts
Control Grid Dissipation	see footnote 1
Cathode Current	45 milliamperes
Heater-Cathode Voltage	50 volts
Bulb Temperature	130 centigrade

MAXIMUM CIRCUIT VALUES

Grid Circuit Resistance:	
For Fixed Bias	0.05 megohm
For Cathode Bias	0.10 megohm

TYPICAL OPERATING CONDITIONS AND CHARACTERISTICS

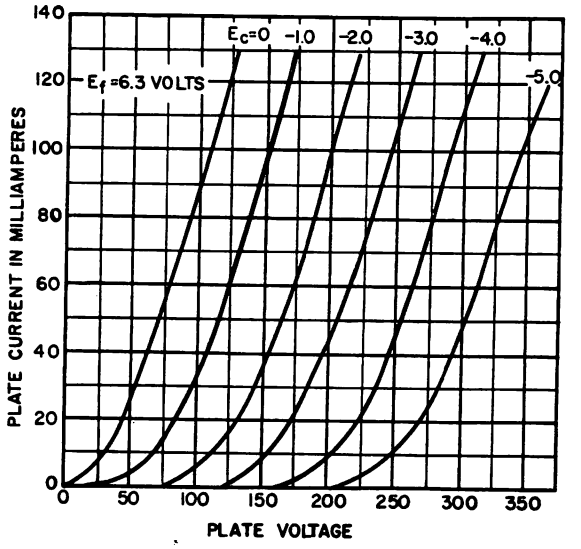
Plate Voltage	140	180	160	volts
Control Grid Voltage	-2.0	-3.0	---	volts
Control Grid Supply Voltage[2]	---	---	+7.5	volts
Cathode Bias Resistor[2]	---	---	262	ohms
Plate Current	29.0	25.0	36.5	milliamperes
Amplification Factor	41.0	41.0	41.0	
Plate Resistance	950	980	900	ohms
Transconductance	43000	42000	46000	micromhos
Control Grid Voltage (approximate) for Plate Current of 10 microamperes	-5.0	-6.3	---	volts
Modulation				
Second Order (2F)[3]	--	---	-37	db
Third Order (3F)[4]	---	---	-56	db
Load Resistance	---	---	270	ohms

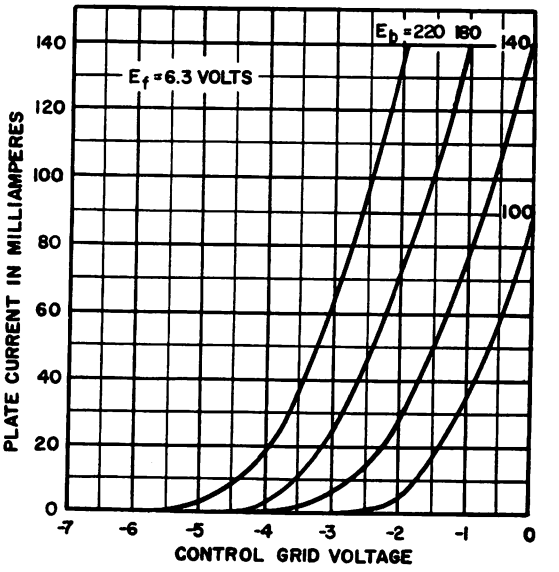
Note 1: Operation with the control grid positive with respect to cathode is not recommended.

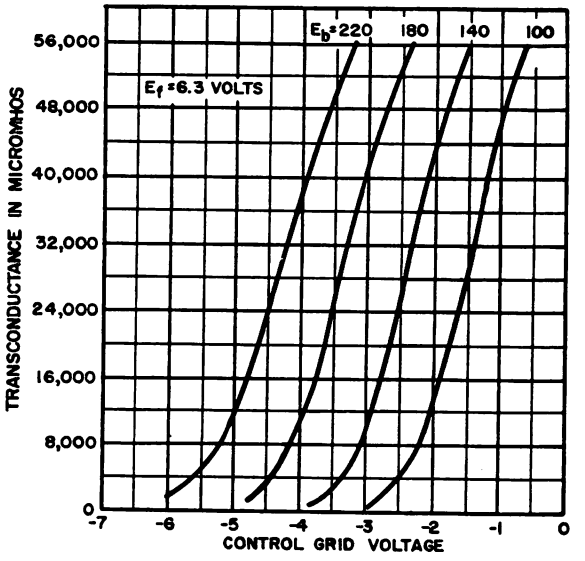
Note 2: Reference point for Control Grid Voltage is the negative end of the cathode bias resistor.

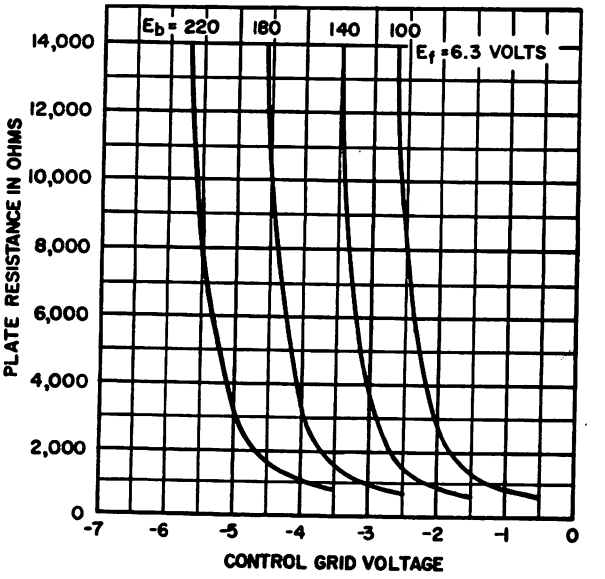
Note 3: Ratio of product to fundamental at output for 0.1 volt rms signal from grid to cathode.

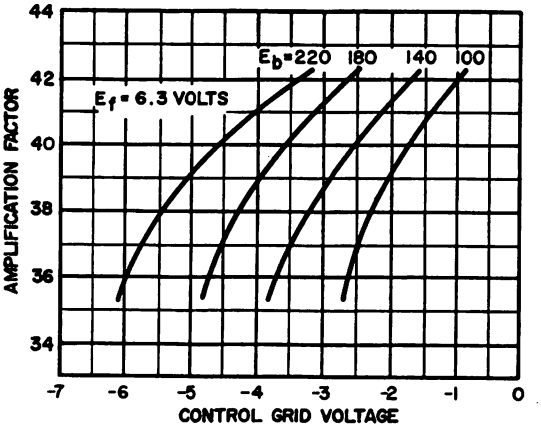
Note 4: Ratio of product to fundamental at output for a 0.2 volt rms signal from grid to cathode.

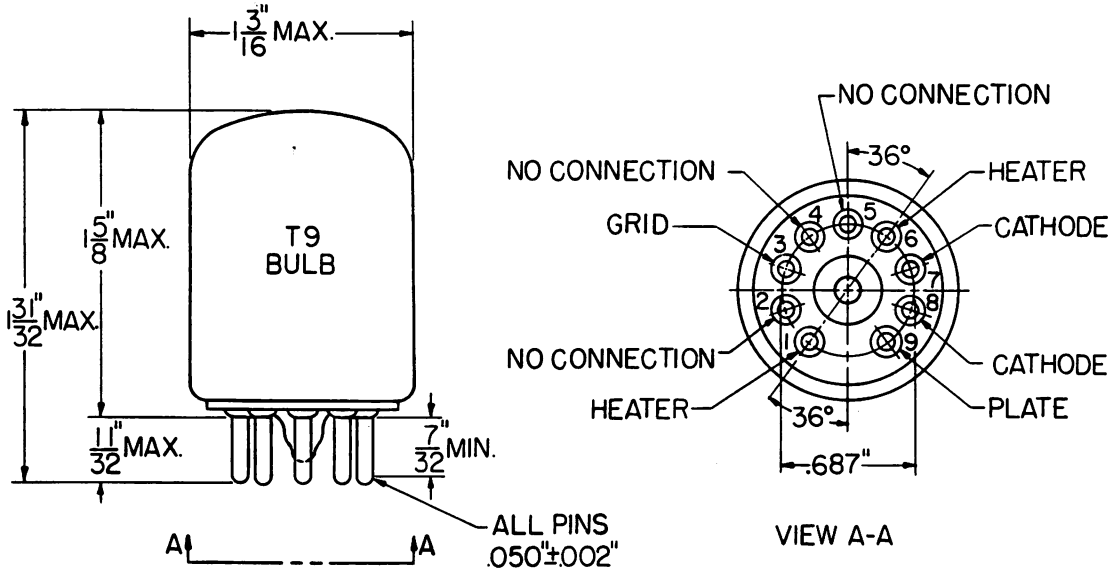

PLATE CURRENT IN MILLIAMPERES
PLATE VOLTAGE
E_f = 6.3 VOLTS
E_c=0 -1.0 -2.0 -3.0 -4.0 -5.0
0 20 40 60 80 100 120 140
0 50 100 150 200 250 300 350


PLATE CURRENT IN MILLIAMPERES
CONTROL GRID VOLTAGE
E_f = 6.3 VOLTS
E_b = 220 180 140 100
0 20 40 60 80 100 120 140
-7 -6 -5 -4 -3 -2 -1 0


TRANSCONDUCTANCE IN MICROMHOS
CONTROL GRID VOLTAGE
E_f = 6.3 VOLTS
E_b = 220 180 140 100
0 8,000 16,000 24,000 32,000 40,000 48,000 56,000
-7 -6 -5 -4 -3 -2 -1 0


PLATE RESISTANCE IN OHMS
CONTROL GRID VOLTAGE
E_b = 220 180 140 100
E_f = 6.3 VOLTS
0 2,000 4,000 6,000 8,000 10,000 12,000 14,000
-7 -6 -5 -4 -3 -2 -1 0


AMPLIFICATION FACTOR
CONTROL GRID VOLTAGE
E_b = 220 180 140 100
E_f = 6.3 VOLTS
34 36 38 40 42 44
-7 -6 -5 -4 -3 -2 -1 0

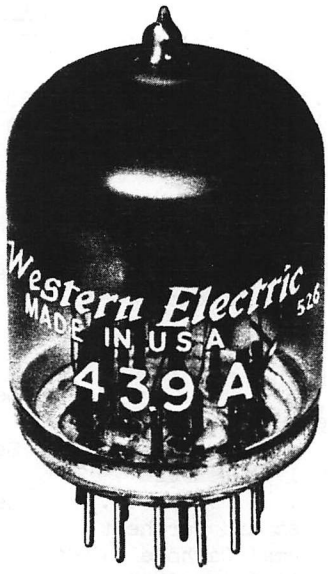


A development of Bell Telephone Laboratories, the research laboratories of the American Telephone and Telegraph Company and the Western Electric Company

AB46.439A
Issue 1, June 1957
A.T.&T. Co. Standard

ELECTRON TUBE DATA SHEET

WESTERN ELECTRIC 439A ELECTRON TUBE



DESCRIPTION

The 439A is a ten-stage cold-cathode gas-discharge stepping tube designed for continuous counting or registration of pulses at pulse rates up to 1000 pulses per second. Design features permit both visual and electrical registration of input pulses. The tube can be operated in decade chains or can be used to drive other electronic devices for the purpose of timing, pulse counting, pulse generation, and similar operations.

File: Cold Cathode Section
Issue 1, 6-57

RATINGS, Absolute Values

Cathode Current	
Maximum Peak	10 milliamperes
Maximum Average	3 milliamperes
Minimum Average	1 milliampere
Maximum Averaging Time	0.5 second
Maximum Inverse Anode or Auxiliary Anode Current	0.0 milliampere
Ambient Temperature Limits	-55° to +60° centigrade

ELECTRICAL DATA[1]

	Min.	Bogey	Max.	
Anode Voltage Drop	---	110	---	volts
Anode Breakdown Voltage				
Normal Cathode	150	225	275	volts
Output Cathodes (K1 - K10)	180	225	300	volts
Stepping Cathodes (B1 - B10)	150	190	250	volts
Auxiliary Anode				
Voltage Drop to Cathode K10	---	112	---	volts
Breakdown Voltage	260	300	---	volts
Transfer Voltage[2] to Cathode K10	See curves - Fig. 1			
Transfer Voltage [2, 3], to any Cathode except K10	260	290	---	volts
Cathode				
Forward Transfer Voltage [4, 9]	See curves - Fig. 2			
Double Transfer Voltage between Output Cathodes [5,8,9]	See curves - Fig. 3			
Transfer Voltage from Normal to Nearest Output Cathodes [6,8,9]	See curves - Fig. 4			
Transfer Voltage from Nearest and Farthest Output Cathodes to the Normal Cathode [7,8,9]	See curves - Fig. 5			
Temperature Sensitivity-Cathode Transfer Voltage[6]	See curves - Fig. 6			

MECHANICAL DATA

Mounting Position	Any
Socket	(Equivalent to or) Cinch #54A17538
Bulb	T9

Dimensions and pin connections shown in outline on Page 10.

Note 1 All data are based on operation of the tube within average current ratings at the time of stepping or transfer of the discharge.

Note 2 Voltage, with respect to an operating cathode, at which conduction occurs from the auxiliary anode to cathode indicated.

Note 3 Measured with maximum K10 voltage of +50 volts with respect to the operating cathode.

Note 4 Voltage, with respect to an operating cathode, applied to the adjacent forward cathode to transfer the discharge to that cathode.

Note 5 Voltage, with respect to an operating output cathode, applied to an adjacent non-operating output cathode, which may cause transfer of the discharge to the non-operating output cathode.

Note 6 Voltage, with respect to the normal cathode, applied to one or both of the output cathodes K1 or K10, which may cause transfer of the discharge from the normal cathode to K1 or K10.

Note 7 Transfer from an output cathode to the normal cathode is the voltage, with respect to an operating output cathode, applied to the normal cathode, which will cause transfer of the discharge to the normal cathode.

Note 8 Values shown are measured under static conditions. The values represent absolute limits on output voltage for circuits in which resistive loads are connected to the output cathodes. See also Notes on Operating Principles and Applications, sections captioned (1) Cathode Output Characteristics, (2) Frequency Characteristics.

Note 9 The transfer characteristics shown in Figs. 2, 3, 4, and 5 apply only at an ambient temperature of 25°C. The transfer characteristics which apply at other ambient temperatures can be obtained by adding the correction voltages shown in Fig. 6 to the curves of Figs. 2, 3, 4, and 5. At ambient temperatures below 25°C the absolute value of the transfer voltage is reduced, and at ambient temperatures above 25°C the absolute value of the transfer voltage is increased.

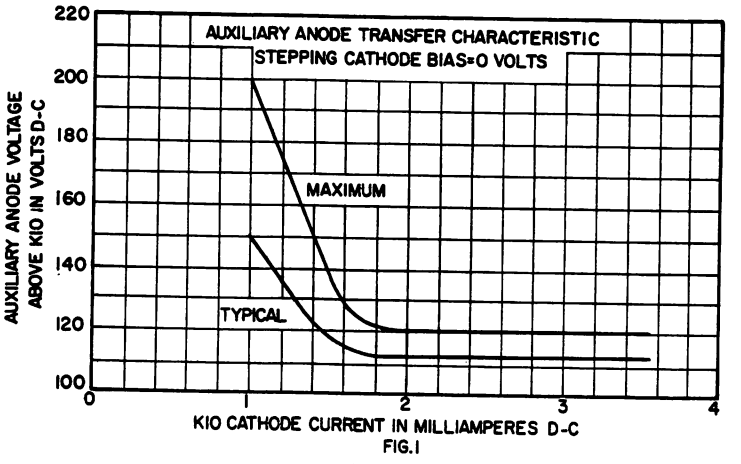


FIG.1

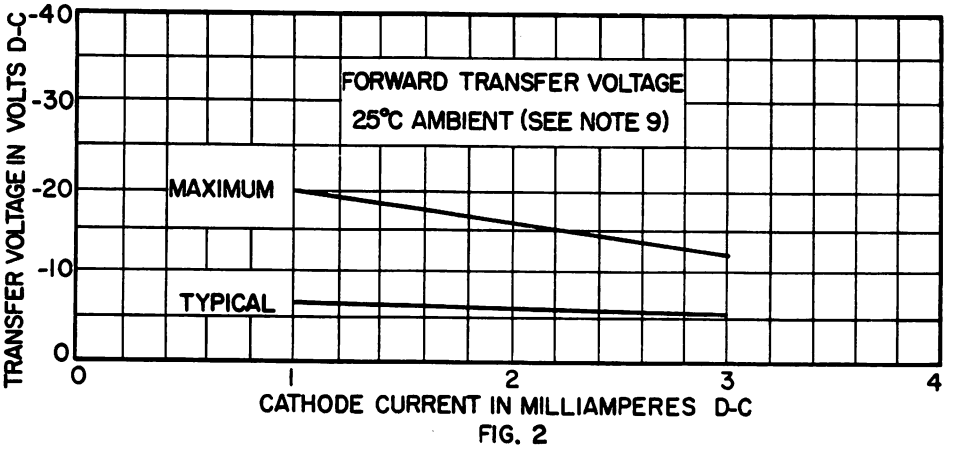
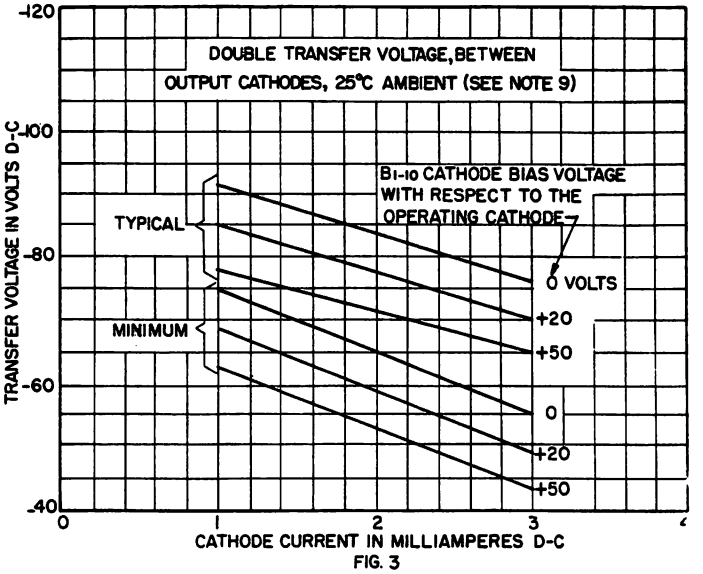
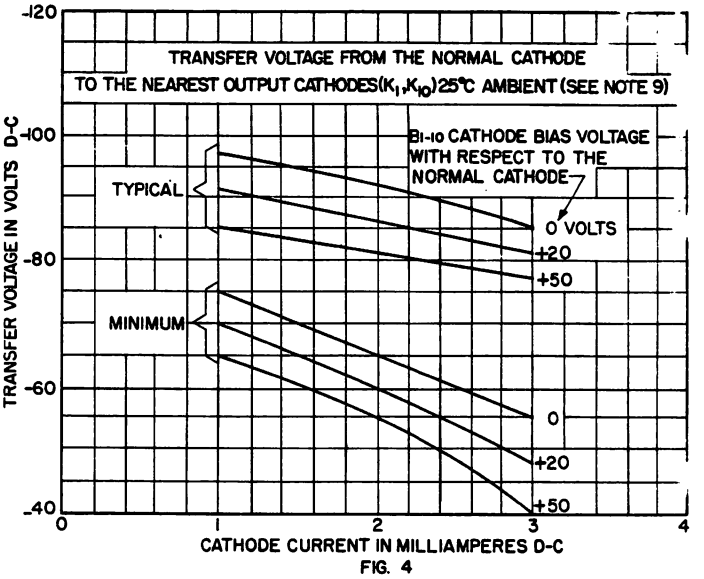


FIG. 2


DOUBLE TRANSFER VOLTAGE, BETWEEN
OUTPUT CATHODES, 25°C AMBIENT (SEE NOTE 9)
B1-10 CATHODE BIAS VOLTAGE
WITH RESPECT TO THE
OPERATING CATHODE
TYPICAL
MINIMUM
0 VOLTS
+20
+50
0
+20
+50
-120
-100
-80
-60
-40
0
1
2
3
TRANSFER VOLTAGE IN VOLTS D-C
CATHODE CURRENT IN MILLIAMPERES D-C
FIG. 3


TRANSFER VOLTAGE FROM THE NORMAL CATHODE
TO THE NEAREST OUTPUT CATHODES(K1, K10) 25°C AMBIENT (SEE NOTE 9)
B1-10 CATHODE BIAS VOLTAGE
WITH RESPECT TO THE
NORMAL CATHODE
TYPICAL
MINIMUM
0 VOLTS
+20
+50
0
+20
+50
-120
-100
-80
-60
-40
0
1
2
3
4
TRANSFER VOLTAGE IN VOLTS D-C
CATHODE CURRENT IN MILLIAMPERES D-C
FIG. 4

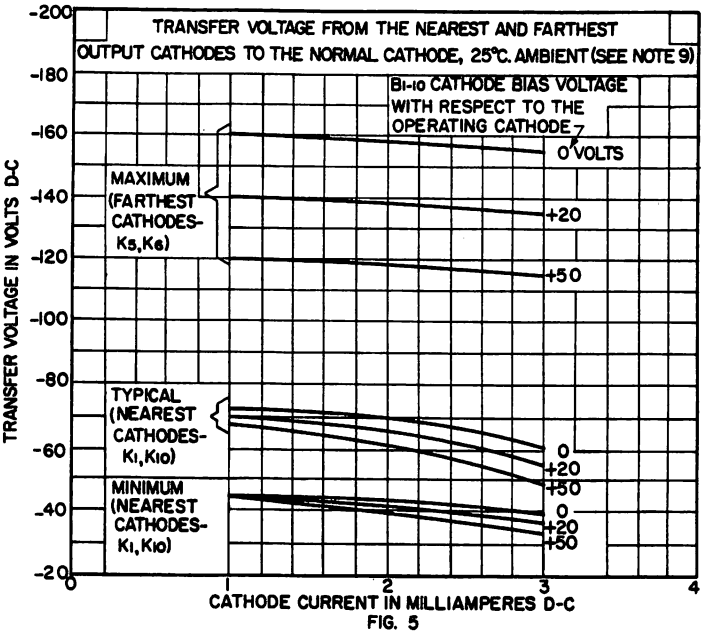

TRANSFER VOLTAGE FROM THE NEAREST AND FARTHEST
OUTPUT CATHODES TO THE NORMAL CATHODE, 25°C. AMBIENT (SEE NOTE 9)
B1-10 CATHODE BIAS VOLTAGE WITH RESPECT TO THE OPERATING CATHODE
0 VOLTS
MAXIMUM (FARTHEST CATHODES- K5, K6)
+20
+50
TYPICAL (NEAREST CATHODES- K1, K10)
0
+20
+50
MINIMUM (NEAREST CATHODES- K1, K10)
0
+20
+50
TRANSFER VOLTAGE IN VOLTS D-C
-200
-180
-160
-140
-120
-100
-80
-60
-40
-20
0
1
2
3
4
CATHODE CURRENT IN MILLIAMPERES D-C

FIG. 5

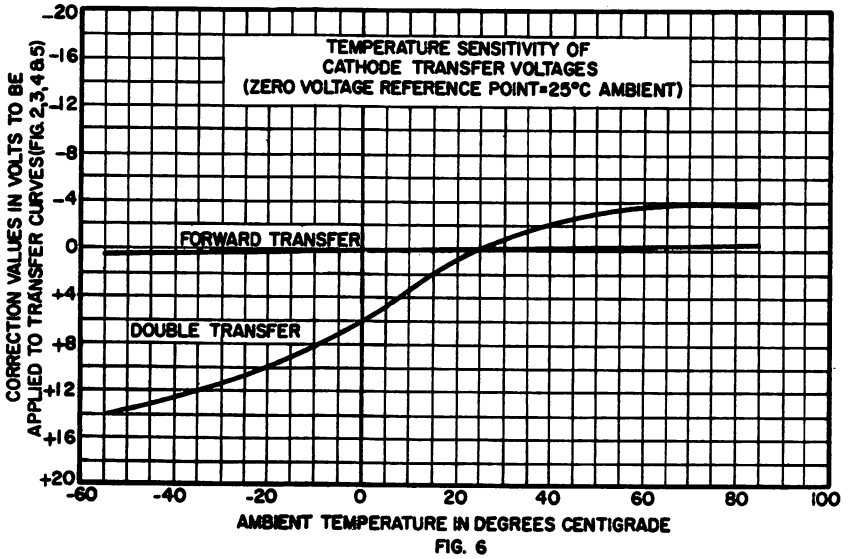

TEMPERATURE SENSITIVITY OF
CATHODE TRANSFER VOLTAGES
(ZERO VOLTAGE REFERENCE POINT=25°C AMBIENT)
FORWARD TRANSFER
DOUBLE TRANSFER
CORRECTION VALUES IN VOLTS TO BE APPLIED TO TRANSFER CURVES (FIG. 2, 3, 4 & 5)
-20
-16
-12
-8
-4
0
+4
+8
+12
+16
+20
-60
-40
-20
0
20
40
60
80
100
AMBIENT TEMPERATURE IN DEGREES CENTIGRADE

FIG. 6

NOTES ON OPERATING PRINCIPLES AND APPLICATIONS

GENERAL DESCRIPTION

The essential features of the tube are shown in Fig. 7. Twenty cathodes surround the common anode. Alternate cathodes are called K or output cathodes and B or stepping cathodes respectively. Each of the ten K cathodes is connected to an external lead for output purposes. The B cathodes are internally connected in two groups of five; for most circuit applications these two groups are tied together externally.

A "normal" cathode, located outside the main ring of cathodes near cathode B_1, can be used to reset or normalize the tube.

The tube also has an auxiliary anode which can be used to produce an output signal on every tenth step.

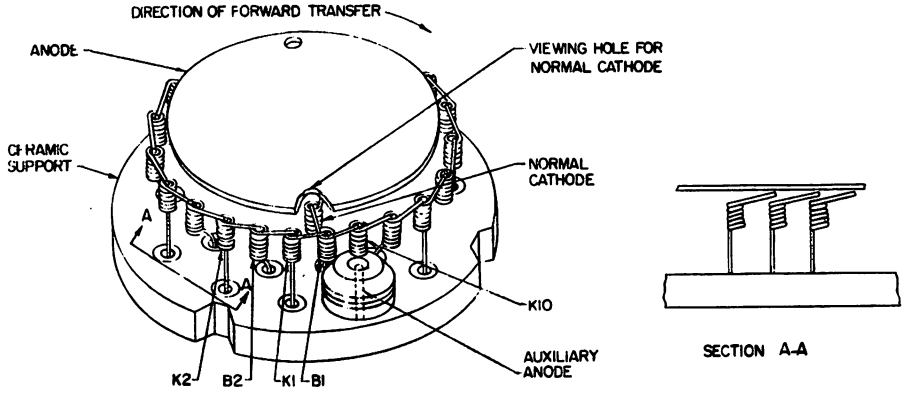


FIG.7 CATHODE-ANODE STRUCTURE

STEPPING MECHANISM

Figure 8 shows three stages of a stepping tube with a discharge established between K_1 and the anode. If the B cathodes are at the same potential as K_1 or higher, the discharge remains in the gap between K_1 and the anode. However, if the potential of the B cathodes is depressed sufficiently below that of the K cathodes, the discharge transfers to one of the adjacent B cathodes. This causes the anode potential to fall below that needed to sustain the discharge to K_1, so that the discharge to K_1 extinguishes. If the B cathodes are then made more positive than the K cathodes, a similar transfer takes place, this time from the operating B cathode to an adjacent K cathode. By virtue of a built-in preference mechanism, the transfer always takes place in one direction (from left to right in Fig. 8). It follows that by biasing the B cathodes positively with respect to the K cathodes and by superimposing large negative pulses on the bias voltage, the discharge can be caused to step from K cathode to K cathode, the position of the discharge advancing one K cathode to the right for each pulse.

The preference in the direction of transfer is accomplished by making each cathode with a low-efficiency portion and a high-efficiency portion. The cathodes consist of a coil of wire forming a "hollow" and a wire extension, called a "pick-up tab" (see Fig. 7). The discharge is more efficient in the hollow than on the tab and the sustain voltage in the hollow is lower. The tab extends into the region of ionization of the preceding cathode. This facilitates transfer of the discharge to the cathode on the right when the potential of the right-hand cathode is sufficiently below that of the operating cathode. The discharge at first transfers to the tab, but since the discharge is relatively inefficient there, it travels immediately to the hollow portion. Curves of typical and maximum transfer voltage are shown in Fig. 2.

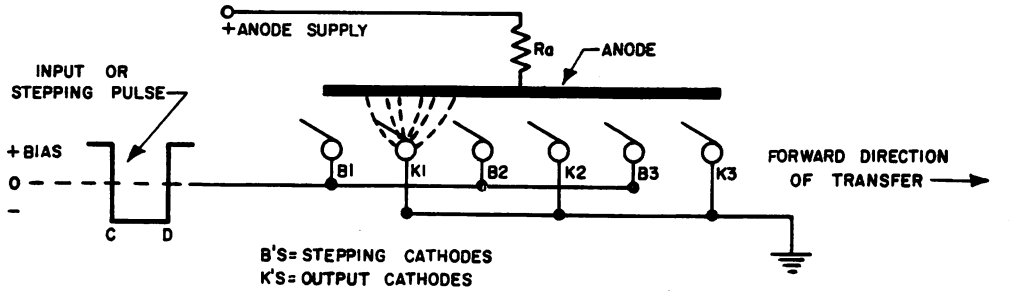


FIG. 8 3-STAGE STEPPING SYSTEM

NORMALIZING

The glow discharge can be transferred from any output cathode to the normal cathode by applying a sufficiently large negative voltage to the normal cathode. The magnitude of voltage needed to accomplish the transfer is given by the curves shown in Fig. 5. From Fig. 7 it can be seen that the stepping cathode B_1 has two pick-up tabs which enable it to transfer the discharge from normal to K_1 or from K_{10} to K_1. Hence, once the discharge is established on the normal cathode, the next stepping pulse transfers the discharge to K_1.

AUXILIARY ANODE OUTPUT

The auxiliary anode is located directly underneath output cathode K_{10} and is shielded from all other cathodes (see Fig. 7). At voltages below the breakdown limits shown in the data, the auxiliary anode remains at its supply voltage except when the discharge is on K_{10}. When the discharge steps to K_{10}, both the auxiliary anode and the main anode conduct to K_{10} and an output voltage can be detected by means of suitable circuitry connected to the auxiliary anode. Fig. 1 shows the minimum voltage which must be applied to the auxiliary anode for transfer to take place.

A typical auxiliary anode circuit is shown in Fig. 9. Shortly after the main discharge steps to K_{10} the auxiliary anode conducts to K_{10} in addition to the main anode. The resulting voltage drop appears across R as a negative signal which can be used to drive a succeeding stage or to operate other devices. If the components are properly chosen, the auxiliary anode discharge can be extinguished by stepping the main discharge to B_1. If R_{aa} and C are sufficiently large and R is sufficiently small, the circuit shown in Fig. 9 may function as a relaxation oscillator, giving output pulses at regular intervals as long as the discharge remains on K_{10}. However, such a circuit may be useful if the discharge is stepped out of K_{10} before the second output pulse is generated by the oscillator.

Time delay T, shown in the waveform of Fig. 9, represents the time required for the discharge to travel along the K_{10} pick-up tab, fill the hollow, and transfer conduction to the auxiliary anode. Its length is of the order of 100 to 200 microseconds, depending on cathode current and auxiliary anode voltage.

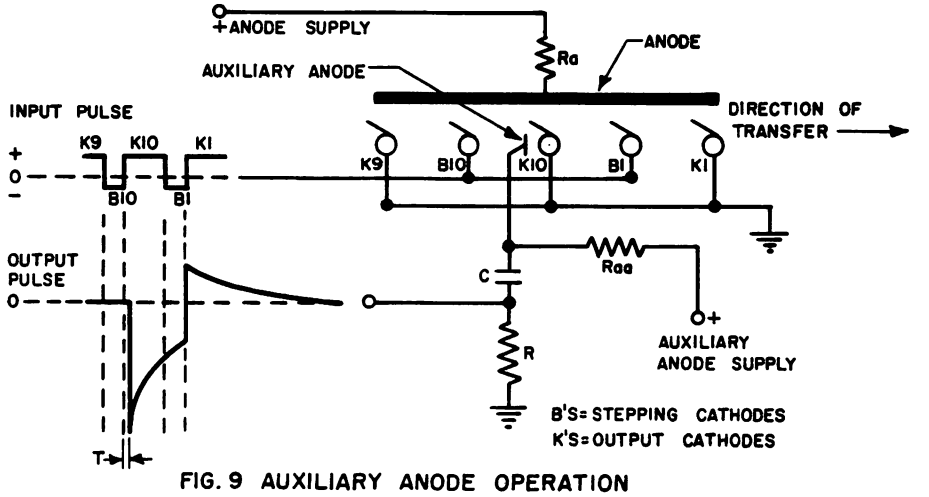


FIG. 9 AUXILIARY ANODE OPERATION

CATHODE OUTPUT CHARACTERISTICS

The position of the discharge can be readily observed from the top of the tube. If visual output is not adequate, an output signal may be taken from any desired K cathode by inserting resistors in series with the cathode leads. Fig. 10 shows a possible circuit. In such a circuit, greater peak-to-peak voltage must be applied to the B cathodes to accomplish the stepping function. To assure that the discharge to the K cathodes will be extinguished when the stepping pulse is applied, the negative swing of the stepping pulse must fall at least 10 volts below the K cathode return voltage. On the other hand, to assure that the discharge to the B cathodes will be extinguished when the stepping pulse is removed, the B cathodes must be biased at least 10 volts above the potential of the operating cathode, i.e., 10 volts above the output voltage developed across the cathode resistor. Therefore, the driving voltage necessarily exceeds the output voltage in magnitude.

In general, the magnitude of the output voltage is limited by the double transfer to either another output cathode or the normal cathode (see notes 5 and 7). The voltage curves which set these limits are shown in Figs. 3, 4, and 5.

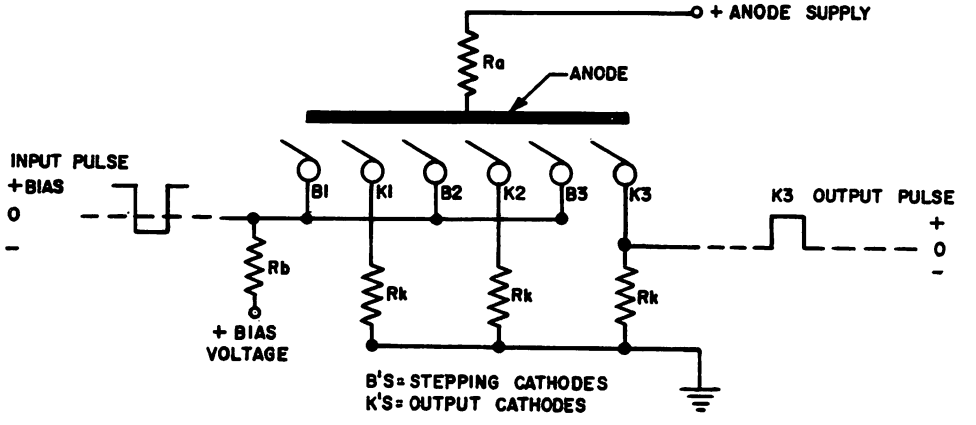


FIG. 10

FREQUENCY CHARACTERISTICS

At frequencies above about 1000 cycles per second, the deionization time of the gaps becomes a limit on available output voltage. To avoid back-transfer at high frequencies because of residual ionization in the preceding gap, it may be necessary to reduce the output voltage. It is also helpful to apply a square wave input pulse. This speeds up the transfer of the discharge into the hollow, thereby allowing more time for deionization of the preceding gap.

The circuit shown in Fig. 11 can be used to obtain greater output voltage at higher frequencies. In this circuit, a capacitor C_k across the output resistor R_k holds the output cathode being deionized positive to prevent back-transfer. In the particular case illustrated, transfer to the next K cathode ($K_n + 1$) takes place as soon as the discharge has traveled down the pick-up tab of $B_n + 1$, because $K_n + 1$ is appreciably more negative than $B_n + 1$. K_n, on the other hand, is held positive by its capacitor, so that transfer can only take place in the forward direction. Because the rise of the $K_n + 1$ voltage is delayed by the capacitor, the discharge to $B_n + 1$ is extinguished at the same voltage level at which transfer occurred. The required driving voltage is therefore smaller than in the all-R circuit. In this circuit the B cathodes are said to be "unstable" because the discharge remains on them for only a portion of the stepping pulse. The driving signal need only go from the bias voltage (V output + 10v) to a voltage which is below the output voltage by the maximum forward transfer voltage. The output voltage in turn must be greater than twice the forward transfer voltage. The time constant R_kC_k should be so chosen that C_k discharges almost completely by the time the same cathode is to conduct again.

The time required for transfer from K cathode to K cathode ($t_2 - t_1$) is less for higher output voltages. This results in an increased frequency limit. However, since the B cathodes are all connected together, no capacitor preference mechanism can be applied to them, and the ultimate frequency limit is determined by the condition that the spacing between B pulses be greater than the B-gap deionization time. The driving frequency limit for the circuit of Fig. 11 is approximately 5000 cps.

Other RC circuits can be constructed in which:

(1) B and K cathodes are stable
(2) B cathodes are stable, K cathodes are unstable
(3) B and K cathodes are unstable

Each of these modes has somewhat different design requirements.

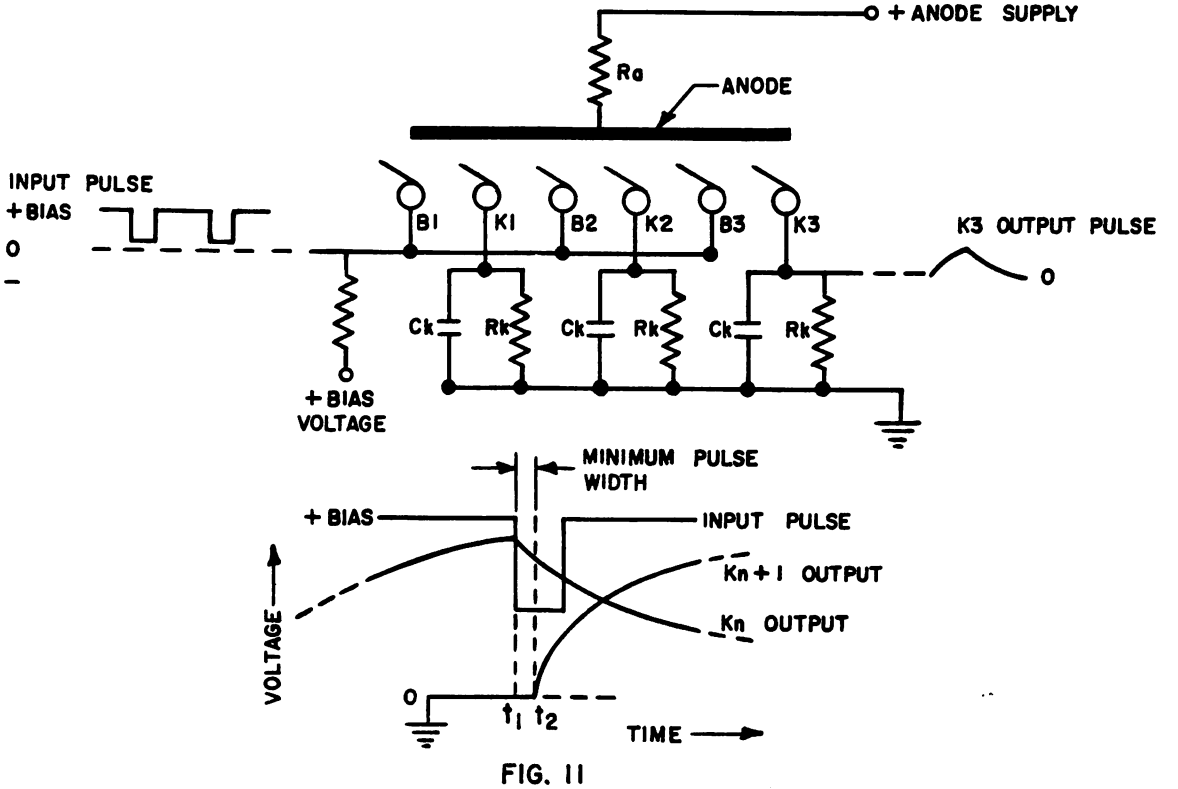
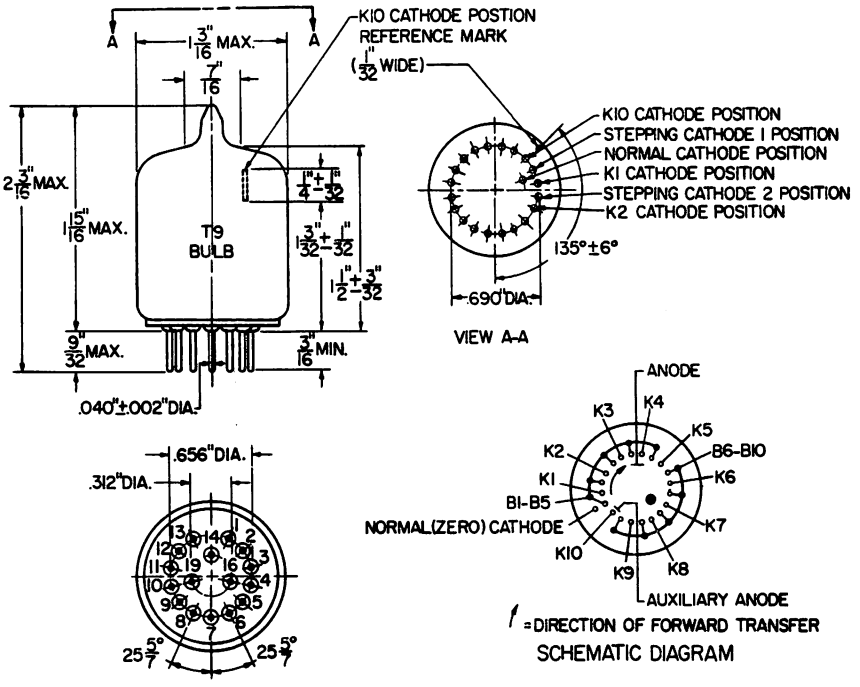


FIG. 11

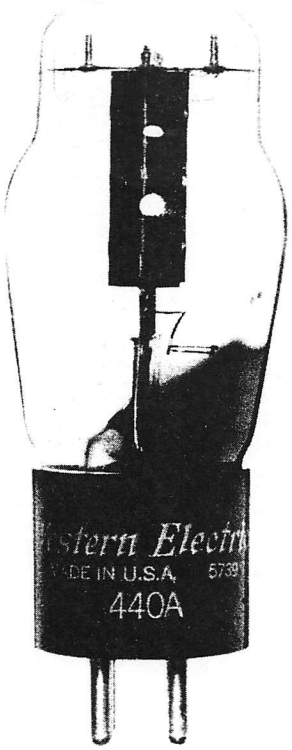


PIN 1. OUTPUT CATHODE (K3)
PIN 2. OUTPUT CATHODE (K2)
PIN 3. OUTPUT CATHODE (K1)
PIN 4. OUTPUT CATHODE (K10)
PIN 5. AUXILIARY ANODE
PIN 6. (IC) INTERNAL CONNECTION
PIN 7. OUTPUT CATHODE (K9)
PIN 8. OUTPUT CATHODE (K8)
PIN 9. OUTPUT CATHODE (K7)
PIN 10. OUTPUT CATHODE (K6)
PIN 11. STEPPING CATHODES B6-B10
PIN 12. OUTPUT CATHODE (K5)
PIN 13. OUTPUT CATHODE (K4)
PIN 14. STEPPING CATHODES B1-B5
PIN 16. NORMAL CATHODE
PIN 19. ANODE

NOTE:- BASE PIN NO. 6 MARKED "INTERNAL CONNECTION" SHOULD NOT BE CONNECTED TO ANY PORTION OF AN EXTERNAL CIRCUIT. FAILURE TO OBSERVE THIS PRECAUTION MAY RESULT IN IMPROPER OPERATION OF THE TUBE.

A development of Bell Telephone Laboratories, the research laboratories of the American Telephone and Telegraph Company and the Western Electric Company

ELECTRON TUBE DATA SHEET
WESTERN ELECTRIC 440A ELECTRON TUBE



TRIODE
LOW-POWER AMPLIFIER

DESCRIPTION

The 440A is a filamentary triode designed for use as a voice frequency and carrier frequency amplifier where low power output is required, also as an oscillator, a modulator, or a demodulator. The 440A is identical to the 101F electron tube except that it is fitted with a standard A4-9 medium 4-pin push type base.

CHARACTERISTICS

Filament Current (Note 1, Page 2)		0.50	ampere
Plate Current . . .	E_b = 130 volts	6.8	milliamperes
Power Output . . .	E_c = -8 volts, R_l = 12000 ohms	53	milliwatts

ELECTRON TUBE DATA SHEET
FILE: GENERAL PURPOSE SECTION

© American Telephone and Telegraph Company 1962

GENERAL CHARACTERISTICS

Electrical Data

Filament Voltage (D-C)	4.15	volts
Filament Current (D-C) (Note 1)	0.50	ampere
Direct Interelectrode Capacitance		
Grid To Plate	5.9	$\mu\mu$f
Grid To Filament	4.2	$\mu\mu$f
Plate To Filament	2.7	$\mu\mu$f

Mechanical Data

Cathode	Coated Filament
Bulb	ST 14
Base	A4-9 medium 4-pin
Mounting Position	Preferably vertical, if horizontal the position of the plane of the filament should be vertical

MAXIMUM RATINGS, Absolute System (Note 2)

Filament Voltage	4.30	volts
Plate Voltage	200	volts
Plate Power	2.0	watts

Dimensions and pin connections shown in outline drawing on page 6.

TYPICAL OPERATING CONDITIONS AND CHARACTERISTICS

Filament Current	0.50	0.50	0.50	0.50	ampere
Plate Voltage	130	160	190	190	volts
Grid Voltage	-8	-10	-14	-14	volts
Plate Current	6.8	10.0	10.9	10.9	milliamperes
Transconductance	1120	1300	1330	1330	micromhos
Plate Resistance	5800	5000	4900	4900	ohms
Amplification Factor	6.5	6.5	6.5	6.5	
Load Resistance	12000	5000	4900	12000	ohms
Power Output	53	100	205	180	milliwatts
Total Harmonic Distortion	1.4	3.2	4.5	1.4	per cent

Note 1: The filament of this tube is designed to operate on a current basis and should be operated at as near the rated current as practicable.

Note 2: In the "Absolute System" the maximum ratings specified are limiting values above which the serviceability of the device may be impaired from the viewpoint of life and satisfactory performance. Maximum ratings, as such, do not constitute a set of operating conditions and all values may not, therefore, be attained simultaneously.

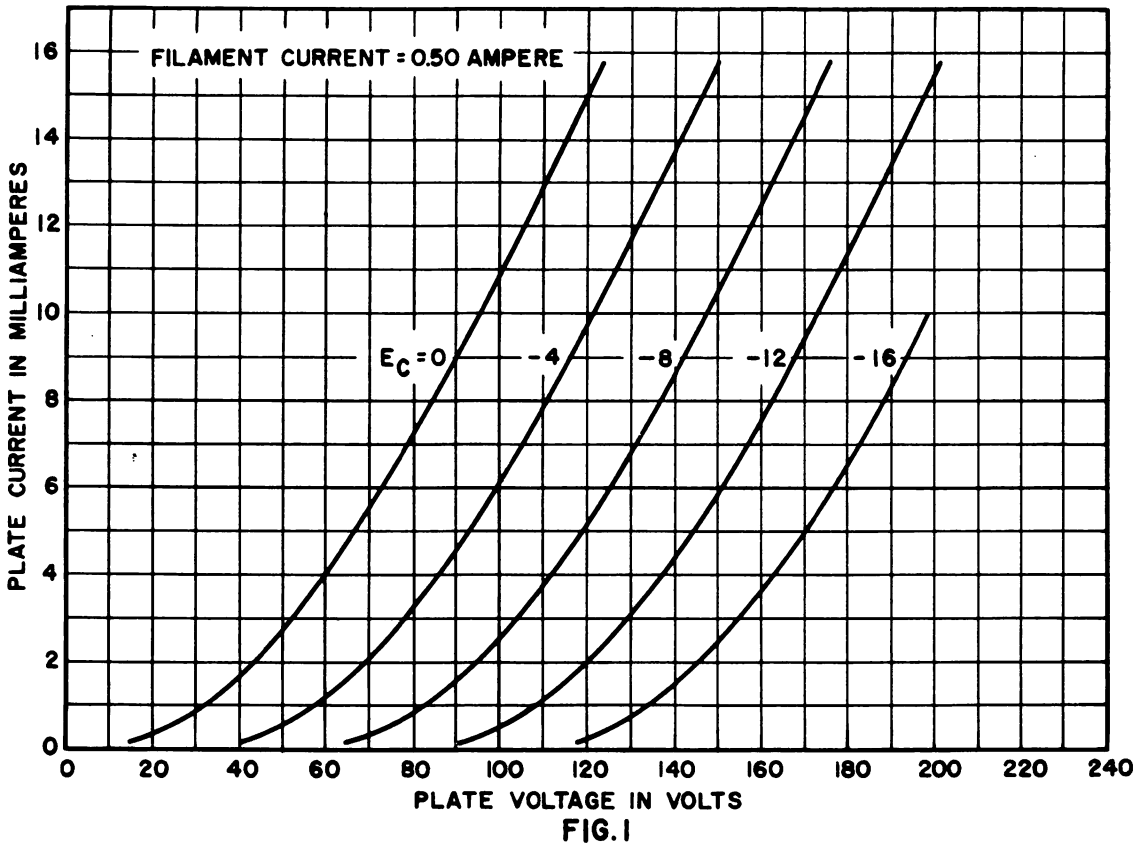

FILAMENT CURRENT = 0.50 AMPERE
E_C = 0
-4
-8
-12
-16
PLATE CURRENT IN MILLIAMPERES
0
2
4
6
8
10
12
14
16
0
20
40
60
80
100
120
140
160
180
200
220
240
PLATE VOLTAGE IN VOLTS

FIG. 1

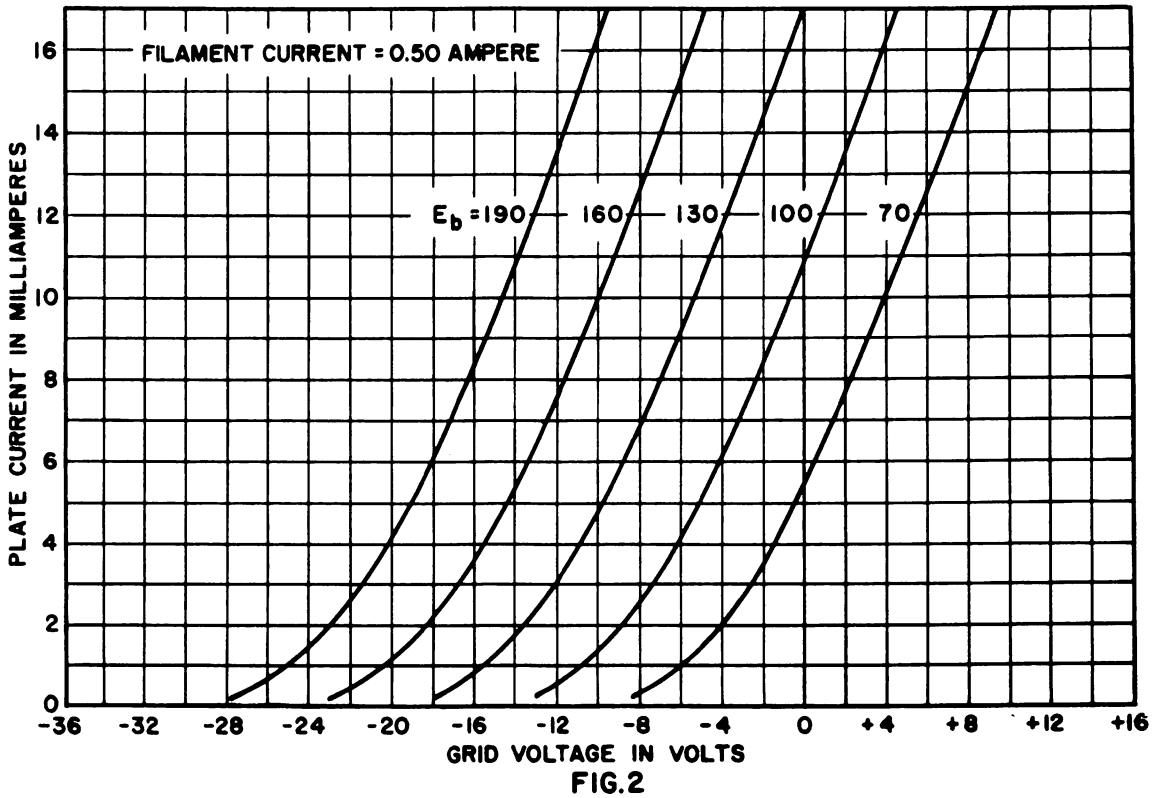

FILAMENT CURRENT = 0.50 AMPERE
E_b = 190
160
130
100
70
PLATE CURRENT IN MILLIAMPERES
0
2
4
6
8
10
12
14
16
-36
-32
-28
-24
-20
-16
-12
-8
-4
0
+4
+8
+12
+16
GRID VOLTAGE IN VOLTS

FIG. 2

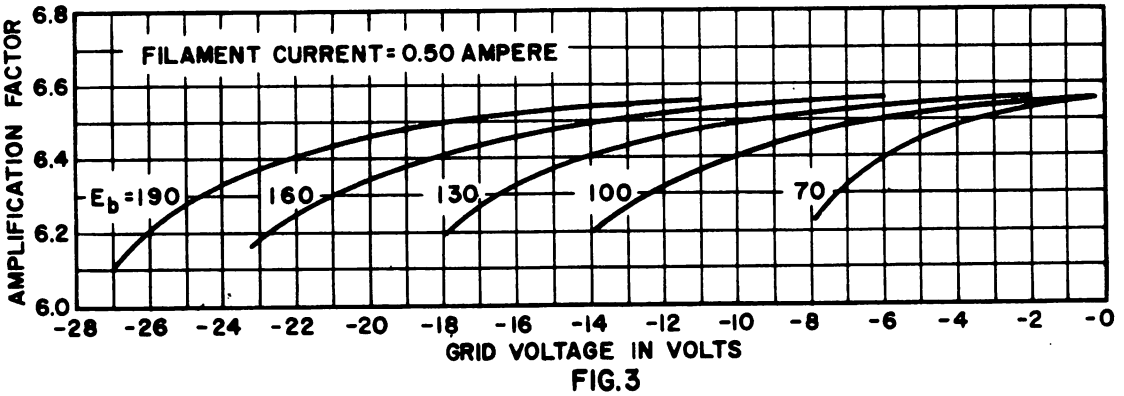

AMPLIFICATION FACTOR
6.8
6.6
6.4
6.2
6.0
FILAMENT CURRENT = 0.50 AMPERE
E_b = 190
160
130
100
70
-28 -26 -24 -22 -20 -18 -16 -14 -12 -10 -8 -6 -4 -2 -0
GRID VOLTAGE IN VOLTS

FIG.3

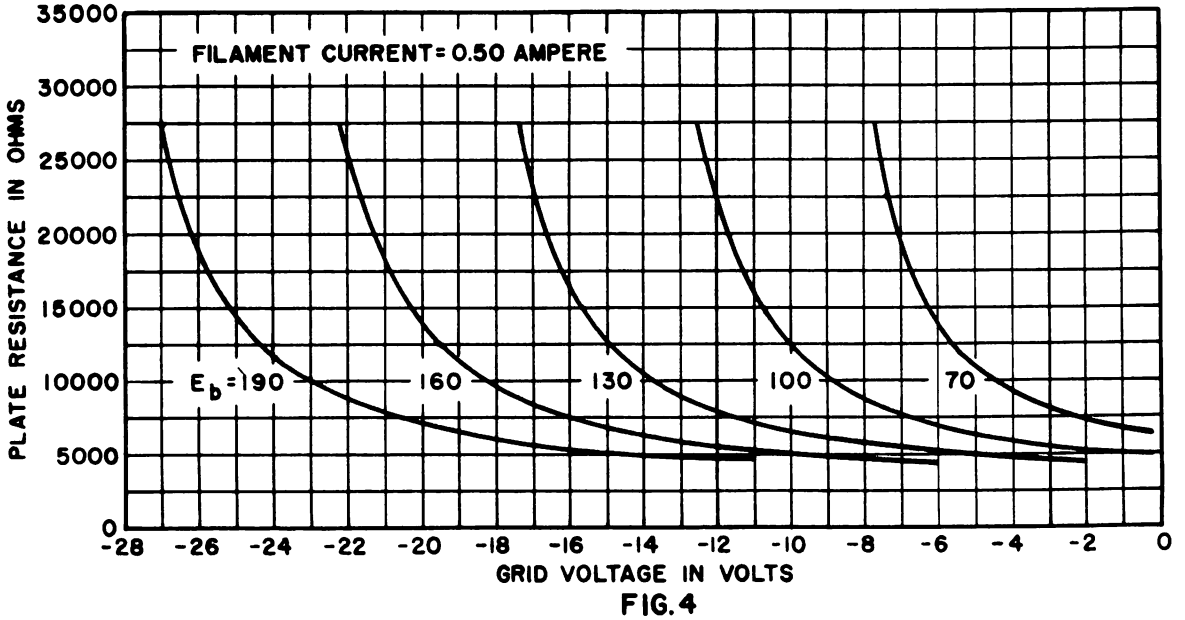

PLATE RESISTANCE IN OHMS
35000
30000
25000
20000
15000
10000
5000
0
FILAMENT CURRENT = 0.50 AMPERE
E_b = 190
160
130
100
70
-28 -26 -24 -22 -20 -18 -16 -14 -12 -10 -8 -6 -4 -2 0
GRID VOLTAGE IN VOLTS

FIG.4

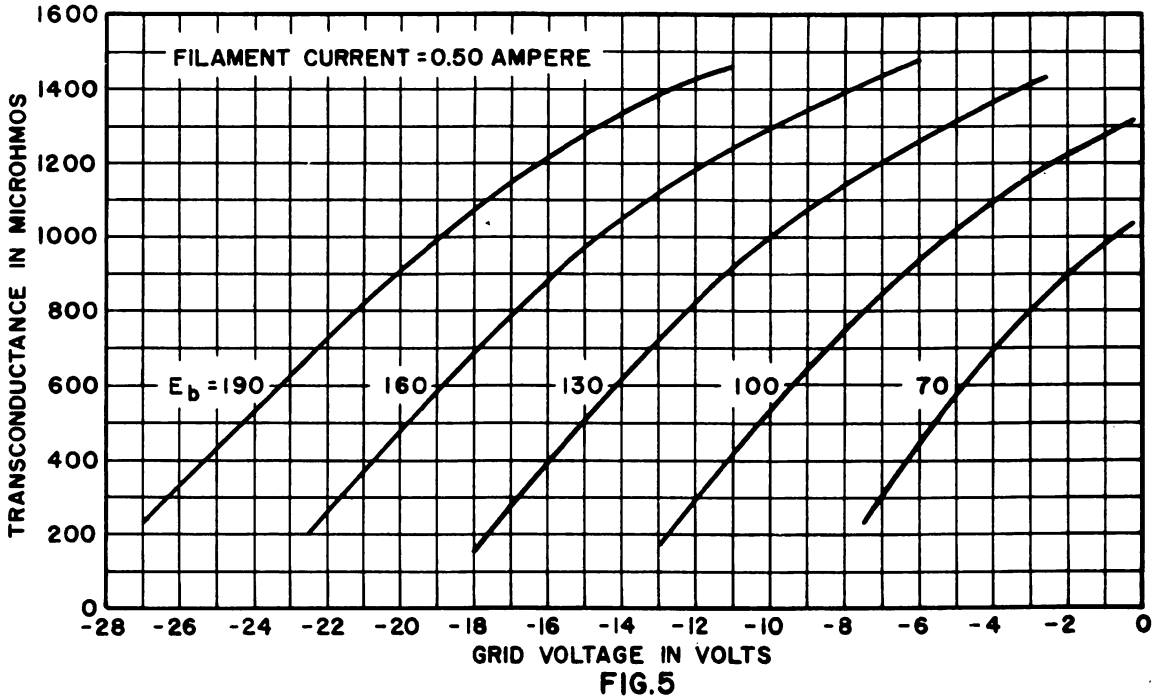
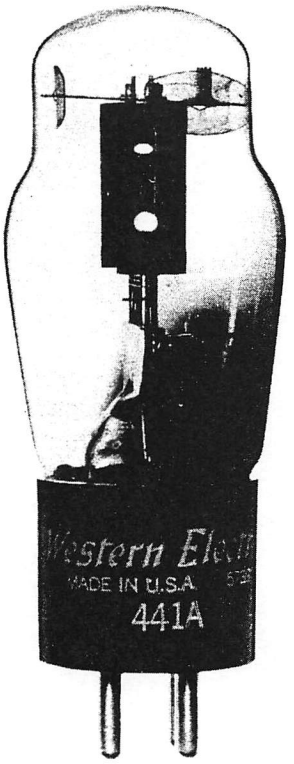

FILAMENT CURRENT = 0.50 AMPERE
E_b = 190
160
130
100
70
TRANSCONDUCTANCE IN MICROHMOS
1600
1400
1200
1000
800
600
400
200
0
-28 -26 -24 -22 -20 -18 -16 -14 -12 -10 -8 -6 -4 -2 0
GRID VOLTAGE IN VOLTS

FIG.5

ELECTRON TUBE DATA SHEET

WESTERN ELECTRIC 441A ELECTRON TUBE



TRIODE
VOLTAGE AMPLIFIER

DESCRIPTION

The 441A is a filamentary triode designed for use as a voice frequency and carrier frequency voltage amplifier, detector, or modulator. The 441A is identical to the 102F electron tube except that it is fitted with a standard A4-9 medium 4-pin push type base.

CHARACTERISTICS

Filament Current (Note 1, Page 2)		0.50	ampere
Plate Current	E_b = 130 volts, E_c = -2.0 volts, R_1 = 0.1 megohm	0.60	milliampere
Peak Output Voltage	E_b = 130 volts, E_c = -2.0 volts, R_1 = 0.1 megohm	37	volts

ELECTRON TUBE DATA SHEET
FILE: GENERAL PURPOSE SECTION

© American Telephone and Telegraph Company 1962

GENERAL CHARACTERISTICS

Electrical Data

Filament Voltage (D-C)	2.1	volts
Filament Current (D-C) (Note 1)	0.5	amperes
Direct Interelectrode Capacitances		
Grid To Plate	5.1	μμf
Grid To Filament	4.0	μμf
Plate To Filament	2.3	μμf

Mechanical Data

Cathode	Coated Filament
Bulb	ST 14
Base	A4-9 medium 4-pin
Mounting Position	Preferably vertical, if horizontal the position of the plane of the filament should be vertical

Dimensions and pin connections shown in outline drawing on page 6.

MAXIMUM RATINGS, Absolute System (Note 2)

Filament Voltage	2.2	volts
Plate Voltage	200	volts
Plate Power	0.5	watts

TYPICAL OPERATING CONDITIONS AND CHARACTERISTICS

Filament Current	0.5	0.5	0.5	0.5	ampere
Plate Voltage	130	160	190	190	volts
Grid Voltage	-2.0	-3.0	-2.0	-2.0	volts
Plate Current	0.60	0.55	1.85	1.85	milliamperes
Transconductance	530	520	800	800	micromhos
Plate Resistance	58000	60000	39000	39000	ohms
Amplification Factor	30.9	30.9	31.0	31.0	
Load Resistance	0.1	0.1	0.1	0.3	megohms
Peak Output Voltage	37	53	41	50	volts

Note 1: The filament of this tube is designed to operate on a current basis and should be operated at as near the rated current as practicable.

Note 2: In the "Absolute System" the maximum ratings specified are limiting values above which the serviceability of the device may be impaired from the viewpoint of life and satisfactory performance. Maximum ratings, as such, do not constitute a set of operating conditions and all values may not, therefore, be attained simultaneously.

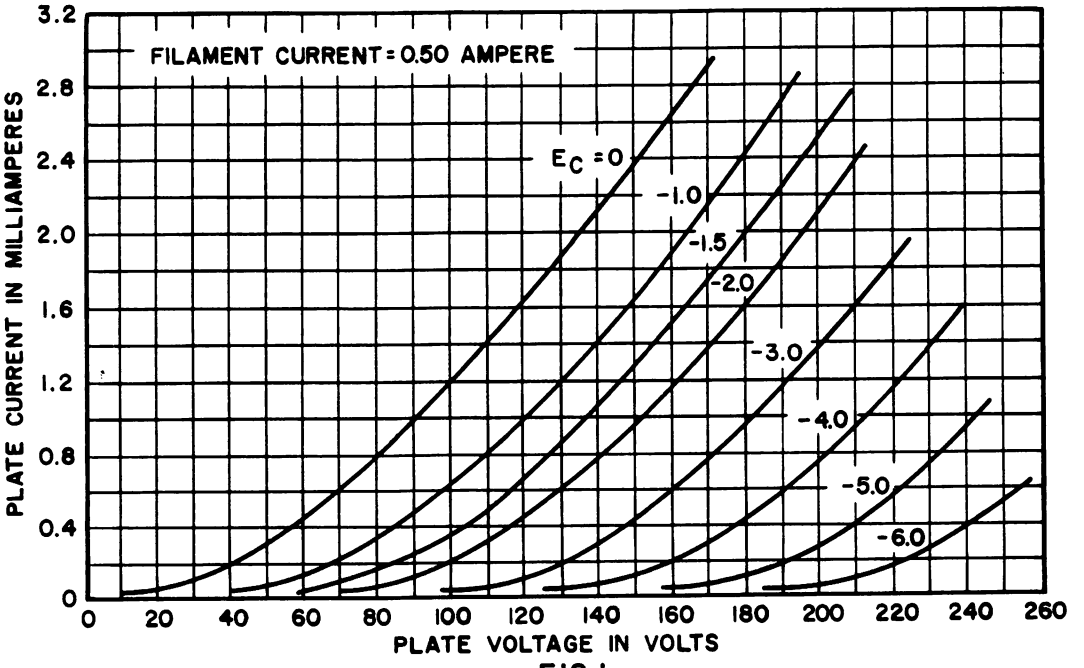

FILAMENT CURRENT = 0.50 AMPERE
E_C = 0
-1.0
-1.5
-2.0
-3.0
-4.0
-5.0
-6.0
PLATE CURRENT IN MILLIAMPERES
0
0.4
0.8
1.2
1.6
2.0
2.4
2.8
3.2
0 20 40 60 80 100 120 140 160 180 200 220 240 260
PLATE VOLTAGE IN VOLTS

FIG. 1

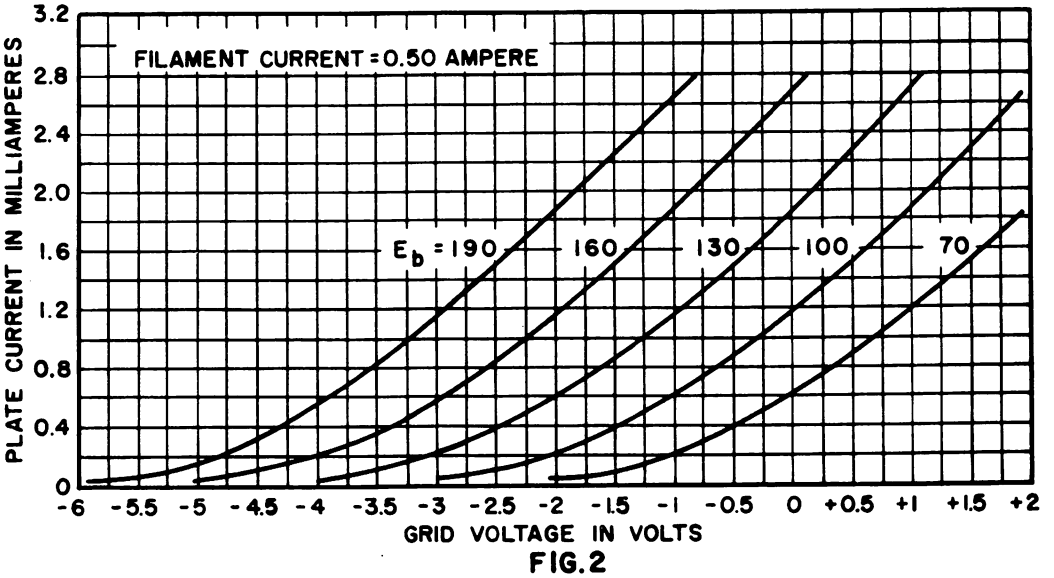

FILAMENT CURRENT = 0.50 AMPERE
E_b = 190
160
130
100
70
PLATE CURRENT IN MILLIAMPERES
0
0.4
0.8
1.2
1.6
2.0
2.4
2.8
3.2
-6 -5.5 -5 -4.5 -4 -3.5 -3 -2.5 -2 -1.5 -1 -0.5 0 +0.5 +1 +1.5 +2
GRID VOLTAGE IN VOLTS

FIG. 2

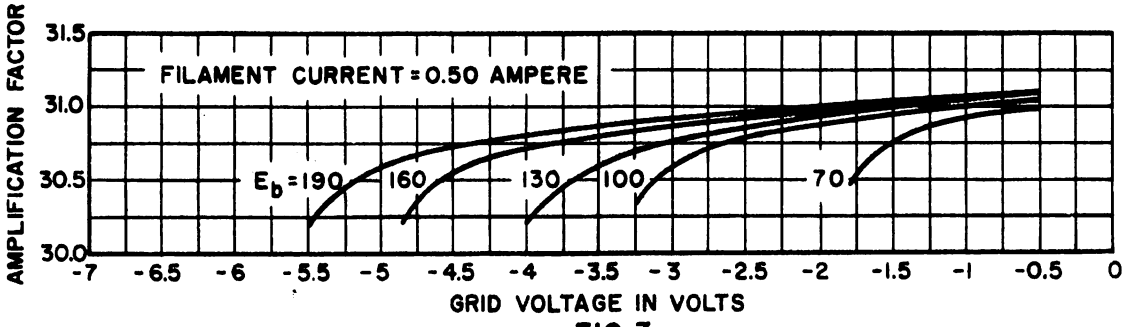

AMPLIFICATION FACTOR
31.5
31.0
30.5
30.0
FILAMENT CURRENT = 0.50 AMPERE
E_b = 190
160
130
100
70
-7 -6.5 -6 -5.5 -5 -4.5 -4 -3.5 -3 -2.5 -2 -1.5 -1 -0.5 0
GRID VOLTAGE IN VOLTS

FIG. 3

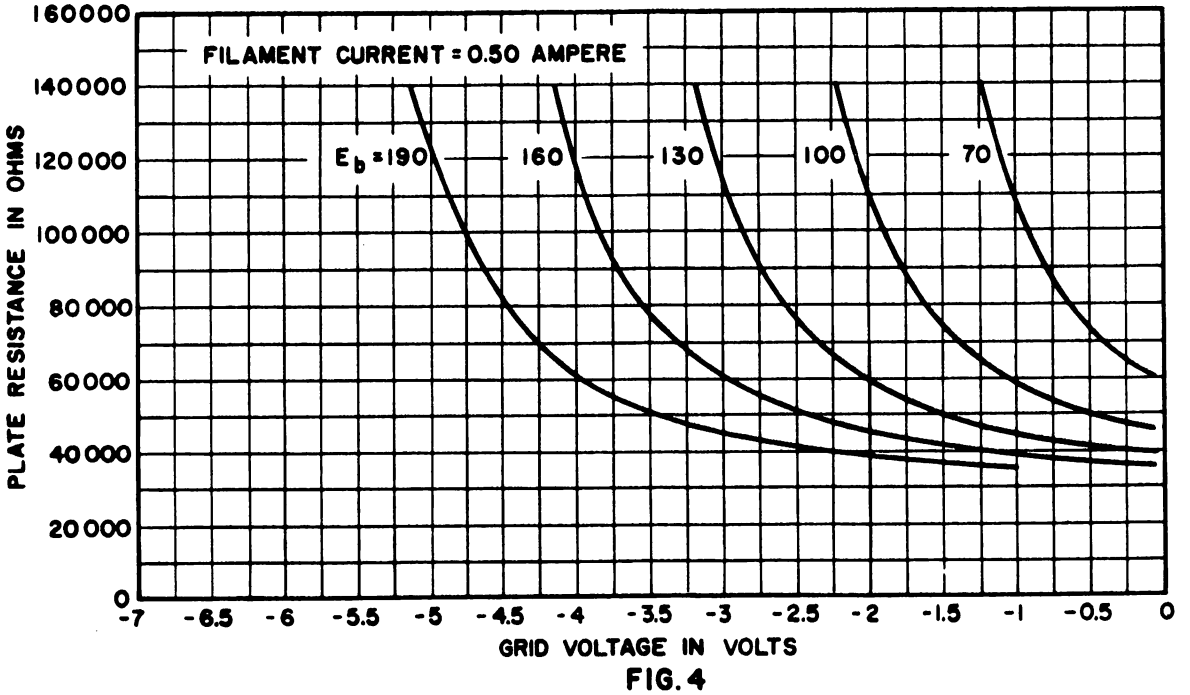

PLATE RESISTANCE IN OHMS
160000
140000
120000
100000
80000
60000
40000
20000
0
FILAMENT CURRENT = 0.50 AMPERE
E_b = 190
160
130
100
70
-7 -6.5 -6 -5.5 -5 -4.5 -4 -3.5 -3 -2.5 -2 -1.5 -1 -0.5 0
GRID VOLTAGE IN VOLTS

FIG. 4

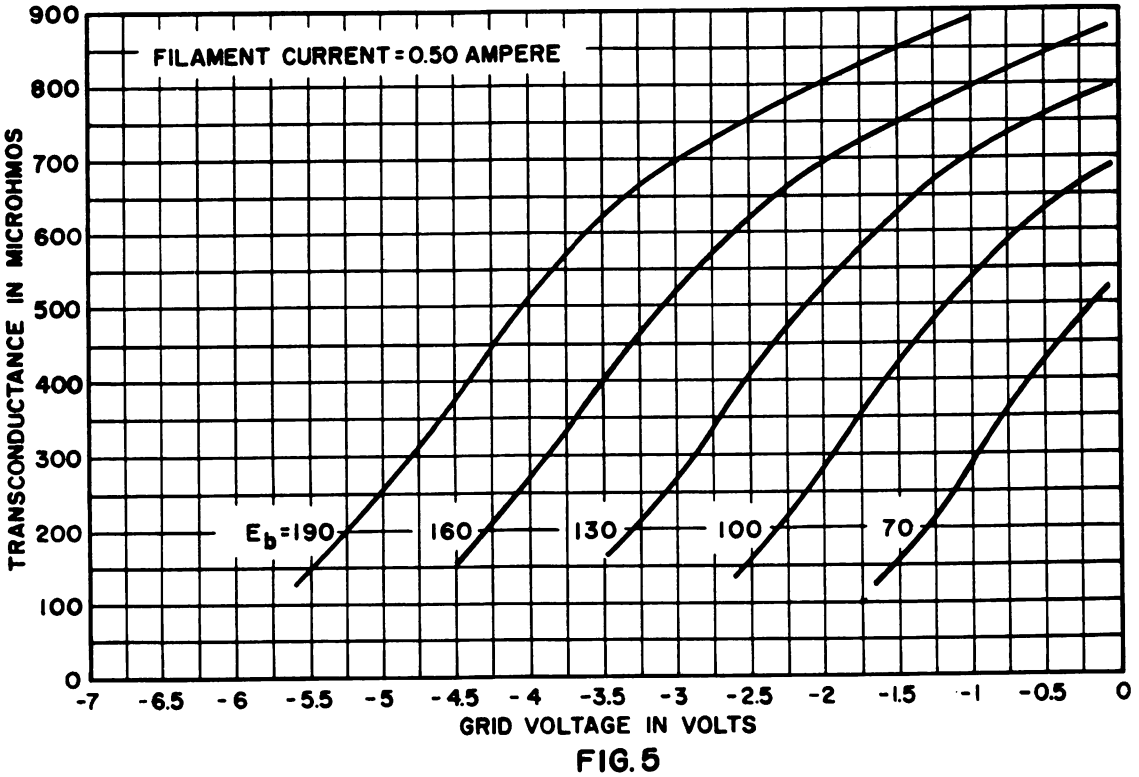
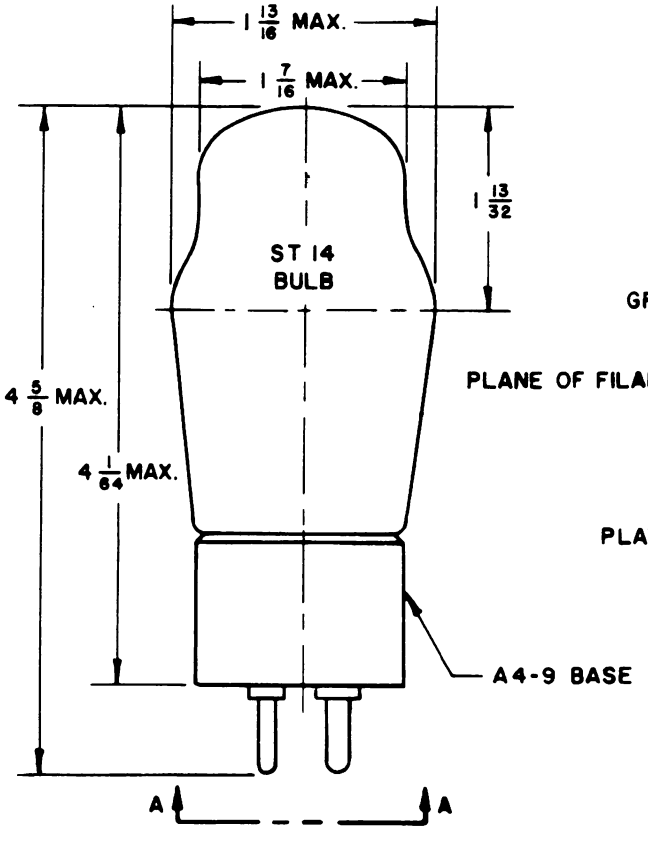
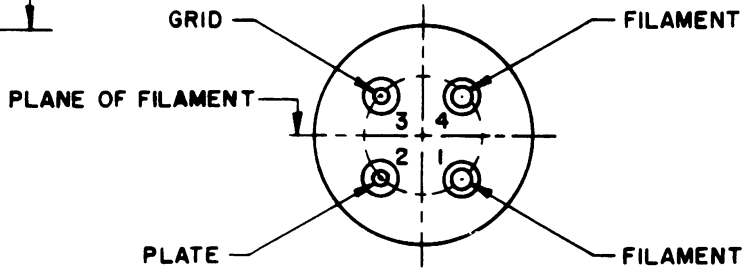

FILAMENT CURRENT = 0.50 AMPERE
E_b = 190
160
130
100
70
TRANSCONDUCTANCE IN MICROHMOS
900
800
700
600
500
400
300
200
100
0
-7
-6.5
-6
-5.5
-5
-4.5
-4
-3.5
-3
-2.5
-2
-1.5
-1
-0.5
0
GRID VOLTAGE IN VOLTS

FIG. 5





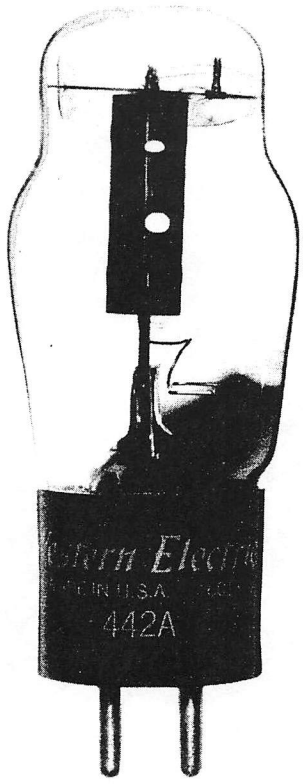
VIEW A-A

A development of Bell Telephone Laboratories, the research laboratories of the American Telephone and Telegraph Company and the Western Electric Company.

PRINTED IN U.S.A.

ELECTRON TUBE DATA SHEET

WESTERN ELECTRIC 442A ELECTRON TUBE



TRIODE
POWER AMPLIFIER

DESCRIPTION

The 442A is a filamentary triode designed for use as an audio-frequency power amplifier or modulator. The 442A is identical to the 205F electron tube except that it is fitted with a standard A4-9 medium 4-pin push type base.

CHARACTERISTICS

Filament Voltage		4.5	volts
Plate Current	E_b = 350 volts	35	milliamperes
Power Output	E_c = -22.5 volts	880	milliwatts

File: General Purpose Section

© American Telephone and Telegraph Company 1962

GENERAL CHARACTERISTICS

Electrical Data

Filament Voltage (A-C) or (D-C)	4.5	volts
Filament Current	1.6	amperes
Direct Interelectrode Capacitances		
Grid To Plate	5.9	μμf
Input	4.1	μμf
Output	2.2	μμf

Mechanical Data

Cathode	Coated Filament
Bulb	ST 14
Base	A4-9 medium 4-pin
Mounting Position	Preferably vertical; if horizontal, pins #1 and #2 must lie in same vertical plane

Dimensions and pin connections shown in outline drawing on page 6.

MAXIMUM RATINGS, Absolute System

Plate Voltage	400	volts
Plate Current	55	milliamperes
Plate Dissipation	14	watts

TYPICAL OPERATING CONDITIONS AND CHARACTERISTICS

Filament Voltage (A-C)	4.5	4.5	4.5	4.5	volts
Plate Voltage	250	300	350	350	volts
Grid Voltage *	-22	-18	-22.5	-22.5	volts
Peak A-F Signal Voltage	22	18	22.5	22.5	volts
Zero Signal Plate Current	11.5	30	35	35	milliamperes
Maximum Signal Plate Current	12	30.5	36	36	milliamperes
Transconductance	1350	1880	1950	1950	micromhos
Plate Resistance	5300	3800	3700	3700	ohms
Load Resistance	12000	8000	4000	8000	ohms
Amplification Factor	7.2	7.2	7.2	7.2	
Maximum Signal Power Output	550	450	880	760	milliwatts
Total Harmonic Distortion	4.6	1.6	2.8	1.4	per cent

* If filament is operated on D-C the characteristics will be approximately the same if the grid voltage, measured from the negative filament, is decreased by 2.3 volts.

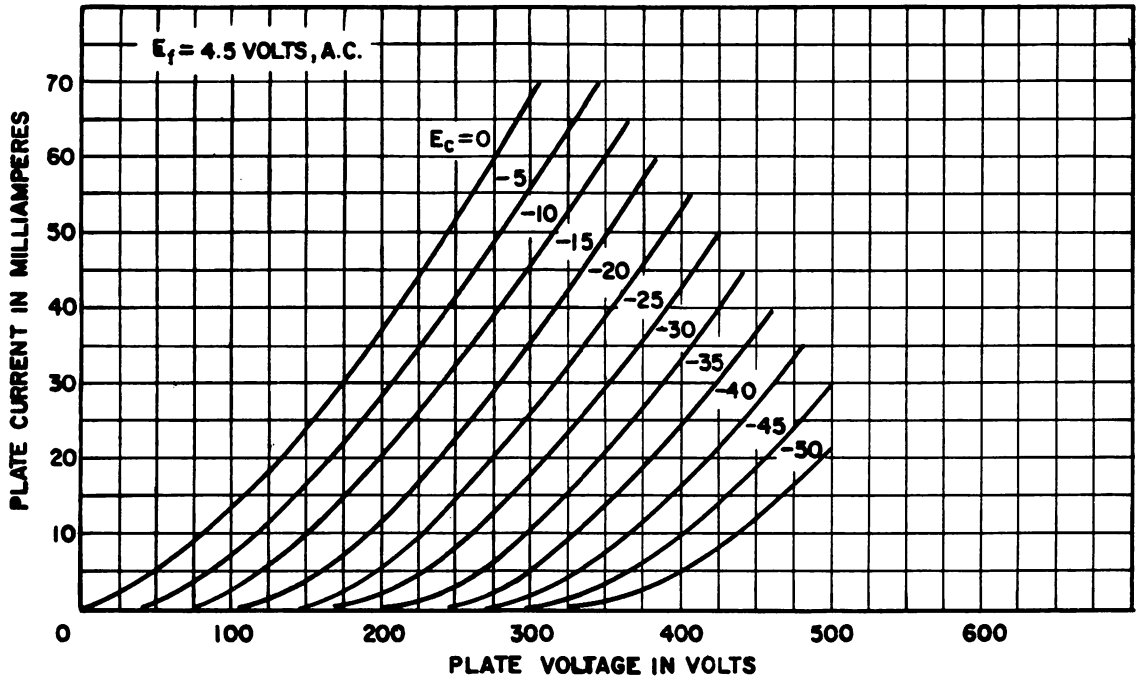

E_f = 4.5 VOLTS, A.C.
E_c=0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
PLATE CURRENT IN MILLIAMPERES
70
60
50
40
30
20
10
0
100
200
300
400
500
600
PLATE VOLTAGE IN VOLTS

FIG. 1

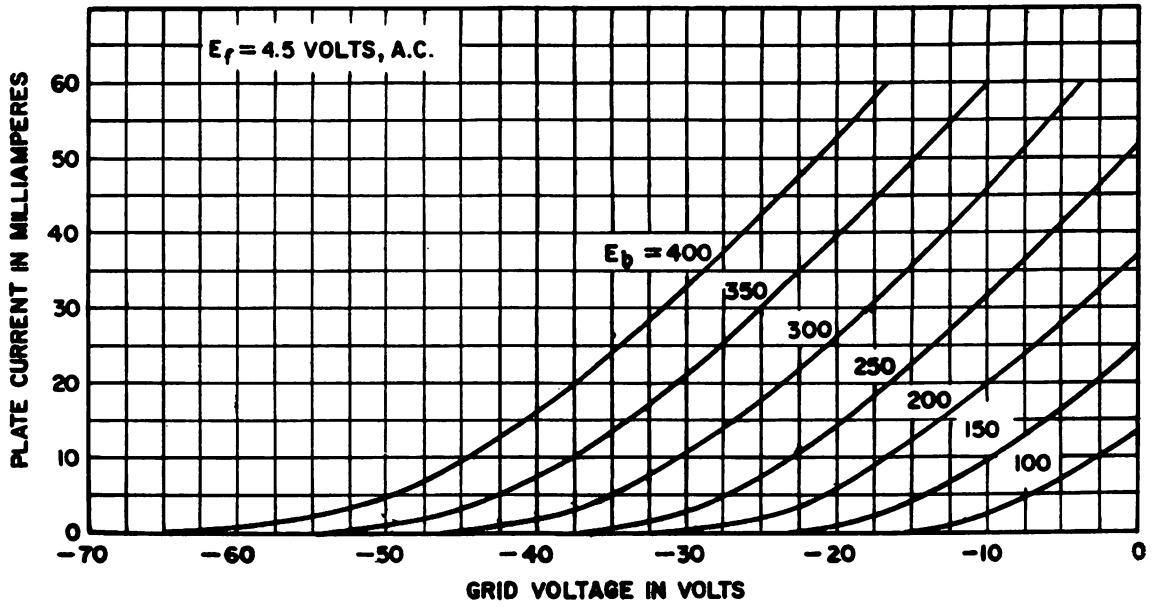

E_f = 4.5 VOLTS, A.C.
E_b = 400
350
300
250
200
150
100
PLATE CURRENT IN MILLIAMPERES
60
50
40
30
20
10
0
-70
-60
-50
-40
-30
-20
-10
0
GRID VOLTAGE IN VOLTS

FIG.2

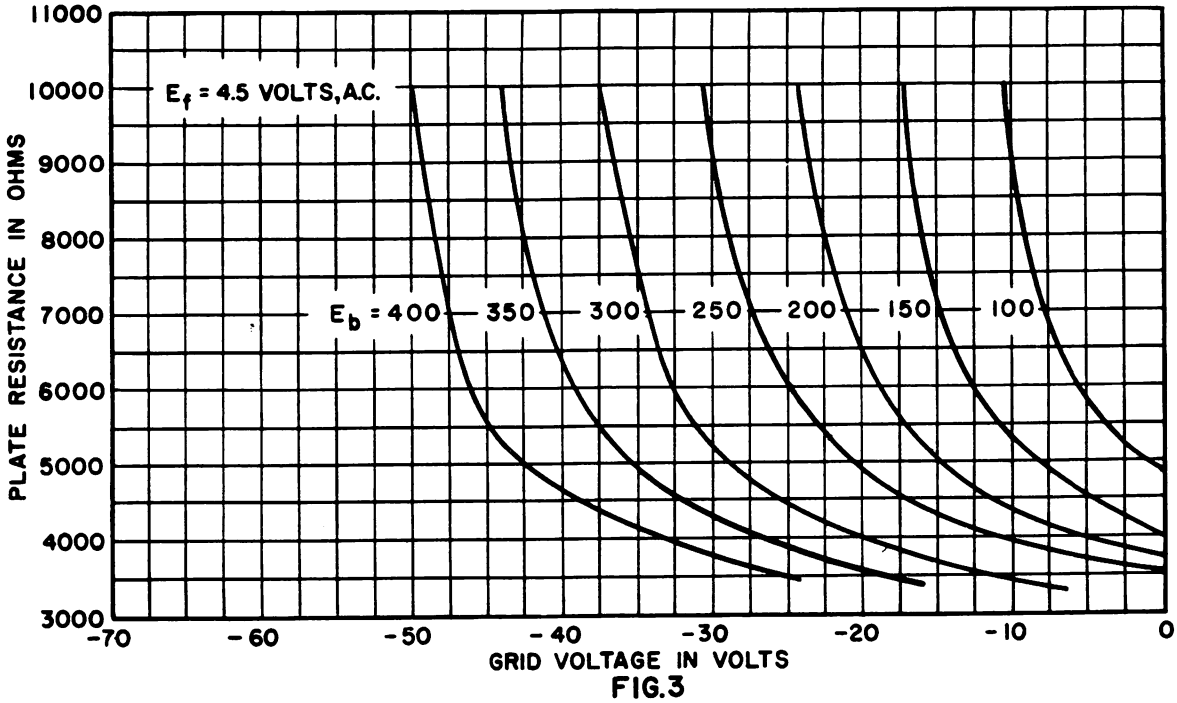

PLATE RESISTANCE IN OHMS
11000
10000
9000
8000
7000
6000
5000
4000
3000
E_f = 4.5 VOLTS, A.C.
E_b = 400
350
300
250
200
150
100
-70
-60
-50
-40
-30
-20
-10
0
GRID VOLTAGE IN VOLTS

FIG.3

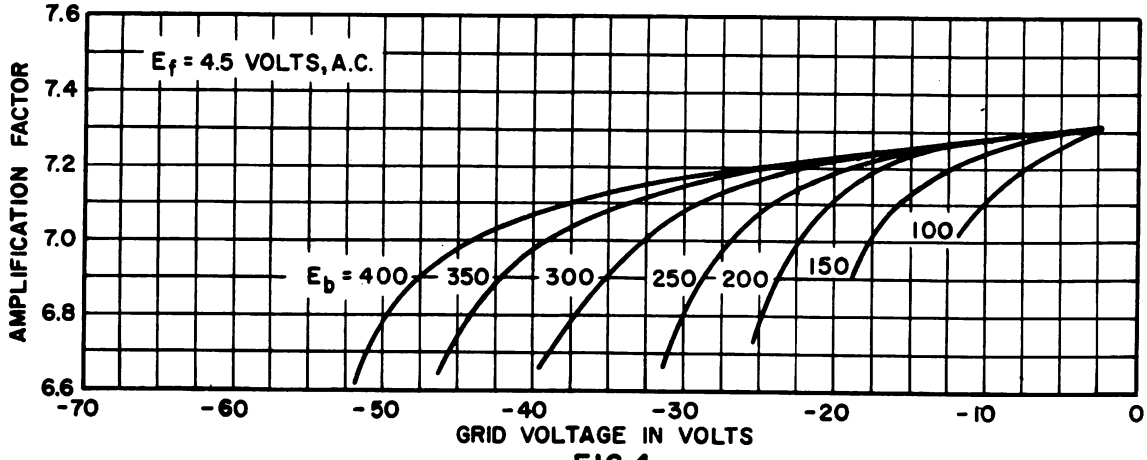

AMPLIFICATION FACTOR
7.6
7.4
7.2
7.0
6.8
6.6
E_f = 4.5 VOLTS, A.C.
E_b = 400
350
300
250
200
150
100
-70
-60
-50
-40
-30
-20
-10
0
GRID VOLTAGE IN VOLTS

FIG.4

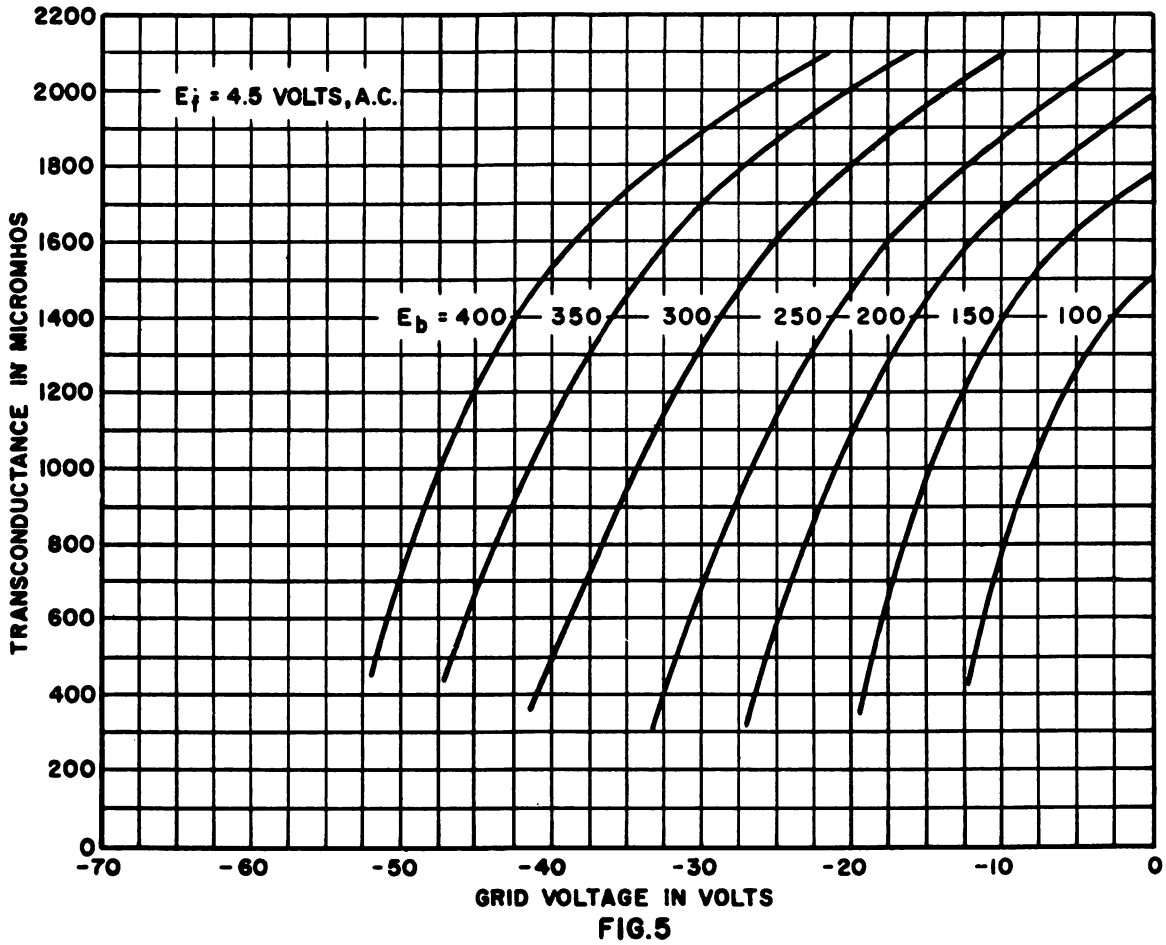
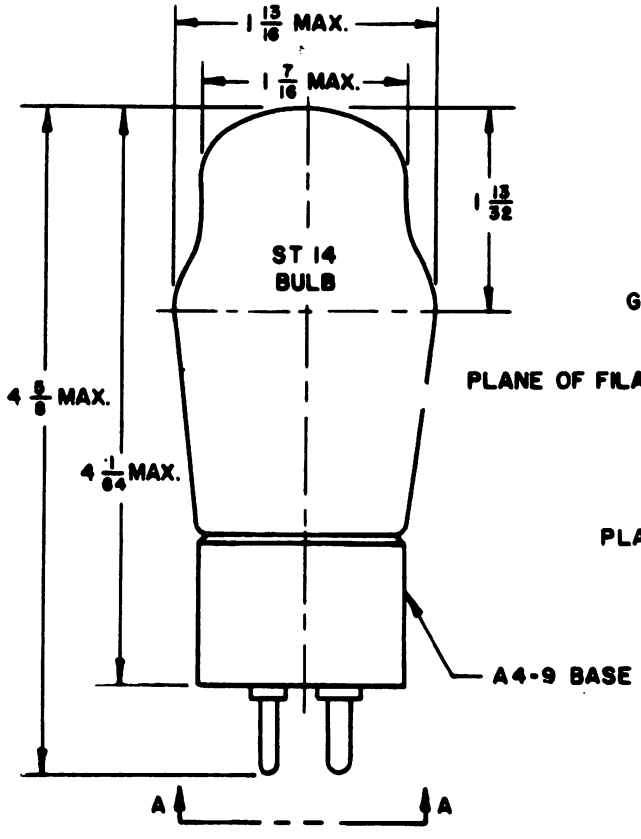
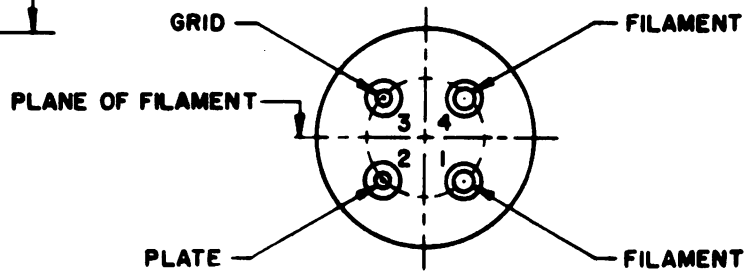

2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
E_f = 4.5 VOLTS, A.C.
E_b = 400
350
300
250
200
150
100
TRANSCONDUCTANCE IN MICROMHOS
-70
-60
-50
-40
-30
-20
-10
0
GRID VOLTAGE IN VOLTS

FIG.5


1 13/16 MAX.
1 7/16 MAX.
1 13/32
ST 14
BULB
4 5/8 MAX.
4 1/64 MAX.
A4-9 BASE
A
A


GRID
FILAMENT
PLANE OF FILAMENT
3
4
2
1
PLATE
FILAMENT

VIEW A-A

ELECTRON TUBE DATA SHEET

WESTERN ELECTRIC 443A ELECTRON TUBE



DESCRIPTION

The 443A is a three-electrode inert-gas filled miniature cold cathode tube for use in relay, voltage regulator or rectifier circuits. This tube is especially suitable for use in control circuits such as in triggering, counting or switching apparatus.

This tube is designed for socket mounting. It is identical, electrically and mechanically, to the 426A except that it is not attached to a plastic angle mounting bracket.

CHARACTERISTICS

Peak Anode Voltage		180	volts
Average Cathode Current	7.5	60	milliamperes
Average Life, Approximate	10000	10	hours

File: Cold Cathode Section

© American Telephone and Telegraph Company 1962

MAXIMUM RATINGS, Absolute System (Note 1)

Forward Peak Anode Voltage	180	volts
Forward Cathode Current (Note 2)		
Peak	60	milliamperes
Average	30	milliamperes
Averaging Time	2	seconds
Peak Inverse Current (Note 2)		
Anode	5	milliamperes
Starter	1	milliampere
Ambient Temperature Limits	-55 to +85	centigrade

ELECTRICAL DATA, Throughout Life

	Min.	Bogey	Max.	
Starter Breakdown Voltage	65	72	85	volts
Starter Voltage Drop at 3 Milliamperes (Note 3)	53	63	72	volts
Anode Voltage Drop at 10 Milliamperes (Notes 4 & 5)	63	69	75	volts
Transfer Current	See Curve - Fig. 1			
Ionization Time, Starter Gap (Note 6)	-	10	-	milliseconds
Deionization Time, Main Gap	-	6	-	milliseconds
Inverse Current at -120 Volts Anode Potential (Note 7)	-	-	3	milliamperes

MECHANICAL DATA

Mounting	Any Position
Net Weight	0.3 Ounce

Dimensions and Pin Connections shown in outline drawing on Page 4.

HANDLING

This tube contains a small amount of krypton-85 gas which is a by-product radioactive material. The amount of krypton-85 is less than five microcuries, which is too small an amount to require any special care in use.

Atomic Energy Commission regulations require that the individual tube carton for tubes containing by-product radioactive material be appropriately marked. The marking includes the statement that tube disposal should be in approved manner.

Approved instructions for disposal of tubes containing krypton-85 are as follows;

> **Tubes to be disposed of should be broken or crushed in a well ventilated place releasing any resulting vapors to the outside atmosphere. The residual broken or crushed tubes should be disposed of in a normal public trash disposal system. Tubes should be disposed of at a rate of not more than 100 each week from any one location. Avoid breathing vapors from broken tubes.**

Note 1: In the "Absolute System" the maximum ratings specified are limiting values above which the serviceability of the device may be impaired from the viewpoint of life and satisfactory performance. Maximum ratings, as such, do not constitute a set of operating conditions and all values may not, therefore, be attained simultaneously.

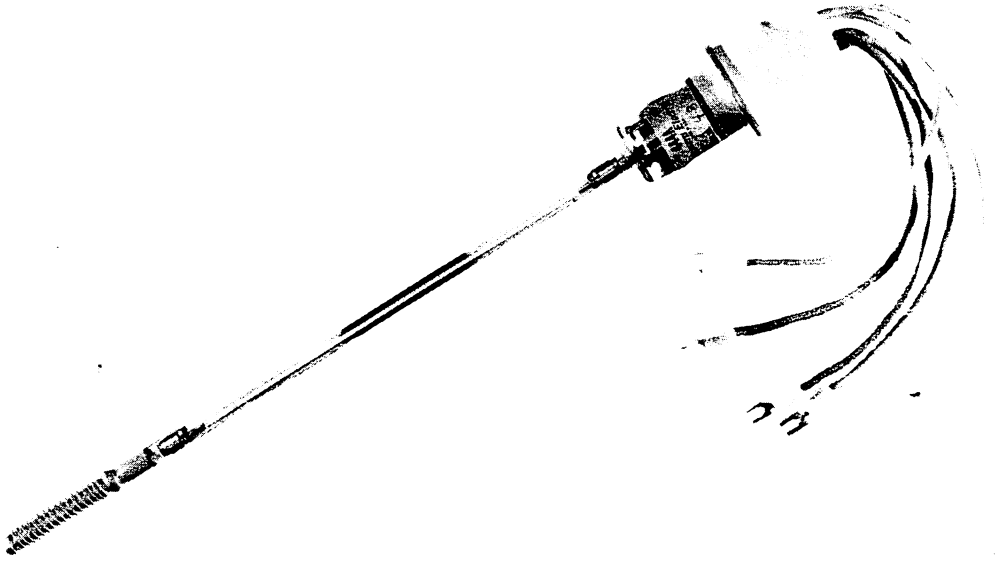
Note 2: Sufficient resistance must be used in series with the tube to assure that the electrode currents do not exceed the maximum rated values.

Note 3: Starter voltage oscillations of approximately 1 to 10 kilocycles and 12 volts peak-to-peak will be present at starter current values below 0.05 milliampere.

Note 4: Approximately 95% of tubes will be within limits of ± 2.8 volts from the bogey value.

ELECTRON TUBE DATA SHEET

WESTERN ELECTRIC 444A ELECTRON TUBE



DESCRIPTION

The 444A tube is a medium power helix-type traveling wave amplifier for application in the 6000 megacycle frequency region. It is intended primarily for operation as a transmitting amplifier in the repeater stations of long-distance radio relay stations.

CHARACTERISTICS

Heater Voltage	6.3 volts
Heater Current	0.92 amp.
Accelerator Anode Voltage	2700 volts
Helix Voltage	2400 volts
Collector Voltage	1200 volts
Power Output. (Min.)	5 watts

File: Microwave Type Section
Data Sheet Issue 1, 8-60

© American Telephone and Telegraph Company 1960

GENERAL CHARACTERISTICS (Notes 1 & 2)

ELECTRICAL DATA

Heater Voltage		6.3 volts
Heater Current		.092 ampere
Acceleration Anode Voltage (Note 3)		2700 volts
Accelerator Anode Current	(Max.)	0.60 milliampere
Helix Voltage (Note 4)		2400 volts
Helix Current	(Max.)	0.4 milliampere
Collector Voltage		1200 volts
Power Output	(Min.)	5.0 watts
Gain at 5 watts (37 dbm) Output		32.5 db
Noise Figure	(Max.)	30 db
Gain Variation (Note 5)		.20 db
Input Match (Note 6)	(Min.)	21 db
Output Match (Note 6)	(Min.)	11 db
Spurious Noise (Note 7)	(Max.)	10 db

MECHANICAL DATA

Cathode	Unipotential
Mounting Position	Any
External Leads	5" Flexible with lugs

MAXIMUM RATINGS, Absolute System

Heater Voltage	6.6 volts
Accelerator Anode Voltage	3000 volts
Anode Current	2.0 milliamperes
Anode Power	2.5 watts
Helix Voltage	2700 volts
Helix Current	2.0 milliamperes
Helix Power	2.5 watts
Collector Voltage	2000 volts
Cathode Current	50 milliamperes
Collector Power	80 watts
Heater Cathode Voltage	± 45 volts
Bulb Temperature	125°C
Collector Temperature (requires forced-air cooling. See Operating precautions - Paragraph A Page 4).	150°C

TYPICAL OPERATING DATA (Notes 1 & 2)

Heater Voltage	6.3 volts
Accelerator Anode Voltage (Note 3)	2700 volts
Helix Voltage (Note 4)	2400 volts
Collector Voltage	1200 volts
Accelerator Anode Current	0.2 milliamperes
Helix Intercept Current	0.2 milliamperes
Collector Current	40 milliamperes
Power Output	5 watts
Gain	32 db
Gain Variation With Frequency Change (Note 5)	0.15 db
Noise Figure	28.5 db
Input Match (Note 6)	23 db
Output Match (Note 6)	19 db
Spurious Noise (Note 7)	5 db

Note 1: Operated in a straight-field permanent magnetic circuit, using WR 159 wave guide coupling, with the following magnetic characteristics: (a) a straight field of 580 gauss minimum which tapers off to 20 gauss nominal at the cathode location (b) a cross field, in the wave guide region, of 1.2 gauss maximum in each of two orthogonal planes (c) a cross field, between wave guides, of 1.7 gauss maximum in each of two orthogonal planes.

Note 2: Operated with the input frequency being swept over the range of 5925 to 6425 mc.

Note 3: Adjusted for collector current of 40 milliamperes.

Note 4: Adjusted for maximum gain while the output power is maintained at 5 watts.

Note 5: Measured over the 50 mc segment of the 5925 - 6425 mc band having the greatest gain variation.

Note 6: The match is measured on the basis of return loss, i.e. the amount by which a reflected signal is down from an incident signal, expressed in decibels. The values given are at the points of minimum return loss in the frequency band of 5925 to 6425 mc with match adjusted to it's best position for the entire band. The match is measured with the tube in its maximum gain condition per Note 4.

Note 7: Spurious noise includes all wide-band or narrow-band spikes. For this test the tube input is single frequency (not swept). The limit given is the level above the normal tube thermal noise output, when thermal noise and spurious noise are measured simultaneously in a bandwidth of 2500 cycles, the 2500 cycle bandwidth being examined over the frequency range of 0.3 to 10 mc away from the driver frequency.

OPERATING PRECAUTIONS

(a) The tube should not be operated without cooling air on the collector terminal. The required air flow will depend on the physical configuration of the housing surrounding the collector.

(b) The operating voltages are arranged to facilitate the flow of positive ions toward the collector rather than toward the cathode. Therefore, for optimum cathode life the accelerator anode voltage should be maintained at least 25 volts above the helix voltage. However, this voltage condition is violated initially when putting the tube into operation. The sequence of voltage application should be - heater, collector, helix and anode. The reverse order is used when terminating operation of the tube.

(c) For optimum tube life the current to the helix should be maintained at the minimum value obtainable.

TYPICAL OPERATION RANGE FOR 100 MC BANDWIDTH

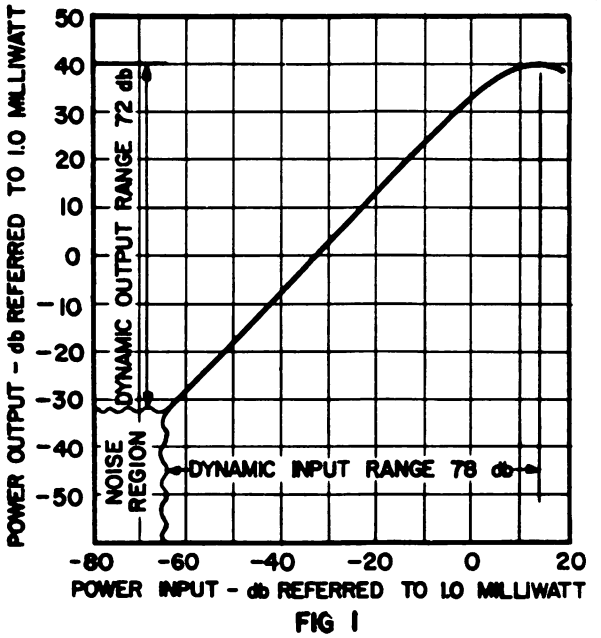


FIG 1

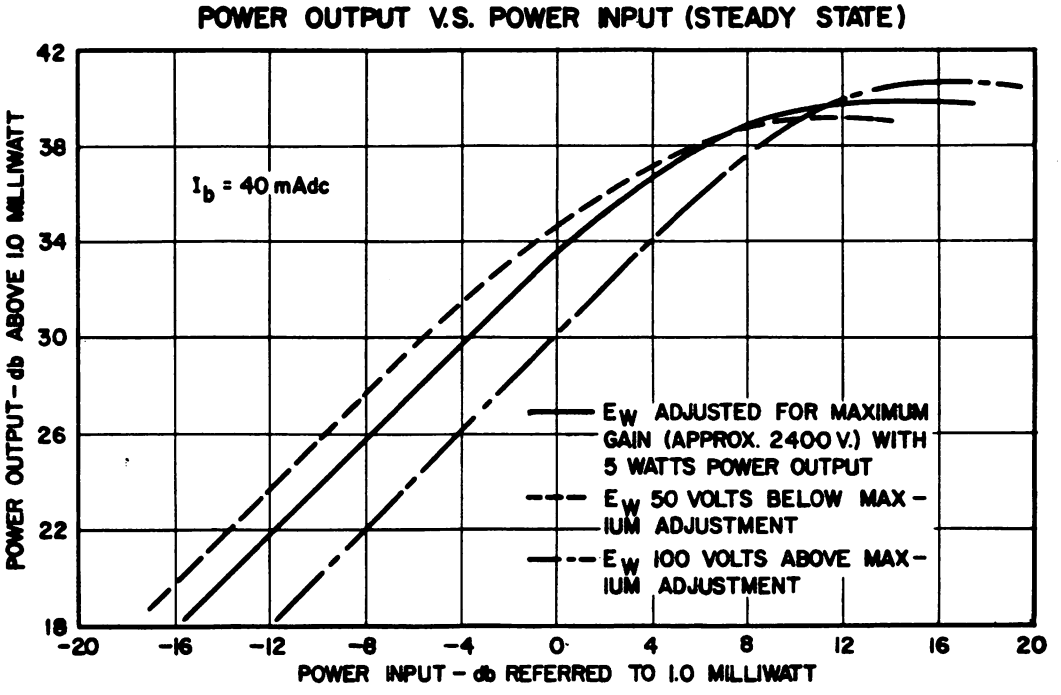

POWER OUTPUT V.S. POWER INPUT (STEADY STATE)
POWER OUTPUT - db ABOVE 1.0 MILLIWATT
42
38
34
30
26
22
18
I_b = 40 mAdc
E_W ADJUSTED FOR MAXIMUM GAIN (APPROX. 2400 V.) WITH 5 WATTS POWER OUTPUT
E_W 50 VOLTS BELOW MAXIMUM ADJUSTMENT
E_W 100 VOLTS ABOVE MAXIMUM ADJUSTMENT
-20 -16 -12 -8 -4 0 4 8 12 16 20
POWER INPUT - db REFERRED TO 1.0 MILLIWATT

FIG. 2

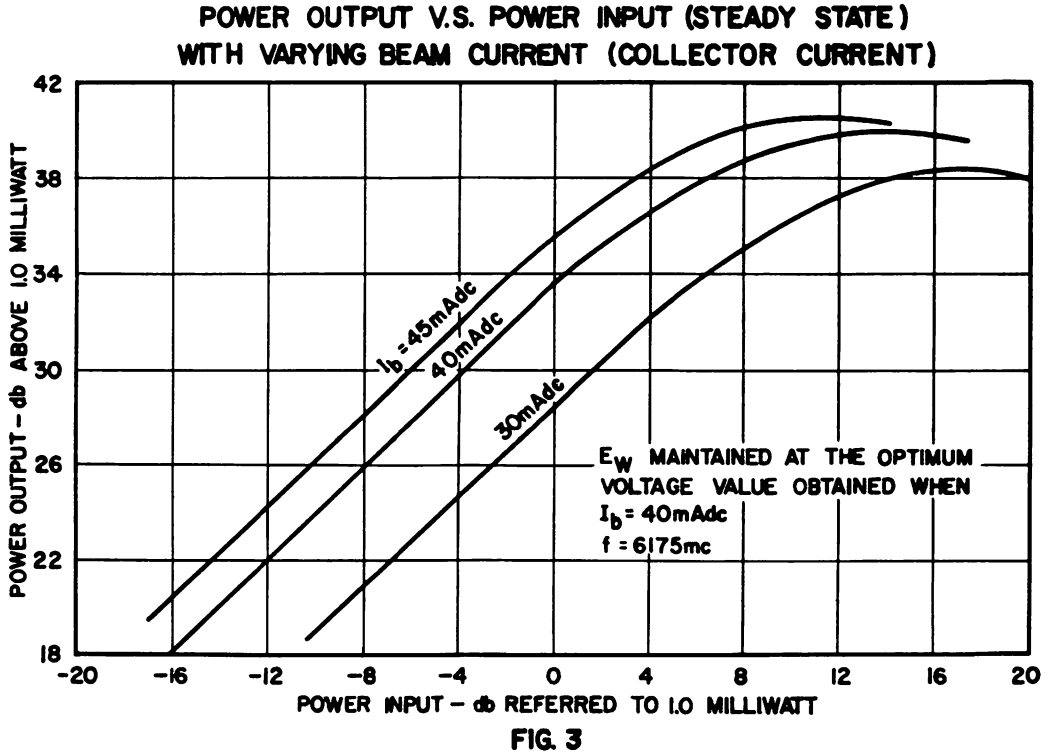
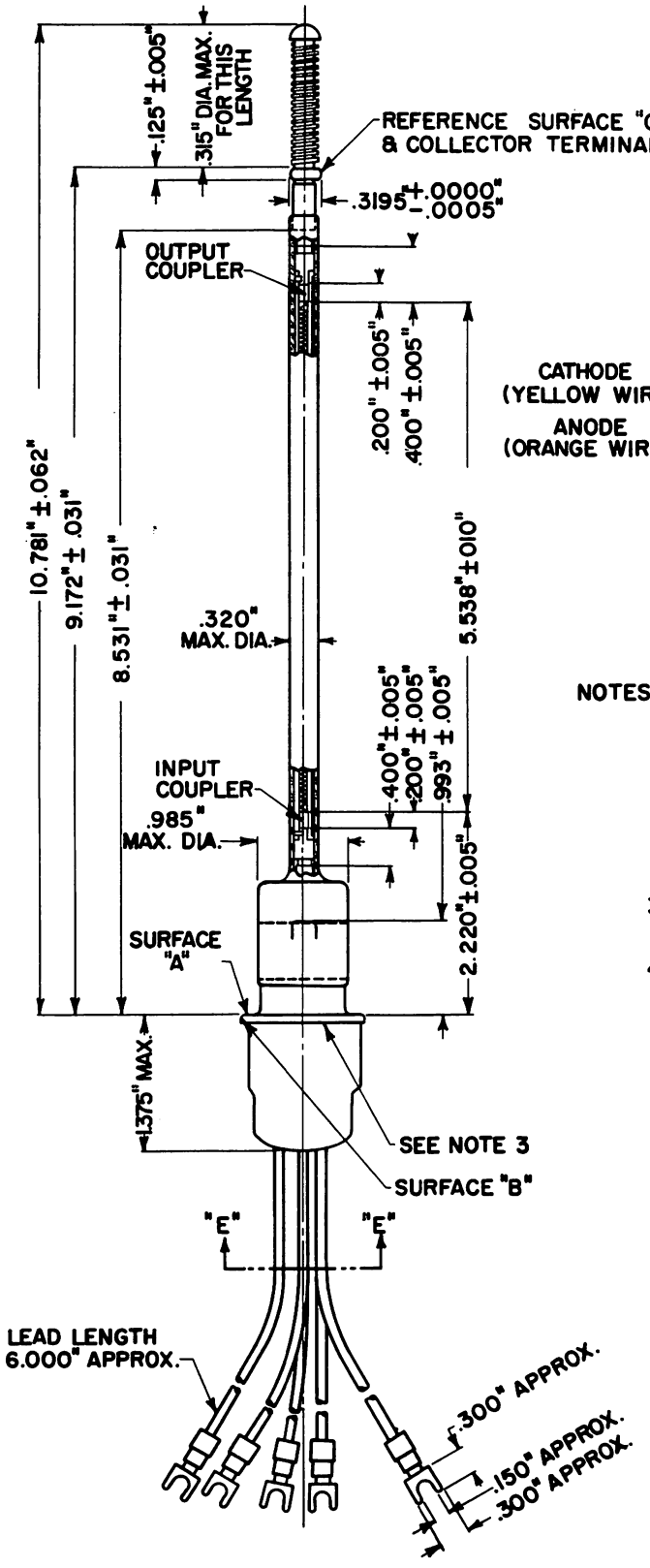
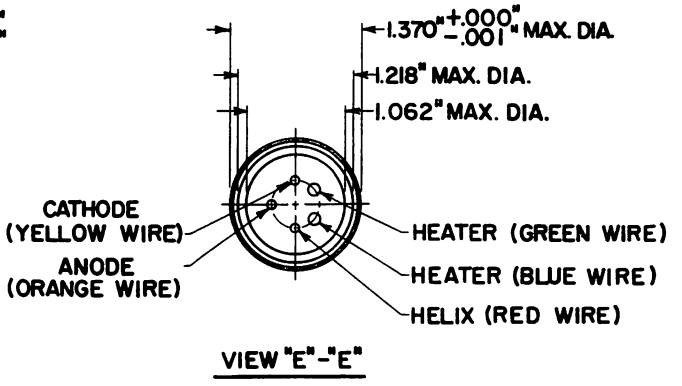

POWER OUTPUT V.S. POWER INPUT (STEADY STATE)
WITH VARYING BEAM CURRENT (COLLECTOR CURRENT)
POWER OUTPUT - db ABOVE 1.0 MILLIWATT
42
38
34
30
26
22
18
I_b = 45mAdc
40mAdc
30mAdc
E_W MAINTAINED AT THE OPTIMUM VOLTAGE VALUE OBTAINED WHEN
I_b = 40mAdc
f = 6175mc
-20 -16 -12 -8 -4 0 4 8 12 16 20
POWER INPUT - db REFERRED TO 1.0 MILLIWATT

FIG. 3





VIEW "E"–"E"

NOTES:

1.– SURFACE "A" IS PERPENDICULAR WITH CENTERLINE ESTABLISHED BY THE 1.370" AND .3195" DIAMETER WITHIN .005" F.I.R. AT .625" RADIUS.

2.– ALL EXTERNAL METAL SURFACES, EXCEPT TERMINALS ARE GOLD PLATED.

3.– RUBBER IS UNDER FLUSH OF BOTTOM OF FLANGE.

4.– MECHANICAL ALIGNMENT OF THE TUBE IS ESTABLISHED BY SURFACES "A", "B", AND "C".

A development of Bell Telephone Laboratories, the research laboratories of the American Telephone and Telegraph Company and the Western Electric Company.

ELECTRON TUBE DATA SHEET

WESTERN ELECTRIC 446A ELECTRON TUBE



DESCRIPTION

The 446A is a three-electrode inert-gas filled cold cathode tube designed for use as a voltage regulator and has characteristics which are exceptionally stable with life. The third electrode is primarily a starting element.

CHARACTERISTICS

Cathode Current	5 to 40	milliamperes
Anode Voltage Drop (E_{td})	81	volts
Regulation at 5 to 40 milliamperes d-c (Note 6)	±1.5	volts

File: Cold Cathode Section

© American Telephone and Telegraph Company 1963

RATINGS, Absolute System (Note 1)

Cathode Current, Forward	
Maximum	40 milliamperes
Minimum	5 milliamperes
Starter Current, Forward	
Maximum	5 milliamperes
Minimum (Note 2)	0.5 milliampere
Maximum Inverse Starter or Anode Current	0.0 milliampere
Ambient Temperature Limits	-55 to +85 centigrade

ELECTRICAL DATA

	Min.	Bogey	Max.	
Anode Breakdown Voltage	-	108	-	volts
Anode Voltage Drop(E_{td})at 40 Milliamperes, (D-C) (Note 3)	80	81.2	82.5	volts
Regulation (5 to 40 Milliamperes, D-C) (Notes 4 & 6)	-	+0.1	±1.0	volts
Starter Breakdown Voltage	90	95	105	volts
Starter Voltage Drop at 5 Milliamperes, (D-C)	81	83	86	volts
Transfer Current at 90 volts Anode Voltage	-	10	50	microamperes

LIFE DATA

Starter Breakdown Voltage (Max.) after 500 hours at 40 mAdc	110 volts
Regulation (5 to 40 mAdc) after 500 hours at 40 mAdc (Note 6)	1.5 volts max.
Drift in Anode Voltage Drop (E_{td}) in 500 hours at 40 mAdc (Note 5)	+0.8 Volts max.

MECHANICAL DATA

Mounting Position	Any
Net Weight, Approximate	0.4 Ounce
Base	Small Button 9 pin
Bulb	T 6½

Dimensions and connections shown in outline drawing on page 4.

HANDLING

This tube contains a small amount of krypton-85 gas which is a by-product radioactive material. The amount of krypton-85 is less than five microcuries, which is too small an amount to require any special care in use.

Atomic Energy Commission regulations require that the individual tube carton for tubes containing by-product radioactive material be appropriately marked. The marking includes the statement that tube disposal should be in approved manner.

Approved instructions for disposal of tubes containing krypton-85 are as follows:

> Tubes to be disposed of should be broken or crushed in a well ventilated place releasing any resulting vapors to the outside atmosphere. The residual broken or crushed tubes should be disposed of in a normal public trash disposal system. Tubes should be disposed of at a rate of not more than 100 each week from any one location. Avoid breathing vapors from broken tubes.

Note 1: In the "Absolute System" the maximum ratings specified are limiting values above which the serviceability of the device may be impaired from the viewpoint of life and satisfactory performance. Maximum ratings, as such, do not constitute a set of operating conditions and all values may not, therefore, be attained simultaneously.

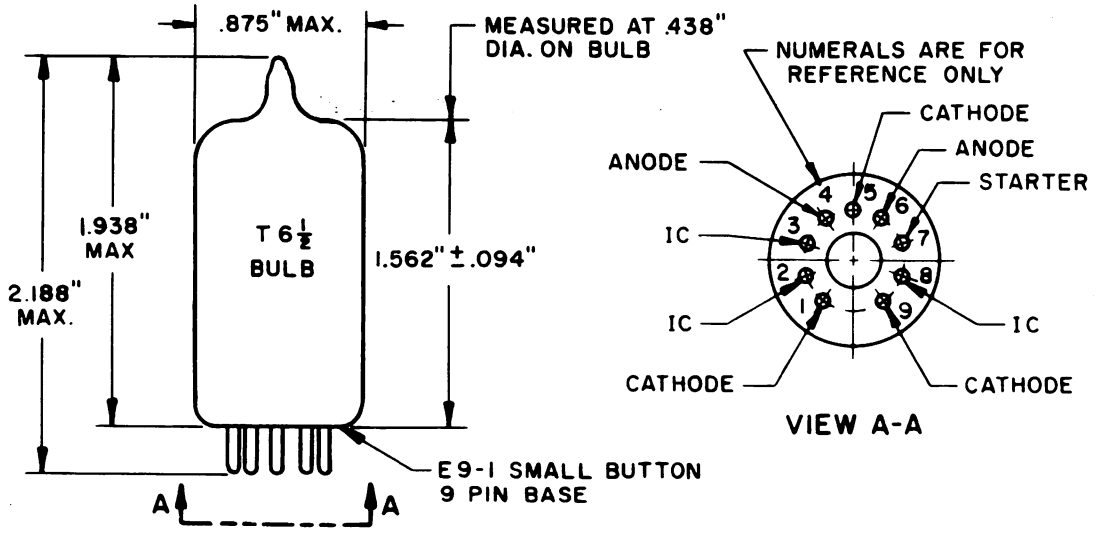
Note 2: The minimum starter current requirement applies only when the tube is operated for extended periods (hundreds of hours) between starting operations to assure maintaining starter breakdown and transfer current characteristics.

Note 3: These values are for new tubes. Anode voltage drop will stabilize within 3 minutes after starting.

Note 4: Continuous operation at a current value in the low portion of the operating range for an extended period (hundreds of hours) may result temporarily in regulation exceeding the stated values.

Note 5: The drift of anode voltage drop improves with operating life. After 1000-2000 hours operation the drift of anode voltage drop per 1000 hours will not exceed 0.3 volt.

Note 6: Regulation is defined to be Anode Voltage Drop (E_{td}) at 40 mAdc minus Anode Voltage Drop (E_{td}) at 5 mAdc.



NOTE: PINS MARKED IC (INTERNAL CONNECTION) SHOULD NOT BE CONNECTED TO ANY PORTION OF AN EXTERNAL CIRCUIT. FAILURE TO OBSERVE THIS PRECAUTION MAY RESULT IN IMPROPER OPERATION OF THE TUBE.

A development of Bell Telephone Laboratories, the research laboratories of the American Telephone and Telegraph Company and the Western Electric Company.

PRINTED IN U.S.A.

Western Electric Company

ELECTRON TUBE DATA SHEET

WESTERN ELECTRIC 447A ELECTRON TUBE



DESCRIPTION

The 447A is a two-electrode inert-gas filled cold cathode tube designed primarily for use as a voltage reference and trouble indicator tube. The cathode red glow is visible through a hole in the anode for indicator use.

CHARACTERISTICS

Cathode Current	8	milliamperes max.
Anode Voltage Drop	82	volts
Regulation at 2 to 4 milliamperes d-c (Note 3, page 3)	0.5	volt

File: Cold Cathode Section

© American Telephone and Telegraph Company 1963

RATINGS, Absolute System (Note 1)

Cathode Current, Forward Maximum	8	milliamperes
Maximum Inverse Anode Current	0.0	milliampere
Ambient Temperature Limits	-55 to +60	centigrade

ELECTRICAL DATA, Throughout Life

	Min.	Bogey	Max.	
Anode Breakdown Voltage	110	115	120	volts
Anode Voltage Drop(E_{td}) at 4 Milliamperes (D-C) (Note 2)	81	82	83	volts
Regulation (2 to 4 Milliamperes, D-C) (Note 3)	-	0.2	0.5	volt
Coverage Current (Note 4)	-	3.0	4.0	milliamperes

MECHANICAL DATA

Mounting Position	Any
New Weight, Approximate	0.3 ounce
Bulb	T 6½
Base	Small Button 9 pin
Light Spot Size, approximate	0.20 inches

Dimensions and connections shown in outline drawing on page 4.

LIFE DATA

Drift in Anode Voltage Drop (E_{td}) in 500 hours at 8 mAdc. . . . 0.6 volts (max.)

HANDLING

This tube contains a small amount of krypton-85 gas which is a by-product radioactive material. The amount of krypton-85 is less than five microcuries, which is too small an amount to require any special care in use.

Atomic Energy Commission regulations require that the individual tube carton for tubes containing by-product radioactive material be appropriately marked. The marking includes the statement that tube disposal should be in approved manner.

Approved instructions for disposal of tubes containing krypton-85 are as follows:

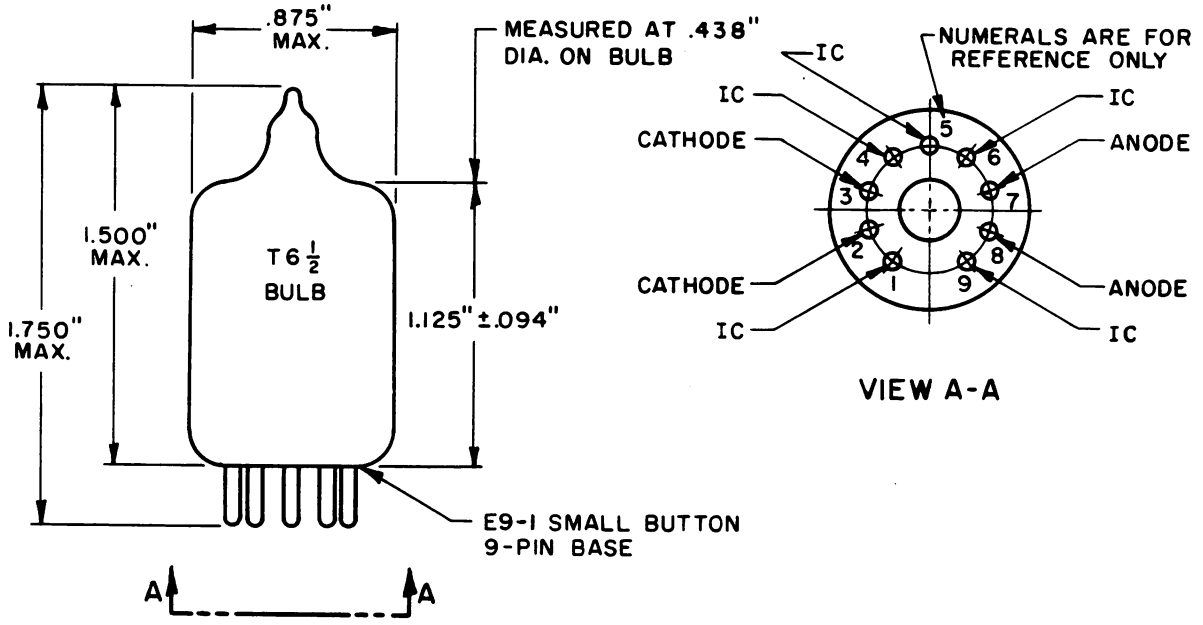
> Tubes to be disposed of should be broken or crushed in a well ventilated place releasing any resulting vapors to the outside atmosphere. The residual broken or crushed tubes should be disposed of in a normal public trash disposal system. Tubes should be disposed of at a rate of not more than 100 each week from any one location. Avoid breathing vapors from broken tubes.

Note 1: In the "Absolute System" the maximum ratings specified are limiting values above which the serviceability of the device may be impaired from the viewpoint of life and satisfactory performance. Maximum ratings, as such, do not constitute a set of operating conditions and all values may not, therefore, be attained simultaneously.

Note 2: These values are for new tubes. Anode voltage drop will stabilize within 3 minutes after starting.

Note 3: Regulation is defined to be Anode Voltage Drop (E_{td}) at 4 mAdc minus Anode Voltage Drop (E_{td}) at 2 mAdc.

Note 4: The current at which cathode glow will entirely cover the area defined by the anode hole. Such current should not exceed the above stated value.



NOTE: PINS MARKED IC (INTERNAL CONNECTION) SHOULD NOT BE CONNECTED TO ANY PORTION OF AN EXTERNAL CIRCUIT. FAILURE TO OBSERVE THIS PRECAUTION MAY RESULT IN IMPROPER OPERATION OF THE TUBE.

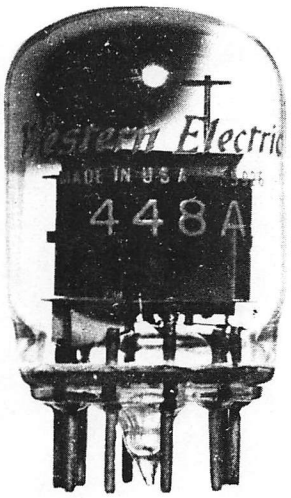
A development of Bell Telephone Laboratories, the research laboratories of the American Telephone and Telegraph Company and the Western Electric Company.

PRINTED IN U.S.A.

Western Electric Company

ELECTRON TUBE DATA SHEET

WESTERN ELECTRIC 448A,448B,454A ELECTRON TUBE







DESCRIPTION

The 448A, 448B and 454A electron tubes are high figure of merit tetrodes of the indirectly heated cathode type. They have plate characteristics approaching those of a pentode and were designed primarily for use in the TH Radio Relay System.

These three tubes have the same electrical characteristics. The 448B has the same mechanical dimensions and appearance as the 448A except the bulb is aquadag coated to suppress fluorescence effects. The 454A is mechanically equivalent to the 448A except that pin #1 (plate) is shortened to permit its use in a special test probe. (See outline drawing - page 4).

CHARACTERISTICS

Heater Voltage	6.3	volts
Cathode Current (E_b = 135 volts; E_{c2} = 135 volts; E_{cc1} = +9.5 volts; R_k = 323 ohms)	33.7	milliamperes
Transconductance (E_b = 135 volts; E_{c2} = 135 volts; E_{cc1} = +9.5 volts; R_k = 323 ohms)	31500	micromhos

© American Telephone and Telegraph Company, 1961

GENERAL CHARACTERISTICS

Electrical Data

Heater Voltage	6.3	volts
Heater Current	450	milliamperes
Direct Interelectrode Capacitances (without external shield)		
Grid to Plate	0.03	μμf
Input: g to (h + k + g_2 + i.s.)	15.4	μμf
Output: p to (h + k + g_2 + i.s.)	2.03	μμf

Mechanical Data

Cathode	Coated Unipotential
Bulb	T-9
Base	See outline drawing Page 4
Mounting Position	Any

Dimensions and pin connections shown in outline drawing on Page 4

Maximum Ratings, Absolute System

Plate Voltage	150	volts
Screen Grid Voltage	150	volts
Control Grid Voltage	-50	volts
Plate Dissipation	6.0	watts
Screen Grid Dissipation	1.75	watts
Control Grid Dissipation	See Footnote *	
Cathode Current	50	milliamperes
Heater - Cathode Voltage	±50	volts
Bulb Temperature	130°	centigrade
Maximum Grid Circuit Resistance for:		
Fixed Bias	0.05	megohm
Cathode Bias	0.10	megohm

* Operation with the control grid positive with respect to the cathode is not recommended.

TYPICAL OPERATING CONDITIONS AND CHARACTERISTICS

Plate Voltage	135	volts
Screen Grid Voltage	135	volts
Control Grid Voltage (Note 1)	+9.5	volts
Cathode Bias Resistor (Note 1)	323	ohms
Plate Current	24.9	milliamperes
Screen Grid Current	8.8	milliamperes
Plate Resistance	33000	ohms
Transconductance	31500	micromhos

Note 1: Reference point for control grid voltage is the negative end of the cathode bias resistor.

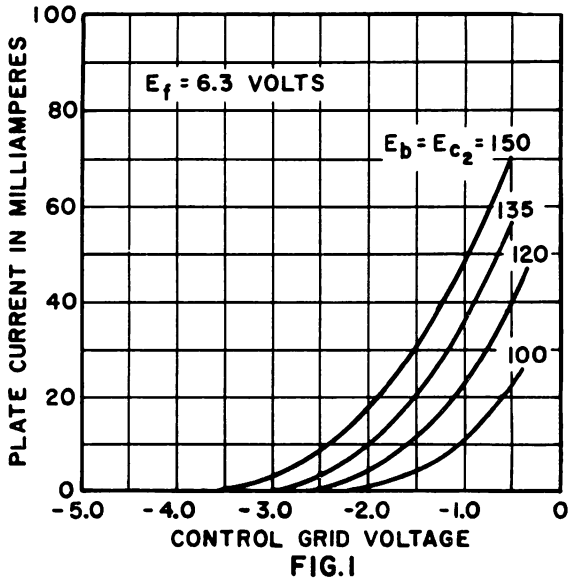


FIG.1

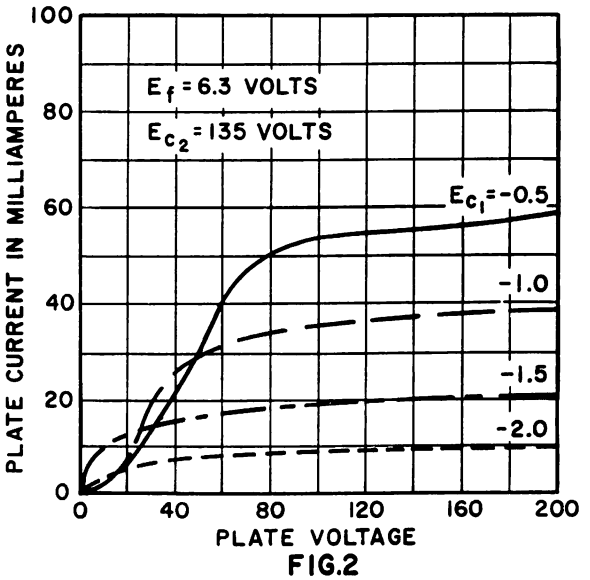
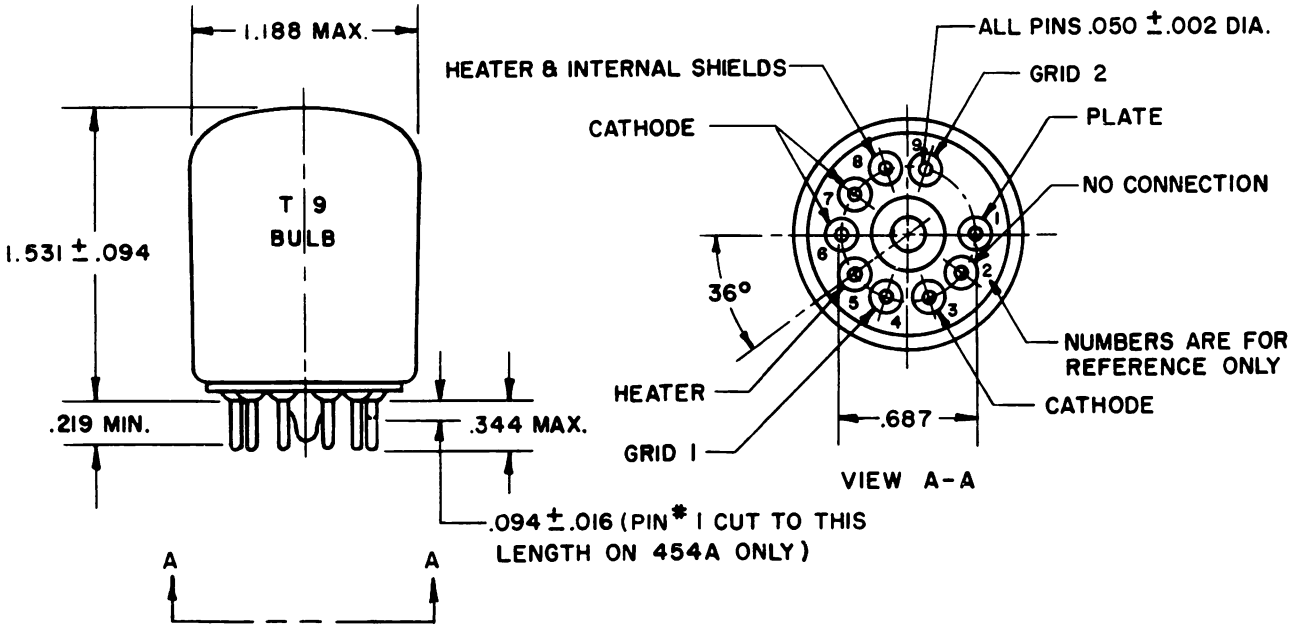


FIG.2

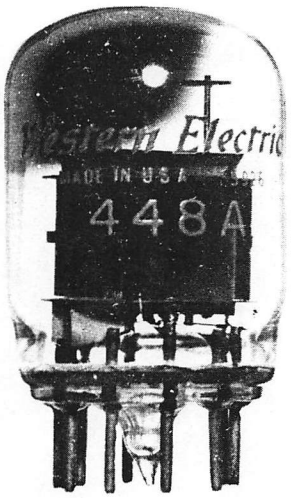


A development of Bell Telephone Laboratories, the research laboratories of the American Telephone and Telegraph Company and the Western Electric Company.

PRINTED IN U.S.A.

ELECTRON TUBE DATA SHEET

WESTERN ELECTRIC 448A,448B,454A ELECTRON TUBE







DESCRIPTION

The 448A, 448B and 454A electron tubes are high figure of merit tetrodes of the indirectly heated cathode type. They have plate characteristics approaching those of a pentode and were designed primarily for use in the TH Radio Relay System.

These three tubes have the same electrical characteristics. The 448B has the same mechanical dimensions and appearance as the 448A except the bulb is aquadag coated to suppress fluorescence effects. The 454A is mechanically equivalent to the 448A except that pin #1 (plate) is shortened to permit its use in a special test probe. (See outline drawing - page 4).

CHARACTERISTICS

Heater Voltage	6.3	volts
Cathode Current (E_b = 135 volts; E_{c2} = 135 volts; E_{cc1} = +9.5 volts; R_k = 323 ohms)	33.7	milliamperes
Transconductance (E_b = 135 volts; E_{c2} = 135 volts; E_{cc1} = +9.5 volts; R_k = 323 ohms)	31500	micromhos

© American Telephone and Telegraph Company, 1961

GENERAL CHARACTERISTICS

Electrical Data

Heater Voltage	6.3	volts
Heater Current	450	milliamperes
Direct Interelectrode Capacitances (without external shield)		
Grid to Plate	0.03	μμf
Input: g to (h + k + g_2 + i.s.)	15.4	μμf
Output: p to (h + k + g_2 + i.s.)	2.03	μμf

Mechanical Data

Cathode	Coated Unipotential
Bulb	T-9
Base	See outline drawing Page 4
Mounting Position	Any

Dimensions and pin connections shown in outline drawing on Page 4

Maximum Ratings, Absolute System

Plate Voltage	150	volts
Screen Grid Voltage	150	volts
Control Grid Voltage	-50	volts
Plate Dissipation	6.0	watts
Screen Grid Dissipation	1.75	watts
Control Grid Dissipation	See Footnote *	
Cathode Current	50	milliamperes
Heater - Cathode Voltage	±50	volts
Bulb Temperature	130°	centigrade
Maximum Grid Circuit Resistance for:		
Fixed Bias	0.05	megohm
Cathode Bias	0.10	megohm

* Operation with the control grid positive with respect to the cathode is not recommended.

TYPICAL OPERATING CONDITIONS AND CHARACTERISTICS

Plate Voltage	135	volts
Screen Grid Voltage	135	volts
Control Grid Voltage (Note 1)	+9.5	volts
Cathode Bias Resistor (Note 1)	323	ohms
Plate Current	24.9	milliamperes
Screen Grid Current	8.8	milliamperes
Plate Resistance	33000	ohms
Transconductance	31500	micromhos

Note 1: Reference point for control grid voltage is the negative end of the cathode bias resistor.

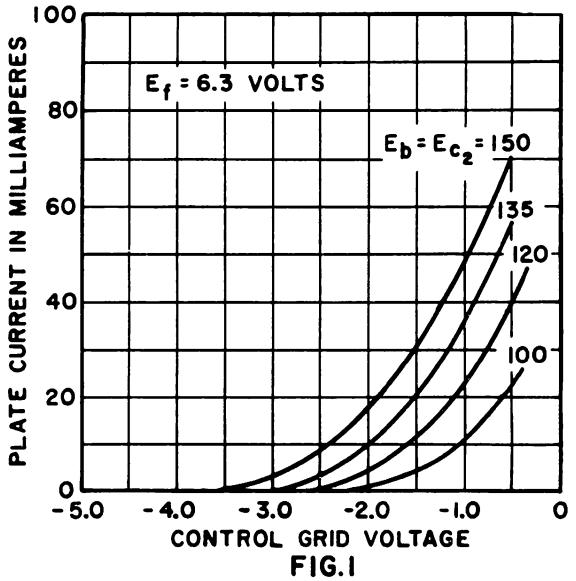


FIG.1

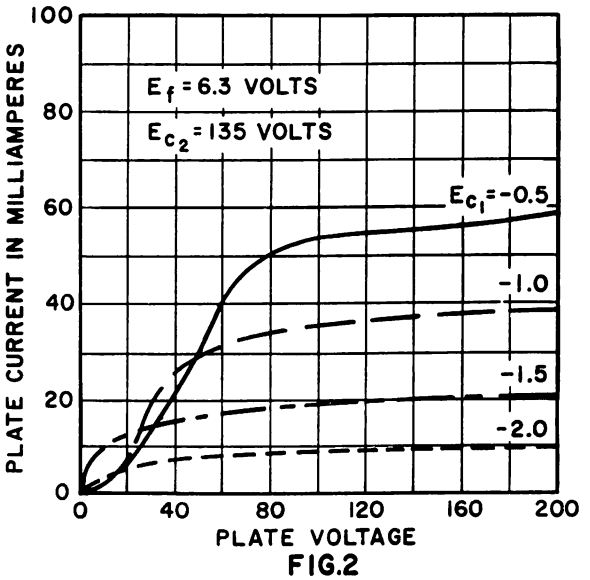
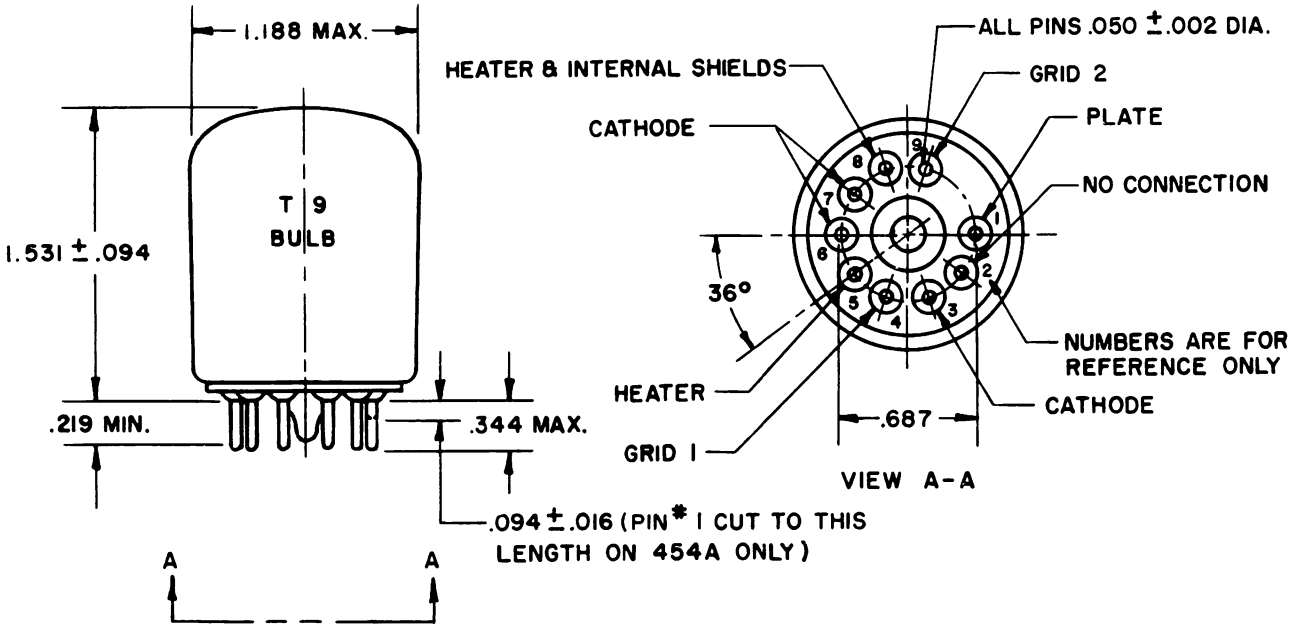


FIG.2



A development of Bell Telephone Laboratories, the research laboratories of the American Telephone and Telegraph Company and the Western Electric Company.

PRINTED IN U.S.A.

ELECTRON TUBE DATA SHEET

WESTERN ELECTRIC 451A ELECTRON TUBE



DESCRIPTION

The 451A is a four-electrode, inert-gas filled cold cathode tube for use as a relay device. The tube is provided with an anode-cathode gap and a starter anode-starter cathode gap such that isolation of the control (starter gap) and controlled (main gap) portions of a circuit may be obtained.

This tube is designed for socket mounting. It is identical, electrically and mechanically, to the 425A except that it is not attached to a plastic angle mounting bracket assembly.

CHARACTERISTICS

Peak Anode Voltage	180	180	volts
Average Starter Cathode Current	0.7	7.0	milliamperes
Average Main Cathode Current	5.0	50	milliamperes
Average Life, Approximate	10000	10	hours

FILE: COLD CATHODE SECTION

© American Telephone and Telegraph Company 1962

MAXIMUM RATINGS, Absolute System (Note 1)

Peak Voltage, Forward or Inverse		
Anode to all Other Electrodes	180	volts
Cathode to all Other Electrodes	180	volts
Cathode Current (Note 2)		
Peak	50	milliamperes
Average	20	milliamperes
Averaging Time	2	seconds
Starter Cathode Current (Note 2)		
Peak	7	milliamperes
Average	2.5	milliamperes
Averaging Time	2	seconds
Peak Inverse Current (Note 2)		
Anode	5	milliamperes
Starter Anode	1	milliamperes
Ambient Temperature Limits	-55° to +85°	centigrade

ELECTRICAL DATA, Throughout Life

	Min.	Bogey	Max.	
Starter Breakdown Voltage (Note 3)	67	80	90	volts
Starter Voltage Drop at 2.5 Milliamperes	55	70	75	volts
Anode Voltage Drop at 10 Milliamperes	58	70	80	volts
Transfer Current (Note 4)	See Curve, Figure 3, Page 4			
Negative Cathode Transfer Voltage (Note 5)	-	-25	-40	volts
Ionization Time, Starter Gap (Approx.) (Note 6)	-	5	-	milliseconds
Deionization Time, Main Gap (Approx.)	-	1	-	millisecond

MECHANICAL DATA

Mounting	Any position	
New Weight, Approximate	0.3	ounce
Dimensions and Connections	See outline drawing on page 4	

HANDLING

This tube contains a small amount of krypton-85 gas which is a by-product radioactive material. The amount of krypton-85 is less than five microcuries, which is too small an amount to require any special care in use.

Atomic Energy Commission regulations require that the individual tube carton for tubes containing by-product radioactive material be appropriately marked. The marking includes the statement that tube disposal should be in approved manner.

Approved instructions for disposal of tubes containing krypton-85 are as follows;

> Tubes to be disposed of should be broken or crushed in a well ventilated place releasing any resulting vapors to the outside atmosphere. The residual broken or crushed tubes should be disposed of in a normal public trash disposal system. Tubes should be disposed of at a rate of not more than 100 each week from any one location. Avoid breathing vapors from broken tubes.

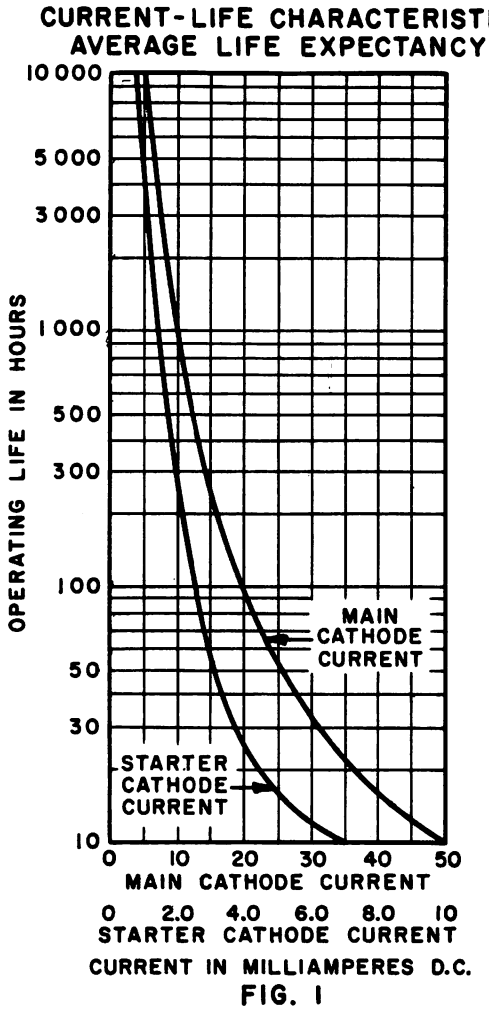


FIG. 1

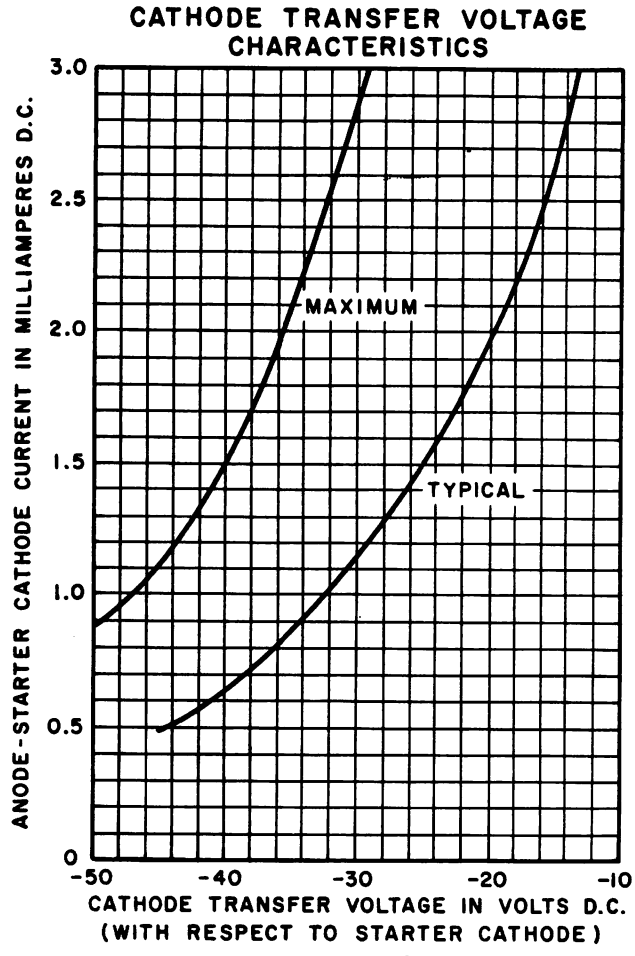


FIG. 2

Note 1: In the "Absolute System" the maximum ratings specified are limiting values above which the serviceability of the device may be impaired from the viewpoint of life and satisfactory performance. Maximum ratings, as such, do not constitute a set of operating conditions and all values may not, therefore, be attained simultaneously.

Note 2: Sufficient resistance must be used in series with the tube discharge paths to assure that the electrode currents do not exceed their maximum rated values.

Note 3: Limits apply immediately after the tube has conducted current. These values may be initially as much as 3 volts higher or lower if the tube has been idle.

Note 4: To assure transfer of conduction from the starter anode-starter cathode gap to the anode-starter cathode gap.

Note 5: To assure transfer of conduction from the anode-starter gap to the anode-cathode gap with 1.5 milliamperes flowing from anode to starter cathode. Cathode voltage is measured with respect to starter cathode.

Note 6: With 15 volts starter overvoltage (15 volts above Starter Breakdown Voltage) and with the tube in total darkness.

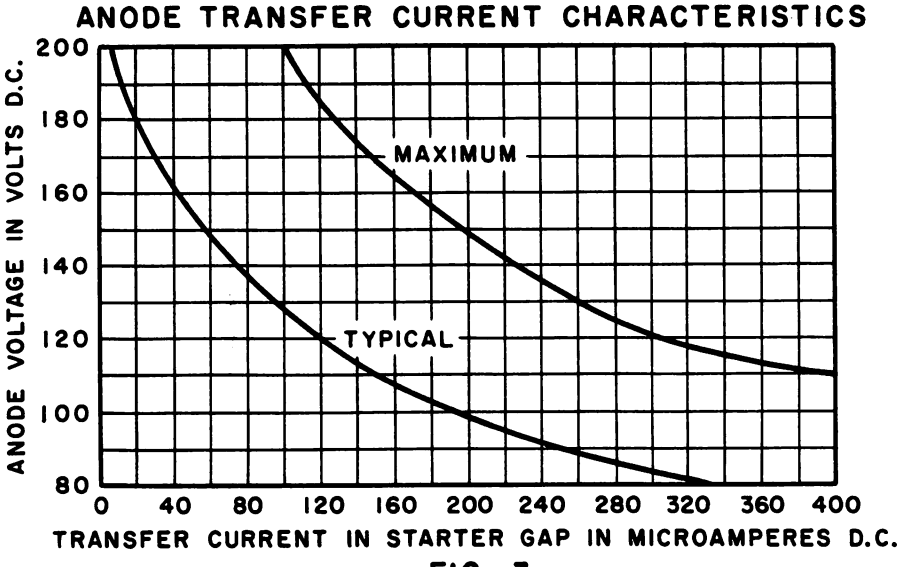
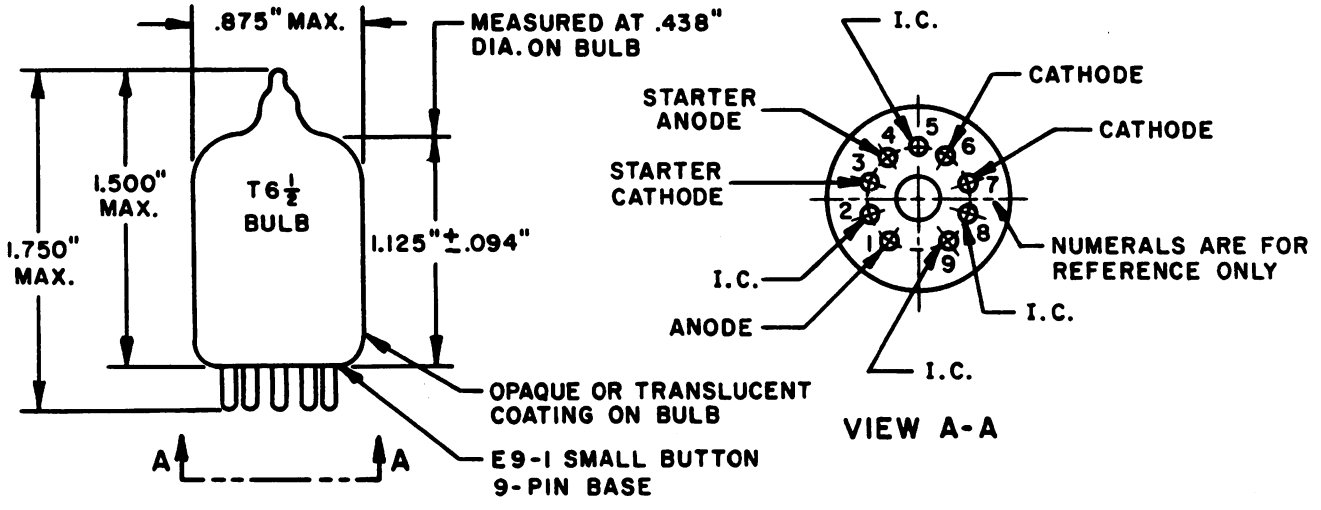


FIG. 3



NOTE: PINS MARKED I.C. (INTERNAL CONNECTION) SHOULD NOT BE CONNECTED TO ANY PORTION OF AN EXTERNAL CIRCUIT. FAILURE TO OBSERVE THIS PRECAUTION MAY RESULT IN IMPROPER OPERATION OF THE TUBE.

A development of Bell Telephone Laboratories, the research laboratories of the American Telephone and Telegraph Company and the Western Electric Company.

PRINTED IN U.S.A.

ELECTRON TUBE DATA SHEET

WESTERN ELECTRIC 453A ELECTRON TUBE



DESCRIPTION

The 453A is a two-electrode inert-gas filled cold cathode tube designed primarily for use as a voltage reference tube. This tube has characteristics which are exceptionally stable with life and with variations in ambient temperature. The tube is relatively free from voltage jumps. (See Note 6, page 3.)

CHARACTERISTICS

Cathode Current	4 to 6	milliamperes
Anode Voltage Drop	83	volts
Regulation at 4 to 6 milliamperes d-c (Note 5, Page 3)	1.2	volts

File: Cold Cathode Section

© American Telephone and Telegraph Company 1963

RATINGS, Absolute System (Note 1)

Cathode Current, Forward		
Maximum	8	milliamperes
Minimum	4	milliamperes
Maximum Inverse Anode Current	0.0	milliampere
Ambient Temperature Limits	-55 to +60	centigrade

ELECTRICAL DATA, Throughout Life

	Min.	Bogey	Max.	
Anode Breakdown Voltage	95	100	105	volts
Anode Voltage Drop(E_{td})at 6 Milliamperes(D-C) (Note 2)	81	83	87	volts
Regulation (4 to 6 Milliamperes, D-C) (Note 5)	-	0.75	1.2	volts
Temperature Sensitivity of Anode Voltage Drop Anode Current, 5 Milliamperes (D-C)	-	-0.0035	-	volt/c
Fluctuation (Note 3)	-	0.002	0.005	volt
Average Ionization Time (Note 4)	-	5.0	-	milliseconds
Voltage Jump (Note 6)	-	5.0	-	millivolts

MECHANICAL DATA

Mounting Position	Any
New Weight, Approximate	0.3 ounce
Bulb	T 6½
Base	Small Button 9 pin

Dimensions and connections shown in outline drawing on page 4.

LIFE DATA

Typical Drift in Anode Voltage Drop (E_{td}) at 5 mAdc . . . . . See Figure 1

HANDLING

This tube contains a small amount of krypton-85 gas which is a by-product radioactive material. The amount of krypton-85 is less than five microcuries, which is too small an amount to require any special care in use.

Atomic Energy Commission regulations require that the individual tube carton for tubes containing by-product radioactive material be appropriately marked. The marking includes the statement that tube disposal should be in approved manner.

Approved instructions for disposal of tubes containing krypton-85 are as follows:

> Tubes to be disposed of should be broken or crushed in a well ventilated place releasing any resulting vapors to the outside atmosphere. The residual broken or crushed tubes should be disposed of in a normal public trash disposal system. Tubes should be disposed of at a rate of not more than 100 each week from any one location. Avoid breathing vapors from broken tubes.

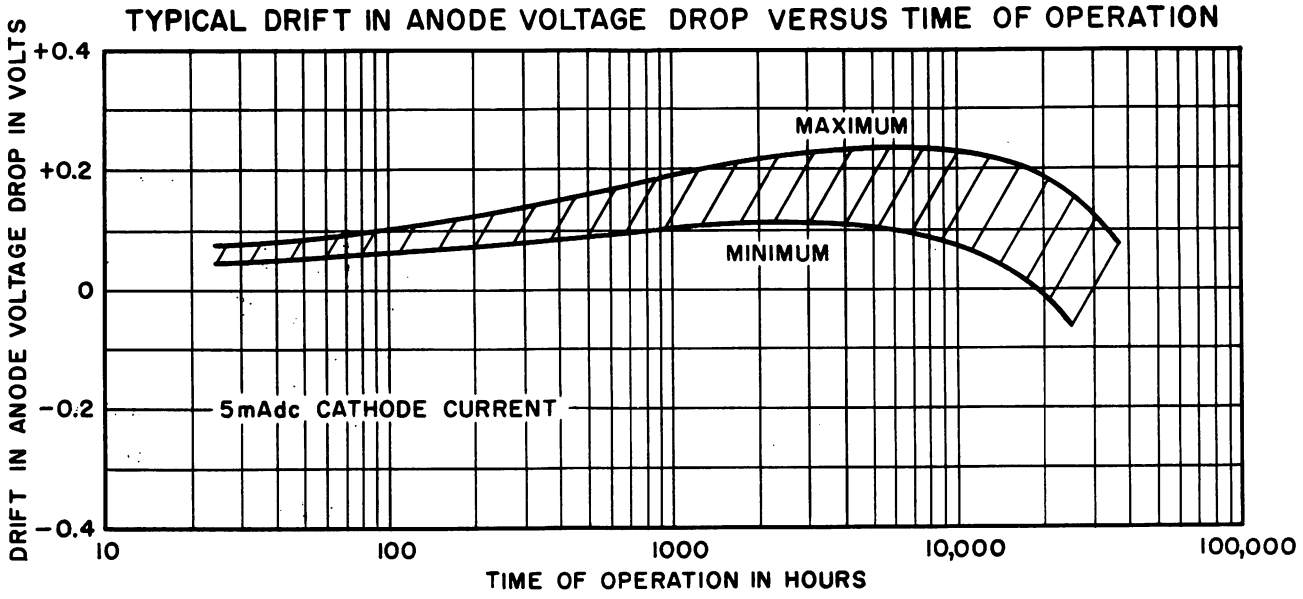


FIG. 1

Note 1: In the "Absolute System" the maximum ratings specified are limiting values above which the serviceability of the device may be impaired from the viewpoint of life and satisfactory performance. Maximum ratings, as such, do not constitute a set of operating conditions and all values may not, therefore, be attained simultaneously.

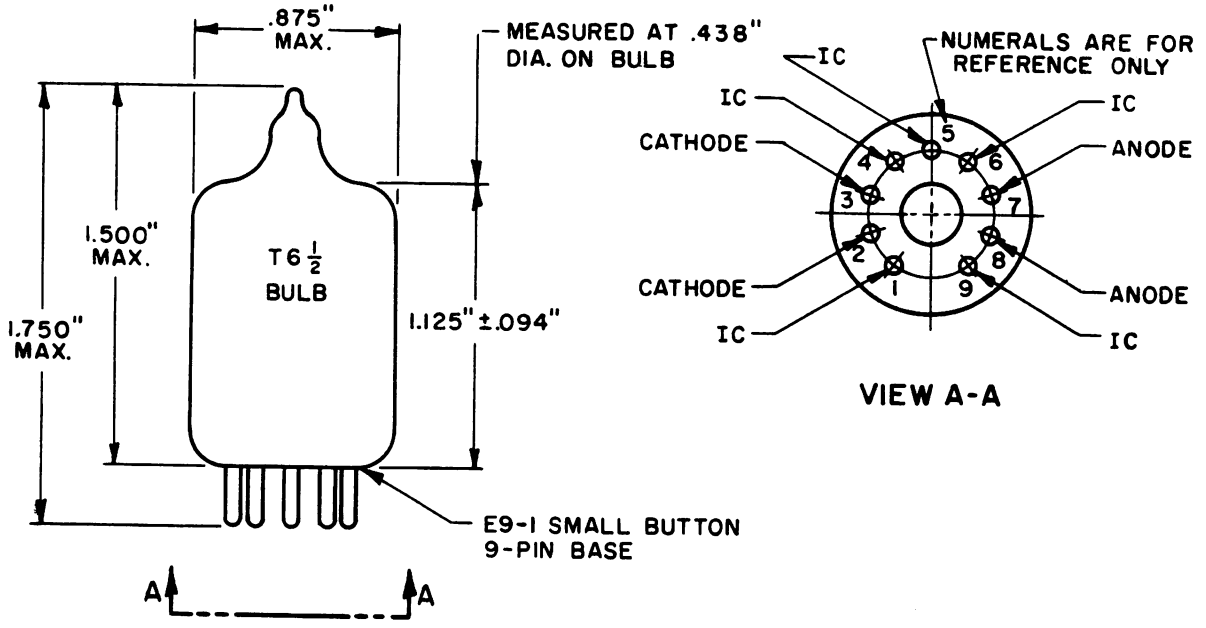
Note 2: These values are for new tubes. Anode voltage drop will stabilize within 3 minutes after starting.

Note 3: The anode voltage drop variation during a short period of time (one to ten minutes), with the tube operating at one value of current and temperature within its ratings, will not exceed the above stated maximum value.

Note 4: With 15 volts overvoltage (15 volts above Anode Breakdown Voltage) with tube in total darkness. Average of 10 measurements taken at 1 second intervals.

Note 5: Regulation is defined to be Anode Voltage Drop (E_{td}) at 6 mAdc minus Anode Voltage Drop (E_{td}) at 4 mAdc.

Note 6: Voltage jump is an abrupt change or discontinuity in tube anode voltage drop when the tube current is varied. Voltage jumps greater than the specified value are relatively rare in the range of anode current of 4 to 6 mAdc.



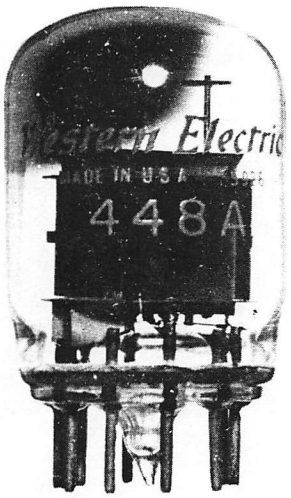
NOTE: PINS MARKED IC (INTERNAL CONNECTION) SHOULD NOT BE CONNECTED TO ANY PORTION OF AN EXTERNAL CIRCUIT. FAILURE TO OBSERVE THIS PRECAUTION MAY RESULT IN IMPROPER OPERATION OF THE TUBE.

A development of Bell Telephone Laboratories, the research laboratories of the American Telephone and Telegraph Company and the Western Electric Company.

PRINTED IN U.S.A.

ELECTRON TUBE DATA SHEET

WESTERN ELECTRIC 448A,448B,454A ELECTRON TUBE







DESCRIPTION

The 448A, 448B and 454A electron tubes are high figure of merit tetrodes of the indirectly heated cathode type. They have plate characteristics approaching those of a pentode and were designed primarily for use in the TH Radio Relay System.

These three tubes have the same electrical characteristics. The 448B has the same mechanical dimensions and appearance as the 448A except the bulb is aquadag coated to suppress fluorescence effects. The 454A is mechanically equivalent to the 448A except that pin #1 (plate) is shortened to permit its use in a special test probe. (See outline drawing - page 4).

CHARACTERISTICS

Heater Voltage	6.3	volts
Cathode Current (E_b = 135 volts; E_{c2} = 135 volts; E_{cc1} = +9.5 volts; R_k = 323 ohms)	33.7	milliamperes
Transconductance (E_b = 135 volts; E_{c2} = 135 volts; E_{cc1} = +9.5 volts; R_k = 323 ohms)	31500	micromhos

© American Telephone and Telegraph Company, 1961

GENERAL CHARACTERISTICS

Electrical Data

Heater Voltage	6.3	volts
Heater Current	450	milliamperes
Direct Interelectrode Capacitances (without external shield)		
Grid to Plate	0.03	μμf
Input: g to (h + k + g_2 + i.s.)	15.4	μμf
Output: p to (h + k + g_2 + i.s.)	2.03	μμf

Mechanical Data

Cathode	Coated Unipotential
Bulb	T-9
Base	See outline drawing Page 4
Mounting Position	Any

Dimensions and pin connections shown in outline drawing on Page 4

Maximum Ratings, Absolute System

Plate Voltage	150	volts
Screen Grid Voltage	150	volts
Control Grid Voltage	-50	volts
Plate Dissipation	6.0	watts
Screen Grid Dissipation	1.75	watts
Control Grid Dissipation	See Footnote *	
Cathode Current	50	milliamperes
Heater - Cathode Voltage	±50	volts
Bulb Temperature	130°	centigrade
Maximum Grid Circuit Resistance for:		
Fixed Bias	0.05	megohm
Cathode Bias	0.10	megohm

* Operation with the control grid positive with respect to the cathode is not recommended.

TYPICAL OPERATING CONDITIONS AND CHARACTERISTICS

Plate Voltage	135	volts
Screen Grid Voltage	135	volts
Control Grid Voltage (Note 1)	+9.5	volts
Cathode Bias Resistor (Note 1)	323	ohms
Plate Current	24.9	milliamperes
Screen Grid Current	8.8	milliamperes
Plate Resistance	33000	ohms
Transconductance	31500	micromhos

Note 1: Reference point for control grid voltage is the negative end of the cathode bias resistor.

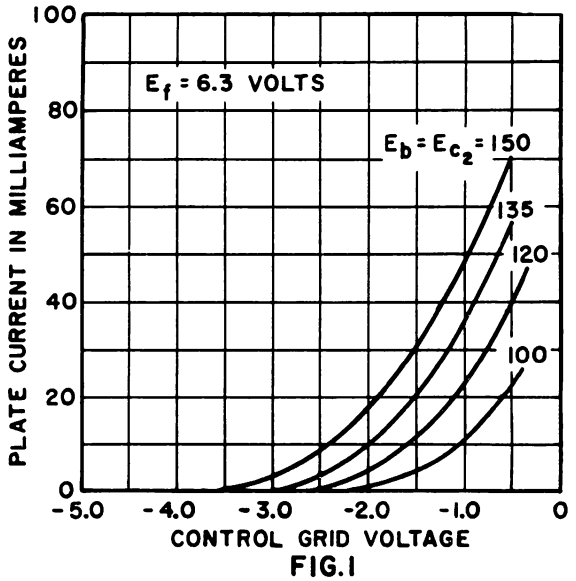


FIG.1

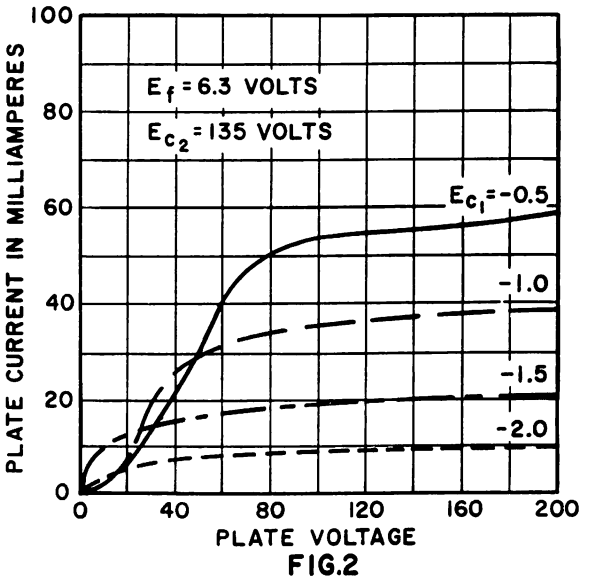
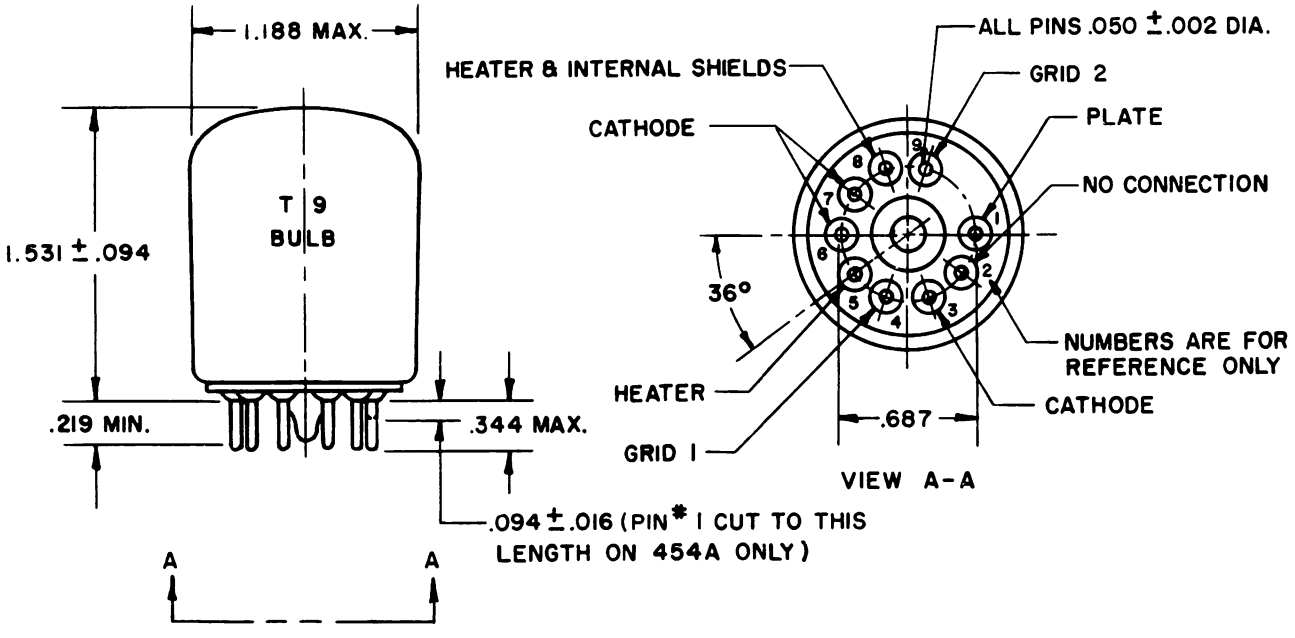


FIG.2



A development of Bell Telephone Laboratories, the research laboratories of the American Telephone and Telegraph Company and the Western Electric Company.

PRINTED IN U.S.A.