

# EIMAC TRANSMITTING TUBES

TUBE TYPES		MAXIMUM RATINGS						ELECTRICAL CHARACTERISTICS						DIMENSIONS		TUBE PRICE	RECOMMENDED HR. HEAT DISSIPATING CONNECTORS		
		PLATE DISSIPATION, WATTS	PLATE VOLTAGE	PLATE CURRENT MILLIAMPERES	GRID DISSIPATION, WATTS	SCREEN VOLTAGE	SCREEN DISSIPATION, WATTS	FILAMENT, VOLTS	FILAMENT, AMPERES	AMPLIFICATION FACTOR	GRID-PLATE, MMF	INPUT, MMF	OUTPUT, MMF	TRANSCONDUCTANCE, UMHOS	LENGTH, INCHES		DIAMETER, INCHES	PLATE	GRID
TETRODES	4-65A	65	3000	150	5	400	10	6.0	3.5	5	0.08	8.0	2.1	4000	4.25	2.31	14.50	HR6	.....
	4X100A*	100	1000	250	2	300	15	6.0	2.8	4.5	0.02	14.1	4.7	12,000	2.87	1.64	30.00	.....	.....
	4-125A	125	3000	225	5	400	20	5.0	6.5	6.2	0.05	10.8	3.1	2450	5.69	2.87	27.50	HR6	.....
	4X150A*	150	1000	250	2	300	15	6.0	2.8	4.5	0.02	14.1	4.7	12,000	2.47	1.64	34.00	.....	.....
	4-250A	250	4000	350	5	600	35	5.0	14.5	5.1	0.12	12.7	4.5	4000	6.38	3.56	37.50	HR6	.....
	4-400A	400	4000	350	5	600	35	5.0	14.5	5.1	0.12	12.5	4.7	4000	6.38	3.56	55.00	HR6	.....
	4X500A*	500	4000	350	10	500	30	5.0	13.5	6.2	0.05	12.8	5.6	5200	4.75	2.63	97.50	.....	.....
	4X500F*	500	4000	350	10	500	30	5.0	12.2	6.2	0.05	11.1	3.7	5200	5.38	2.75	85.00	.....	.....
4-1000A	1000	6000	700	25	1000	75	7.5	21	7.2	0.24	27.2	7.6	10,000	9.5	5.12	120.00	HR8	.....	
TRIODES	25T	25	2000	75	7	.....	.....	6.3	3.0	24	1.5	2.7	0.3	2500	4.38	1.43	8.00	HR1	.....
	3C24	25	2000	75	8	.....	.....	6.3	3.0	23	1.5	1.7	0.3	2500	4.38	1.43	8.00	HR1	HR1
	35T	50	2000	150	15	.....	.....	5.0	4.0	39	1.8	4.1	0.3	2850	5.5	1.81	9.50	HR3	.....
	35TG	50	2000	150	15	.....	.....	5.0	4.0	39	1.8	2.5	0.4	2850	5.75	1.81	10.00	HR3	HR3
	75TH	75	3000	225	16	.....	.....	5.0	6.25	20	2.3	2.7	0.3	4150	7.25	2.81	12.00	HR3	HR2
	75TL	75	3000	225	13	.....	.....	5.0	6.25	12	2.4	2.6	0.4	3350	7.25	2.81	12.00	HR3	HR2
	2C39*	100	1000	100†	3	.....	.....	6.3	1.1	100	1.9	6.5	0.03	17,000	2.75	1.26	33.00	.....	.....
	100TH	100	3000	225	20	.....	.....	5.0	6.3	40	2.0	2.9	0.4	5500	7.75	3.19	16.50	HR6	HR2
	100TL	100	3000	225	15	.....	.....	5.0	6.3	14	2.0	2.3	0.4	2300	7.75	3.19	16.50	HR6	HR2
	152TH	150	3000	450	30	.....	.....	5 or 10	12.5 or 6.2	20	4.8	5.7	0.8	8300	7.63	3.0	26.00	HR5	HR6
	152TL	150	3000	450	25	.....	.....	5 or 10	12.5 or 6.2	12	4.4	4.5	0.7	7150	7.63	3.0	26.00	HR5	HR6
	250TH	250	4000	350	40	.....	.....	5.0	10.5	37	2.9	5.0	0.7	6650	10.13	3.81	30.00	HR6	HR3
	250TL	250	4000	350	35	.....	.....	5.0	10.5	14	3.1	3.7	0.7	2650	10.13	3.81	30.00	HR6	HR3
	304TH	300	3000	900	60	.....	.....	5 or 10	25 or 12.5	20	10.2	13.5	0.7	16,700	7.63	3.56	55.00	HR7	HR6
	304TL	300	3000	900	50	.....	.....	5 or 10	25 or 12.5	12	9.1	8.5	0.6	16,700	7.63	3.56	55.00	HR7	HR6
	450TH	450	6000	600	80	.....	.....	7.5	12.0	38	5.0	8.8	0.8	6650	12.63	5.13	70.00	HR8	HR8
	450TL	450	6000	600	65	.....	.....	7.5	12.0	18	5.2	7.3	0.9	6060	12.63	5.13	70.00	HR8	HR8
	750TL	750	10,000	1000	100	.....	.....	7.5	21.0	15	5.8	8.5	1.2	3500	17.0	7.13	125.00	HR8	HR8
	1000T	1000	7,500	750	80	.....	.....	7.5	17.0	35	5.1	9.3	0.5	9050	12.63	5.13	125.00	HR9	HR9
	1500T	1500	8,000	1250	125	.....	.....	7.5	24.0	24	7.2	9.9	1.5	10,000	17.0	7.13	200.00	HR8	HR9
	2000T	2000	8,000	1750	150	.....	.....	10.0	25.0	23	8.5	12.7	1.7	11,000	17.75	8.13	250.00	HR8	HR9
	3X2500A3*	2500	6,000	2000	150	.....	.....	7.5	48	20	20	48	1.2	20,000	9.0	4.16	180.00	.....	.....
	3X2500F3*	2500	6,000	2000	150	.....	.....	7.5	48	20	20	48	1.2	20,000	9.0	4.16	180.00	.....	.....
	3X12500A3*	12,500	6,000	8000	600	.....	.....	7.5	192	20	95	240	5	80,000	9.5	11.06	875.00*	.....	.....
	3X20000A3*	20,000	6,000	12,000	900	.....	.....	7.5	288	20	.....	.....	.....	120,000	10.0	12.5	1275.00*	.....	.....

## EIMAC RECTIFIERS

	MERCURY VAPOR RECTIFIERS				HIGH VACUUM RECTIFIERS			
	866A (866)	RX21A (RX21)	872A (872)	KY21A (KY21) (Grid Control)	2-01C	100-R	2-150D (152-RA)	250-R
Filament Voltage	2.5	2.5	5.0	2.5	5.3	5.0	5.0	5.0
Filament Current	5.0 amp.	10 amp.	7.5 amp.	10 amp.	0.4	6.5	13.0	10.5
Peak Inverse Voltage	10,000	11,000	10,000	11,000	1000	40,000	30,000	60,000
Peak Plate Current	1.0 mp.	3 amp.	5.0 amp.	3 amp.	0.010	.....	.....	.....
Average Plate Current	.25 amp.	.75 amp.	1.25 amp.	.75 amp.	.....	.100 amp.	.150 amp.	.250 amp.
Price	\$1.75	\$8.00	\$7.50	\$12.00	\$6.75	\$13.50	\$17.50	\$20.00

## EIMAC VACUUM CAPACITORS

Type	VARIABLE	FIXED							
	VVC60	VC6-20	VC12-20	VC25-20	VC50-20	VC6-32	VC12-32	VC25-32	VC50-32
Capacity	10-60 mmf	6-mm	12-mm	25-mm	50-mm	6-mm	12-mm	25-mm	50-mm
Rating	20-KV	20-KV	20-KV	20-KV	20-KV	32-KV	32-KV	32-KV	32-KV
Price	\$60.00	\$13.50	\$15.00	\$18.00	\$22.00	\$15.50	\$18.00	\$21.00	\$25.00

## HEAT DISSIPATING CONNECTORS

Type	Hole Dia.	Price	HR-5	.125	\$ .80
HR-1	.052	\$ .60	HR-6	.360	.80
HR-2	.0625	.60	HR-7	.125	1.60
HR-3	.070	.60	HR-8	.570	1.60
	.1015	.80	HR-9	.570	3.00

## DIFFUSION PUMP

<b>HV-1 Diffusion Pump</b> An air-cooled, oil diffusion type, vacuum pump. Ultimate vacuum, 4x10 <sup>-6</sup> mm of mercury. Speed (without baffle) approx. 67 liters/seconds.	\$125.00
<b>100 IG, Ionization Gauge</b> An electronic vacuum pressure gauge. Filament voltage 3.5 to 7.5 volts.	\$22.50
<b>Eimac Pump Oil A</b>	\$5.00 qt.

## AIR-SYSTEM SOCKETS

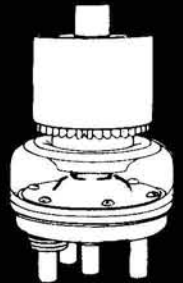
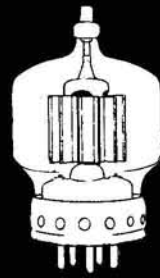
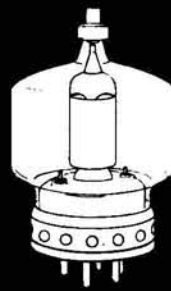
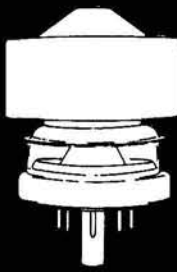
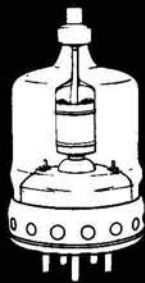
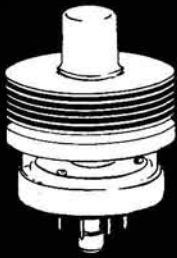
<b>Complete Assembly</b>	
4-400A/4000	- - - 16.00
4-1000A/4000	- - - 22.50
<b>Replacement Chimney</b>	
4-400A/4006	- - - 6.00
4-1000A/4006	- - - 7.50

## EIMAC VACUUM SWITCHES

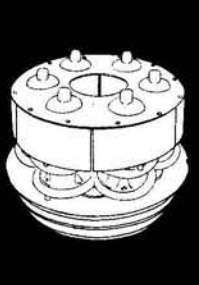
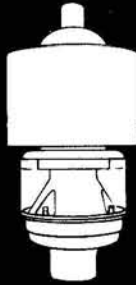
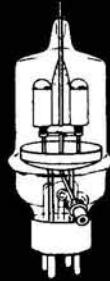
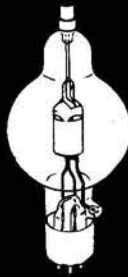
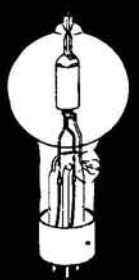
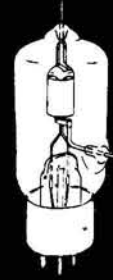
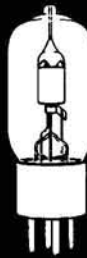
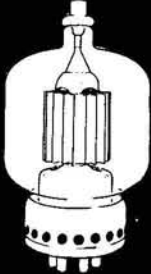
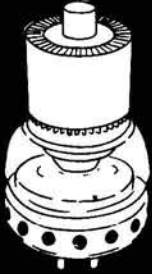
Type	General Data	Price
<b>VS-2</b>	Single pole double throw switch within a high vacuum adaptable for high voltage switching. Contact spacing .015". Switch will handle R-f potentials as high as 20 Kv. in DC switching will handle approximately 1.5 Amps at 5 Kv.	\$12.00
<b>VS-1</b>	Same as above except for slightly smaller glass tubulation.	\$12.00

*Eimac*  
REG. U. S. PAT. OFF.  
**TUBES**

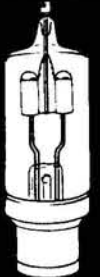
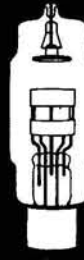
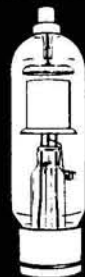
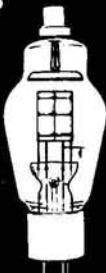
## TETRODES



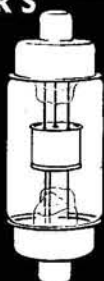
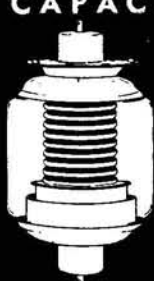
## TRIODES



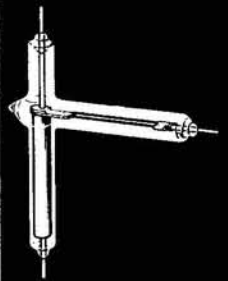
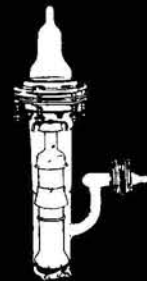
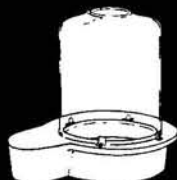
## RECTIFIERS



## CAPACITORS



## MISCELLANEOUS



# AN EIMAC DEALER IS NEAR YOU

For Your Assurance to Obtain The Most Modern, Guaranteed Eimac Tubes—Purchase Only from These Authorized Distributors

## ALASKA

### Anchorage

Alaska Radio Supply, Inc.  
Box 84

### Fairbanks

Fairbanks Radio Supply Co.  
329 Third Ave.,  
P. O. Box 1385

## ALABAMA

### Birmingham

Ack Radio Supply Co.  
223 North 22nd St.

James W. Clary Co.  
2024 North 4th Ave.

### Mobile

Harris Supply Co.  
PO Box 1009  
10 N. Water St.

### Montgomery

Nolin-McInnis, Inc.  
PO Box 2229  
205 Commerce St.

Southeastern Radio Parts Co.  
210 N. Court St.

## ARIZONA

### Phoenix

Radio Parts of Arizona  
36 West Madison St.

Radio Supply Co.  
500 W. Washington St.

Radio Specialties &  
Appliance Corp.  
401 W. Jackson St.

### Tucson

Elliott Electronics  
418 N. 4th Ave.

## ARKANSAS

### Ft. Smith

Wise Radio Supply  
914 Towson St.

### Little Rock

Southern Radio Supply  
1419 Main St.

Tanner Radio & Electric Co.  
906 Main St.

### Texarkana

Lavender Radio Supply Co.  
PO Box 596

## CALIFORNIA

### Bakersfield

Valley Radio Supply  
716 Baker St.

### Burbank

Valley Electronic Supply Co.  
1302 W. Magnolia Blvd.

### Fresno

Arbuckle Radio Mfg. Co.  
1427 Broadway

B. J. DeJarnatt Wholesale  
Radio Co.  
1260 Van Ness Ave.

Martin Distributing Co., Inc.  
2618 Tulare

### Glendale

Hagerty Radio Supply  
6826 San Fernando Road

### Los Angeles

Graybar Electric Co., Inc.  
201 Santa Fe Ave.

Henry Radio  
11240 West Olympic  
Kierulff & Company  
1837 Flower St.

Leo J. Meyberg Co.  
2027 S. Figueroa St.

Radio Products Sales Co.  
1501 South Hill

Radio Specialties Co.  
1956 So. Figueroa St.

Radio Television Supply Co.  
1509 S. Figueroa St.

### Long Beach

Fred S. Dean Co.  
969 American Ave.

Scott Radio Supply  
266 Alamos Ave.

### Modesto

Jack Warren Wholesale  
Radio Supply  
209 Yosemite Blvd.

### Oakland

W. D. Brill Co.  
10th & Jackson Sts.

Electric Supply Co.  
149 - 12th St.

E. C. Wenger Co.  
1450 Harrison St.

### Pasadena

Dow Radio Supply Co.  
1759 E. Colorado St.

### Sacramento

E. M. Kemp Co.  
1115 R Street

Sacramento Elec. Supply Co.  
711 Capitol Ave.

### Santa Ana

Radio & Television Equipment Co.  
207 Oak St.

### Santa Barbara

Channel Radio Supply Co.  
434 State St.

### San Bernardino

Electronic Equipment Distributors  
973 West Baseline

Inland Electronic Supply  
863 Colton Ave.

### San Diego

Coast Electric Co.  
744 G Street

Electronic Equipment Distributors  
1228-2nd Ave.

Western Radio & Television  
Supply Co.  
1415 India St.

### San Francisco

Associated Radio Distributors  
1251 Folsom St.

Graybar Electric Co.  
9th & Howard Sts.

Leo J. Meyberg Co.  
70 - 10th St.

Zack Radio Supply Co.  
1426 Market St.

San Francisco Radio Supply Co.  
1284 Market St.

### San Jose

Frank Quement, Inc.  
161 W. San Fernando St.

### Stockton

B. J. DeJarnatt Wholesale  
Radio Co.  
515 N. Hunter St.

## COLORADO

### Colorado Springs

Murray Radio Co.  
502 W. Colorado Ave.

### Denver

Inter-State Radio & Supply Co.  
1639 Tremont Place

Radio Products Sales Co.  
1237 - 16th St.

Stafford Electronics  
1423 Curtis St.

### Pueblo

L. B. Walker Radio Co.  
218 W. 8th St.

## CONNECTICUT

### Bridgeport

Hatry & Young, Inc.  
544 East Main St.

R. G. Sceli Co.  
84 Elm St.

### Hartford

Hatry & Young, Inc.  
203 Ann St.

R. G. Sceli Co.  
317 Asylum St.

### New Britain

United Radio Supply Co.  
47-53 East Main St.

### New Haven

Thomas H. Brown Co.  
106 State St.

Congress Radio Co.  
207 Congress Ave.

Hatry & Young, Inc.  
77 Broadway

### New London

Hatry & Young of  
New London Inc.  
428 Bank Street

### Stamford

Hatry & Young Inc.  
525 Main St.  
Stamford, Conn.

### Waterbury

The Bond Radio Supply  
18 Willow St.

Hatry & Young, Inc.  
89 Cherry St.

## DELAWARE

### Wilmington

Radio Electric Service Co.  
4th & Tatnall Sts.

Wilmington Electrical  
Specialty Co., Inc.  
405 Delaware Ave.

## FLORIDA

### Jacksonville

Graybar Electric Co.  
12th & Main Sts.

Kinkade Radio Supply  
1402 Laura St.

Thurow Distributors, Inc.  
15 - 17 E. Church St.

### Miami

Electronic Supply Co.  
61 N. E. 9th St.

Thurow Distributors, Inc.  
420 South West 8th St.

Walder Radio & Appliance Co.  
1809 N. E. 2nd Ave.  
Box 2240

### Orlando

Graybar Electric Co., Inc.  
533 West Central Ave.

Hammond-Morgan, Inc.  
PO Box 3162  
9 South Terry St.

Radio Accessories Co.  
65 - 69 East Church St.

Thurow Distributors, Inc.  
131 S. Court St.

### Pensacola

Gulf Electric Supply  
115 E. Gregory St.

Thurow Distributors, Inc.

### St. Petersburg

Cooper Radio Co.  
648 Second Ave., So.

Welch Radio Supply  
408 - 9th St. S.

### Tallahassee

Thurow Distributors, Inc.  
213 East Tennessee Ave.

## Tampa

Thurow Distributors, Inc.  
134 - 136 S. Tampa St.

## West Palm Beach

Thurow Distributors, Inc.  
308 S. Olive St.

## GEORGIA

### Atlanta

Concord Radio Corp.  
265 Peachtree St.

Graybar Electric Co.  
167 Walton St. N. W.

Southeastern Radio Parts Co.  
442 W. Peachtree St. N. W.

Specialty Distributing Co., Inc.  
425 Peachtree St. N. E.

### Columbus

Radio Sales & Service Co.  
1326 First Ave.

### Macon

Specialty Distributing Co.  
559 Mulberry St.

### Savannah

Southeastern Radio Parts Co.  
38 Montgomery St.

Specialty Distributing Co.  
223 E. Broughton St.

## HONOLULU, T. H.

Radio Wholesale & Supply Co.  
817 Alakea St.  
P. O. Box 3768

## IDAHO

### Boise

Craddock's Radio Supply  
1522 State St.

## ILLINOIS

### Chicago

Allied Radio Corporation  
833 W. Jackson Blvd.

Chicago Radio Apparatus  
Co., Inc.  
415 So. Dearborn St.

Concord Radio Corp.  
227 West Madison St.

Concord Radio Corp.  
901 W. Jackson Blvd.

Graybar Electric Co.  
500 S. Clinton St.

Green Mill Radio Supply  
145 West 111th St.

Lukko Sales Corp.  
5024 Irving Park Rd.

Montgomery-Ward & Co.  
619 W. Chicago Ave.

Newark Electric Co.  
323 West Madison St.

Radio Television Supply Co.  
435 N. LaSalle St.

Sears-Roebuck & Co.  
Homan & Arthington

Walker Jimieson  
311 So. Western Ave.

### DuQuoin

Meyers Radio Service

### Kankakee

Radio Doctors Supply House  
220 East Station St.

### Moline

Lofgren Distributing Co.  
1202 - 4th Ave.

### Peoria

Klaus Radio & Electric Co.  
707 Main St.

### Quincy

Cooper Supply Co.  
935 Main St.

### Rockford

Art A. Johnson Sales & Service  
1117 Charles St.

Mid-West Associated Distributors  
506 Walnut St.

**Rock Island**  
Tri-City Radio Supply  
1919 Fourth Ave.

**Springfield**  
Harold Bruce  
303 East Monroe St.  
Wilson Supply Co.  
108 W. Jefferson St.

## INDIANA

**Anderson**  
Seyberts Radio Supply  
19 East 12th St.

**Angola**  
Lakeland Radio Supply  
525 South West St.

**Evansville**  
Wesco Radio Parts  
7th & Pennsylvania Sts.

**Fort Wayne**  
Pemberton Laboratories  
236 East Columbia @ Barr St.  
Protective Electric Supply  
130 W. Columbia St.  
Warren Radio Company  
720 S. Clinton St.

**Gary**  
Cosmopolitan Radio  
524 Washington St.

**Hammond**  
Stanton Radio Supply  
521 State St.

**Indianapolis**  
Radio Distributing Co.  
1013 N. Capitol Ave.  
Van Sickle Radio Supply Co.  
34 West Ohio St.

**Kokomo**  
George's Radio & Appliances  
125 N. Buckeye St.

**Muncie**  
Standard Radio Parts Co., Inc.  
718 South Walnut St.

**Peru**  
Clingaman Radio  
814 W. Main St.

**Richmond**  
Fox Sound Equipment Co.  
126 S. 6th St.

**South Bend**  
Radio Distributing Co.  
Monroe & Carroll Sts.

**Terre Haute**  
Archer & Evinger  
1348 Wabash Ave.  
Terre Haute Radio  
501 Ohio St.

## IOWA

**Cedar Rapids**  
Gifford Brown Inc.  
106-108 First St., S. W.

**Council Bluffs**  
World Radio Laboratories, Inc.  
744 West Broadway

**Des Moines**  
Gifford Brown, Inc.  
1216 Grand Ave.  
Radio Trade Supply Co.  
1224 Grand Ave.

**Fort Dodge**  
Gifford Brown, Inc.  
1030 Central Ave.

**Ottumwa**  
Radio Trade Supply Co.  
115 W. 2nd St.

**Sioux City**  
Dukes Radio Co.  
209 - 11 Sixth St.

Power City Radio Co.  
513 Seventh St.

**Waterloo**  
Farnsworth Radio & Television  
623 Jefferson St.

Gifford-Brown, Inc.  
219 West 6th St.  
Ray-Mac Radio Supply  
324 West 4th St.  
Radio Trade Supply Co.  
110 W. 5th St.

## KANSAS

**Pittsburg**  
Pittsburg Radio Supply  
103 North Broadway

**Topeka**  
Acme Radio Supply  
634 Quincy St.  
Utility Supply Co.  
125 Kansas Ave.

**Wichita**  
Amateur Radio Equip. Co., Inc.  
1215 East Douglas  
Interstate Distributors, Inc.  
1236 East Douglas  
Radio Supply Co.  
1125 - 27 E. Douglas

## KENTUCKY

**Lexington**  
Electronic Distributors  
134 West 3rd St.  
PO Box 55

Kentucky Radio Supply  
519 Georgetown St.  
Radio Equipment Co.  
377 East Main St.

**Louisville**  
P. L. Burks & Co., Inc.  
911 West Broadway  
Universal Radio Supply Co.  
715 South Seventh St.

## LOUISIANA

**Alexandria**  
Central Radio Supply Co.  
113 De Soto St.  
PO Box 1688

**Lake Providence**  
F. H. Schneider & Sons, Inc.

**Monroe**  
Hale & McNeil

**New Orleans**  
Radio Parts, Inc.  
807 Howard Ave.  
Shuler Supply Co.  
415 Dryades St.  
Southern Radio Supply Co.  
407 S. Roman St.

**Shreveport**  
Inter-state Electric Co. of  
Shreveport, Inc.  
Koelemay Sales Co.  
327 Market St.

## MAINE

**Bangor**  
Radio Service Laboratory  
45 Haymarket Square

**Portland**  
Maine Electronic Supply Corp.  
13 Deer St.  
Radio Service Laboratory  
45 A Free St.

## MARYLAND

**Baltimore**  
Henry O. Berman Co.  
12 E. Lombard St.  
Kann-Ellert Electronics Inc.  
9 South Howard St.

Radio Electric Service Co.  
3 North Howard St.  
Wholesale Radio Parts Co., Inc.  
311 West Baltimore St.

## Hagerstown

Zimmerman Wholesalers  
114 E. Washington St.

## MASSACHUSETTS

**Boston**  
DeMambro Radio Supply Co.  
1111 Commonwealth Ave.  
Dormitzer Electric & Mfg. Corp.  
782 Commonwealth Ave.  
Graybar Electric Co., Inc.  
287 Columbus Ave.  
Hatry & Young, Inc.  
42 - 44 Cornhill  
A. W. Mayer Co.  
895 Boylston St.  
Radio Shack Corp.  
167 Washington St.  
Radio Wire Television, Inc.  
110 Federal St.

**Brockton**  
Ware Radio Supply Co.  
913 Center St.

**Cambridge**  
The Eastern Co.  
620 Memorial Drive

**Holyoke**  
Springfield Radio Co.  
93 High St.

**Lawrence**  
Hatry & Young, Inc.  
639 Essex St.

**New Bedford**  
C. E. Beckman Co.  
11 Commercial St.

**Pittsfield**  
Pittsfield Radio Co.  
44 West St.

**Springfield**  
T. F. Cushing  
349 Worthington St.  
Springfield Radio Co.  
405 Dwight St.

**Worcester**  
Eastern Company  
326 Chandler St.  
Radio Electronics Sales Co.  
46 Chandler St.  
Radio Maintenance Supply Co.  
19-25 Central St.

## MICHIGAN

**Ann Arbor**  
Wedemeyer Electronic Supply Co.  
213 N. Fourth Ave.

**Bay City**  
Kinde Distributing Co.  
504 Washington Ave.

**Butte Creek**  
Wedemeyer Electronic Supply Co.

**Detroit**  
M. N. Duffy & Co.  
2040 Grand River Ave.  
Graybar Electric Co.  
55 W. Canfield Ave.  
Radio Electronic Supply Co.  
1112 Warren Ave. West

Radio Specialties Co.  
456 Charlotte Ave.  
Radio Supply & Engineering  
Co., Inc.  
129 Selden

**Flint**  
Shand Radio Specialties  
203 W. Kearsley St.

**Grand Rapids**  
Radio Electronic Supply Co.  
443 S. Division  
Wholesale Radio Co.  
317 Division Ave., S.

**Jackson**  
Fulton Radio Supply Co.  
265 W. Cortland St.

**Kalamazoo**  
Ralph M. Ralston Co.  
201 N. Park St.

**Lansing**  
Wedemeyer Electronic Supply Co.  
205 North Cedar St.

**Larum**  
Northwest Radio

**Muskegon**  
Industrial Electric Supply Co.  
1839 Peck St.

**Pontiac**  
Electronic Supply Co.  
248 E. Pike St.

## MINNESOTA

**Duluth**  
Lew Bonn Company  
228 E. Superior St.  
Northwest Radio  
109 E. First St.

**Minneapolis**  
Lew Bonn Company  
1211 La Salle Ave.  
Graybar Electric Co.  
824 S. 4th St.  
Northwest Radio & Electronic  
Supply  
204 South 10th St.  
Stark Radio Supply Co.  
71 S. Twelfth St.

**St. Paul**  
Lew Bonn Co.  
141 - 147 West Seventh St.  
Hall Electric  
386 Minnesota St.

## MISSISSIPPI

**Greenville**  
The Goyer Supply Co.  
Radio Parts Dept.  
Greenville

**Jackson**  
Ellington Radio, Inc.  
816 South Gallatin St.  
Graybar Electric Co.  
758 Ricks St.

## MISSOURI

**Butler**  
Henry Radio  
211 North Main

**Joplin**  
4-State Radio & Supply Company  
201 Main St.

**Kansas City**  
Burststein-Applebee Co.  
1021 - 14 McGee St.  
Graybar Electric Co., Inc.  
1644 Baltimore Ave.

Radiolab  
1612 Grand Ave.

**Poplar Bluff**  
Tri-State Radio & Supply  
136 Bartlett St.

**Springfield**  
Harry Reed Radio & Supply Co.  
833 - 37 Boonville Ave.

**St. Joseph**  
St. Joseph Radio & Supply Co.  
922 Frances St.



## St. Louis

Graybar Electric Co., Inc.  
2642 Washington Ave.  
Walter Ashe Radio Co.  
1125 Pine St.  
Van Sickle Radio Co.  
1113 Pine St.

## MONTANA

### Billings

Electronic Supply Co.  
214 Eleventh St., West

## NEBRASKA

### Lincoln

Leuck Radio Supply  
243 So. 11th St.

### Omaha

J. B. Distributing Co.  
2855 - 57 Farnam St.  
Radio Equipment Co.  
2820 - 22 Farnam St.

## NEVADA

### Reno

Mariner Music House  
124 North Virginia St.

## NEW HAMPSHIRE

### Concord

Evans Radio  
8 No. Main St.

### Manchester

Radio Service Laboratory  
1191 Elm St.

## NEW JERSEY

### Atlantic City

Kearns, Inc.  
Harrisburg & Atlantic Aves.

### Camden

Radio Electric Service Co.  
513 Cooper St.

### Clifton

Eastern Radio Corp.  
637 Main Ave.

### Jersey City

Nidisco  
713 Newark Ave.

### Newark

Continental Sales Co.  
195 - 197 Central Ave.  
Aaron Lippman & Co.  
246 Central Ave.  
Radio Wire-Television, Inc.  
24 Central Ave.

### Phillipsburg

Carl B. Williams  
154 S. Main St.

### Trenton

Allen and Hurley  
25 South Warren St.

## NEW MEXICO

### Albuquerque

Radio Equipment Co.  
523 East Central Ave.  
Southwest Radio Supply  
324 N. Fourth St.

### Roswell

Falconi Electrical Service  
125 West 2nd St.

## NEW YORK

### Albany

Fort Orange Distributing Co., Inc.  
642 - 44 Broadway  
E. E. Taylor Co.  
465 Central Ave.

### Amsterdam

Adirondack Radio Supply  
32 Guy Park Ave.

### Binghamton

Federal Radio Supply Co.  
188 State St.

## Buffalo

Dymac, Inc.  
2329 Main St.  
Radio Equipment Corp.  
147 - 151 Genesee St.

## Cortland

C. A. Winchell  
37 Central Ave.

## Elmira

John M. Mulligan  
819 Clairmont Ave.

## Ithaca

Stallman of Ithaca  
210 - 12 N. Tioga St.  
P. O. Box 306

## Long Island

Harrison Radio Corp.  
172 - 31 Hillside Ave.  
Jamaica 3  
Norman Radio Distributors, Inc.  
94 - 29 Merrick Rd.  
Jamaica  
Peerless Radio Distributors, Inc.  
92 - 32 Merrick Rd.  
Jamaica

## Mt. Vernon

Davis Radio Distributing Co.  
66 E. 3rd St.

## New York City

Arrow Electronics Co.  
82 Cortlandt St.  
H. L. Dalis, Inc.  
17 Union Square  
Electronic Marketers, Inc.  
190 Varick St.  
Federated Purchaser  
80 Park Place  
Fordham Radio Supply Co.  
2269 - 71 Jerome Ave.  
Graybar Electric Co., Inc.  
420 Lexington Ave.  
Graybar Electric Co., Inc.  
180 Varick St.  
Harrison Radio Corp.  
12 W. Broadway  
Harvey Radio Co., Inc.  
103 W. 43rd  
Heins & Bolet, Inc.  
68 Cortlandt St.  
Milo Radio & Electronics Corp.  
200 Greenwich St.  
New Yorker Electronics Co.  
40 East 21st St.  
Newark Electric Co., Inc.  
212 Fulton St.  
Newark Electric Co., Inc.  
242 - 50 West 55th St.  
Newark Electric Co., Inc.  
115 W. 45th St.  
Niagara Radio Supply Corp.  
160 Greenwich St.  
Radio-Wire Television, Inc.  
100 Sixth Ave.  
Sanford Electronics Corp.  
136 Liberty St.  
Sun Radio & Electronics Co., Inc.  
122 - 24 Duane St.  
Technical Equipment Co.  
135 Liberty St.  
Terminal Radio Corp.  
85 Cortlandt St.

## Rochester

Beaucaire, Inc.  
114 Monroe Ave.  
Hunter Electronics  
233 East Ave.  
Mastline Radio & Electronic Equip. Co.  
192 - 96 Clinton Ave. N.  
Rochester Radio Supply Co.  
114 St. Paul St.

Radio Parts & Equipment Co.  
244 Clinton Ave. N.

## Niagara Falls

Niagara Radio & Parts Co.  
1518 Main St.

## Schenectady

M. Schwartz & Son  
710 Broadway

## Syracuse

W. E. Berndt  
655 S. Warren St.  
Broome Distributing Co.  
912 Erie Blvd. E.  
Syracuse Radio Supply  
238 W. Willow St.

## Utica

Beacon Radio Distributing  
703 Varick St.  
Beacon Electronics, Inc.  
218-220 Pearl St.  
Electronic Laboratories & Supply Co.  
512 Columbia St.  
Vaeth Elec. Co.  
35 Genesee St.

## Watertown

Beacon Electronics, Inc.  
108 Lincoln Bldg.

## White Plains

Westchester Electronic Supply Co.  
333 Mamaroneck Ave.

## NORTH CAROLINA

### Asheville

Freck Radio & Supply Co.  
38 Biltmore Ave.

### Charlotte

Dixie Radio Supply Co.  
912 S. Tryon St.  
Shaw Distributing Co.  
205 W. First St.

### Greensboro

Dixie Radio Supply Co., Inc.  
416 W. Market St.  
PO Box 2730  
Johannesen Electric Co.  
312 - 14 N. Eugene St.

### Raleigh

Carolina Radio Equipment Co.  
105 East Martin St.  
Southeastern Radio Supply Co.  
411 Hillsboro St.

### Wilmington

French Radio Co.  
1304 Market St.

### Winston-Salem

Dalton-Hege Radio Supply Co.  
340 Brookstown Ave.

## NORTH DAKOTA

### Fargo

Fargo Radio Service Co.  
515 Third Ave. N.

## OKLAHOMA

### Enid

Radio-Electronics, Inc.  
1032 E. Broadway

### Oklahoma City

Graybar Electric Co.  
706 West Main St.  
Radio Supply, Inc.  
724 N. Hudson  
Box 1972

### Tulsa

Radio, Inc.  
1000 S. Main St.  
S & S Radio Supply Co.  
721 S. Detroit St.

## OHIO

### Akron

Brighton Sporting Goods Corp.  
110 East Market St.

### Ashtabula

Morrison's Radio Supply  
331 Center St.

### Canton

Armstrong Radio Supply  
226 - 28 Second St. S. E.  
Burroughs Radio Co.  
620 Tuscarawas St. W.

### Cincinnati

Graybar Electric Co.  
310 Elm St.  
Herrlinger Distributing Co.  
15th & Vine Sts.  
Steinberg's Inc.  
633 Walnut St.  
The Mytronic Co.  
121 West Central Parkway  
United Radio, Inc.  
1314 Vine St.

### Cleveland

Graybar Electric Co., Inc.  
1010 Rockwell Ave.  
Northern Ohio Labs.  
2073 W. 85th St.  
Pioneer Radio Supply Corp.  
2115 Prospect Ave.  
The Progress Radio Supply Co.  
415 Huron Rd.  
Radio & Electronics Part Corp.  
519 Huron Rd.  
Winteradio, Inc.  
1468 W. 25th St.

### Columbus

Hughes-Peters, Inc.  
111 - 117 East Long St.  
Thompson Radio Supplies  
218 E. Gay St.

### Dayton

Hughes-Peters, Inc.  
300 W. 5th at Perry  
Standard Radio & Electronic Products Co.  
135 E. Second St.

### East Liverpool

D & R Radio Supply  
631 Dresden Ave.

### Mansfield

Burroughs Radio Co.  
43 So. Diamond St.

### Springfield

Eberlie's Radio Supply  
522 West Main St.

### Steubenville

D & R Radio Supply  
156 S. 3rd St.

### Toledo

The H & W Auto Accessories Co.  
713 Adams St.  
G. L. Snow Electronic Service  
922 Monroe St.

### Youngstown

Ross Radio Company  
325 W. Federal St.

## OREGON

### Eugene

United Radio Supply, Inc.  
179 W. 8th St.

### Medford

Verl G. Walker Co.  
205 West Jackson

### Portland

Bargelt Supply Co.  
1131 SW Washington  
Harper Megee Co.  
1506 N W Irving St.

Northwest Radio Supply Co.  
717 S W Ankeny St.  
Stubbs Electric Co.  
33 N W Park Ave.  
United Radio Supply, Inc.  
22 N. W. Ninth Ave.

## PENNSYLVANIA

### Allentown

Radio Electric Service Co.  
1042 Hamilton St.

### Easton

Radio Electric Service Co.  
9 N. 2nd St.

### Erie

J. V. Duncombe Co.  
1011 W. 8th St.  
Jordan Electronic Co.  
201 W. 4th St.

### Harrisburg

Radio Distributing Co.  
140 S. Second St.

### Lancaster

George D. Barbey Co.  
29 E. Vine St.

### Philadelphia

Almo Radio Co.  
509 Arch St.  
Consolidated Radio Co.  
612 Arch St.  
Electric Warehouse  
1320 W. Erie Ave.  
Graybar Electric Co., Inc.  
910 Cherry St.  
Herbach & Rademan Co.  
522 Market St.  
M & H Sporting Goods Co.  
512 Market St.  
Radio Electric Service Co.  
5133 Market St.  
Radio Electric Service Co.  
3145 N. Broad St.  
Radio Electric Service Co.  
N. W. Corner 7th & Arch Sts.  
Eugene G. Wile  
10 S. 10th St.

### Pittsburgh

Cameradio  
963 Liberty Ave.  
Graybar Electric Co., Inc.  
37 Water St.  
M. V. Mansfield Co.  
937 Liberty Ave.  
Tydings Company  
632 Grand St.

### Reading

George D. Barbey Co.  
2nd & Penn Sts.

### Scranton

Fred P. Purcell  
548 - 550 Wyoming Ave.  
Scranton Radio & Television  
Supply Co.  
519 Mulberry St.

## RHODE ISLAND

### Providence

DeMambo Radio Supply Co.  
90 Broadway  
Eastern Company  
130 Broadway  
W. H. Edwards Co.  
94 Broadway

## SOUTH CAROLINA

### Columbia

Dixie Radio Supply Co., Inc.  
1715 Main St.

### Charleston

Radio Laboratories  
215 King St.

### Greenville

Dixie Radio Supply Co.  
22 S. Richardson St.  
Gilliam Radio Co.  
117 W. Coffee St.

## SOUTH DAKOTA

### Sioux Falls

Power City Radio Co.  
209 So. First Ave.

## TENNESSEE

### Chattanooga

Specialty Distributing Co.  
709 Chestnut St.

### Jackson

L. K. Rush Company  
Box 1418

### Knoxville

Chemcity Radio & Electric Co.  
12 Emory Park  
PO Box 3131  
Roden Electrical Supply Co.  
808 N. Central Ave.

### Memphis

Bluff City Distributing Co.  
905 Union Ave.

### Nashville

Braid Electric Co.  
109 Eleventh Ave. So.  
Electra Distributing Co.  
1914 West End Ave.

## TEXAS

### Abilene

R. & R. Electronic Co.  
1074 N. 1st St.

### Amarillo

R. & R. Electronic Co.  
412 W. 10th St.

### Austin

The Hargis Co.  
706 - W. 6th St.

### Beaumont

Montague Radio Distributing Co.  
220 Willow St.  
PO Box 3045

### Corpus Christi

Electronic Equipment &  
Engineering Co.  
1310 So. Staples St.  
Modern Radio Supply  
308 South Staples St.  
Wicks-DeVilbiss Co.  
516 - 18 South Staples St.

### Dallas

Crabtree's Wholesale Radios  
2608 Ross Ave.  
Globe Radio, Inc.  
2922 Elm St.  
Graybar Electric Co., Inc.  
400 So. Austin St.  
R. C. & L. F. Hall  
2123 Cedar Springs Ave.  
Wilkinson Bros.  
PO Box 1169  
Southwest Radio Supply  
1820 N. Harwood St.

### Denison

Denison Radio Supply  
124 West Main St.

### El Paso

Reeves-Elliott Co.  
720 N. Stanton St.

### Fort Worth

Electronic Equipment Co.  
301 E. 5th St.  
Ft. Worth Radio Supply Co.  
1201 Commerce St.

### Galveston

R. C. & L. F. Hall  
1803 Tremont St.

### Harlington

Modern Radio Supply  
111 West Van Buren St.

### Houston

R. C. & L. F. Hall  
1306 Clay Ave.  
PO Box 2434  
Harrison Equipment Co.  
1422 San Jacinto St.  
Houston Radio Supply Co., Inc.  
Clay at LaBranch  
Straus-Frank Company  
4000 Leeland Ave.

### Lubbock

R & R Supply Co., Inc.  
706 Main St.

### San Antonio

Amateur Radio Supply Co.  
746 E. Myrtle St.  
Straus-Frank Company  
301 S. Flores St.

### Tyler

Lavender Radio Supply Co.  
110 Swann St.

### Waco

The Hargis Co., Inc.  
1305 Austin St.

### Wichita Falls

Clark & Gose Radio Supply  
1204 Ohio St.

## UTAH

### Salt Lake City

Graybar Electric Co., Inc.  
245 South 1st West St.  
O'Laughlin's Radio Supply Co.  
113 East Third South  
Radio Supply Co.  
45 East Fourth South  
Standard Supply Co.  
531 So. State St.

## VIRGINIA

### Ashland

Radio Service Co.

### Lynchburg

Eastern Electric Co.  
315 Twelfth St.

### Norfolk

Radio Equipment Co.  
821 West 21st St.  
Radio Parts Distributing Co.  
128 W. Olney Rd.  
Radio Supply Co.  
711 Granby St.

### Richmond

The Arnold Company  
2349 W. Broad St.  
Graybar Electric Co., Inc.  
6th & Cary Sts.

Mattson's Radio  
519 W. Broad

Radio Supply Co.  
3302 W. Broad St.

### Roanoke

H. C. Baker Sales Co., Inc.  
19 Franklin Rd.  
Leonard Electronic Supply Co.  
106 Second St. S. W.

## WEST VIRGINIA

### Charleston

Chemcity Radio & Electric Co.  
1225 E. Washington St.  
Sigmon's  
708 Bigley Ave.

### Huntington

Electronic Supply, Inc.  
422 Eleventh St.

### Wheeling

General Distributors  
Hotel Wheeling Bldg.

## WASHINGTON

### Bellingham

Waifkus Supply Co.  
110 Grand Ave.

### Everett

Pringle Radio Wholesale Co.  
2514 Colby Ave.

### Seattle

Alaska Radio Supply, Inc.  
14613 - 11th S. W.  
Graybar Electric Co.  
King & Occidental Sts.  
Harper-Meggee, Inc.  
960 Republican St.  
Radio Products Sales Co.  
1214 - 1st Ave.  
Seattle Radio Supply, Inc.  
2117 - 2nd Ave.  
Western Electronic-Supply Co.  
2609 First Ave.

### Spokane

Columbia Electric & Mfg. Co.  
So. 123 Wall St.  
Harper-Meggee Co.  
N. 734 Division  
Northwest Electronics Co.  
North - 102 Monroe St.

### Tacoma

C & G Radio Supply Co.  
714 St. Helens Ave.

### Walla Walla

Kar Radio & Electric Co.  
PO Box 676  
12th & Pine Sts.

### Yakima

Lay & Nord  
112 South Second St.

## WASHINGTON D. C.

Capitol Radio Wholesalers  
2120 - 14th St. N. W.  
General Electric Supply Corp.  
1330 New York Ave. N. W.  
Graybar Electric Co.  
1329 E. Street N. W.  
Kenyon Radio Supply Company  
2214 - 14th Street, N. W.  
Rucker Radio Wholesalers  
1312 - 14th St. N. W.

## WISCONSIN

### Appleton

Appleton Radio Supply Co.  
1217 N. Richmond St.  
Valley Radio Distributors  
518 N. Appleton St.

### Beaver Dam

Kamrath Radio Service  
306 South Spring St.

### Madison

Satterfield Radio Supply  
326 W. Gorham St.

### Milwaukee

Central Radio Parts Co.  
1723 W. Fond du Lac Ave.  
Electro-Pliance Distributors, Inc.  
2458 W. Lisbon Ave.  
Milwaukee 5  
Radio Parts Co., Inc.  
536 - 38 West State St.

### Wausau

Radio Service & Supply Co.  
615 - 3rd St.

# TUBE REPLACEMENT CHART

Tubes in the column marked "TYPE REPLACED" should be replaced with "EIMAC TUBE TYPE" shown in first column. Replacement with the EIMAC TUBE TYPE will require no reductions in voltages or power input or changes in mechanical connections.

Tubes under the heading "NEAR EQUIVALENT" can be replaced with EIMAC tubes provided changes are made in the electrical values or mechanical connections. Where an "X" appears in the "REQUIRED CHANGES" column some change is indicated.

Eimac Tube Type	Type Replaced	NEAR EQUIVALENT					
		Type	REQUIRED CHANGES				
			FIL. V	BIAS	SOCKET	PLATE CONNECTOR	GRID CONNECTOR
2C39	3X100A11 GL2C39 ZP572						
3C24	25TG 3-25D3 VT204 24G DR24G PE130A	3C28 TUF20 PE130B		X	X	X	X X X
3C37	3X150A3						
3X2500A3		7C24 7C25 WL473	X X X		X X X	X X X	X X X
25T	3-25A3 3C34 24 PE130C	HY30Z NU30Z 809 GL809 NU809  WL809 1623 GL1623 NU1623		X X X X X  X		X X X X X  X X X X	
35T	3-50A4 PE35T	HY40 T40 NU40T HY40Z TZ40  NU40TZ T55  811 DR811 GL811 NU811 WL811  812 812H DR812 GL812 NU812  WL812	X X X X X  X X  X X X X X  X X X X X  X	   X X  X X		X X X X X  X X  X X X X X  X X X X X  X	
35TG	3-50D4	4C25 54 356A 808 DR808	   X X	X X	   X	   X X X X	X X X X X
UH50	3-50G2 BW11 304B 834						



## TUBE REPLACEMENT CHART TRIODES (Continued)

Eimac Tube Type	Type Replaced	NEAR EQUIVALENT					
		Type	REQUIRED CHANGES				
			FIL. V	BIAS	SOCKET	PLATE CONNECTOR	GRID CONNECTOR
75TH	3-75A3	HY51A	X			X	X
		NU51A	X			X	X
		HY51B	X			X	X
		HY51Z	X	X		X	X
		TW75	X			X	X
		8005	X			X	X
75TL	3-75A2 75T						
100TH	3-100A4 VT218 RK38	4C22	X	X		X	X
		HF100	X	X		X	X
		T125	X		X	X	X
		254		X	X	X	
		810	X		X	X	X
		GL810	X		X	X	X
		WL810	X		X	X	X
	DR100TH						
100TL	3-100A2 RK36 50T	8000	X		X	X	X
152TH	3-150A3 152H						
152TL	3-150A2 152L 152T						
250TH	3-250A4 VT220 RK36	4C32	X			X	X
		TW150	X			X	X
		354E				X	X
		354F		X		X	X
		WL463		X	X	X	X
		PE530	X			X	X
		GL592	X		X		
	454H	822S	X			X	X
250TL	3-250A2 VT130 150T 454L	4C34	X			X	X
		HV18	X			X	X
		KU23	X			X	X
		DR200	X			X	X
		EE200	X			X	X
		HF200	X			X	X
		NU200	X			X	X
		T200	X			X	X
		DR300	X			X	X
		EE300	X			X	X
		HF300	X			X	X
		NU300	X			X	X
		354C		X		X	X
		354D		X		X	X
		WL460	X			X	X
		806				X	X
		GL806				X	X
		WL806				X	X
	3-300A3 VT254 304H WL535						
	3-300A2 VT129 304L 304T WL525						
450TH	3-450A4 VT108 WL450 F450TH 854H	357A	X		X	X	X
		833A	X		X		X
		DR833A	X		X		X
		GL833A	X		X		X
		ML833A	X		X		X
		WL833A	X		X		X



## TUBE REPLACEMENT CHART TRIODES (Continued)

Eimac Tube Type	Type Replaced	NEAR EQUIVALENT					
		Type	REQUIRED CHANGES				
			FIL. V	BIAS	SOCKET	PLATE CONNECTOR	GRID CONNECTOR
450TL	3-450A2 300T 854L						
750TL	3-750A2 1054L						
1000T	3-1000A4 1000UHF						
1500T	3-1500A3						
2000T	3-2000A3	HF3000 ZB3200	X X	X	X X	X X	X X

## TETRODES

Eimac Tube Type	Type Replaced	Type	NEAR EQUIVALENT				
			REQUIRED CHANGES				
			FIL. V	BIAS	SOCKET	PLATE CONNECTOR	GRID CONNECTOR
4-125A	4D21 4D23 AT340 PE340	4E27		X	X	X	
		RK65			X	X	
		257		X	X	X	
		257B		X	X	X	
		AT257C		X	X	X	
		PE257C		X	X	X	
		813	X	X	X	X	
		GL813	X	X	X	X	
		ML813	X	X	X	X	
		NU813	X	X	X	X	
		WL813	X	X	X	X	
		8001		X	X	X	
4-250A	5D22 5D24	363A GL592	X X	X	X X	X X	X
4X500A		RK6D22	X	X	X	X	X

## RECTIFIERS

Eimac Tube Type	Type Replaced
2-150A 2-150D RX21A KY21A 100R	2-100A GL451 WL578 8020 DR8020 GL8020
250R	2-250A TR40M 371B DR371B NU371B
866A	866 UE966 UE966A
872A	872 UE972

## VACUUM CAPACITORS

EIMAC VAC CAP	TYPE REPLACED	NEAR EQUIVALENT		
		TYPE NO.	REQUIRED CHANGES	
			CONNECTORS	SPACING
VC6-20	VC6			
VC12-20	VC12	GL1L21 GL1L25	X X	X X
VC25-20	VC25	GL1L22 GL1L36	X X	X X
VC50-20	VC50	GL1L23 GL1L38	X X	X X
VC250				
VC1000				
VC6-32	VC6			
VC12-32	VC12			
VC25-32	VC25			
VC50-32	VC50			





## TUBE REPLACEMENT CHART—CROSS INDEX

FOR TYPE NO.	USE EIMAC	FOR TYPE NO.	USE EIMAC	FOR TYPE NO.	USE EIMAC	FOR TYPE NO.	USE EIMAC
GL1L21	VC12-20	KU23	250TL	VT220	250TH	809	25T
GL1L22	VC25-20	24	25T	254	100TH	GL809	25T
GL1L23	VC50-20	24G	3C24	VT254	304TH	NU809	25T
GL1L25	VC12-20	DR24G	3C24	257	4-125A	WL809	25T
GL1L36	VC25-20	25TG	3C24	257B	4-125A	810	100TH
GL1L38	VC50-20	HY30Z	25T	PE257B	4-125A	GL810	100TH
2-100A	100R	NU30Z	25T	AT257C	4-125A	WL810	100TH
2-250A	250R	PE35T	35T	PE257C	4-125A	811	35T
GL2C39	2C39	RK36	100TL	DR300	250TL	DR811	35T
3-25A3	25T	RK38	100TH	EE300	250TL	GL811	35T
3-25D3	3C24	HY40	35T	HF300	250TL	NU811	35T
3-50A4	35T	HY40Z	35T	NU300	250TL	WL811	35T
3-50D4	35TG	NU40T	35T	300T	450TL	812	35T
3-50G2	UH50	NU40TZ	35T	304B	UH50	812H	35T
3-75A2	75TL	T40	35T	304H	304TH	DR812	35T
3-75A3	75TH	TR40M	250R	304L	304TL	GL812	35T
3-100A2	100TL	TZ40	35T	304T	304TL	NU812	35T
3-100A3	100TH	50T	100TL	AT340	4-125A	WL812	35T
3-150A2	152TL	HY51A	75TH	PE340	4-125A	813	4-125A
3-150A3	152TH	HY51B	75TH	354C	250TL	GL813	4-125A
3-250A3	250TL	HY51Z	75TH	354D	250TL	ML813	4-125A
3-250A4	250TH	NU51A	75TH	354E	250TH	NU813	4-125A
3-300A2	304TL	54	35TG	354F	250TH	WL813	4-125A
3-300A3	304TH	T55	35T	356A	35TG	822S	250TH
3-450A2	450TL	RK63	250TH	357A	450TH	833	450TH
3-450A4	450TH	RK65	4-125A	363A	4-250A	833A	450TH
3-750A2	750TL	75T	75TL	371B	250R	DR833A	450TH
3-1000A4	1000T	TW75	75TH	DR371B	250R	GL833	450TH
3-1500A3	1500T	DR100TH	100TH	NU371B	250R	ML833A	450TH
3-2000A3	2000T	HF100	100TH	F450	450TH	WL833A	450TH
3C28	3C24	VT108	450TH	WL450	450TH	834	UH50
3C34	25T	T125	100TH	GL451	100R	854H	450TH
3X100A11	2C39	VT129	304TL	454H	250TH	854L	450TH
3X150A3	3C37	PE130A	3C24	454L	250TL	1000UHF	1000T
4C22	100TH	PE130B	3C24	WL460	250TL	1054L	750TL
4C25	35TG	PE130C	25T	WL463	250TH	1623	25T
4C32	250TH	VT130	250TL	WL473	3X2500A3	GL1623	25T
4C34	250TL	150T	250TL	WL525	304TL	NU1623	25T
4D21	4-125A	TW150	250TH	PE530	250TH	HF3000	2000T
4D23	4-125A	152H	152TH	WL535	304TH	8000	100TL
4E27	4-125A	152L	152TL	ZP572	2C39	8001	4-125A
5D22	4-250A	152T	152TL	WL578	100R	8005	75TH
5D24	4-250A	DR200	250TL	GL592	4-250A	8020	100R
RK6D22	4X500A	EE200	250TL	GL592	250TH	DR8020	100R
7C24	3X2500A3	HF200	250TL	806	250TL	GL8020	100R
7C25	3X2500A3	NU200	250TL	GL806	250TL		
BW11	UH50	T200	250TL	WL806	250TL		
HV18	250TL	VT204	3C24	808	35TG		
TUF20	3C24	VT218	100TH	DR808	35TG		

# Class C Amplifier Calculations With The Aid of Constant-Current Characteristics

In calculating and predicting the operation of a vacuum tube as a class-C radio frequency amplifier, the considerations which determine the operating conditions are plate efficiency, power output required, maximum allowable grid and plate dissipation, maximum allowable plate voltage and maximum allowable plate current. The values chosen for these factors will depend both on the demands of a particular application and the tube selected to do the job.

The plate and grid currents of a class-C amplifier are periodic pulses, the durations of which are always less than 180 degrees. For this reason the average plate and grid currents, power output, driving power, etc., cannot be directly calculated but must be determined by a Fourier analysis from points selected along the line of operation as plotted on the constant-current characteristics. This may be done either analytically, or graphically. While the Fourier analysis has the advantage of accuracy, it also has the disadvantage of being tedious and involved.

An approximate analysis which has proven to be sufficiently accurate for most purposes is presented in the following material. This system has the advantage of giving the desired information at the first trial. The system, which is an adaption of a method developed by Wagener<sup>1</sup>, is direct because the important factors, power output, plate efficiency and plate voltage may be arbitrarily selected at the beginning.

In the material which follows, the following set of symbols will be used. These symbols are illustrated graphically in Figure 1.

## Symbols

- $P_i$  = Plate power input
- $P_o$  = Plate power output
- $P_p$  = Plate dissipation
- $n$  = Plate efficiency expressed as a decimal
- $E_{bb}$  = D-c plate supply voltage
- $E_{pm}$  = Peak fundamental plate voltage
- $E_{bmin}$  = Minimum instantaneous plate voltage
- $I_b$  = Average plate current
- $I_{bm}$  = Peak fundamental plate current
- $i_{bmax}$  = Maximum instantaneous plate current
- $\theta_p$  = One-half angle of plate current flow
- $E_{cc}$  = D-c grid bias voltage (a negative quantity)

- $E_{gm}$  = Peak fundamental grid excitation voltage
- $e_{cmp}$  = Maximum positive instantaneous grid voltage
- $I_c$  = Average grid current
- $i_{cmmax}$  = Maximum instantaneous grid current
- $P_d$  = Grid driving power (including both grid and bias losses)
- $P_g$  = Grid dissipation
- $\mu$  = Amplification factor

## Method

The first step in the use of the system to be described is to determine the power which must be delivered by the class-C amplifier. In making this determination it is well to remember that ordinarily from 5 to 10 per cent of the power delivered by the amplifier tube or tubes will be lost in well-designed tank and coupling circuits at frequencies below 20 Mc. Above 20 Mc. the tank and coupling circuit losses are ordinarily somewhat above 10 per cent.

The plate power input necessary to produce the required output is determined by the plate efficiency:

$$P_i = \frac{P_o}{n}$$

For most applications it is desirable to operate at the highest possible efficiency. High-efficiency operation usually requires less expensive tubes and power supplies, and the amount of artificial cooling needed is frequently less than for low-efficiency operation. On the other hand, high-efficiency operation often requires more driving power and higher operating plate voltages. Eimac triodes will operate satisfactorily at 80 per cent efficiency at the highest recommended plate voltages and at 75 per cent efficiency at medium plate voltages.

The first determining factor in selecting a tube or tubes for any particular application is the maximum allowable plate dissipation. The total plate dissipation rating for the number of tubes used must be equal to or greater than that calculated from

$$P_p = P_i - P_o$$

After selecting a tube or tubes to meet the power output and plate dissipation requirements it becomes necessary to determine from the tube characteristics whether the tube selected is capable of the required operation and, if so, to determine the driving power, grid bias and grid current.

<sup>1</sup> W. G. Wagener "Simplified Methods for Computing Performance of Transmitting Tubes," *Proc. I.R.E.*, Vol. 25, p. 47, (Jan. 1937).

The complete procedure necessary to determine the class-C-amplifier operating conditions is as follows<sup>2</sup>:

1. Select plate voltage, power output and efficiency.

2. Determine plate input from

$$P_i = \frac{P_o}{\eta}$$

3. Determine plate dissipation from

$$P_p = P_i - P_o$$

$P_p$  must not exceed maximum rated plate dissipation for tube or tubes selected.

4. Determine average plate current from

$$I_b = \frac{P_i}{E_{bb}}$$

$I_b$  must not exceed maximum rated plate current for tube selected.

5. Determine approximate  $i_{bmax}$  from

$$\begin{aligned} i_{bmax} &= 4.5I_b \text{ for } \eta = 0.80 \\ i_{bmax} &= 4.0I_b \text{ for } \eta = 0.75 \\ i_{bmax} &= 3.5I_b \text{ for } \eta = 0.70 \end{aligned}$$

6. Locate the point on constant-current characteristics where the constant plate current line corresponding to the approximate  $i_{bmax}$  determined in step 5 crosses the line of equal plate and grid voltages ("diode line"). Read  $e_{bmin}$  at this point.<sup>3</sup>

7. Calculate  $E_{pm}$  from

$$E_{pm} = E_{bb} - e_{bmin}$$

8. Calculate the ratio  $\frac{I_{pm}}{I_b}$  from

$$\frac{I_{pm}}{I_b} = \frac{2\eta E_{bb}}{E_{pm}}$$

9. From the ratio of  $\frac{I_{pm}}{I_b}$  calculated in step 8 determine the ratio  $\frac{i_{bmax}}{I_b}$  from Chart 1.

10. Calculate a new value for  $i_{bmax}$  from ratio found in step 9.

$$i_{bmax} = (\text{ratio from step 9}) I_b$$

11. Read  $e_{cmp}$  and  $i_{cmax}$  from constant current characteristics for values of  $e_{bmin}$  and  $i_{bmax}$  determined in steps 6 and 10.

12. Calculate the cosine of one-half the angle of plate current flow from

$$\cos \theta_p = 2.3 \left( \frac{I_{pm}}{I_b} - 1.57 \right)$$

13. Calculate the grid bias voltage from

$$E_{cc} = \frac{1}{1 - \cos \theta_p} \left[ \cos \theta_p \left( \frac{E_{pm}}{\mu} - e_{cmp} \right) - \frac{E_{bb}}{\mu} \right]$$

14. Calculate the peak fundamental grid excitation voltage from

$$E_{gm} = e_{cmp} - E_{cc}$$

15. Calculate the ratio  $\frac{E_{gm}}{E_{cc}}$  for values of  $E_{cc}$  and  $E_{gm}$  found in steps 13 and 14.

16. Read ratio  $\frac{i_{cmax}}{I_c}$  from Chart 2 for ratio  $\frac{E_{gm}}{E_{cc}}$  found in step 15.

17. Calculate average grid current from ratio found in step 16 and value of  $i_{cmax}$  found in step 11.

$$I_c = \frac{i_{cmax}}{\text{ratio from step 16}}$$

18. Calculate approximate grid driving power from

$$P_d = 0.9 E_{gm} I_c$$

19. Determine grid dissipation from

$$P_g = P_d + E_{cc} I_c$$

$P_g$  must not exceed the maximum rated grid dissipation for the tube selected.

### Example

A typical application of this procedure is shown in the example below.

1. Desired power output..... 1250 watts  
Desired plate voltage..... 4000 volts  
Desired plate efficiency..... 75 per cent ( $\eta = 0.75$ )

$$2. \quad P_i = \frac{1250}{0.75} = 1670 \text{ watts}$$

$$3. \quad P_p = 1670 - 1250 = 420 \text{ watts}$$

Try type 450TL; Max.  $P_p = 450W$ ;  $\mu = 18$

$$4. \quad I_b = \frac{1670}{4000} = 0.417 \text{ ampere}$$

(Max.  $I_b$  for 450TL = 0.600 ampere)

5. Approximate  $i_{bmax} = 4.0 \times 0.417 = 1.67$  ampere

$$6. \quad e_{bmin} = 315 \text{ volts (see figure 2)}$$

$$7. \quad E_{pm} = 4000 - 315 = 3685 \text{ volts}$$

$$8. \quad \frac{I_{pm}}{I_b} = \frac{2 \times 0.75 \times 4000}{3685} = 1.63$$

$$9. \quad \frac{i_{bmax}}{I_b} = 3.45 \text{ (from Chart 1)}$$

$$10. \quad i_{bmax} = 3.45 \times 0.417 = 1.44 \text{ amperes}$$

$$11. \quad e_{cmp} = 280 \text{ volts}$$

$$i_{cmax} = 0.330 \text{ amperes}$$

(see figure 3)

$$12. \quad \cos \theta_p = 2.32 (1.63 - 1.57) = 0.139$$

$$13. \quad E_{cc} = \frac{1}{1 - 0.139} \left[ 0.139 \left( \frac{3685}{18} - 280 \right) - \frac{4000}{18} \right] = -270 \text{ volts}$$

$$14. \quad E_{gm} = 280 - (-270) = 550 \text{ volts}$$

$$15. \quad \frac{E_{gm}}{E_{cc}} = \frac{550}{-270} = -2.04$$

$$16. \quad \frac{i_{cmax}}{I_c} = 5.69 \text{ (from Chart 2)}$$

$$17. \quad I_c = \frac{0.330}{5.69} = 0.058 \text{ amperes}$$

$$18. \quad P_d = 0.9 \times 550 \times 0.058 = 28.7 \text{ watts}$$

$$19. \quad P_g = 28.7 + (-270 \times 0.058) = 13.0 \text{ watts}$$

(Max  $P_g$  for 450TL = 65 watts)<sup>6</sup>

<sup>2</sup> In the case of push-pull or parallel amplifier tubes the analysis should be carried out on the basis of a single tube, dividing  $P_i$ ,  $P_o$  and  $P_p$  by the number of tubes before starting the analysis and multiplying  $I_b$ ,  $I_c$  and  $P_d$  by the same factor after completing the analysis.

<sup>3</sup> In a few cases the lines of constant plate current will inflect sharply upward before reaching the diode line. In these cases  $e_{bmin}$  should not be read at the diode line but at the point where the plate current line intersects a line drawn from the origin through these points of inflection.

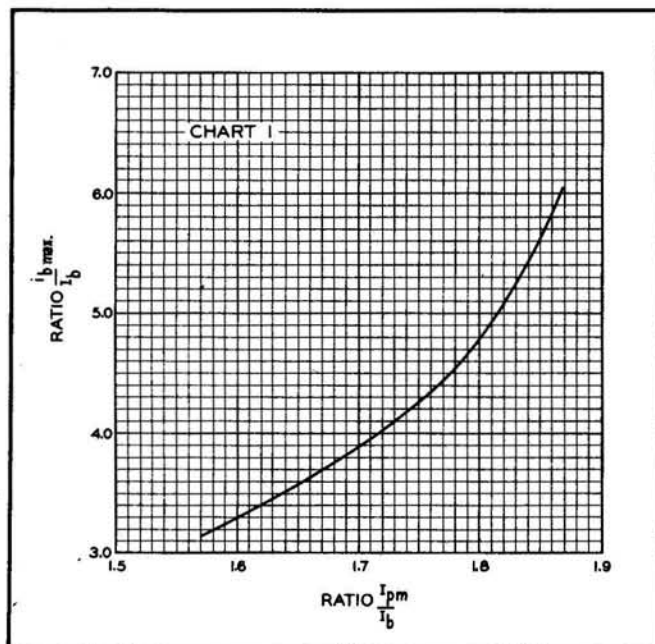


Chart 1

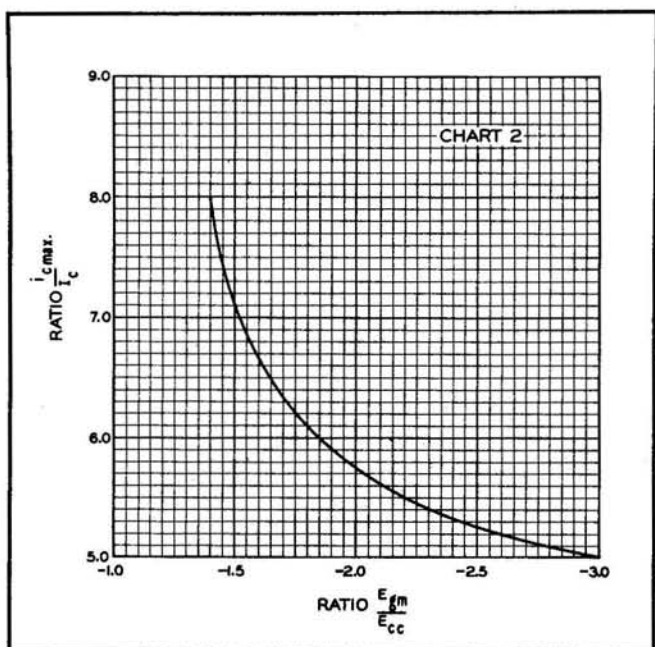


Chart 2

### Nomographs

This system of class-C amplifier analysis is now being converted to nomograph form for presentation in the near future.

- 4 If this calculation gives  $\cos \theta_p$  as zero or a negative quantity class-B operation is indicated and new operating conditions should be chosen on a basis of higher efficiency (less plate dissipation, more power output or less power input).
- 5 The calculated driving power is that actually used in supplying the grid and bias losses. Suitable allowance in driver design must be made to allow for losses in the coupling circuits between the driver plate and the amplifier grid.
- 6 "Vacuum Tube Ratings" Eimac News, Industrial Edition, Jan. 1945.

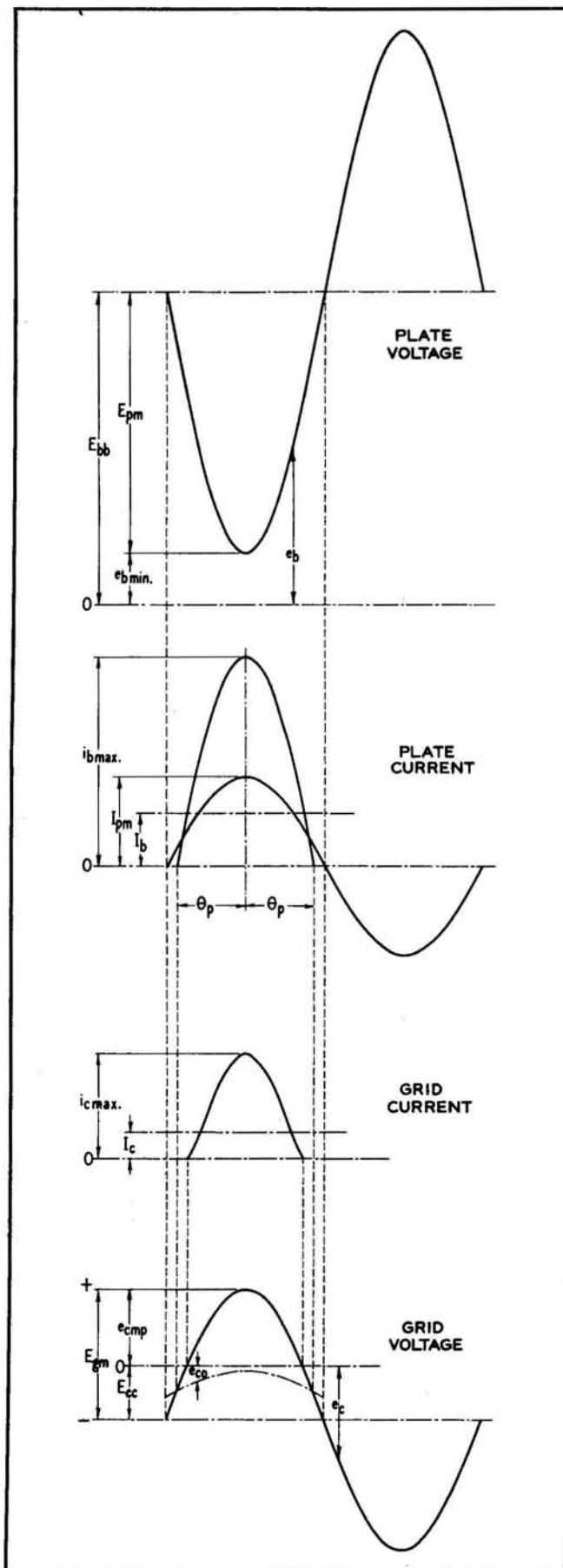


Figure 1. Symbols

**EIMAC**  
450TL

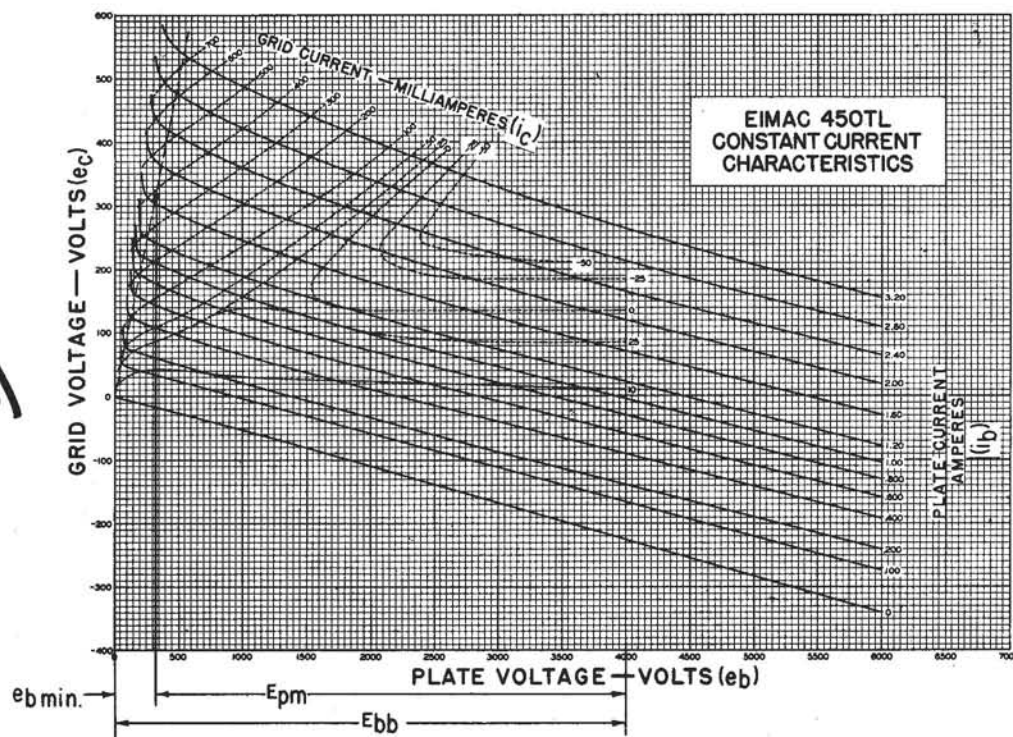


Figure 2. 450TL constant-current characteristics showing method of determining  $e_{b \min.}$  and  $E_{pm}$  in steps 6 and 7 from value of  $i_b$  obtained in step 5.

**EIMAC**  
450TL

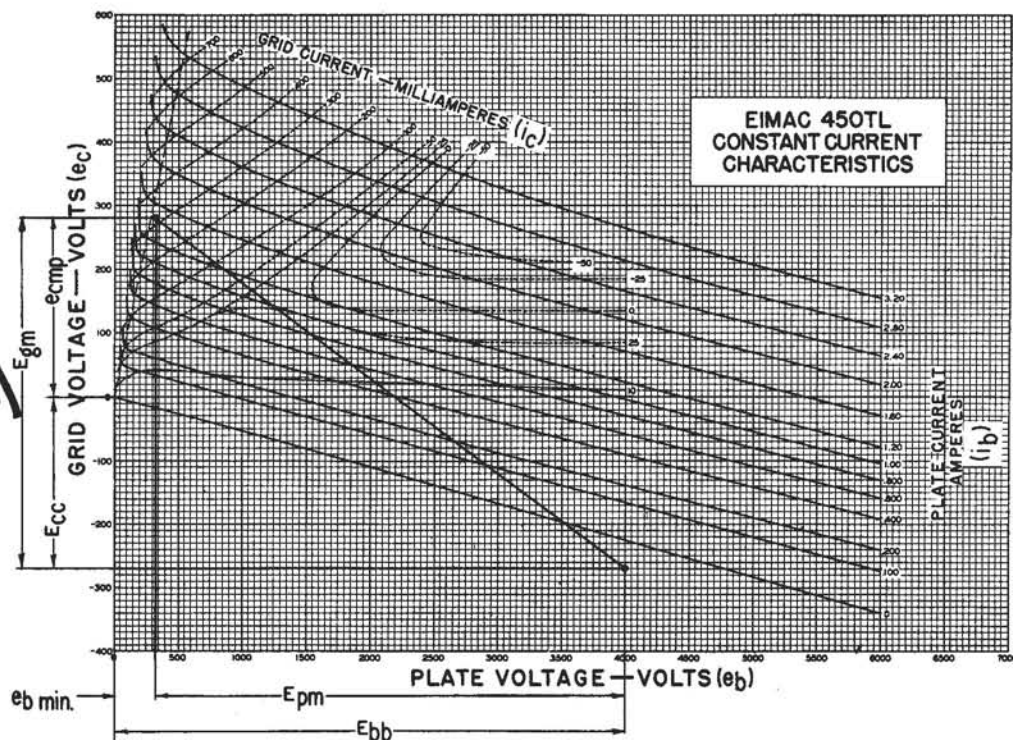


Figure 3. Method of determining  $e_{cmp}$  and  $i_c$  on 450TL constant-current characteristics from values of  $e_{b \min.}$  and  $E_{pm}$  found in steps 6 and 7 and value of  $i_b$  found in step 10. The value of  $E_{cc}$  and  $E_{gm}$  from steps 13 and 14 and the operating line are also shown.



*(Reprinted from January, 1945 industrial edition of the Eimac News)*

# Vacuum Tube Ratings

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EITEL-McCULLOUGH, INC.  
SAN BRUNO, CALIF.

# Vacuum Tube Ratings

The data presented on tube data sheets are usually divided into three categories, (1) Electrical and Mechanical Characteristics, (2) Maximum Ratings and (3) Typical Operating Conditions. Electrical and mechanical characteristics are self-explanatory. The typical operating conditions are intended to guide the user in application of the tube under certain "typical" conditions. Several typical operating conditions for each class of service are usually given, with plate voltage as the independent variable. The conditions are chosen so that maximum performance is obtained for each value of plate voltage.

The conditions indicated as "typical" are not the only ones under which the tube can be used, however, and for this reason maximum ratings are given, so that if the user desires to choose his own conditions he will know the maximum capabilities of the tube in regard to certain restricting factors.

Maximum ratings are set solely on a basis of expected tube life. Each rating has been carefully determined by the tube manufacturer as the maximum value which will still permit a reasonable life expectancy for the tube.

Ordinarily the manufacturer sets each limit on an individual basis without regard to any other limit except where such limits are by their nature interdependent within the tube itself. Where the limits are interdependent in this way simultaneous operation at the maximum ratings involved is assumed in setting the limits, which may then be used as individual maximums.

## Maximum Plate Dissipation

The plate dissipation of all radiation-cooled Eimac tubes is limited by plate temperature and its effects on parts of the tube other than the plate. The plates of all radiation-cooled Eimac tubes will withstand several times their maximum rated plate dissipation, but the heat generated by such operation has a considerable effect on other parts of the tube. The radiant heat from the plate causes the grid, filament and envelope to become heated, while heat conducted away from the plate by the plate lead contributes to the heating of the plate seal.

These effects are not ordinarily instantaneous, however, and for this reason all radiation-cooled Eimac tubes may be momentarily subjected to plate dissipation in excess of the maximum rating. The maximum plate dissipation rating is intended to set a point where continuous operation may be carried out without damage to any part of the tube, even though the other portions may at the same time be operating at their maximum ratings.

*Regardless of other conditions, the maximum plate dissipation rating should not be exceeded in continuous operation.* Plate dissipation in excess of the maximum rating is permissible for short periods of time with all Eimac radiation-cooled types.

## Maximum Plate Voltage

Since Eimac tubes have no internal insulators, the only purpose of the maximum plate voltage limitation is to set a point above which the glass envelope will become damaged from dielectric losses or to set indirectly a limit to the r.f. charging current flowing in the plate and filament leads. The charging current is a function of the r.f. plate voltage, which is in turn a function of the d.c. plate voltage; this makes it possible to set an adequate limit on r.f. plate current without requiring the difficult task of determining the current directly. Most Eimac maximum plate voltage ratings fall in the r-f-plate-current-limit category. However, an example of the glass-stress type of limit may be seen in the UH-50 data. This tube has the same electrode structure as the 75TL. Due to the fact that its grid and plate leads are adjacent at the top of the envelope, however, the UH-50 has a maximum plate voltage rating of 1250 volts, whereas its counterpart, the 75TL, which has widely separated electrode terminations, has a maximum plate voltage rating of 3000 volts.

*Regardless of other conditions, the maximum plate voltage rating should not be exceeded.*

## Maximum Plate Current

The maximum d-c plate current limit on Eimac tubes is based on the available filament emission. The maximum figure is intended to set a value which may be easily realized throughout the life of the tube. There has been no conclusive indication to date that excessive current has any direct effect on the life of the filament, although there is a certain amount of evidence to support such a belief. However, if operating conditions are chosen which require that the maximum plate current limitation be exceeded at the start of tube life, it may become increasingly difficult to maintain the excessive plate current as the tube ages.

*Regardless of other conditions, the maximum plate current rating should not be exceeded.*

## Maximum Grid Ratings

Maximum grid current ratings, when coupled with maximum bias voltage or maximum r-f grid voltage ratings could conceivably limit grid dissipation. In many tubes, however, there is little justification for an independent grid bias or r-f grid voltage rating from a practical standpoint. Actually, of course, excessive r-f or bias voltage could cause excessive seal heating or breakdown of glass insulation. On most Eimac tubes these limitations are more academic than actual, since the magnitudes of voltage required to damage the tube are far in excess of those needed in practice, and their use results in no advantage to the tube user.

In the practical sense, the only grid limitation for most Eimac tubes is grid dissipation. Excessive grid dissipation can result in either primary (thermionic) emission from the grid or in deformation or melting of the grid through overheating. Most Eimac tubes now have non-emissive grids,

The influence of plate dissipation on grid temperature has been taken into consideration in setting up the grid dissipation maximums. The maximum grid dissipation figure given for each tube may be used simultaneously with maximum rated plate dissipation.

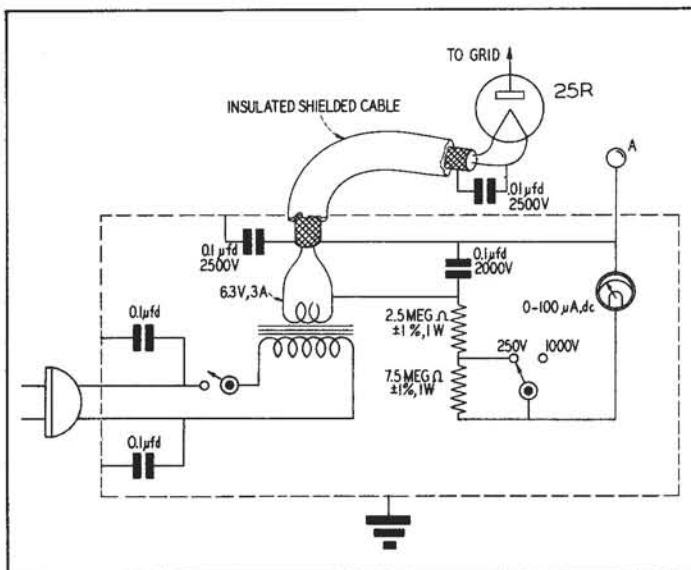


Figure 1. Peak vacuum tube voltmeter for making  $E_{gm}$  or  $e_{gm}$  measurements.

2. Everitt, "Communication Engineering" p. 562; McGraw-Hill.

**EITE** *Ginnac* **ROUGH, INC.**  
S. NO, CALIFORNIA

HIGH-MU TRIODE

MODULATOR  
OSCILLATOR  
AMPLIFIER



## GENERAL CHARACTERISTICS

GENERAL CHARACTERISTICS		5.0 volts	6.3 amperes	40
<b>ELECTRICAL</b>				
Filament:	Thoriated tungsten			
Voltage				
Current				
Amplification Factor (Average)				2.0 $\mu\text{f}$
Direct Interelectrode Capacitances (Average)				2.9 $\mu\text{f}$
Grid-Plate				0.4 $\mu\text{f}$
Grid-Filament				5500 $\mu\text{mhos}$
Plate-Filament				
Transconductance ( $I_b=200$ ma., $E_b=3000$ , $e_c=-15$ )				
<b>MECHANICAL</b>				
(Medium 4-pin bayonet, ceramic)				
Base				RMA type M8-078
Basing				RMA type 2M
Maximum Overall Dimensions:				
Length				7.75 inches
Diameter				3.19 inches
Net weight				4 ounces
Shipping weight (Average)				1.5 pounds

Net weight (Average)  
Shipping weight (Average)

**AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR**  
**Class B**

... tube ...

D-C Plate Voltage  
 Max.-Signal D-C Plate Current, per tube\*  
 Plate Dissipation, per tube\*  
 D-C Grid Voltage (approx.)  
 Peak A-F Grid Input Voltage  
 Zero-Signal D-C Plate Current  
 Max.-Signal D-C Plate Current  
 Max.-Signal Driving Power (approx.)  
 Effective Load, Plate-to-Plate  
 Max.-Signal Plate Power Output  
 \*Averaged over any sinusoidal audio frequency cycle.

OR

TYPICAL OPERATION—2 TUBES

1500	2000	3000
•	•	•
-20	-35	-65
290	310	335
80	60	40
320	280	215
7	7	5
8750	15000	31000
280	360	650

**RADIO FREQUENCY POWER AMPLIFIER AND OSCILLATOR**  
**Class-C • Telephony**  
(Key down conditions without modulation)

D-C Plate Voltage  
D-C Plate Current  
D-C Grid Current  
D-C Grid Voltage  
Plate Power Output  
Plate Input  
Plate Dissipation  
Peak R. F. Grid Input Voltage, (approx.)  
Driving Power, (approx.)

TYPICAL OPERATION—1		TUBE
1500	2000	3000
190	165	165
48	39	51
-65	-80	-200
185	235	400
285	335	500
100	100	100
230	230	385
10	8	18

Maximum Rating

MAX. RATING  
3000 volts  
225 ma.  
100 watts  
volts  
volts  
ma.  
ma.  
watts  
ohms  
watts

MAX. RATING	
3000	volts
225	ma.
60	ma.
	volts
	watts
	watts
100	watts
	volts
	watts

C Grid	-	-	-	-	-	230
Plate Power Output	-	-	-	-	-	10
Plate Input	-	-	-	-	-	
Plate Dissipation	-	-	-	-	-	
Peak R. F. Grid Input Voltage, (approx.)	-	-	-	-	-	
Driving Power, (approx.)	-	-	-	-	-	

\*The above figures show actual measured tube performance, and do not allow for variations in circuit losses.

(Effective 8-1-44)

Typical Operating Conditions

Typical Operating Conditions

## TENTATIVE DATA

**Eitel-McCullough, Inc.**  
*Eimac*  
 SAN BRUNO, CALIFORNIA

**4-65A**  
 POWER TETRODE

The Eimac 4-65A is a small radiation-cooled transmitting tetrode having a maximum plate dissipation rating of 65 watts. The plate operates at a red color at maximum dissipation. Short, heavy leads and low interelectrode capacitances contribute to stable efficient operation at high frequencies.

Although it is capable of withstanding high plate voltages, the internal geometry of the 4-65A is such that it will deliver relatively high power output at low plate voltage.

The quick-heating filament allows conservation of power during standby periods in mobile applications.

## GENERAL CHARACTERISTICS

## ELECTRICAL

Filament:	Thoriated tungsten	
Voltage		6.0 volts
Current		3.5 amperes
Grid-Screen Amplification Factor (Average)		5
Direct Interelectrode Capacitances (Average)		
Grid-Plate		0.08 uuf.
Input		8.0 uuf.
Output		2.1 uuf.

## MECHANICAL

Base	5-pin -- Fits Johnson No. 122-247 or 122-101 Socket.
Mounting	Vertical, base down or up
Cooling	Radiation <sup>1</sup>
Maximum Overall Dimensions:	
Length	4.25 inches
Diameter	2.31 inches
Net Weight	3 ounces
Shipping Weight (Average)	1.5 pounds

## RADIO-FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class-C Telegraphy or FM Telephony (Key-down conditions, per tube)

## MAXIMUM RATINGS

D-C PLATE VOLTAGE <sup>1</sup>	3000 MAX. VOLTS
D-C SCREEN VOLTAGE	400 MAX. VOLTS
D-C GRID VOLTAGE	-500 MAX. VOLTS
D-C PLATE CURRENT	150 MAX. MA.
PLATE DISSIPATION	65 MAX. WATTS
SCREEN DISSIPATION	10 MAX. WATTS
GRID DISSIPATION	5 MAX. WATTS

## TYPICAL OPERATION

D-C PLATE VOLTAGE	600	1000	1500	VOLTS
D-C SCREEN VOLTAGE	250	250	250	VOLTS
D-C GRID VOLTAGE	-45	-70	-75	VOLTS
D-C PLATE CURRENT	125	125	125	MA.
D-C SCREEN CURRENT	40	35	25	MA.
D-C GRID CURRENT	17	14	12	MA.
PEAK R-F GRID INPUT VOLTAGE (approx.)	116	132	133	VOLTS
DRIVING POWER (approx.)	2	1.8	1.6	WATTS
SCREEN DISSIPATION	10	8.7	6.2	WATTS
PLATE POWER INPUT	75	125	188	WATTS
PLATE DISSIPATION	26	37	50	WATTS
PLATE POWER OUTPUT	49	88	138	WATTS

<sup>1</sup>Maximum allowable voltage is limited by seal temperatures, which increase with increasing frequency. With normal ventilation, maximum rated plate voltage may be used at frequencies up to approximately 50 Mc. Above this frequency, the plate voltage should be reduced, or special attention should be given to seal cooling. The temperature of any seal should not be allowed to exceed 200 degrees C. Where ventilation is not adequate, special attention to seal cooling may be required below 50 Mc.

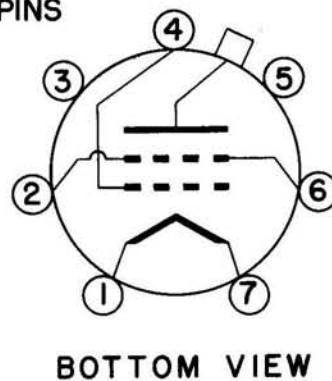
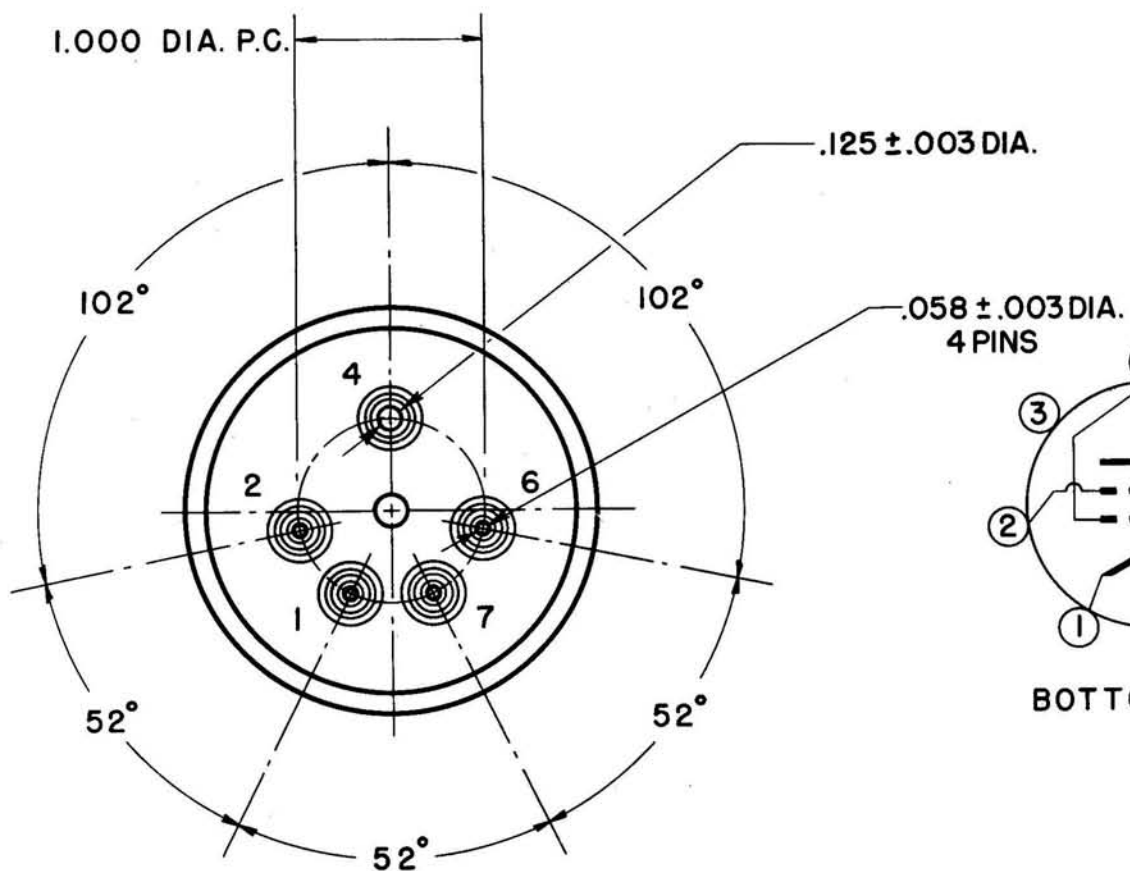
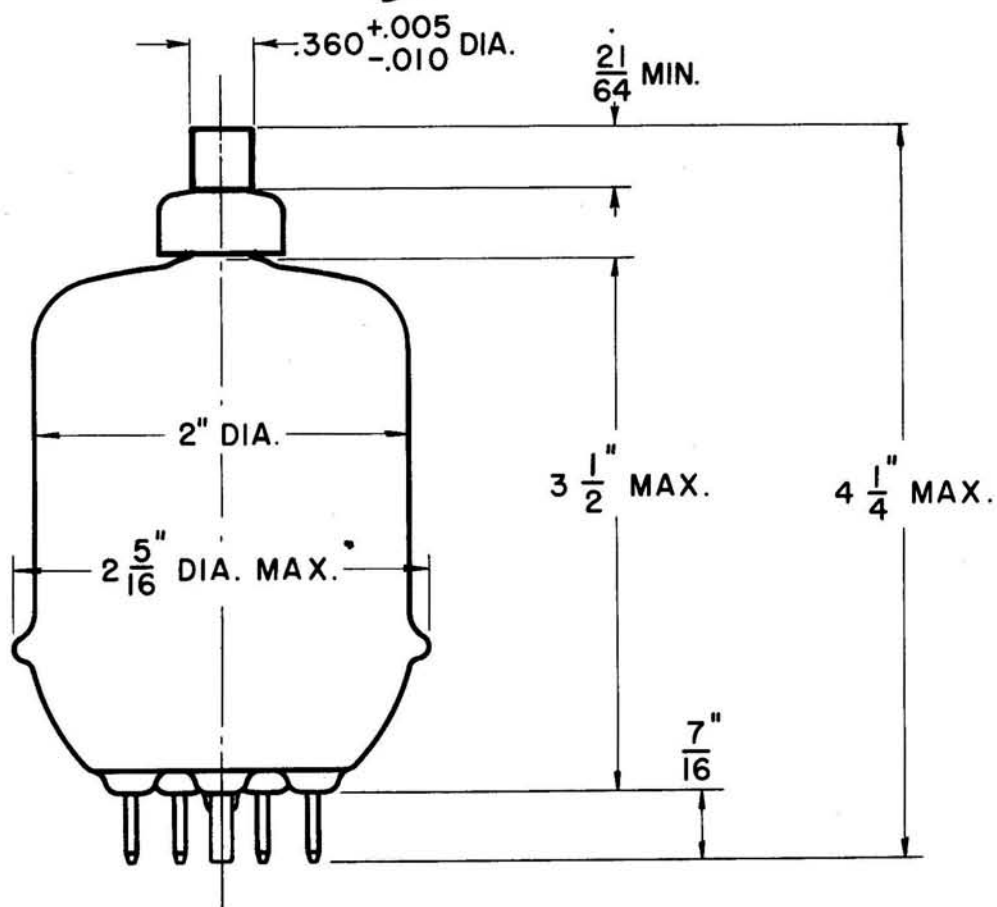
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(Effective 4-15-47)

TENTATIVE DATA







# EITEL-McCULLOUGH, INC.

SAN BRUNO, CALIFORNIA

## 4-125A

(RMA 4D21)

POWER TETRODE

MODULATOR  
OSCILLATOR  
AMPLIFIER

The Eimac 4-125A is a power tetrode having a maximum plate dissipation rating of 125 watts, and is intended for use as an amplifier, oscillator or modulator. Due to its high power sensitivity, it will deliver relatively large output with low driving power. The low grid-plate capacitance of the 4-125A makes neutralization unnecessary in most cases, and simplifies it in other cases. The compact construction of this tube permits its operation at full input up to frequencies as high as 120 Mc.

Cooling of the 4-125A is accomplished by radiation from the plate, which operates at a visible red color at maximum dissipation, and by air circulation through the base and around the envelope.



### GENERAL CHARACTERISTICS

#### ELECTRICAL

Filament: Thoriated tungsten

Voltage - - - - - 5.0 volts

Current - - - - - 6.5 amperes

Grid-Screen Amplification Factor (Average) - - - - - 6.2

Direct Interelectrode Capacitances (Average)

Grid-Plate (without shielding, base grounded) - - - - - 0.05  $\mu\text{fd.}$

Input - - - - - 10.8  $\mu\text{fd.}$

Output - - - - - 3.1  $\mu\text{fd.}$

Transconductance ( $i_b=50 \text{ ma.}$ ,  $E_b=2500 \text{ v.}$ ,  $E_{c2}=400 \text{ v.}$ ) - - - - - 2450  $\mu\text{mhos}$

#### MECHANICAL

Base - - - - - 5-pin metal shell, No. 5008B

Basing - - - - - RMA type 5BK

Cooling - - - - - Radiation and forced air

Maximum Overall Dimensions:

Length - - - - - 5.69 inches

Diameter - - - - - 2.72 inches

Net Weight - - - - - 6.5 ounces

Shipping Weight (Average) - - - - - 1.5 pounds

IF IT IS DESIRED TO OPERATE THIS TUBE UNDER CONDITIONS WIDELY DIFFERENT THAN THOSE GIVEN UNDER "TYPICAL OPERATION," AND WHICH POSSIBLY EXCEED MAXIMUM RATINGS, WRITE EITEL-McCULLOUGH, INC., FOR INFORMATION AND RECOMMENDATIONS.

**RADIO FREQUENCY POWER AMPLIFIER AND OSCILLATOR**  
Class-C Telephony or FM Telephony (Key-down conditions, 1 tube)

**MAXIMUM RATINGS**

D-C PLATE VOLTAGE <sup>1</sup>	-	-	-	-	-	3000 MAX. VOLTS
D-C SCREEN VOLTAGE	-	-	-	-	-	400 MAX. VOLTS
D-C GRID VOLTAGE	-	-	-	-	-	-500 MAX. VOLTS
D-C PLATE CURRENT	-	-	-	-	-	225 MAX. MA.
PLATE DISSIPATION	-	-	-	-	-	125 MAX. WATTS
SCREEN DISSIPATION	-	-	-	-	-	20 MAX. WATTS
GRID DISSIPATION	-	-	-	-	-	5 MAX. WATTS

**TYPICAL OPERATION** (Frequencies below 120 Mc.)

D-C Plate Voltage	-	-	-	2000	2500	3000	volts
D-C Screen Voltage	-	-	-	350	350	350	volts
D-C Grid Voltage	-	-	-	-100	-150	-150	volts
D-C Plate Current	-	-	-	200	200	167	ma.
D-C Screen Current	-	-	-	50	40	30	ma.
D-C Grid Current	-	-	-	12	12	9	ma.
Screen Dissipation	-	-	-	18	14	10.5	watts
Grid Dissipation	-	-	-	1.6	2	1.2	watts
Peak R-F Grid Input Voltage (approx.) <sup>2</sup>	-	-	-	230	320	280	volts
Driving Power (approx.) <sup>2</sup>	-	-	-	2.8	3.8	2.5	watts
Plate Power Input	-	-	-	400	500	500	watts
Plate Dissipation	-	-	-	125	125	125	watts
Plate Power Output	-	-	-	275	375	375	watts

**AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR**  
Class-AB<sub>2</sub> (Sinusoidal wave, two tubes unless otherwise specified)

**MAXIMUM RATINGS**

D-C PLATE VOLTAGE	-	-	-	-	-	3000 MAX. VOLTS
D-C SCREEN VOLTAGE	-	-	-	-	-	600 MAX. VOLTS
MAX-SIGNAL D-C PLATE CURRENT, PER TUBE	-	-	-	-	-	225 MAX. MA.
PLATE DISSIPATION, PER TUBE	-	-	-	-	-	125 MAX. WATTS
SCREEN DISSIPATION, PER TUBE	-	-	-	-	-	20 MAX. WATTS

**TYPICAL OPERATION**

D-C Plate Voltage	-	-	-	1500	2000	2500	volts
D-C Screen Voltage	-	-	-	600	600	600	volts
D-C Grid Voltage <sup>2</sup>	-	-	-	-90	-94	-96	volts
Zero-Signal D-C Plate Current	-	-	-	60	50	50	ma.
Max-Signal D-C Plate Current	-	-	-	222	240	232	ma.
Zero-Signal D-C Screen Current	-	-	-	-1.0	-0.5	-0.3	ma.
Max-Signal D-C Screen Current	-	-	-	17	6.4	8.5	ma.
Effective Load, Plate-to-Plate	-	-	-	10,200	13,400	20,300	ohms
Peak A-F Grid Input Voltage (per tube)	-	-	-	90	94	96	volts
Driving Power	-	-	-	0	0	0	watt
Max-Signal Plate Dissipation (per tube)	-	-	-	87.5	125	125	watts
Max-Signal Plate Power Output	-	-	-	158	230	330	watts
Total Harmonic Distortion	-	-	-	5	2	2.6	per ct.

<sup>1</sup> Above 120 Mc. the maximum plate voltage rating depends upon frequency see page 8.

Indicates change from sheet dated 11-1-46

**HIGH-LEVEL MODULATED RADIO FREQUENCY AMPLIFIER**  
Class-C Telephony (Carrier conditions unless otherwise specified, 1 tube)

**MAXIMUM RATINGS**

D-C PLATE VOLTAGE <sup>1</sup>	-	-	-	-	-	2500 MAX. VOLTS
D-C SCREEN VOLTAGE	-	-	-	-	-	400 MAX. VOLTS
D-C GRID VOLTAGE	-	-	-	-	-	-500 MAX. VOLTS
D-C PLATE CURRENT	-	-	-	-	-	200 MAX. MA.
PLATE DISSIPATION	-	-	-	-	-	85 MAX. WATTS
SCREEN DISSIPATION	-	-	-	-	-	20 MAX. WATTS
GRID DISSIPATION	-	-	-	-	-	5 MAX. WATTS

**TYPICAL OPERATION** (Frequencies below 120 Mc.)

D-C Plate Voltage	-	-	-	-	-	2000	2500	volts
D-C Screen Voltage	-	-	-	-	-	350	350	volts
D-C Grid Voltage	-	-	-	-	-	-220	-210	volts
D-C Plate Current	-	-	-	-	-	150	152	ma.
D-C Screen Current	-	-	-	-	-	33	30	ma.
D-C Grid Current	-	-	-	-	-	10	9	ma.
Screen Dissipation	-	-	-	-	-	11.5	10.5	watts
Grid Dissipation	-	-	-	-	-	1.6	1.4	watts
Peak A-F Screen Voltage, 100% Modulation	-	-	-	-	-	210	210	volts
Peak R-F Grid Input Voltage (approx.)	-	-	-	-	-	375	360	volts
Driving Power (approx.) <sup>2</sup>	-	-	-	-	-	3.8	3.3	watts
Plate Power Input	-	-	-	-	-	300	380	watts
Plate Dissipation	-	-	-	-	-	75	80	watts
Plate Power Output	-	-	-	-	-	225	300	watts

**AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR**  
Class-AB<sub>2</sub> (Sinusoidal wave, two tubes unless otherwise specified)

**MAXIMUM RATINGS**

D-C PLATE VOLTAGE	-	-	-	-	-	3000 MAX. VOLTS
D-C SCREEN VOLTAGE	-	-	-	-	-	400 MAX. VOLTS
MAX-SIGNAL D-C PLATE CURRENT, PER TUBE	-	-	-	-	-	225 MAX. MA.
PLATE DISSIPATION, PER TUBE	-	-	-	-	-	125 MAX. WATTS
SCREEN DISSIPATION, PER TUBE	-	-	-	-	-	20 MAX. WATTS

**TYPICAL OPERATION**

D-C Plate Voltage	-	-	-	1500	2000	2500	volts
D-C Screen Voltage	-	-	-	350	350	350	volts
D-C Grid Voltage	-	-	-	-41	-45	-43	volts
Zero-Signal D-C Plate Current	-	-	-	87	72	93	ma.
Max-Signal D-C Plate Current	-	-	-	400	300	260	ma.
Zero-Signal D-C Screen Current	-	-	-	0	0	0	ma.
Max-Signal D-C Screen Current	-	-	-	34	5	6	ma.
Effective Load, Plate-to-Plate	-	-	-	7200	13,600	22,200	ohms
Peak A-F Grid Input Voltage (per tube)	-	-	-	141	105	89	volts
Max-Signal Avg. Driving Power (approx.)	-	-	-	2.5	1.4	1	watts
Max-Signal Peak Driving Power	-	-	-	5.2	3.1	2.4	watts
Max-Signal Plate Dissipation (per tube)	-	-	-	125	125	122	watts
Max-Signal Plate Power Output	-	-	-	350	350	400	watts
Total Harmonic Distortion	-	-	-	2.5	1	2.2	per ct.

<sup>2</sup> The effective grid circuit resistance for each tube must not exceed 250,000 ohms.

<sup>3</sup> Driving power increases above 70 Mc. See Page Eight.

## APPLICATION

### MECHANICAL

**Mounting**—The 4-125A must be mounted vertically, base up or base down. The socket must provide clearance for the glass tip-off which extends through the center of the base. The metal base shell should be grounded by means of suitable spring fingers. A flexible connecting strap should be provided between the plate terminal and the external plate circuit. The socket must not apply excessive lateral pressure against the base pins. The tube must be protected from severe vibration and shock.

**Cooling**—Adequate cooling must be provided for the seals and envelope of the 4-125A. In continuous-service applications, the temperature of the plate seal, as measured on the top of the plate cap, should not exceed 170° C. A relatively slow movement of air past the tube is sufficient to prevent seal temperatures in excess of maximum at frequencies below 30 Mc. At frequencies above 30 Mc., radio-frequency losses in the leads and envelope contribute to seal and envelope heating, and special attention should be given to cooling. A small fan or centrifugal blower directed toward the upper portion of the envelope will usually provide sufficient circulation for cooling at frequencies above 30 Mc., however.

In intermittent-service applications where the "on" time does not exceed a total of five minutes in any ten-minute period, plate seal temperatures as high as 220° C. are permissible. When the ambient temperature does not exceed 30° C. it will not ordinarily be necessary to provide forced cooling to hold the temperature below this maximum at frequencies below 30 Mc., provided that a heat-dissipating plate connector is used, and the tube is so located that normal circulation of air past the envelope is not impeded.

Provision must be made for circulation of air through the base of the tube. Where shielding or socket design makes it impossible to allow free circulation of air through the base, it will be necessary to apply forced-air cooling to the stem structure. An air flow of two cubic feet per minute through the base will be sufficient for stem cooling.

### ELECTRICAL

**Filament Voltage**—For maximum tube life the filament voltage, as measured directly at the filament pins, should be the rated value of 5.0 volts. Unavoidable variations in filament voltage must be kept within the range from 4.75 to 5.25 volts.

**Bias Voltage**—D-c bias voltage for the 4-125A should not exceed 500 volts. If grid-leak bias is used, suitable protective means must be provided to prevent excessive plate or screen dissipation in the event of loss of excitation.

**Screen Voltage**—The d-c screen voltage for the 4-125A should not exceed 400 volts, except for class-AB<sub>1</sub> audio operation.

**Plate Voltage**—The plate-supply voltage for the 4-125A should not exceed 3000 volts for frequencies below 120 Mc. The maximum permissible plate voltage is less than

3000 volts above 120 Mc., as shown by the graph on page 8.

**Grid Dissipation**—Grid dissipation for the 4-125A should not be allowed to exceed five watts. Grid dissipation may be calculated from the following expression:

$$P_g = e_{cmp} I_c$$

where  $P_g$  = Grid dissipation,

$e_{cmp}$  = Peak positive grid voltage, and

$I_c$  = D-c grid current.

$e_{cmp}$  may be measured by means of a suitable peak voltmeter connected between filament and grid<sup>3</sup>.

**Screen Dissipation**—The power dissipated by the screen of the 4-125A must not exceed 20 watts. Screen dissipation is likely to rise to excessive values when the plate voltage, bias voltage or plate load are removed with filament and screen voltages applied. Suitable protective means must be provided to limit screen dissipation to 20 watts in the event of circuit failure.

**Plate Dissipation**—Under normal operating conditions, the plate dissipation of the 4-125A should not be allowed to exceed 125 watts in unmodulated applications.

In high-level-modulated amplifier applications, the maximum allowable carrier-condition plate dissipation is 85 watts. The plate dissipation will rise to 125 watts under 100% sinusoidal modulation.

Plate dissipation in excess of the maximum rating is permissible for short periods of time, such as during tuning procedures.

### OPERATION

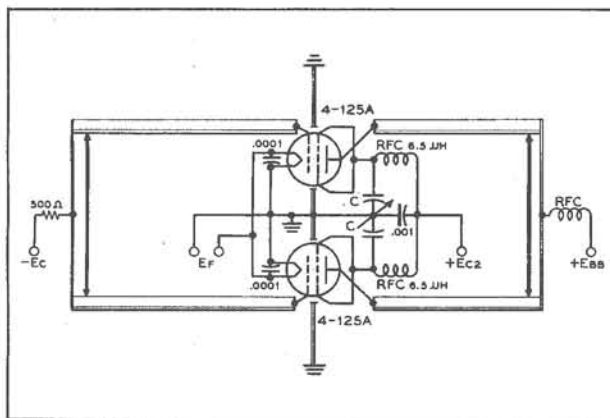
**Class-C Telephony or FM Telephony**—The 4-125A may be operated as a class-C telegraph or FM telephone amplifier without neutralization up to 100 Mc. if reasonable precautions are taken to prevent coupling between input and output circuits external to the tube. A grounded metallic plate on which the socket may be mounted and to which suitable connectors may be attached to ground the tube base shell provides an effective isolating shield between grid and plate circuits. In single-ended circuits, plate, grid, filament and screen by-pass capacitors should be returned through the shortest possible leads to a common chassis point. In push-pull applications the filament and screen terminals of each tube should be by-passed to a common chassis point by the shortest possible leads, and short, heavy leads should be used to interconnect the screens and filaments of the two tubes. Care should be taken to prevent leakage of radio-frequency energy to leads entering the amplifier, to prevent grid-plate coupling between these leads external to the amplifier.

Above 100 Mc., or at lower frequencies if shielding is inadequate, it is necessary to neutralize the 4-125A in ordinary applications.

Where shielding is adequate, the feed-back at frequencies above 100 Mc. is due principally to screen-lead-inductance effects, and it becomes necessary to introduce

<sup>3</sup> For suitable peak v.t.v.m. circuits see, for instance, "Vacuum Tube Ratings," Eimac News, January, 1945. This article is available in reprint form on request.

in-phase voltage from the plate circuit into the grid circuit. This can be done by adding capacitance between plate and grid external to the tube. Ordinarily, a small metal tab approximately  $\frac{3}{4}$ -inch square connected to the grid terminal and located adjacent to the envelope opposite the plate will suffice for neutralization. Means should be provided for adjusting the spacing between the neutralizing capacitor plate and the envelope, but care must be taken to prevent the neutralizing plate from touching the envelope. An alternative neutralization scheme is illustrated in the diagram below. In this circuit feed-back is eliminated by series-tuning the screen to ground with a small capacitor. The socket screen terminals should be strapped together, as shown on the dia-



Screen-tuning neutralization circuit for use above 100 Mc.

C is a small split-stator capacitor.

$$C_{(uv/d)} = \frac{640,000}{f^2 (\text{Mc.})}, \text{ approx.}$$

gram, by the shortest possible lead, and the leads from the screen terminal to the capacitor, C, and from the capacitor to ground should be made as short as possible. All connections to the screen terminals should be made to the center of the strap between the terminals, in order to equalize the current in the two screen leads and prevent overheating one of them. The value for C given under the diagram presupposes the use of the shortest possible leads.

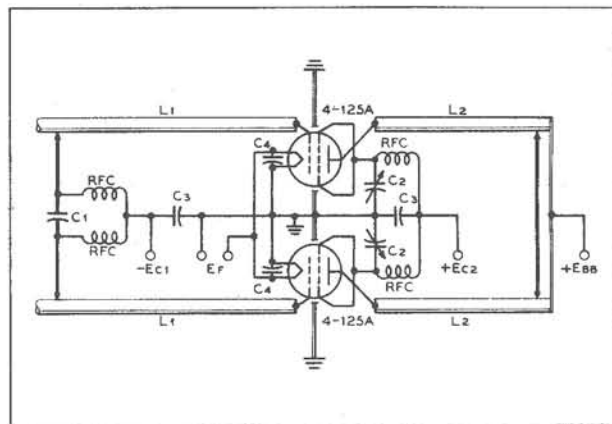
At frequencies below 100 Mc., and where shielding is inadequate, ordinary neutralization systems may be used. With reasonably effective shielding, however, neutralization should not be required below 100 Mc.

The driving power and power output under typical operating conditions, with maximum output and plate voltage, are shown on page 8. The power output shown is the actual plate power delivered by the tube; the power delivered to the load will depend upon the efficiency of the plate tank and output coupling system. The driving power is likewise the driving power required by the tube (includes bias loss). The driver output power should exceed the driving power requirement by a sufficient margin to allow for coupling-circuit losses. These losses will not ordinarily amount to more than 30 or 40 per cent of the driving power, except at frequencies above 150 Mc. The

use of silver-plated linear tank-circuit elements is recommended at frequencies above 100 Mc.

Conventional capacitance-shortened quarter-wave linear grid tank circuits having a calculated  $Z_0$  of 160 ohms or less may be used with the 4-125A up to 175 Mc. Above 175 Mc. linear grid tank circuits employing a "capacitor"-type shorting bar, as illustrated in the diagram below, may be used. The capacitor, C<sub>1</sub>, may consist of two silver-plated brass plates one inch square with a piece of .010-inch mica or polystyrene as insulation.

**Class-C AM Telephony**—The r-f circuit considerations discussed above under Class-C Telegraphy or FM Telephony also apply to amplitude-modulated operation of the 4-125A. When the 4-125A is used as a class-C high-level-



Typical circuit arrangement useful for frequencies above 175 Mc.

C<sub>1</sub>—See above.  
C<sub>2</sub>—Neutralizing capacitor.  
C<sub>3</sub>—100 ufd.  
C<sub>4</sub>—100 ufd.

L<sub>1</sub>—3/8" dia. copper spaced,  
1" center-to-center, 6" long.  
L<sub>2</sub>—7/8" dia. brass, silver plated,  
spaced 1 1/2" center-to-center,  
14" long.

modulated amplifier, modulation should be applied to both plate and screen. Modulation voltage for the screen may be obtained from a separate winding on the modulation transformer, by supplying the screen voltage via a series dropping resistor from the unmodulated plate supply, or by the use of an audio-frequency reactor in the positive screen-supply lead. When screen modulation is obtained by either the series-resistor or the audio-reactor method, the audio-frequency variations in screen current which result from variations in plate voltage as the plate is modulated automatically give the required screen modulation. Where a reactor is used, it should have a rated inductance of not less than 10 henries divided by the number of tubes in the modulated amplifier and a maximum current rating of two or three times the operating d-c screen current. To prevent phase shift between the screen and plate modulation voltages at high audio frequencies, the screen by-pass capacitor should be no larger than necessary for adequate r-f by-passing. Where screen voltage is obtained from a separate winding on the modulation transformer, the screen winding should be designed to deliver the peak screen modulation voltage given in the typical operating data on page 1.



For high-level modulated service, the use of partial grid-leak bias is recommended. Any by-pass capacitors placed across the grid-leak resistance should have a reactance at the highest modulation frequency equal to at least twice the grid-leak resistance.

**Class-AB<sub>1</sub> and Class-AB<sub>2</sub> Audio**—Two 4-125A's may be used in a push-pull circuit to give relatively high audio output power at low distortion. Maximum ratings and typical operating conditions for class-AB<sub>1</sub> and class-AB<sub>2</sub> audio operation are given in the tabulated data.

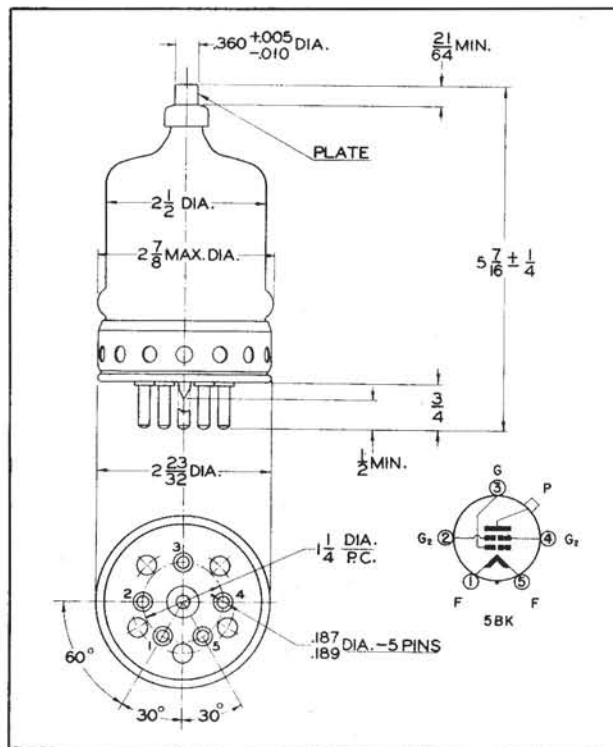
When type 4-125A tubes are used as class-AB<sub>1</sub> or class-AB<sub>2</sub> audio amplifiers at 1500 plate volts, under the conditions given under "Typical Operation," the screen voltage must be obtained from a source having reasonably good regulation, to prevent variations in screen voltage from zero-signal to maximum-signal conditions. The use of voltage regulator tubes in a standard circuit will provide adequate regulation. The variation in screen current at plate voltages of 2000 and above is low enough so that any screen power supply having a normal order of regulation will serve. The driver plate supply makes a convenient source of screen voltage under these conditions.

Grid bias voltage for class-AB<sub>2</sub> service may be obtained from batteries or from a small fixed-bias supply. When a bias supply is used, the d-c resistance of the bias source should not exceed 250 ohms. Under class-AB<sub>1</sub> conditions the effective grid-circuit resistance for each tube should not exceed 250,000 ohms.

The peak driving power figures given in the class-AB<sub>2</sub> tabulated data are included to make possible an accurate determination of the required driver output power. The driving amplifier must be capable of supplying the peak driving power without distortion. The driver stage should, therefore, be capable of providing an undistorted average output equal to half the peak driving power require-

ment. A small amount of additional driver output should be provided to allow for losses in the coupling transformer.

The power output figures given in the tabulated data refer to the total power output from the amplifier tubes. The useful power output will be from 5 to 15 per cent less than the figures shown, due to losses in the output transformer.



## COMPONENTS FOR TYPICAL CIRCUITS

(Diagrams, Page 6)

$L_{p1} - C_{p1}$  — Tank circuit appropriate for operating frequency;  
 $Q = 12$ . Capacitor plate spacing = .200".

$L_{p2} - C_{p2}$  — Tank circuit appropriate for operating frequency;  
 $Q = 12$ . Capacitor plate spacing = .200".

$L_{p3} - C_{p3}$  — Tank circuit appropriate for operating frequency;  
 $Q = 12$ . Capacitor plate spacing = .375".

$L_{p4} - C_{p4}$  — Tank circuit appropriate for operating frequency;  
 $Q = 12$ . Capacitor plate spacing = .375".

$L_{g1} - C_{g1}$  — Tuned circuit appropriate for operating frequency.

$L_{g2} - C_{g2}$  — Tuned circuit appropriate for operating frequency.

$C_1$  — .002-ufd., 500-v. mica

$C_2$  — .002-ufd., 5000-v. mica

$C_3$  — .001-ufd., 2500-v. mica

$C_4$  — 16-ufd., 450-v. electrolytic

$C_5$  — 10-ufd., 25-v. electrolytic

$R_1$  — 7000 ohms, 5 watts

$R_2$  — 70,000 ohms, 100 watts

$R_3$  — 3500 ohms, 5 watts

$R_4$  — 35,000 ohms, 200 watts

$R_5$  — 560 ohms, 1 watt

$R_6$  — 25,000 ohms, 2 watts

$R_7$  — 1500 ohms, 5 watts

$RFC_1$  — 2.5-mhy., 125-ma. r-f choke

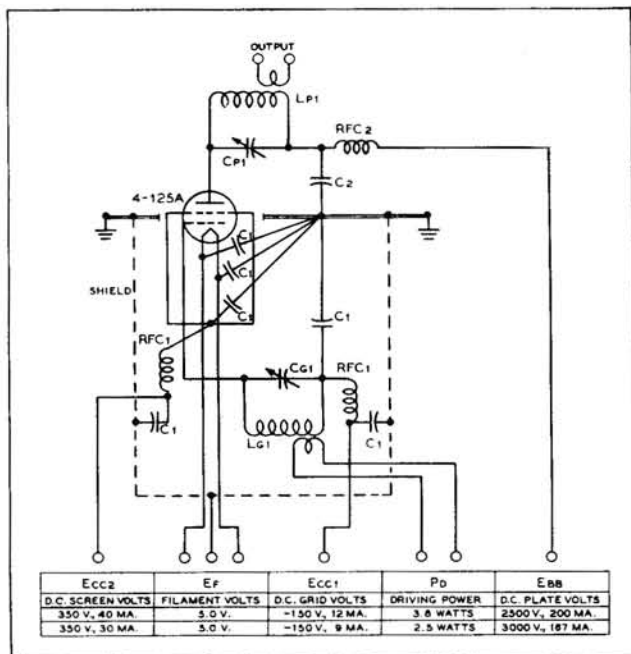
$RFC_2$  — 1-mhy., 500-ma. r-f choke

$T_1$  — 10-watt driver transformer; ratio pri. to 1/2 sec. approx. 2:1.

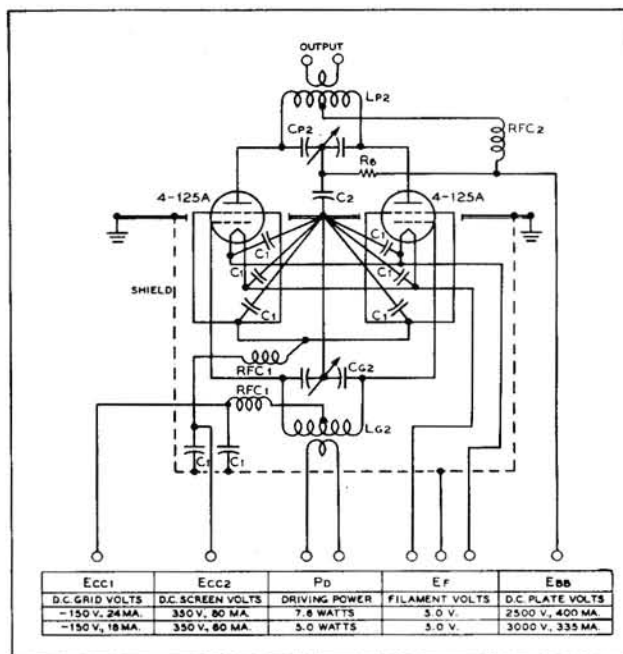
$T_2$  — 200-watt modulation transformer; ratio pri. to sec. approx. 1:1; pri. impedance = 16,200 ohms, sec. impedance = 16,500 ohms.

$T_3$  — 5-watt driver transformer; ratio pri. to 1/2 sec. approx. 1:1:1.

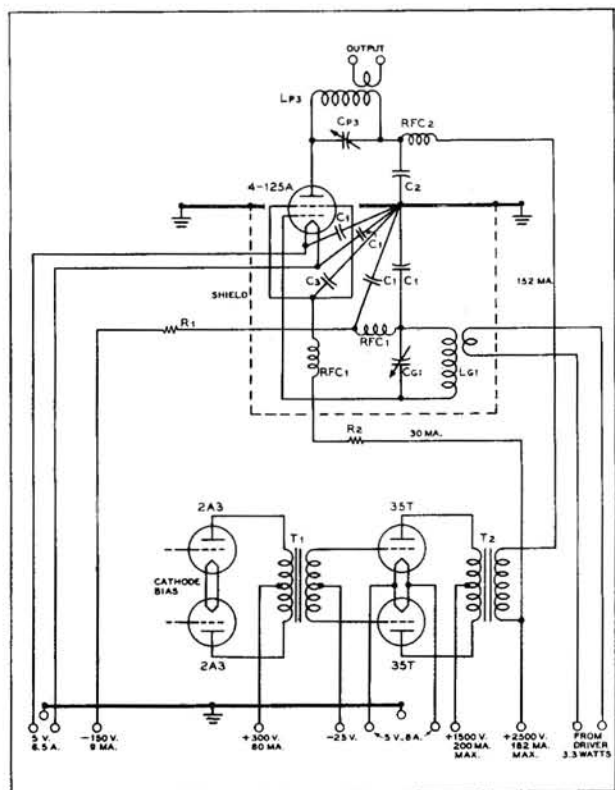
$T_4$  — 400-watt modulation transformer; ratio pri. to sec. approx. 2.7:1; pri. impedance = 22,200 ohms, sec. impedance = 8300 ohms.



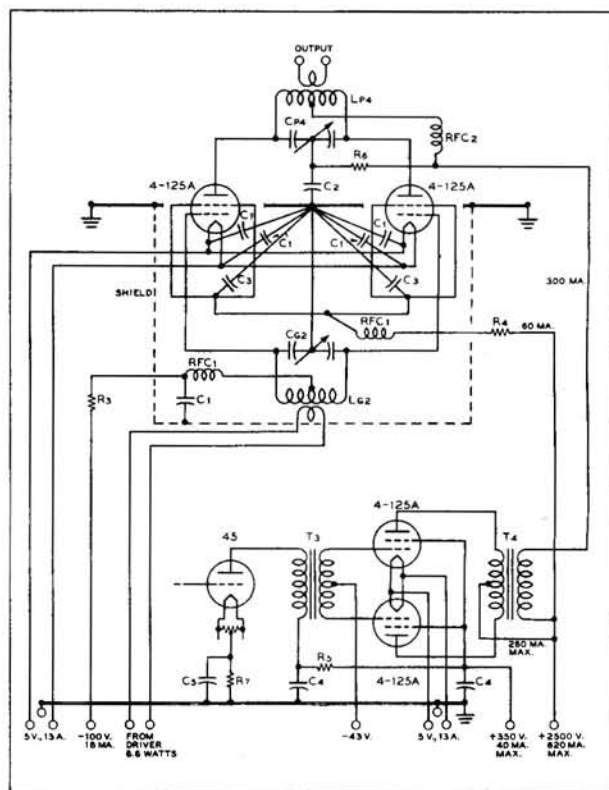
Typical radio-frequency power amplifier circuit, Class-C telegraphy, 500 watts input.



Typical radio-frequency power amplifier circuit, Class-C telegraphy, 1000 watts input.

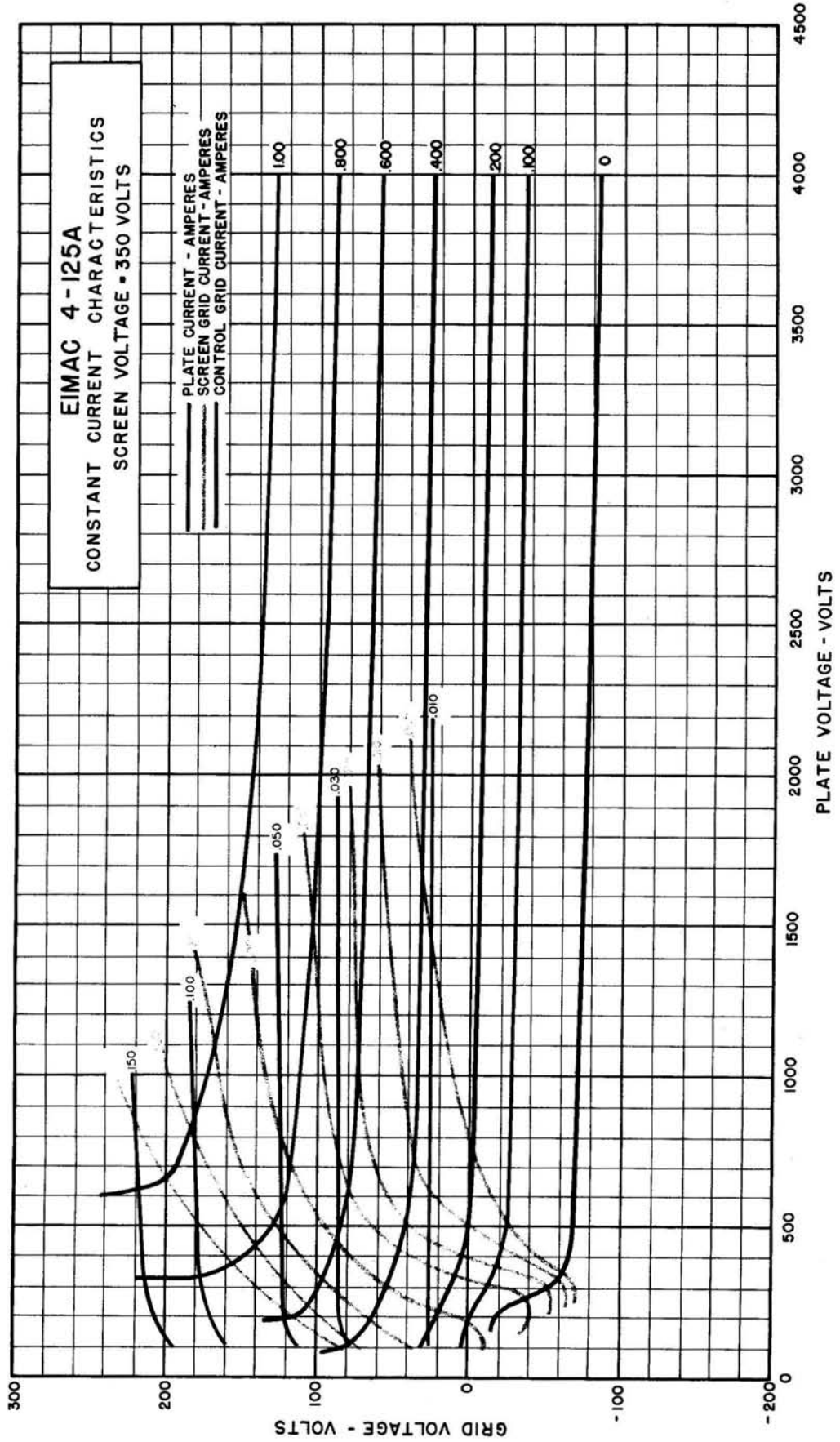


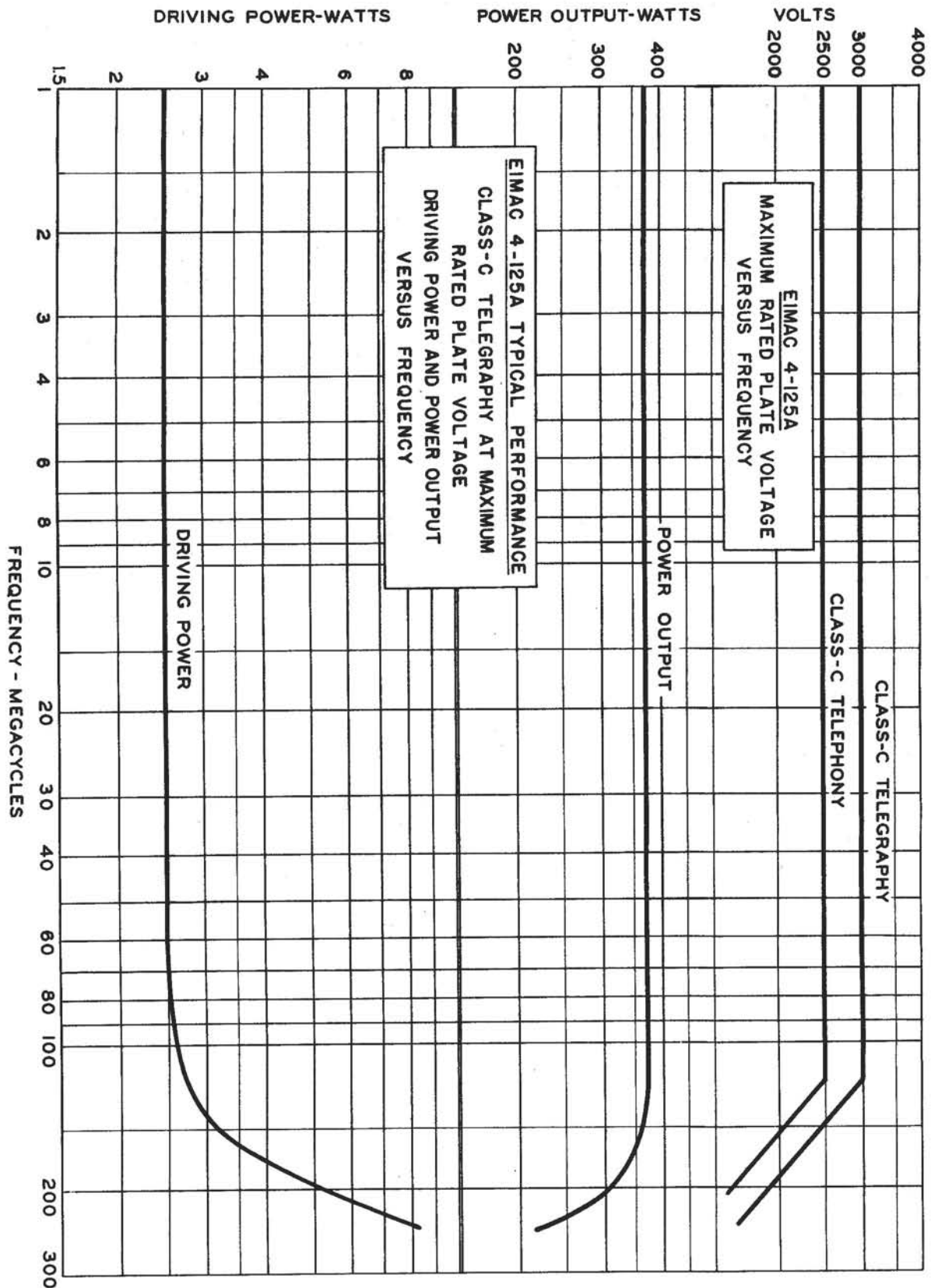
Typical high-level-modulated r-f amplifier circuit, with modulator and driver stages, 380 watts plate input.



Typical high-level-modulated r-f amplifier circuit, with modulator and driver stages, 750 watts plate input.

SEE PRECEDING PAGE FOR LIST OF COMPONENTS





## TENTATIVE DATA

**EITEL-McCULLOUGH, Inc.**  
SAN BRUNO, CALIFORNIA

# 4X150A

POWER TETRODE

The Eimac 4X150A is an extremely compact external-anode tetrode intended for use as a radio-frequency amplifier or oscillator at frequencies well into the uhf region or as an amplifier in any service requiring a high-gain tube capable of delivering high-power output at low plate voltage. Although it is capable of withstanding relatively high plate voltages, the 4X150A operates well at plate voltages of 400 to 500 volts, making it particularly well suited for high-power mobile applications. The combination of a high ratio of transconductance to capacitance and a maximum plate dissipation capability of 150 watts makes the tube an excellent wide-band amplifier for video applications.

The 4X150A is based in a manner which allows it to be used with a ceramic loktal socket. The base pins are arranged for maximum convenience in using the tube with either coaxial or linear tank circuits at uhf. To provide maximum circuit isolation at these frequencies, the screen is terminated in a contact ring located between the anode and the base. For low-frequency applications, a base pin is provided for the screen termination.

A single 4X150A operating in a coaxial amplifier circuit will deliver as high as 75 watts useful output at 500 Mc.

## GENERAL CHARACTERISTICS

### ELECTRICAL

Cathode: Coated Unipotential

Heater Voltage	- - - - -	6.0	volts
Heater Current	- - - - -	2.8	amperes
Minimum Heating Time	- - - - -	30	seconds

Screen-Grid Amplification Factor (Average) - - - - - 4.5

Direct Interelectrode Capacitances (Average)

Grid-Plate (without shielding)	- - - - -	0.02	$\mu\mu\text{f.}$
Input	- - - - -	14.1	$\mu\mu\text{f.}$
Output	- - - - -	4.7	$\mu\mu\text{f.}$

Transconductance ( $i_b=250$  ma.,  $e_b=500$  v.,  $E_{c2}=250$  v.) - 12,000  $\mu\text{mhos}$

### MECHANICAL

Cooling	- - - - -	Forced Air <sup>1</sup>
Mounting Position	- - - - -	Any
Maximum Overall Dimensions		
Length	- - - - -	2.50 inches
Diameter	- - - - -	1.75 inches
Maximum Seated Height	- - - - -	1.88 inches
Net Weight	- - - - -	5 ounces
Shipping Weight (average)	- - - - -	1.75 pounds

### RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class-C Telephony or FM Telephony

MAXIMUM RATINGS (Frequencies up to 500 Mc.)

D-C PLATE VOLTAGE	- - - - -	1000 MAX. VOLTS
D-C SCREEN VOLTAGE	- - - - -	300 MAX. VOLTS
D-C GRID VOLTAGE	- - - - -	250 MAX. VOLTS
D-C PLATE CURRENT	- - - - -	250 MAX. MA.
PLATE DISSIPATION <sup>1</sup>	- - - - -	150 MAX. WATTS
SCREEN DISSIPATION	- - - - -	15 MAX. WATTS
GRID DISSIPATION	- - - - -	2 MAX. WATTS

#### TYPICAL OPERATION

Single tube, frequencies below 165 Mc.

D-C Plate Voltage	- - - - -	600	750	1000 volts
D-C Plate Current	- - - - -	200	200	200 ma.
D-C Screen Voltage	- - - - -	250	250	250 volts
D-C Screen Current	- - - - -	35	37	39 ma.
D-C Grid Voltage	- - - - -	-75	-80	-80 volts
D-C Grid Current	- - - - -	6	6.5	7 ma.
Peak R-F Grid Input Voltage (approx.)	- - - - -	87	96	99 volts
Driving Power (approx.)	- - - - -	.52	.63	.69 watt
Useful Power Output	- - - - -	85	110	148 watts

#### TYPICAL OPERATION

(Per tube, 500 Mc.)

D-C Plate Voltage	- - - - -	500	650	800 volts
D-C Plate Current	- - - - -	250	250	250 ma.
D-C Screen Voltage	- - - - -	240	235	230 volts
D-C Screen Current	- - - - -	9.5	7.5	5 ma.
D-C Grid Voltage	- - - - -	-56	-56	-56 volts
D-C Grid Current	- - - - -	6	6	6 ma.
Plate Dissipation (Approx.)	- - - - -	65	85	110 watts
Useful Power Output	- - - - -	52	68	74 watts
Overall Efficiency	- - - - -	42	41	37 percent

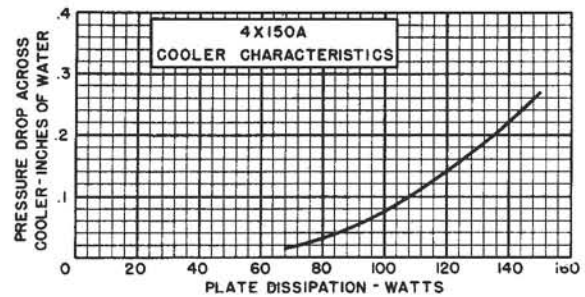
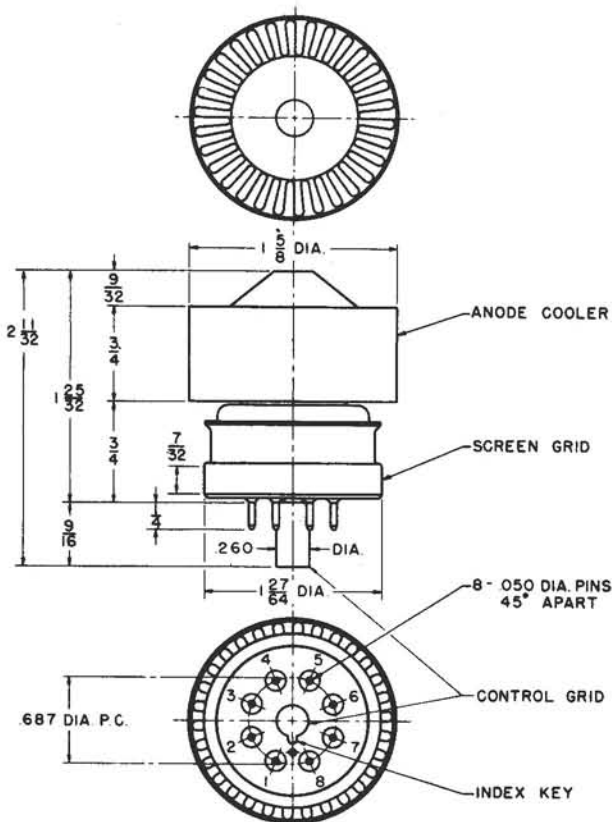
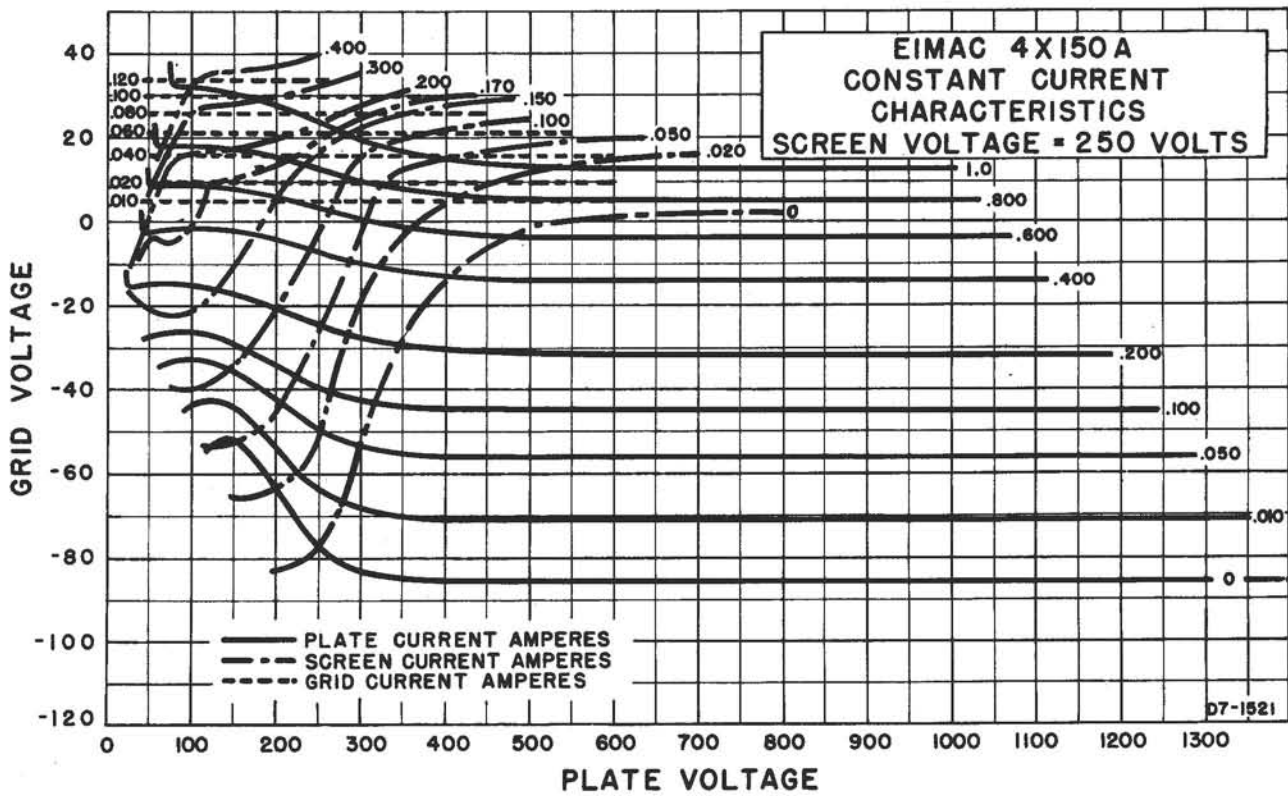
<sup>1</sup> At 150 watts plate dissipation a minimum flow of 5.6 cubic feet of air per minute must be passed through the plate cooler. The pressure drop across the cooler at this flow equals 0.26" of water. Free circulation of air around the base of the tube is required. Where shielding or

components restrict the natural circulation of air around the base or where abnormal circuit conditions can cause high lead current, forced air cooling of the base should be provided. In no case should the temperature of the base seals be allowed to exceed 150 degrees C.

Indicates change from sheet dated 2-25-47







- |            |   |   |
|------------|---|---|
| PIN NO.    | 1 | SCREEN GRID                               |
| " "        | 2 | CATHODE                                   |
| " "        | 3 | HEATER                                    |
| " "        | 4 | CATHODE                                   |
| " "        | 5 | I.C. (DO NOT USE FOR EXTERNAL CONNECTION) |
| " "        | 6 | CATHODE                                   |
| " "        | 7 | HEATER                                    |
| " "        | 8 | CATHODE                                   |
| CENTER PIN |   | CONTROL GRID                              |



# EITEL-McCULLOUGH, INC.

SAN BRUNO, CALIFORNIA

## 4-250A

(RMA 5D22)

**POWER TETRODE**  
•  
**MODULATOR**  
**OSCILLATOR**  
**AMPLIFIER**

The Eimac 4-250A is a high-vacuum power tetrode having a maximum plate dissipation rating of 250 watts. It is intended for amplifier, oscillator and modulator service. Cooling of the 4-250A is accomplished by radiation from the plate, which operates at a visibly red temperature at maximum dissipation, and by forced air circulation through the base and around the envelope.

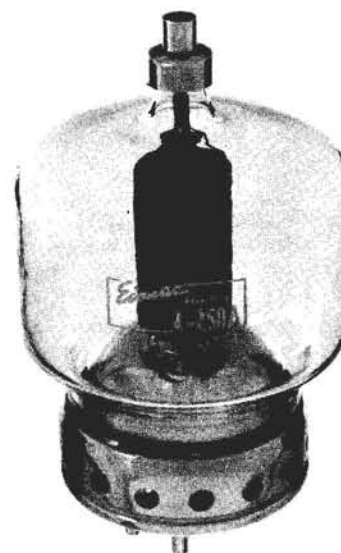
The low driving power required by the 4-250A, together with its low grid-plate capacitance and compact and rugged construction, allows considerable simplification of the associated circuits and the driver stage.

### ELECTRICAL

Filament: Thoriated tungsten	
Voltage	5.0 volts
Current	14.5 amperes
Grid-Screen Amplification Factor (Average)	5.1
Direct Interelectrode Capacitances (Average)	
Grid-Plate (without shielding, base grounded)	0.12 $\mu\text{fd.}$
Input	12.7 $\mu\text{fd.}$
Output	4.5 $\mu\text{fd.}$
Transconductance ( $i_b = 100 \text{ ma.}$ , $E_b = 2500 \text{ v.}$ , $E_{c2} = 500 \text{ v.}$ )	4000 $\mu\text{mhos}$

### MECHANICAL

Base	5-pin metal shell, No. 5008B
Basing	RMA type 5BK
Cooling	Radiation and forced air
Maximum Overall Dimensions:	
Length	6.38 inches
Diameter	3.56 inches
Net Weight	8.0 ounces
Shipping Weight (Average)	2.5 pounds



### RADIO FREQUENCY POWER AMPLIFIER AND OSCILLATOR

Class-C FM or Telegraphy (Key-down conditions, 1 tube)

#### MAXIMUM RATINGS

D-C PLATE VOLTAGE <sup>1</sup>	4000 MAX. VOLTS
D-C SCREEN VOLTAGE	600 MAX. VOLTS
D-C GRID VOLTAGE	-500 MAX. VOLTS
D-C PLATE CURRENT	350 MAX. MA.
PLATE DISSIPATION	250 MAX. WATTS
SCREEN DISSIPATION	35 MAX. WATTS
GRID DISSIPATION	5 MAX. WATTS

#### ► TYPICAL OPERATION (Frequencies below 75 Mc.)

D-C Plate Voltage	2500	3000	4000	volts
D-C Screen Voltage	500	500	500	volts
D-C Grid Voltage	-150	-180	-225	volts
D-C Plate Current	300	345	312	ma.
D-C Screen Current	60	60	45	ma.
D-C Grid Current	9	10	9	ma.
Screen Dissipation	30	30	22.5	watts
Grid Dissipation	0.35	0.8	0.46	watts
Peak R-F Grid Input Voltage (approx.)	220	265	303	volts
Driving Power (approx.) <sup>2</sup>	1.70	2.6	2.46	watts
Plate Power Input	750	1035	1250	watts
Plate Dissipation	175	235	250	watts
Plate Power Output	575	800	1000	watts

► Indicates change from sheet dated 9-1-46.

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### HIGH-LEVEL-MODULATED RADIO FREQUENCY AMPLIFIER

Class-C Telephony (Carrier conditions unless otherwise specified, 1 tube)

#### MAXIMUM RATINGS

D-C PLATE VOLTAGE <sup>1</sup>	3200 MAX. VOLTS
D-C SCREEN VOLTAGE	600 MAX. VOLTS
D-C GRID VOLTAGE	-500 MAX. VOLTS
D-C PLATE CURRENT	275 MAX. MA.
PLATE DISSIPATION	165 MAX. WATTS
SCREEN DISSIPATION	35 MAX. WATTS
GRID DISSIPATION	5 MAX. WATTS

#### ► TYPICAL OPERATION (Frequencies below 75 Mc.)

D-C Plate Voltage	2500	3000	volts
D-C Screen Voltage	400	400	volts
D-C Grid Voltage	-200	-310	volts
D-C Plate Current	200	225	ma.
D-C Screen Current	30	30	ma.
D-C Grid Current	9	9	ma.
Screen Dissipation	12	12	watts
Grid Dissipation	1.8	2.7	watts
Peak R-F Grid Input Voltage (approx.)	255	365	volts
Driving Power (approx.)	2.2	3.2	watts
Plate Power Input	500	675	watts
Plate Dissipation	125	165	watts
Plate Power Output	375	510	watts

<sup>1</sup> Above 75 Mc. the maximum plate voltage rating depends upon frequency, see page six.

► <sup>2</sup> Driving power increases above 40 Mc. See Page Six.

## AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR

Class-AB<sub>2</sub> (Sinusoidal wave, two tubes unless otherwise specified)

### MAXIMUM RATINGS

D-C PLATE VOLTAGE	4000 MAX. VOLTS
D-C SCREEN VOLTAGE	600 MAX. VOLTS
MAX-SIGNAL D-C PLATE CURRENT, PER TUBE	350 MAX. MA.
PLATE DISSIPATION, PER TUBE	250 MAX. WATTS
SCREEN DISSIPATION, PER TUBE	35 MAX. WATTS

### TYPICAL OPERATION

D-C Plate Voltage	1500	2000	2500	3000	volts
D-C Screen Voltage	500	500	500	500	volts
D-C Grid Voltage <sup>2</sup>	-64	-88	-90	-93	volts
Zero-Signal D-C Plate Current	120	110	120	120	ma.
Max-Signal D-C Plate Current	400	405	430	417	ma.
Zero-Signal D-C Screen Current	-0.4	-0.3	-0.3	-0.2	ma.
Max-Signal D-C Screen Current	23	22	13	10.5	ma.
Effective Load, Plate-to-Plate	6250	9170	11,400	15,000	ohms
Peak A-F Grid Input Voltage (per tube)	64	88	90	93	volts
Driving Power	0	0	0	0	watt
Max-Signal Plate Dissipation (per tube)	145	175	225	250	watts
Max-Signal Plate Power Output	310	460	625	750	watts
Total Harmonic Distortion	4	2.5	2	2.5	per cent

<sup>2</sup> The effective grid-circuit resistance must not exceed 250,000 ohms.

## AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR

Class-AB<sub>2</sub> (Sinusoidal wave, two tubes unless otherwise specified)

### MAXIMUM RATINGS

D-C PLATE VOLTAGE	4000 MAX. VOLTS
D-C SCREEN VOLTAGE	600 MAX. VOLTS
MAX-SIGNAL D-C PLATE CURRENT, PER TUBE	350 MAX. MA.
PLATE DISSIPATION, PER TUBE	250 MAX. WATTS
SCREEN DISSIPATION, PER TUBE	35 MAX. WATTS

### TYPICAL OPERATION

D-C Plate Voltage	1500	2000	2500	3000	volts
D-C Screen Voltage	300	300	300	300	volts
D-C Grid Voltage	-48	-48	-51	-53	volts
Zero-Signal D-C Plate Current	100	120	120	125	ma.
Max-Signal D-C Plate Current	485	510	500	473	ma.
Zero-Signal D-C Screen Current	0	0	0	0	ma.
Max-Signal D-C Screen Current	34	26	23	33	ma.
Effective Load, Plate-to-Plate	5400	8000	10,900	16,000	ohms
Peak A-F Grid Input Voltage (per tube)	96	99	100	99	volts
Max-Signal Avg. Driving Power (approx.)	2.1	2.3	2.2	1.9	watts
Max-Signal Peak Driving Power	4.7	5.5	4.8	4.6	watts
Max-Signal Plate Dissipation (per tube)	150	185	205	190	watts
Max-Signal Plate Power Output	428	650	840	1040	watts
Total Harmonic Distortion	3	4	4	4.5	per cent

## APPLICATION

### MECHANICAL

**Mounting**—The 4-250A must be mounted vertically, base up or base down. The socket must provide clearance for the glass tip-off which extends through the center of the base. The metal base shell should be grounded by means of suitable spring fingers. A flexible connecting strap should be provided between the plate terminal and the external plate circuit. The socket must not apply excessive lateral pressure against the base pins. The tube must be protected from severe vibration and shock.

**Adequate cooling must be provided for the seals and envelope of the 4-250A. Forced-air circulation in the amount of five cubic feet per minute through the base of the tube is required. This air should be applied simultaneously with filament power. The temperature of the plate seal, as measured on the top of the plate cap, should not exceed 170° C in continuous-service applications.**

A relatively slow movement of air past the tube is sufficient to prevent a plate seal temperature in excess of maximum at frequencies below 30 Mc. At frequencies above 30 Mc., radio-frequency losses in the leads and envelope contribute to seal and envelope heating, and special attention should be given to bulb and plate seal cooling. A small fan or centrifugal blower directed toward the upper portion of the envelope will usually provide sufficient circulation for cooling at frequencies above 30 Mc., however.

In intermittent-service applications where the "on" time does not exceed a total of five minutes in any ten-minute period, plate seal temperatures as high as 220° C are permissible. When the ambient temperature does not exceed 30° C it will not ordinarily be necessary to pro-

vide forced cooling of the bulb and plate seal to hold the temperature below this maximum at frequencies below 30 Mc., provided that a heat-radiating plate connector is used, and the tube is so located that normal circulation of air past the envelope is not impeded.

### ELECTRICAL

**Filament Voltage**—The filament voltage, as measured directly at the filament pins, should be between 4.75 and 5.25 volts.

**Bias Voltage**—D-c bias voltage for the 4-250A should not exceed 500 volts. If grid-leak bias is used, suitable protective means must be provided to prevent excessive plate or screen dissipation in the event of loss of excitation.

**Grid Dissipation**—Grid dissipation for the 4-250A should not be allowed to exceed five watts. Grid dissipation may be calculated from the following expression:

$$P_g = e_{cmp} I_c$$

where  $P_g$  = Grid dissipation,

$e_{cmp}$  = Peak positive grid voltage, and

$I_c$  = D-c grid current.

$e_{cmp}$  may be measured by means of a suitable peak voltmeter connected between filament and grid<sup>3</sup>.

**Screen Voltage**—The d-c screen voltage for the 4-250A should not exceed 600 volts.

**Screen Dissipation**—The power dissipated by the screen of the 4-250A must not exceed 35 watts. Screen dissipa-

<sup>3</sup> For suitable peak v.t.v.m. circuits see, for instance, "Vacuum Tube Ratings," Eimac News, January, 1945. This article is available in reprint form on request.

Indicates change from sheet dated 9-1-46.

tion is likely to rise to excessive values when the plate voltage, bias voltage or plate load is removed with filament and screen voltages applied. Suitable protective means must be provided to limit screen dissipation to 35 watts in the event of circuit failure.

**Plate Voltage**—The plate-supply voltage for the 4-250A should not exceed 4000 volts for frequencies below 75 Mc. Above 75 Mc., the maximum permissible plate voltage is less than 4000 volts, as shown by the graph on page 6.

**Plate Dissipation**—Under normal operating conditions, the plate dissipation of the 4-250A should not be allowed to exceed 250 watts in unmodulated applications.

In high-level-modulated amplifier applications, the maximum allowable carrier-condition plate dissipation is 165 watts.

Plate dissipation in excess of the maximum rating is permissible for short periods of time, such as during tuning procedures.

### OPERATION

**Class-C FM or Telegraphy**—The 4-250A may be operated as a class-C FM or telegraph amplifier without neutralization up to 30 Mc. if reasonable precautions are taken to prevent coupling between input and output circuits external to the tube. A grounded metallic plate on which the socket may be mounted and to which suitable connectors may be attached to ground the tube base shell, provides an effective isolating shield between grid and plate circuits. In single-ended circuits, plate, grid, filament and screen by-pass capacitors should be returned through the shortest possible leads to a common chassis point. In push-pull applications the filament and screen terminals of each tube should be by-passed to a common chassis point by the shortest possible leads, and short, heavy leads should be used to interconnect the screens and filaments of the two tubes. Care should be taken to prevent leakage of radio-frequency energy to leads entering the amplifier, in order to minimize grid-plate coupling between these leads external to the amplifier.

At frequencies from 30 Mc. to 45 Mc. ordinary neutralization systems may be used.

Where shielding is adequate, the feed-back at frequencies above 45 Mc. is due principally to screen-lead-

inductance effects, and it becomes necessary to introduce in-phase voltage from the plate circuit into the grid circuit. This can be done by adding capacitance between plate and grid external to the tube. Ordinarily, a small metal tab approximately  $\frac{3}{4}$ -inch square connected to the grid terminal and located adjacent to the envelope opposite the plate will suffice for neutralization. Means should be provided for adjusting the spacing between the neutralizing capacitor plate and the envelope. An alternative neutralization scheme is illustrated in the diagram below. In this circuit, feed-back is eliminated by series-tuning the screen to ground with a small capacitor. The socket screen terminals should be strapped together, as shown on the diagram, by the shortest possible lead, and the leads from the screen terminal to the capacitor, C, and from the capacitor to ground should be made as short as possible.

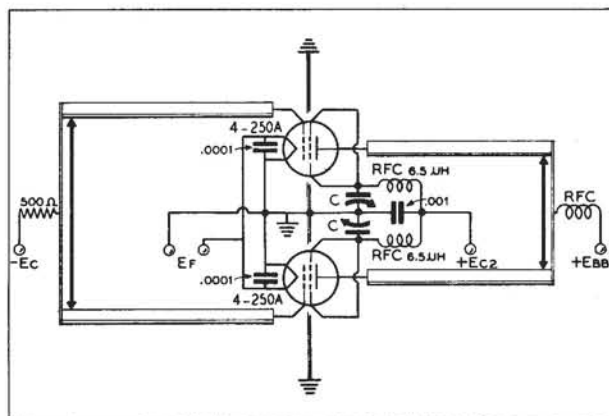
Driving power and power output under maximum output and plate voltage conditions are shown on page 6. The power output shown is the actual plate power delivered by the tube; the power delivered to the load will depend upon the efficiency of the plate tank and output coupling system. The driving power is likewise the driving power required by the tube (includes bias loss). The driver output power should exceed the driving power requirement by a sufficient margin to allow for coupling-circuit losses. The use of silver-plated linear tank-circuit elements is recommended for all frequencies above 75 Mc.

**Class-C AM Telephony**—The r-f circuit considerations discussed above under Class-C FM or Telegraphy also apply to amplitude-modulated operation of the 4-250A. When the 4-250A is used as a class-C high-level-modulated amplifier, modulation should be applied to both plate and screen. Modulation voltage for the screen may be obtained from a separate winding on the modulation transformer, by supplying the screen voltage via a series dropping resistor from the unmodulated plate supply, or by the use of an audio-frequency reactor in the positive screen-supply lead. When screen modulation is obtained by either the series-resistor or the audio-reactor method, the audio-frequency variations in screen current which result from the variations in plate voltage as the plate is modulated automatically give the required screen modulation. Where a reactor is used, it should have a rated inductance of not less than 10 henries divided by the number of tubes in the modulated amplifier and a maximum current rating of two or three times the operating d-c screen current. To prevent phase shift between the screen and plate modulation voltages at high audio frequencies, the screen by-pass capacitor should be no larger than necessary for adequate r-f by-passing.

For high-level modulated service, the use of partial grid-leak bias is recommended. Any by-pass capacitors placed across the grid-leak resistance should have a reactance at the highest modulation frequency equal to at least twice the grid-leak resistance.

**Class-AB<sub>1</sub> and Class-AB<sub>2</sub> Audio**—Two 4-250A's may be used in a push-pull circuit to give relatively high audio output power at low distortion. Maximum ratings and typical operating conditions for class-AB<sub>1</sub> and class-AB<sub>2</sub> audio operation are given in the tabulated data.

Screen voltage should be obtained from a source having reasonably good regulation, to prevent variations in screen voltage from zero-signal to maximum-signal conditions. The use of voltage regulator tubes in a standard circuit should provide adequate regulation.



Screen-tuning neutralization circuit for use above 45 Mc.  
C — Approximately 100  $\mu\mu\text{fd.}$  per section, maximum.

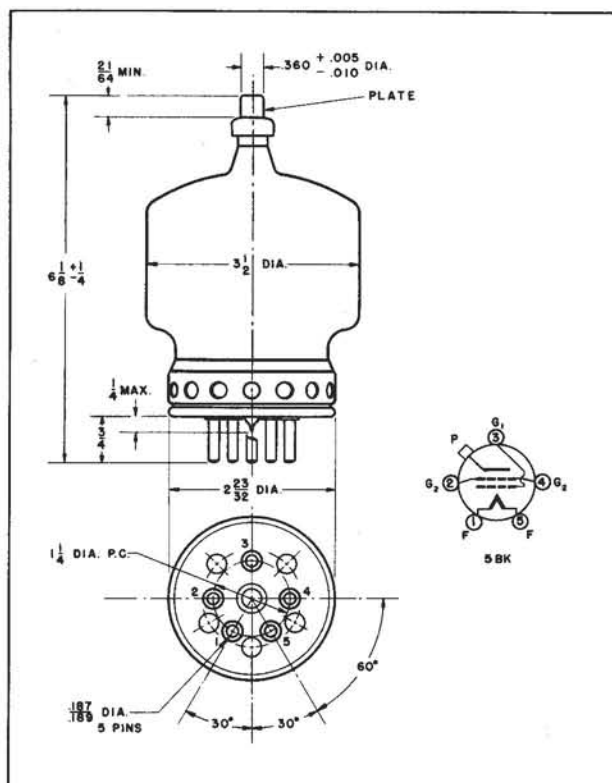


Grid bias voltage for class-AB<sub>2</sub> service may be obtained from batteries or from a small fixed-bias supply. When a bias supply is used, the d-c resistance of the bias source should not exceed 250 ohms. Under class-AB<sub>1</sub> conditions the effective grid-circuit resistance should not exceed 250,000 ohms.

The peak driving power figures given in the class-AB<sub>2</sub> tabulated data are included to make possible an accurate determination of the required driver output power. The driver amplifier must be capable of supplying the peak driving power without distortion. The driver stage should, therefore, be capable of providing an undistorted average output equal to half the peak driving power requirement. A small amount of additional driver output should be provided to allow for losses in the coupling transformer.

In some cases the maximum-signal plate dissipation shown under "Typical Operation" is less than the maximum rated plate dissipation of the 4-250A. In these cases, the plate dissipation reaches a maximum value, equal to the maximum rating, at a point somewhat below maximum-signal conditions.

The power output figures given in the tabulated data refer to the total power output from the amplifier tubes. The useful power output will be from 5 to 15 per cent less than the figures shown, due to losses in the output transformer.



## COMPONENTS FOR TYPICAL CIRCUITS

$L_{p1} - C_{p1}$  — Tank circuit appropriate for operating frequency;  
 $Q = 12$ . Capacitor plate spacing = .200".

$L_{p2} - C_{p2}$  — Tank circuit appropriate for operating frequency;  
 $Q = 12$ . Capacitor plate spacing = .200".

$L_{p3} - C_{p3}$  — Tank circuit appropriate for operating frequency;  
 $Q = 12$ . Capacitor plate spacing = .375".

$L_{g1} - C_{g1}$  — Tuned circuit appropriate for operating frequency.

$L_{g2} - C_{g2}$  — Tuned circuit appropriate for operating frequency.

$C_1$  — .002-ufd., 500-v. mica

$C_2$  — .002-ufd., 5000-v. mica

$C_3$  — .001-ufd., 2500-v. mica

$C_4$  — .1-ufd., 1000-v. paper

$C_5$  — .1-ufd., 600-v. paper

$C_6$  — .5-ufd., 600-v. paper

$C_7$  — .03-ufd., 600-v. paper

$C_8$  — .1-ufd., 1000-v. paper

$C_9$  — .25-ufd., 1000-v. paper

$R_1$  — 86,700 ohms, adjustable 100,000 ohms, 100 watts

$R_2$  — 250,000 ohms, 1/2 watt

$R_4$  — 15,000 ohms, 5 watts

$R_5$  — 25,000 ohms, 2 watts

$R_6$  — 2,500 ohms, 5 watts

$R_7$  — 35,000 ohms, 160 watts

$R_8$  — 250,000 ohms, 1/2 watt

$R_9$  — 200,000 ohms, 2 watts

$R_{10}$  — 500 ohms, 1/2 watt

$R_{11}$  — 1 megohm, 1/2 watt

$R_{12}$  — 100,000 ohms, 1 watt

$R_{13}$  — 200,000 ohms, 1/2 watt

$R_{14}$  — 10,000 ohms, 1/2 watt

$R_{15}$  — 50 ohms, 10 watts

$R_{16}$  — 100,000 ohms, 100 watts

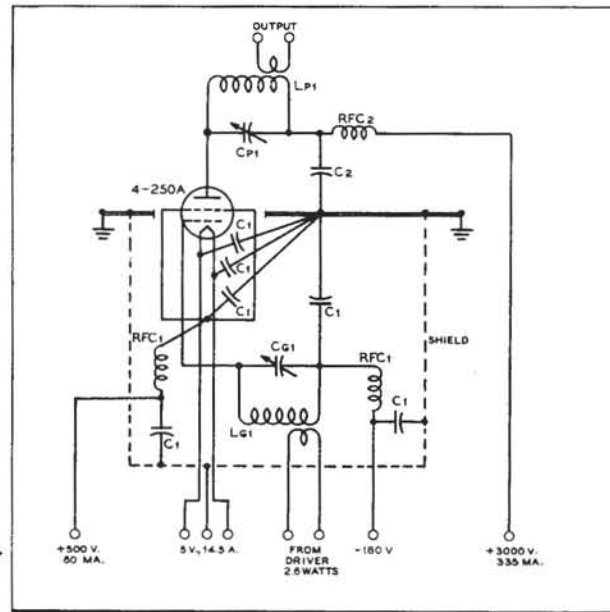
$RFC_1$  — 2.5-mhy., 125-ma. r-f choke

$RFC_2$  — 1-mhy., 500-ma. r-f choke

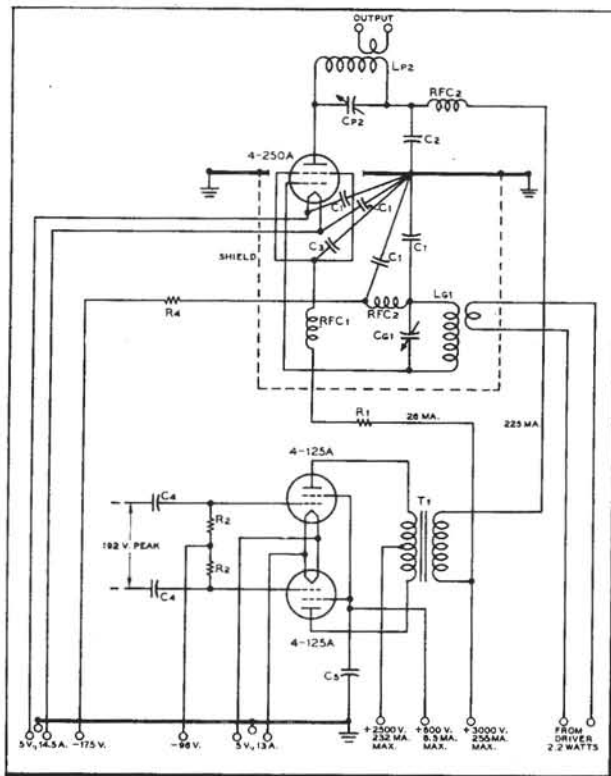
$T_1$  — 350-watt modulation transformer; ratio pri. to sec. approx. 1.5 : 1; pri. impedance 20,300 ohms, sec. impedance 13,300 ohms.

$T_2$  — 600-watt modulation transformer; ratio pri. to sec. approx. 1.8 : 1; pri. impedance 11,400 ohms, sec. impedance 6,250 ohms.

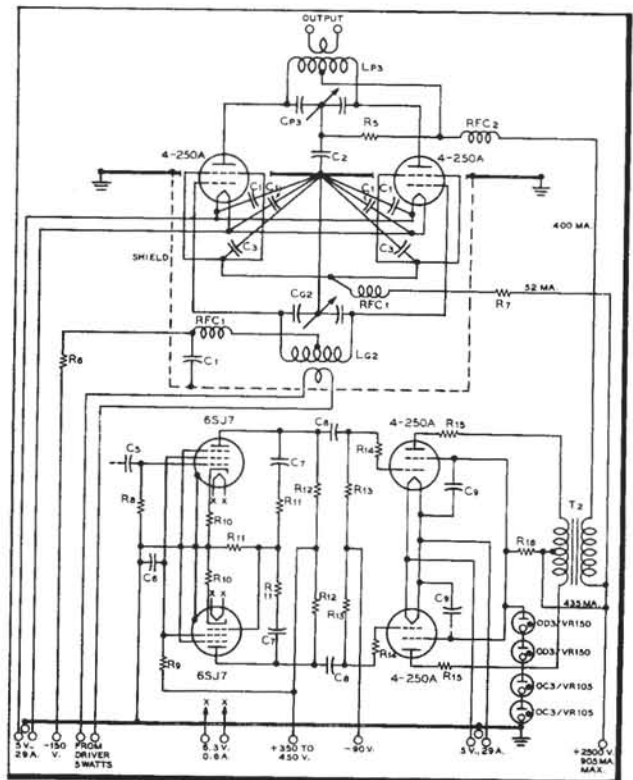




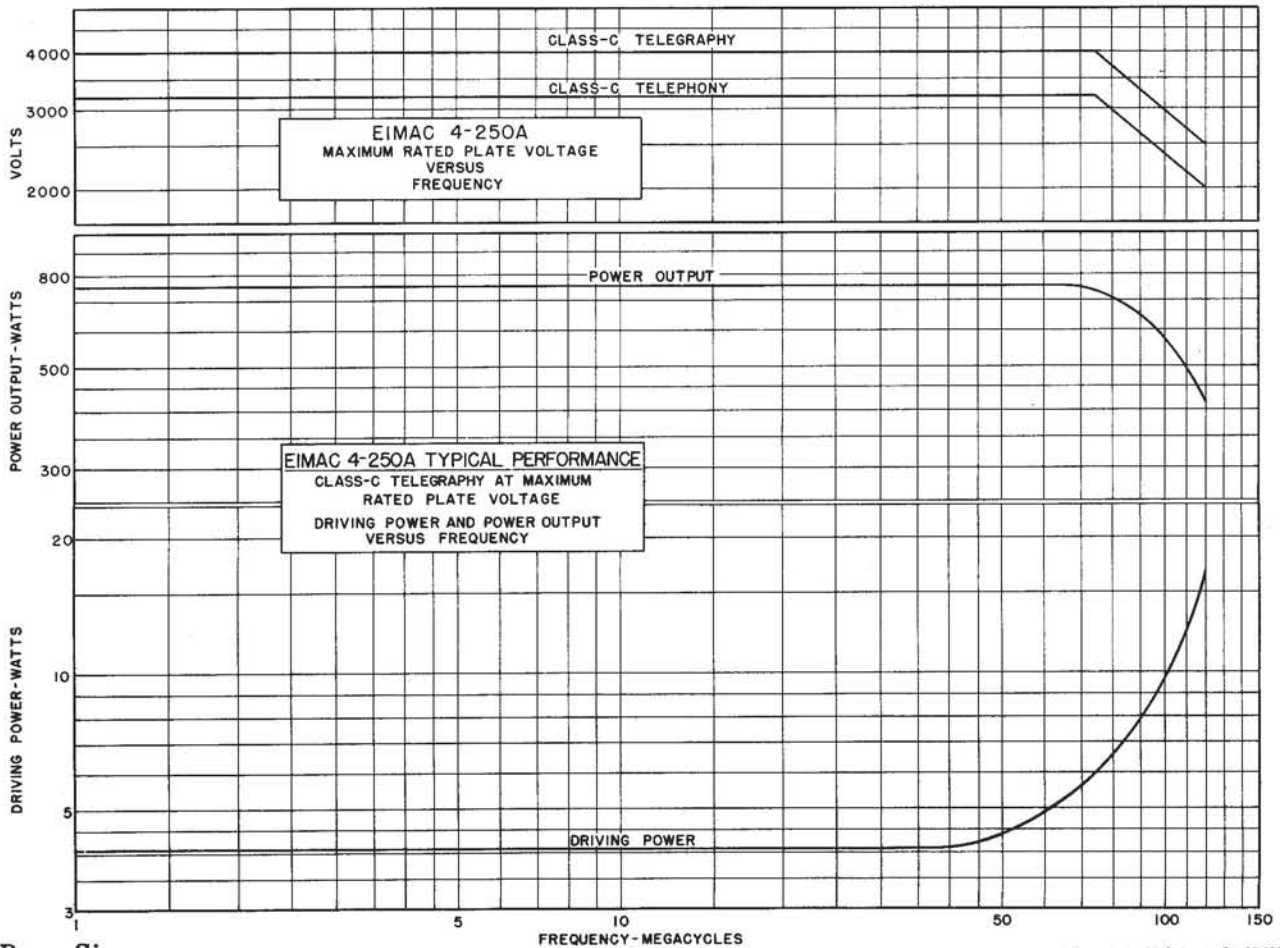
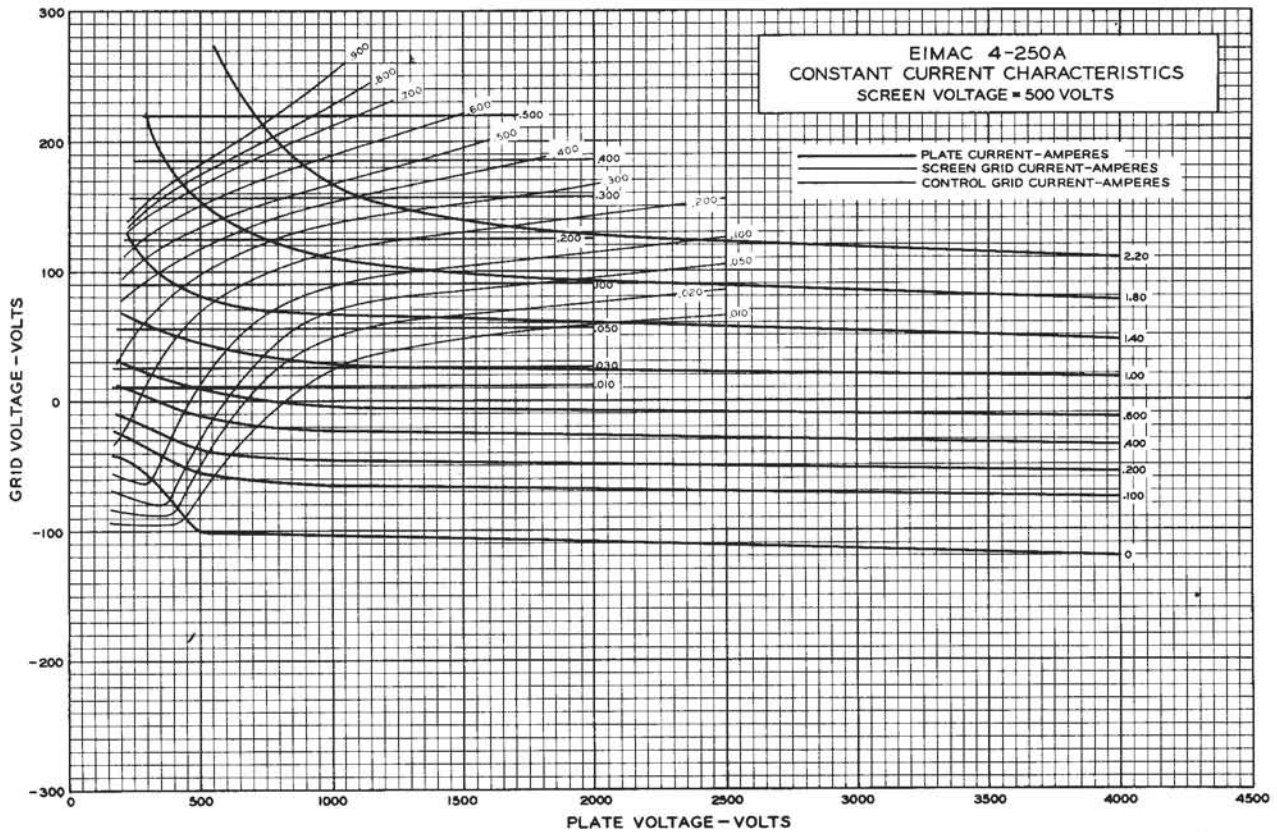
Typical radio frequency power amplifier circuit, Class-C telegraphy, 1000 watts input.



Typical high-level-modulated r-f amplifier circuit, with modulator stage, 675 watts input.



Typical high-level-modulated r-f amplifier circuit, with modulator and driver stages, 1000 watts input.



# Eitel-McCullough, Inc.

SAN BRUNO, CALIFORNIA

## 4-400A

POWER TETRODE

•  
RF

AMPLIFIER

The Eimac 4-400A is a high vacuum power tetrode having a maximum plate dissipation rating of 400 watts. It is intended for power amplifier service in 1 kw FM broadcast transmitters on the 88-108 Mc. band. Two tubes operating in this service will deliver a useful power output in excess of 1000 watts while operating under conservative conditions and with low driving-power requirements. The 4-400A is of compact and rugged construction and its low grid-plate capacitance coupled with its low driving power requirement allows considerable simplification of the associated circuit and driver stage.

Cooling of the 4-400A is accomplished by radiation from the plate and with circulation of forced-air through the base around the envelope and over the plate seal. The problem of cooling is greatly simplified by using an Eimac Air-System Socket and its accompanying glass chimney. This system is designed to efficiently maintain the correct balance of cooling air between the component parts of the tube.\*†

## GENERAL CHARACTERISTICS

### ELECTRICAL

Filament: Thoriated tungsten

Voltage - - - - - 5.0 volts

Current - - - - - 14.5 amperes

Grid-Screen Amplification Factor (Average) - - - - - 5.1

Direct Interelectrode Capacitances (Average)

Grid-Plate (without shielding, base grounded) - 0.12  $\mu\text{fd}$

Input - - - - - 12.5  $\mu\text{fd}$

Output - - - - - 4.7  $\mu\text{fd}$

Transconductance ( $i_b=100\text{ ma.}$ ,  $E_b=2500\text{V.}$ ,  $E_{c2}=500\text{V.}$ ) - 4,000  $\mu\text{mhos}$

### MECHANICAL

Base - - - - - 5-pin metal shell, No. 5008B

Basing - - - - - RMA type 5BK

\*Cooling - - - - - Radiation and forced air.

When the Eimac Air-System Socket 4-400A/4000 is used, 14 cu. ft. of air per minute at  $\frac{1}{4}$  inch pressure as measured in the socket, is required per tube.

Maximum Overall Dimensions:

	Tube Only	Tube with Socket, Chimney and HR-6 Plate Connector
Length - - - - -	6.38 inches	8.00 inches
Diameter - - - - -	3.56 inches	5.44 inches
Net Weight - - - - -	9. ounces	
Shipping Weight (Avg.) - - - - -	2.5 pounds	

### RATINGS

#### RADIO-FREQUENCY POWER AMPLIFIER

Class-C FM Telephony or Telegraphy(Key-down conditions, 1 tube)

MAXIMUM RATINGS (Frequencies up to 110-Mc.)

D-C PLATE VOLTAGE - - - - -	4000 MAX VOLTS
D-C PLATE CURRENT - - - - -	350 MAX. MA.
D-C SCREEN VOLTAGE - - - - -	600 MAX. VOLTS
D-C GRID VOLTAGE - - - - -	-500 MAX. VOLTS
PLATE DISSIPATION - - - - -	400 MAX. WATTS
SCREEN DISSIPATION - - - - -	35 MAX. WATTS
GRID DISSIPATION - - - - -	5 MAX. WATTS

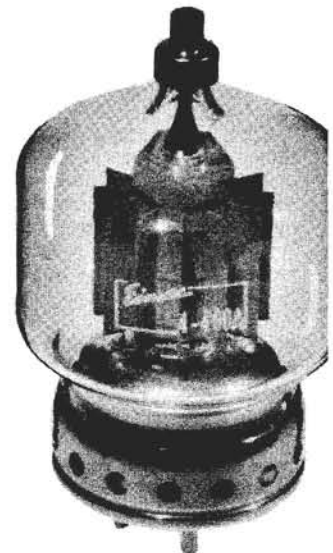
\*Guarantee applies only when the 4-400A is used as specified with adequate air in the 4-400A/4000 Air-System Socket or equivalent.

†The Radio-frequency losses in a vacuum tube increase with frequency (Effective 3-1-48) Copyright 1948 by Eitel-McCullough, Inc.

#### TYPICAL OPERATION (110-Mc., Two Tubes)

D-C PLATE VOLTAGE - - - - -	3500	4000	VOLTS
D-C PLATE CURRENT - - - - -	500	540	MA.
D-C SCREEN VOLTAGE - - - - -	300	300	VOLTS
D-C SCREEN CURRENT - - - - -	40	45	MA.
D-C GRID VOLTAGE - - - - -	-170	-170	VOLTS
D-C GRID CURRENT - - - - -	20	20	MA.
DRIVING POWER (APPROX.) - - - - -	20	20	WATTS
PLATE POWER OUTPUT (APPROX.) - - - - -	1300	1600	WATTS
USEFUL POWER OUTPUT - - - - -	1160	1440	WATTS

and at 110-Mc become an appreciable source of heat. Since these losses occur mainly in the leads and the glass surrounding these leads, adequate cooling must be provided to prevent the deterioration of the envelope at the point where the leads go through the glass.

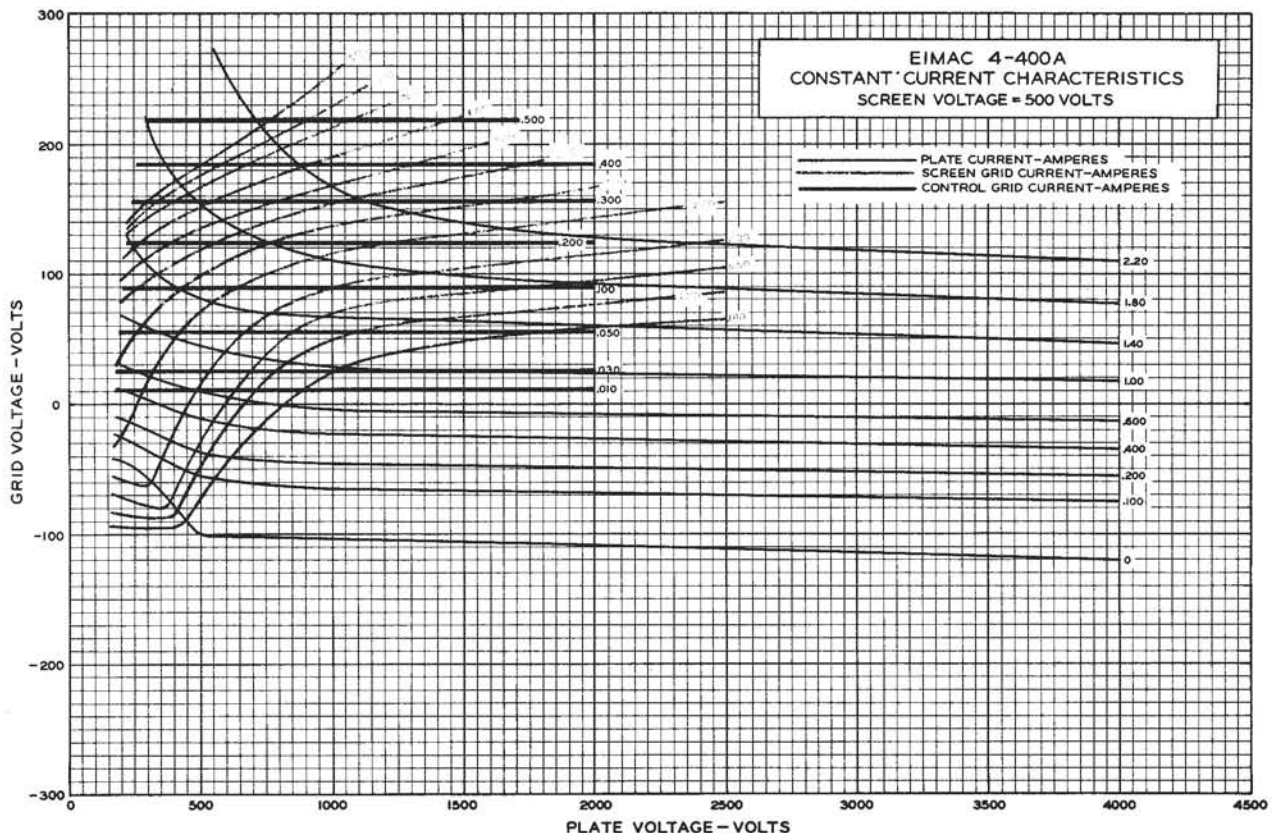
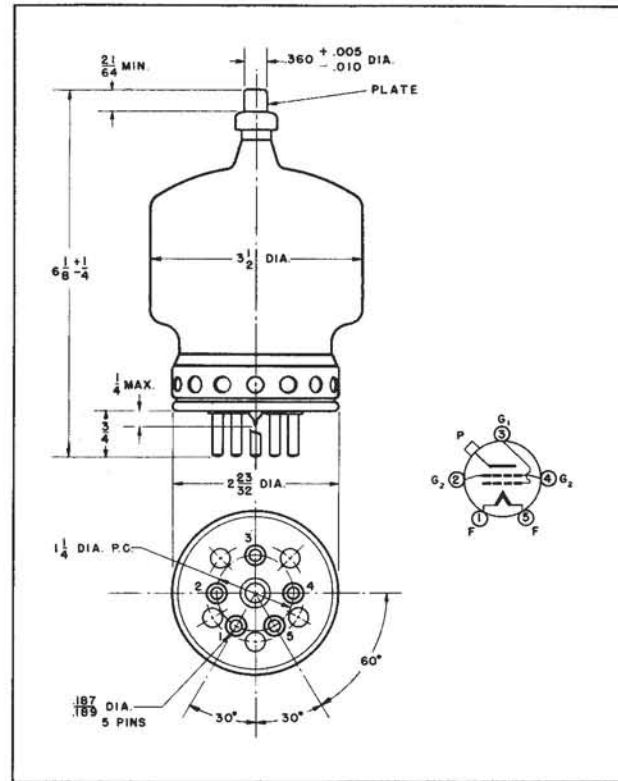


## APPLICATION

Conventional capacitance-shortened quarter wave linear grid and plate tank circuits may be used at 110-Mc. The circuit elements should be silver-plated for best results at this frequency. The 4-400A screen lead inductance is minimized by two screen leads brought through the base of the tube. In order to take advantage of this design feature the screen lead terminals on a socket must be strapped together and all R-F connections must be made to the center of this strap to provide balanced current distribution to ground.

With adequate shielding on frequencies above 30-Mc. there will still be some feed-back present, which is due principally to screen-lead-inductance effects. This may be neutralized by introducing inphase voltage from the plate circuit back into the grid circuit of the same tube. Ordinarily a small metal tab 1 inch by 1½ inches connected to the grid terminal and located parallel to the plate outside of the cooling chimney will suffice for neutralization. Means should be provided for adjusting the distance between the tab and the plate until the correct amount of neutralization is obtained. Trimming the tab to the correct size will also accomplish the same result.

An alternate neutralization method would be to series-tune each screen to ground by means of a small variable capacitor. The leads to each capacitor and to ground should be kept as short as possible and the lead from the screen strap to the capacitor should be brought from the center of the screen strap as previously mentioned.





*Eimac*  
**EITEL-McCULLOUGH, INC.**  
SAN BRUNO, CALIFORNIA

**4-400A/4000**

**AIR-SYSTEM  
SOCKET**

In order to simplify the cooling problem of the Eimac 4-400A Tetrode and assure adequate air-flow to the various seals, the Eimac Air-System Socket was developed. This system is so designed that the correct amount of cooling air is distributed to the various seals in the right proportion.

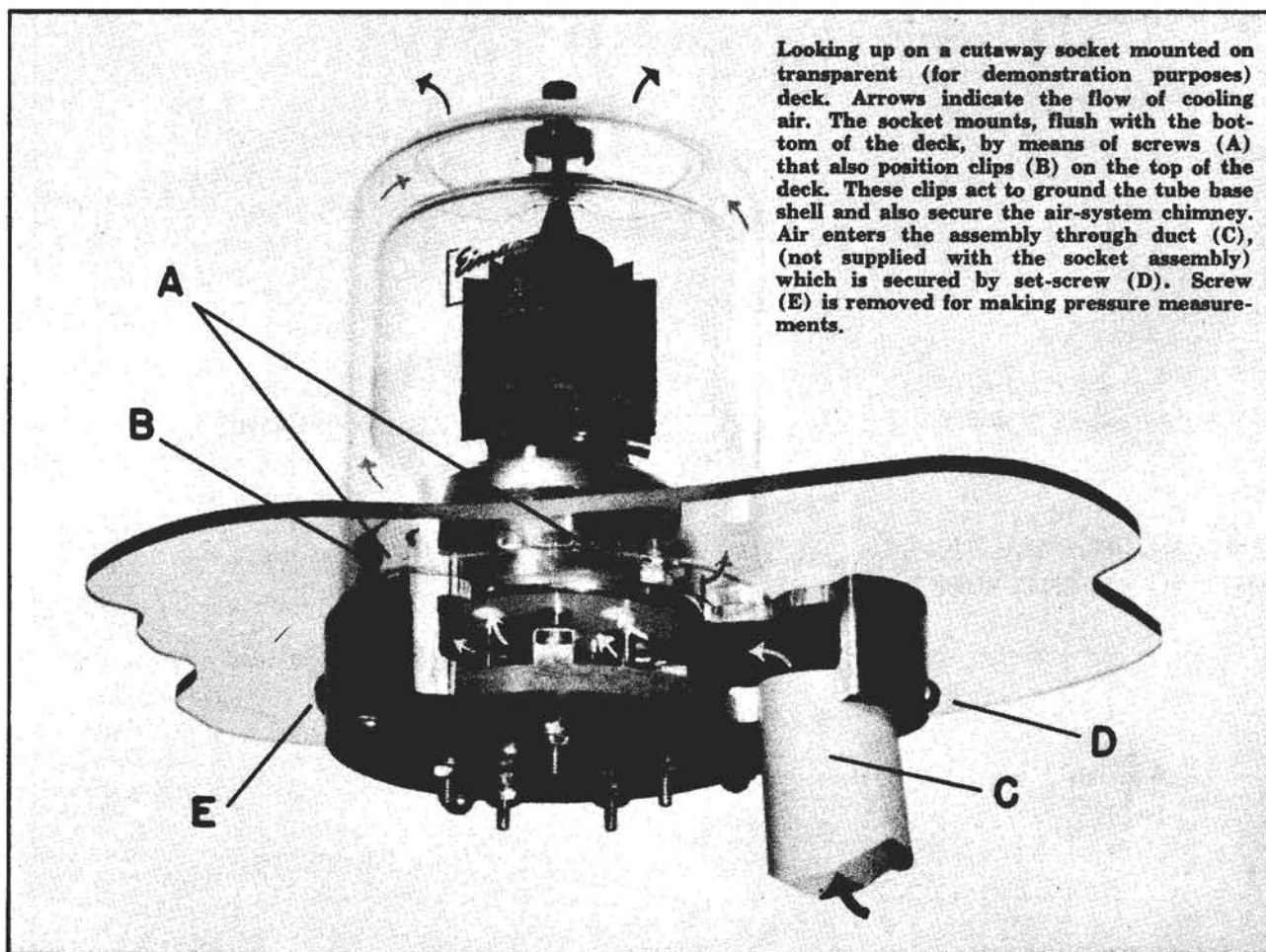
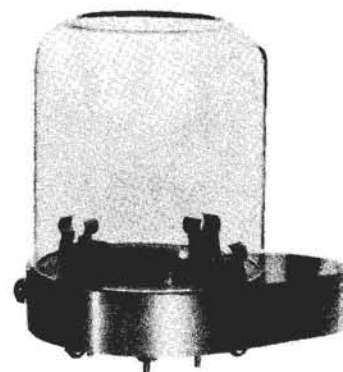
The system consists of two parts: a specially designed cooling socket and a glass chimney that fits over the tube envelope. The air is introduced into the system at a single port in the socket and then circulates through and around the base, cooling the base pins and seals. It then flows over the envelope, the plate seal and finally exhausts at the chimney top.

A  $\frac{1}{4}$  inch diameter hole tapped 28 threads per inch is provided in the socket for the purpose of reading the static air pressure. Under full operating conditions at 110-Mc, with an ambient temperature of 25 degrees Centigrade, each tube requires cooling air at the rate of 14 cu. ft. per minute into the system with a static pressure of 0.25 inches of water as measured at the socket measuring port.

In selecting a blower, allowance should be made for pressure drop occurring in the duct and manifold between the blower and the socket. This drop will, of course, depend on the length and diameter of the air duct and manifold between the blower and the socket.

These air requirements are readily furnished by a small centrifugal blower of the dual type, with the output of each blower going to a socket. The single motor of this type of blower need require only 65 watts of power while furnishing 14 cu. ft. per minute air-flow at  $\frac{1}{2}$  inch pressure from each of two blowers.

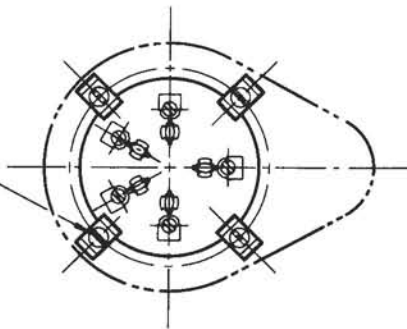
The 4-400A/4000 Air-System Socket can also be used without modification for the Eimac 4-250A and 4-125A Tetrodes.



Looking up on a cutaway socket mounted on transparent (for demonstration purposes) deck. Arrows indicate the flow of cooling air. The socket mounts, flush with the bottom of the deck, by means of screws (A) that also position clips (B) on the top of the deck. These clips act to ground the tube base shell and also secure the air-system chimney. Air enters the assembly through duct (C), (not supplied with the socket assembly) which is secured by set-screw (D). Screw (E) is removed for making pressure measurements.

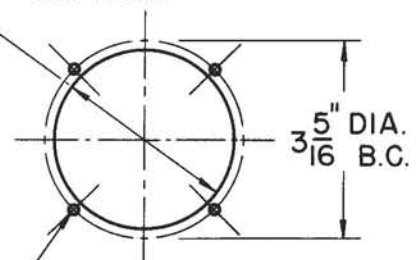


# 10-32 MACHINE  
SCREWS MOUNT  
SPRING CLIPS AND  
SOCKET ON CHASSIS



TOP VIEW

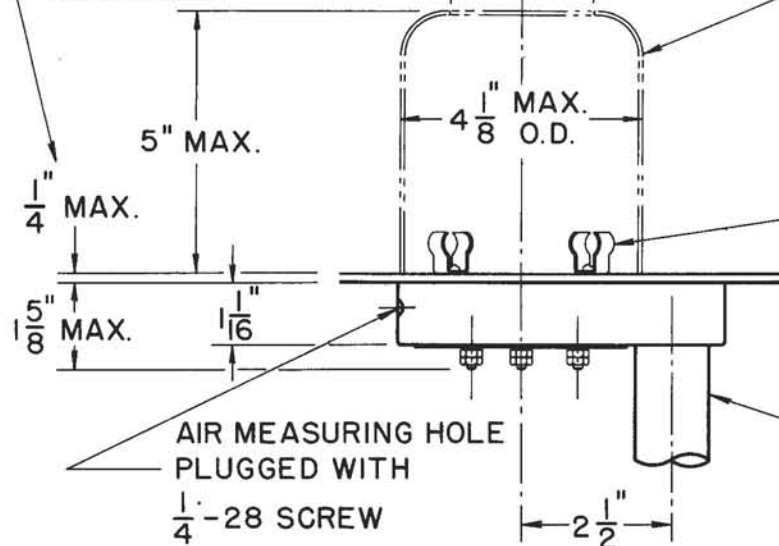
3" DIA. HOLE THRU  
CHASSIS



CHASSIS  
DRILLING

#9 (.196) DRILL THRU  
4 HOLES

CHASSIS  
THICKNESS



2 7/16" DIA. AIR  
HOLE

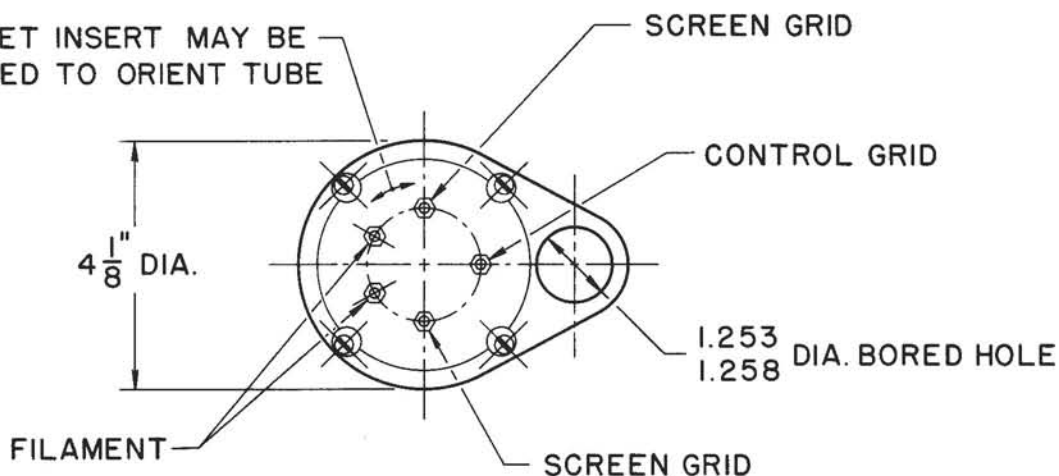
GLASS AIR  
FLOW CHIMNEY

SPRING CLIPS GROUND  
TUBE BASE AND HOLD  
AIR FLOW CHIMNEY

AIR INLET 1 1/4" O.D.  
TUBING OR FITTING

AIR MEASURING HOLE  
PLUGGED WITH  
1/4"-28 SCREW

SOCKET INSERT MAY BE  
TURNED TO ORIENT TUBE



SCREEN GRID

CONTROL GRID

1.253  
1.258 DIA. BORED HOLE

SCREEN GRID

FILAMENT

## TENTATIVE DATA

**EITEL-McCULLOUGH, INC.**  
SAN BRUNO, CALIFORNIA

**4X500**

POWER TETRODE

The Eimac 4X500A is an external-anode tetrode having a maximum plate dissipation rating of 500 watts. Its small size and low-inductance leads permit efficient operation at relatively large outputs well into the VHF region. The screen grid is mounted on a disc which terminates in a connector ring located between grid and plate, thus making possible effective shielding between the grid and plate circuits. The grid terminal is located at the center of the glass base, to facilitate single-tube operation in coaxial circuits.

The combination of low grid-plate capacitance, low screen-lead inductance and functionally located terminals contributes to the stable operation of the 4X500A at high frequencies, making neutralization unnecessary in most cases and greatly simplifying it in others.

**GENERAL CHARACTERISTICS****ELECTRICAL**

Filament: Thoriated Tungsten	
Voltage	5.0 volts
Current	13.5 amperes
Screen Grid Amplification Factor (Average)	6.2
Direct Interelectrode Capacitances (Average)	
Grid-Plate	0.05 $\mu\text{mfd}$
Input	12.8 $\mu\text{mfd}$
Output	5.6 $\mu\text{mfd}$
Transconductance ( $i_b=200 \text{ ma.}$ , $e_b=2500 \text{ v.}$ , $E_{c2}=500 \text{ v.}$ )	5200 $\mu\text{hms}$

**MECHANICAL**

Maximum Overall Dimensions:	
Length	4.375 inches
Diameter	2.563 inches
Net Weight	1.17 pounds
Shipping Weight (Average)	6 pounds
Mounting Position:	Vertical, Base up or down

**RADIO FREQUENCY POWER AMPLIFIER AND OSCILLATOR**

Class-C FM or Telegraphy (Key-down conditions, 1 tube)

MAXIMUM RATINGS (Frequencies up to 120 Mc.)

D-C PLATE VOLTAGE	4000 MAX. VOLTS
D-C SCREEN VOLTAGE	500 MAX. VOLTS
D-C GRID VOLTAGE	500 MAX. VOLTS
D-C PLATE CURRENT	350 MAX. MA.
PLATE DISSIPATION <sup>1</sup>	500 MAX. WATTS
SCREEN DISSIPATION	30 MAX. WATTS
GRID DISSIPATION	10 MAX. WATTS

## TYPICAL OPERATION

(Two-Tubes, push-pull amplifier, 110 Mc.)

D-C Plate Voltage	2500	3000	volts
D-C Plate Current	690	400	ma.
D-C Screen Voltage	500	400	volts
D-C Grid Voltage	100	95	ma.
D-C Screen Current	-250	-200	volts
D-C Grid Current	40	45	ma.
Driving Power (approx.)	20	18	watts
Plate Power Output (approx.)	1300	1320	watts
Useful Power Output	1150	1180	watts

<sup>1</sup> A minimum flow of 22 cubic feet of air per minute must be passed through the plate cooler. The pressure drop across the cooler at this flow equals 1.4 inches of water. The glass at the base of the tube must be cooled by passing air at a minimum velocity of 1000 feet per minute

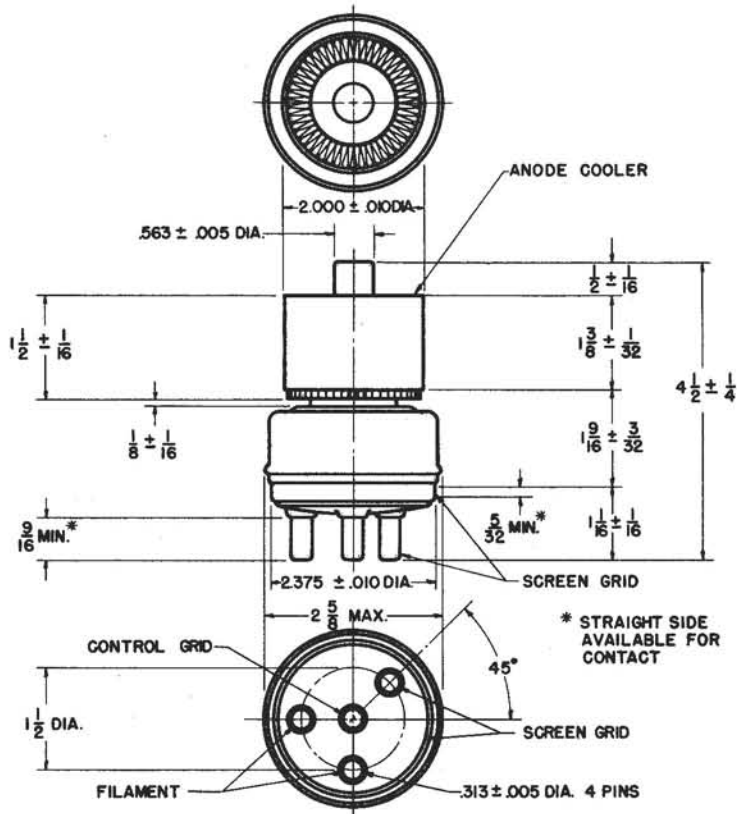
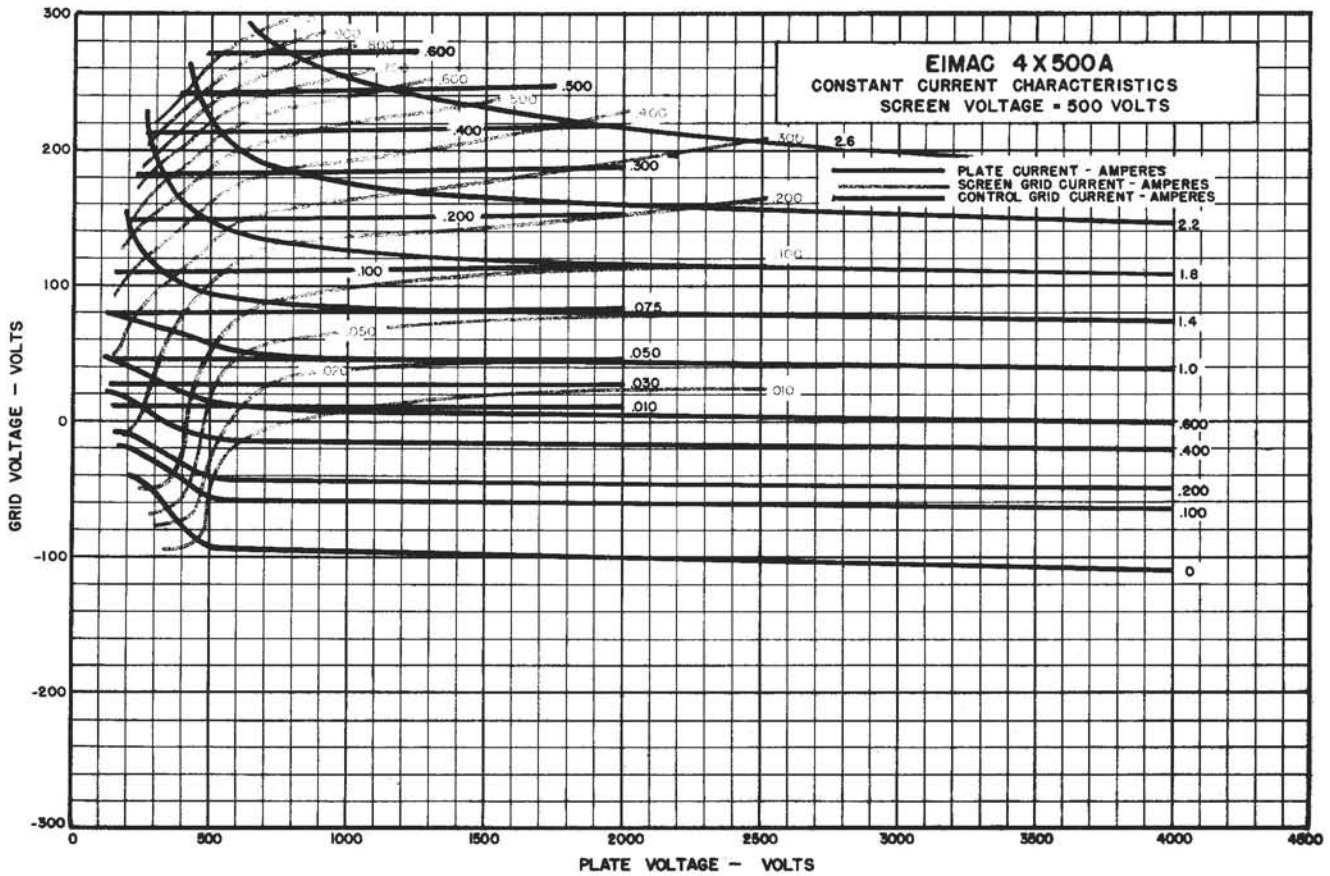
## TYPICAL OPERATION

(Four tubes, push-pull-parallel amplifier, 110 Mc.)

D-C Plate Voltage	4000	volts
D-C Plate Current	1.25	amp.
D-C Screen Voltage	500	volts
D-C Screen Current	160	ma.
D-C Grid Voltage	-250	volts
D-C Grid Current	70	ma.
Driving Power (approx.)	50	watts
Plate Power Output (approx.)	3900	watts
Useful Power Output	3500	watts

across the base. Sufficient air for this purpose will ordinarily be obtained from a small fan or low-pressure centrifugal blower. Cooling air must be supplied to both the plate cooler and base before applying filament voltage.





## TENTATIVE DATA

**EITEL-McCULLOUGH, INC.**  
SAN BRUNO, CALIFORNIA

**4-1000A**

SUPERSEDES TYPE 4-750

POWER TETRODE

MODULATOR

OSCILLATOR

AMPLIFIER

The Eimac 4-1000A is a power tetrode having a maximum plate dissipation of 1000 watts. Cooling of the 4-1000A is accomplished by radiation from the plate and by forced-air circulation around the glass envelope and through the compact low-inductance base structure. At maximum dissipation the plate operates at a red-orange color.

The 4-1000A permits a single-stage gain of more than 230 times up to approximately 30 Mc., or from 14 watts driving power to over 3 KW power output per tube. This output can be obtained at frequencies well into the VHF range. At 100 Mc. a pair of 4-1000A's will deliver a useful power output of more than 4000 watts.

**GENERAL CHARACTERISTICS****ELECTRICAL**

Filament: Thoriated tungsten

Voltage - - - - - 7.5 volts

Current - - - - - 21 amperes

Grid-Screen Amplification Factor (Average) - - - - - 7.2

Direct Interelectrode Capacitances (Average)

Grid-Plate (without shielding, base grounded) - - 0.24  $\mu\text{fd}$ Input - - - - - 27.2  $\mu\text{fd}$ Output - - - - - 7.6  $\mu\text{fd}$ Transconductance ( $i_b=300\text{ ma.}$ ,  $E_b=2500\text{ v.}$ ,  $E_{c2}=500\text{ v.}$ ) - 10,000  $\mu\text{mhos}$ **MECHANICAL**

Base - - - - - 5-pin metal shell, (see dwg.)

Basing - - - - - RMA type 5BK

Cooling - - - - - Radiation and forced air<sup>1</sup>

Mounting position - - - - - Vertical, base down or up

Maximum Overall Dimensions

Length - - - - - 9.25 inches

Diameter - - - - - 5 inches

Net Weight - - - - - 1.5 pounds

Shipping Weight (Average) - - - - - 12 pounds

**RADIO FREQUENCY POWER AMPLIFIER AND OSCILLATOR**

Class-C Telephony (Key-down conditions, per tube)

**MAXIMUM RATINGS**

D-C Plate Voltage	-	-	-	-	-	6000	Max. Volts
D-C Screen Voltage	-	-	-	-	-	1000	Max. Volts
D-C Grid Voltage	-	-	-	-	-	500	Max. Volts
D-C Plate Current	-	-	-	-	-	700	Max. ma
Plate Dissipation	-	-	-	-	-	1000	Max. Watts
Screen Dissipation	-	-	-	-	-	75	Max. Watts
Grid Dissipation	-	-	-	-	-	25	Max. Watts

**TYPICAL OPERATION (Frequencies below 40 Mc.)**

D-C Plate Voltage	-	-	-	-	3000	4000	5000	6000	Volts
D-C Screen Voltage	-	-	-	-	500	500	500	500	Volts
D-C Grid Voltage	-	-	-	-	150	150	200	200	Volts
D-C Plate Current	-	-	-	-	693	700	665	681	ma
D-C Screen Current	-	-	-	-	146	137	125	141	ma
D-C Grid Current	-	-	-	-	38	39	37	41	ma
Screen Dissipation	-	-	-	-	73	69	63	71	Watts
Grid Dissipation	-	-	-	-	5.4	5.5	5.3	6.1	Watts
Peak R-F Grid Input Voltage (approx.)	-	-	-	-	292	292	342	348	Volts
Driving Power (approx.) <sup>2</sup>	-	-	-	-	11.1	11.4	12.7	14.3	Watts
Plate Power Input	-	-	-	-	2079	2800	3325	4086	Watts
Plate Dissipation	-	-	-	-	667	700	715	746	Watts
Plate Power Output	-	-	-	-	1412	2100	2610	3340	Watts

**RADIO FREQUENCY POWER AMPLIFIER**

FM Telephony or Class C Telephony

**MAXIMUM RATINGS (Per tube at 110 Mc.)**

D-C Plate Voltage	-	-	-	-	-	5000	Max. Volts
D-C Screen Voltage	-	-	-	-	-	1000	Max. Volts
D-C Grid Voltage	-	-	-	-	-	500	Max. Volts
D-C Plate Current	-	-	-	-	-	700	Max. ma
Plate Dissipation	-	-	-	-	-	1000	Max. Watts
Screen Dissipation	-	-	-	-	-	75	Max. Watts
Grid Dissipation	-	-	-	-	-	25	Max. Watts

**TYPICAL OPERATION (Two Tubes Push-Pull at 110 Mc.)**

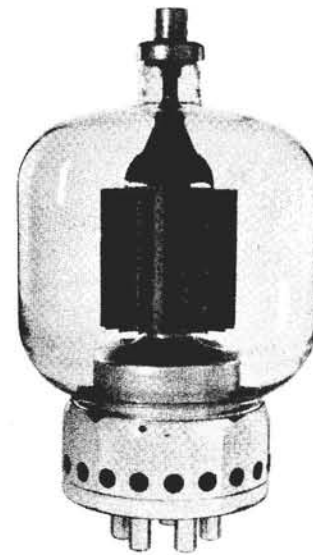
D-C Plate Voltage	-	-	-	-	-	4000	5000	Volts
D-C Screen Voltage	-	-	-	-	-	350	330	Volts
D-C Grid Voltage	-	-	-	-	-	350	487	Volts
D-C Plate Current	-	-	-	-	-	1.1	1.22	Amp
D-C Screen Current	-	-	-	-	-	290	250	ma.
D-C Grid Current	-	-	-	-	-	70	65	ma.
Screen Dissipation	-	-	-	-	-	100	83	Watts
Driving Power (approx.) <sup>2</sup>	-	-	-	-	-	200	250	Watts
Plate Power Input	-	-	-	-	-	4400	6100	Watts
Plate Dissipation (per tube)	-	-	-	-	-	565	670	Watts
Useful Power Output	-	-	-	-	-	3050	4400	Watts

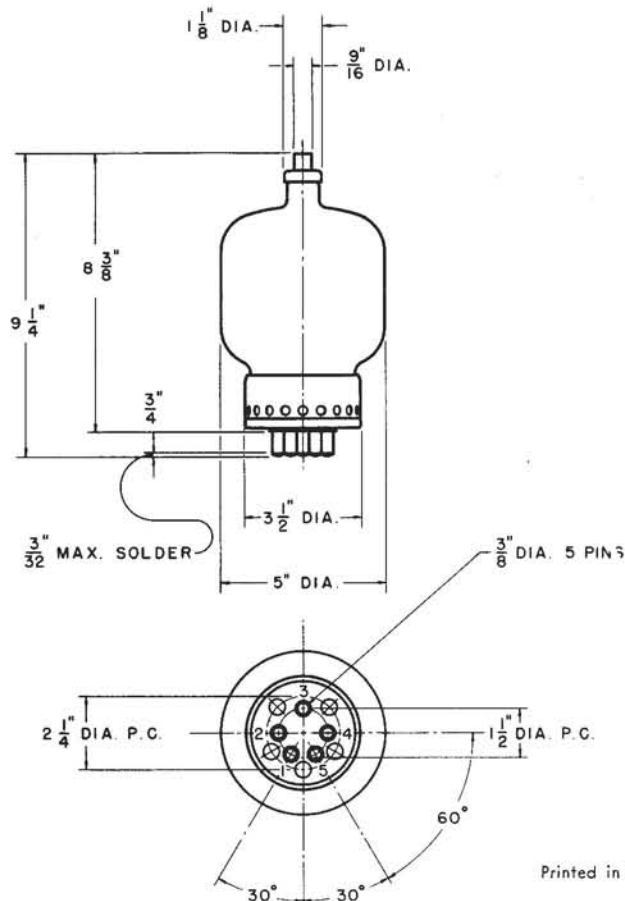
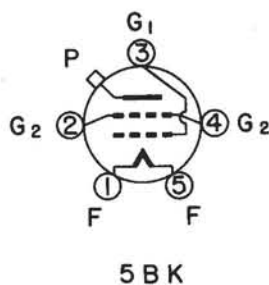
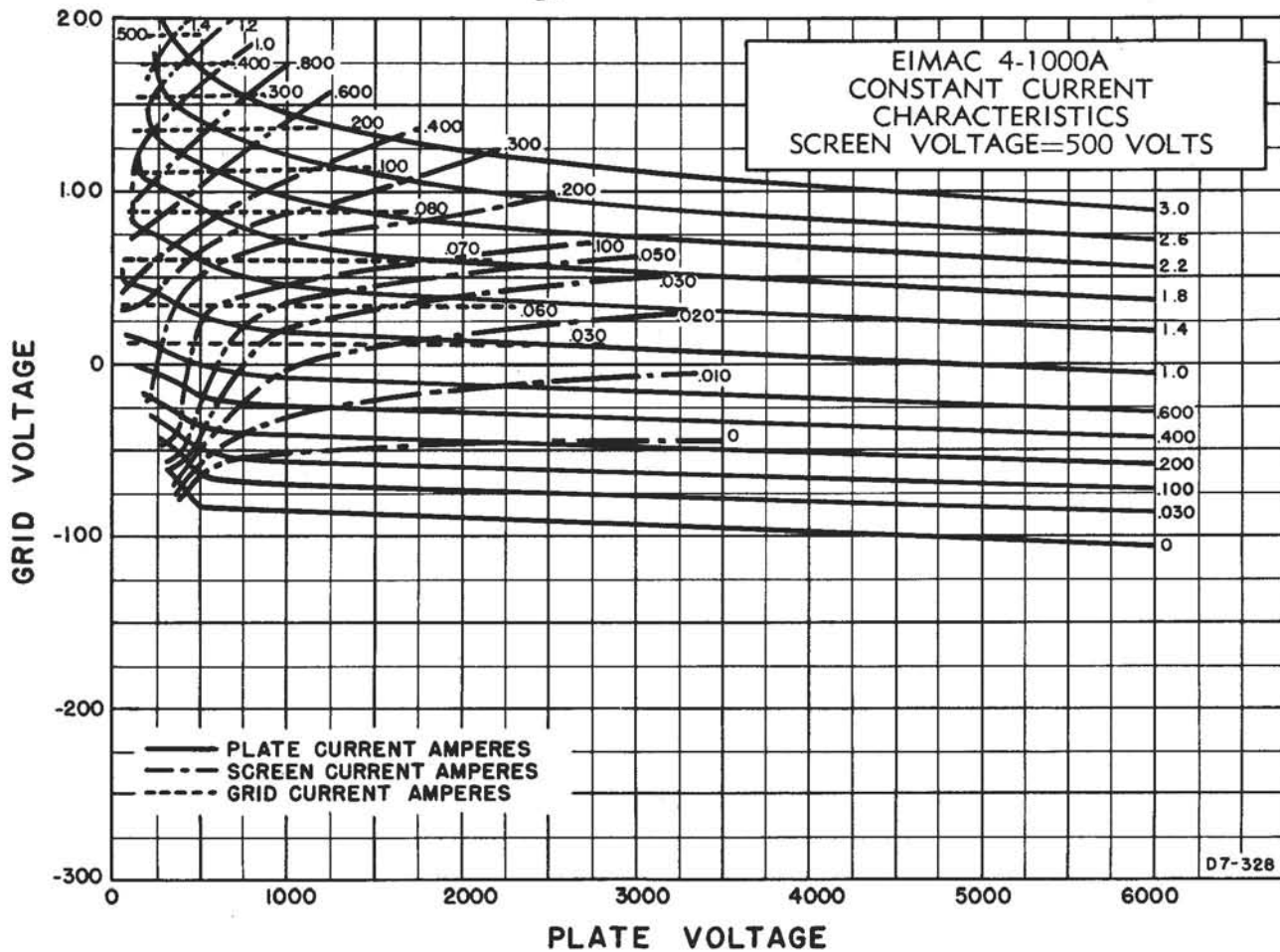
<sup>1</sup> Adequate cooling must be provided for the seals and envelope of the 4-1000A. Forced air circulation in the amount of 20 cubic feet per minute through the base of the tube is required. This air should be applied simultaneously with filament power. The temperature at the top of

(Effective 4-15-47) Copyright 1947 by Eitel-McCullough, Inc.

the plate terminal and on the pins at the base of the tube should not exceed 150 degrees centigrade in continuous-service applications.

<sup>2</sup> Driving power increases for frequencies above approximately 30 Mc.

**TENTATIVE DATA**





# Eitel-McCULLOUGH, Inc.

SAN BRUNO, CALIFORNIA

# 25T

MEDIUM-MU TRIODE

MODULATOR

OSCILLATOR

AMPLIFIER

## GENERAL CHARACTERISTICS

### ELECTRICAL

Filament: Thoriated tungsten	
Voltage - - - - -	6.3 volts
Current - - - - -	3.0 amperes
Amplification Factor (Average) - - - - -	24
Direct Interelectrode Capacitances (Average)	
Grid-Plate - - - - -	1.5 $\mu\mu\text{f}$
Grid-Filament - - - - -	2.7 $\mu\mu\text{f}$
Plate-Filament - - - - -	0.3 $\mu\mu\text{f}$
Transconductance ( $I_b=25$ ma., $E_b=1000$ , $e_c=-15$ ) - - -	2500 $\mu\text{mhos}$

### MECHANICAL

Base - - - - -	(Small 4-pin bayonet, ceramic)	RMA type M8-071
Basing - - - - -		RMA type 3G
Maximum Overall Dimensions:		
Length - - - - -	4.50	inches
Diameter - - - - -	1.44	inches
Net weight - - - - -	1.00	ounce
Shipping weight (Average) - - - - -	1.25	pounds



## AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR

### Class B

	TYPICAL OPERATION—2 TUBES				MAX. RATING	
D-C Plate Voltage - - - - -	750	1000	1500	2000	2000	volts
Max.-Signal D-C Plate Current, per tube* -	•	•	•	•	75	ma.
Plate Dissipation, per tube* - - - - -	•	•	•	•	25	watts
D-C Grid Voltage (approx.) - - - - -	-20	-30	-55	-80		volts
Peak A-F Grid Input Voltage - - - - -	205	210	230	270		volts
Zero-Signal D-C Plate Current - - - - -	43	32	21	16		ma.
Max.-Signal D-C Plate Current - - - - -	133	120	94	80		ma.
Max.-Signal Driving Power (approx.) - - -	1.4	1.2	0.8	0.7		watts
Effective Load, Plate-to-Plate - - - - -	9200	15800	33700	55500		ohms
Max.-Signal Plate Power Output - - - - -	50	70	90	110		watts

\*Averaged over any sinusoidal audio frequency cycle.

## RADIO FREQUENCY POWER AMPLIFIER AND OSCILLATOR

### Class-C \*Telegraphy

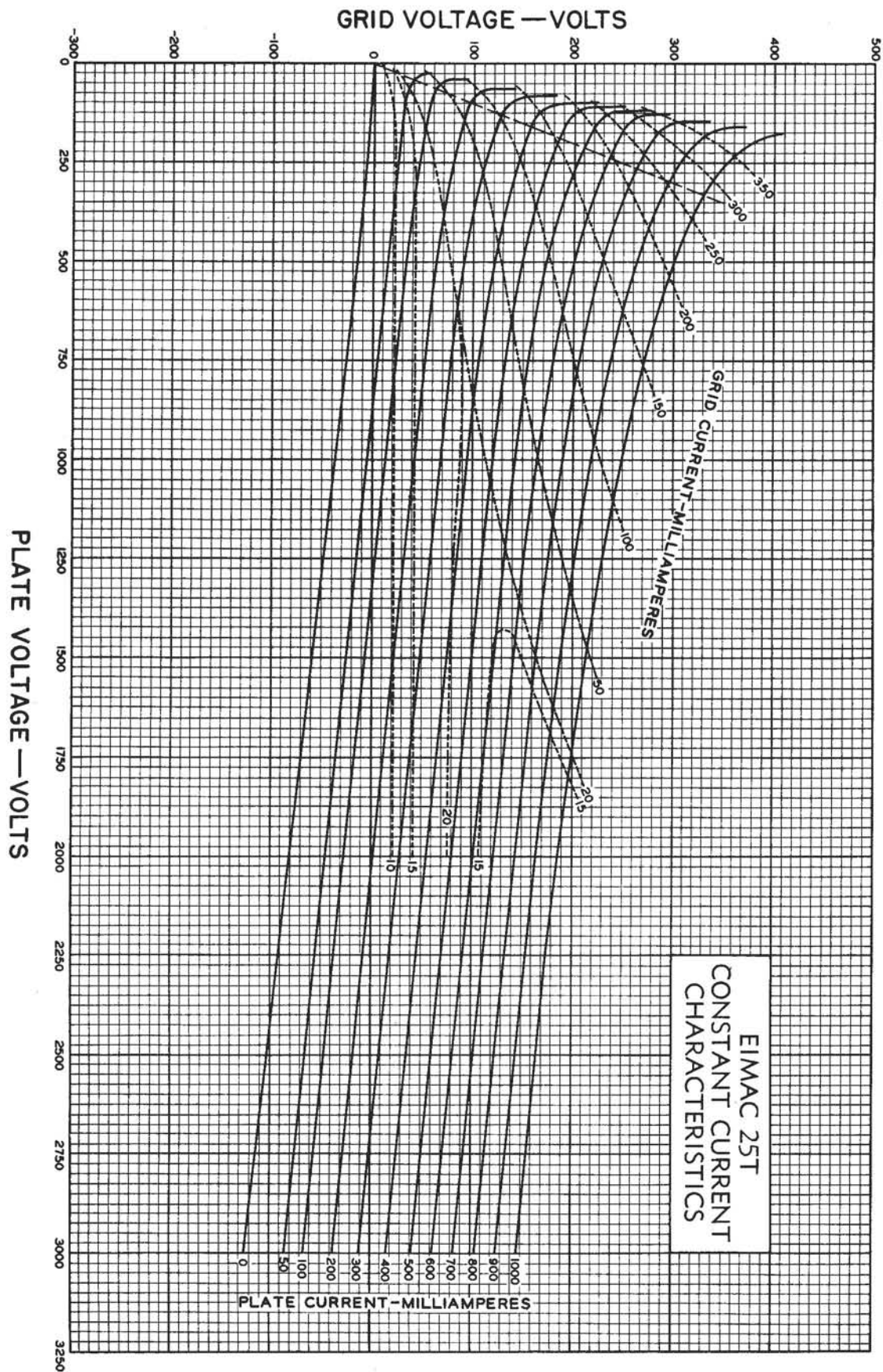
(Key down conditions without modulation)

	TYPICAL OPERATION—1 TUBE			MAX. RATING	
D-C Plate Voltage - - - - -	1000	1500	2000	2000	volts
D-C Plate Current - - - - -	72	67	63	75	ma.
D-C Grid Current - - - - -	9	13	18	25	ma.
D-C Grid Voltage - - - - -	-70	-95	-130		volts
Plate Power Output - - - - -	47	75	100		watts
Plate Input - - - - -	72	100	125		watts
Plate Dissipation - - - - -	25	25	25	25	watts
Peak R. F. Grid Input Voltage, (approx.) -	170	195	245		volts
Driving Power, (approx.) - - - - -	1.3	2.2	4.0		watts

\*The above figures show actual measured tube performance, and do not allow for variation in circuit losses.

►Corrects typographical error on sheet dated 8-15-44.

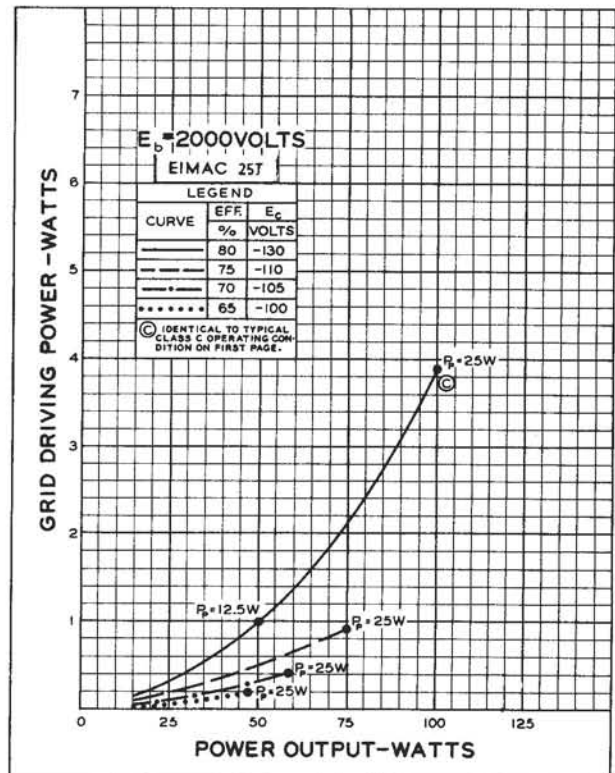
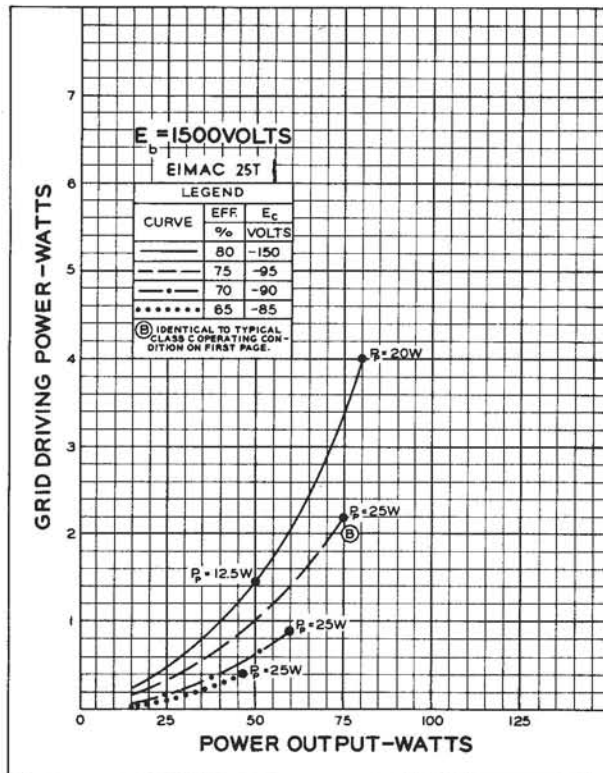
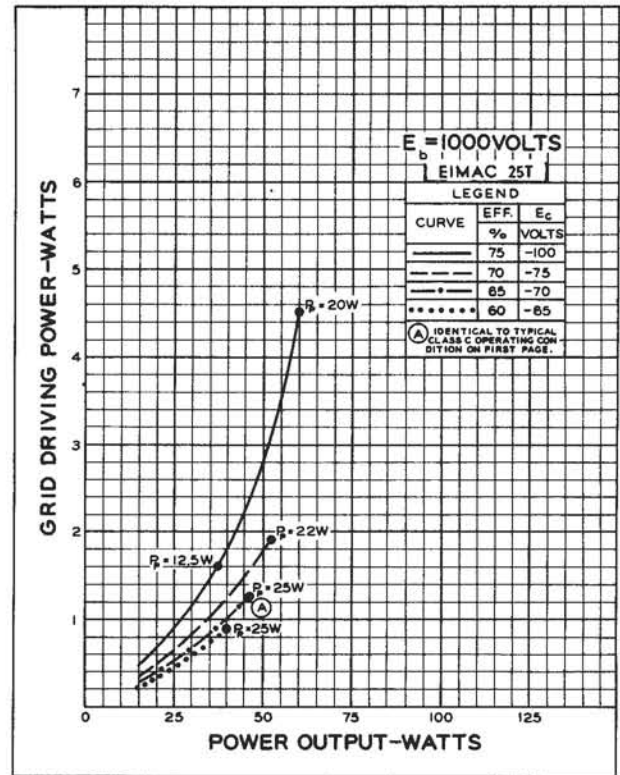
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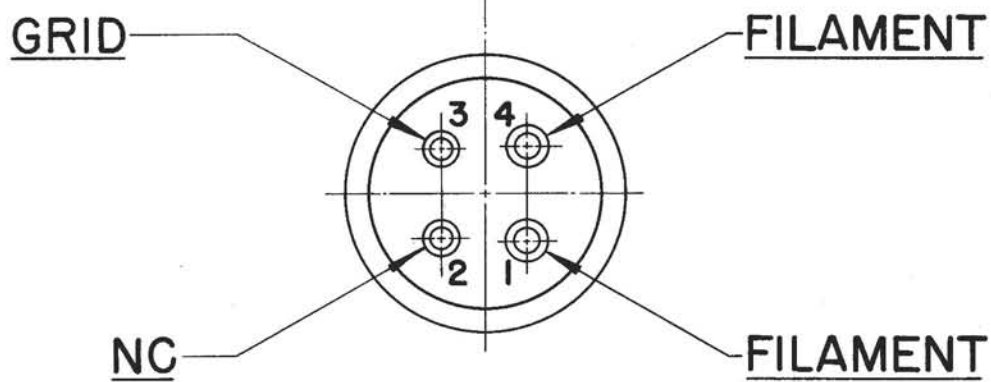
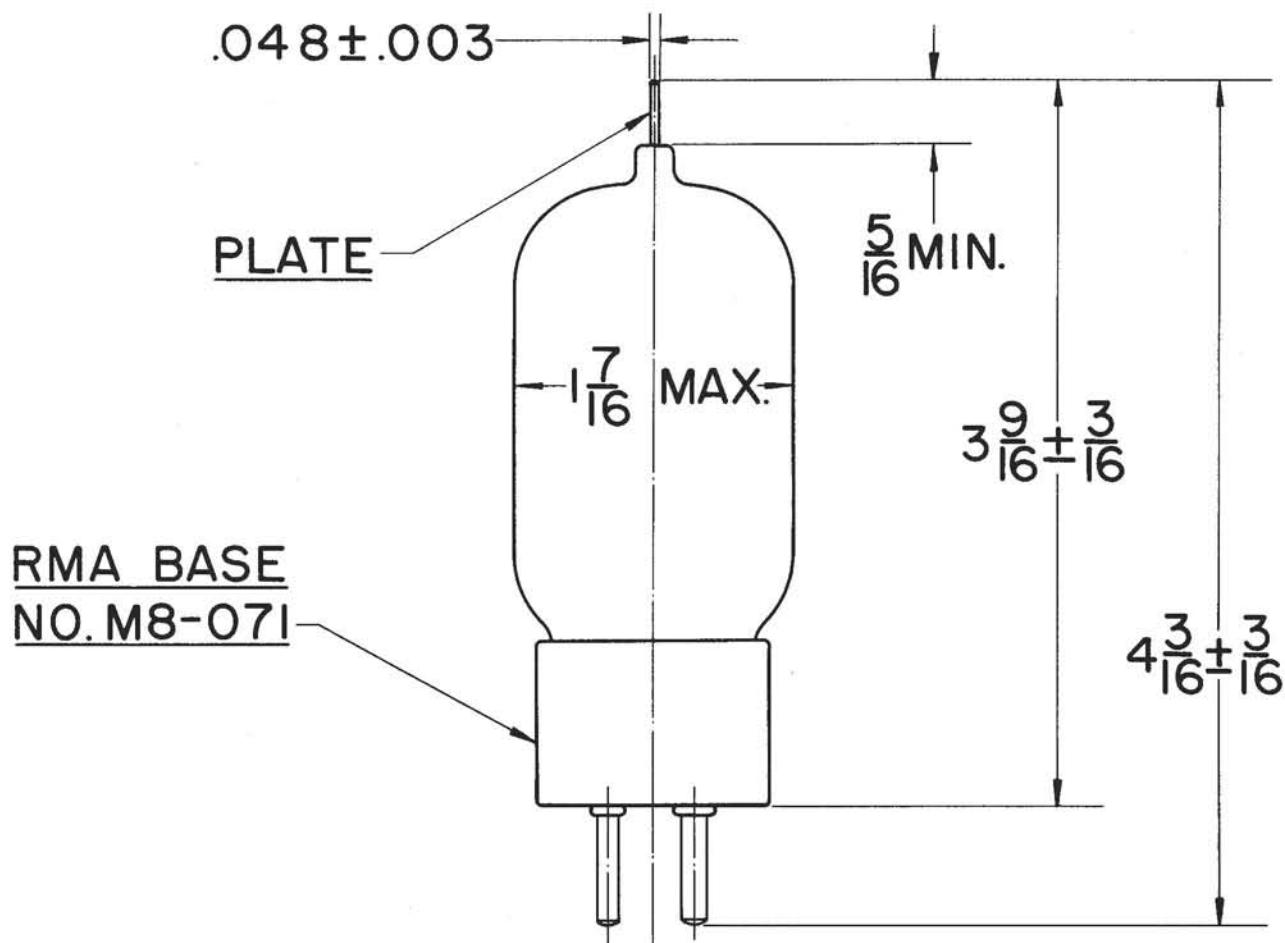


## DRIVING POWER vs. POWER OUTPUT

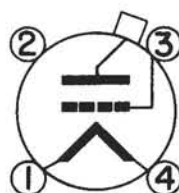
The three charts on this page show the relationship of plate efficiency, power output and grid driving power at plate voltages of 1000, 1500 and 2000 volts. These charts show combined grid and bias losses only. The driving power and power output figures do not include circuit losses. The plate dissipation in watts is indicated by  $P_p$ .

Points A, B, and C are identical to the typical Class C operating conditions shown on the first page under 1000, 1500, and 2000 volts respectively.





**3G**



# EITEL-McCULLOUGH, INC.

SAN BRUNO, CALIFORNIA

## 3 C 2 4

MEDIUM-MU TRIODE

MODULATOR  
OSCILLATOR  
AMPLIFIER

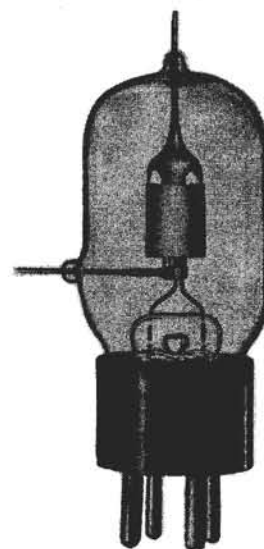
### GENERAL CHARACTERISTICS

#### ELECTRICAL

Filament: Thoriated tungsten	
Voltage - - - - -	6.3 volts
Current - - - - -	3.0 amperes
Amplification Factor (Average) - - - - -	23
Direct Interelectrode Capacitances (Average)	
Grid-Plate - - - - -	1.5 $\mu\mu\text{f}$
Grid-Filament - - - - -	1.7 $\mu\mu\text{f}$
Plate-Filament - - - - -	0.3 $\mu\mu\text{f}$
Transconductance ( $I_b=25$ ma., $E_b=1000$ , $e_c=-20$ )	2500 $\mu\text{mhos}$

#### MECHANICAL

Base - - - - -	(Small 4-pin bayonet) RMA type M8-071
Basing - - - - -	RMA type 2D
Maximum Overall Dimensions:	
Length - - - - -	4.38 inches
Diameter - - - - -	1.44 inches
Net weight - - - - -	1.00 ounce
Shipping weight (Average) - - - - -	1.25 pounds



### AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR

#### Class B

	TYPICAL OPERATION—2 TUBES				MAX. RATING	
D-C Plate Voltage - - - - -	750	1000	1500	2000	2000	volts
Max.-Signal D-C Plate Current, per tube* - -	•	•	•	•	75	ma.
Plate Dissipation, per tube* - - - - -	•	•	•	•	25	watts
D-C Grid Voltage (approx.) - - - - -	-20	-30	-60	-85		volts
Peak A-F Grid Input Voltage - - - - -	230	230	250	290		volts
Zero-Signal D-C Plate Current - - - - -	43	32	21	16		ma.
Max.-Signal D-C Plate Current - - - - -	133	120	94	80		ma.
Max.-Signal Driving Power (approx.) - - -	2.0	1.7	1.2	1.1		watts
Effective Load, Plate-to-Plate - - - - -	9200	15800	33700	55500		ohms
Max.-Signal Plate Power Output - - - - -	50	70	90	110		watts

\*Averaged over any sinusoidal audio frequency cycle.

### RADIO FREQUENCY POWER AMPLIFIER AND OSCILLATOR

#### Class-C \*Telegraphy

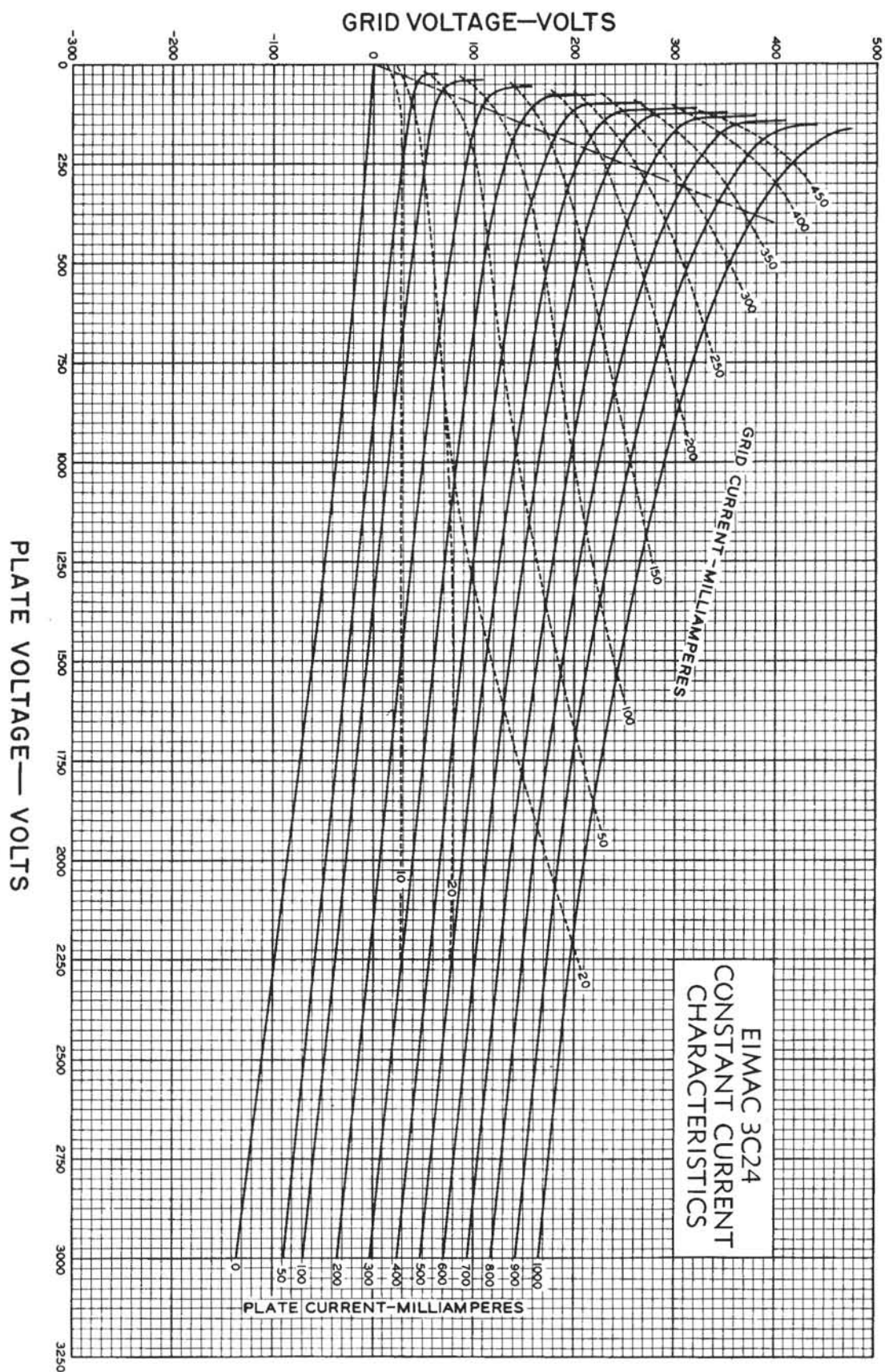
(Key down conditions without modulation)

	TYPICAL OPERATION—1 TUBE			MAX. RATING	
D-C Plate Voltage - - - - -	1000	1500	2000	2000	volts
D-C Plate Current - - - - -	72	67	63	75	ma.
D-C Grid Current - - - - -	15	15	17	25	ma.
D-C Grid Voltage - - - - -	-80	-110	-170		volts
Plate Power Output - - - - -	47	75	100		watts
Plate Input - - - - -	72	100	125		watts
Plate Dissipation - - - - -	25	25	25	25	watts
Peak R. F. Grid Input Voltage, (approx.) - -	200	225	295		volts
Driving Power, (approx.) - - - - -	2.6	3.1	4.5		watts

\*The above figures show actual measured tube performance, and do not allow for variations in circuit losses.

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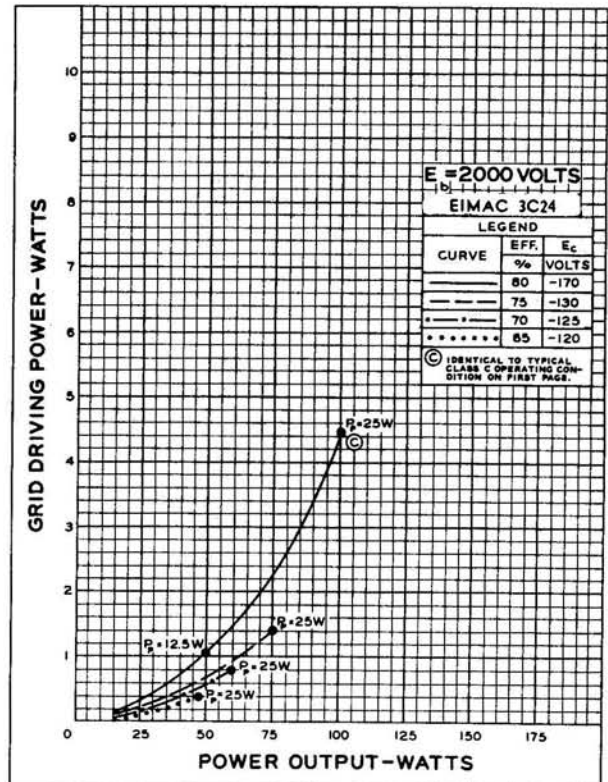
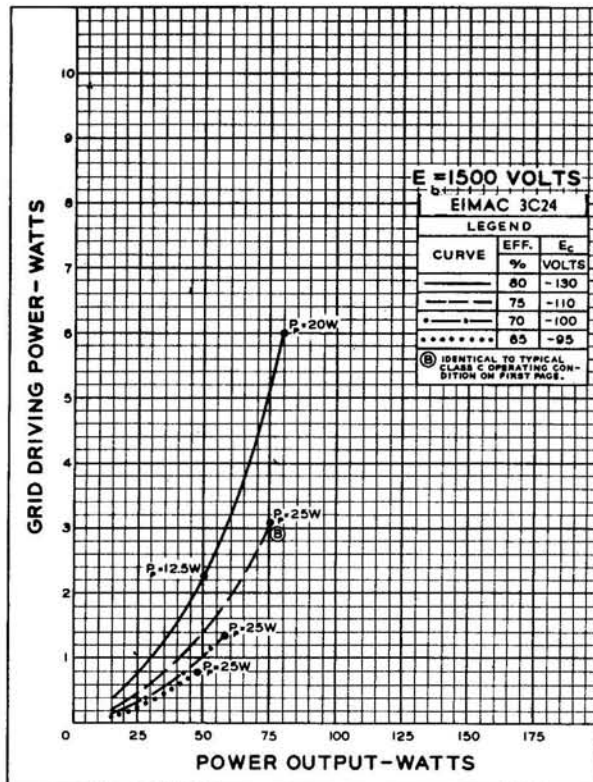
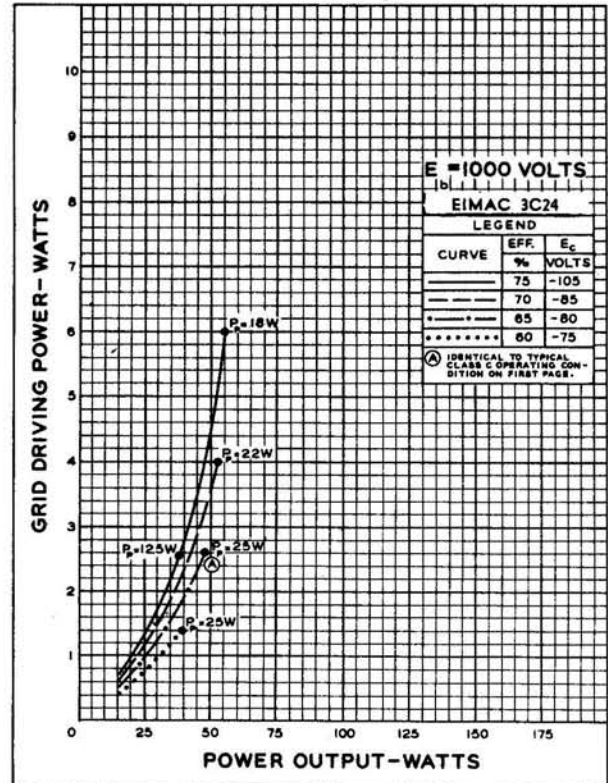


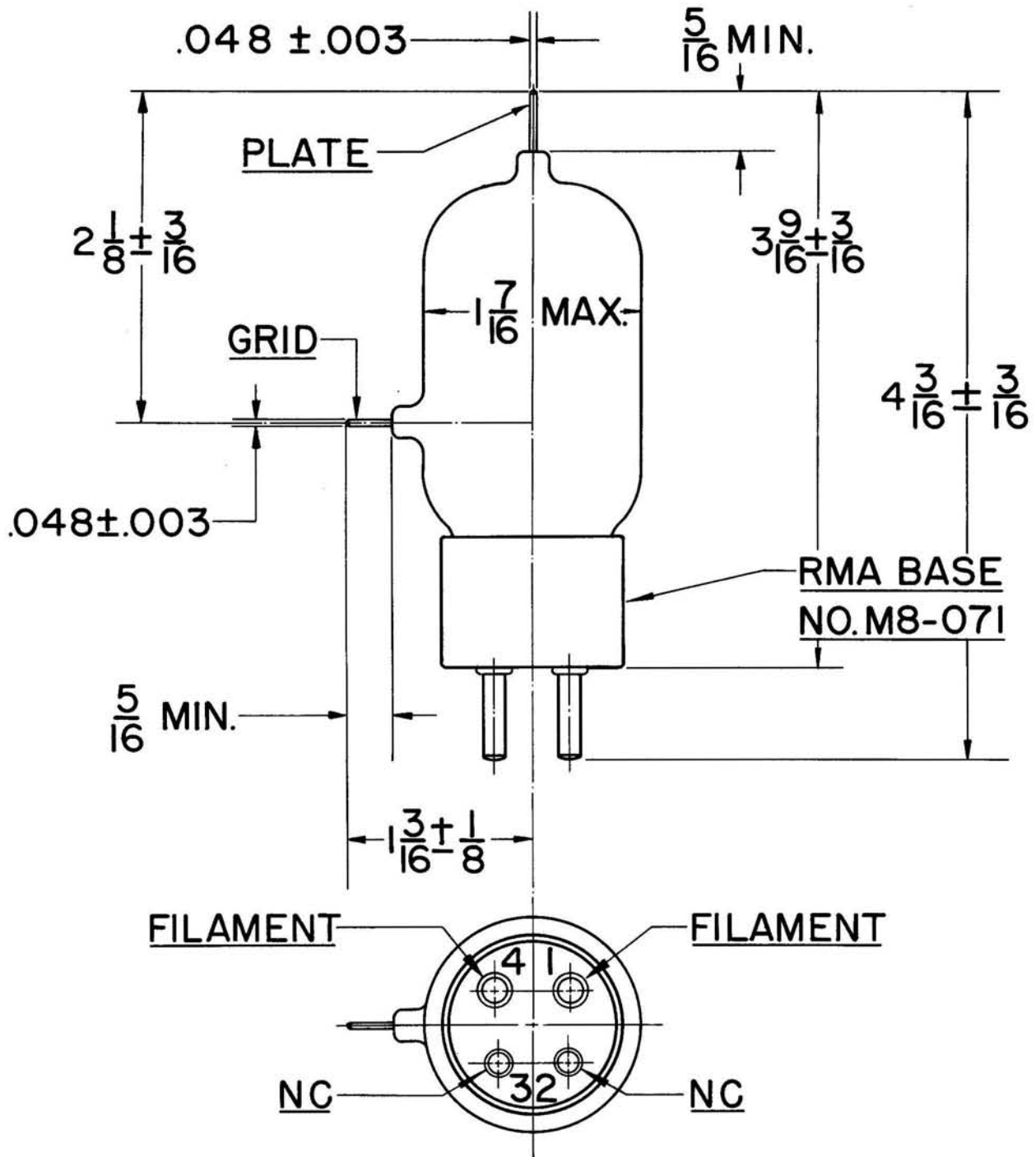


## DRIVING POWER vs. POWER OUTPUT

The three charts on this page show the relationship of plate efficiency, power output and grid driving power at plate voltages of 1000, 1500 and 2000 volts. These charts show combined grid and bias losses only. The driving power and power output figures do not include circuit losses. The plate dissipation in watts is indicated by  $P_p$ .

Points A, B, and C are identical to the typical Class C operating conditions shown on the first page under 1000, 1500, and 2000 volts respectively.





2D



# EITEL-McCULLOUGH, INC.

SAN BRUNO, CALIFORNIA

## 35T

HIGH- $\mu$  TRIODE  
MODULATOR  
OSCILLATOR  
AMPLIFIER

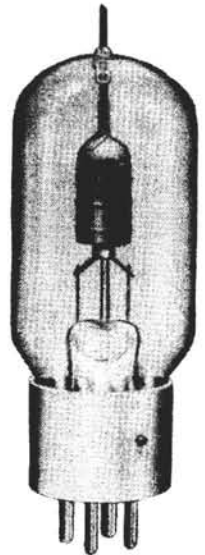
### GENERAL CHARACTERISTICS

#### ELECTRICAL

Filament: Thoriated tungsten	
Voltage - - - - -	5.0 volts
Current - - - - -	4.0 amperes
Amplification Factor (Average) - - - - -	39
Direct Interelectrode Capacitances (Average)	
Grid-Plate - - - - -	1.8 $\mu$ f
Grid-Filament - - - - -	4.1 $\mu$ f
Plate-Filament - - - - -	0.3 $\mu$ f
Transconductance ( $I_b=100$ ma., $E_b=2000$ , $e_c=-30$ )	2850 $\mu$ mhos
Frequency for Maximum Ratings - - - - -	100 mc.

#### MECHANICAL

Base - - - - -	(Medium 4-pin bayonet, ceramic)	RMA type M8-078
Basing - - - - -		RMA type 3G
Maximum Overall Dimensions:		
Length - - - - -		5.5 inches
Diameter - - - - -		1.81 inches
Net weight - - - - -		2.5 ounces
Shipping weight (Average) - - - - -		1.25 pounds



### AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR Class B

	TYPICAL OPERATION—2 TUBES			MAX. RATING	
D-C Plate Voltage - - - - -	1000	1500	2000	2000	volts
Max.-Signal D-C Plate Current, per tube* - -	•	•	•	150	ma.
Plate Dissipation, per tube* - - - - -	•	•	•	50	watts
D-C Grid Voltage (approx.) - - - - -	-8	-25	-40		volts
Peak A-F Grid Input Voltage - - - - -	240	250	255		volts
Zero-Signal D-C Plate Current - - - - -	67	45	34		ma.
Max.-Signal D-C Plate Current - - - - -	240	200	167		ma.
Max.-Signal Driving Power (approx.) - - - -	7	5	4		watts
Effective Load, Plate-to-Plate - - - - -	7900	16200	27500		ohms
Max.-Signal Plate Power Output - - - - -	140	200	235		watts

\*Averaged over any sinusoidal audio frequency cycle.

### RADIO FREQUENCY POWER AMPLIFIER AND OSCILLATOR Class-C \*Telegraphy

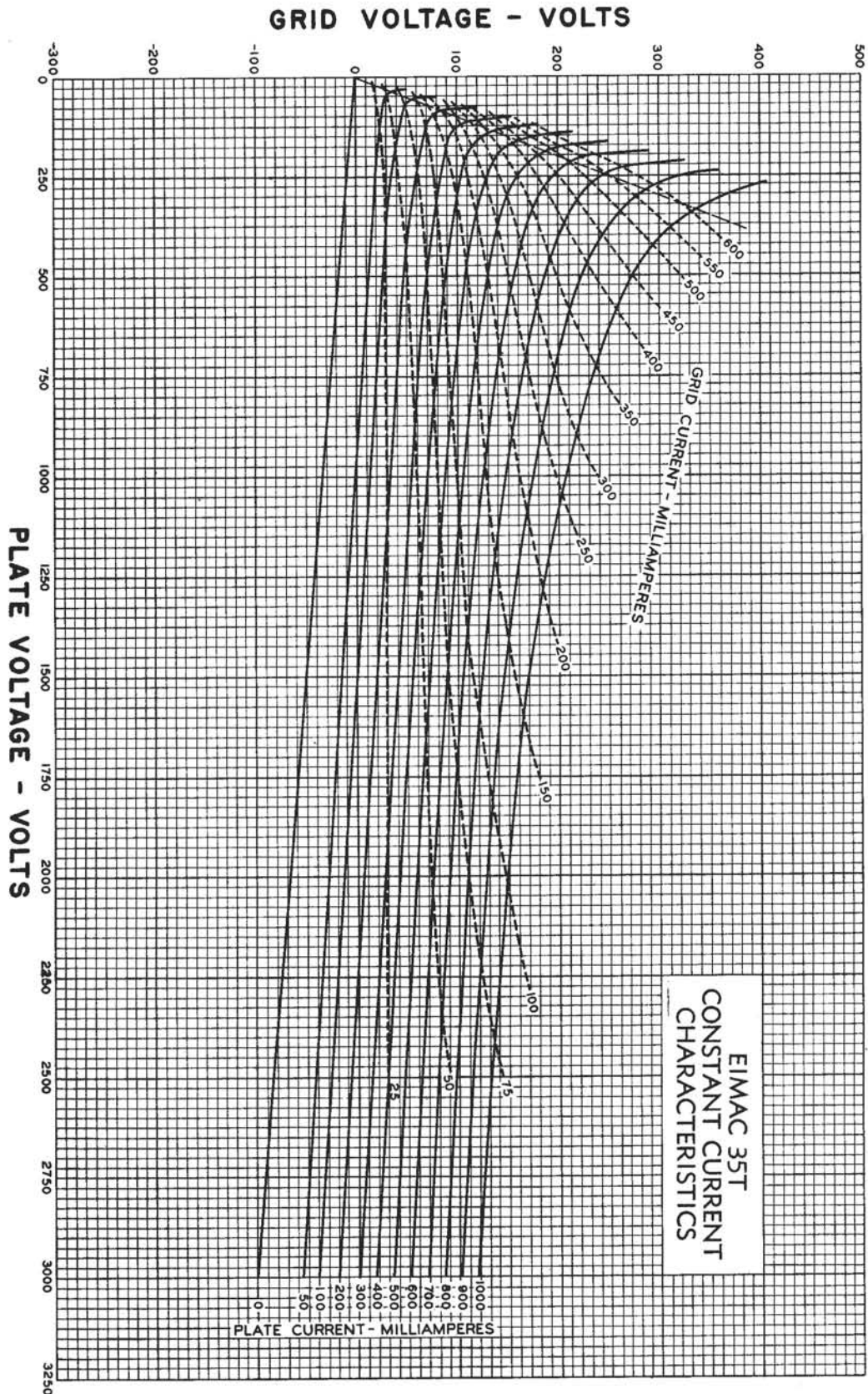
(Key down conditions without modulation)

	TYPICAL OPERATION—1 TUBE			MAX. RATING	
D-C Plate Voltage - - - - -	1000	1500	2000	2000	volts
D-C Plate Current - - - - -	125	125	125	150	ma.
D-C Grid Current - - - - -	40	40	45	50	ma.
D-C Grid Voltage - - - - -	-60	-120	-135		volts
Plate Power Output - - - - -	87	141	200		watts
Plate Input - - - - -	125	188	250		watts
Plate Dissipation - - - - -	38	47	50	50	watts
Peak R. F. Grid Input Voltage, (approx.) - -	165	250	285		volts
Driving Power, (approx.) - - - - -	7	9	13		watts

\*The above figures show actual measured tube performance, and do not allow for variations in circuit losses.

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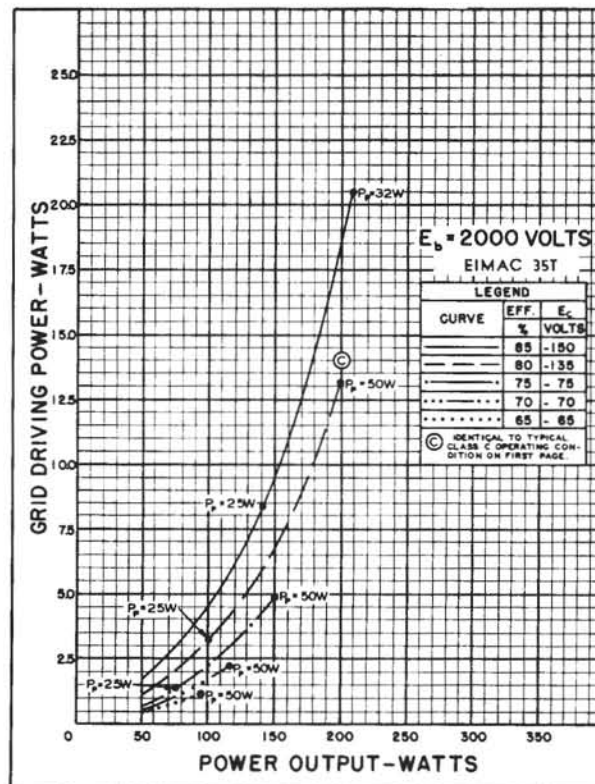
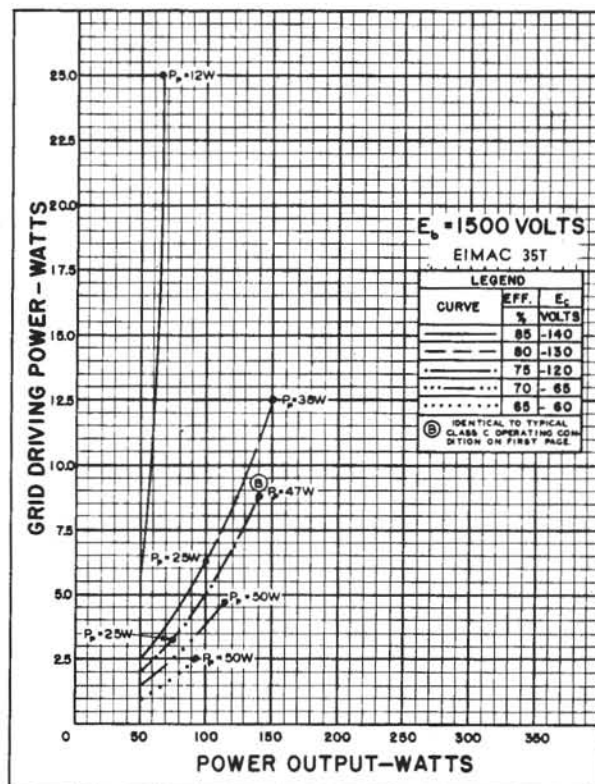
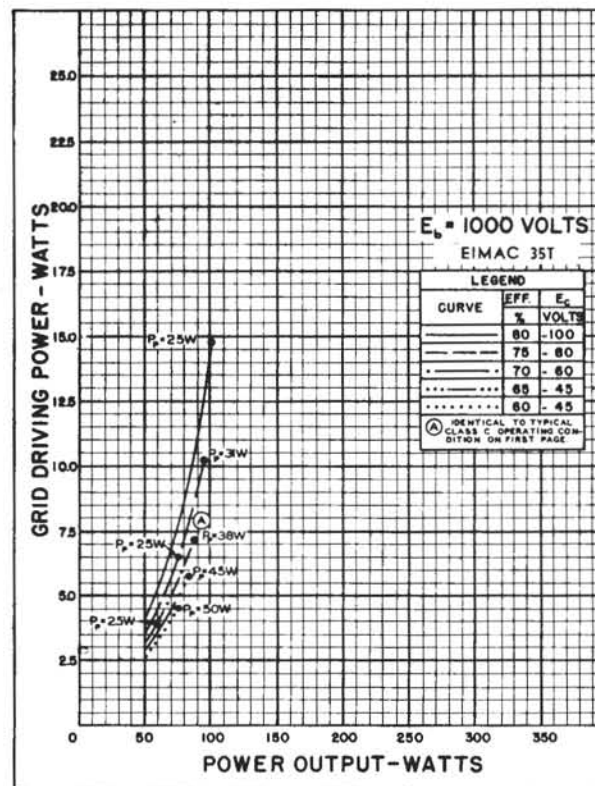


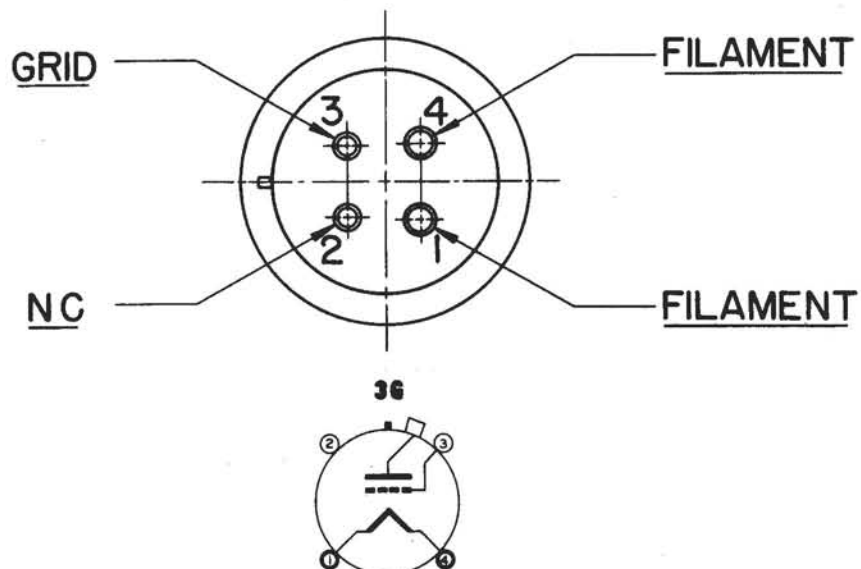
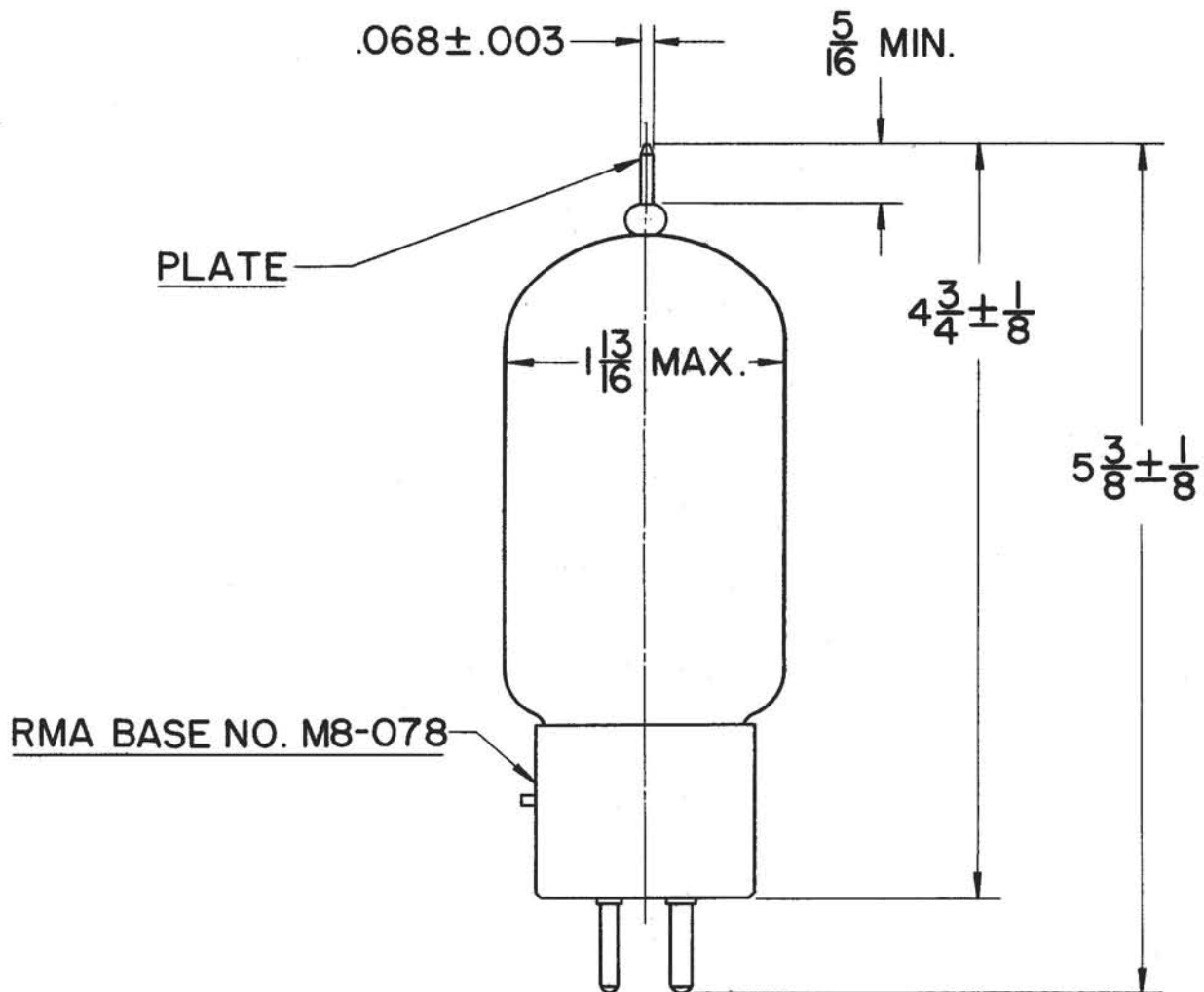


## DRIVING POWER vs. POWER OUTPUT

The three charts on this page show the relationship of plate efficiency, power output and grid driving power at plate voltages of 1000, 1500 and 2000 volts. These charts show combined grid and bias losses only. The driving power and power output figures do not include circuit losses. The plate dissipation in watts is indicated by  $P_p$ .

Points A, B, and C are identical to the typical Class C operating conditions shown on the first page under 1000, 1500, and 2000 volts respectively.





# Eitel-McCullough, Inc.

SAN BRUNO, CALIFORNIA

## 3 5 T 6

HIGH-MU TRIODE

MODULATOR  
OSCILLATOR  
AMPLIFIER

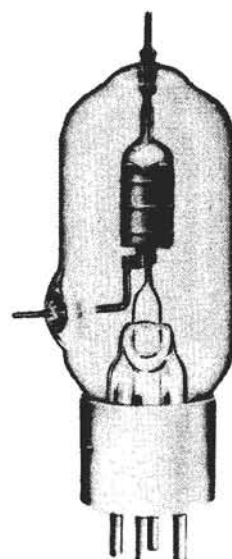
### GENERAL CHARACTERISTICS

#### ELECTRICAL

Filament: Thoriated tungsten	
Voltage - - - - -	5.0 volts
Current - - - - -	4.0 amperes
Amplification Factor (Average) - - - - -	39
Direct Interelectrode Capacitances (Average)	
Grid-Plate - - - - -	1.8 $\mu\text{mf}$
Grid-Filament - - - - -	2.5 $\mu\text{mf}$
Plate-Filament - - - - -	0.4 $\mu\text{mf}$
Transconductance ( $I_b=100 \text{ ma.}$ , $E_b=2000$ , $e_c=-30$ )	2850 $\mu\text{mhos}$
Frequency for Maximum Ratings - - - - -	100 mc.

#### MECHANICAL

Base - - - - -	(Medium 4-pin bayonet, ceramic)	RMA type M8-078
Basing - - - - -		RMA type 2M
Maximum Overall Dimensions:		
Length - - - - -	5.75 inches	
Diameter - - - - -	1.81 inches	
Net weight - - - - -	2.5 ounces	
Shipping weight (Average) - - - - -	1.25 pounds	



### AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR

#### Class B

	TYPICAL OPERATION—2 TUBES			MAX. RATING	
D-C Plate Voltage - - - - -	1000	1500	2000	2000	volts
Max.-Signal D-C Plate Current, per tube* - -	•	•	•	150	ma.
Plate Dissipation, per tube* - - - - -	•	•	•	50	watts
D-C Grid Voltage (approx.) - - - - -	-8	-25	-40		volts
Peak A-F Grid Input Voltage - - - - -	240	250	255		volts
Zero-Signal D-C Plate Current - - - - -	67	45	34		ma.
Max.-Signal D-C Plate Current - - - - -	240	200	167		ma.
Max.-Signal Driving Power (approx.) - - -	7	5	4		watts
Effective Load, Plate-to-Plate - - - - -	7900	16200	27500		ohms
Max.-Signal Plate Power Output - - - - -	140	200	235		watts

\*Averaged over any sinusoidal audio frequency cycle.

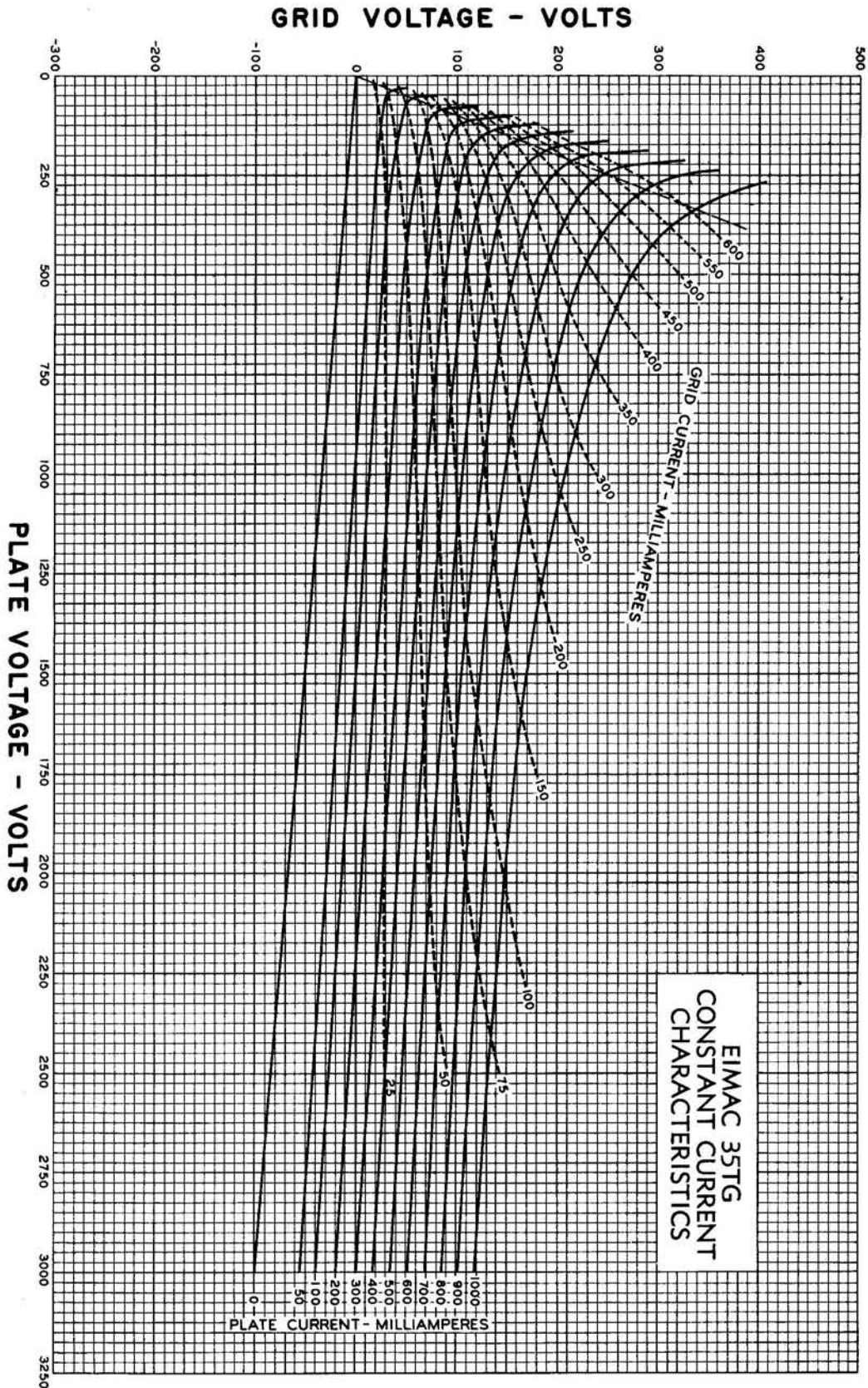
### RADIO FREQUENCY POWER AMPLIFIER AND OSCILLATOR

#### Class-C \*Telegraphy

(Key down conditions without modulation)

	TYPICAL OPERATION—1 TUBE			MAX. RATING	
D-C Plate Voltage - - - - -	1000	1500	2000	2000	volts
D-C Plate Current - - - - -	125	125	125	150	ma.
D-C Grid Current - - - - -	40	40	45	50	ma.
D-C Grid Voltage - - - - -	-60	-120	-135		volts
Plate Power Output - - - - -	87	141	200		watts
Plate Input - - - - -	125	188	250		watts
Plate Dissipation - - - - -	38	47	50	50	watts
Peak R. F. Grid Input Voltage, (approx.) - -	165	250	285		volts
Driving Power, (approx.) - - - - -	7	9	13		watts

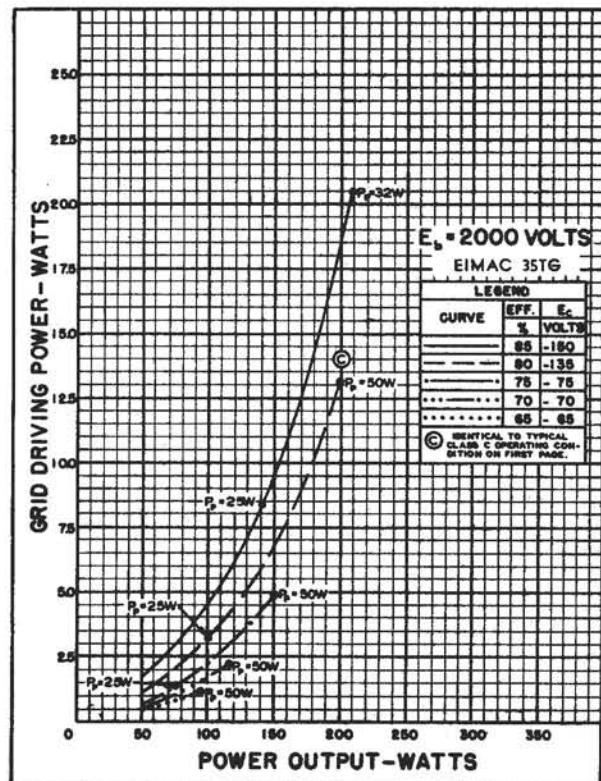
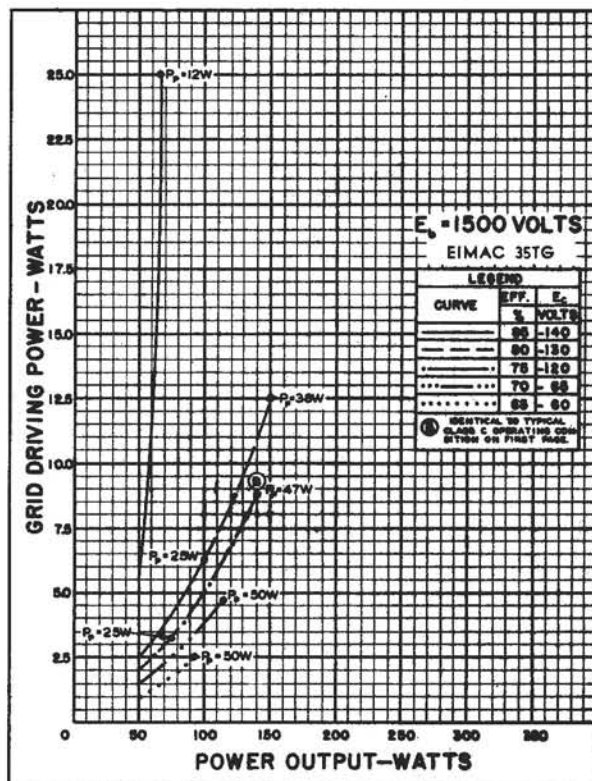
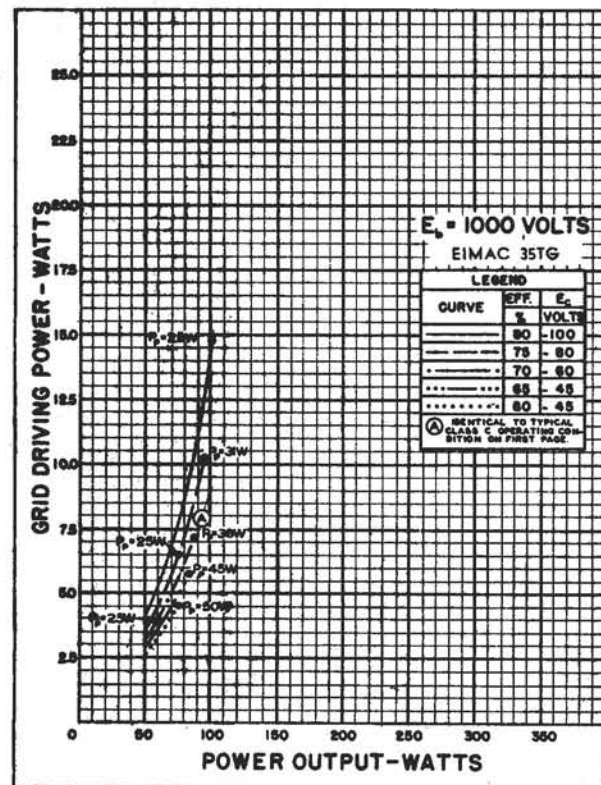
\*The above figures show actual measured tube performance, and do not allow for variations in circuit losses.



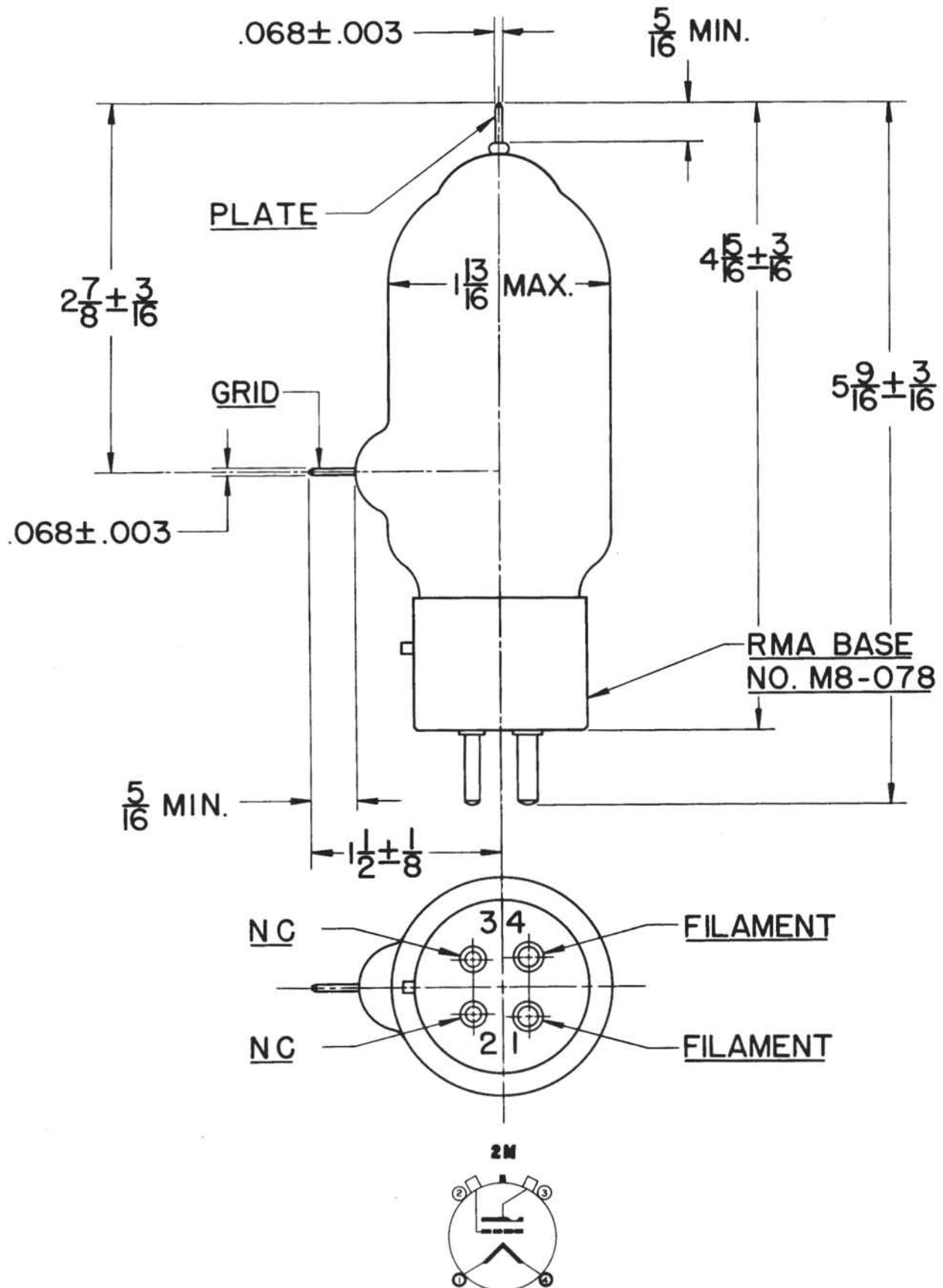
## DRIVING POWER vs. POWER OUTPUT

The three charts on this page show the relationship of plate efficiency, power output and grid driving power at plate voltages of 1000, 1500 and 2000 volts. These charts show combined grid and bias losses only. The driving power and power output figures do not include circuit losses. The plate dissipation in watts is indicated by  $P_p$ .

Points A, B, and C are identical to the typical Class C operating conditions shown on the first page under 1000, 1500, and 2000 volts respectively.







# EITEL-McCULLOUGH, INC.

SAN BRUNO, CALIFORNIA

## 75TH

MEDIUM-MU TRIODE  
MODULATOR  
OSCILLATOR  
AMPLIFIER

The Eimac 75TH is a medium-mu, high-vacuum transmitting triode intended for amplifier, oscillator and modulator service. It has a maximum plate dissipation rating of 75 watts. Cooling of the 75TH is accomplished by radiation from the plate, which operates at a visibly red temperature at maximum dissipation, and by air circulation around the envelope.

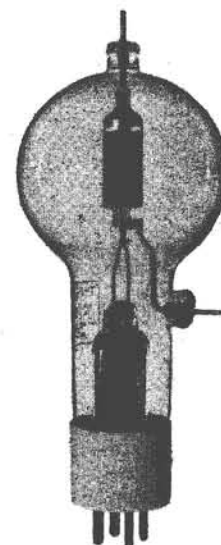
### GENERAL CHARACTERISTICS

#### ELECTRICAL

Filament: Thoriated tungsten	
Voltage	5.0 volts
Current	6.25 amperes
Amplification Factor (Average)	20
Direct Interelectrode Capacitances (Average)	
Grid-Plate	2.3 $\mu\text{fd.}$
Grid-Filament	2.7 $\mu\text{fd.}$
Plate-Filament	0.3 $\mu\text{fd.}$
Transconductance ( $i_b=225 \text{ ma.}$ , $E_b=3000 \text{ v.}$ , $E_c=-40 \text{ v.}$ )	4150 $\mu\text{mhos}$

#### MECHANICAL

Base	Medium 4-pin bayonet, ceramic, RMA type M8-078
Basing	RMA type 2M
Cooling	Radiation and air circulation
Maximum Overall Dimensions:	
Length	7.25 inches
Diameter	2.81 inches
Net Weight	3 ounces
Shipping Weight (Average)	1.5 pounds



#### RADIO FREQUENCY POWER AMPLIFIER AND OSCILLATOR

Class-C Telephony (Key-down conditions, 1 tube)

MAXIMUM RATINGS (Frequencies below 40 Mc.)

D-C PLATE VOLTAGE	3000 MAX. VOLTS.
D-C PLATE CURRENT	225 MAX. MA.
PLATE DISSIPATION	75 MAX. WATTS
GRID DISSIPATION	16 MAX. WATTS

TYPICAL OPERATION (Frequencies below 40 Mc.)

D-C Plate Voltage	1000	1500	2000	volts
D-C Grid Voltage	-80	-125	-200	volts
D-C Plate Current	215	167	150	ma.
D-C Grid Current	40	30	32	ma.
Peak R-F Grid Input Voltage (approx.)	290	250	325	volts
Driving Power (approx.)	9	6	10	watts
Plate Power Input	215	250	300	watts
Plate Dissipation	75	75	75	watts
Plate Power Output	140	175	225	watts

#### AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR

Class-B (Sinusoidal wave, two tubes unless otherwise specified)

MAXIMUM RATINGS

D-C PLATE VOLTAGE	3000 MAX. VOLTS
MAX-SIGNAL D-C PLATE CURRENT, PER TUBE	225 MAX. MA.
PLATE DISSIPATION, PER TUBE	75 MAX. WATTS
GRID DISSIPATION, PER TUBE	16 MAX. WATTS

TYPICAL OPERATION

D-C Plate Voltage	1000	1500	2000	volts
D-C Grid Voltage (approx.)	-25	-65	-90	ma.
Zero-Signal D-C Plate Current	90	67	50	ma.
Max-Signal D-C Plate Current	350	267	225	ma.
Effective Load, Plate-to-Plate	5300	11,400	19,300	ohms
Peak A-F Grid Input Voltage (per tube)	175	165	175	volts
Max-Signal Driving Power (approx.)	7	4	3	watts
Max-Signal Plate Dissipation (per tube)	75	75	75	watts
Max-Signal Plate Power Output	200	250	300	watts

## APPLICATION

### MECHANICAL

**Mounting**—The 75TH must be mounted vertically, base up or base down. Flexible connecting straps should be provided between the grid and plate terminals and the external grid and plate circuits. The tube must be protected from severe vibration and shock.

**Cooling**—Provision should be made for ample circulation of air around the 75TH. In the event that the design of the equipment restricts natural circulation, a small fan or centrifugal blower should be used to provide additional cooling for the envelope and plate and grid seals.

### ELECTRICAL

**Filament Voltage**—The filament voltage, as measured directly at the filament pins, should be between 4.75 and 5.25 volts.

**Bias Voltage**—Although there is no maximum limit on the bias voltage which may be used on the 75TH, there is little advantage in using bias voltages in excess of those given under "Typical Operation," except in certain very specialized applications. Where bias is obtained by a grid leak, suitable protective means must be provided to prevent excessive plate dissipation in the event of loss of excitation.

**Plate Voltage**—The plate-supply voltage for the 75TH should not exceed 3000 volts. In most cases there is little advantage in using plate-supply voltages higher than those given under "Typical Operation" for the power output desired.

**Grid Dissipation**—The power dissipated by the grid of the 75TH must not exceed 16 watts. Grid dissipation may be calculated from the following expression:

$$P_g = e_{cnp} I_c$$

where  $P_g$  = Grid dissipation,

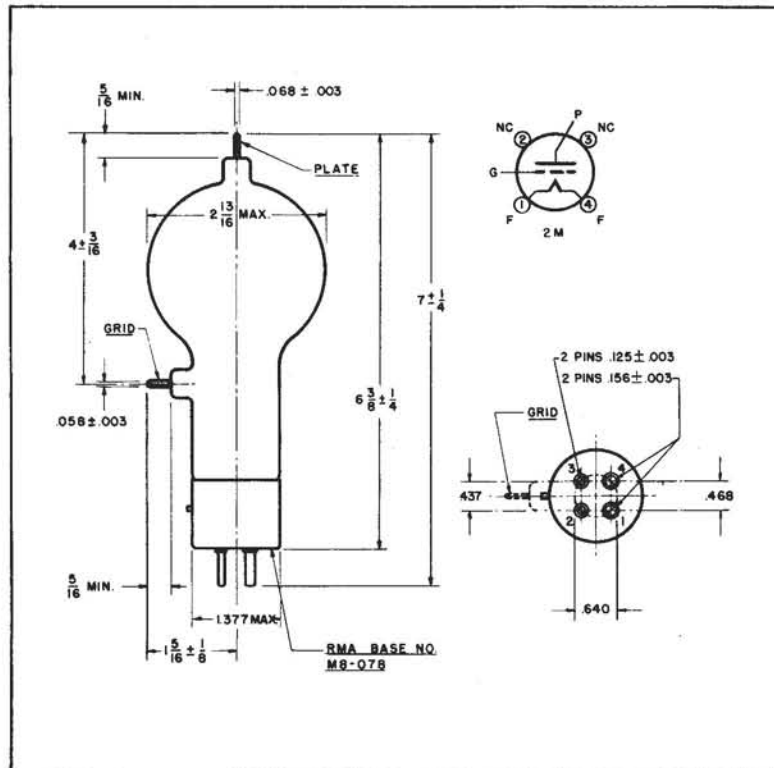
$e_{cnp}$  = Peak positive grid voltage, and

$I_c$  = D-c grid current.

$e_{cnp}$  may be measured by means of a suitable peak voltmeter connected between filament and grid.<sup>1</sup> In equipment in which the plate loading varies widely, such as oscillators used for radio-frequency heating, care should be taken to make certain that the grid dissipation does not exceed the maximum rating under any condition of loading.

**Plate Dissipation**—Under normal operating conditions, the power dissipated by the plate of the 75TH should not be allowed to exceed 75 watts. Plate dissipation in excess of the maximum rating is permissible for short periods of time, such as during tuning procedures.

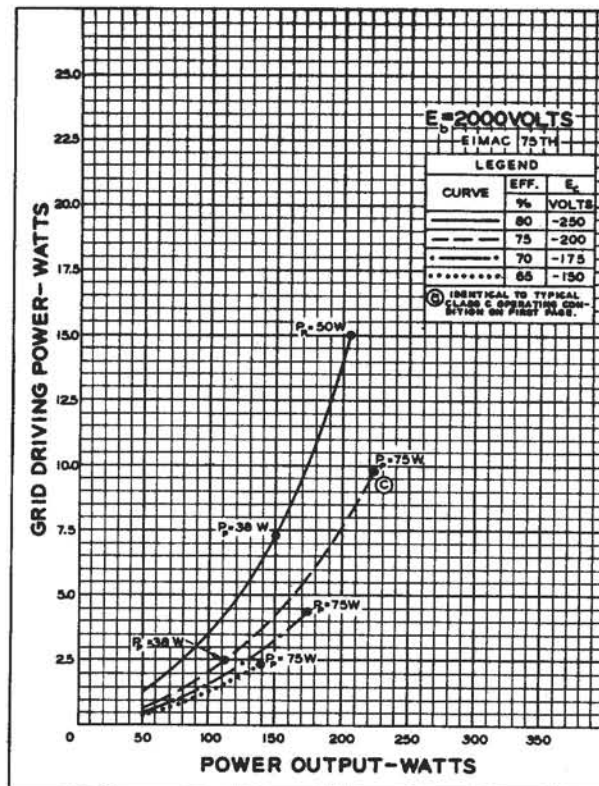
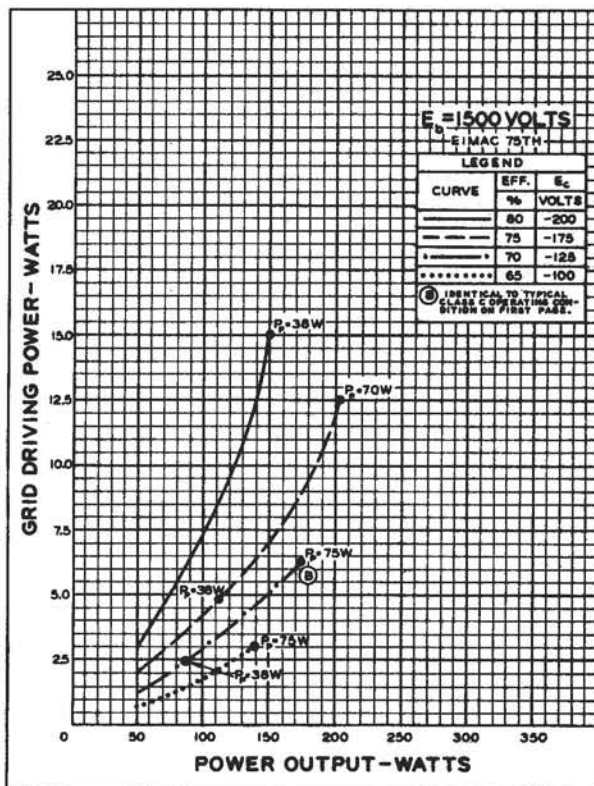
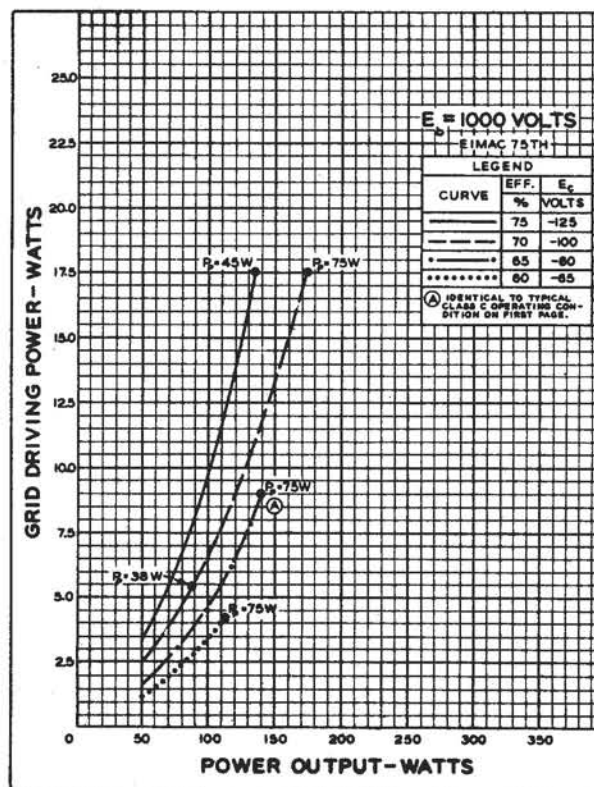
<sup>1</sup> For suitable peak v.t.v.m. circuits see, for instance, "Vacuum Tube Ratings," Eimac News, January, 1945. This article is available in reprint form on request.



## DRIVING POWER vs. POWER OUTPUT

The three charts on this page show the relationship of plate efficiency, power output and grid driving power at plate voltages of 1000, 1500 and 2000 volts. These charts show combined grid and bias losses only. The driving power and power output figures do not include circuit losses. The plate dissipation in watts is indicated by  $P_p$ .

Points A, B, and C are identical to the typical Class C operating conditions shown on the first page under 1000, 1500, and 2000 volts respectively.







# EITEL-McCULLOUGH, INC.

SAN BRUNO, CALIFORNIA

# 75TL

LOW-MU TRIODE  
MODULATOR  
OSCILLATOR  
AMPLIFIER

The Eimac 75TL is a low-mu, high-vacuum transmitting triode intended for amplifier, oscillator and modulator service. It has a maximum plate dissipation rating of 75 watts. Cooling of the 75TL is accomplished by radiation from the plate, which operates at a visibly red temperature at maximum dissipation, and by air circulation around the envelope.

## GENERAL CHARACTERISTICS

### ELECTRICAL

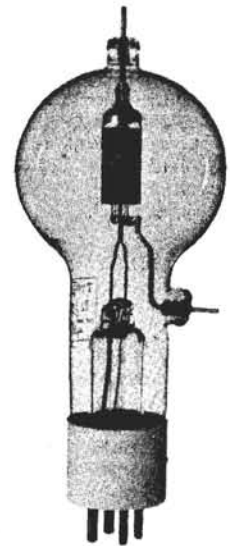
Filament: Thoriated tungsten	
Voltage	5.0 volts
Current	6.25 amperes
Amplification Factor (Average)	12
Direct Interelectrode Capacitances (Average)	
Grid-Plate	2.4 $\mu\text{fd.}$
Grid-Filament	2.6 $\mu\text{fd.}$
Plate-Filament	0.4 $\mu\text{fd.}$
Transconductance ( $i_b = 225\text{ma.}$ , $E_b = 2500\text{v.}$ , $E_c = -182\text{v.}$ )	3350 $\mu\text{mhos}$

### MECHANICAL

Base	Medium 4-pin bayonet, ceramic, RMA type M8-078
Basing	RMA type 2M
Cooling	Radiation and air circulation

#### Maximum Overall Dimensions:

Length	7.25 inches
Diameter	2.81 inches
Net weight	3 ounces
Shipping weight (Average)	1.5 pounds



## RADIO FREQUENCY POWER AMPLIFIER AND OSCILLATOR

### Class-C Telephony (Key-down conditions, 1 tube)

#### MAXIMUM RATINGS (Frequencies below 40 Mc.)

D-C PLATE VOLTAGE	3000 MAX. VOLTS
D-C PLATE CURRENT	225 MAX. MA.
PLATE DISSIPATION	75 MAX. WATTS
GRID DISSIPATION	13 MAX. WATTS

#### TYPICAL OPERATION (Frequencies below 40 Mc.)

D-C Plate Voltage	1000	1500	2000	volts
D-C Plate Current	215	167	150	ma.
Plate Dissipation	75	75	75	watts
D-C Grid Voltage	-150	-250	-300	volts
D-C Grid Current	28	22	21	ma.
Peak A-F Grid Input Voltage (approx.)	320	355	425	volts
Driving Power, (approx.)	8	6	8	watts
Plate Power Input	215	250	300	watts
Plate Power Output	140	175	225	watts

## AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR

### Class-AB<sub>1</sub> (Sinusoidal wave, two tubes unless otherwise specified)

#### MAXIMUM RATINGS

D-C PLATE VOLTAGE	3000 MAX. VOLTS
MAX-SIGNAL D-C PLATE CURRENT, PER TUBE	225 MAX. MA.
PLATE DISSIPATION, PER TUBE	75 MAX. WATTS

<sup>1</sup> The effective grid-circuit resistance for each tube must not exceed 250,000 ohms.

## AUDIO FREQUENCY AMPLIFIER (Continued)

### TYPICAL OPERATION

D-C Plate Voltage	1500	2000	volts
D-C Grid Voltage <sup>1</sup>	-105	-160	volts
Peak A-F Grid Input Voltage (per tube)	105	160	volts
Zero-Signal D-C Plate Current	67	50	ma.
Max-Signal D-C Plate Current	143	130	ma.
Driving Power	0	0	watt
Effective Load, Plate-to-Plate	10,200	21,200	ohms
Max-Signal Plate Power Output	64	110	watts
Max-Signal Plate Dissipation (per tube)	75	75	watts

## AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR

### Class-B (Sinusoidal wave, two tubes unless otherwise specified)

#### MAXIMUM RATINGS

D-C PLATE VOLTAGE	3000 MAX. VOLTS
MAX-SIGNAL D-C PLATE CURRENT, PER TUBE	225 MAX. MA.
PLATE DISSIPATION, PER TUBE	75 MAX. WATTS
GRID DISSIPATION, PER TUBE	13 MAX. WATTS

#### TYPICAL OPERATION

D-C Plate Voltage	1000	1500	2000	volts
D-C Grid Voltage	-65	-105	-160	volts
Peak A-F Grid Input Voltage (per tube)	205	225	267	volts
Zero-Signal D-C Plate Current	100	67	50	ma.
Max-Signal D-C Plate Current	350	285	250	ma.
Max-Signal Avg. Driving Power (approx.)	7	6	5	watts
Max-Signal Peak Driving Power	26	23	19	watts
Effective Load, Plate-to-Plate	5,300	11,000	18,000	ohms
Max-Signal Plate Power Output	200	280	350	watts
Max-Signal Plate Dissipation (per tube)	75	75	75	watts

## APPLICATION

### MECHANICAL

**Mounting**—The 75TL must be mounted vertically, base up or base down. Flexible connecting straps should be provided between the grid and plate terminals and the external grid and plate circuits. The tube must be protected from severe vibration and shock.

**Cooling**—Provision should be made for ample circulation of air around the 75TL. In the event that the design of the equipment restricts natural circulation, a small fan or centrifugal blower should be used to provide additional cooling for the envelope and plate and grid seals.

### ELECTRICAL

**Filament Voltage**—The filament voltage, as measured directly at the filament pins, should be between 4.75 and 5.25 volts.

**Bias Voltage**—Although there is no maximum limit on the bias voltage which may be used on the 75TL, there is little advantage in using bias voltages in excess of those given under "Typical Operation," except in certain very specialized applications. Where bias is obtained by a grid leak, suitable protective means must be provided to prevent excessive plate dissipation in the event of loss of excitation.

**Plate Voltage**—The plate-supply voltage for the 75TL should not exceed 3000 volts. In most cases there is little advantage in using plate-supply voltages higher than those given under "Typical Operation" for the power output desired.

**Grid Dissipation**—The power dissipated by the grid of the 75TL must not exceed 13 watts. Grid dissipation may be calculated from the following expression:

$$P_g = e_{cgp} I_c$$

where  $P_g$  = Grid dissipation,

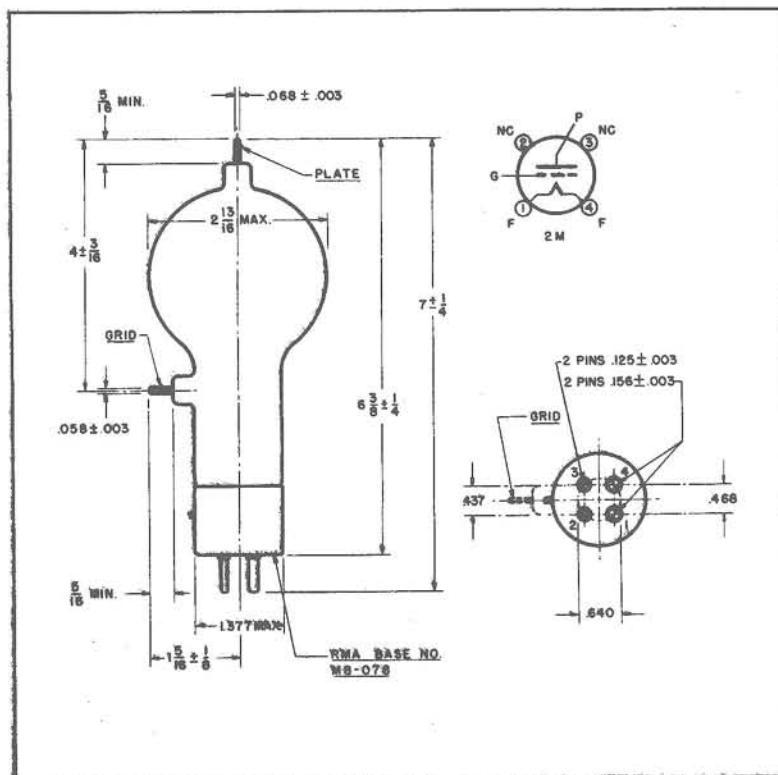
$e_{cgp}$  = Peak positive grid voltage, and

$I_c$  = D-c grid current.

$e_{cgp}$  may be measured by means of a suitable peak voltmeter connected between filament and grid.<sup>2</sup> In equipment in which the plate loading varies widely, such as oscillators used for radio-frequency heating, care should be taken to make certain that the grid dissipation does not exceed the maximum rating under any condition of loading.

**Plate Dissipation**—Under normal operating conditions, the power dissipated by the plate of the 75TL should not be allowed to exceed 75 watts. Plate dissipation in excess of the maximum rating is permissible for short periods of time, such as during tuning procedures.

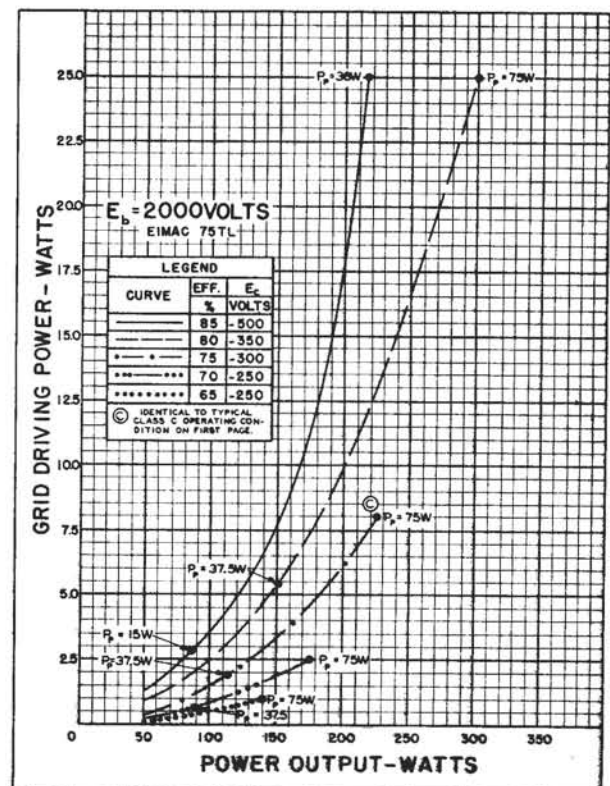
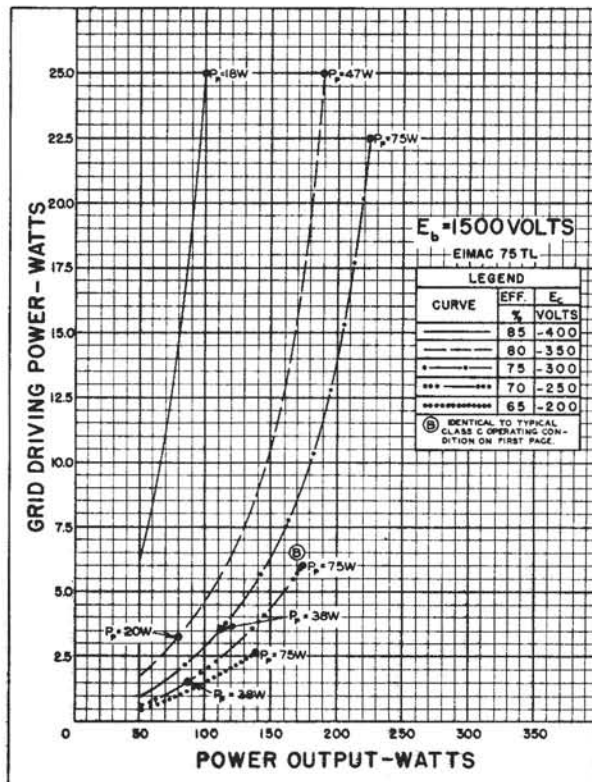
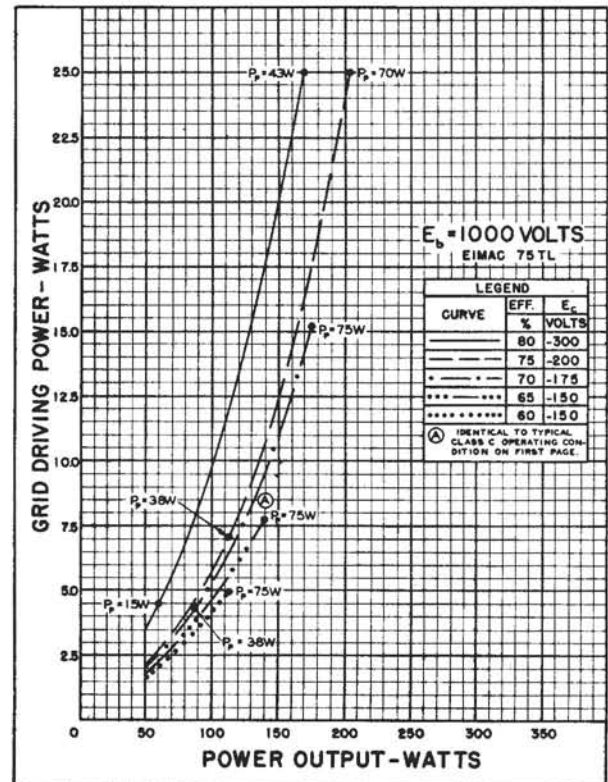
<sup>2</sup> For suitable peak v.t.v.m. circuits see, for instance, "Vacuum Tube Ratings," Eimac News, January, 1945. This article is available in reprint form on request.

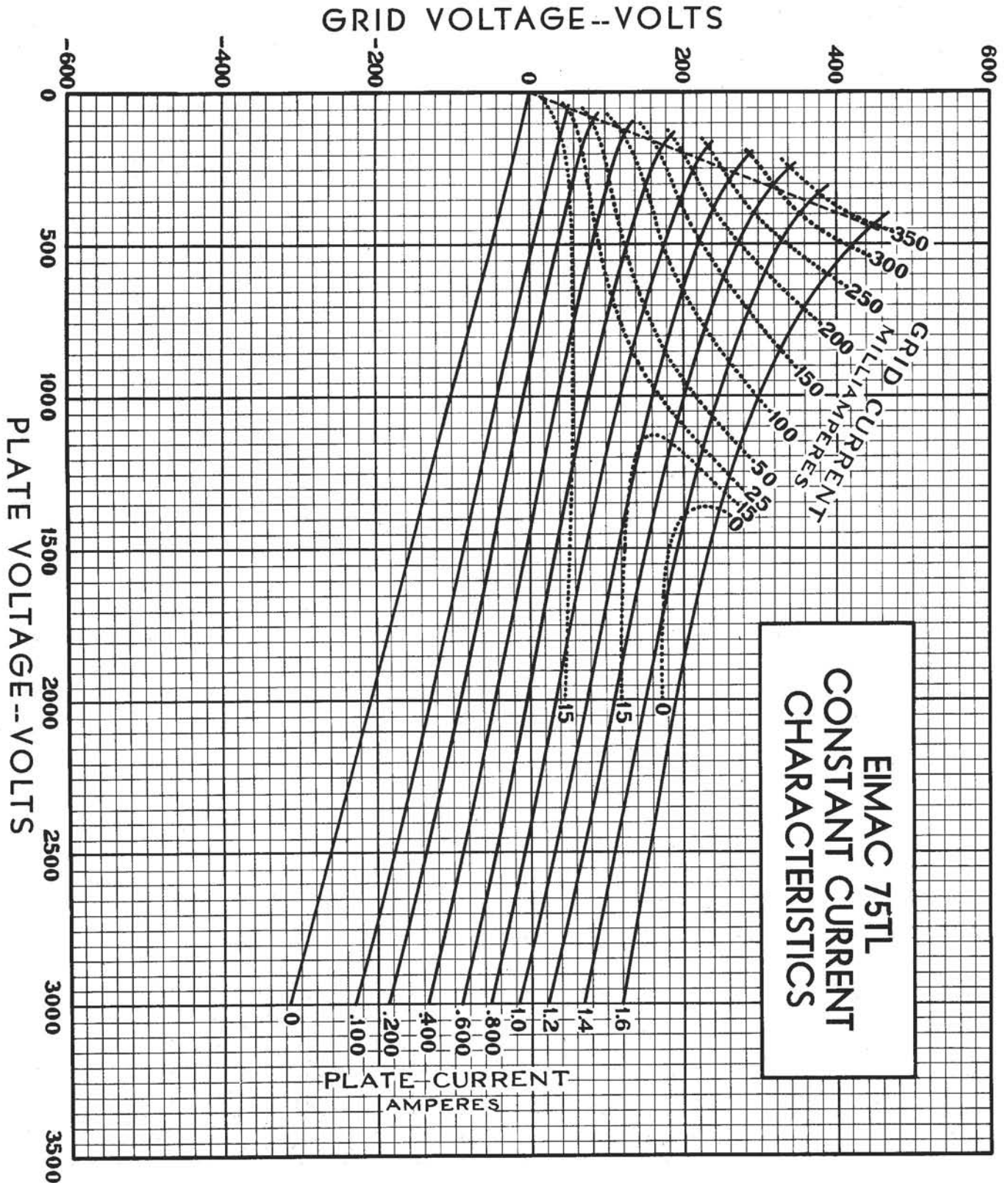


## DRIVING POWER vs. POWER OUTPUT

The three charts on this page show the relationship of plate efficiency, power output and grid driving power at plate voltages of 1000, 1500 and 2000 volts. These charts show combined grid and bias losses only. The driving power and power output figures do not include circuit losses. The plate dissipation in watts is indicated by  $P_p$ .

Points A, B, and C are identical to the typical Class C operating conditions shown on the first page under 1000, 1500, and 2000 volts respectively.





# Eitel-McCullough, Inc.

SAN BRUNO, CALIFORNIA

## 2 C 3 9

HIGH-MU TRIODE

The Eimac 2C39 is a high-mu, forced-air cooled, external-anode transmitting triode incorporating features which make it useful at frequencies well into the U. H. F. range, as well as at lower frequencies. Its small size, rugged construction, unusually high transconductance, and relatively high plate dissipation permit the design of compact equipment of moderate power output for either fixed or mobile applications.

The grid of the Eimac 2C39 terminates in a ring interposed between the plate and cathode-heater terminals, and the heater and cathode are provided with a concentric, cylindrical stem structure, facilitating its use in "grid isolation" amplifiers with cavity-type tank circuits.

### GENERAL CHARACTERISTICS

#### ELECTRICAL

Cathode: Coated Unipotential	
Heater Voltage - - - - -	6.3 volts
Heater Current - - - - -	1.1 amperes
Amplification Factor (Average) - - - - -	100
Direct Interelectrode Capacitances (Average)	
Grid-Plate - - - - -	1.95 $\mu\mu\text{fd.}$
Grid-Cathode - - - - -	6.50 $\mu\mu\text{fd.}$
Plate-Cathode - - - - -	0.030 $\mu\mu\text{fd.}$
Transconductance ( $i_b=75 \text{ ma.}$ , $E_b=600 \text{ v.}$ ) (Average) -	17,000 $\mu\text{mhos}$

#### MECHANICAL

Maximum Overall Dimensions:	
Length - - - - -	2.75 inches
Diameter - - - - -	1.26 inches
Net Weight - - - - -	2.8 ounces
Shipping Weight (Average) - - - - -	7 ounces

### RADIO FREQUENCY POWER AMPLIFIER

**Class-C FM Telephony or Telegraphy** (Key-down conditions, 1 tube)

#### MAXIMUM RATINGS (Frequencies below 500 Mc.)

D-C PLATE VOLTAGE - - - - -	1000 MAX. VOLTS
D-C CATHODE CURRENT - - - - -	100 MAX. MA.
D-C GRID VOLTAGE - - - - -	-150 MAX. VOLTS
PEAK POSITIVE R-F GRID VOLTAGE - - - - -	30 MAX. VOLTS
PEAK NEGATIVE R-F GRID VOLTAGE - - - - -	-400 MAX. VOLTS
PLATE DISSIPATION <sup>1</sup> - - - - -	100 MAX. WATTS
GRID DISSIPATION - - - - -	3 MAX. WATTS

#### TYPICAL OPERATION (400 Mc.)

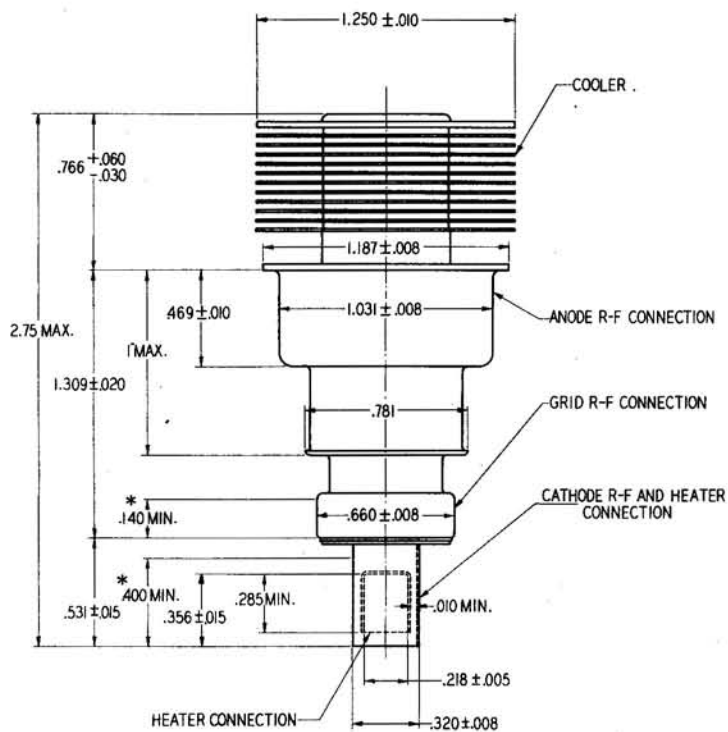
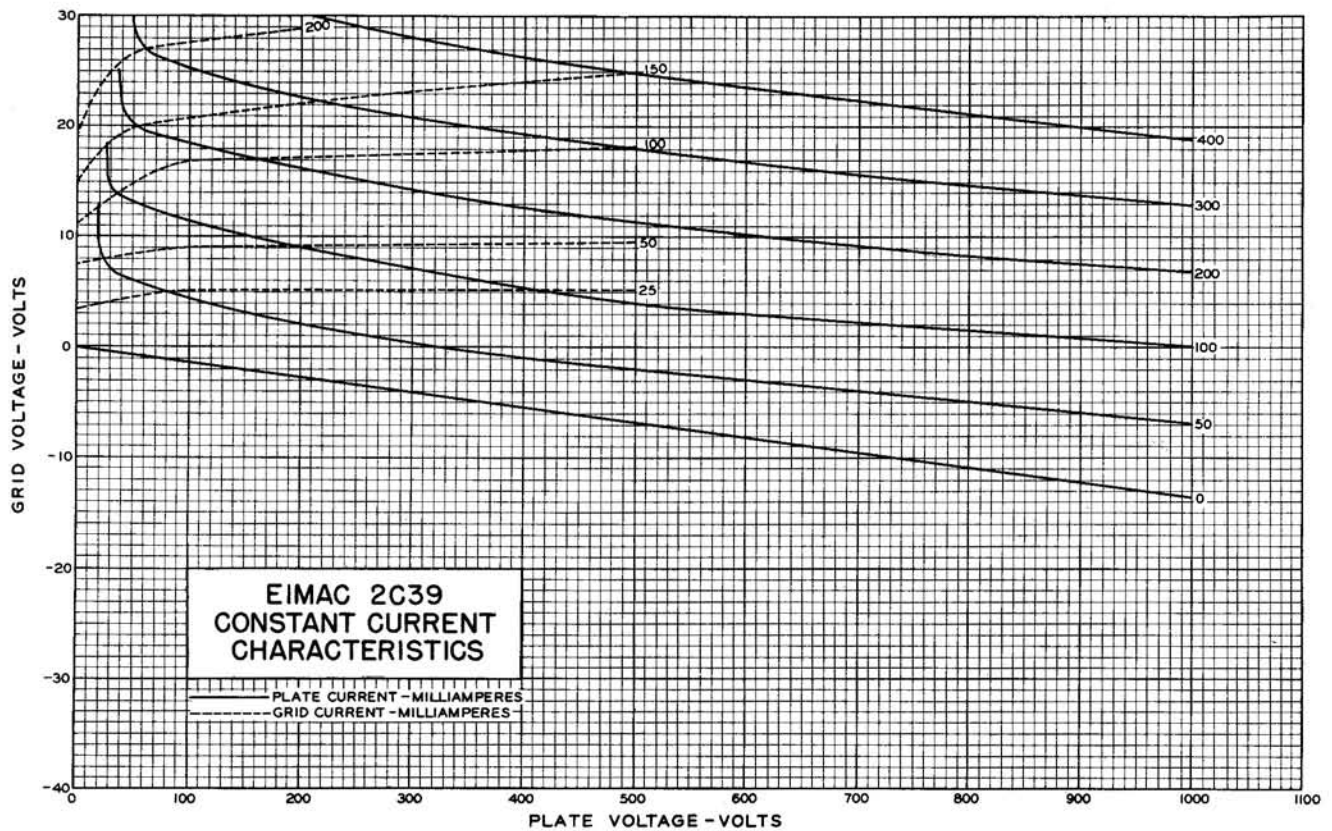
"Grid Isolation" Circuit

D-C Plate Voltage - - - - -	600 volts
D-C Plate Current - - - - -	60 ma.
D-C Grid Voltage - - - - -	-35 volts
D-C Grid Current - - - - -	40 ma.
Driving Power (approx.) - - - - -	5 watts
Useful Power Output - - - - -	20 watts

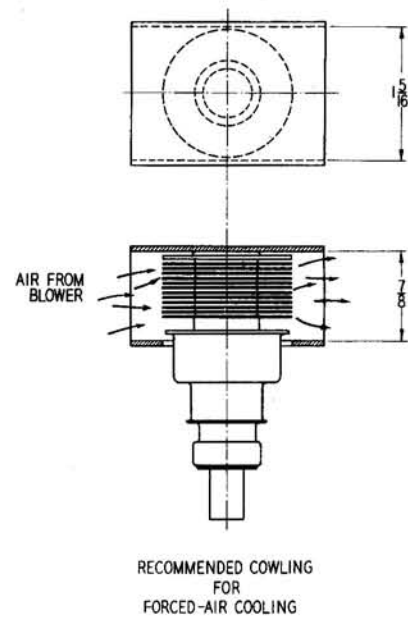
<sup>1</sup> Forced-air cooling required. 12 cubic feet of air per minute must be passed through plate cooler. Maximum plate dissipation without forced-air cooling = 12 watts.







\* CLEAN AND SMOOTH AREA AVAILABLE FOR CONTACT.



# EITEL-McCULLOUGH, Inc.

SAN BRUNO, CALIFORNIA

## 100TH

HIGH-MU TRIODE

MODULATOR

OSCILLATOR

AMPLIFIER

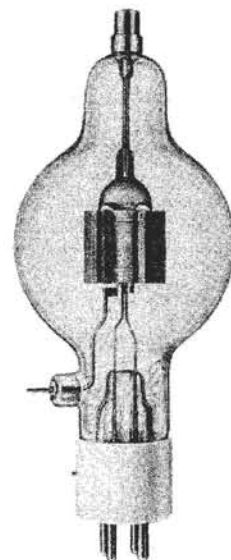
### GENERAL CHARACTERISTICS

#### ELECTRICAL

Filament: Thoriated tungsten	
Voltage - - - - -	5.0 volts
Current - - - - -	6.3 amperes
Amplification Factor (Average) - - - - -	40
Direct Interelectrode Capacitances (Average)	
Grid-Plate - - - - -	2.0 $\mu\mu\text{f}$
Grid-Filament - - - - -	2.9 $\mu\mu\text{f}$
Plate-Filament - - - - -	0.4 $\mu\mu\text{f}$
Transconductance ( $I_b=200$ ma., $E_b=3000$ , $e_c=-15$ )	5500 $\mu\text{mhos}$

#### MECHANICAL

Base - - -	(Medium 4-pin bayonet, ceramic) RMA type M8-078
Basing - - -	RMA type 2M
Maximum Overall Dimensions:	
Length - - - - -	7.75 inches
Diameter - - - - -	3.19 inches
Net weight - - - - -	4 ounces
Shipping weight (Average) - - - - -	1.5 pounds



### AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR Class B

	TYPICAL OPERATION—2 TUBES			MAX. RATING	
D-C Plate Voltage - - - - -	1500	2000	3000	3000	volts
Max.-Signal D-C Plate Current, per tube* - -	•	•	•	225	ma.
Plate Dissipation, per tube* - - - - -	•	•	•	100	watts
D-C Grid Voltage (approx.) - - - - -	-20	-35	-65		volts
Peak A-F Grid Input Voltage - - - - -	290	310	335		volts
Zero-Signal D-C Plate Current - - - - -	80	60	40		ma.
Max.-Signal D-C Plate Current - - - - -	320	280	215		ma.
Max.-Signal Driving Power (approx.) - - -	7	7	5		watts
Effective Load, Plate-to-Plate - - - - -	8750	15000	31000		ohms
Max.-Signal Plate Power Output - - - - -	280	360	650		watts

\*Averaged over any sinusoidal audio frequency cycle.

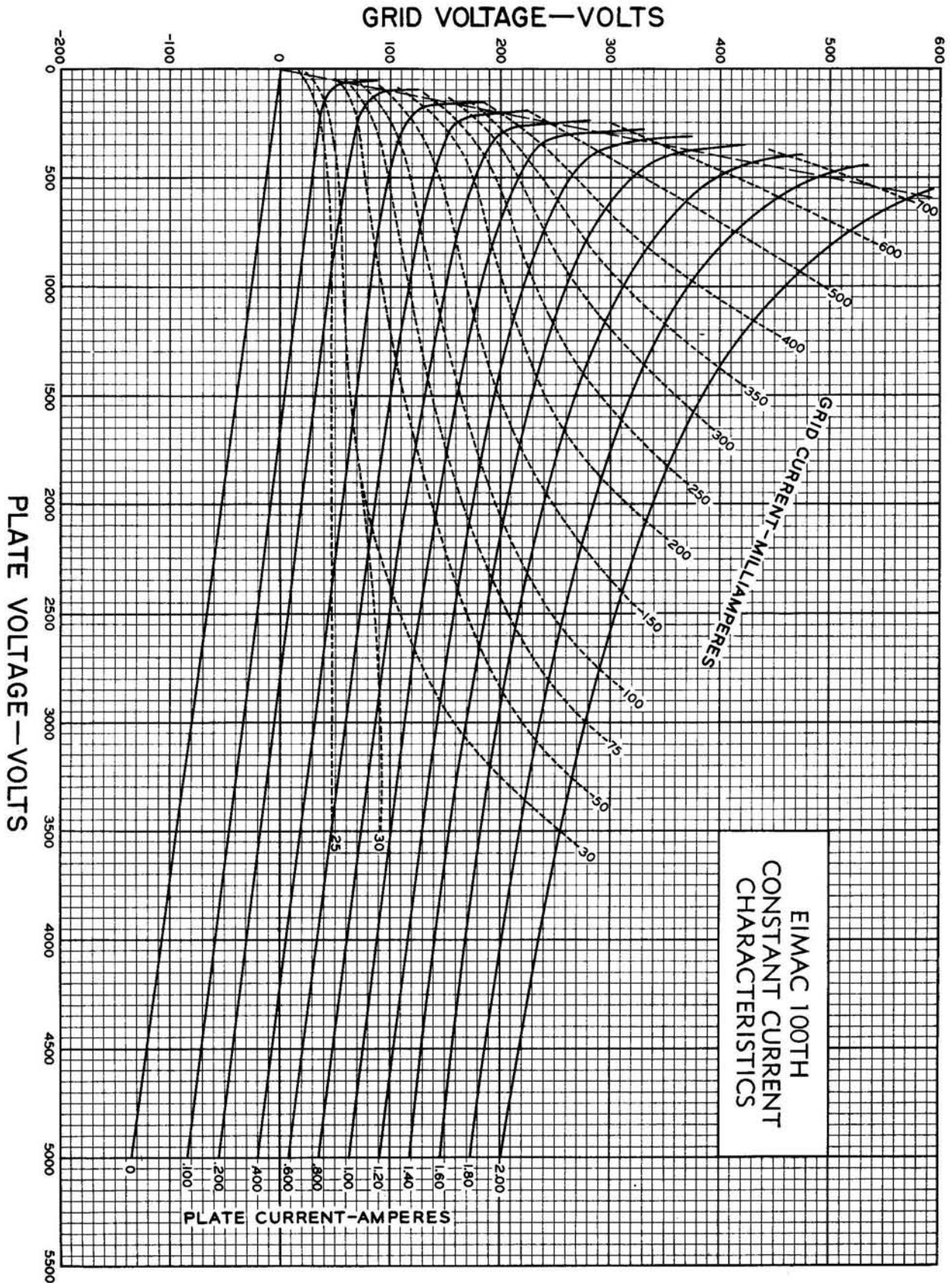
### RADIO FREQUENCY POWER AMPLIFIER AND OSCILLATOR Class-C \*Telegraphy

(Key down conditions without modulation)

	TYPICAL OPERATION—1 TUBE			MAX. RATING	
D-C Plate Voltage - - - - -	1500	2000	3000	3000	volts
D-C Plate Current - - - - -	190	165	165	225	ma.
D-C Grid Current - - - - -	48	39	51	60	ma.
D-C Grid Voltage - - - - -	-65	-80	-200		volts
Plate Power Output - - - - -	185	235	400		watts
Plate Input - - - - -	285	335	500		watts
Plate Dissipation - - - - -	100	100	100	100	watts
Peak R. F. Grid Input Voltage, (approx.) -	230	230	385		volts
Driving Power, (approx.) - - - - -	10	8	18		watts

\*The above figures show actual measured tube performance, and do not allow for variations in circuit losses.

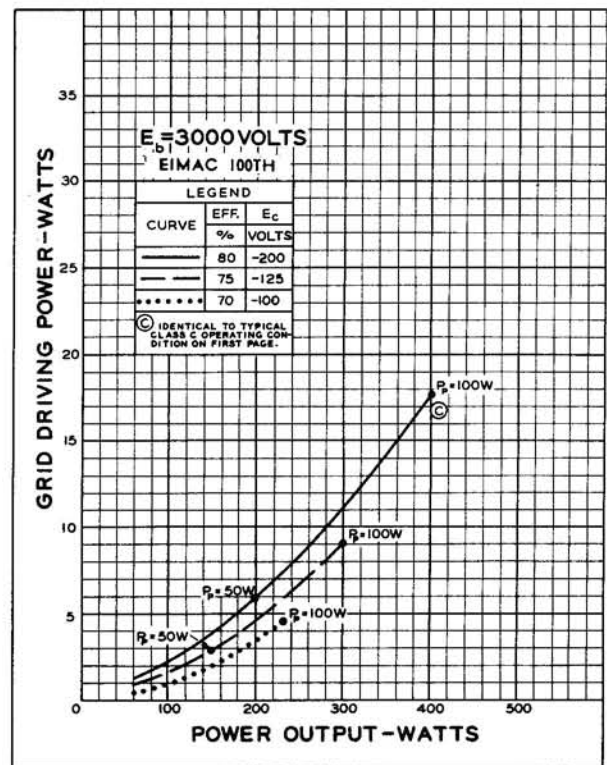
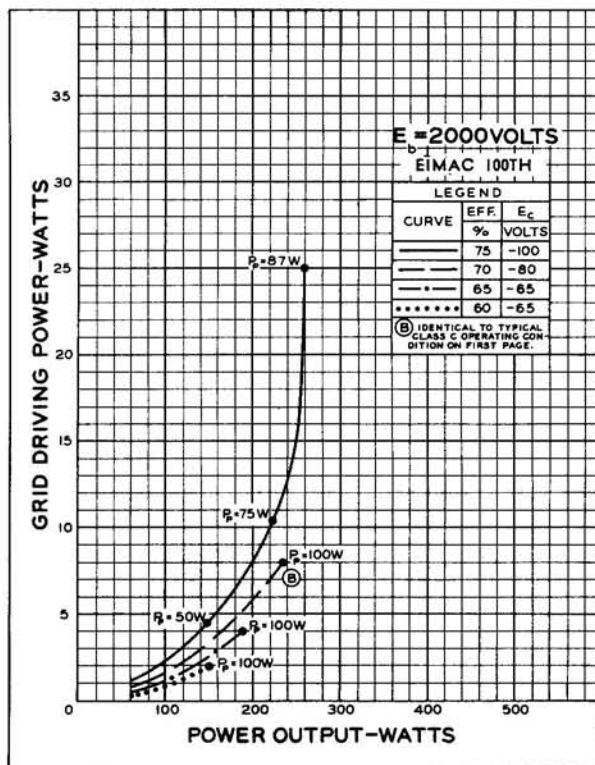
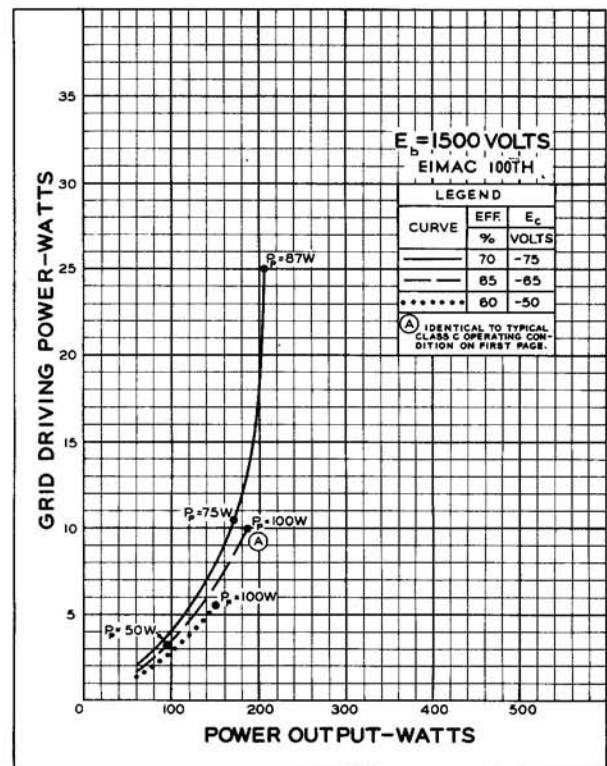
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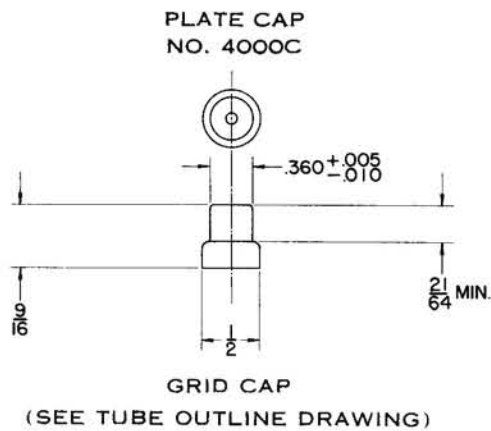
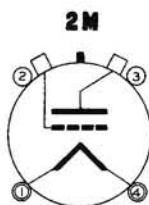
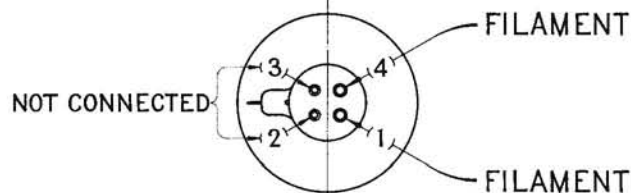
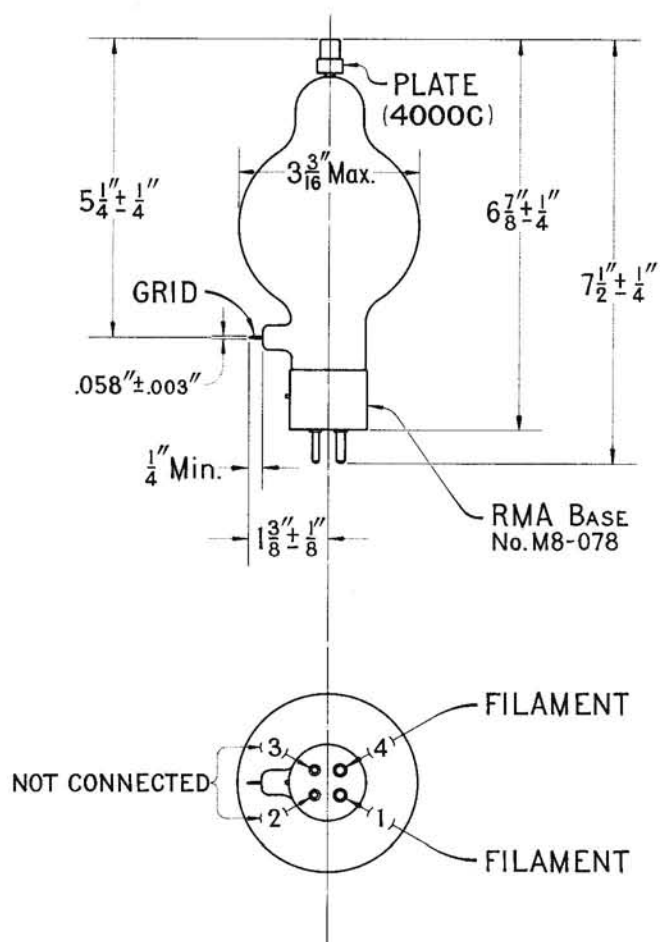


## DRIVING POWER vs. POWER OUTPUT

The three charts on this page show the relationship of plate efficiency, power output and grid driving power at plate voltages of 1500, 2000 and 3000 volts. These charts show combined grid and bias losses only. The driving power and power output figures do not include circuit losses. The plate dissipation in watts is indicated by  $P_p$ .

Points A, B, and C are identical to the typical Class C operating conditions shown on the first page under 1500, 2000, and 3000 volts respectively.







# EITEL-McCULLOUGH, INC.

SAN BRUNO, CALIFORNIA

## 100TH

LOW-MU TRIODE

MODULATOR  
OSCILLATOR  
AMPLIFIER

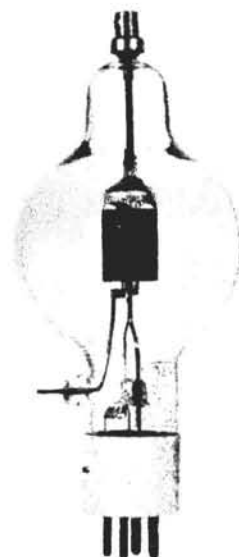
### GENERAL CHARACTERISTICS

#### ELECTRICAL

Filament: Thoriated tungsten	
Voltage - - - - -	5.0 volts
Current - - - - -	6.3 amperes
Amplification Factor (Average) - - - - -	14
Direct Interelectrode Capacitances (Average)	
Grid-Plate - - - - -	2.0 $\mu\mu\text{f}$
Grid-Filament - - - - -	2.3 $\mu\mu\text{f}$
Plate-Filament - - - - -	0.4 $\mu\mu\text{f}$
Transconductance ( $i_b = 225 \text{ ma.}$ , $E_b = 3000 \text{ v.}$ , $E_c = -160 \text{ v.}$ )	2300 $\mu\text{mhos}$
Frequency for Maximum Ratings - - - - -	40 mc

#### MECHANICAL

Base - - - (Medium 4-pin bayonet, ceramic)	RMA type M8-078
Basing - - -	RMA type 2M
Maximum Overall Dimensions:	
Length - - - - -	7.75 inches
Diameter - - - - -	3.19 inches
Net weight - - - - -	4 ounces
Shipping weight (Average) - - - - -	1.5 pounds



### AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR

#### Class B

	TYPICAL OPERATION—2 TUBES			MAX. RATING	
D-C Plate Voltage - - - - -	1500	2000	3000	3000	volts
Max.-Signal D-C Plate Current, per tube* - -	•	•	•	225	ma.
Plate Dissipation, per tube* - - - - -	•	•	•	100	watts
D-C Grid Voltage (approx.) - - - - -	-65	-110	-185		volts
Peak A-F Grid Input Voltage - - - - -	470	540	640		volts
Zero-Signal D-C Plate Current - - - - -	80	60	40		ma.
Max.-Signal D-C Plate Current - - - - -	320	280	215		ma.
Max.-Signal Driving Power (approx.) - - - -	8	7	6		watts
Effective Load, Plate-to-Plate - - - - -	8750	15000	30000		ohms
Max.-Signal Plate Power Output - - - - -	280	360	450		watts

\*Averaged over any sinusoidal audio frequency cycle.

### RADIO FREQUENCY POWER AMPLIFIER AND OSCILLATOR

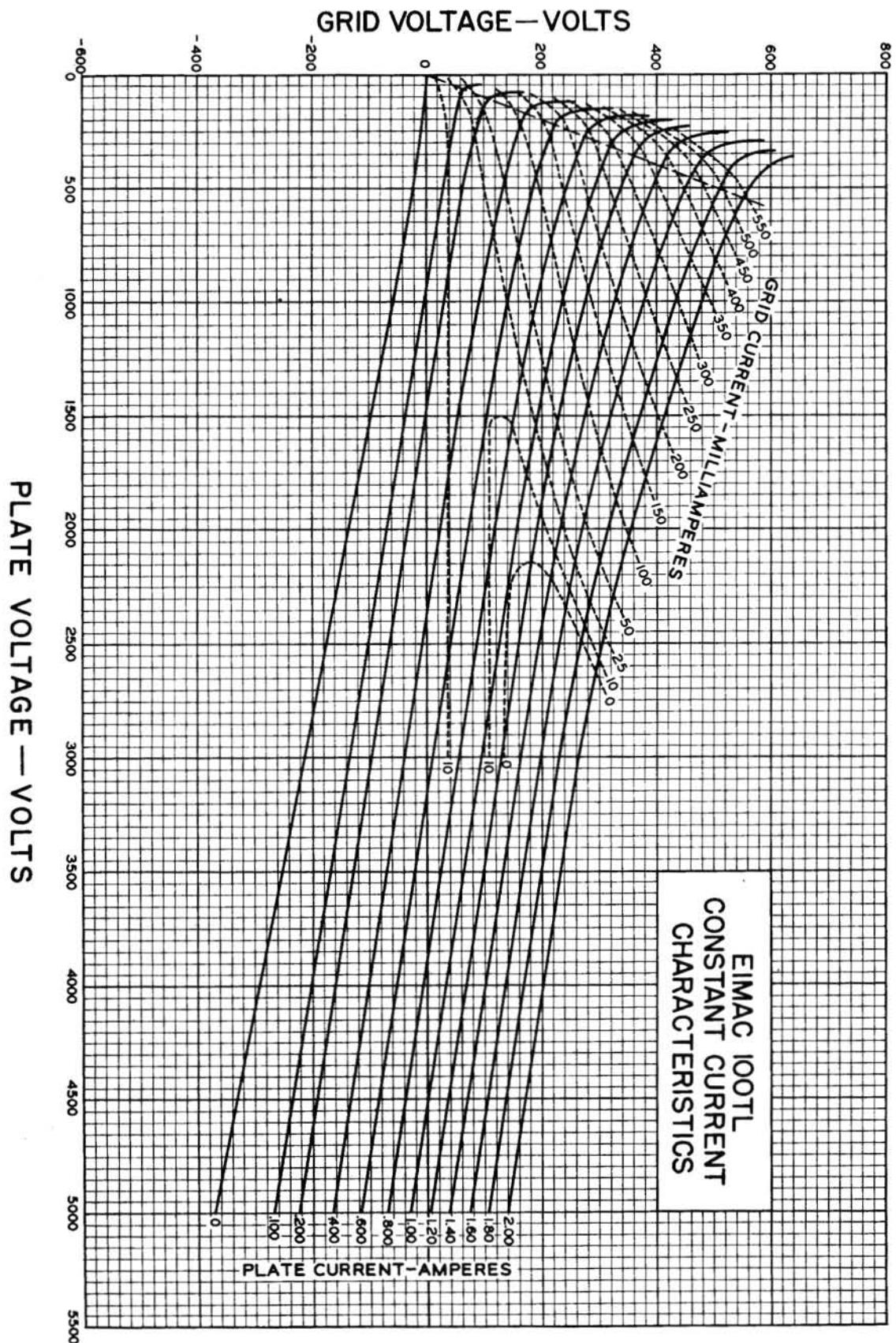
#### Class-C \*Telegraphy

(Key down conditions without modulation)

	TYPICAL OPERATION—1 TUBE			MAX. RATING	
D-C Plate Voltage - - - - -	1500	2000	3000	3000	volts
D-C Plate Current - - - - -	190	165	165	225	ma.
D-C Grid Current - - - - -	37	28	30	50	ma.
D-C Grid Voltage - - - - -	-175	-225	-400		volts
Plate Power Output - - - - -	185	235	400		watts
Plate Input - - - - -	285	335	500		watts
Plate Dissipation - - - - -	100	100	100	100	watts
Peak R. F. Grid Input Voltage, (approx.) - -	425	450	650		volts
Driving Power, (approx.) - - - - -	14	11	20		watts

\*The above figures show actual measured tube performance, and do not allow for variations in circuit losses.

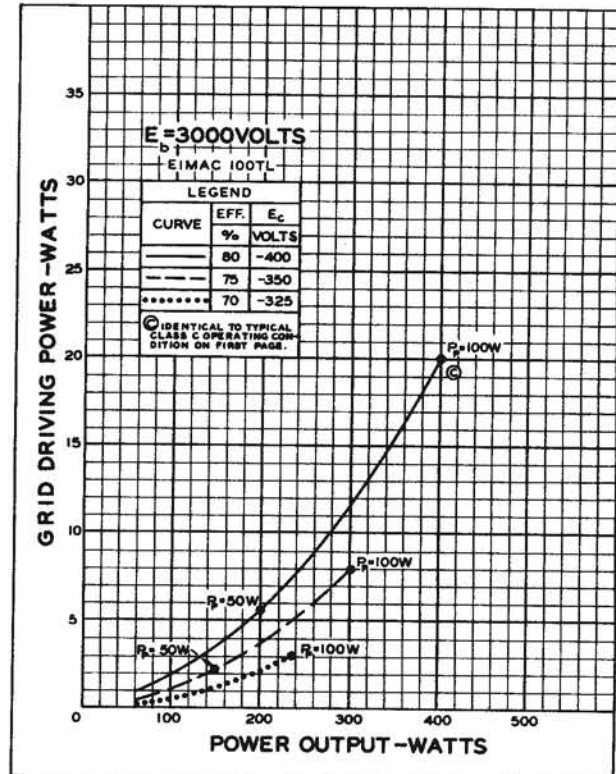
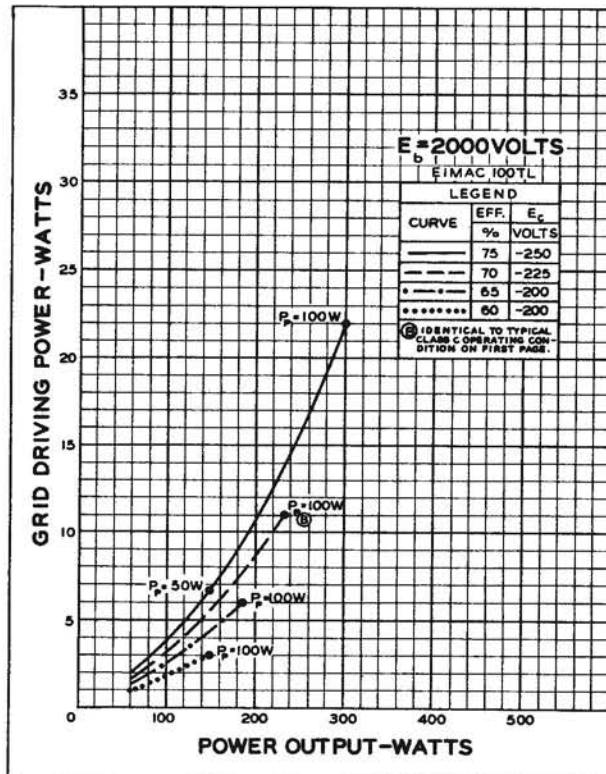
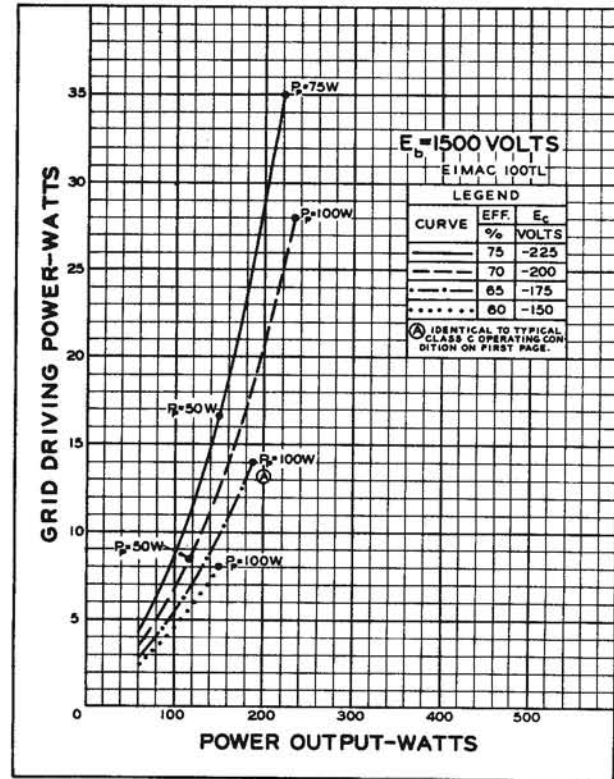
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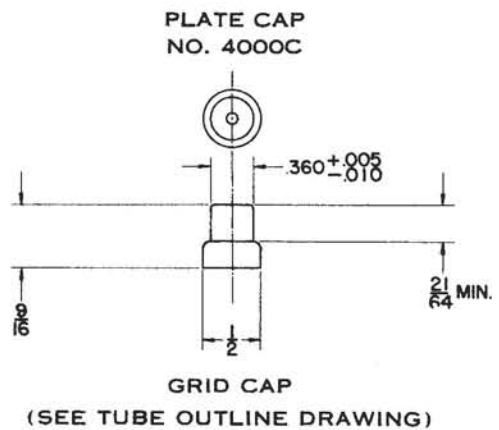
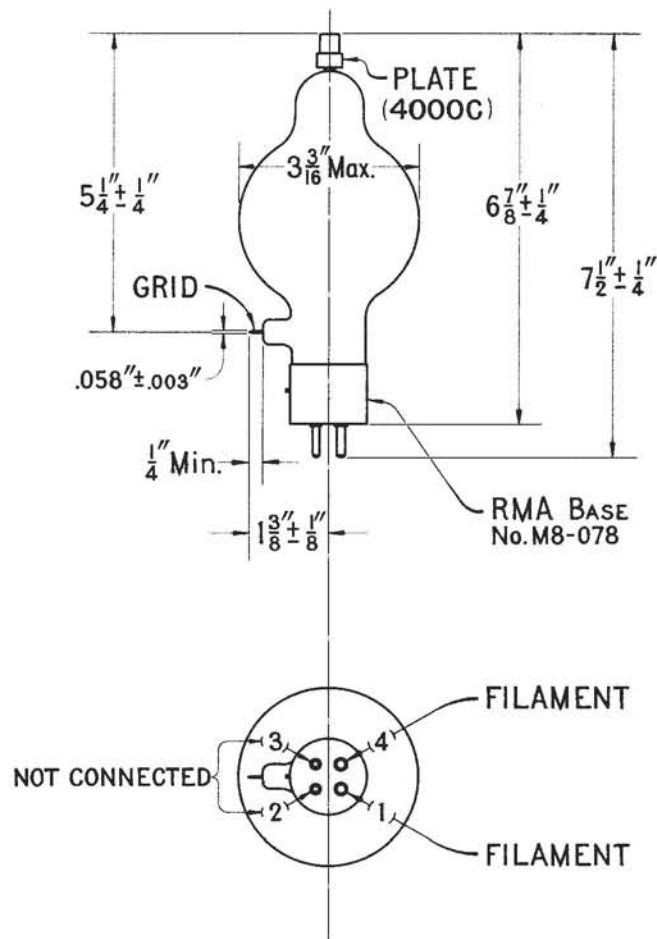


## DRIVING POWER vs. POWER OUTPUT

The three charts on this page show the relationship of plate efficiency, power output and grid driving power at plate voltages of 1500, 2000 and 3000 volts. These charts show combined grid and bias losses only. The driving power and power output figures do not include circuit losses. The plate dissipation in watts is indicated by  $P_p$ .

Points A, B, and C are identical to the typical Class C operating conditions shown on the first page under 1500, 2000, and 3000 volts respectively.





# EITEL-McCULLOUGH, INC.

SAN BRUNO, CALIFORNIA

# 152TH

MEDIUM-MU TRIODE

MODULATOR  
OSCILLATOR  
AMPLIFIER

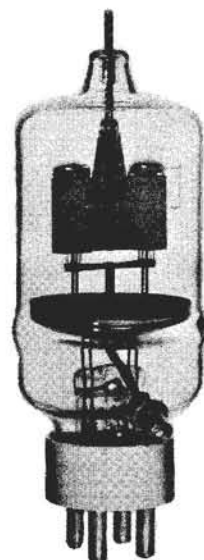
## GENERAL CHARACTERISTICS

### ELECTRICAL

Filament: Thoriated tungsten	
Voltage - - - - -	5.0 or 10.0 volts
Current - - - - -	12.5 or 6.25 amperes
Amplification Factor (Average) - - - - -	20
Direct Interelectrode Capacitances (Average)	
Grid-Plate - - - - -	4.8 $\mu\mu\text{f}$
Grid-Filament - - - - -	5.7 $\mu\mu\text{f}$
Plate-Filament - - - - -	0.8 $\mu\mu\text{f}$
Transconductance ( $i_b = 500 \text{ ma.}$ , $E_b = 3000 \text{ v.}$ , $E_c = -40 \text{ v.}$ )	8300 $\mu\text{mhos}$
Frequency for Maximum Ratings - - - - -	40 mc

### MECHANICAL

Base - - - - -	Special 4 pin, No. 5000B
Basing - - - - -	RMA type 4BC
Maximum Overall Dimensions:	
Length - - - - -	7.625 inches
Diameter - - - - -	2.563 inches
Net weight - - - - -	7 ounces
Shipping weight (Average) - - - - -	2.0 pounds



## AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR

### Class B

	TYPICAL OPERATION—2 TUBES			MAX. RATING	
D-C Plate Voltage - - - - -	1500	2000	3000	3000	volts
Max.-Signal D-C Plate Current, per tube* - -	•	•	•	450	ma.
Plate Dissipation, per tube* - - - - -	•	•	•	150	watts
D-C Grid Voltage (approx.) - - - - -	-65	-90	-150		volts
Peak A-F Grid Input Voltage - - - - -	340	350	430		volts
Zero-Signal D-C Plate Current - - - - -	133	100	67		ma.
Max.-Signal D-C Plate Current - - - - -	535	450	335		ma.
Max.-Signal Driving Power (approx.) - - - -	9	6	3		watts
Effective Load, Plate-to-Plate - - - - -	5700	9600	20300		ohms
Max.-Signal Plate Power Output - - - - -	500	600	700		watts

\*Averaged over any sinusoidal audio frequency cycle.

## RADIO FREQUENCY POWER AMPLIFIER AND OSCILLATOR

### Class-C \*Telegraphy

(Key down conditions without modulation)

	TYPICAL OPERATION—1 TUBE			MAX. RATING	
D-C Plate Voltage - - - - -	1500	2000	3000	3000	volts
D-C Plate Current - - - - -	333	300	250	450	ma.
D-C Grid Current - - - - -	58	74	70	85	ma.
D-C Grid Voltage - - - - -	-125	-200	-300		volts
Plate Power Output - - - - -	350	450	600		watts
Plate Input - - - - -	500	600	750		watts
Plate Dissipation - - - - -	150	150	150	150	watts
Peak R. F. Grid Input Voltage, (approx.) - -	267	334	410		volts
Driving Power, (approx.) - - - - -	13	20	27		watts

\*The above figures show actual measured tube performance, and do not allow for variations in circuit losses.

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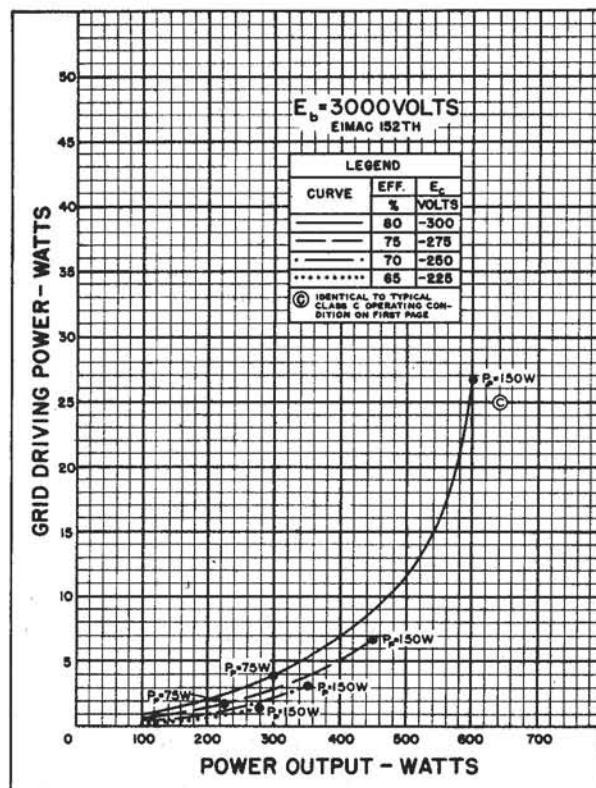
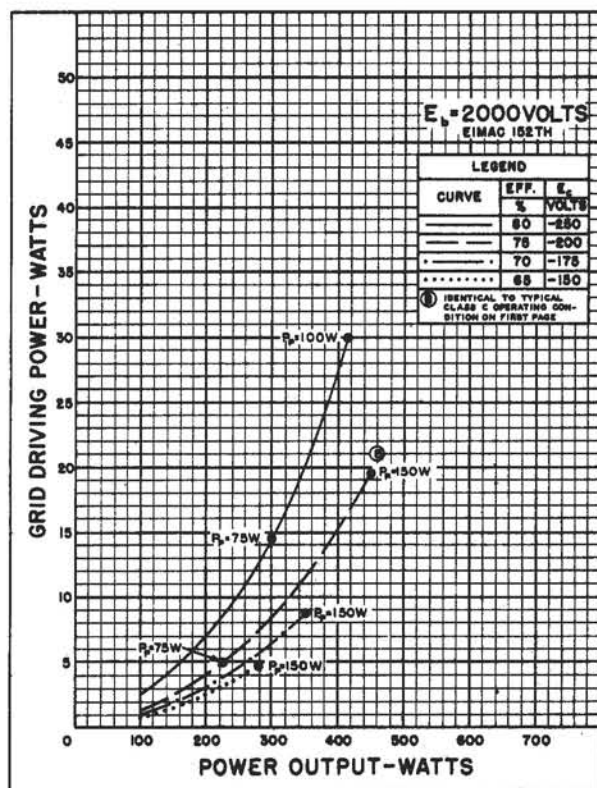
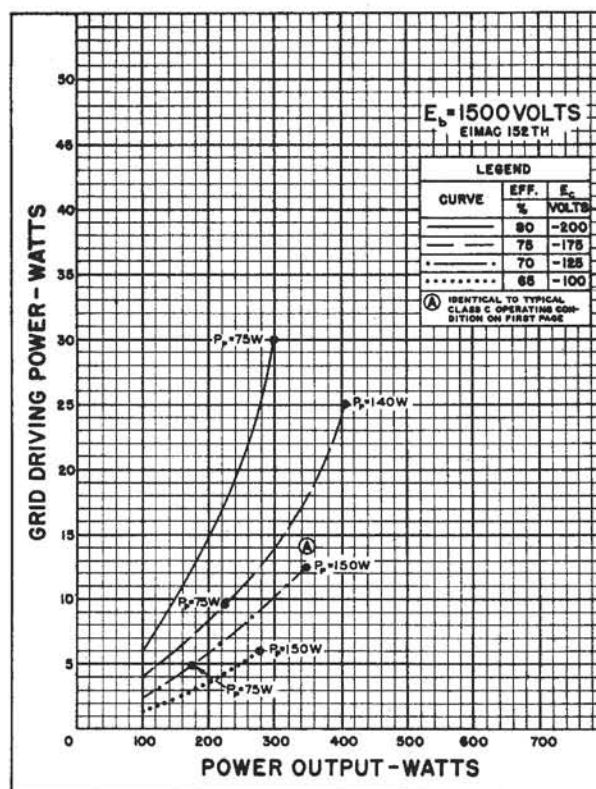




## DRIVING POWER vs. POWER OUTPUT

The three charts on this page show the relationship of plate efficiency, power output and grid driving power at plate voltages of 1500, 2000 and 3000 volts. These charts show combined grid and bias losses only. The driving power and power output figures do not include circuit losses. The plate dissipation in watts is indicated by  $P_p$ .

Points A, B, and C are identical to the typical Class C operating conditions shown on the first page under 1500, 2000, and 3000 volts respectively.



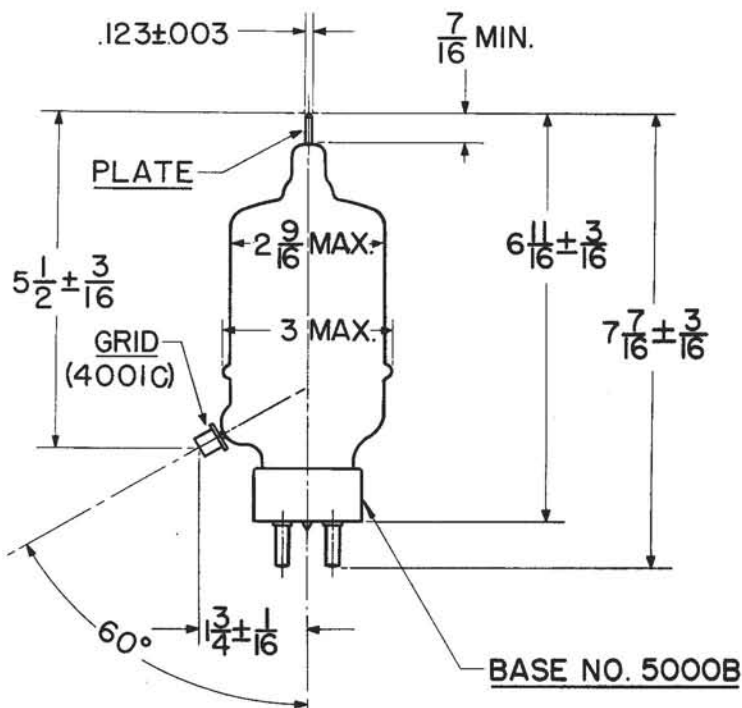
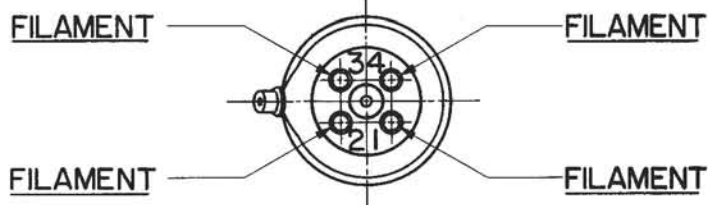
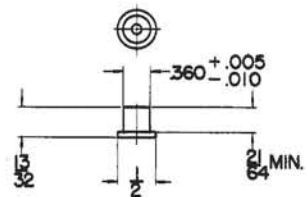
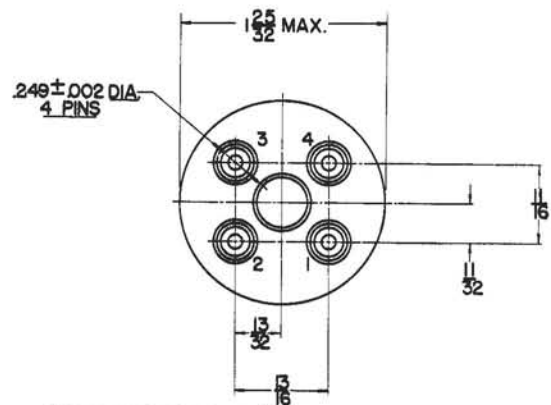
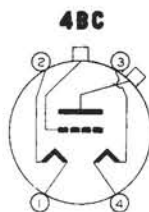
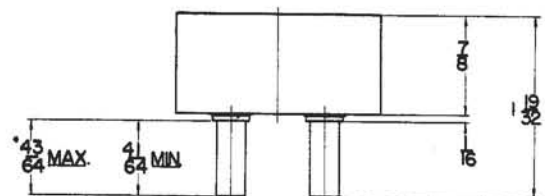


PLATE CAP  
(SEE TUBE OUTLINE DRAWING)

GRID CAP  
NO. 4001C



**BASE NO. 5000B**



\*ON FINISHED TUBE ADD .060 FOR SOLDER

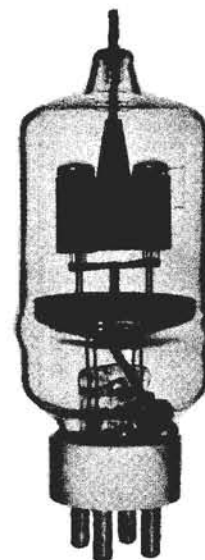
## GENERAL CHARACTERISTICS

### ELECTRICAL

Filament: Thoriated tungsten	
Voltage - - - - -	5.0 of 10.0 volts
Current - - - - -	12.5 or 6.25 amperes
Amplification Factor (Average) - - - - -	12
Direct Interelectrode Capacitances (Average)	
Grid-Plate - - - - -	4.4 $\mu\text{mf}$
Grid-Filament - - - - -	4.5 $\mu\text{mf}$
Plate-Filament - - - - -	0.7 $\mu\text{mf}$
Transconductance ( $i_b = 500 \text{ ma.}$ , $E_b = 3000 \text{ v.}$ , $E_c = -85 \text{ v.}$ )	7150 $\mu\text{mhos}$

### MECHANICAL

Base - - - - -	Special 4 pin, No. 5000B
Basing - - - - -	RMA type 4BC
Maximum Overall Dimensions:	
Length - - - - -	7.625 inches
Diameter - - - - -	2.563 inches
Net weight - - - - -	7 ounces
Shipping weight (Average) - - - - -	2.0 pounds



## AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR

### Class B

	ZERO GRID CURRENT OPERATION—2 TUBES			TYPICAL OPERATION 2 TUBES			MAX. RATING	
D-C Plate Voltage - - - - -	1500	2000	3000	1500	2000	3000	3000	volts
Max.-Sig. D-C Plate Current, per tube* - - -	•	•	•	•	•	•	450	ma.
Plate Dissipation, per tube* - - -	•	•	•	•	•	•	150	watts
D-C Grid Voltage (approx.) - - -	-105	-160	-260	-105	-160	-260		volts
Peak A-F Grid Input Voltage - - -	210	320	520	500	620	675		volts
Zero-Signal D-C Plate Current - - -	135	100	65	135	100	65		ma.
Max.-Signal D-C Plate Current - - -	286	260	220	570	500	335		ma.
Max.-Signal Driving Power (approx.) - - -	0	0	0	15	13	3		watts
Effective Load, Plate-to-Plate - - -	5100	10500	24000	5500	9000	20400		ohms
Max.-Signal Plate Power Output - - -	130	220	370	560	700	700		watts

\*Averaged over any sinusoidal audio frequency cycle.

## RADIO FREQUENCY POWER AMPLIFIER AND OSCILLATOR

### Class-C \*Telegraphy

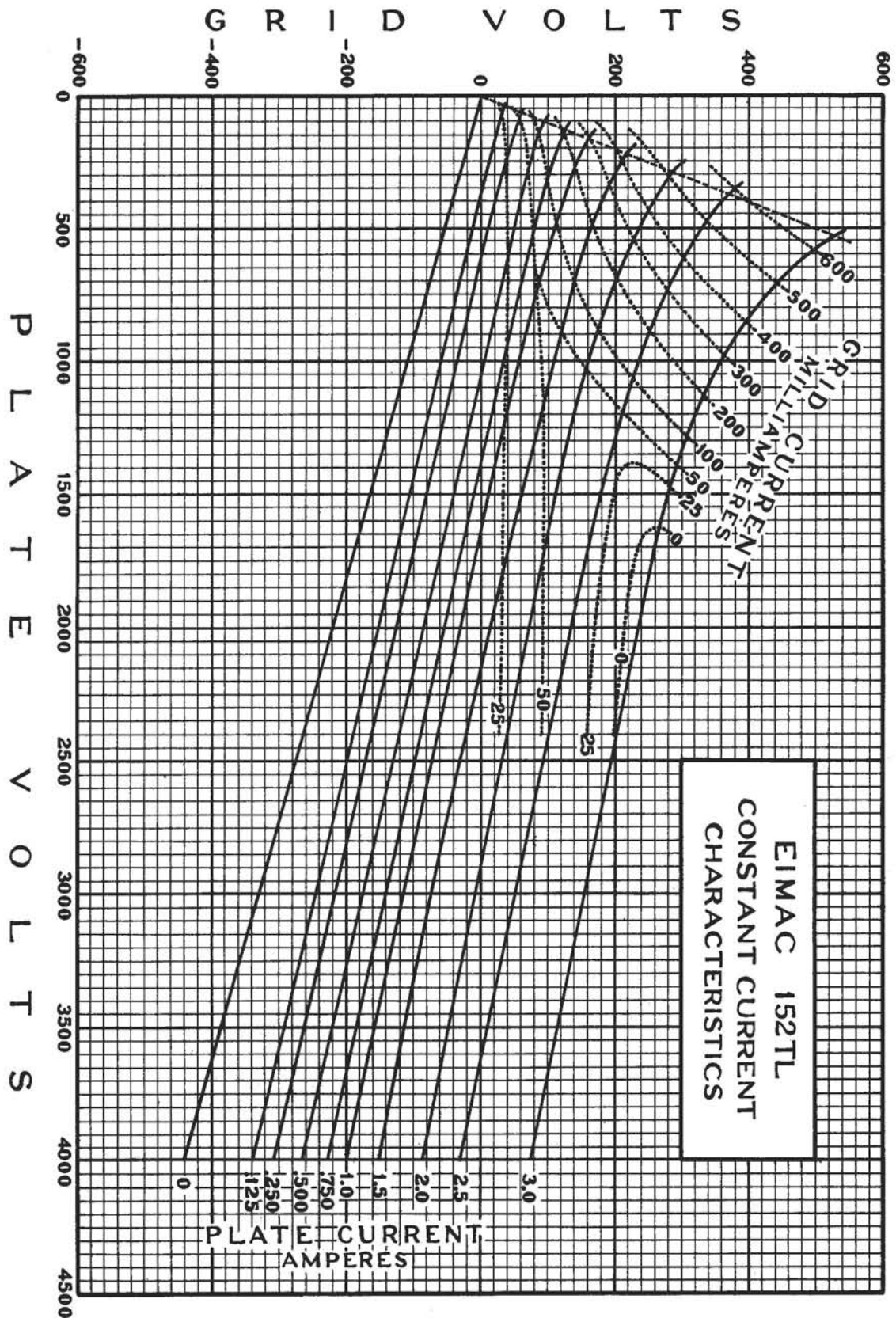
(Key down conditions without modulation)

	TYPICAL OPERATION—1 TUBE			MAX. RATING	
D-C Plate Voltage - - - - -	1500	2000	3000	3000	volts
D-C Plate Current - - - - -	333	300	250	450	ma.
D-C Grid Current - - - - -	45	42	40	75	ma.
D-C Grid Voltage - - - - -	-250	-300	-400		volts
Plate Power Output - - - - -	350	450	600		watts
Plate Input - - - - -	500	600	750		watts
Plate Dissipation - - - - -	150	150	150	150	watts
Peak R. F. Grid Input Voltage, (approx.) - -	400	455	550		volts
Driving Power, (approx.) - - - - -	16	18	20		watts

\*The above figures show actual measured tube performance, and do not allow for variations in circuit losses.

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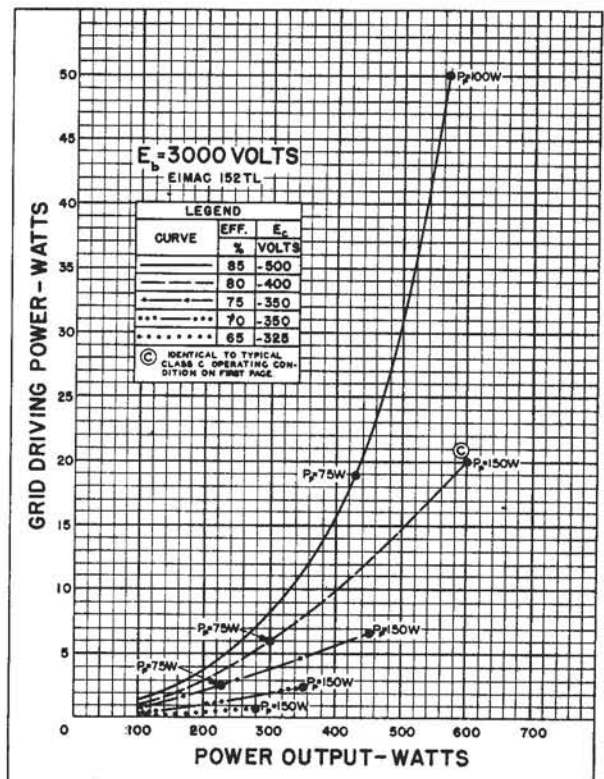
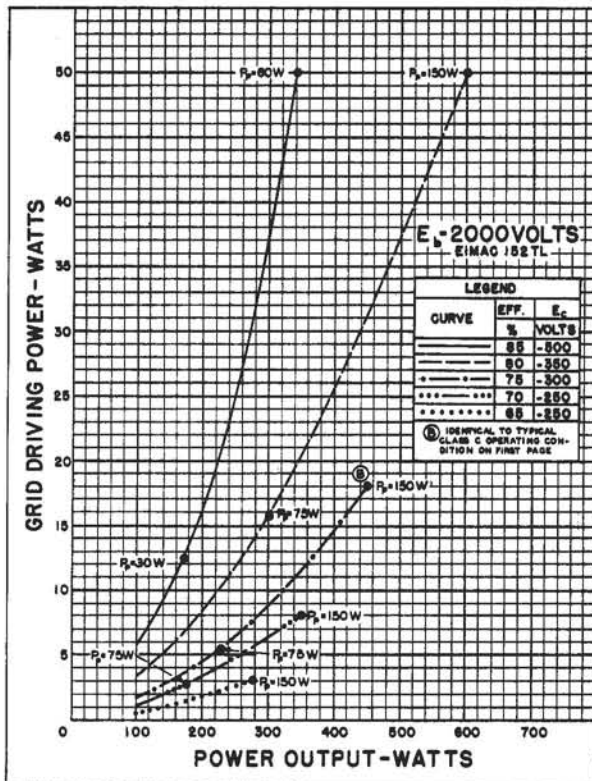
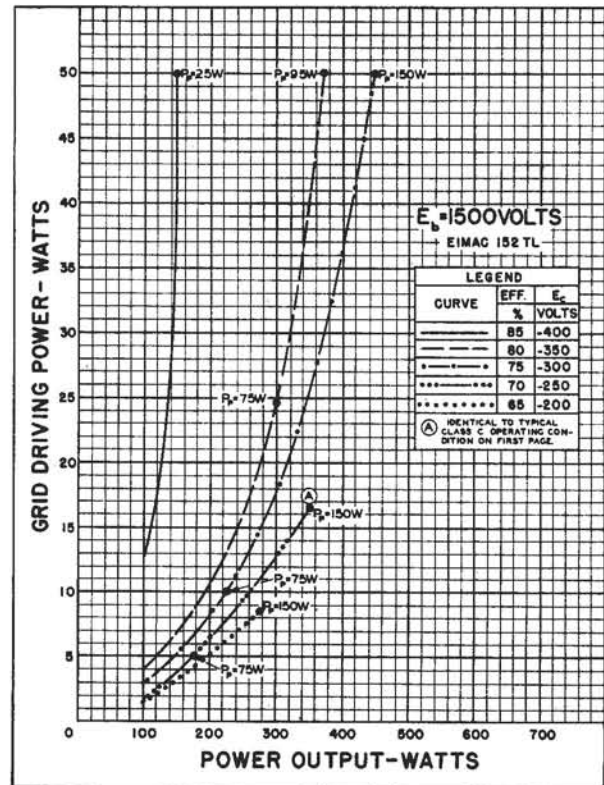


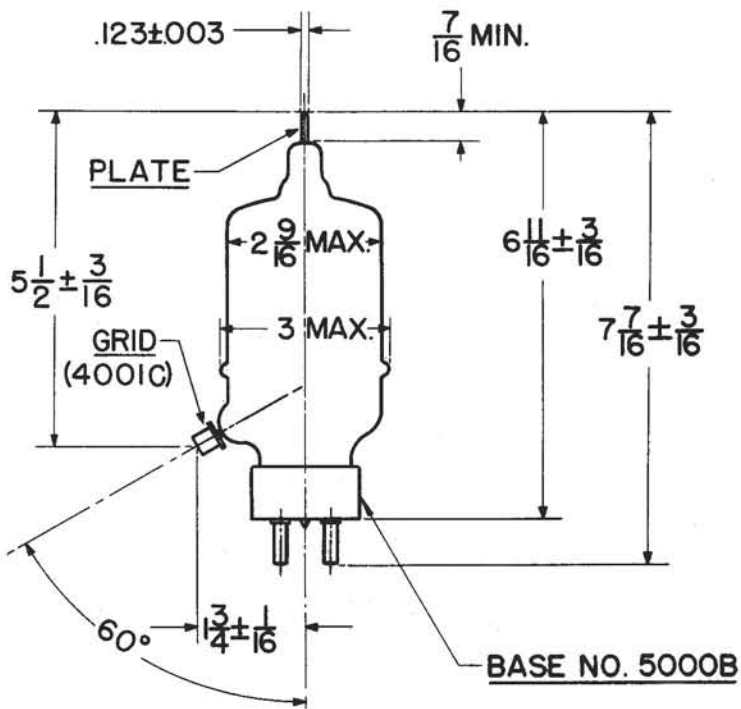


## DRIVING POWER vs. POWER OUTPUT

The three charts on this page show the relationship of plate efficiency, power output and grid driving power at plate voltages of 1500, 2000 and 3000 volts. These charts show combined grid and bias losses only. The driving power and power output figures do not include circuit losses. The plate dissipation in watts is indicated by  $P_p$ .

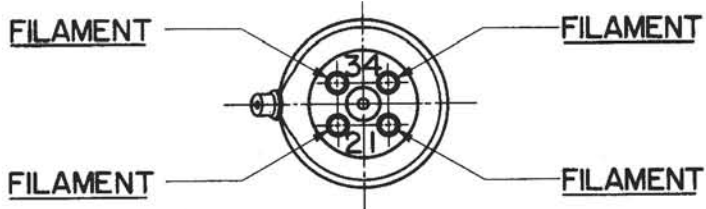
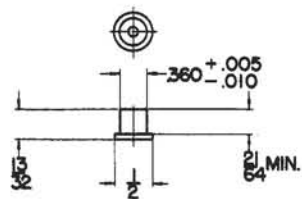
Points A, B, and C are identical to the typical Class C operating conditions shown on the first page under 1500, 2000, and 3000 volts respectively.



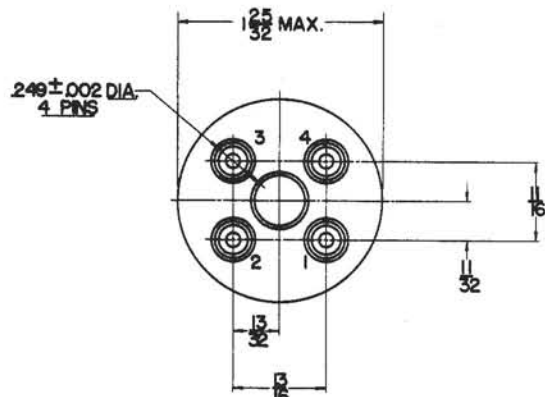
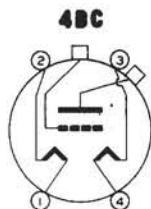
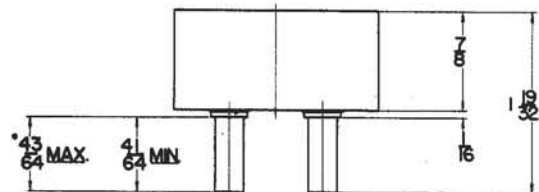


**PLATE CAP**  
 (SEE TUBE OUTLINE DRAWING)

**GRID CAP**  
**NO. 4001C**



**BASE NO. 5000B**



\*ON FINISHED TUBE ADD .060 FOR SOLDER

# EITEL-McCULLOUGH, INC.

SAN BRUNO, CALIFORNIA

## 250TH

HIGH-MU TRIODE

MODULATOR

OSCILLATOR

AMPLIFIER

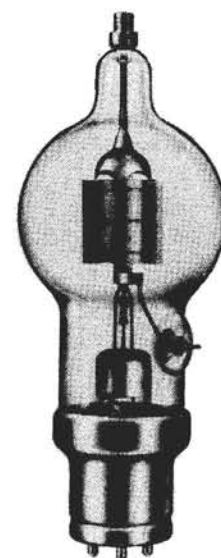
### GENERAL CHARACTERISTICS

#### ELECTRICAL

Filament: Thoriated tungsten		
Voltage - - - - -	5.0	volts
Current - - - - -	10.5	amperes
Amplification Factor (Average) - - - - -	37	
Direct Interelectrode Capacitances (Average)		
Grid-Plate - - - - -	2.9	uuf
Grid-Filament - - - - -	5.0	uuf
Plate-Filament - - - - -	0.7	uuf
Transconductance ( $I_b=300$ ma., $E_b=3000$ , $e_c=-20$ )	6650	umhos
Frequency for Maximum Ratings - - - - -	40	mc.

#### MECHANICAL

Base - - - - -	4 pin, No. 5001B
Basing - - - - -	RMA type 2N
Maximum Overall Dimensions:	
Length - - - - -	10.125 inches
Diameter - - - - -	3.813 inches
Net weight - - - - -	12 ounces
Shipping weight (Average) - - - - -	2.25 pounds



### AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR

#### Class B

	TYPICAL OPERATION—2 TUBES			MAX. RATING	
D-C Plate Voltage - - - - -	1500	2000	3000	3000	volts
Max.-Signal D-C Plate Current, per tube* - -	•	•	•	350	ma.
Plate Dissipation, per tube* - - - - -	•	•	•	250	watts
D-C Grid Voltage (approx.) - - - - -	0	-30	-65		volts
Peak A-F Grid Input Voltage - - - - -	410	460	460		volts
Zero-Signal D-C Plate Current - - - - -	220	140	100		ma.
Max.-Signal D-C Plate Current - - - - -	700	700	560		ma.
Max.-Signal Driving Power (approx.) - - -	36	34	24		watts
Effective Load, Plate-to-Plate - - - - -	4300	6000	12250		ohms
Max.-Signal Plate Power Output - - - - -	650	900	1150		watts

\*Averaged over any sinusoidal audio frequency cycle.

### RADIO FREQUENCY POWER AMPLIFIER AND OSCILLATOR

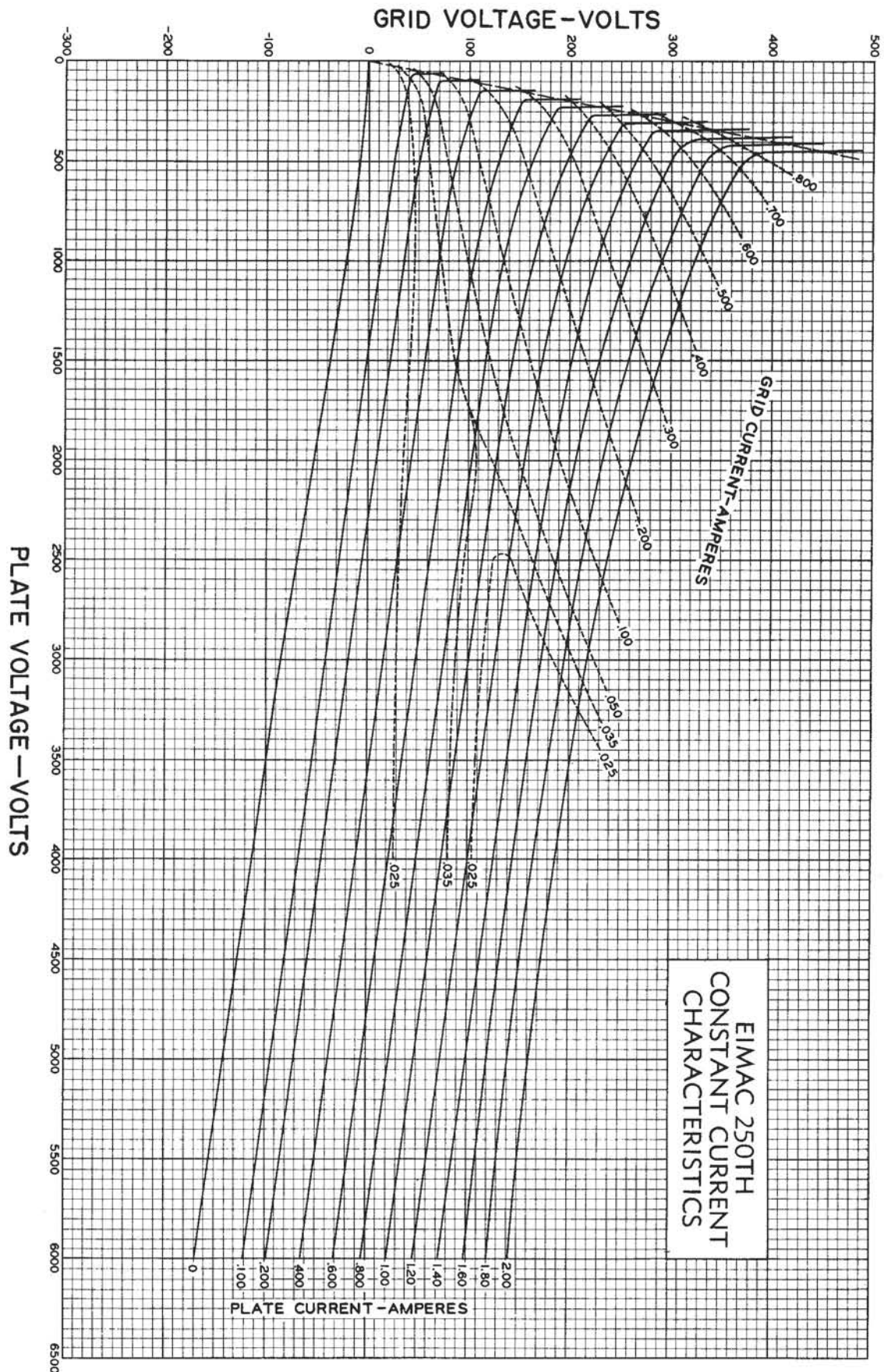
#### Class-C \*Telegraphy

(Key down conditions without modulation)

	TYPICAL OPERATION—1 TUBE			MAX. RATING	
D-C Plate Voltage - - - - -	2000	3000	4000	4000	volts
D-C Plate Current - - - - -	357	333	313	350	ma.
D-C Grid Current - - - - -	94	90	93	100	ma.
D-C Grid Voltage - - - - -	-100	-150	-220		volts
Plate Power Output - - - - -	464	750	1000		watts
Plate Input - - - - -	714	1000	1250		watts
Plate Dissipation - - - - -	250	250	250	250	watts
Peak R. F. Grid Input Voltage, (approx.) - -	345	395	470		volts
Driving Power, (approx.) - - - - -	29	32	39		watts

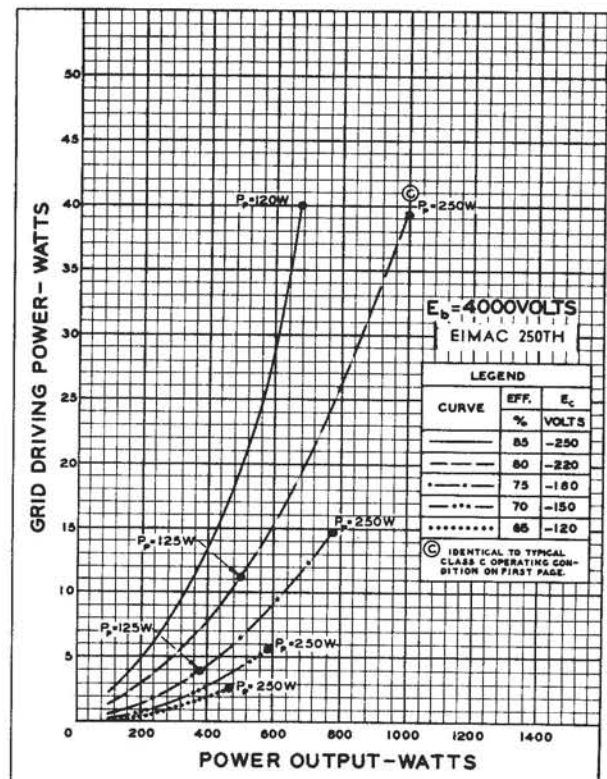
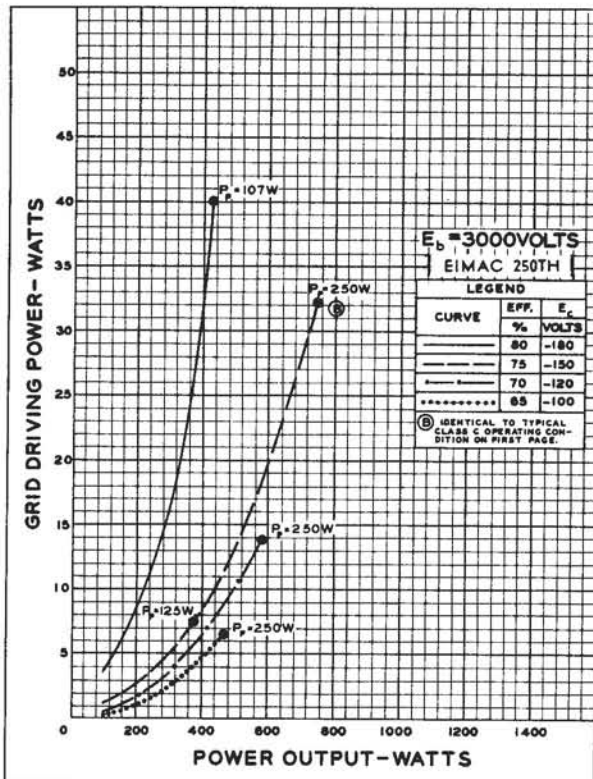
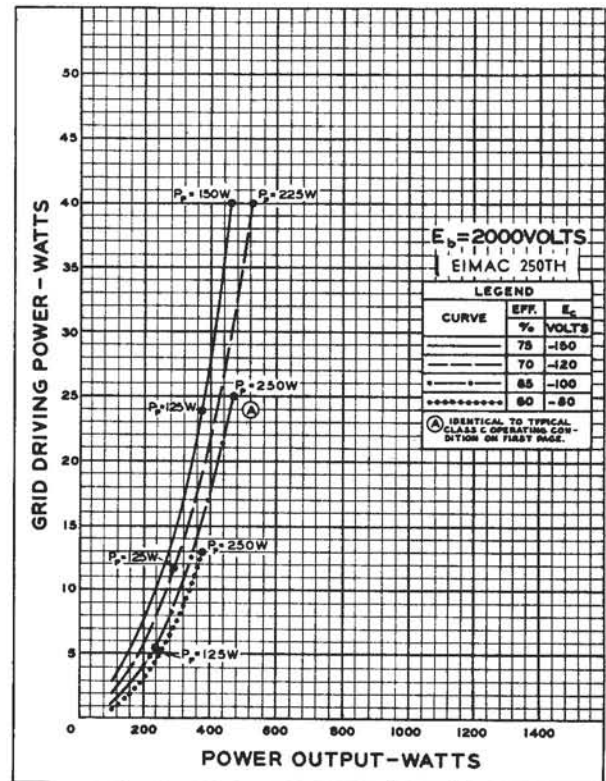
\*The above figures show actual measured tube performance, and do not allow for variations in circuit losses.

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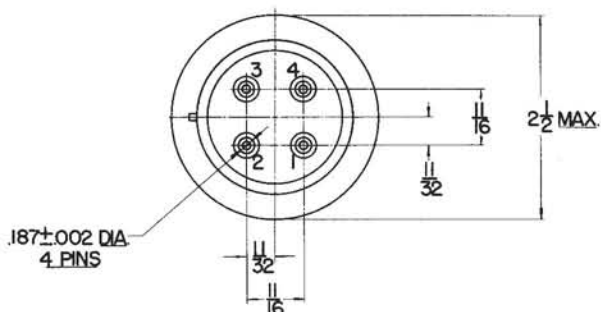
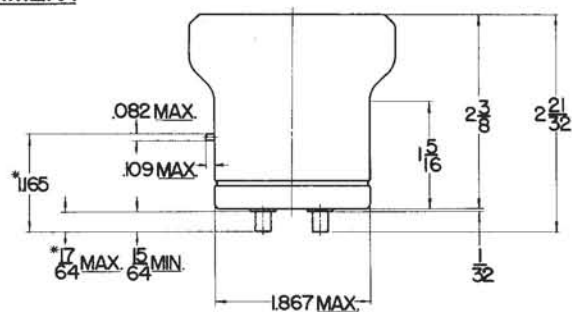
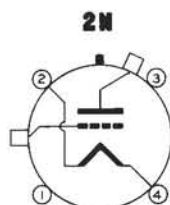
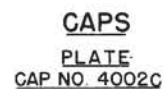


## DRIVING POWER vs. POWER OUTPUT

The three charts on this page show the relationship of plate efficiency, power output and grid driving power at plate voltages of 2000, 3000, and 4000 volts. These charts show combined grid and bias losses only. The driving power and power output figures do not include circuit losses. Points A, B, and C are identical to the typical Class C operating conditions shown on the first page under 2000, 3000, and 4000 volts respectively.







\*ON FINISHED TUBE ADD .060 FOR SOLDER.

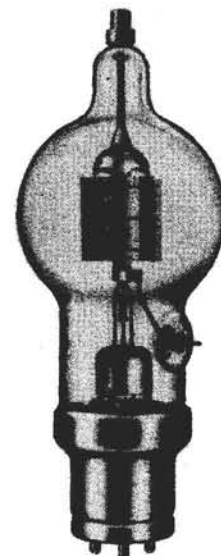
## GENERAL CHARACTERISTICS

### ELECTRICAL

Filament: Thoriated tungsten	
Voltage - - - - -	5.0 volts
Current - - - - -	10.5 amperes
Amplification Factor (Average) - - - - -	14
Direct Interelectrode Capacitances (Average)	
Grid-Plate - - - - -	3.1 $\mu\mu\text{f}$
Grid-Filament - - - - -	3.7 $\mu\mu\text{f}$
Plate-Filament - - - - -	0.7 $\mu\mu\text{f}$
Transconductance ( $I_b=350$ ma., $E_b=3000$ , $e_c=-130$ )	2650 $\mu\text{mhos}$
Frequency for Maximum Ratings - - - - -	40 mc

### MECHANICAL

Base - - - - -	4 pin, No. 500IB
Basing - - - - -	RMA type 2N
Maximum Overall Dimensions:	
Length - - - - -	10.125 inches
Diameter - - - - -	3.813 inches
Net weight - - - - -	12 ounces
Shipping weight (Average) - - - - -	2.25 pounds



## AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR

### Class B

	TYPICAL OPERATION—2 TUBES			MAX. RATING	
D-C Plate Voltage - - - - -	1500	2000	3000	3000	volts
Max.-Signal D-C Plate Current, per tube* - - - - -	•	•	•	350	ma.
Plate Dissipation, per tube* - - - - -	•	•	•	250	watts
D-C Grid Voltage (approx.) - - - - -	-40	-80	-175		volts
Peak A-F Grid Input Voltage - - - - -	770	800	840		volts
Zero-Signal D-C Plate Current - - - - -	200	150	100		ma.
Max.-Signal D-C Plate Current - - - - -	700	650	500		ma.
Max.-Signal Driving Power (approx.) - - - - -	32	28	17		watts
Effective Load, Plate-to-Plate - - - - -	3700	6150	13000		ohms
Max.-Signal Plate Power Output - - - - -	580	800	1000		watts

\*Averaged over any sinusoidal audio frequency cycle.

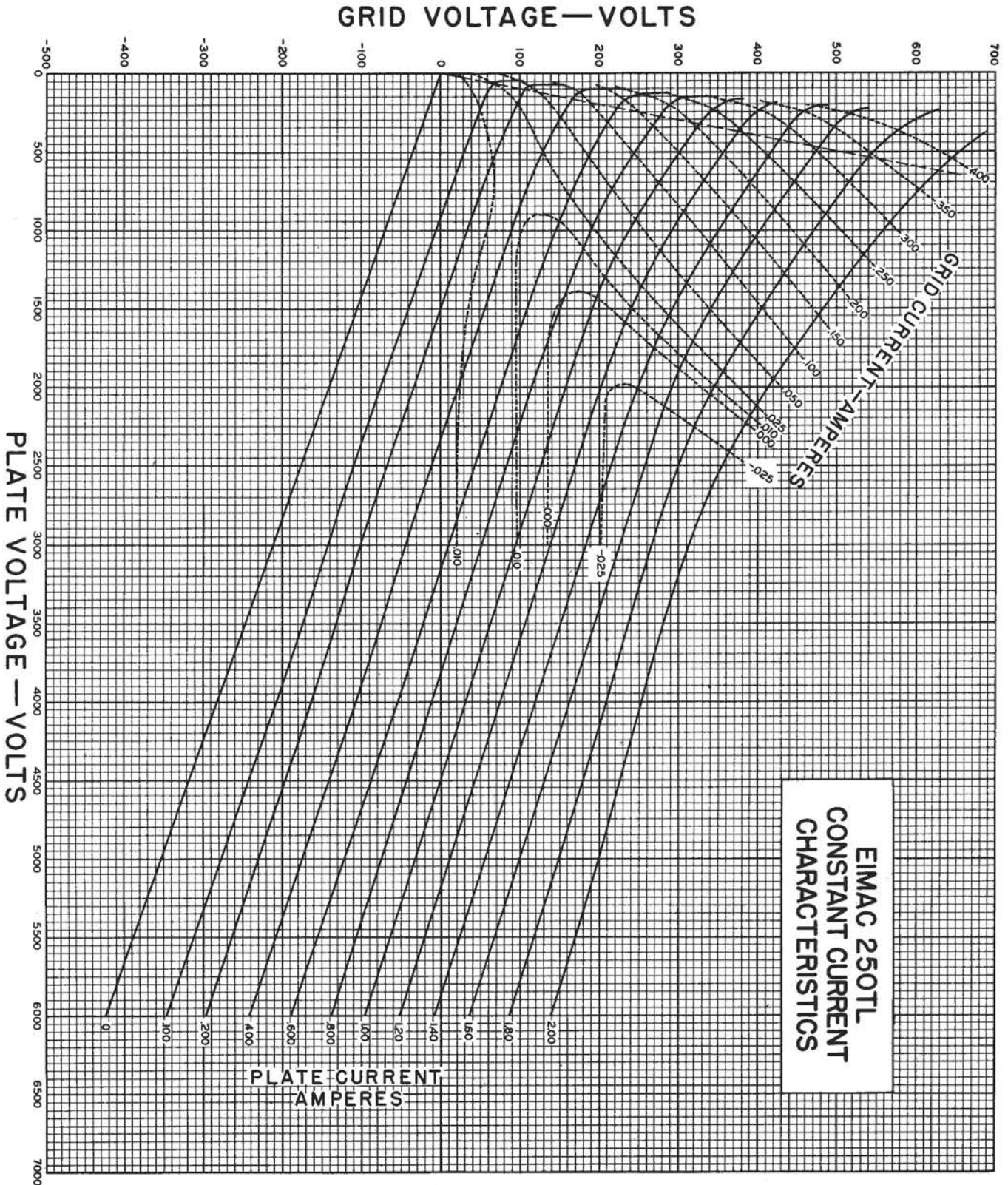
## RADIO FREQUENCY POWER AMPLIFIER AND OSCILLATOR

### Class-C \*Telegraphy

(Key down conditions without modulation)

	TYPICAL OPERATION—1 TUBE			MAX. RATING	
D-C Plate Voltage - - - - -	2000	3000	4000	4000	volts
D-C Plate Current - - - - -	350	335	310	350	ma.
D-C Grid Current - - - - -	45	45	40	50	ma.
D-C Grid Voltage - - - - -	-200	-350	-500		volts
Plate Power Output - - - - -	455	750	1000		watts
Plate Input - - - - -	700	1000	1250		watts
Plate Dissipation - - - - -	245	250	250	250	watts
Peak R. F. Grid Input Voltage, (approx.) - - - - -	575	720	900		volts
Driving Power, (approx.) - - - - -	22	29	33		watts

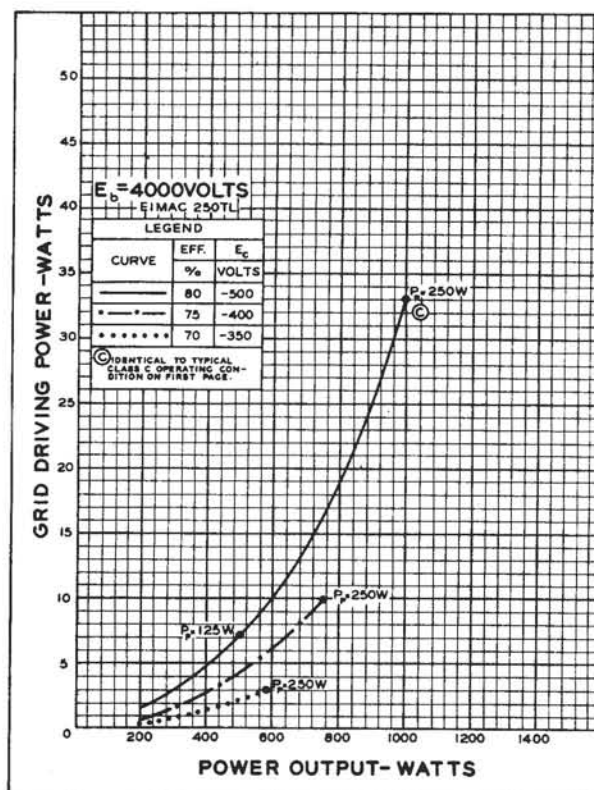
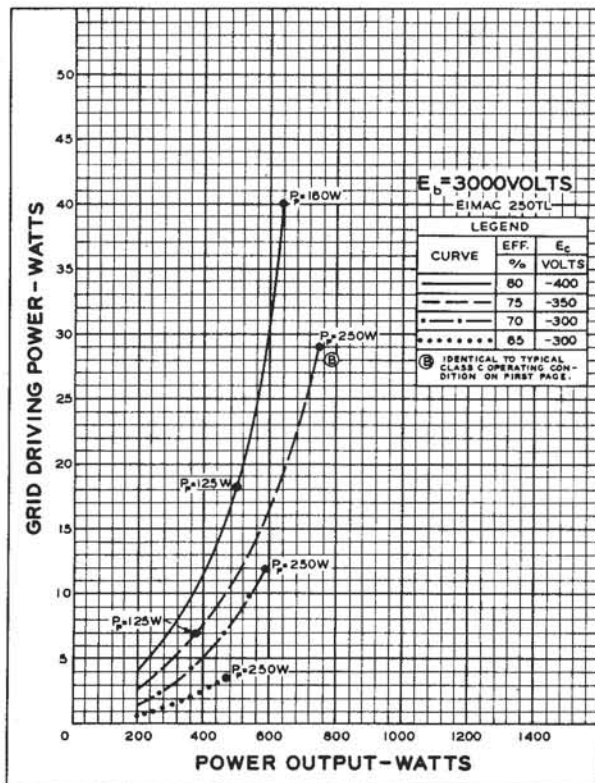
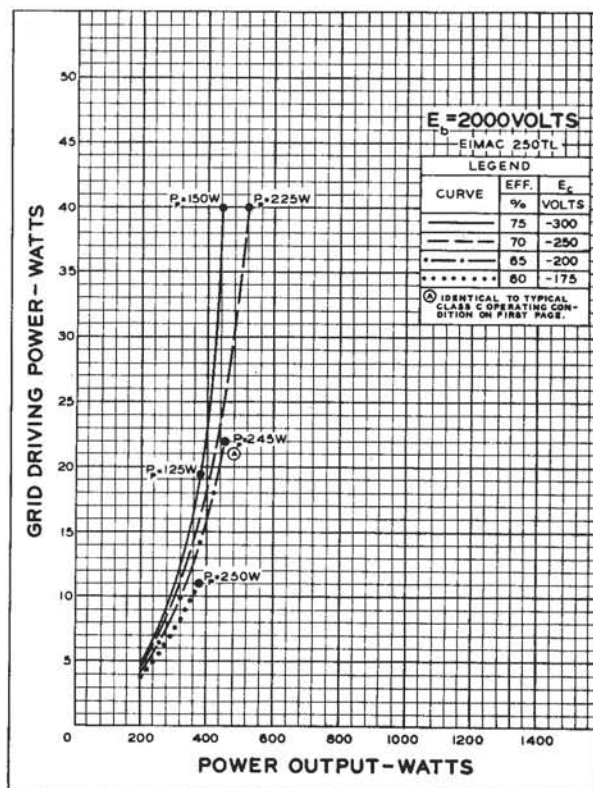
\*The above figures show actual measured tube performance, and do not allow for variations in circuit losses.

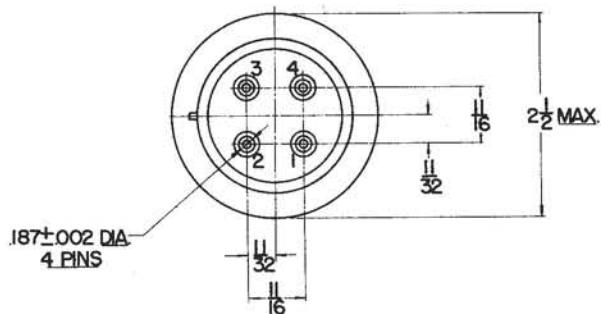
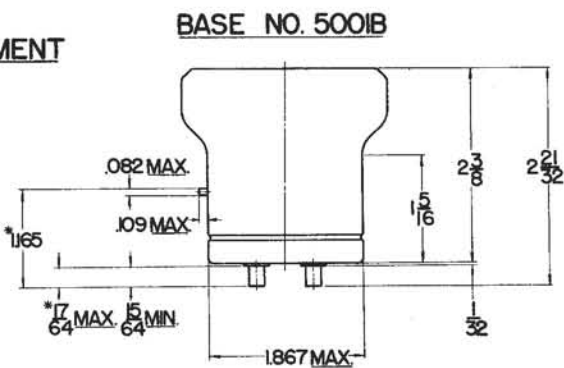
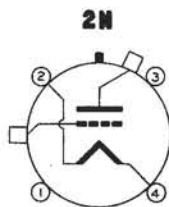
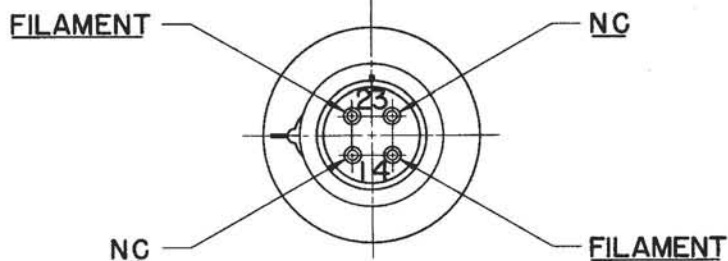
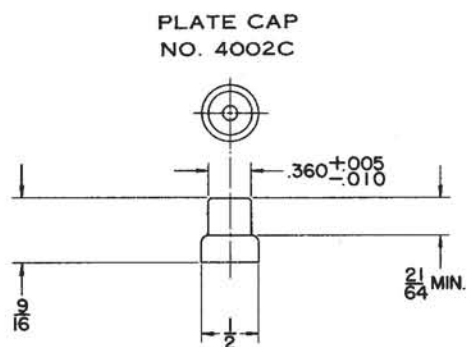
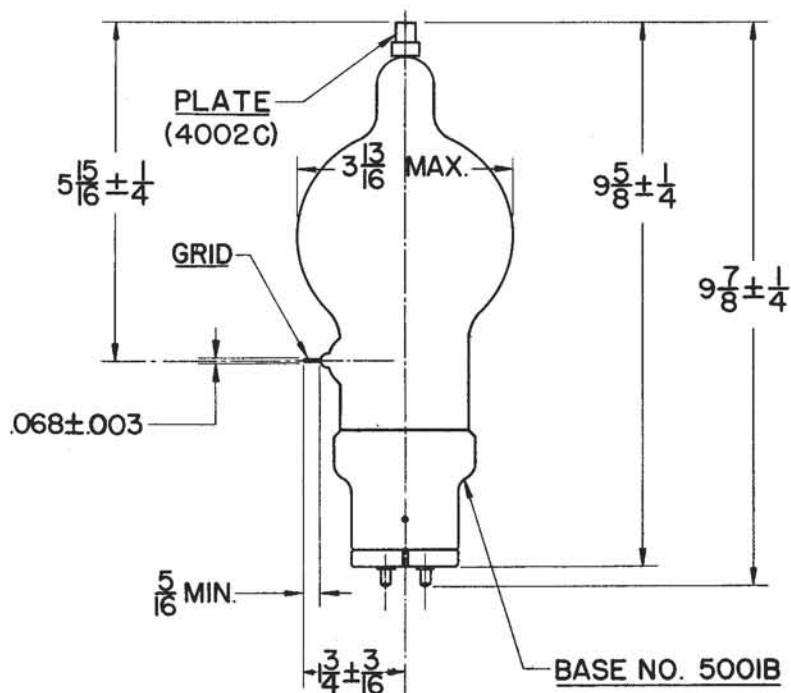


## DRIVING POWER vs. POWER OUTPUT

The three charts on this page show the relationship of plate efficiency, power output and grid driving power at plate voltages of 2000, 3000 and 4000 volts. These charts show combined grid and bias losses only. The driving power and power output figures do not include circuit losses. The plate dissipation in watts is indicated by  $P_p$ .

Points A, B, and C are identical to the typical Class C operating conditions shown on the first page under 2000, 3000, and 4000 volts respectively.





\*ON FINISHED TUBE ADD .060 FOR SOLDER



# EITEL-McCULLOUGH, INC.

SAN BRUNO, CALIFORNIA

## 304TH

MEDIUM-MU TRIODE  
MODULATOR  
OSCILLATOR  
AMPLIFIER

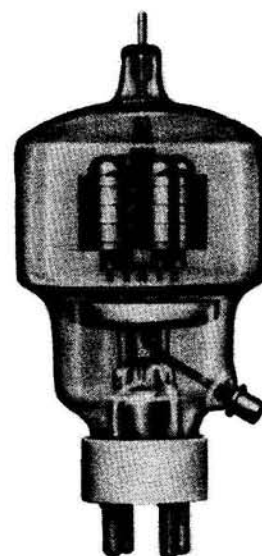
### GENERAL CHARACTERISTICS

#### ELECTRICAL

Filament: Thoriated tungsten	
Voltage - - - - -	5.0 or 10.0 volts
Current - - - - -	25.0 or 12.5 amperes
Amplification Factor (Average) - - - - -	20
Direct Interelectrode Capacitances (Average)	
Grid-Plate - - - - -	10.2 $\mu\mu\text{f}$
Grid-Filament - - - - -	13.5 $\mu\mu\text{f}$
Plate-Filament - - - - -	0.7 $\mu\mu\text{f}$
Transconductance ( $I_b=1.0$ amp., $E_b=3000$ , $e_c=-40$ )	16,700 $\mu\text{mhos}$
Frequency for Maximum Ratings - - - - -	40 mc

#### MECHANICAL

Base - - - - -	Special 4 pin, No. 5000B
Basing - - - - -	RMA type 4BC
Maximum Overall Dimensions:	
Length - - - - -	7.625 inches
Diameter - - - - -	3.563 inches
Net weight - - - - -	12 ounces
Shipping weight (Average) - - - - -	3.0 pounds



### AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR

#### Class B

	TYPICAL OPERATION—2 TUBES			MAX. RATING	
D-C Plate Voltage - - - - -	1500	2000	3000	3000	volts
Max.-Signal D-C Plate Current, per tube* - - -	•	•	•	900	ma.
Plate Dissipation, per tube* - - - - -	•	•	•	300	watts
D-C Grid Voltage (approx.) - - - - -	-65	-90	-150		volts
Peak A-F Grid Input Voltage - - - - -	330	350	420		volts
Zero-Signal D-C Plate Current - - - - -	267	200	134		ma.
Max.-Signal D-C Plate Current - - - - -	1066	900	667		ma.
Max.-Signal Driving Power (approx.) - - - - -	17	12	6		watts
Effective Load, Plate-to-Plate - - - - -	2840	4820	10200		ohms
Max.-Signal Plate Power Output - - - - -	1000	1200	1400		watts

\*Averaged over any sinusoidal audio frequency cycle.

### RADIO FREQUENCY POWER AMPLIFIER AND OSCILLATOR

#### Class-C \*Telegraphy

(Key down conditions without modulation)

	TYPICAL OPERATION—1 TUBE			MAX. RATING	
D-C Plate Voltage - - - - -	1500	2000	3000	3000	volts
D-C Plate Current - - - - -	667	600	500	900	ma.
D-C Grid Current - - - - -	115	125	135	170	ma.
D-C Grid Voltage - - - - -	-125	-200	-300		volts
Plate Power Output - - - - -	700	900	1200		watts
Plate Input - - - - -	1000	1200	1500		watts
Plate Dissipation - - - - -	300	300	300	300	watts
Peak R. F. Grid Input Voltage, (approx.) - - -	250	325	395		volts
Driving Power, (approx.) - - - - -	25	39	53		watts

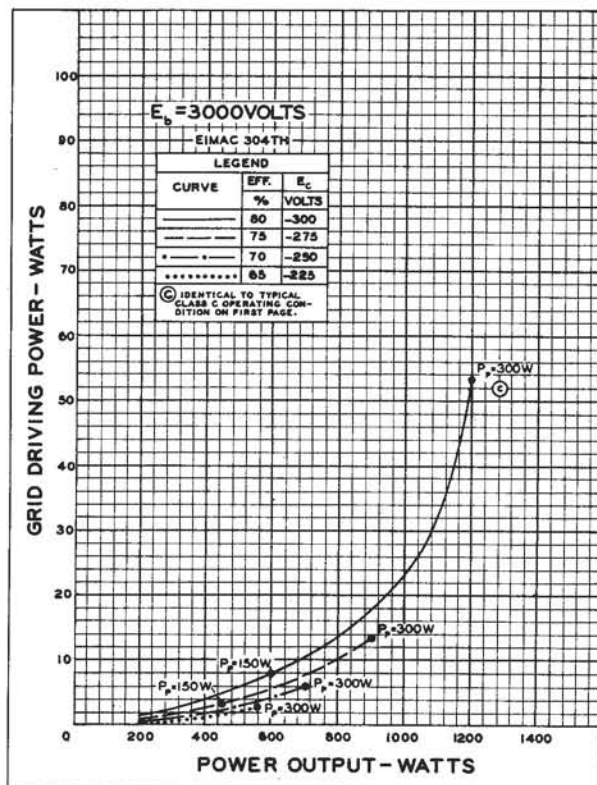
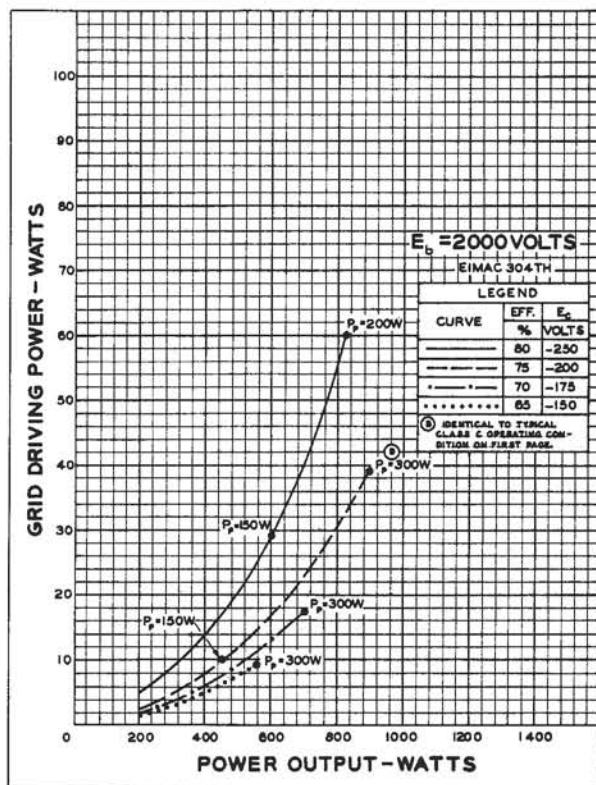
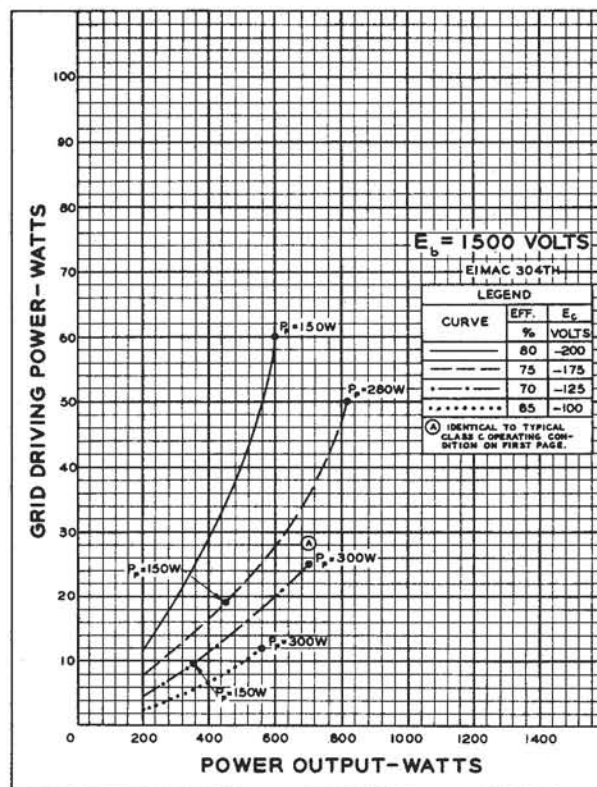
\*The above figures show actual measured tube performance, and do not allow for variations in circuit losses.



## DRIVING POWER vs. POWER OUTPUT

The three charts on this page show the relationship of plate efficiency, power output and grid driving power at plate voltages of 1500, 2000 and 3000 volts. These charts show combined grid and bias losses only. The driving power and power output figures do not include circuit losses. The plate dissipation in watts is indicated by  $P_p$ .

Points A, B, and C are identical to the typical Class C operating conditions shown on the first page under 1500, 2000, and 3000 volts respectively.



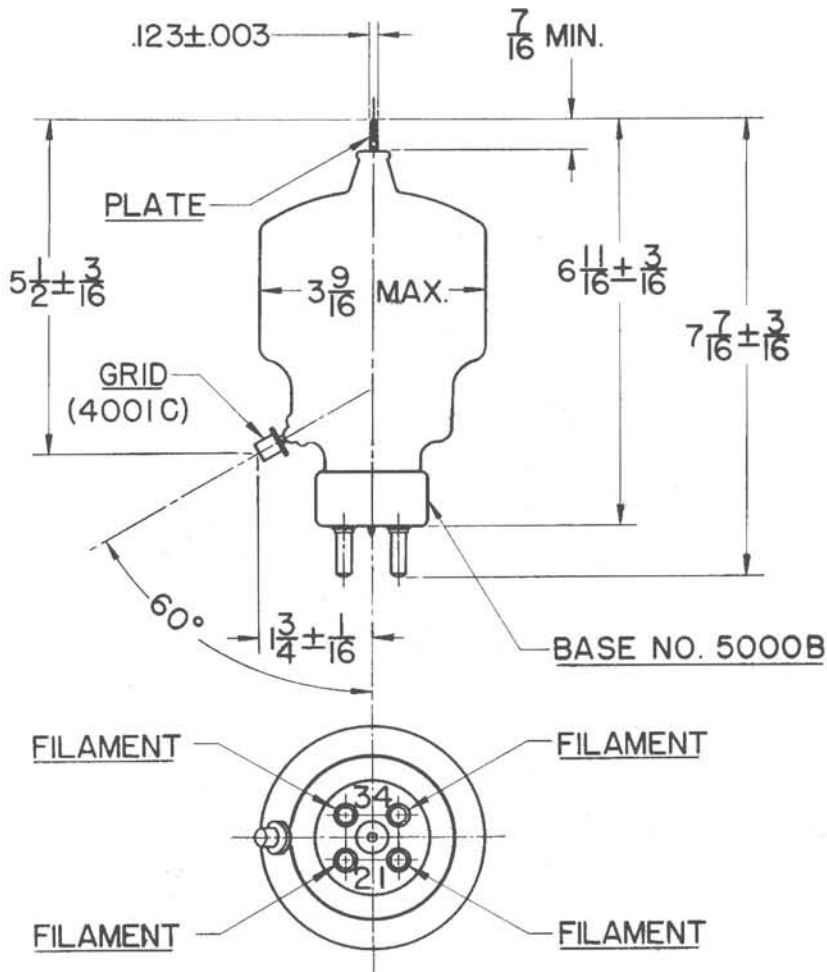
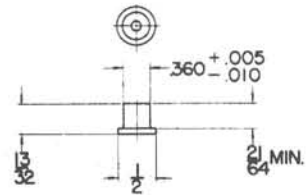
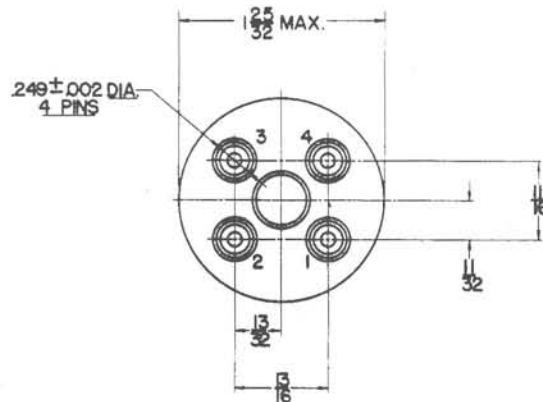
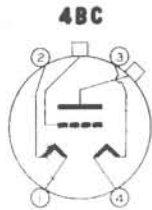
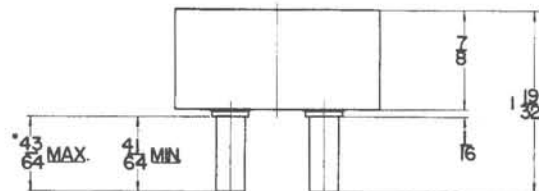


PLATE CAP  
 (SEE TUBE OUTLINE DRAWING)

GRID CAP  
 NO. 4001C



BASE NO. 5000B



\*ON FINISHED TUBE ADD .060 FOR SOLDER

# Eitel-McCullough, Inc.

SAN BRUNO, CALIFORNIA

## 304TL

LOW-MU TRIODE

MODULATOR

OSCILLATOR

AMPLIFIER

### GENERAL CHARACTERISTICS

#### ELECTRICAL

Filament: Thoriated tungsten	
Voltage - - - - -	5.0 or 10.0 volts
Current - - - - -	25.0 or 12.5 amperes
Amplification Factor (Average) - - - - -	12
Direct Interelectrode Capacitances (Average)	
Grid-Plate - - - - -	9.1 uuf
Grid-Filament - - - - -	8.5 uuf
Plate-Filament - - - - -	0.6 uuf
Transconductance ( $I_b=1.0$ amp., $E_b=3000$ , $e_c=-200$ )	16,700 umhos
Frequency for Maximum Ratings - - - - -	40 mc.

#### MECHANICAL

Base - - - - -	Special 4 pin, No. 5000B
Basing - - - - -	RMA type 4BC
Maximum Overall Dimensions:	
Length - - - - -	7.625 inches
Diameter - - - - -	3.563 inches
Net weight - - - - -	12 ounces
Shipping weight (Average) - - - - -	3.0 pounds



### AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR

#### Class B

	ZERO GRID CURRENT OPERATION—2 TUBES			TYPICAL OPERATION 2 TUBES			MAX. RATING	
D-C Plate Voltage - - - - -	1500	2000	3000	1500	2000	3000	3000	volts
Max.-Sig. D-C Plate Current, per tube*	•	•	•	•	•	•	900	ma.
Plate Dissipation, per tube* - - -	•	•	•	•	•	•	300	watts
D-C Grid Voltage (approx.) - - -	-105	-160	-260	-105	-160	-260		volts
Peak A-F Grid Input Voltage - - -	210	320	520	500	580	650		volts
Zero-Signal D-C Plate Current - - -	270	200	130	270	200	130		ma.
Max.-Signal D-C Plate Current - - -	572	546	444	1140	1000	667		ma.
Max.-Signal Driving Power (approx.)	0	0	0	30	25	6		watts
Effective Load, Plate-to-Plate - - -	2540	5300	12000	2750	4500	10200		ohms
Max.-Signal Plate Power Output - - -	256	490	730	1100	1400	1400		watts

\*Averaged over any sinusoidal audio frequency cycle.

### RADIO FREQUENCY POWER AMPLIFIER AND OSCILLATOR

#### Class-C \*Telegraphy

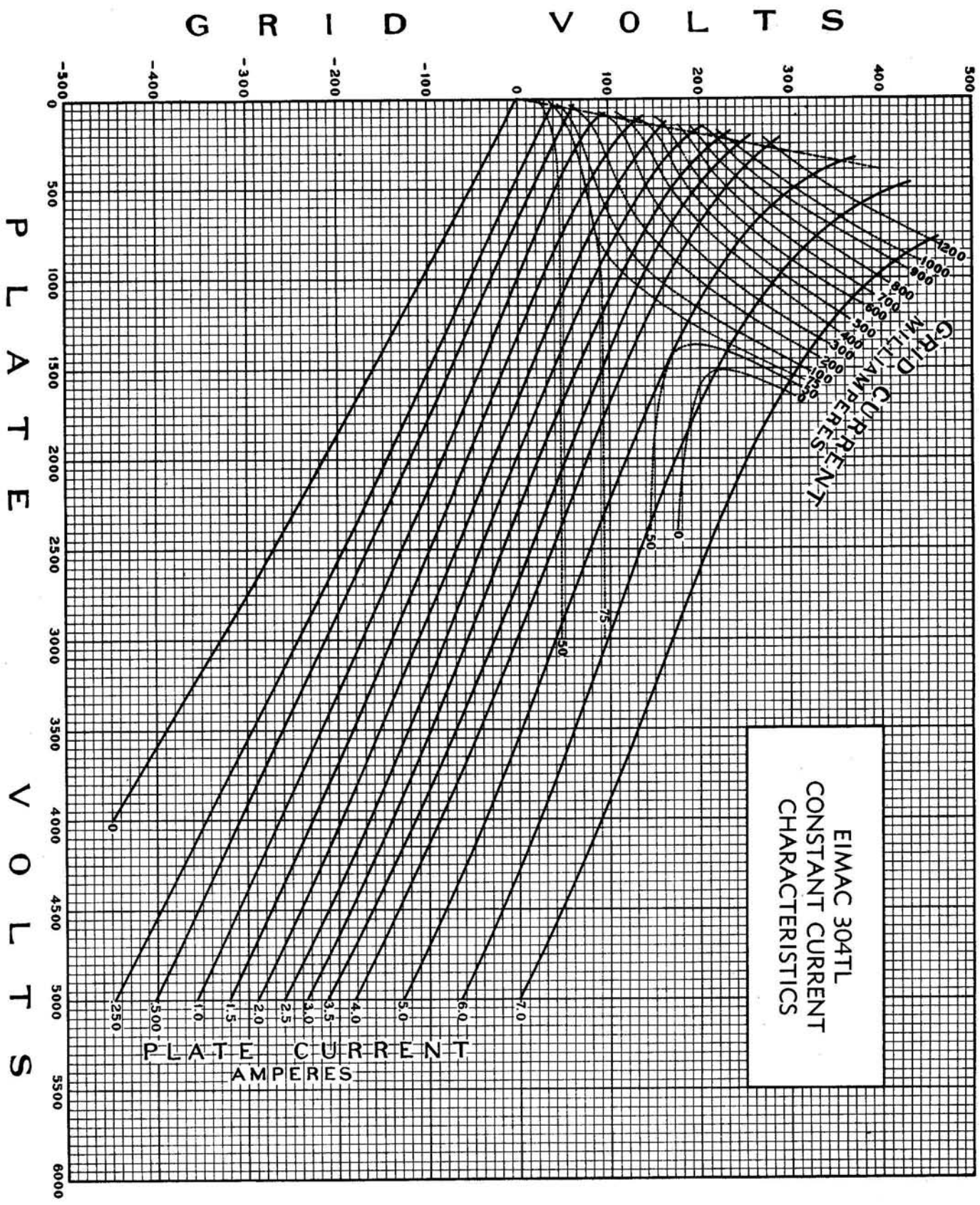
(Key down conditions without modulation)

	TYPICAL OPERATION—1 TUBE			MAX. RATING	
D-C Plate Voltage - - - - -	1500	2000	3000	3000	volts
D-C Plate Current - - - - -	665	600	500	900	ma.
D-C Grid Current - - - - -	90	85	80	150	ma.
D-C Grid Voltage - - - - -	-250	-300	-400		volts
Plate Power Output - - - - -	700	900	1200		watts
Plate Input - - - - -	1000	1200	1500		watts
Plate Dissipation - - - - -	300	300	300	300	watts
Peak R. F. Grid Input Voltage, (approx.) - - -	430	480	575		volts
Driving Power, (approx.) - - - - -	33	36	40		watts

\*The above figures show actual measured tube performance, and do not allow for variations in circuit losses.

(Effective 1-1-44) Copyright, 1946 by Eitel-McCullough, Inc.

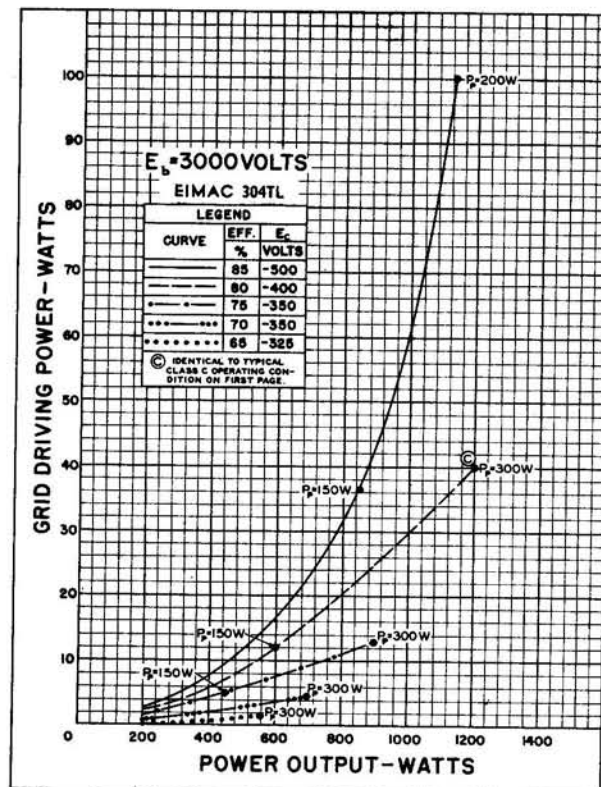
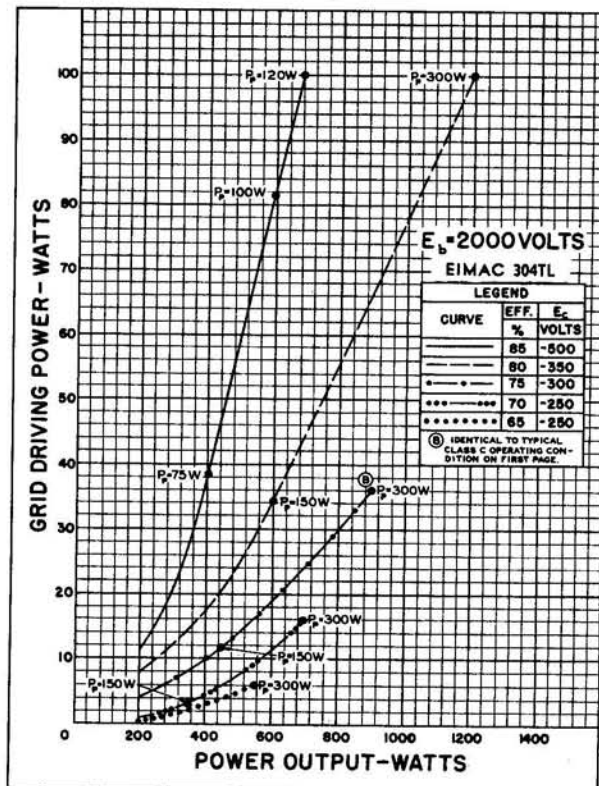
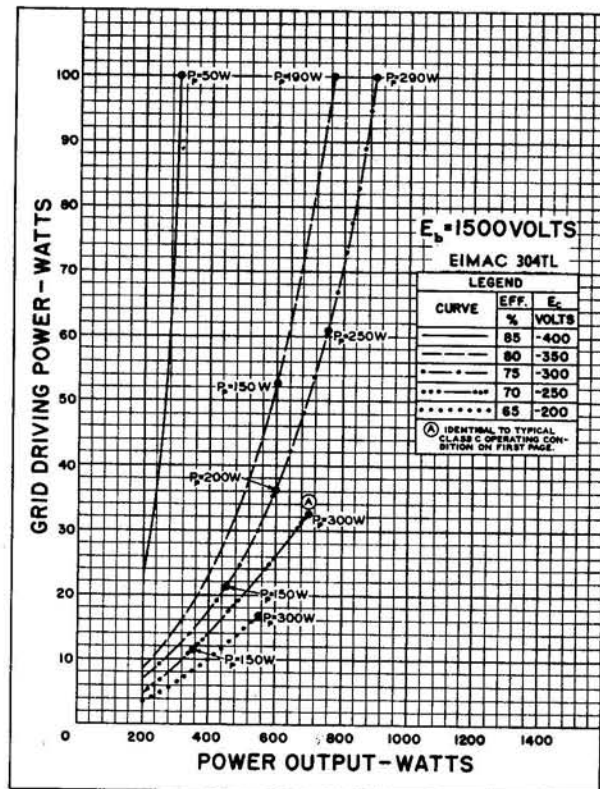




## DRIVING POWER vs. POWER OUTPUT

The three charts on this page show the relationship of plate efficiency, power output and grid driving power at plate voltages of 1500, 2000 and 3000 volts. These charts show combined grid and bias losses only. The driving power and power output figures do not include circuit losses. The plate dissipation in watts is indicated by  $P_p$ .

Points A, B, and C are identical to the typical Class C operating conditions shown on the first page under 1500, 2000, and 3000 volts respectively.



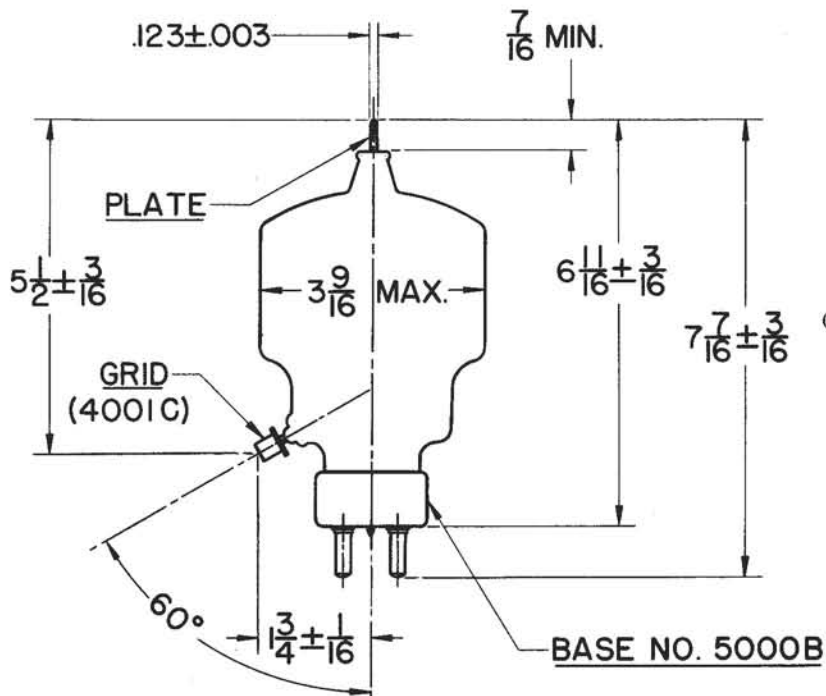
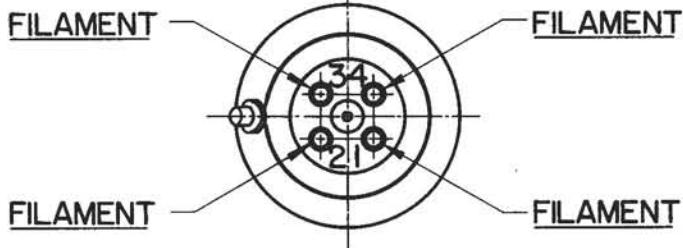
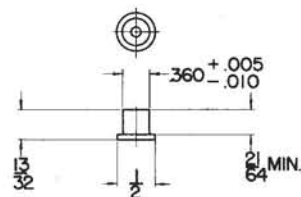
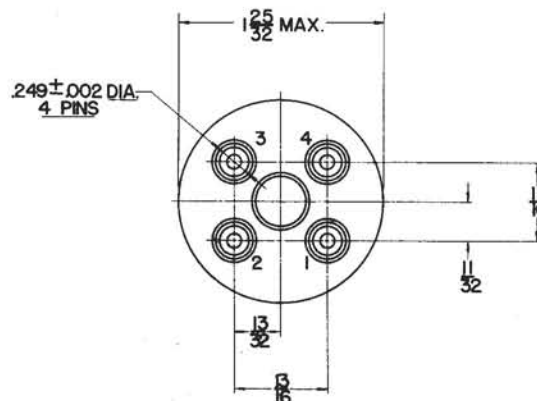
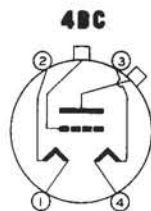
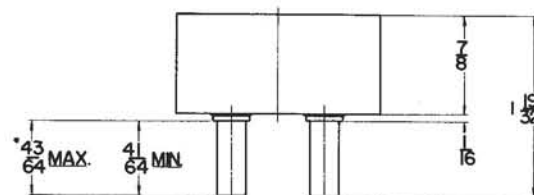


PLATE CAP  
(SEE TUBE OUTLINE DRAWING)

GRID CAP  
NO. 4001C



BASE NO. 5000B



\*ON FINISHED TUBE ADD .060 FOR SOLDER

# Eitel-McCULLOUGH, Inc.

SAN BRUNO, CALIFORNIA

## 450TH

HIGH-MU TRIODE  
MODULATOR  
OSCILLATOR  
AMPLIFIER

The Eimac 450TH is a high-mu power triode having a maximum plate dissipation rating of 450 watts, and is intended for use as an amplifier, oscillator and modulator. It can be used at its maximum ratings at frequencies as high as 40 Mc.

Cooling of the 450TH is accomplished by radiation from the plate, which exhibits a red-orange color at maximum dissipation, and by means of air circulation around the envelope.

### GENERAL CHARACTERISTICS

#### ELECTRICAL

Filament: Thoriated tungsten	
Voltage - - - - -	7.5 volts
Current - - - - -	12.0 amperes
Amplification Factor (Average) - - - - -	38
Direct Interelectrode Capacitances (Average)	
Grid-plate - - - - -	5.0 $\mu\text{mfd.}$
Grid-Filament - - - - -	8.8 $\mu\text{mfd.}$
Plate-Filament - - - - -	0.8 $\mu\text{mfd.}$
Tranconductance ( $I_b=500 \text{ ma.}$ , $E_b=4000 \text{ v.}$ ) - - - - -	6650 $\mu\text{mhos}$

#### MECHANICAL

Base - - - - -	Special 4-pin, No. 5002B
Basing - - - - -	RMA type 4AQ
Cooling - - - - -	Radiation and air circulation
Maximum Overall Dimensions:	
Length - - - - -	12.625 inches
Diameter - - - - -	5.125 inches
Net Weight - - - - -	1 pound
Shipping Weight (Average) - - - - -	4 pounds

#### RADIO FREQUENCY POWER AMPLIFIER AND OSCILLATOR

Class-C Telephony (Key-down conditions, 1 tube)

MAXIMUM RATINGS (Frequencies below 40 Mc.)

D-C PLATE VOLTAGE - - - - -	6000 MAX. VOLTS
D-C PLATE CURRENT - - - - -	600 MAX. MA.
PLATE DISSIPATION - - - - -	450 MAX. WATTS
GRID DISSIPATION - - - - -	65 MAX. WATTS

TYPICAL OPERATION (Frequencies below 40 Mc.)

D-C Plate Voltage - - - - -	3000	4000	5000	volts
D-C Grid Voltage - - - - -	-175	-200	-300	volts
D-C Plate Current - - - - -	500	450	450	ma.
D-C Grid Current - - - - -	95	85	90	ma.
Grid Dissipation - - - - -	18.4	18	19	watts
Peak R-F Grid Input Voltage (approx.) - - - - -	400	410	570	volts
Driving Power (approx.) - - - - -	35	35	46	watts
Plate Power Input - - - - -	1500	1800	2250	watts
Plate Dissipation - - - - -	450	450	450	watts
Plate Power Output - - - - -	1050	1350	1800	watts

#### AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR

Class-B (Sinusoidal wave, two tubes unless otherwise specified)

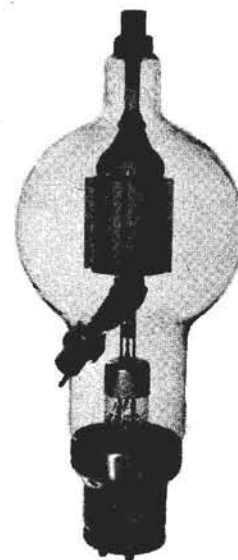
MAXIMUM RATINGS

D-C PLATE VOLTAGE - - - - -	6000 MAX. VOLTS
MAX-SIGNAL D-C PLATE CURRENT, PER TUBE - - - - -	600 MAX. MA.
PLATE DISSIPATION, PER TUBE - - - - -	450 MAX. WATTS
GRID DISSIPATION, PER TUBE - - - - -	65 MAX. WATTS

TYPICAL OPERATION

D-C Grid Voltage (approx.) - - - - -	-50	-85	-115	volts
D-C Plate Voltage - - - - -	3000	4000	5000	volts
Zero-Signal D-C Plate Current - - - - -	200	150	120	ma.
Max-Signal D-C Plate Current - - - - -	770	675	620	ma.
Effective Load, Plate-to-Plate - - - - -	7800	12,800	18,600	ohms
Peak A-F Grid Input Voltage (per tube) - - - - -	225	235	267	volts
Max-Signal Avg. Driving Power (approx.) - - - - -	17	14	10	watts
Max-Signal Peak Driving Power (approx.) - - - - -	40	34	40	watts
Max-Signal Plate Dissipation (per tube) - - - - -	450	450	450	watts
Max-Signal Plate Power Output - - - - -	1400	1800	2200	watts

IF IT IS DESIRED TO OPERATE THIS TUBE UNDER CONDITIONS WIDELY DIFFERENT THAN THOSE GIVEN UNDER "TYPICAL OPERATION," AND WHICH POSSIBLY EXCEED MAXIMUM RATINGS, WRITE EITEL-McCULLOUGH, INC., FOR INFORMATION AND RECOMMENDATIONS.





## APPLICATION

### MECHANICAL

**Mounting**—The 450TH must be mounted vertically, base up or base down. Flexible connecting straps should be provided from the grid and plate terminals to the external grid and plate circuits. The tube must be protected from severe vibration and shock.

**Cooling**—Provision should be made for ample circulation of air around the 450TH. In the event that the design of the equipment restricts natural circulation, the use of a small fan or centrifugal blower to provide additional cooling for the tube will aid in obtaining maximum tube life. Special heat-dissipating connectors (Eimac HR-8) are available for use on the plate and grid terminals. These connectors help to prolong tube life by reducing the temperature of the seals.

The grid terminal of the 450TH is now .560" in diameter. To accommodate existing equipment designed for the older style 450TH having .098" diameter grid terminals, an adapter pin is provided with the newer tubes. This adapter pin is threaded so that it may be removed from the grid terminal of the tube. The small grid terminal requires an HR-4 heat-dissipating connector.

### ELECTRICAL

**Filament Voltage**—For maximum tube life the filament voltage, as measured directly at the filament pins, should be the rated value of 7.5 volts. Unavoidable variations in filament voltage must be kept within the range from 7.03 to 7.88 volts.

**Bias Voltage**—Although there is no maximum limit on the bias voltage which may be used on the 450TH, there is little advantage in using bias voltages in excess of those given under "Typical Operation," except in certain very specialized applications. Where bias is obtained by a grid leak, suitable protective means must be provided to

prevent excessive plate dissipation in the event of loss of excitation.

**Grid Dissipation**—The power dissipated by the grid of the 450TH must not exceed 80 watts. Grid dissipation may be calculated from the following expression:

$$P_g = e_{cmp} I_c$$

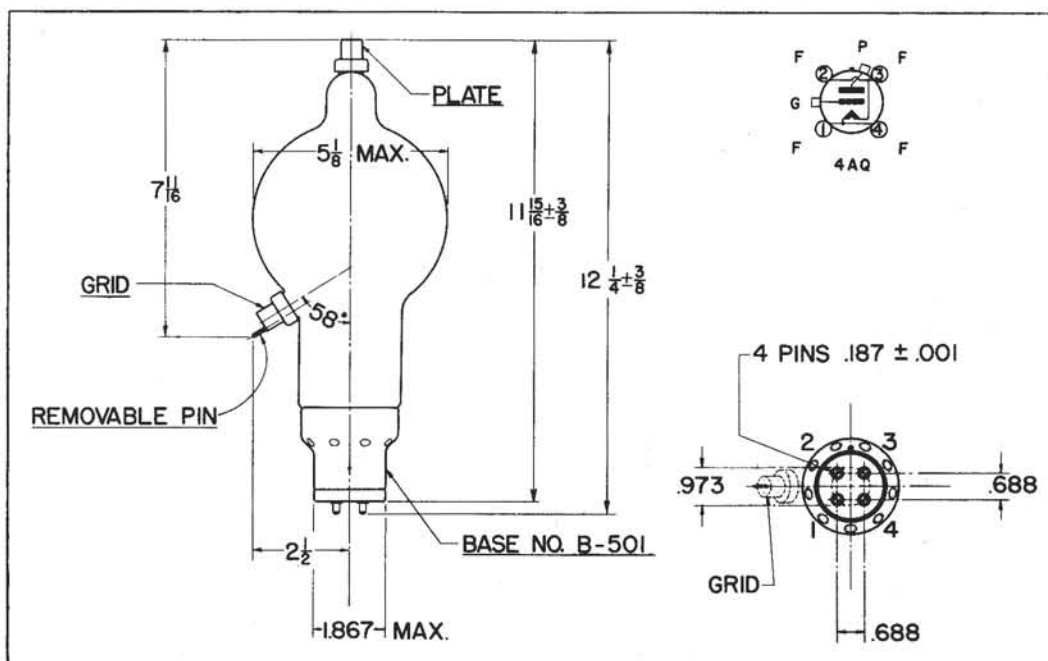
where  $P_g$  = Grid dissipation,  
 $e_{cmp}$  = Peak positive grid voltage, and  
 $I_c$  = D-c grid current.

$e_{cmp}$  may be measured by means of a suitable peak voltmeter connected between filament and grid.<sup>1</sup> In equipment in which the plate loading varies widely, such as oscillators used for radio-frequency heating, care should be taken to make certain that the grid dissipation does not exceed the maximum rating under any conditions of loading.

**Plate Voltage**—Except in very special applications, the plate supply voltage for the 450TH should not exceed 6000 volts. In most cases there is little advantage in using plate-supply voltages higher than those given under "Typical Operation" for the power output desired.

**Plate Dissipation**—Under normal operating conditions, the power dissipated by the plate of the 450TH should not be allowed to exceed 450 watts. At this dissipation the brightness temperature of the plate will appear a red-orange in color. The value of this color is somewhat affected by light from the filament as well as from external sources. Plate dissipation in excess of the maximum rating is permissible for short periods of time, such as during tuning procedures.

<sup>1</sup> For suitable peak v.t.v.m. circuits see, for instance, "Vacuum Tube Ratings," Eimac News, January, 1945. This article is available in reprint form on request.

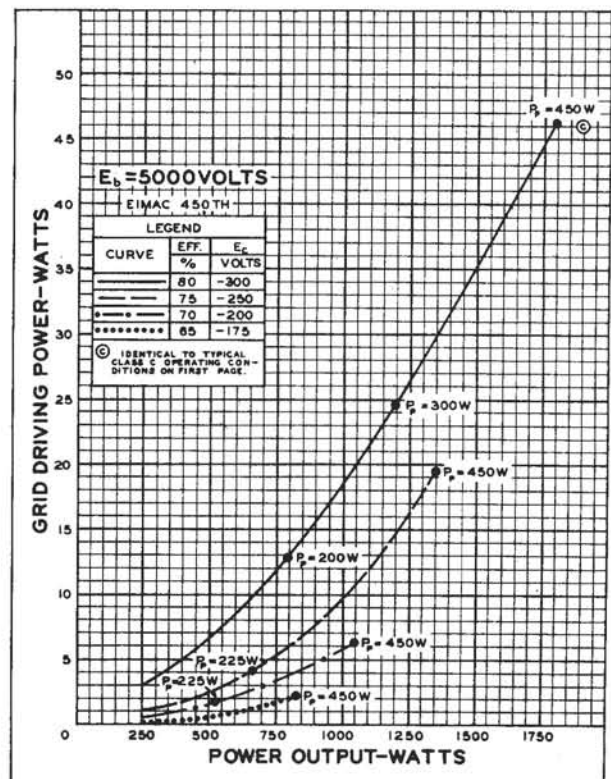
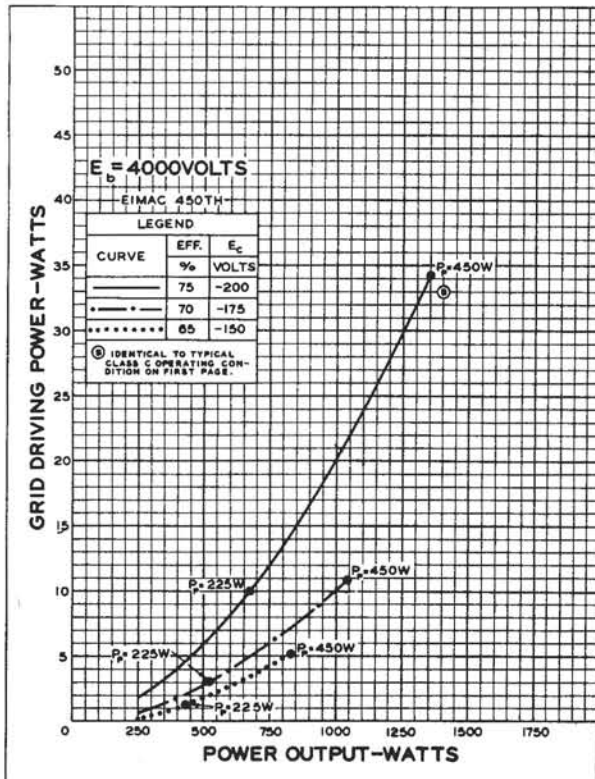
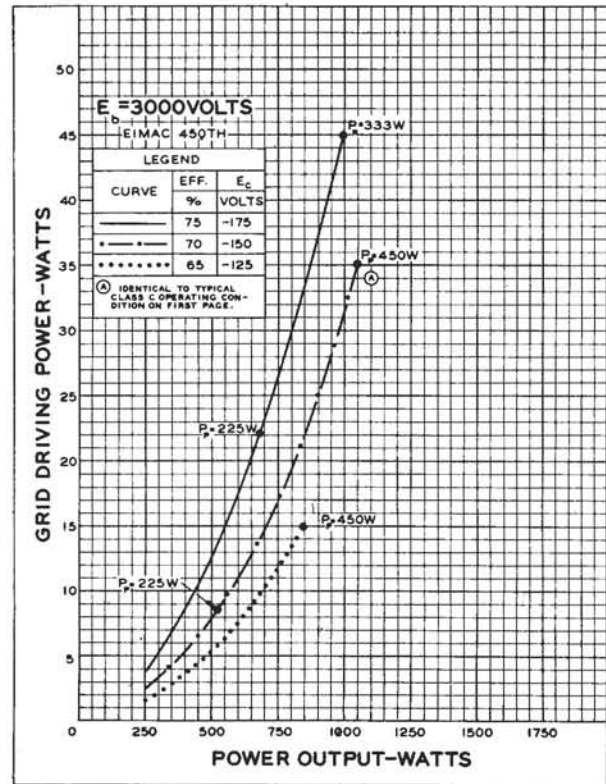


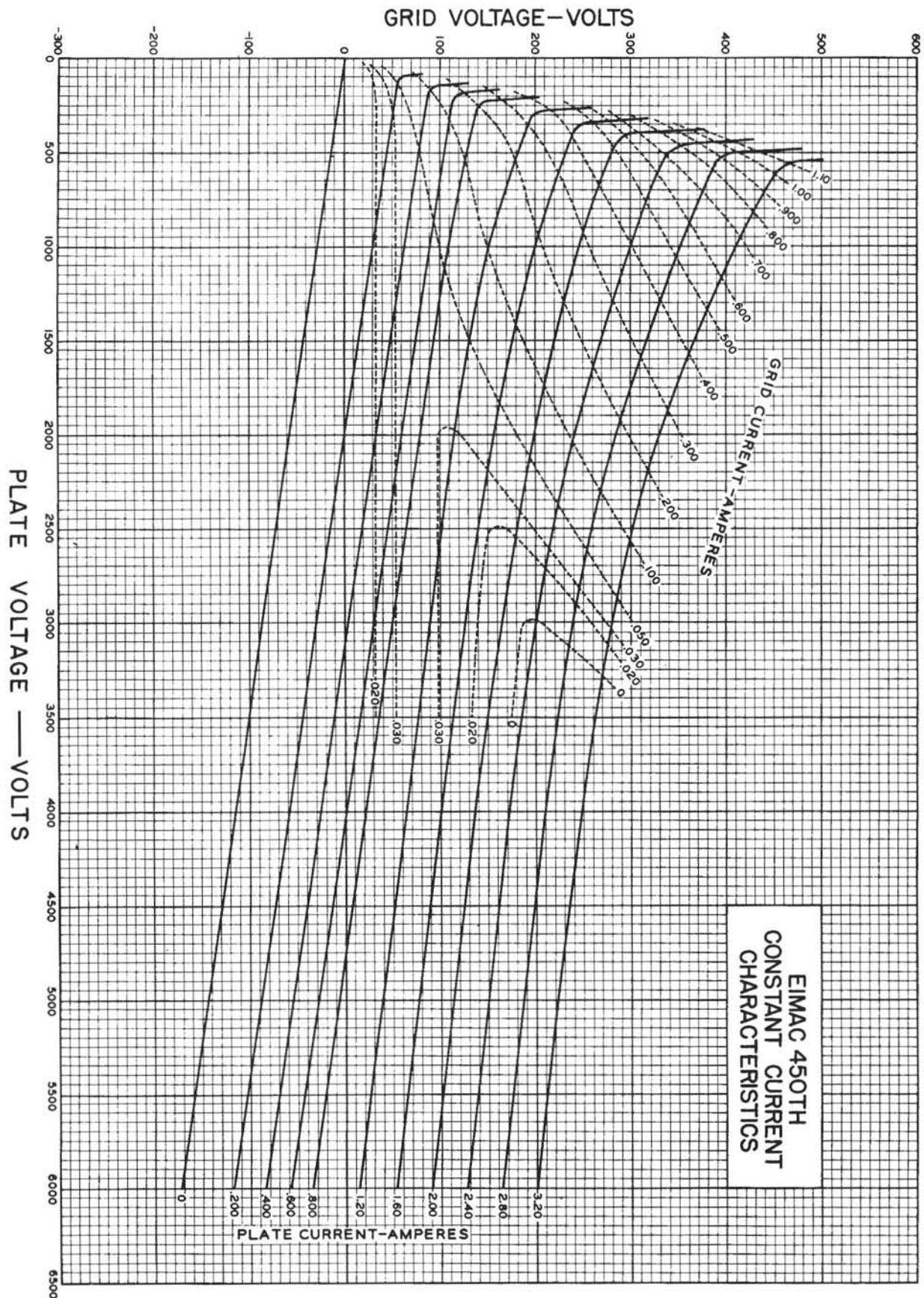


## DRIVING POWER vs. POWER OUTPUT

The three charts on this page show the relationship of plate efficiency, power output and grid driving power at plate voltages of 3000, 4000, and 5000 volts. These charts show combined grid and bias losses only. The driving power and power output figures do not include circuit losses. The plate dissipation in watts is indicated by  $P_p$ .

Points A, B, and C are identical to the typical Class C operating conditions shown on the first page under 3000, 4000, and 5000 volts respectively.





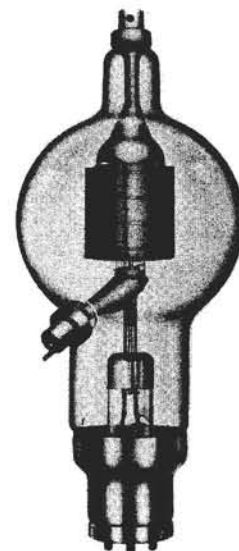
## GENERAL CHARACTERISTICS

### ELECTRICAL

Filament: Thoriated tungsten	
Voltage - - - - -	7.5 volts
Current - - - - -	12.0 amperes
Amplification Factor (Average) - - - - -	18
Direct Interelectrode Capacitances (Average)	
Grid-Plate - - - - -	5.2 $\mu\mu\text{f}$
Grid-Filament - - - - -	7.3 $\mu\mu\text{f}$
Plate-Filament - - - - -	0.9 $\mu\mu\text{f}$
Transconductance ( $I_b=500$ ma., $E_b=4000$ , $e_c=-75$ ) - -	6060 $\mu\text{mhos}$

### MECHANICAL

Base - - - - -	4 pin, No. 5002B
Basing - - - - -	RMA type 4AQ
Maximum Overall Dimensions:	
Length - - - - -	12.625 inches
Diameter - - - - -	5.125 inches
Net weight - - - - -	1 pound
Shipping weight (Average) - - - - -	4 pounds



### AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR Class B

	TYPICAL OPERATION—2 TUBES			MAX. RATING	
D-C Plate Voltage - - - - -	3000	4000	5000	6000	volts
Max.-Signal D-C Plate Current, per tube* - -	•	•	•	600	ma.
Plate Dissipation, per tube* - - - - -	•	•	•	450	watts
D-C Grid Voltage (approx.) - - - - -	-110	-175	-240		volts
Peak A-F Grid Input Voltage - - - - -	650	740	860		volts
Zero-Signal D-C Plate Current - - - - -	200	150	120		ma.
Max.-Signal D-C Plate Current - - - - -	770	675	620		ma.
Max.-Signal Driving Power (approx.) - - -	15	13	15		watts
Effective Load, Plate-to-Plate - - - - -	7800	12800	18600		ohms
Max.-Signal Plate Power Output - - - - -	1400	1800	2200		watts

\*Averaged over any sinusoidal audio frequency cycle.

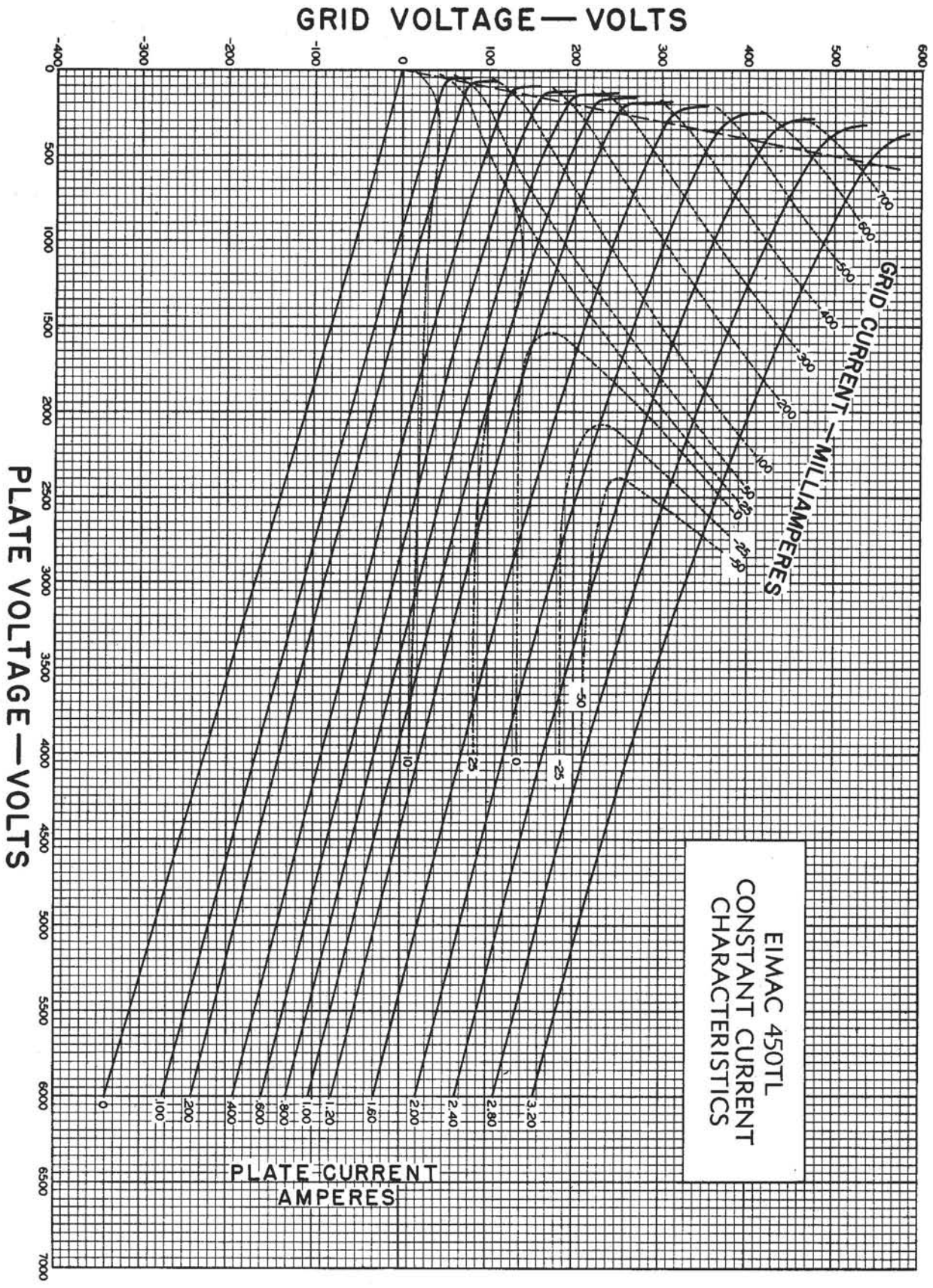
### RADIO FREQUENCY POWER AMPLIFIER AND OSCILLATOR Class-C \*Telegraphy

(Key down conditions without modulation)

	TYPICAL OPERATION—1 TUBE			MAX. RATING	
D-C Plate Voltage - - - - -	3000	4000	5000	6000	volts
D-C Plate Current - - - - -	500	450	450	600	ma.
D-C Grid Current - - - - -	65	53	54	75	ma.
D-C Grid Voltage - - - - -	-275	-400	-500		volts
Plate Power Output - - - - -	1050	1350	1800		watts
Plate Input - - - - -	1500	1800	2250		watts
Plate Dissipation - - - - -	450	450	450	450	watts
Peak R. F. Grid Input Voltage, (approx.) - -	640	740	870		volts
Driving Power, (approx.) - - - - -	38	35	42		watts

\*The above figures show actual measured tube performance, and do not allow for variations in circuit losses.



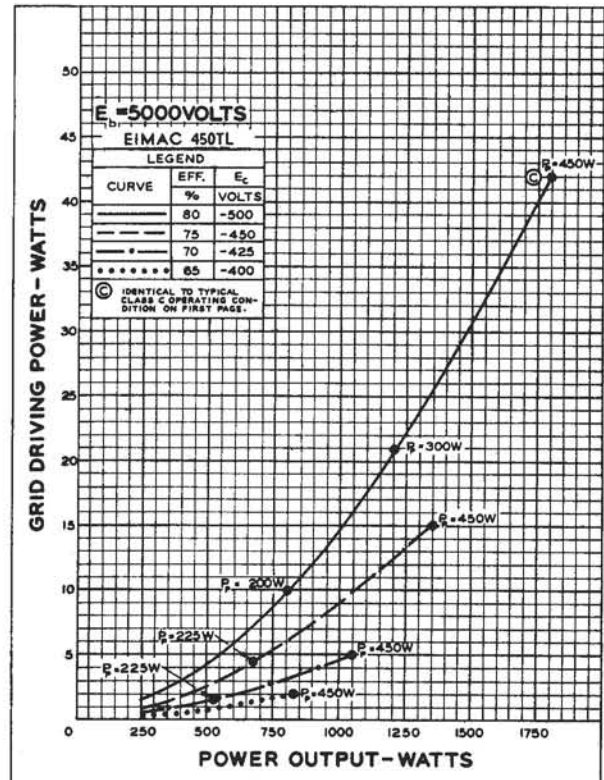
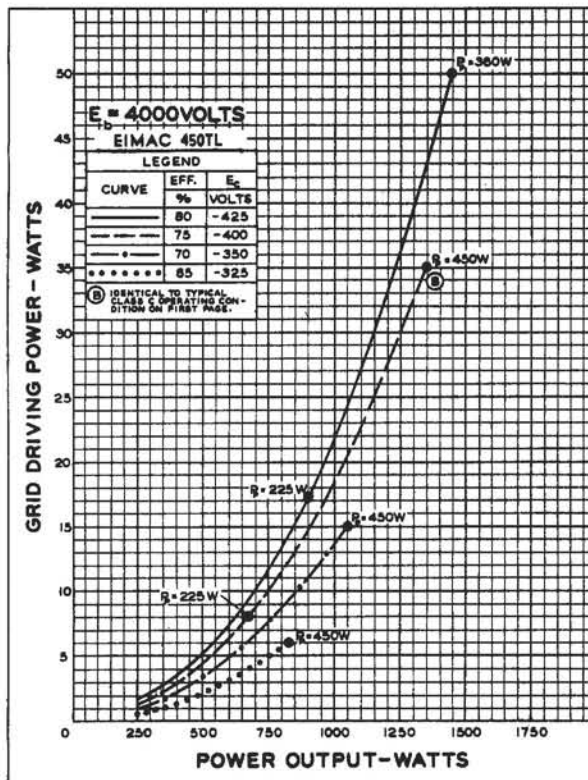
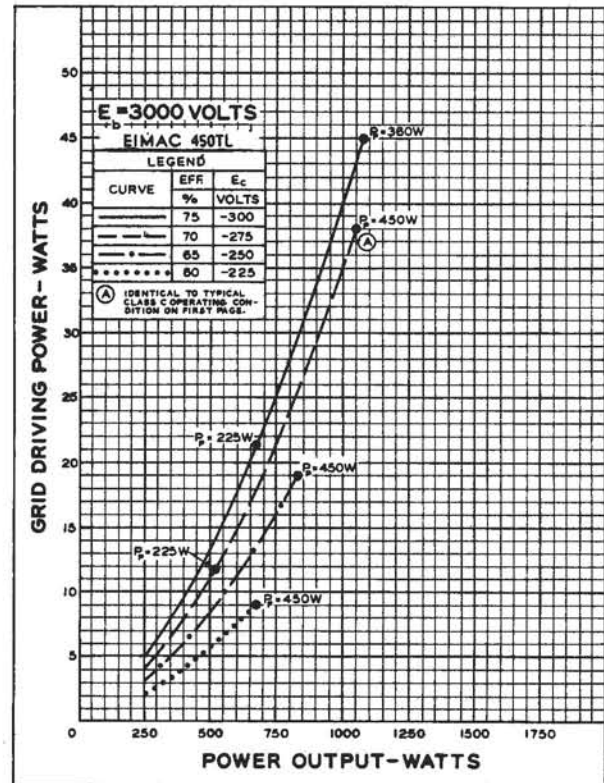


EIMAC 450TL  
 CONSTANT CURRENT  
 CHARACTERISTICS

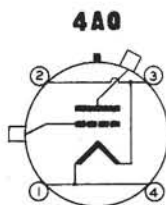
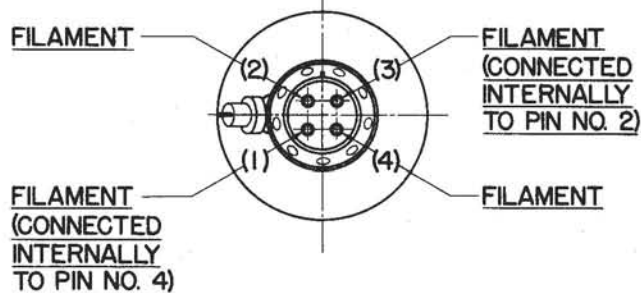
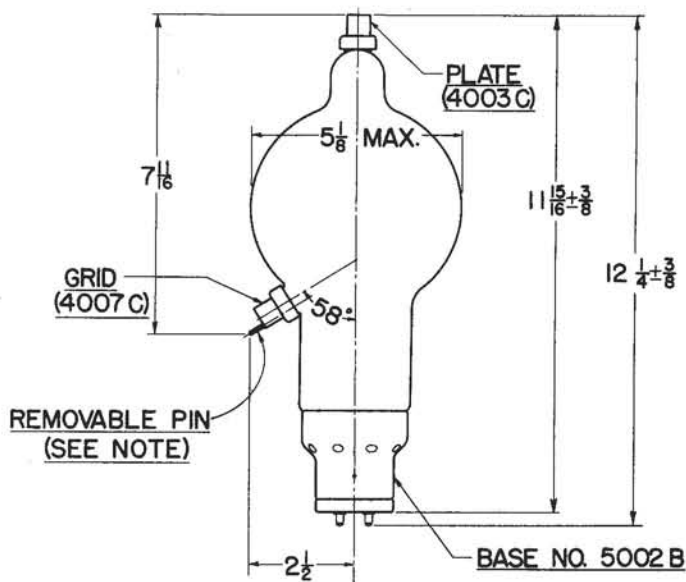
## DRIVING POWER vs. POWER OUTPUT

The three charts on this page show the relationship of plate efficiency, power output and grid driving power at plate voltages of 3000, 4000, and 5000 volts. These charts show combined grid and bias losses only. The driving power and power output figures do not include circuit losses. The plate dissipation in watts is indicated by  $P_p$ .

Points A, B, and C are identical to the typical Class C operating conditions shown on the first page under 3000, 4000, and 5000 volts respectively.

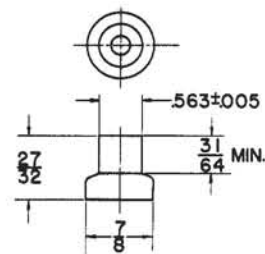




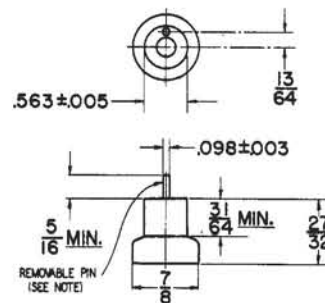


NOTE:—The grid terminal on the new 450TH and TL type tube is now .563" in diameter. To accommodate existing equipment which uses the 450TH or TL tubes with the old style .098" grid terminal, an adaptor pin is provided. This adaptor pin, if not needed, may be removed by unscrewing.

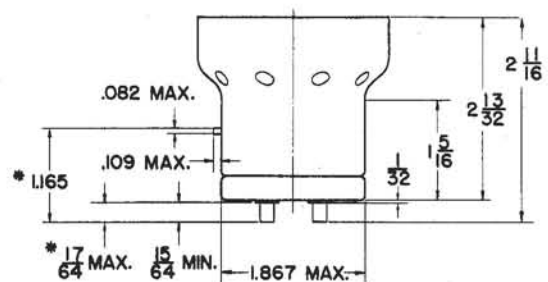
PLATE CAP  
NO. 4003C



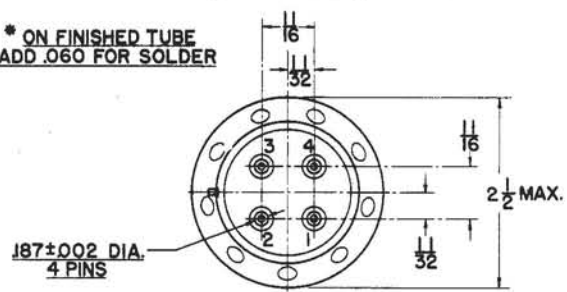
GRID CAP  
NO. 4007C



BASE NO. 5002 B



\* ON FINISHED TUBE  
ADD .060 FOR SOLDER



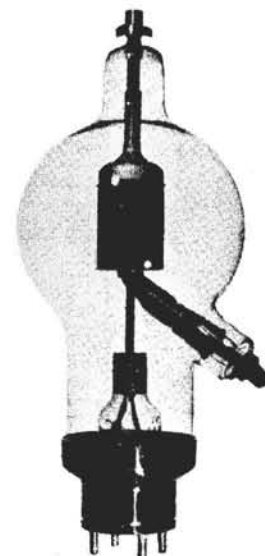
## GENERAL CHARACTERISTICS

### ELECTRICAL

Filament: Thoriated tungsten	
Voltage - - - - -	7.5 volts
Current - - - - -	21.0 amperes
Amplification Factor (Average) - - - - -	15
Direct Interelectrode Capacitances (Average)	
Grid-Plate - - - - -	5.8 $\mu\text{f}$
Grid-Filament - - - - -	8.5 $\mu\text{f}$
Plate-Filament - - - - -	1.2 $\mu\text{f}$
Transconductance ( $I_b=1.0$ amp., $E_b=5000$ , $e_c=-100$ )	3500 $\mu\text{mhos}$
Frequency for Maximum Ratings - - - - -	40 mc

### MECHANICAL

Base - Special 4 pin, (Fits Johnson No. 214 Socket, or equal) No. 5003B	
Basing - - - - -	RMA type 4BD
Maximum Overall Dimensions:	
Length - - - - -	17.0 inches
Diameter - - - - -	7.125 inches
Net weight - - - - -	2.75 pounds
Shipping weight (Average) - - - - -	8.0 pounds



## AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR

### Class B

	TYPICAL OPERATION—2 TUBES			MAX. RATING	
D-C Plate Voltage - - - - -	4000	5000	6000	10000	volts
Max.-Signal D-C Plate Current, per tube* - -	•	•	•	1000	ma.
Plate Dissipation, per tube* - - - - -	•	•	•	750	watts
D-C Grid Voltage (approx.) - - - - -	-200	-285	-350		volts
Peak A-F Grid Input Voltage - - - - -	910	1060	1200		volts
Zero-Signal D-C Plate Current - - - - -	.250	.200	.166		amps.
Max.-Signal D-C Plate Current - - - - -	.950	.860	.834		amps.
Max.-Signal Driving Power (approx.) - - - -	24	23	30		watts
Effective Load, Plate-to-Plate - - - - -	8270	12300	16300		ohms
Max.-Signal Plate Power Output - - - - -	2300	2800	3500		watts

\*Averaged over any sinusoidal audio frequency cycle.

## RADIO FREQUENCY POWER AMPLIFIER AND OSCILLATOR

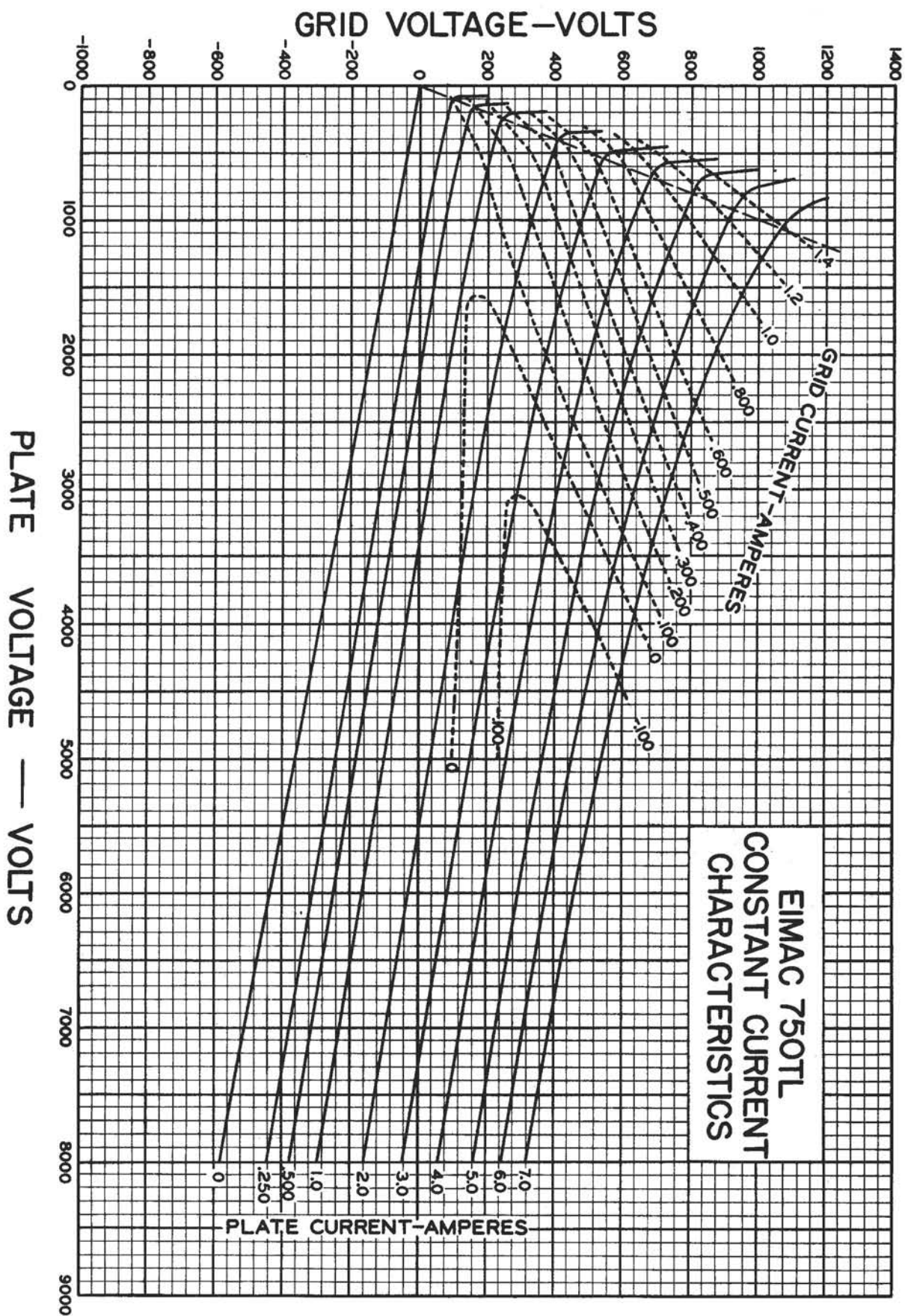
### Class-C \*Telegraphy

(Key down conditions without modulation)

	TYPICAL OPERATION—1 TUBE				MAX. RATING	
D-C Plate Voltage - - - - -	3000	4000	5000	6000	10000	volts
D-C Plate Current - - - - -	713	625	600	625	1000	ma.
D-C Grid Current - - - - -	95	69	67	78	125	ma.
D-C Grid Voltage - - - - -	-350	-450	-550	-700		volts
Plate Power Output - - - - -	1390	1750	2250	3000		watts
Plate Input - - - - -	2140	2500	3000	3750		watts
Plate Dissipation - - - - -	750	750	750	750	750	watts
Peak R. F. Grid Input Voltage, (approx.) - -	860	900	1000	1120		volts
Driving Power, (approx.) - - - - -	74	53	61	93		watts

\*The above figures show actual measured tube performance, and do not allow for variations in circuit losses.

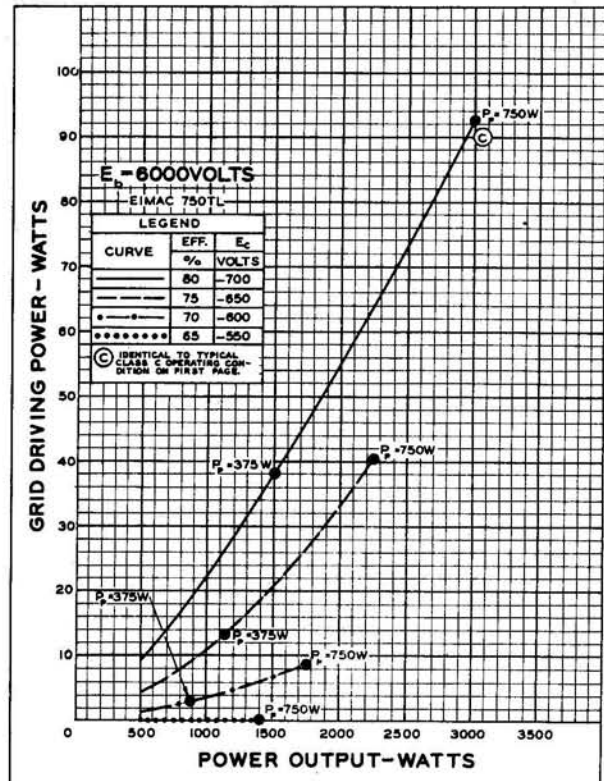
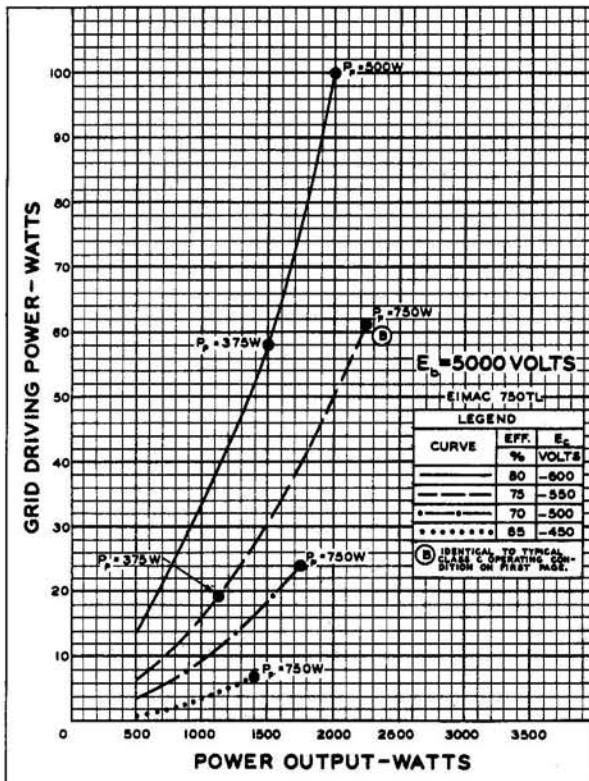
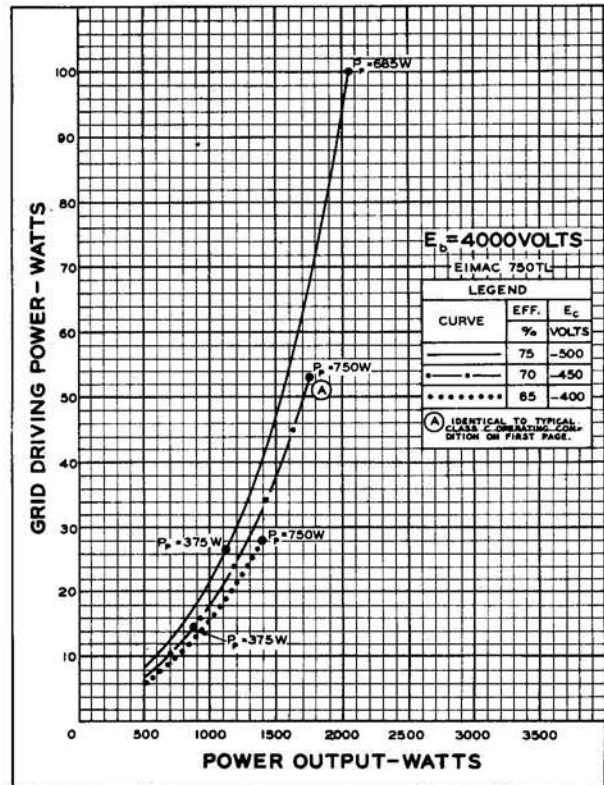
(Effective 5-15-44) Copyright, 1946 by Eitel-McCullough, Inc.

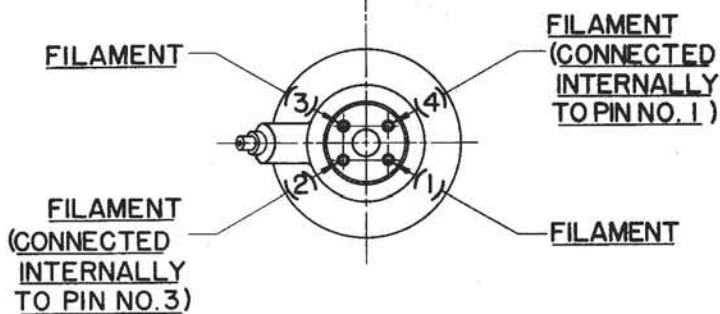
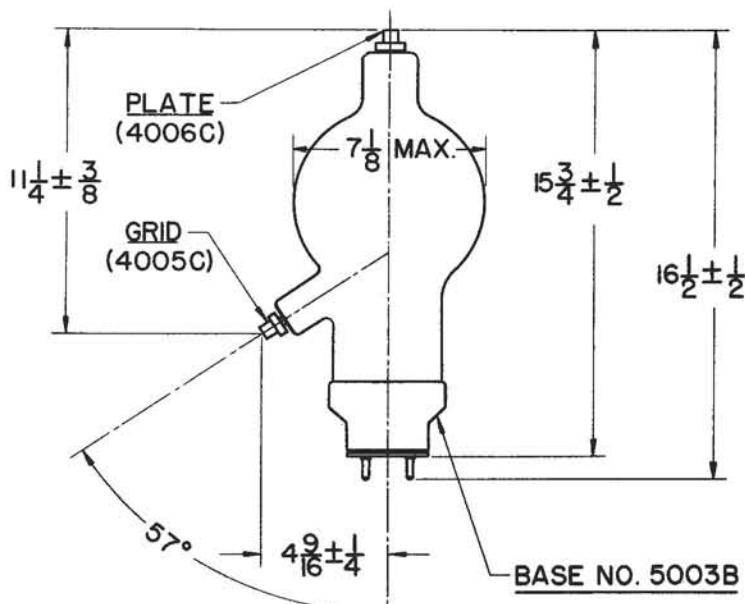


## DRIVING POWER vs. POWER OUTPUT

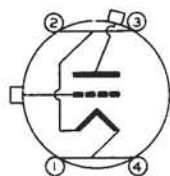
The three charts on this page show the relationship of plate efficiency, power output and grid driving power at plate voltages of 4000, 5000, and 6000 volts. These charts show combined grid and bias losses only. The driving power and power output figures do not include circuit losses. The plate dissipation in watts is indicated by  $P_p$ .

Points A, B, and C are identical to the typical Class C operating conditions shown on the first page under 4000, 5000, and 6000 volts respectively.

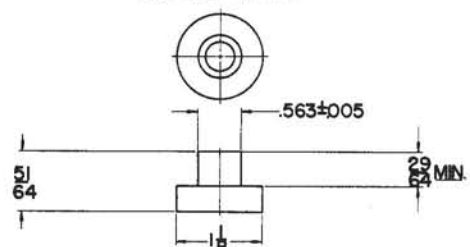




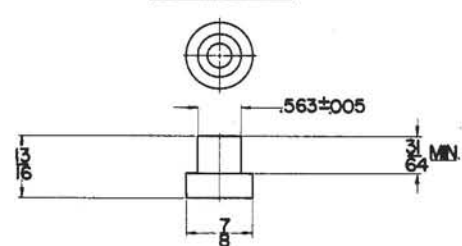
49D



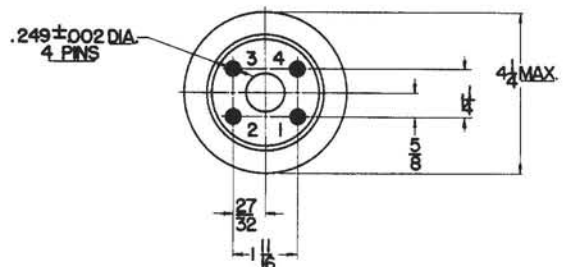
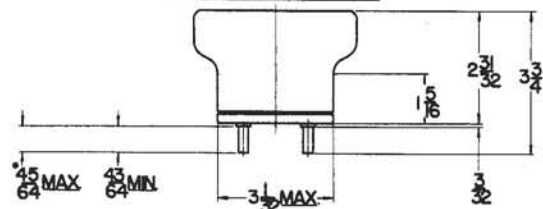
CAPS  
PLATE  
CAP NO. 4006C



GRID  
CAP NO. 4005C



BASE NO. 5003B



\*ON FINISHED TUBE ADD .060 FOR SOLDER.

## AIR COOLING

Provision should be made for ample circulation of air in the equipment employing this type tube.



# Eitel-McCullough, Inc.

SAN BRUNO, CALIFORNIA

## 1000T

HIGH-MU TRIODE

MODULATOR  
OSCILLATOR  
AMPLIFIER

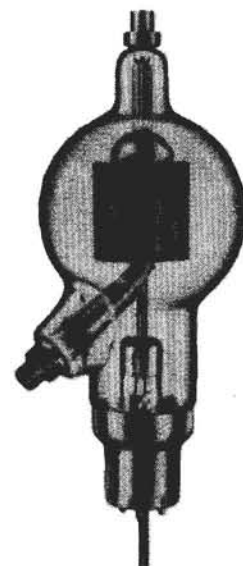
### GENERAL CHARACTERISTICS

#### ELECTRICAL

Filament: Thoriated tungsten	
Voltage - - - - -	7.5 volts
Current - - - - -	17.0 amperes
Amplification Factor (Average) - - - - -	35
Direct Interelectrode Capacitances (Average)	
Grid-Plate - - - - -	5.1 $\mu\text{mf}$
Grid-Filament - - - - -	9.3 $\mu\text{mf}$
Plate-Filament - - - - -	0.5 $\mu\text{mf}$
Transconductance ( $I_b=750$ ma., $E_b=6000$ , $e_c=-62$ )	9050 $\mu\text{mhos}$
Frequency for Maximum Ratings - - - - -	50 mc

#### MECHANICAL

Base - - - - -	4-pin with tubing for forced air No. 5004B
Basing - - - - -	RMA type 4AQ
Maximum Overall Dimensions:	
Length - - - - -	12.625 inches
Diameter - - - - -	5.125 inches
Net weight - - - - -	1.25 pounds
Shipping weight (Average) - - - - -	6.25 pounds



### AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR Class B

	TYPICAL OPERATION—2 TUBES			MAX. RATING	
D-C Plate Voltage - - - - -	4000	5000	6000	7500	volts
Max.-Signal D-C Plate Current, per tube* - -	•	•	•	750	ma.
Plate Dissipation, per tube* - - - - -	•	•	•	1000	watts
D-C Grid Voltage (approx.) - - - - -	-70	-105	-135		volts
Peak A-F Grid Input Voltage - - - - -	490	530	600		volts
Zero-Signal D-C Plate Current - - - - -	.300	.240	.200		amps.
Max.-Signal D-C Plate Current - - - - -	1.25	1.14	1.11		amps.
Max.-Signal Driving Power (approx.) - - -	28	31	35		watts
Effective Load, Plate-to-Plate - - - - -	6350	9250	12200		ohms
Max.-Signal Plate Power Output - - - - -	3000	3700	4600		watts

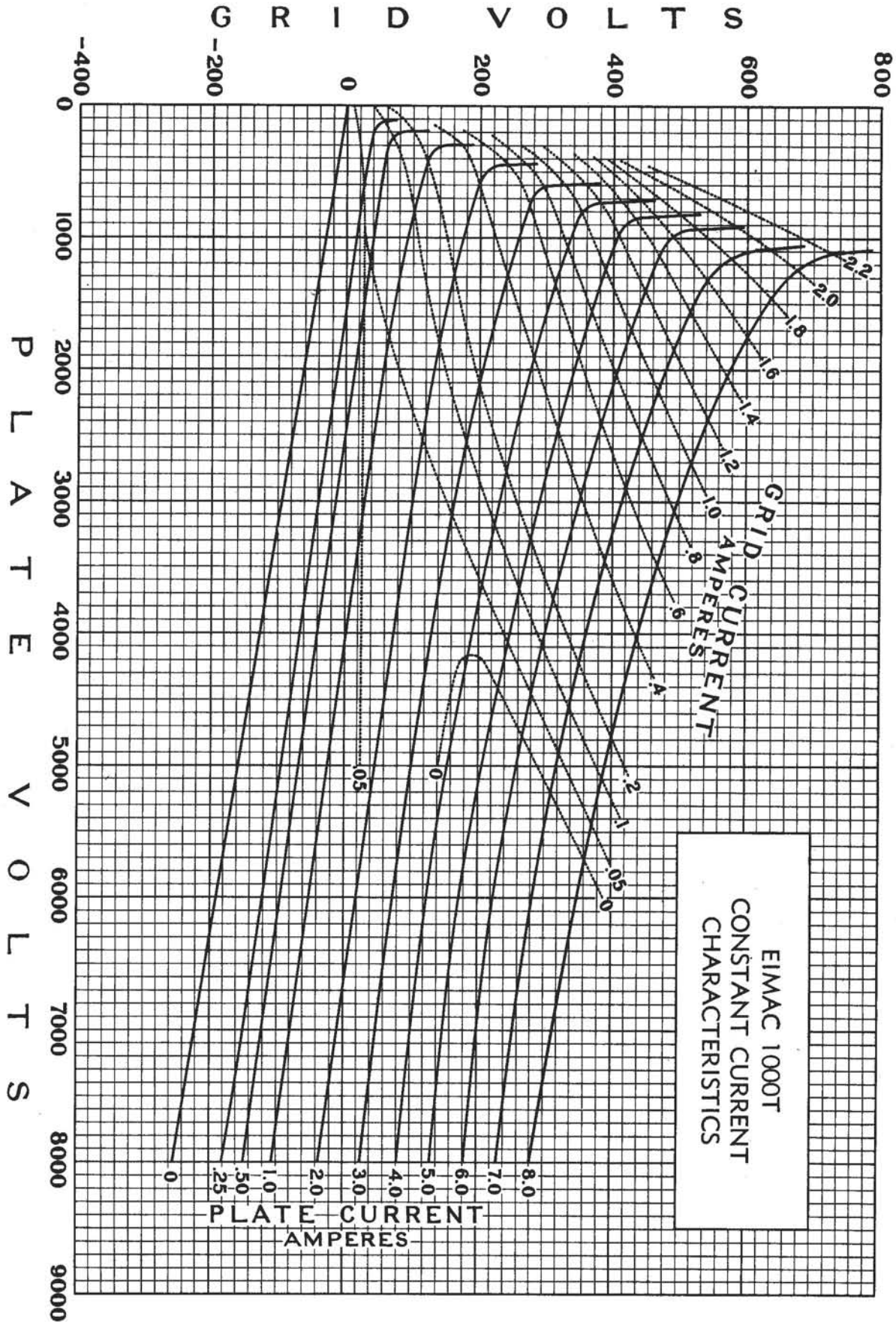
\*Averaged over any sinusoidal audio frequency cycle.

### RADIO FREQUENCY POWER AMPLIFIER AND OSCILLATOR Class-C \*Telegraphy

(Key down conditions without modulation)

	TYPICAL OPERATION—1 TUBE				MAX. RATING	
D-C Plate Voltage - - - - -	3000	4000	5000	6000	7500	volts
D-C Plate Current - - - - -	750	713	667	667	750	ma.
D-C Grid Current - - - - -	90	100	87	110	125	ma.
D-C Grid Voltage - - - - -	-150	-150	-225	-350		volts
Plate Power Output - - - - -	1350	1850	2333	3000		watts
Plate Input - - - - -	2250	2850	3333	4000		watts
Plate Dissipation - - - - -	900	1000	1000	1000	1000	watts
Peak R. F. Grid Input Voltage, (approx.) -	350	365	420	610		volts
Driving Power, (approx.) - - - - -	30	33	33	60		watts

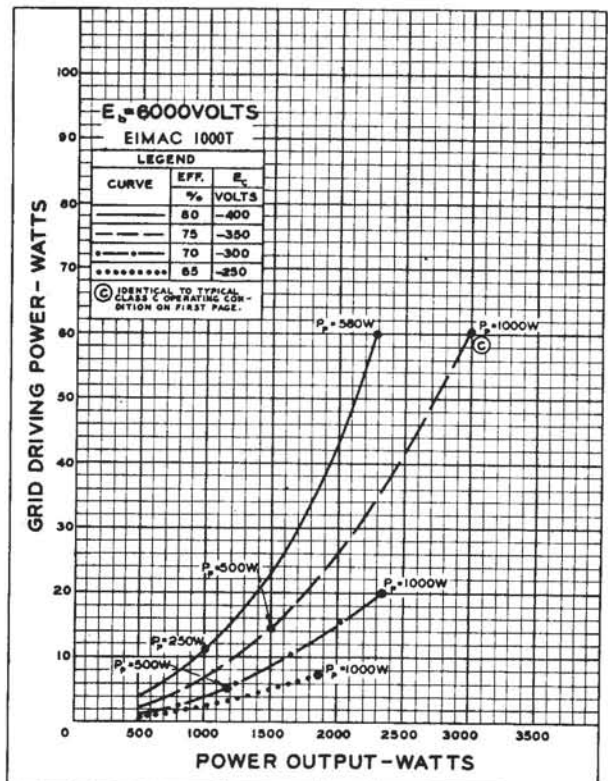
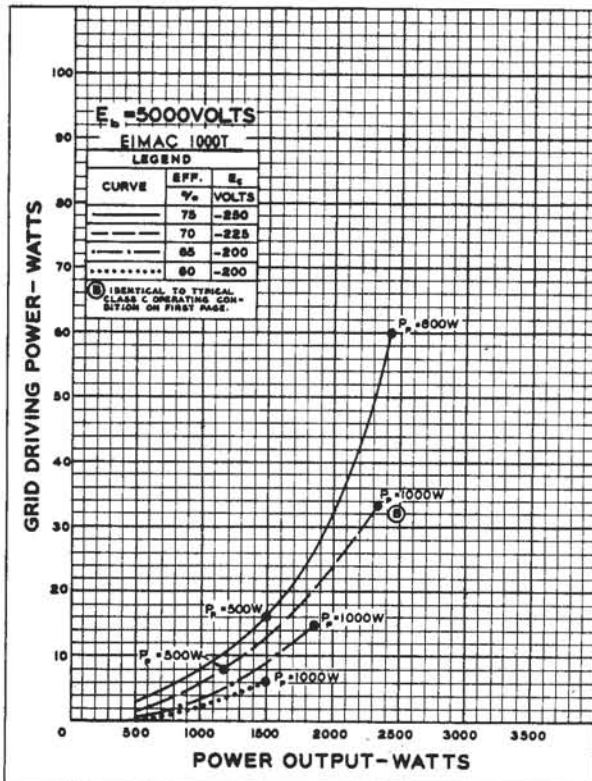
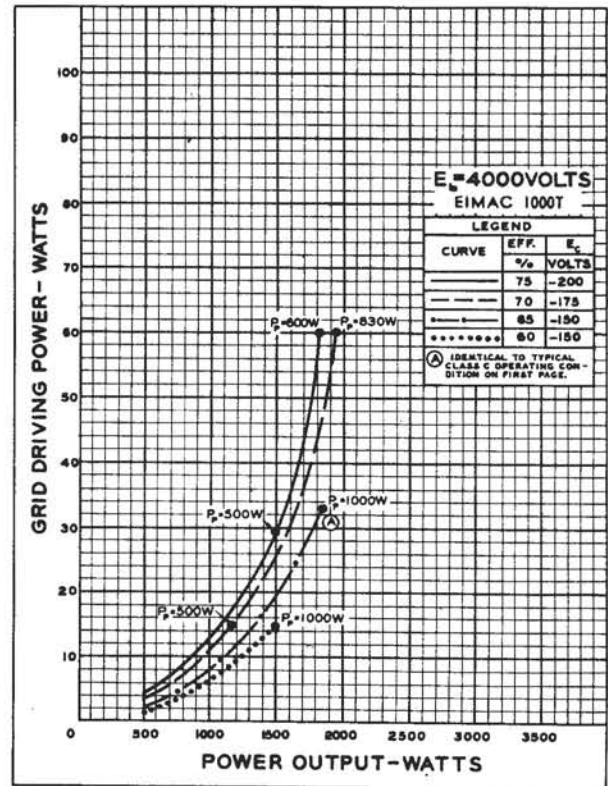
\*The above figures show actual measured tube performance, and do not allow for variations in circuit losses.



## DRIVING POWER vs. POWER OUTPUT

The three charts on this page show the relationship of plate efficiency, power output and grid driving power at plate voltages of 4000, 5000 and 6000 volts. These charts show combined grid and bias losses only. The driving power and power output figures do not include circuit losses. The plate dissipation in watts is indicated by  $P_p$ .

Points A, B, and C are identical to the typical Class C operating conditions shown on the first page under 4000, 5000, and 6000 volts respectively.



\* ON FINISHED TUBE ADD .060 FOR SOLDER

# EITEL-McCULLOUGH, INC.

SAN BRUNO, CALIFORNIA

# 1500T

MEDIUM-MU TRIODE

MODULATOR  
OSCILLATOR  
AMPLIFIER

The Eimac 1500T is a medium-mu, high-vacuum transmitting triode intended for amplifier, oscillator and modulator service. It has a maximum plate dissipation rating of 1500 watts. Cooling of the 1500T is accomplished by radiation from the plate, which operates at a visibly red temperature at maximum dissipation, and by means of forced air circulation around the envelope and at the seals.

## GENERAL CHARACTERISTICS

### ELECTRICAL

Filament: Thoriated tungsten

Voltage - - - - - 7.5 volts

Current - - - - - 24.0 amperes

Amplification Factor (Average) - - - - - 24

Direct Interelectrode Capacitances (Average)

Grid-Plate - - - - - 7.2  $\mu$ fd.

Grid-Filament - - - - - 9.9  $\mu$ fd.

Plate-Filament - - - - - 1.5  $\mu$ fd.

Transconductance ( $i_b = 1.25$  amp.,  $E_b = 6000$  v.,  $E_c = -155$  v.) 10,000  $\mu$ mhos

### MECHANICAL

Base - - - - - Special 4-pin, No. 5005B  
Basing - - - - - RMA type 4BD  
Cooling - - - - - Radiation and forced air

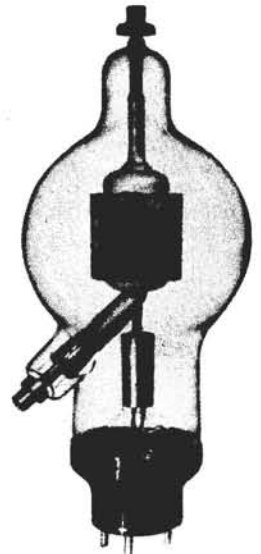
Maximum Overall Dimensions:

Length - - - - - 17.0 inches

Diameter - - - - - 7.125 inches

Net Weight - - - - - 3.5 pounds

Shipping Weight (Average) - - - - - 8.5 pounds



### RADIO FREQUENCY POWER AMPLIFIER AND OSCILLATOR

Class-C Telegraphy (Key-down conditions, 1 tube)

MAXIMUM RATINGS (Frequencies below 40 Mc.)

D-C PLATE VOLTAGE	- - - - -	8000 MAX. VOLTS
D-C PLATE CURRENT	- - - - -	1.25 MAX. AMPS.
PLATE DISSIPATION	- - - - -	1500 MAX. WATTS
GRID DISSIPATION	- - - - -	125 MAX. WATTS

TYPICAL OPERATION (Frequencies below 40 Mc.)

D-C Plate Voltage	- - - - -	5000	6000	7000	volts
D-C Grid Voltage	- - - - -	-375	-600	-500	volts
D-C Plate Current	- - - - -	1.00	1.00	.860	amps.
D-C Grid Current	- - - - -	150	165	110	ma.
Grid Dissipation	- - - - -	59	61	30	watts
Peak R-F Grid Input Voltage (approx.)	- - - - -	850	1100	885	volts
Driving Power (approx.)	- - - - -	115	160	85	watts
Plate Power Input	- - - - -	5000	6000	6000	watts
Plate Dissipation	- - - - -	1500	1500	1500	watts
Plate Power Output	- - - - -	3500	4500	4500	watts

### AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR

Class-B (Sinusoidal wave, two tubes unless otherwise specified)

MAXIMUM RATINGS

D-C PLATE VOLTAGE	- - - - -	8000 MAX. VOLTS
MAX-SIGNAL D-C PLATE CURRENT, PER TUBE	- - - - -	1.25 MAX. AMPS.
PLATE DISSIPATION, PER TUBE	- - - - -	1500 MAX. WATTS
GRID DISSIPATION, PER TUBE	- - - - -	125 MAX. WATTS

TYPICAL OPERATION

D-C Plate Voltage	- - - - -	4000	5000	6000	volts
D-C Grid Voltage (approx.)	- - - - -	-95	-145	-190	volts
Zero-Signal D-C Plate Current	- - - - -	500	400	330	ma.
Max-Signal D-C Plate Current	- - - - -	1.88	1.72	1.65	amps.
Effective Load, Plate-to-Plate	- - - - -	4150	6150	8200	ohms
Peak A-F Grid Input Voltage (per tube)	- - - - -	485	535	570	volts
Max-Signal Avg. Driving Power (approx.)	- - - - -	95	105	115	watts
Max-Signal Plate Dissipation	- - - - -	1500	1500	1450	watts
Max-Signal Plate Power Output	- - - - -	4500	5600	7000	watts



# EITEL-McCULLOUGH, INC.

SAN BRUNO, CALIFORNIA

## 2000T

MEDIUM-MU TRIODE

MODULATOR  
OSCILLATOR  
AMPLIFIER

The 2000T is a medium-mu, high-vacuum transmitting triode intended for amplifier, oscillator and modulator service. It has a maximum plate dissipation rating of 2000 watts. Cooling of the 2000T is accomplished by radiation from the plate, which operates at a visibly red temperature at maximum dissipation, and by means of forced air circulation around the envelope and at the seals.

### GENERAL CHARACTERISTICS

#### ELECTRICAL

Filament: Thoriated tungsten

Voltage - - - - - 10.0 volts

Current - - - - - 25.0 amperes

Amplification Factor (Average) - - - - - 23

Direct Interelectrode Capacitances (Average)

Grid-Plate - - - - - 8.5  $\mu\text{fd.}$

Grid-Filament - - - - - 12.7  $\mu\text{fd.}$

Plate-Filament - - - - - 1.7  $\mu\text{fd.}$

Transconductance ( $i_b = 1.75 \text{ amp.}$ ,  $E_b = 6000 \text{ v.}$ ,  $E_c = -95 \text{ v.}$ ) 11,000  $\mu\text{mhos}$

#### MECHANICAL

Base - - - - - Special 4-pin, No. 5006B

Basing - - - - - RMA type 4BD

Cooling - - - - - Radiation and forced air

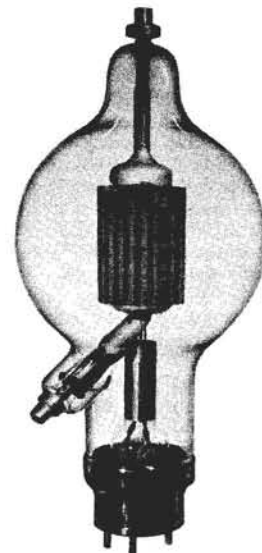
Maximum Overall Dimensions:

Length - - - - - 17.75 inches

Diameter - - - - - 8.125 inches

Net weight - - - - - 3.5 pounds

Shipping weight (Average) - - - - - 8.5 pounds



#### RADIO FREQUENCY POWER AMPLIFIER AND OSCILLATOR

Class-C Telegraphy (Key-down conditions, 1 tube)

MAXIMUM RATINGS (Frequencies below 40 Mc.)

D-C PLATE VOLTAGE - - - - - 8000 MAX. VOLTS

D-C PLATE CURRENT - - - - - 1.75 MAX. AMPS.

PLATE DISSIPATION - - - - - 2000 MAX. WATTS

GRID DISSIPATION - - - - - 150 MAX. WATTS

TYPICAL OPERATION (Frequencies below 40 Mc.)

D-C Plate Voltage - - - - - 5000 6000 7000 volts

D-C Grid Voltage - - - - - -350 -500 -600 volts

D-C Plate Current - - - - - 1.35 1.35 1.15 amps

D-C Grid Current - - - - - .175 .165 .120 ma.

Grid Dissipation - - - - - 79 78 43 watts

Peak R-F Grid Input Voltage (approx.) 900 1050 1060 volts

Driving Power, (approx.) - - - - - 140 160 115 watts

Plate Power Input - - - - - 6670 8000 8000 watts

Plate Dissipation - - - - - 2000 2000 2000 watts

Plate Power Output - - - - - 4670 6000 6000 watts

#### AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR

Class-B (Sinusoidal wave, two tubes unless otherwise specified)

MAXIMUM RATINGS

D-C PLATE VOLTAGE - - - - - 8000 MAX. VOLTS

MAX-SIGNAL D-C PLATE CURRENT, PER TUBE - 1.75 MAX. AMPS.

PLATE DISSIPATION, PER TUBE - - - - - 2000 MAX. WATTS

GRID DISSIPATION, PER TUBE - - - - - 150 MAX. WATTS

TYPICAL OPERATION

D-C Plate Voltage - - - - - 5000 6000 7000 volts

D-C Grid Voltage - - - - - -180 -230 -290 volts

Zero-Signal D-C Plate Current - - - - - 480 400 350 ma.

Max-Signal D-C Plate Current - - - - - 2.00 1.88 1.86 amps.

Effective Load, Plate-to-Plate - - - - - 4900 6650 8500 ohms

Peak A-F Grid Input Voltage (per tube) 470 525 590 volts

Max-Signal Avg. Driving Power (approx.) 50 60 75 watts

Max-Signal Peak Driving Power - - - - - 178 184 212 watts

Max-Signal Plate Dissipation (per tube) - 2000 1875 2000 watts

Max-Signal Plate Power Output - - - - - 6000 7500 9000 watts

## APPLICATION

### MECHANICAL

**Mounting**—The 2000T must be mounted vertically, base up or base down. Flexible connecting straps should be provided between the grid and plate terminals and the external grid and plate circuits. The tube must be protected from severe vibration and shock.

**Cooling**—The envelope and seals of the 2000T require artificial cooling. An ordinary 8- or 10-inch fan located one foot from the tube will provide sufficient air for cooling the envelope. The air should be directed at the tube in a manner which will allow the most uniform cooling of the envelope. The grid and plate seals each require a minimum flow of two cubic feet of air per minute. The air for the grid seal is fed through the grid connector. A special connector (Eimac HR-9) is available for this purpose. A special heat-dissipating connector (Eimac HR-8) is also available for use on the plate terminal. A minimum flow of two cubic feet of air per minute must likewise be supplied to the filament seals through the hole at the center of the base. Suitable electrical interlocks should be provided to remove the plate and filament voltages in the event that the supply of cooling air is interrupted.

### ELECTRICAL

**Filament Voltage**—The filament voltage, as measured directly at the filament pins, should be between 9.5 and 10.5 volts.

**Bias Voltage**—Although there is no maximum limit on the bias voltage which may be used on the 2000T there is little advantage in using bias voltages in excess of those given under "Typical Operation," except in certain very specialized applications. Where bias is obtained by a grid

leak, suitable protective means must be provided to prevent excessive plate dissipation in the event of loss of excitation.

**Plate Voltage**—The plate supply voltage for the 2000T should not exceed 8000 volts. In most cases there is little advantage in using plate-supply voltages higher than those given under "Typical Operation" for the power output desired.

**Grid Dissipation**—The power dissipated by the grid of the 2000T must not exceed 150 watts. Grid dissipation may be calculated from the following expression:

$$P_g = e_{cmp} I_c$$

where  $P_g$  = Grid dissipation,

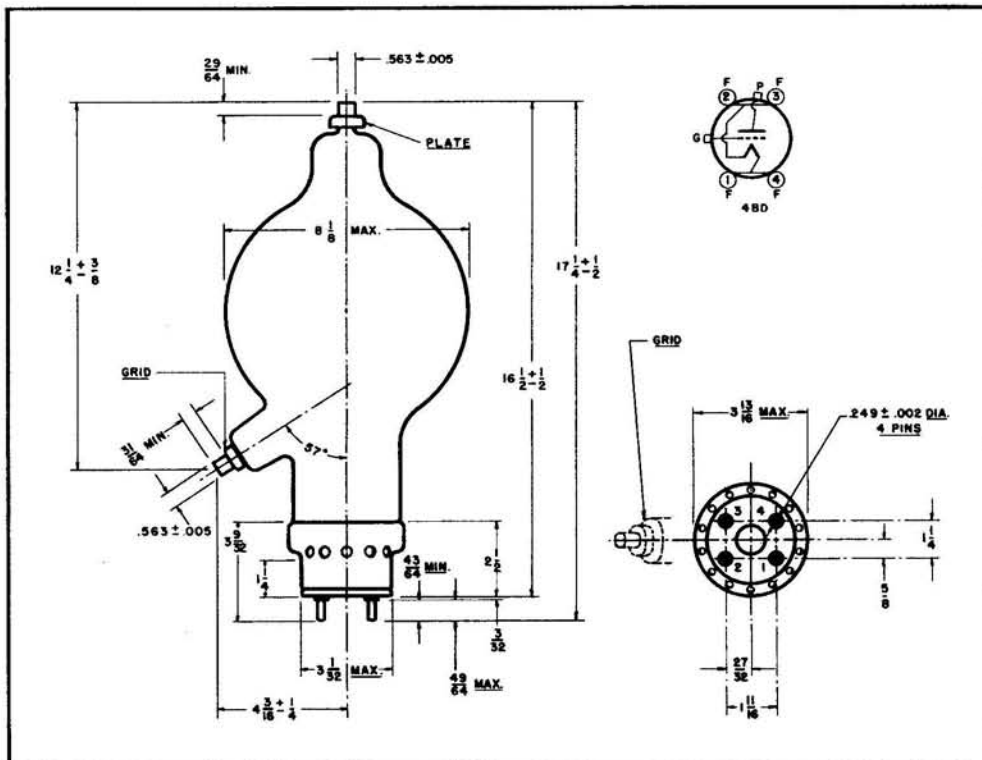
$e_{cmp}$  = Peak positive grid voltage, and

$I_c$  = D-c grid current.

$e_{cmp}$  may be measured by means of a suitable peak voltmeter connected between filament and grid.<sup>1</sup> In equipment in which the plate loading varies widely, such as oscillators used for radio-frequency heating, care should be taken to make certain that the grid dissipation does not exceed the maximum rating under any condition of loading.

**Plate Dissipation**—Under normal operating conditions, the power dissipated by the plate of the 2000T should not be allowed to exceed 2000 watts. Plate dissipation in excess of the maximum rating is permissible for short periods of time, such as during tuning procedures.

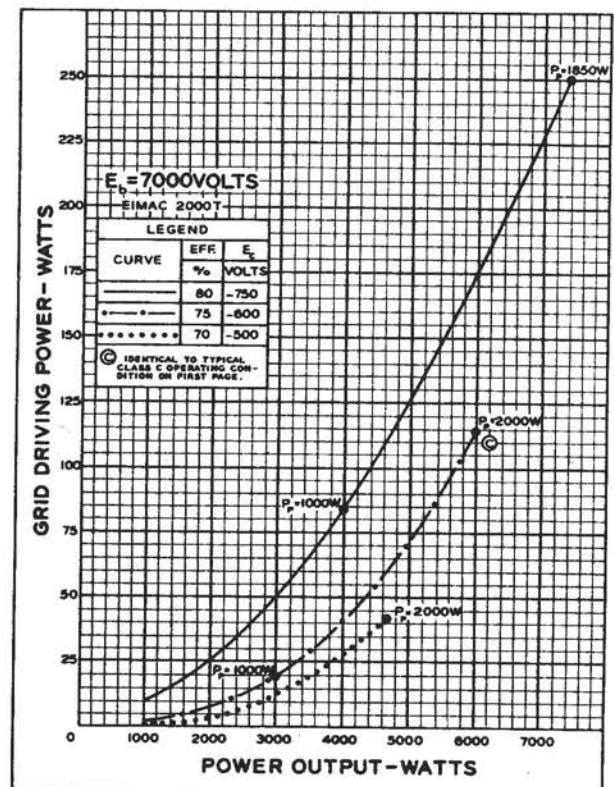
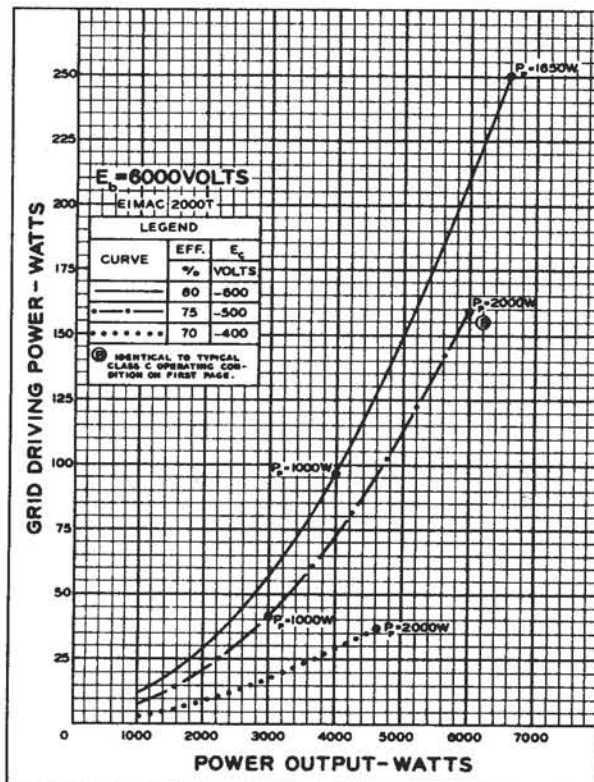
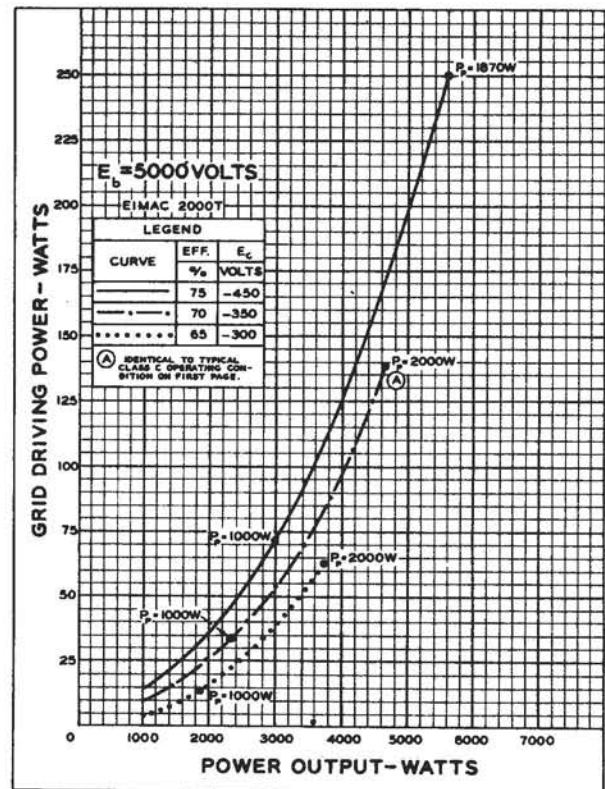
<sup>1</sup> For suitable peak v.t.v.m. circuits see, for instance, "Vacuum Tube Ratings," Eimac News, January, 1945. This article is available in reprint form on request.

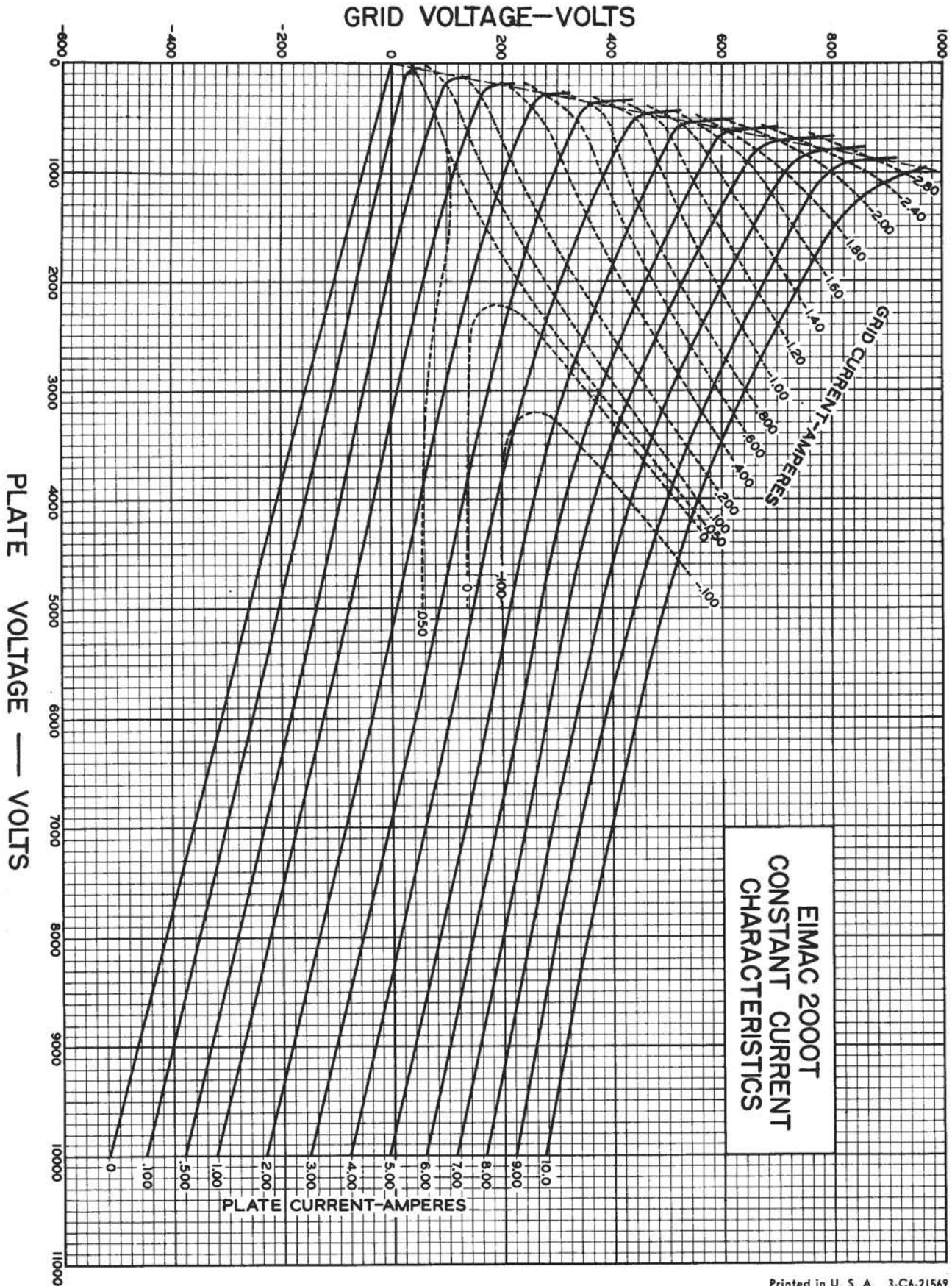


## DRIVING POWER vs. POWER OUTPUT

The three charts on this page show the relationship of plate efficiency, power output and grid driving power at plate voltages of 5000, 6000, and 7000 volts. These charts show combined grid and bias losses only. The driving power and power output figures do not include circuit losses. The plate dissipation in watts is indicated by  $P_p$ .

Points A, B, and C are identical to the typical Class C operating conditions shown on the first page under 5000, 6000, and 7000 volts respectively.







# Eitel-McCullough, Inc.

SAN BRUNO, CALIFORNIA

## 3X2500A3

MEDIUM MU TRIODE

The Eimac 3X2500A3 is a medium-mu, forced-air cooled, external-anode transmitting triode incorporating features which make it suitable for effective use at frequencies well into the V. H. F. range, as well as at lower frequencies. The grid of the 3X2500A3 terminates in a ring interposed between the plate and filament, to permit maximum convenience in the use of a tube as a "grounded-grid" amplifier at high frequencies with coaxial plate and filament tank circuits. The tube is also provided with a rugged, low-inductance cylindrical filament-stem structure, which allows a smooth transition between a linear filament tank circuit and the tube. As a result of the use of these unique grid and filament terminal arrangements, it is possible to install or remove the 3X2500A3 without the aid of tools.

The 3X2500A3 is capable of delivering relatively high power output at low plate voltages. A single tube will deliver a radio-frequency output of 5000 watts at 3500 plate volts at low frequencies, and 7500 watts at 4000 plate volts at a frequency of 110 Mc.

### GENERAL CHARACTERISTICS

#### ELECTRICAL

Filament: Thoriated tungsten	
Voltage	7.5 volts
Current	48 amperes
Maximum starting current	100 amperes
Amplification Factor (Average)	20
Direct Interelectrode Capacitances (Average)	
Grid-Plate	20 $\mu\text{mfd.}$
Grid-Filament	48 $\mu\text{mfd.}$
Plate-Filament	1.2 $\mu\text{mfd.}$
Transconductance ( $i_b = 830 \text{ ma.}$ , $E_b = 3000 \text{ v.}$ )	20,000 $\mu\text{mhos}$

#### MECHANICAL

Cooling	Forced air
Maximum Overall Dimensions:	
Length	9.0 inches
Diameter	4.25 inches
Net Weight	5.8 pounds
Shipping Weight (Average)	17 pounds

#### RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR

(Conventional Neutralized Amplifier)

Class-C Telephony (Key-down conditions, per tube)

MAXIMUM RATINGS (Frequencies below 50 Mc.)			
D-C PLATE VOLTAGE	-	-	5000 MAX VOLTS
D-C PLATE CURRENT	-	-	2.0 MAX. AMPS
PLATE DISSIPATION <sup>1</sup>	-	-	2500 MAX. WATTS
PLATE COOLER CORE TEMPERATURE	-	-	150 MAX. °C
GRID DISSIPATION	-	-	150 MAX. WATTS

TYPICAL OPERATION (Frequencies below 50 Mc., per tube)

D-C Plate Voltage	-	-	3500	4000	5000	volts
D-C Grid Voltage	-	-	-420	-360	-400	volts
D-C Plate Current	-	-	1.8	1.6	2	amps.
D-C Grid Current	-	-	500	425	475	ma.
Peak R-F Grid Input Voltage	-	-	735	630	710	volts
Driving Power (Approx.)	-	-	325	238	338	watts
Grid Dissipation	-	-	120	88	148	watts
Plate Input	-	-	6300	6400	10,000	watts
Plate Dissipation	-	-	1300	1400	2500	watts
Plate Power Output	-	-	5000	5000	7500	watts

<sup>1</sup> A minimum flow of 120 cubic feet of air per minute must be passed through the plate cooler. The pressure drop across the cooler at this flow equals 1.6" of water. A minimum air flow of 6 cubic feet per minute must also be directed toward the filament stem structure, between the inner and outer filament conductors. Cooling air in the above quantities must be supplied to both plate cooler and filament seals before applying filament voltage and should be continued for five minutes after the filament power is removed.

#### RADIO FREQUENCY POWER AMPLIFIER

Grounded-Grid Circuit

Class-C F-M Telephony

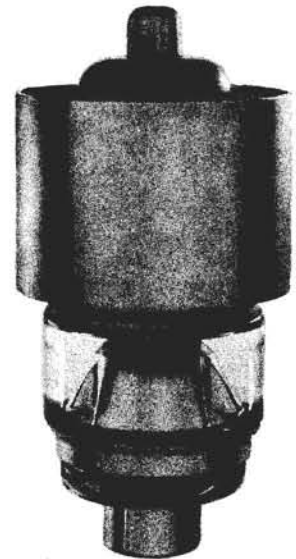
MAXIMUM RATINGS (Frequencies between 85 and 110 Mc.)

D-C PLATE VOLTAGE	-	-	-	4000 MAX. VOLTS
D-C PLATE CURRENT	-	-	-	2.0 MAX. AMPS
PLATE DISSIPATION <sup>1</sup>	-	-	-	2500 MAX. WATTS
PLATE COOLER CORE TEMPERATURE	-	-	-	150 MAX. °C
GRID DISSIPATION	-	-	-	150 MAX. WATTS

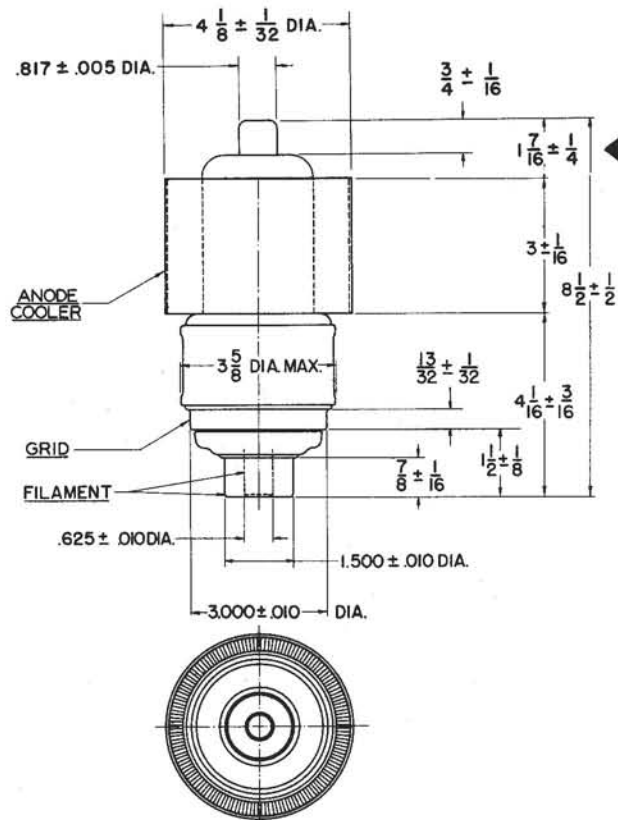
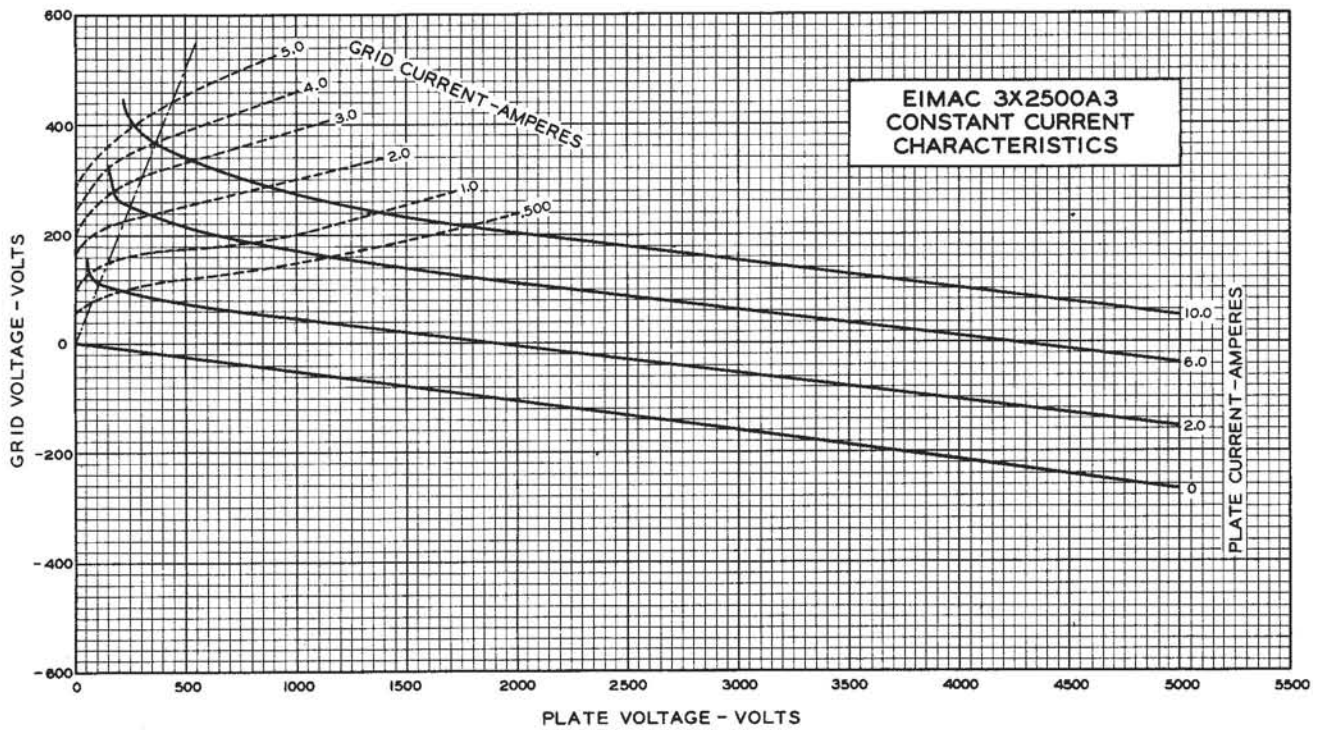
TYPICAL OPERATION (110 Mc., per tube)

D-C Plate Voltage	-	-	-	3700	4000	volts
D-C Grid Voltage	-	-	-	-450	-550	volts
D-C Plate Current	-	-	-	1.8	1.85	amps.
D-C Grid Current	-	-	-	225	275	ma.
Driving Power (Approx.)	-	-	-	1400	1900	watts
Useful Power Output	-	-	-	6850	7500	watts

<sup>1</sup> Indicates change from sheet dated 1-15-47.







# EITEL-McCULLOUGH, INC.

SAN BRUNO, CALIFORNIA

**3X2500F3**

MEDIUM MU TRIODE

The Eimac 3X2500F3 is a medium-mu, forced air-cooled, external-anode power triode capable of high output at relatively low plate voltages. A single tube will deliver a radio-frequency plate power output of 5000 watts at a plate voltage of 3500.

Flexible grid and filament leads simplify socketing and equipment design for industrial and communication frequencies below 50 Mc. The grid lead is detachable so that for grounded-grid operation, complete external shielding may be used between plate and filament circuits.

**GENERAL CHARACTERISTICS****ELECTRICAL**

Filament: Thoriated tungsten

Voltage - - - - - 7.5 volts

Current - - - - - 48 amperes

Maximum starting current - - - - - 100 amperes

Amplification Factor (Average) - - - - - 20

Direct Interelectrode Capacitances (Average)

Grid-Plate - - - - - 20  $\mu\text{fd.}$ Grid-Filament - - - - - 48  $\mu\text{fd.}$ Plate-Filament - - - - - 1.2  $\mu\text{fd.}$ Transconductance ( $i_b=830$  ma.,  $E_b=3000$  v.) - - - - - 20,000  $\mu\text{mhos}$ **MECHANICAL**Cooling - - - - - Forced air<sup>1</sup>

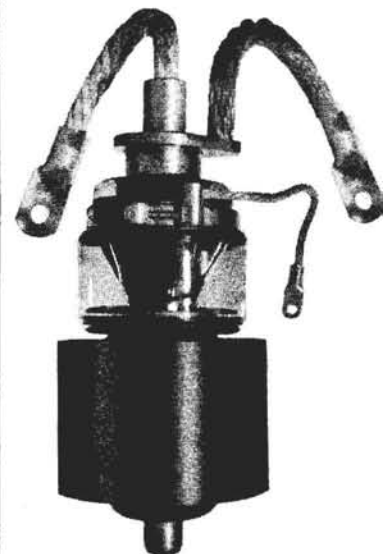
Maximum Overall Dimensions:

Length - - - - - 10 inches

Diameter - - - - - 4.25 inches

Net Weight - - - - - 7.5 pounds

Shipping Weight (Average) - - - - - 17 pounds

**RADIO FREQUENCY POWER AMPLIFIER****Conventional Neutralized Amplifier****Class-C Telegraphy** (Key-down conditions, per tube)**MAXIMUM RATINGS** (Frequencies below 50 Mc.)

D-C PLATE VOLTAGE - - - - - 5000 MAX. VOLTS

D-C PLATE CURRENT - - - - - 2.0 MAX. AMPS

PLATE DISSIPATION<sup>1</sup> - - - - - 2500 MAX. WATTS

PLATE COOLER CORE TEMPERATURE - - - - - 150 MAX. °C

GRID DISSIPATION - - - - - 150 MAX. WATTS

**TYPICAL OPERATION**

D-C Plate Voltage - - - - - 3500 4000 5000 volts

D-C Grid Voltage - - - - - -420 -360 -400 volts

D-C Plate Current - - - - - 1.8 1.6 2 amps

D-C Grid Current - - - - - 500 425 475 ma.

Peak R-F input Voltage - - - - - 735 630 710 volts

Driving Power (approx.) - - - - - 325 238 338 watts

Grid Dissipation - - - - - 120 88 148 watts

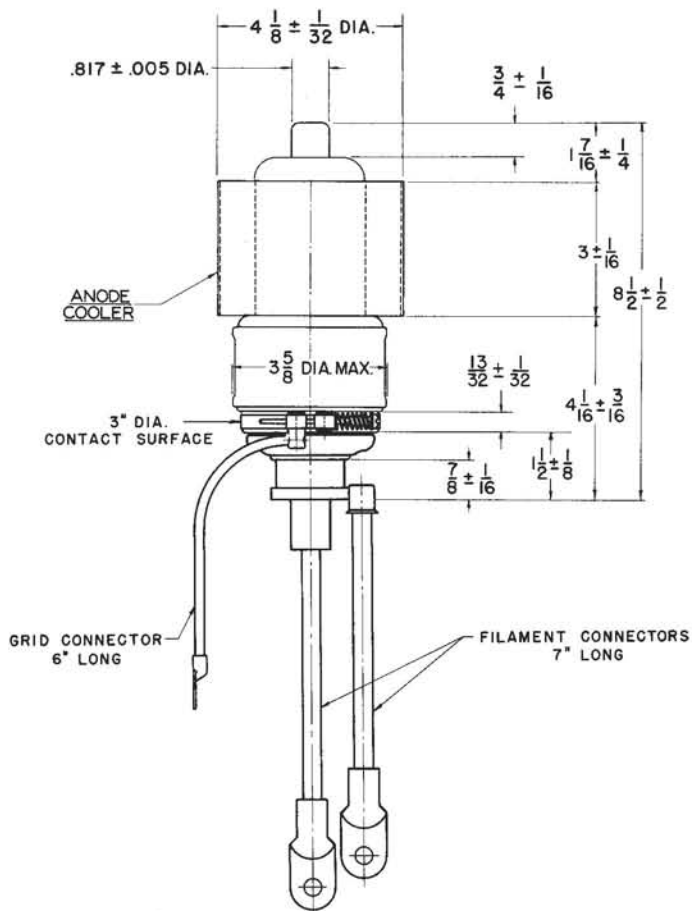
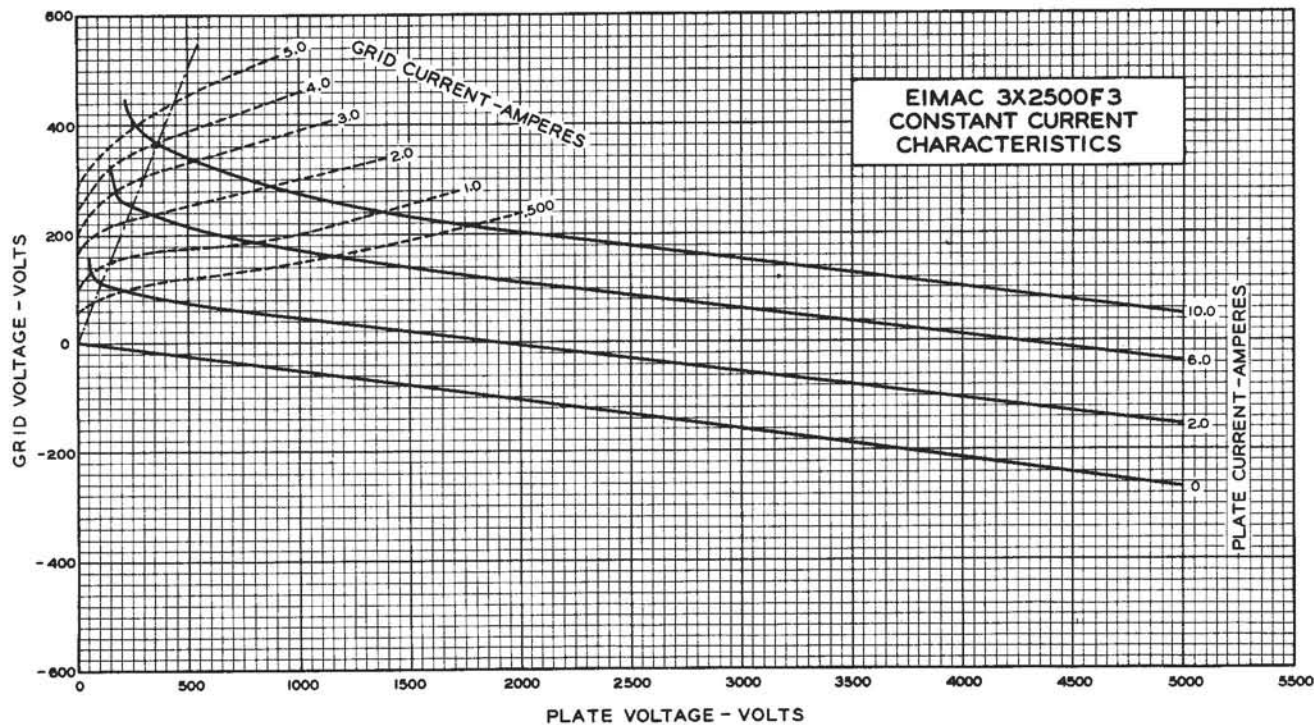
Plate Input - - - - - 6300 6400 10000 watts

Plate Dissipation - - - - - 1300 1400 2500 watts

Plate Power Output - - - - - 5000 5000 7500 watts

<sup>1</sup> A minimum flow of 120 cubic feet of air per minute must be passed through the plate cooler. The pressure drop across the cooler at this flow equals 1.6" of water. A minimum air flow of 6 cubic feet per minute must also be directed toward the filament stem structure, between the inner and outer filament conductors. Cooling air in the above quantities must be supplied to both plate cooler and filament seals before applying filament voltage, and should be continued for five minutes after the filament power is removed.

tween the inner and outer filament conductors. Cooling air in the above quantities must be supplied to both plate cooler and filament seals before applying filament voltage, and should be continued for five minutes after the filament power is removed.



## TENTATIVE DATA

**EITEL-McCULLOUGH, INC.**  
SAN BRUNO, CALIFORNIA

# 3X12500A3

Medium Mu Triode

The Eimac 3X12500A3 is a medium-mu, forced-air cooled, external anode transmitting triode incorporating features which make it suitable for effective use at frequencies well into the vhf region, as well as at lower frequencies. Close electrode spacings and maximum utilization of electrode areas are made possible through the multi-unit design, which allows the production of high power at exceptionally low plate voltage, thus reducing circuit losses to an insignificant amount.

As a push-pull grounded-grid 110-Mc FM amplifier, a pair of 3X12500A3's will deliver a useful output of over 50 kilowatts at a plate voltage of 3700 volts. As a conventional grounded-filament amplifier, a power output of 30 kilowatts per tube may be obtained in class-C telegraphy service.

## GENERAL CHARACTERISTICS

## ELECTRICAL

Filament: Thoriated tungsten

Voltage	- - - - -	7.5	volts
Current	- - - - -	192	amperes
Maximum starting current	- - - - -	400	amperes

Amplification Factor (Average) - - - - - 20

Direct Interelectrode Capacitances (Average)

Grid-Plate	- - - - -	95	$\mu\text{mf.}$
Grid Filament	- - - - -	240	$\mu\text{mf.}$
Plate Filament	- - - - -	5	$\mu\text{mf.}$

Transconductance ( $e_b=3000$  v.,  $i_b=4$  a.) - - - - - 80,000  $\mu\text{mhos}$ 

## MECHANICAL

Cooling - - - - - Forced air<sup>1</sup>

Maximum Overall Dimensions

Length	- - - - -	9.5	inches
Diameter	- - - - -	11.1	inches

Net Weight - - - - - 32 pounds

Shipping Weight (Average) - - - - - 80 pounds

## RADIO FREQUENCY POWER AMPLIFIER

Grounded-Grid Circuit

Class-C FM Telephony or Telegraphy

MAXIMUM RATINGS (Frequencies below 110 Mc.)

D-C PLATE VOLTAGE	- - - - -	4000	MAX. VOLTS
D-C PLATE CURRENT	- - - - -	8	MAX. AMPS.
PLATE DISSIPATION <sup>1</sup>	- - - - -	12,500	MAX. WATTS
GRID DISSIPATION	- - - - -	600	MAX. WATTS

TYPICAL OPERATION (110 Mc., per tube)

D-C Plate Voltage	- - - - -	3700	4000	volts
D-C Grid Voltage	- - - - -	-450	-550	volts
D-C Plate Current	- - - - -	7.2	7.4	amps.
D-C Grid Current	- - - - -	0.9	1.1	amps
Driving Power (approx.)	- - - - -	6.4	7.6	kw
Useful Power Output	- - - - -	27.4	30	kw

## RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Grounded-Filament Circuit

Class-C Telegraphy (Key-down conditions, per tube)

MAXIMUM RATINGS (Frequencies below 85 Mc.)

D-C PLATE VOLTAGE	- - - - -	5000	MAX. VOLTS
D-C PLATE CURRENT	- - - - -	8	MAX. AMPS.
PLATE DISSIPATION <sup>1</sup>	- - - - -	12,500	MAX. WATTS
GRID DISSIPATION	- - - - -	600	MAX. WATTS

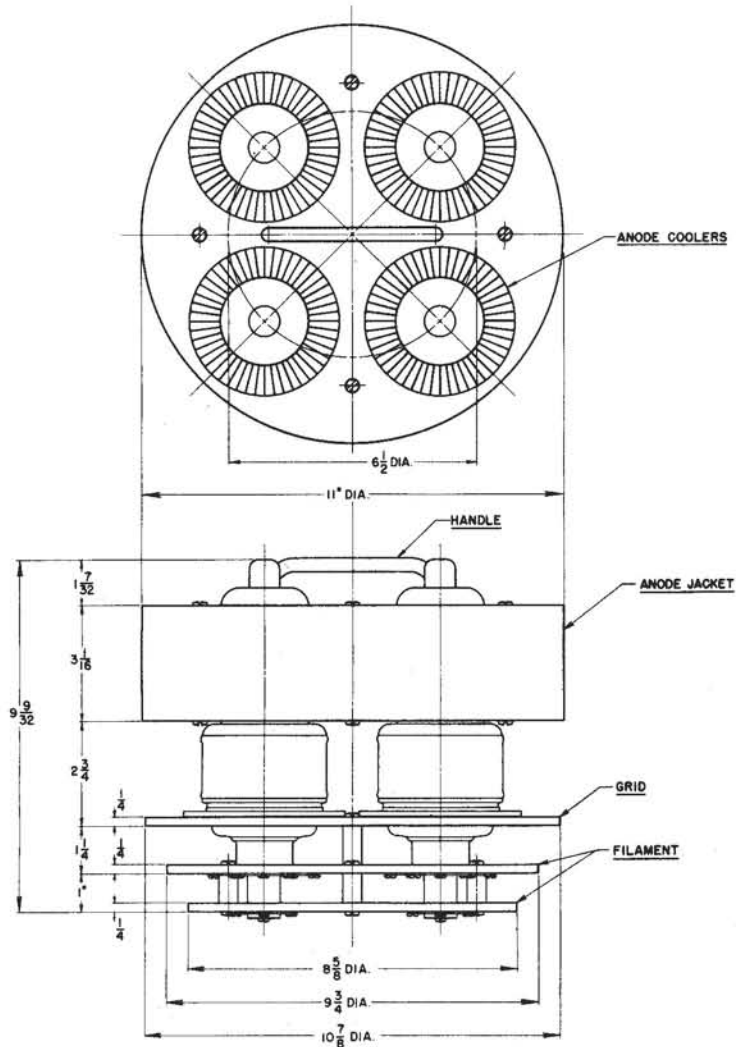
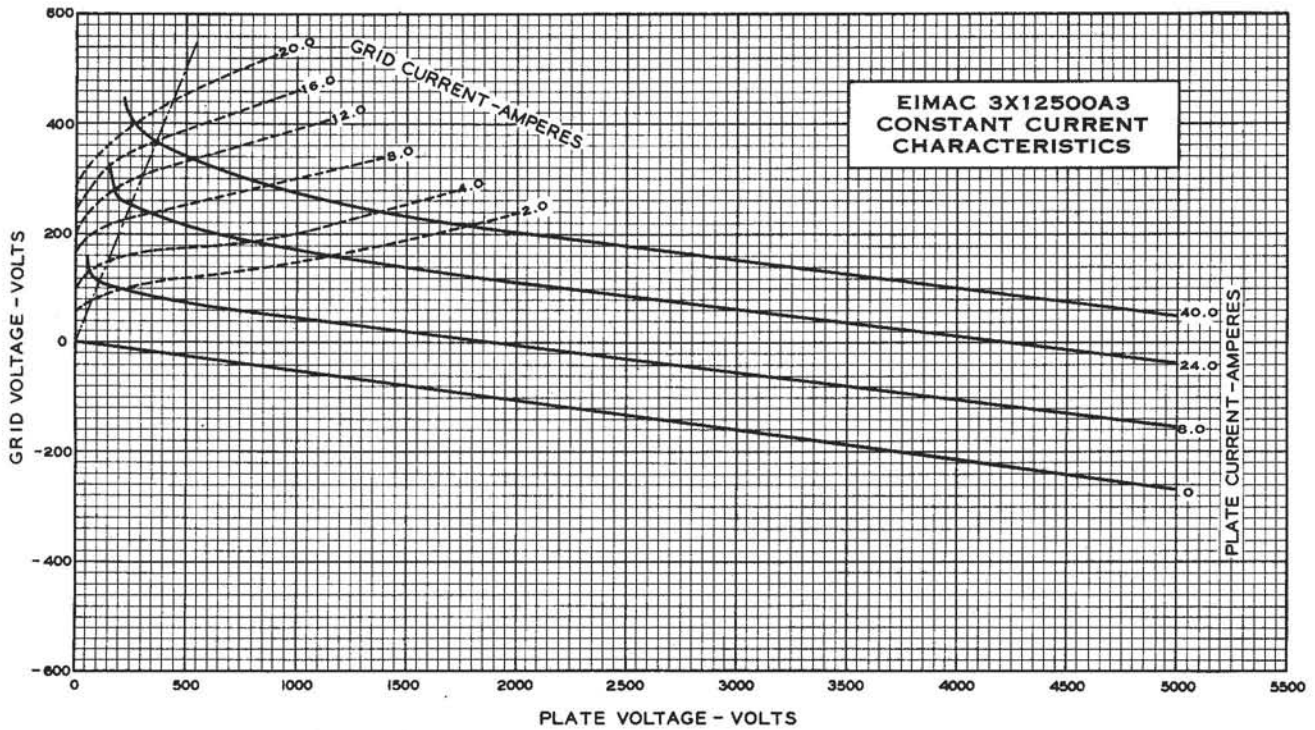
TYPICAL OPERATION (Frequencies below 50 Mc., per tube)

D-C Plate Voltage	- - - - -	3500	4000	5000	volts
D-C Grid Voltage	- - - - -	-420	-360	-400	volts
D-C Plate Current	- - - - -	7.2	6.4	8	amps
D-C Grid Current	- - - - -	2	1.7	1.9	amps
Peak R-F Grid Input Voltage	- - - - -	735	630	710	volts
Driving Power (Approx.)	- - - - -	1.3	0.95	1.35	kw
Grid Dissipation	- - - - -	480	350	590	watts
Plate Input	- - - - -	25.2	25.6	40	kw
Plate Dissipation	- - - - -	5.2	5.6	10	kw
Plate Power Output	- - - - -	20	20	30	kw

<sup>1</sup> A minimum flow of 400 cubic feet of air per minute must be passed through the plate cooler. The pressure drop across the cooler at this flow equals 1.5" of water. A minimum air flow of 200 cubic feet per minute must also be directed toward the filament end of the tube. The pressure required for filament-structure cooling is low, and depends upon the details of the tube mounting. Preference should be given to

filament-structure cooling systems which allow air to enter or exhaust through the central hole in the lower filament strapping plate. Cooling air in the above amounts must be applied to both the plate cooler and filament assembly before applying filament voltage and should be continued for five minutes after the filament power is removed.

► Indicates change from sheet dated 2-25-47





# Eitel-McCullough, Inc.

SAN BRUNO, CALIFORNIA

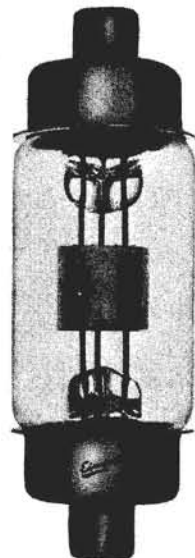
## VACUUM CAPACITOR

VC50-32	VC50-20
VC25-32	VC25-20
VC12-32	VC12-20
VC6-32	VC6-20

Eimac vacuum capacitors are small, vacuum-dielectric units intended principally for use as all or part of the plate tank capacitance in radio-frequency amplifiers or oscillators. They are also frequently used as high-voltage coupling and by-pass capacitors at high frequencies and as high-voltage neutralizing capacitors, when used in conjunction with small high-voltage variable capacitors having a small capacitance range. The use of a vacuum as a dielectric permits the construction of a comparatively small, lightweight capacitor for a given voltage rating and capacitance. In addition, the effects of dust and atmospheric conditions on the capacitor are eliminated by sealing the plates within a glass envelope.

These capacitors are manufactured in two maximum peak voltage ratings, 32,000 and 20,000 volts, and in capacitances of 6, 12, 25 and 50 uufd. All types have a maximum current rating of 28 amperes. Each of the capacitors may be operated at its full maximum voltage rating at any frequency below that at which the rms current through the capacitor is 28 amperes. Above this frequency, the r-f voltage across the capacitor must be reduced as the frequency increases, to prevent the current from exceeding the maximum rating. The graphs below show the maximum peak r-f voltage which may be applied to each type of capacitor at frequencies between 100 kilocycles and 50 megacycles. Curves are also shown which indicate the rms current flowing through the capacitor under maximum r-f voltage conditions at any frequency between 100 kilocycles and 50 megacycles. Where both r-f and d-c voltages are applied to the capacitor, the sum of the peak r-f and d-c voltages must not exceed the peak voltage rating of the capacitor.

Eimac vacuum capacitors are provided with terminals which allow the use of standard 60-ampere fuse clips for mounting. These clips must be kept clean and must at all times make firm and positive contact with the capacitor terminals. Failure to maintain a low-resistance contact to the capacitor terminals may result in excessive heating and permanent damage to the capacitor seals.

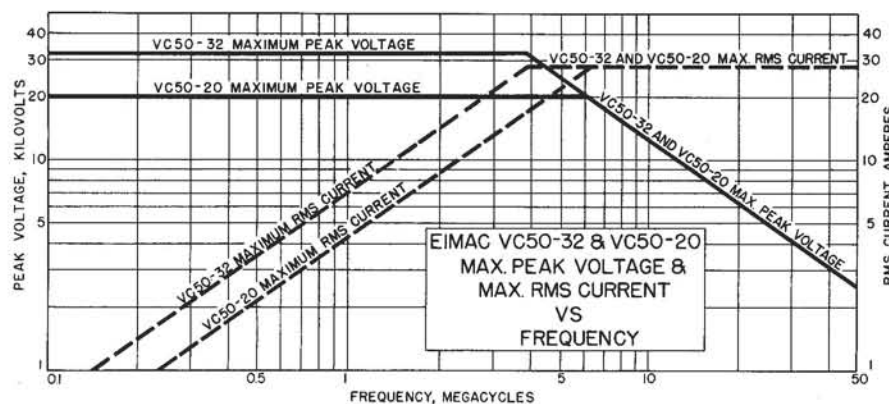


### VC50-32

Capacitance\* . . . . . 50  $\mu$ fd.  
Max. Peak Voltage . . . . . 32,000 volts  
Max. RMS Current . . . . . 28 amps.

### VC50-20

Capacitance\* . . . . . 50  $\mu$ fd.  
Max. Peak Voltage . . . . . 20,000 volts  
Max. RMS Current . . . . . 28 amps.

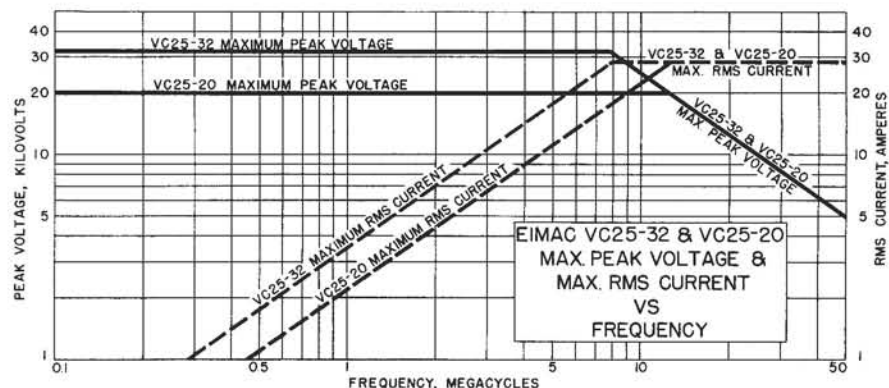


### VC25-32

Capacitance\* . . . . . 25  $\mu$ fd.  
Max. Peak Voltage . . . . . 32,000 volts  
Max. RMS Current . . . . . 28 amps.

### VC25-20

Capacitance\* . . . . . 25  $\mu$ fd.  
Max. Peak Voltage . . . . . 20,000 volts  
Max. RMS Current . . . . . 28 amps.

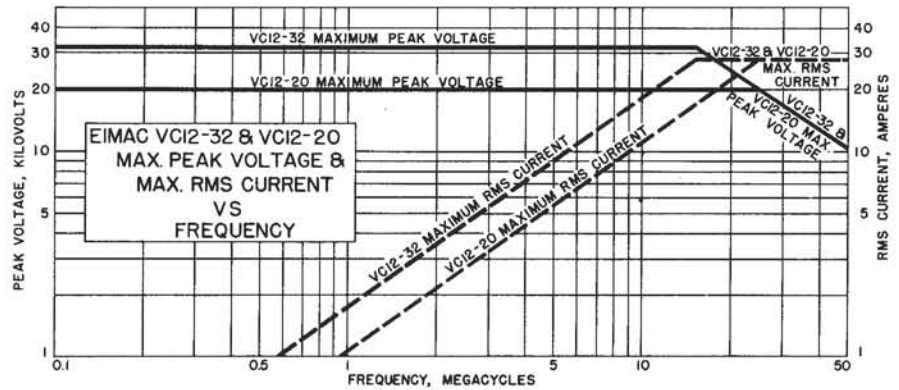


## VC12-32

Capacitance\* . . . . . 12  $\mu\mu\text{fd.}$   
Max. Peak Voltage . . . . . 32,000 volts  
Max. RMS Current . . . . . 28 amps.

## VC12-20

Capacitance\* . . . . . 12  $\mu\mu\text{fd.}$   
Max. Peak Voltage . . . . . 20,000 volts  
Max. RMS Current . . . . . 28 amps.

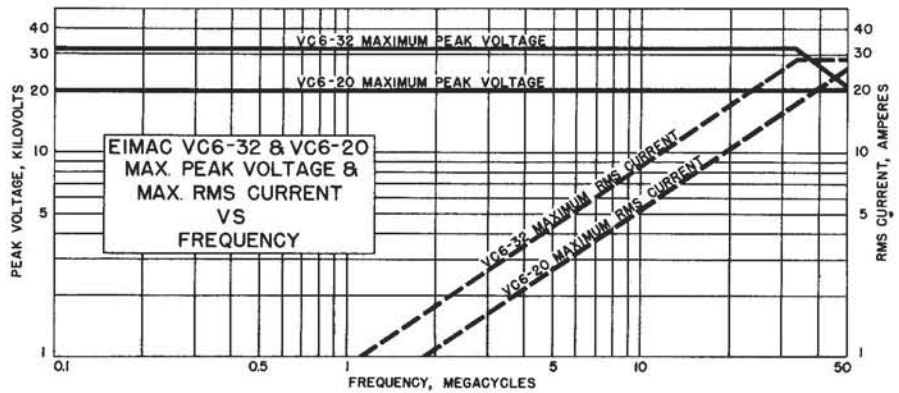


## VC6-32

Capacitance\* . . . . . 6  $\mu\mu\text{fd.}$   
Max. Peak Voltage . . . . . 32,000 volts  
Max. RMS Current . . . . . 28 amps.

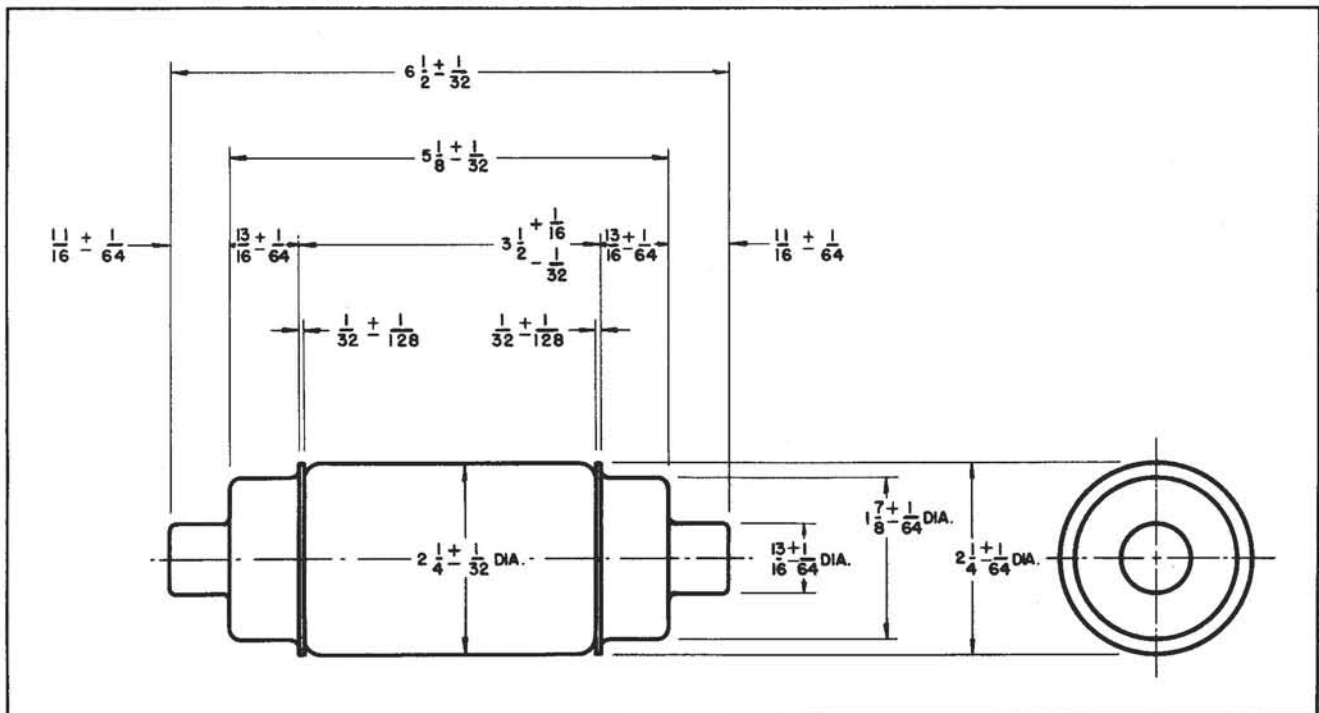
## VC6-20

Capacitance\* . . . . . 6  $\mu\mu\text{fd.}$   
Max. Peak Voltage . . . . . 20,000 volts  
Max. RMS Current . . . . . 28 amps.

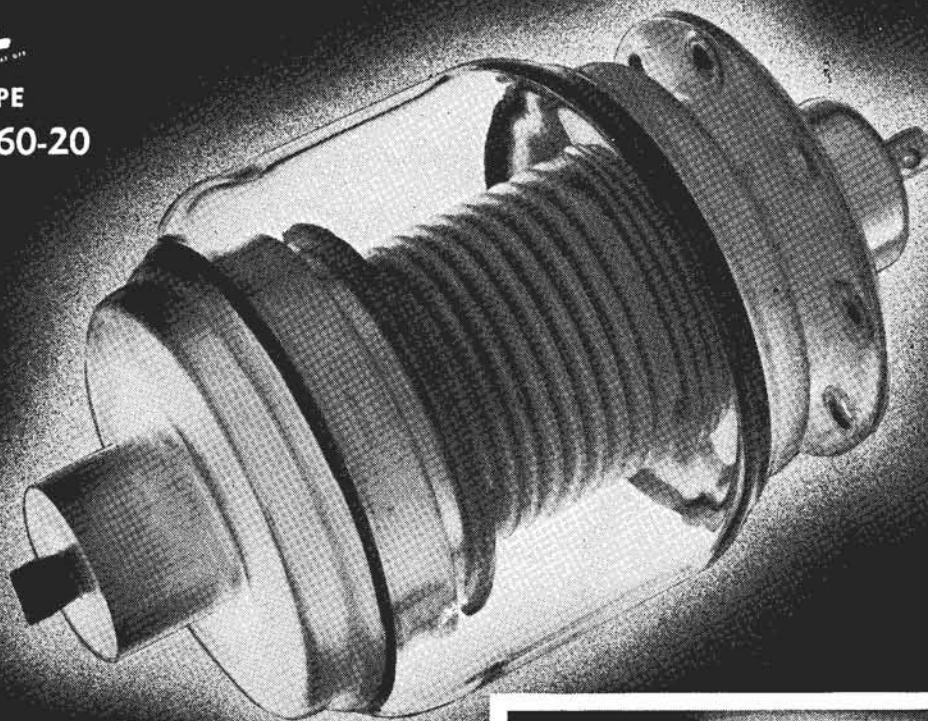


\*Tolerances:

VC50-32, VC50-20 . . . . .  $\pm 1 \mu\mu\text{fd.}$ ; VC25-32, VC25-20 . . . . .  $\pm 1 \mu\mu\text{fd.}$ ; VC12-32, VC12-20 . . . . .  $\pm 1 \mu\mu\text{fd.}$ ; VC6-32, VC6-20 . . . . .  $\pm 0.5 \mu\mu\text{fd.}$



**Eimac**  
TYPE  
**VVC 60-20**



## NOW . . . VARIABLE VACUUM CAPACITORS . . . by EIMAC

Here at last is a dependable variable vacuum capacitor that is physically designed for practical application. Every detail of construction makes the Eimac VVC series the standout variable vacuum capacitor component for your equipment. Here is supreme performance and dependability as only Eimac research and engineering can provide.

### CHECK THESE FEATURES

**PRACTICAL MOUNTING** . . . designed for wide application, the base plate on the single units mounts on panel for direct control, or vertically on chassis for control from a flexible shaft or angular control. Multiple units are conveniently bracketed for chassis and panel installation.

**COMPACT SIZE** . . . the single unit VVC-60 is but 3 inches in diameter and 5 inches in length. Multiple units are proportionally larger.

**COPPER COMPONENTS** . . . for increased R-F conductivity and minimum internal losses. All contact surfaces are silver plated.

**MECHANICALLY RUGGED** . . . bellows, bearings and adjusting mechanism designed to withstand excessive use and provide long life.

**SIMPLE CONTROL** . . . single and multiple units vary capacitance by rotation of a single knob. Return to previously indexed settings is positive.

For further information see your Eimac dealer or write direct.

#### EITEL-McCULLOUGH, INC.

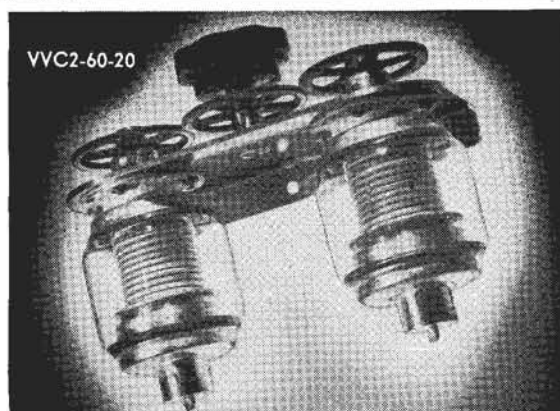
194 San Mateo Avenue, San Bruno, California

EXPORT AGENTS: Frazar & Hansen—301 Clay St.—San Francisco, Calif.

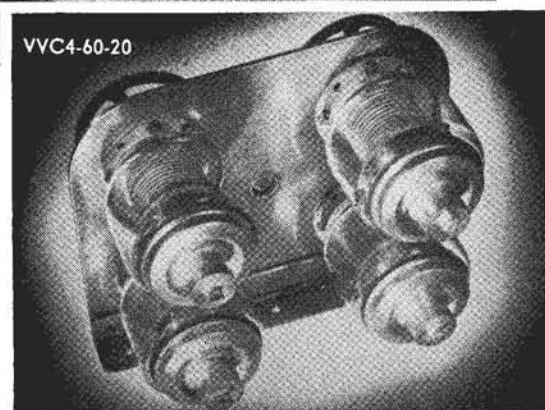
Follow the Leaders to

**Eimac**  
TUBES  
The Power for R-F

VVC2-60-20

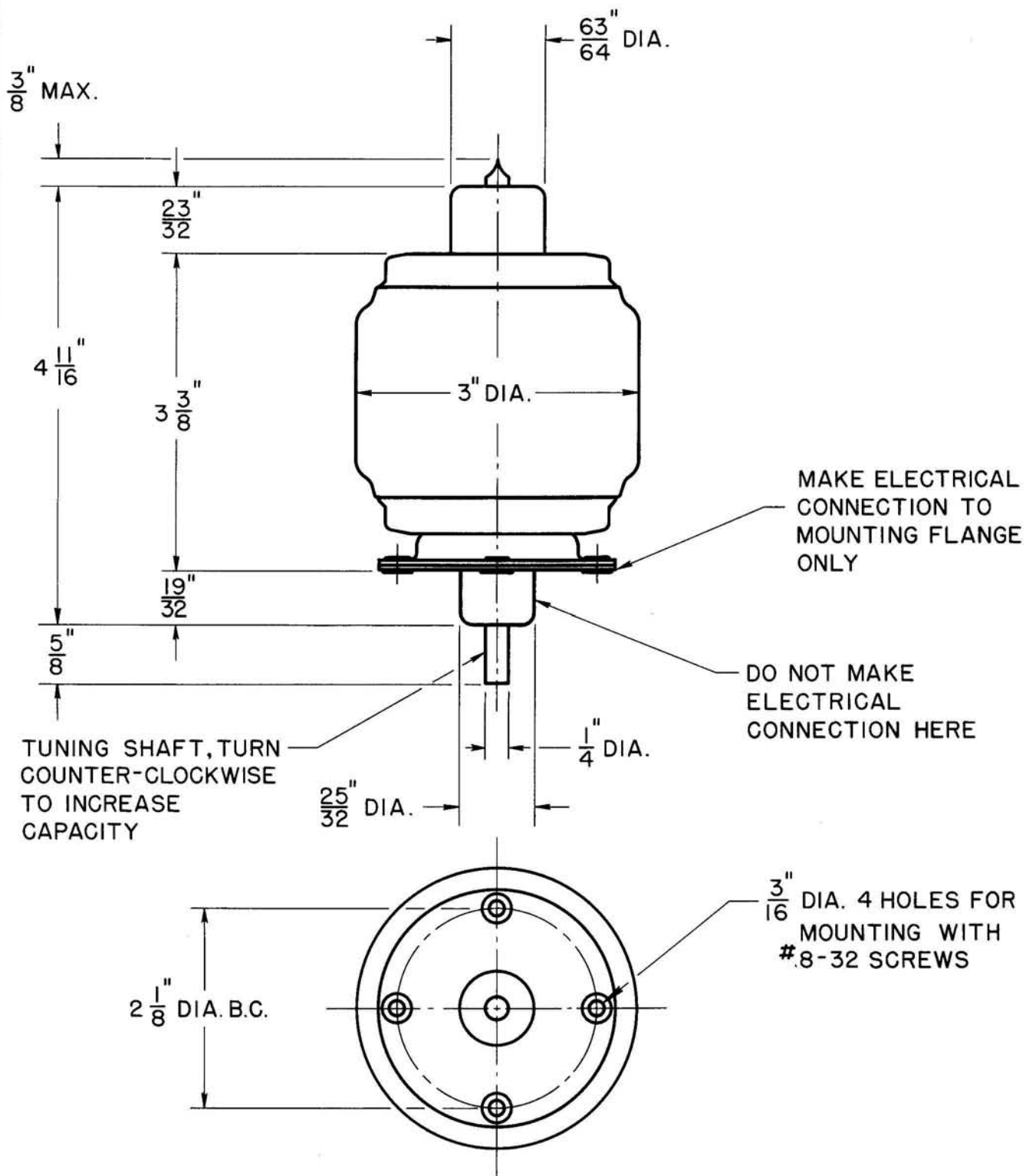


VVC4-60-20



#### GENERAL CHARACTERISTICS

	Capacity	R-F Peak Voltage	Maximum RMS Current
VVC 60-20	10-60 mmf.	20-KV	40 amp.
VVC2-60-20 Parallel	20-120 mmf.	20-KV	80 amp.
Split-stator	5-30 mmf.	40-KV	40 amp.
VVC4-60-20 Parallel	40-240 mmf.	20-KV	160 amp.
Split-stator	10-60 mmf.	40-KV	80 amp.



The Eimac 866-A/866 is a half-wave mercury-vapor rectifier incorporating features which enable it to withstand high peak-inverse voltages and to conduct at relatively low applied-voltages. The shielded ribbon filament, edgewise-wound, provides a large emission reserve and long life.

## GENERAL CHARACTERISTICS

## ELECTRICAL

[illegible]

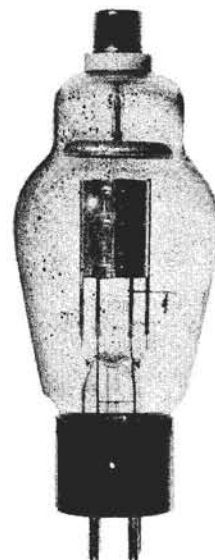
## MECHANICAL

[illegible]

### MAXIMUM RATINGS (single tube)

PEAK INVERSE ANODE VOLTAGE	-	-	2,000	5,000	10,000	MAX. VOLTS
PEAK ANODE CURRENT	-	-	2.0	1.0	1.0	MAX. AMPERES
AVERAGE ANODE CURRENT	-	-	0.5	0.25	0.25	MAX. AMPERES
SUPPLY FREQUENCY	-	-	150	1,000	150	MAX. C. P. S.
CONDENSED-MERCURY TEMPERATURE RANGE <sup>1</sup>	-	-	25-70	25-70	25-60	°C

<sup>1</sup>Operation at 40 degrees plus or minus 5 degrees C is recommended.



## APPLICATION

## MECHANICAL

**MOUNTING**—The 866-A/866 must be mounted vertically, base down.

**COOLING**—Provision should be made for adequate air circulation around the tube, because cooling is accomplished by convection. The temperature of the condensed-mercury in the 866-A/866 should be kept within the ranges given under "MAXIMUM RATINGS". This temperature should be maintained at 40 degrees plus or minus 5 degrees C for most satisfactory operation of the tube. To measure the condensed-mercury temperature a thermocouple or small thermometer may be attached to the bulb in the area designated on the outline drawing, using a very small amount of putty. A condensed-mercury temperature lower than the recommended value raises the voltage at which the tube becomes conducting and tends to reduce the life of the filament. A temperature higher than recommended lowers the voltage at which the tube becomes conducting and tends to increase the life of the filament, but reduces the peak inverse voltage rating of the tube. When it is necessary to use a shield around the 866-A/866 care must be taken to insure adequate ventilation and maintenance of normal condensed-mercury temperature.

## ELECTRICAL

**FILAMENT VOLTAGE**—For maximum tube life, the filament voltage as measured directly at the filament pins, should be held at the rated value of 2.5 volts. Unnecessary variations in filament voltage must be kept within the range of 2.38 to 2.62 volts. Filament voltage less than the minimum recommended value may cause a high tube voltage drop with consequent bombardment of the filament and eventual loss of emission. A filament voltage higher than the recommended maximum value will also decrease the life of the filament.

CAUTION SHOULD BE OBSERVED IN MEASURING THE FILAMENT VOLTAGE, AS THE FILAMENT CIRCUIT MAY BE AT A HIGH D-C POTENTIAL.

The plate-circuit return of each tube should preferably be connected to the center tap of the transformer winding supplying its filament voltage; if this cannot be done, the return should be connected to that side of the filament to which the cathode shields are connected (pin No. 4). When the filaments of two or more tubes are connected in parallel, the filament terminals to which the cathode shields are connected should be joined. These precautions are recommended to insure the starting voltage for each tube when several are used in a given circuit.

The filament of the 866-A/866 should be allowed to reach operating temperature before the plate voltage is applied. Under normal conditions, a delay of approximately 30 seconds will be required. The delay times should be increased if there is any evidence of arc-back within the tube. In radio transmitter applications, the filament should be kept at its rated voltage during "standby" periods to avoid delay due to warm-up. It is desirable to use a protective relay in the plate circuit to prevent the application of plate voltage before the filament has reached operating temperature. This relay should have a time delay adjustable up to a maximum of one minute.

When an 866-A/866 is first installed, the filament should be operated at normal voltage for approximately ten minutes with no plate voltage applied, in order that the mercury may be properly distributed. It will not be necessary to repeat this procedure unless the mercury is spattered on the filament and plate during subsequent handling.

**SHIELDING**—Electromagnetic and electrostatic fields tend to cause the mercury vapor to break down, are detrimental to tube life and make proper wiring difficult. Consequently, the 860-A/864 should be isolated from such fields as exist and any necessary shielding equipment. When the tubes are located in the region of such fields, shielding with adequate ventilation should be used around the tubes. R-f filtering should also be employed when the tubes are affected by r-f voltages.

**FILTERING**—The nomograph for circuits 1 and 3, and tables for circuits 2, 4 and 5 give empirical values of inductance and capacitance for a single-section choke-input filter which will keep the peak plate current below the maximum rated value, provided the average d-c load current does not exceed the maximum load current indicated. The values of L and C are based on a power-supply frequency of 60 cycles.

The value of the capacitor is made small enough to prevent excessive surges when power is first applied to the circuit. If the available inductance is larger than the minimum allowable value, the capacitance may be increased proportionately over its nomograph or table maximum. In a two-section filter with two unequal inductances, the input inductances should be the larger. The maximum value of each capacitor in such a filter is based upon the value of the preceding inductance.

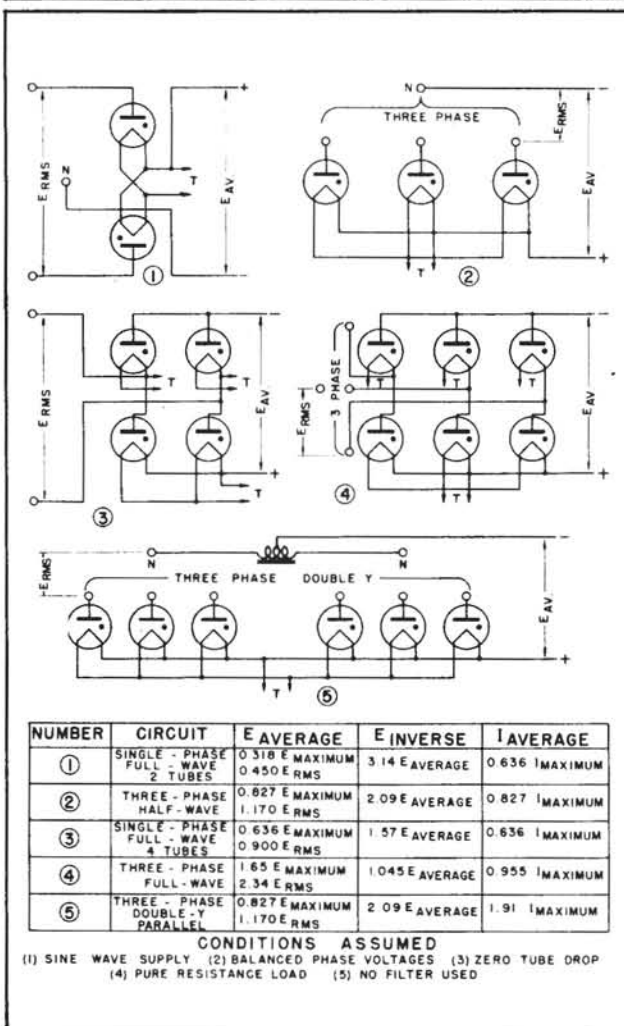
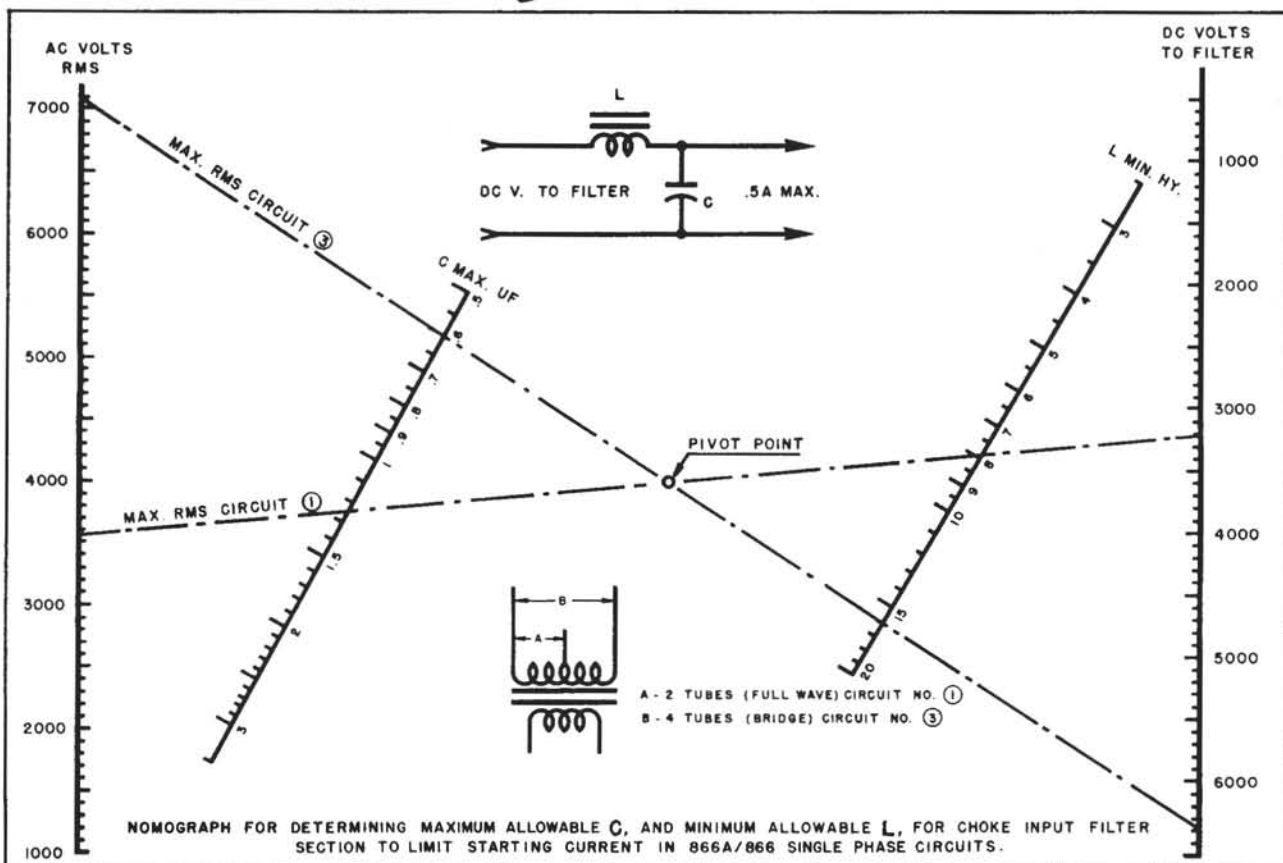
In the single phase circuits (1 and 3), if the current drawn by the load is reduced or varies under operating conditions to values less than approximately 70% of the indicated maximum d-c load current, a swinging (input) choke will supply the necessary additional inductance to prevent the voltage from rising, and will afford proper filtering over a much greater current range.

Arrangements such as those shown in Circuits 1, 2 and 3 produce less than 5% ripple voltage when a two-section filter with minimum inductance and corresponding minimum capacitance is employed. Circuits such as those shown in circuits 4 and 5 will produce less than 1% ripple voltage. Better filtering may be obtained with any of these circuits by using larger values of inductance than the minimum indicated. Still greater improvement may be had by then proportionately increasing the corresponding capacitor values.

When "condenser input" filter is used, the peak current will be relatively high in respect to the suitable load current, and the voltage across the capacitor may be as high as 1.4 times the nominal RMS voltage of the transformer.

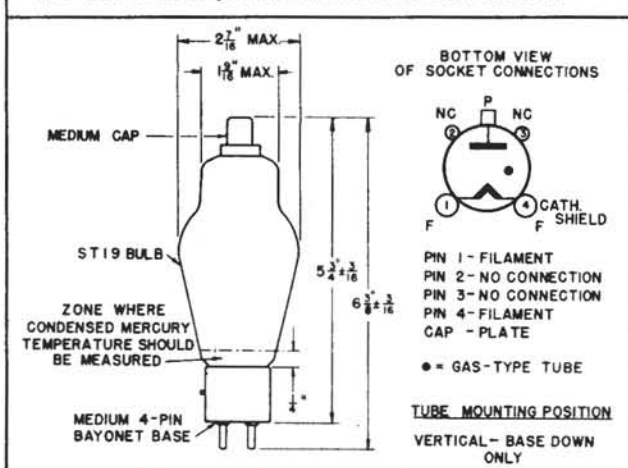
For parallel operation of 866-A/866 rectifiers, suitable resistors or small inductors may be used in series with each plate lead to permit equal loading and starting characteristic. The inductors aid in reducing the peak current, and are more desirable due to their low d-c resistance. An approximate value for suitable resistors is 50 ohms, and for inductors, approximately one-third henry each.



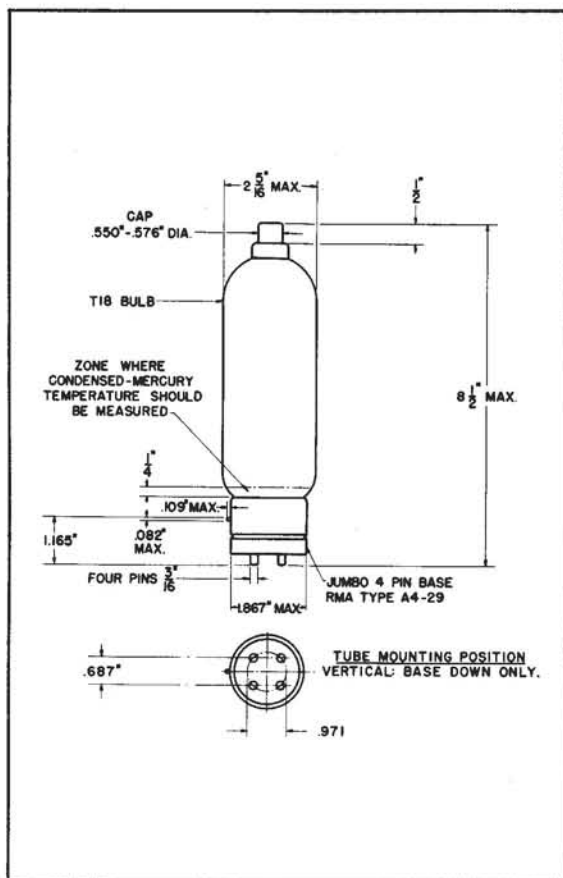
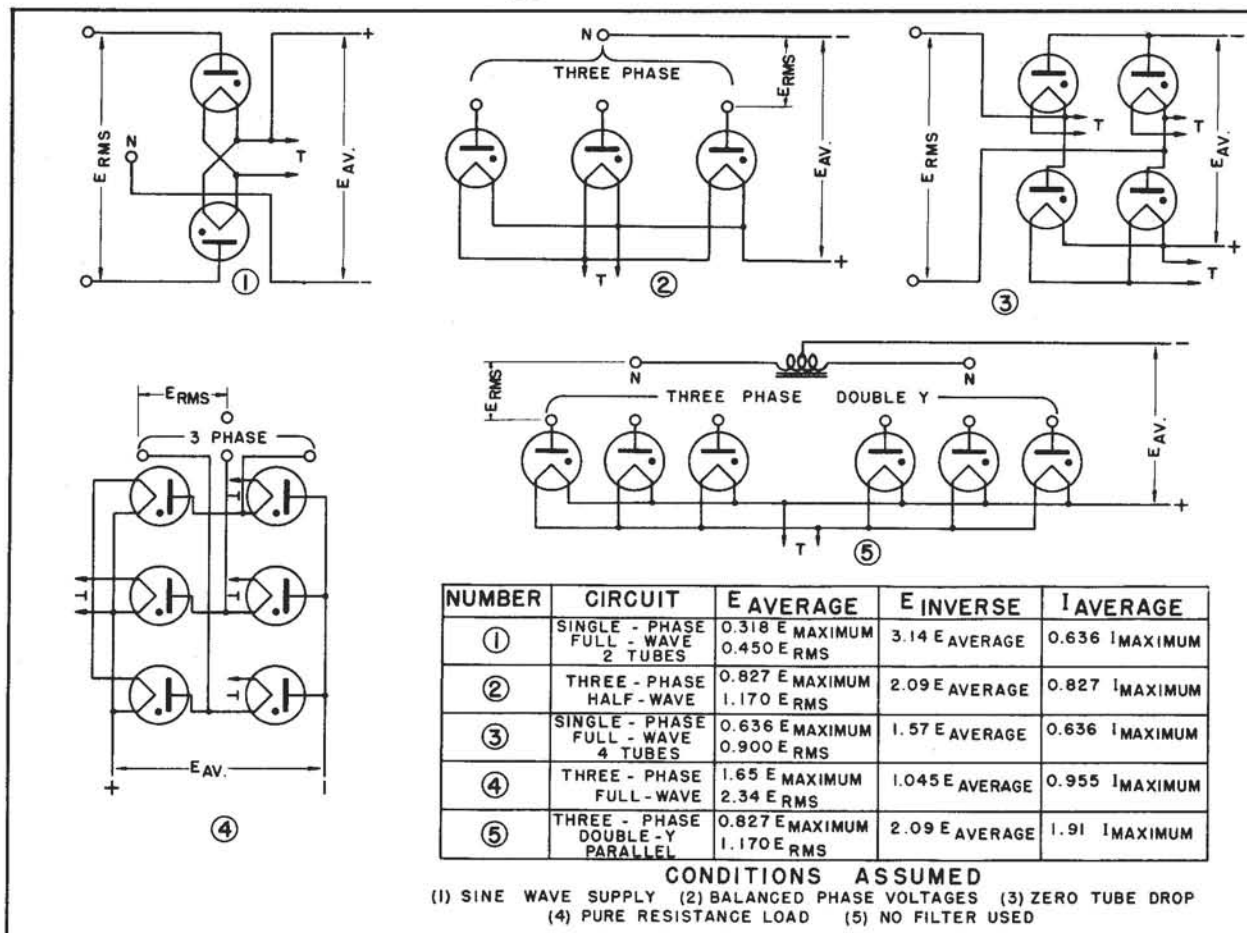


CIRCUIT	A-C INPUT VOLTS** (RMS)	MAX. D-C OUTPUT VOLTS TO FILTER	CHOKE INPUT ONE-SECTION FILTER		MAX. D-C LOAD CURRENT amperes
			MIN. CHOKE (L) henrys	MAX. CON-DENSER (C) uf	
THREE-PHASE HALF-WAVE CIRCUIT 2	per leg				
	4080	4780	3.2	1.4	0.75
	3000	3510	2.2	2.0	0.75
	2000	2340	1.4	3.0	0.75
THREE-PHASE FULL-WAVE CIRCUIT 4	per leg				
	4080	9570	1.8	0.5	0.75
	3000	7020	1.4	0.7	0.75
	2000	4680	0.9	1.2	0.75
THREE-PHASE DOUBLE-Y PARALLEL CIRCUIT 5	per leg				
	4080	4780	2.0	0.5	1.5
	3000	3510	1.5	0.7	1.5
	2000	2340	1.0	1.1	1.5
SINGLE PHASE FULL-WAVE (2 tubes) CIRCUIT 1*	per tube				
	3535	3950	—	—	0.25
	3000	3390	—	—	0.25
	2000	2240	—	—	0.25
	1500	1700	—	—	0.25

\* With condenser input to filter.  
\*\* For use under the conditions of the 10000-volt peak inverse rating. If the 866A/866 is to be used under frequency and/or temperature conditions such that the peak inverse voltage is limited to 5000 volts, the a-c input voltage and d-c output voltage values in the table should be multiplied by a factor of 0.5 to give new values for the 5000-volt conditions.

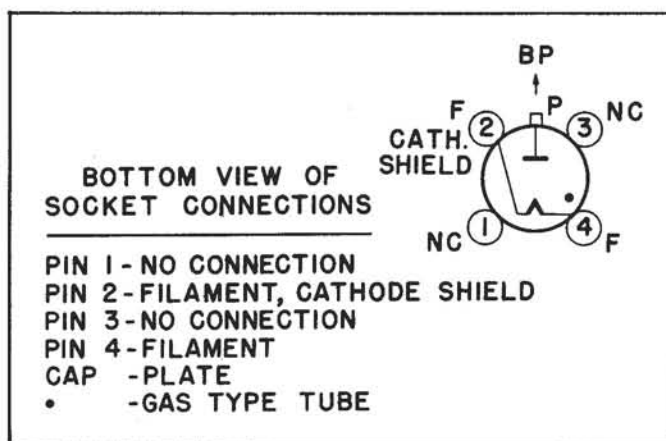






CIRCUIT	INPUT VOLTS/ MAXIMUM A-C (RMS)	APPROX. D-C OUTPUT VOLTS TO FILTER	MAXIMUM D-C OUTPUT CURRENT AMPERES
1	3535 per tube	3180	2.5
2	4080 per leg	4780	3.75
3	7070 total	6360	2.5
4	4080 per leg	9570	3.75
5	4080 per leg	4780	7.5

1 Max. peak inverse voltage of 10,000 volts.



# EITEL-McCULLOUGH, INC.

SAN BRUNO, CALIFORNIA

## HR HEAT DISSIPATING CONNECTORS

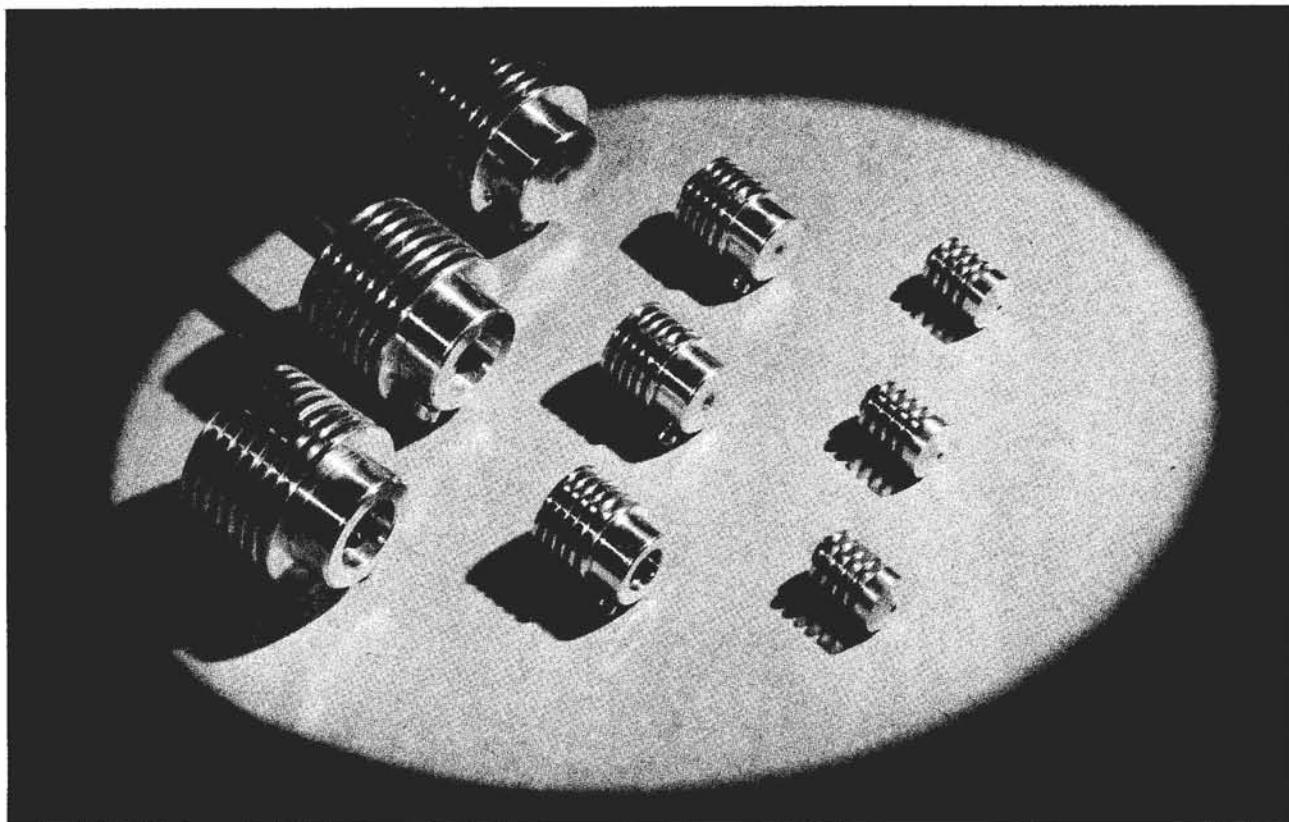
Eimac HR Heat Dissipating Connectors are used to make electrical connections to the plate and grid terminals of Eimac tubes, and, at the same time, provide efficient heat transfer from the tube element and glass seal to the air. The HR connectors aid materially in keeping seal temperatures at safe values. However, it is sometimes necessary to forced-air-cool the connector by means of a small fan or blower. In such cases the air flow should be parallel with the fins of the connector. De-

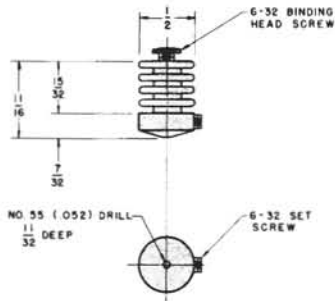
signed for use on the larger tubes, the HR-9 Heat Dissipating Connector is provided with an air duct to conduct the cooling air directly to the glass seal.

HR Heat Dissipating Connectors are machined from solid dural rod, and are supplied with the necessary machine screws. The table below lists the proper connectors for use with each Eimac tube type.

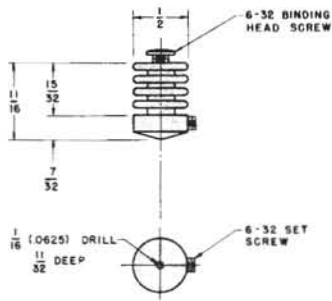
TUBE	PLATE CONNECTOR	GRID CONNECTOR	TUBE	PLATE CONNECTOR	GRID CONNECTOR
25T	HR-1	.....	1000T	HR-9	HR-9
3C24	HR-1	HR-1	1500T	HR-8	HR-9
35T	HR-3	.....	2000T	HR-8	HR-9
35TG	HR-3	HR-3	4-125A	HR-6	.....
UH50	HR-2	HR-2	4-250A	HR-6	.....
75TH-TL	HR-3	HR-2	RX21A	HR-3	.....
100TH-TL	HR-6	HR-2	KY21A	HR-3	.....
152TH-TL	HR-5	HR-6	100-R	HR-8	.....
250TH-TL	HR-6	HR-3	2-150A	HR-5	.....
304TH-TL	HR-7	HR-6	2-150D	HR-6	.....
450TH-TL	HR-8	HR-8*	250-R	HR-6	.....
750TL	HR-8	HR-8			

\*The grid terminal of the 450TH-TL type tube is now .560" in diameter. To accommodate existing equipment designed for the older style 450TH-TL having .098" diameter grid terminals, an adapter pin is provided with the newer tubes. This adapter pin is threaded so that it may be removed from the grid terminal of the tube. The small grid terminal requires an HR-4 connector.

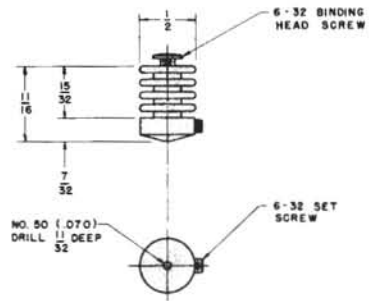




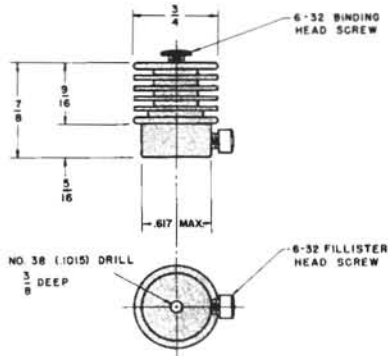
HR - 1



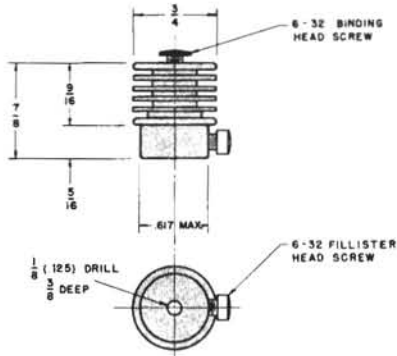
HR - 2



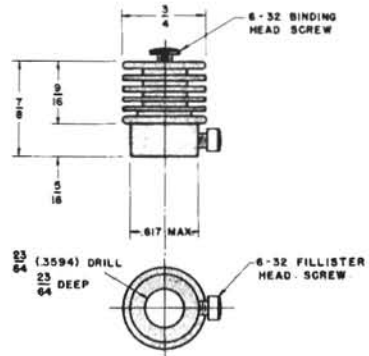
HR - 3



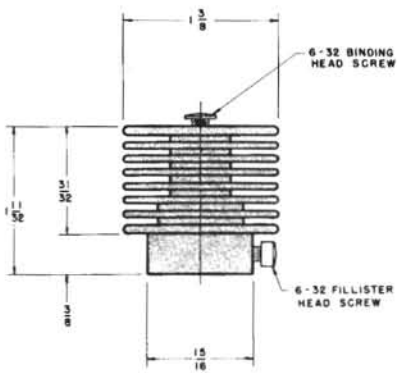
HR - 4



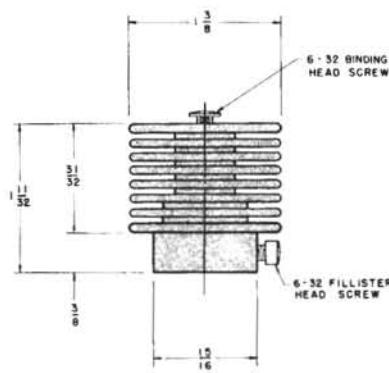
HR - 5



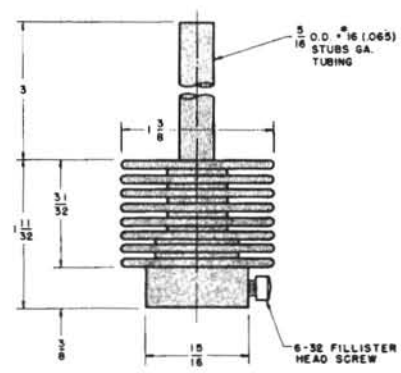
HR - 6



HR - 7

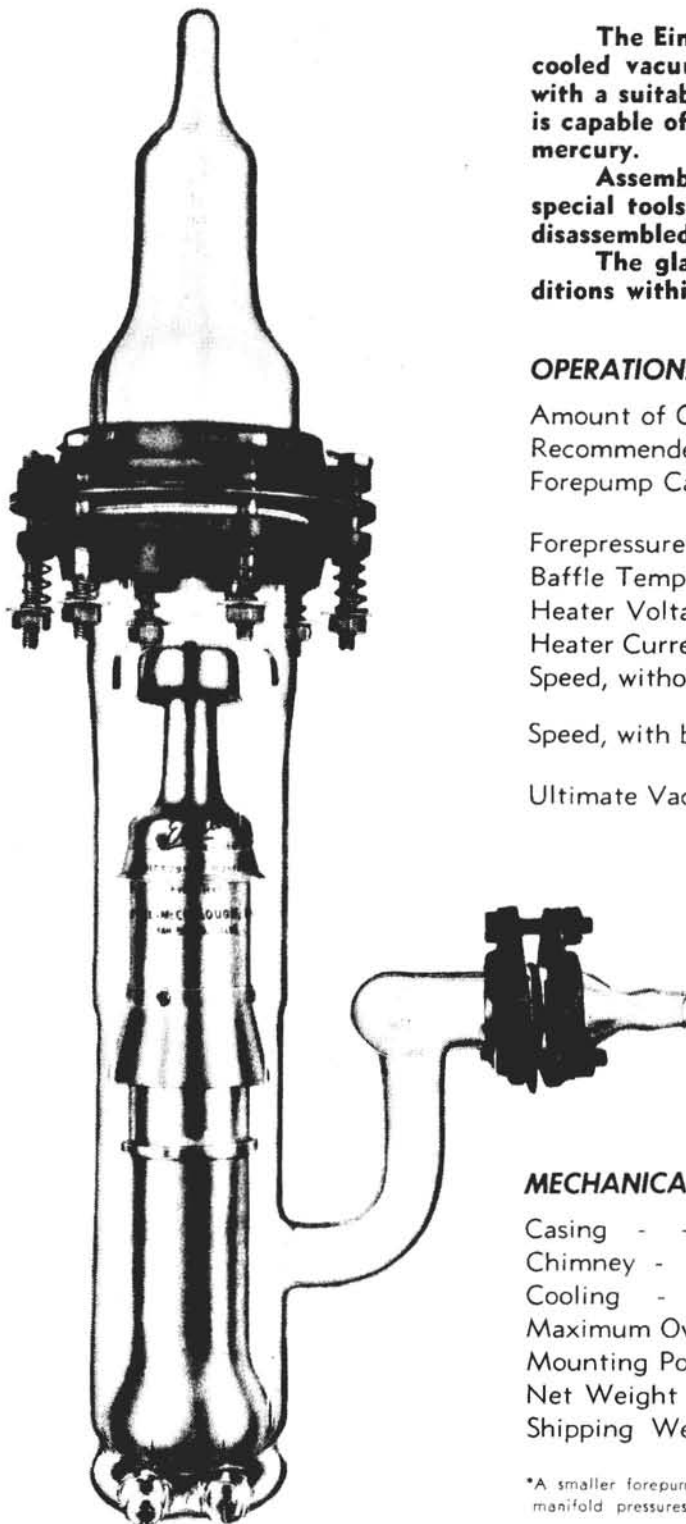


HR - 8



HR - 9





The Eimac HV-1 Diffusion Pump is a fast, triple-jet, air-cooled vacuum pump of the oil-diffusion type. When used with a suitable mechanical forepump and Eimac type A oil it is capable of reaching an ultimate vacuum of  $4 \times 10^{-7}$  mm of mercury.

Assembly of the pump is a simple operation, requiring no special tools or intricate adjustments. It can be completely disassembled for cleaning in five minutes or less.

The glass construction permits rapid inspection of conditions within the pump.

## OPERATIONAL DATA

Amount of Oil	- - - - -	150 milliliters
Recommended Oil	- -	Eimac Diffusion Pump Oil, Type A
Forepump Capacity*	- - - - -	0.1 to 2.0 liters per second at 0.001 mm of mercury, or less
Forepressure (maximum)	- - - - -	0.02 mm of mercury
Baffle Temperature	- - - - -	35° C or lower
Heater Voltage	- - - - -	100 to 110 volts
Heater Current (at 110 volts)	- - - - -	1.7 amperes
Speed, without baffle (approx.) *	- - - - -	67 liters per second at $4 \times 10^{-4}$ to $4 \times 10^{-6}$ mm Hg
Speed, with baffle (approx.) *	- - - - -	32 liters per second at $4 \times 10^{-4}$ to $4 \times 10^{-6}$ mm Hg
Ultimate Vacuum, at 25° C (approx.)	- -	$4 \times 10^{-7}$ mm Hg when using recommended oil.

## MECHANICAL DATA

Casing	- - - - -	Pyrex Glass
Chimney	- - - - -	3 Jet, Aluminum
Cooling	- - - - -	Air
Maximum Overall Dimensions	- - -	See Outline Drawing
Mounting Position	- - - - -	-Vertical, boiler down
Net Weight	- - - - -	11 pounds
Shipping Weight	- - - - -	16 pounds

\*A smaller forepump may be used, but this will reduce the pumping speed at the higher manifold pressures.

### OPERATION

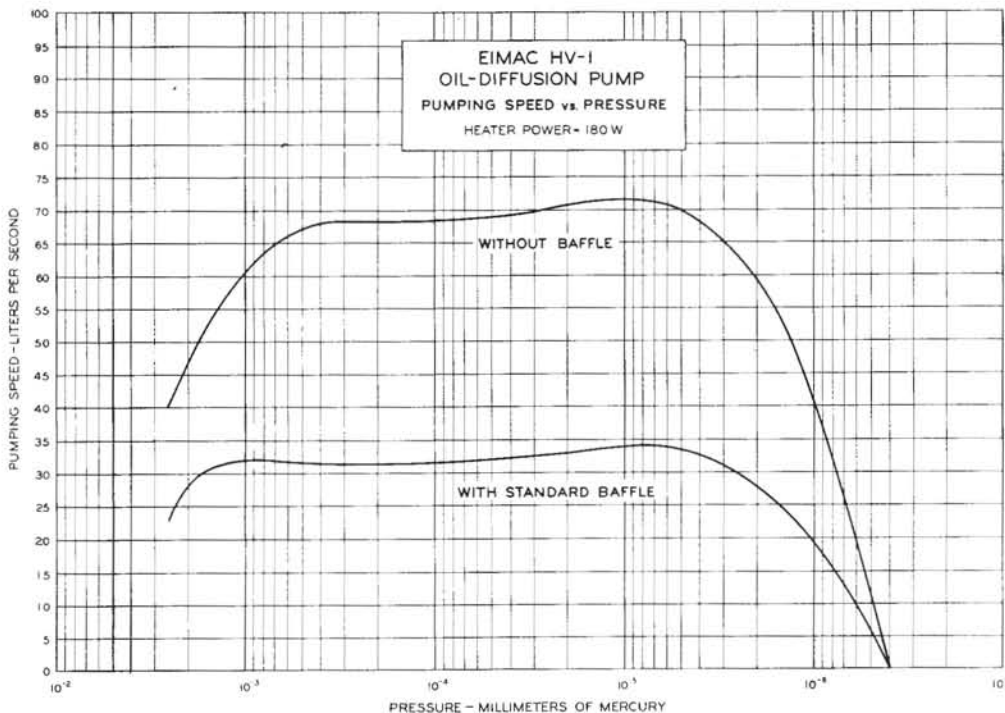
The principle upon which the oil-diffusion pump operates may be explained as follows. The drawing on page three illustrates the accepted theory. Gas to be removed from the high-vacuum system enters the pump at the top, whence it moves into the region of the upper jet. Emerging from this jet is a stream of oil vapor which is generated by the electrically-heated oil boiler at the bottom of the pump. Molecules of the unwanted gas diffuse into this stream of oil vapor and are carried down and out toward the cooler glass-wall of the pump. Upon reaching the glass-wall, the oil vapor condenses to a film of liquid oil which runs down the wall and returns to the boiler. The gas molecules are forced downward by the oil vapor and gas above them and come under the influence of the middle jet, where they are again forced down toward the bottom of the pump by a stream of oil vapor.

in the system are to be avoided wherever possible. A short length of small-bore tubing can cause a considerable reduction in pumping speed.

Pumping speed is also affected by the capabilities of the forepump. The forepump must be able to remove the gas from the system while maintaining the required low pressure at its end of the diffusion pump.

Increased pumping speed may be obtained by operating several HV-1 units in multiple. The number of units which may effectively be used in multiple will be determined by the ability of the forepump to produce the required forepressure, and the ability of the manifold and tubulations to handle the desired pumping speed.

The HV-1 is capable of reaching an ultimate vacuum of  $4 \times 10^{-7}$  mm of mercury. To reach this low pressure, however, it is essential to avoid any contaminant in the high-vacuum system. Water, even in small amounts, or



The curves at the left show the gas handling capabilities of the HV-1 over a range of pressures both with and without a baffle. These curves apply when a forepump with the required capacity is used. The rapid loss in pumping speed at the higher pressures is due to the inability of the forepump to handle the necessary volume of gas. With a larger forepump, the pumping speed would be maintained out to higher pressures.

The process of "packing" the molecules of gas down toward the bottom of the pump is again repeated at the bottom jet. During pumping, as the manifold pressure drops, the amount of oil issuing from the lower jet is sufficient to form a visible ring of oil on the wall of the pump at a point well below the bottom skirt. In this region the concentration of gas is great enough to raise the pressure to a point which will allow a mechanical forepump to effectively remove the gas from the system.

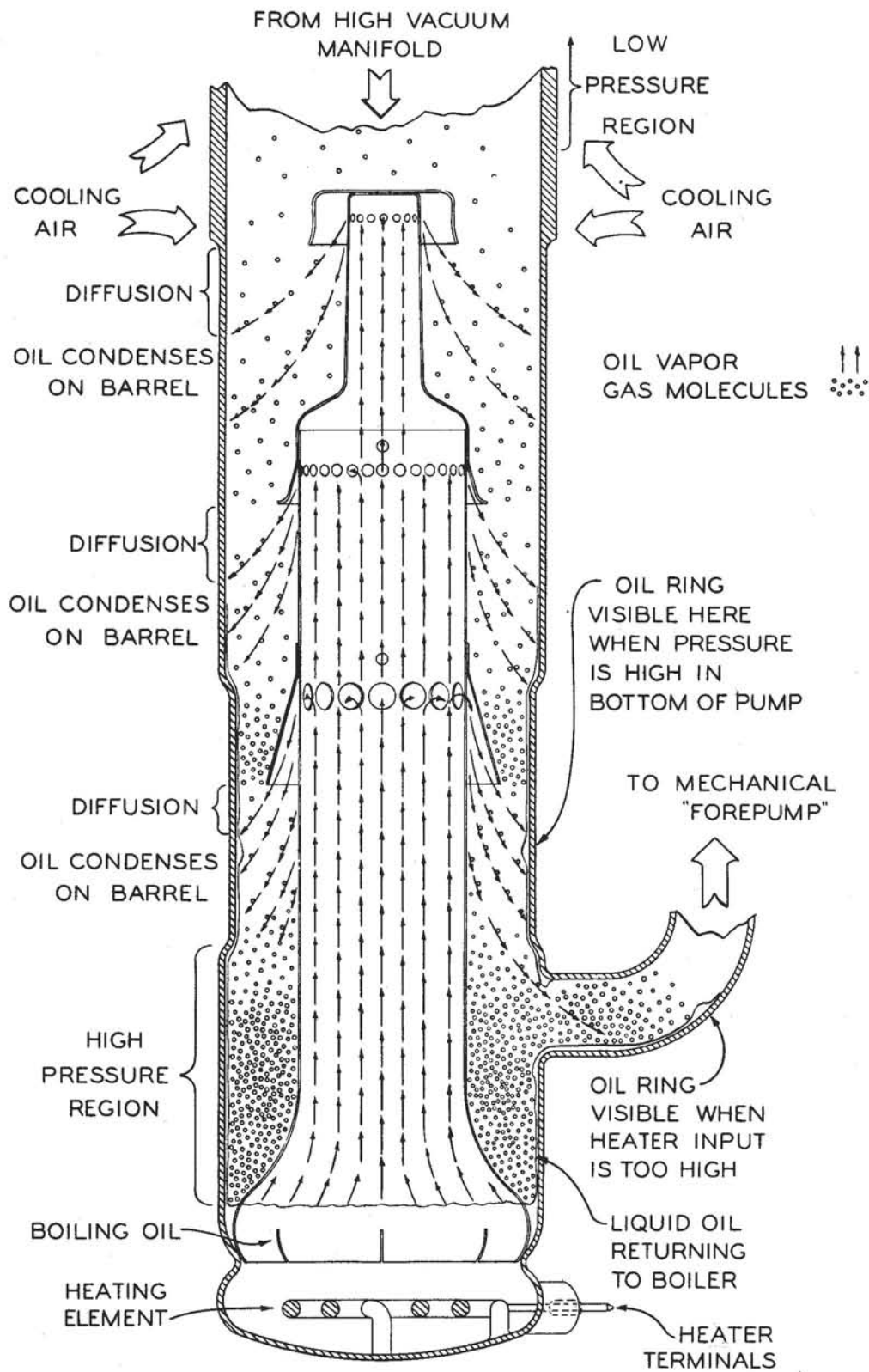
To prevent small amounts of oil vapor from finding their way back into the high-vacuum side of the system, a baffle is often employed between the diffusion pump and the high-vacuum system. In the HV-1 this baffle is a pair of aluminum discs which are kept relatively cool by the pump cooling fan. Oil vapor reaching the baffle condenses and is returned to the boiler. The baffle reduces the pumping speed by about one-half. If there are several bends in the high-vacuum manifold between the pump and the space to be evacuated, the baffle may be dispensed with, as the bends will serve to collect the oil vapor. However, the bends will also reduce the pumping speed. This is well illustrated in the curves. Constrictions

any hygroscopic matter should be carefully excluded. When so located as to be affected by heat, rubber is particularly objectionable, and a poor ultimate vacuum is likely to result if rubber gaskets are used in the diffusion pump. For this reason, Neoprene gaskets are supplied with the HV-1.

In systems employing stop-cocks, valves or gaskets, it is necessary that the stop-cock, valve or gasket lubricant have the minimum possible vapor pressure, because poor lubricants can easily destroy the high-vacuum capabilities of the pump.

### APPLICATION

The HV-1 diffusion pump must be mounted securely, but not too rigidly. A satisfactory method of mounting consists of 1 X 1 X 1/8 inch angle shaped and drilled to pass four of the six spring loaded bolts used to join the large flanges at the top of the barrel (see illustration). When the desired manifold has been sealed to the manifold adapter (914 on outline drawing), the pump is prepared for operation (after rinsing thoroughly as specified under "cleaning") in accordance with the following procedure:



1. Pour 150 milliliters of Eimac Diffusion Pump Oil, Type A, into the pump barrel (917).
2. Insert the aluminum jet assembly (4911) into the pump barrel.
3. Assemble the pump carefully, moistening both sides of each gasket with pump oil, or with a thin layer of heavy-grade "Celvacene," or equivalent grease.
4. Install the pump in its mounting.  
**IMPORTANT: DO NOT START DIFFUSION PUMP HEATER UNTIL FOREPUMP IS IN OPERATION AND SYSTEM IS FREE OF LEAKS, TO AVOID PREMATURE HIGH TEMPERATURE AND DECOMPOSITION OF THE OIL.**
5. After making certain that the forepump is connected to the nipple (8911) through the suitable flexible coupling (vacuum-hose or vacuum type bellows), start the forepump motor. Check the manifold with a Tesla or other high-voltage, high-frequency spark coil for leaks BEFORE CONTINUING.

The Tesla coil, with a flexible wire probe may be used to indicate the presence of leaks above the baffle. It is also valuable in estimating pressure in the manifold during the early stages of evacuation. **CAUTION:** Too high a voltage may puncture the manifold at its weak points, i. e. where the glass may be very thin or at a seal-off tubulation. A rough indication for a suitable Tesla voltage is that which will produce a corona of about one-eighth inch on the end of a No. 14 B & S probe wire, visible in the dark only, and a stringy spark not over five-eighths inch to a grounded metal surface.

If the system is known to be free of leaks, the forepump and HV-1 may be started together. However, to protect the system and its oil, the manifold first should be checked with the Tesla coil, with the HV-1 "off." When the cold oil stops bubbling and the pink glow is seen to be diminishing at a normal rate, the system may be assumed to be reasonably tight and the HV-1 may be started.

6. Connect the oil heater terminals via a switch to the source of power. The oil heater voltage should be set to between 100 and 110 volts for best results. An adjustable resistor or an auto transformer of the tapped or continuously variable types is recommended. The current at 110 volts is approximately 1.7 amperes.
7. The baffle assembly and upper end of the pump barrel should be kept cool (35° C or lower) by a small fan or blower (see illustration).

**OIL**—Eimac Type A Diffusion Pump Oil is a special petroleum product carefully processed by Eitel-McCullough, Inc. to afford the high-vacuum desired in diffusion pump work. The ultimate vacuum attainable for Type-A oil is on the order of  $10^{-7}$  mm Hg. Its boiling-point at pressures on the order of  $10^{-2}$  mm Hg is 135° C.

One noteworthy property of this oil is that under normal conditions, no particles of condensed oil will be found deposited in the high-vacuum manifold. This lack of condensation is indicative of the absence of "light ends." Such products of distillation usually must be barred from the high vacuum system by the use of liquid air or charcoal traps which invariably reduce the speed of any system and require extensive maintenance.

**VACUUM GAGES**—To properly evaluate the vacuum conditions at the manifold, a sensitive gage in the desired range is necessary. There are many systems used for this purpose, the most sensitive in the high-vacuum spectrum being the Ionization (or Ion) gage. Its range of usefulness extends from approximately 5 microns to a region in the upper experimental vacuum limits on the order of  $10^{-6}$  microns ( $5 \times 10^{-3}$  to  $10^{-9}$  mm Hg). Recently, tubes and circuits have been developed which con-

tribute to the high stability of this instrument. The Eimac type 100-IG Ion Gage tube is designed to give the maximum internal leakage path, thus avoiding erratic readings due to possible contamination from the system.

**LEAKS**—If the system does not "clean-up" in a reasonable time, considering the nature and size of the manifold and connected chambers, a leak may be looked for by means of the Tesla coil. The probe should be run over the entire surface of the glass work involved. A "fast" leak will be indicated where sparks concentrate at a point on the glass and a pinkish glow takes place within the evacuated space.

Where a slow leak is suspected, before "bake-out" and where the vacuum is high but still not satisfactory, a solvent such as carbon tetrachloride may be applied to the manifold surface with an atomizer, a wad of cotton or brush. If a leak is found, the Tesla voltage will cause a marked bluish glow while the solvent is entering the aperture, or the ion gage reading will indicate increased pressure.

After "bake-out" or when the manifold is too hot for the application of liquids, illuminating gas or hydrogen may be applied to the surface from an unlighted torch. Gas entering the hole will effect the ionization gage reading immediately. A very small leak may be found in this way. If there are no leaks, the manifold and pump assembly is ready for use.

With the manifold at high vacuum, no ionization will be apparent from the effects of a Tesla probe held on the manifold (above the baffle). Below the baffle on the barrel of the HV-1 pump the probe will cause fluorescence of the oil vapors as well as a visible disturbance of the oil flow below the jets. The probe when touched to the HV-1 outlet will show a faint blue-violet glow. If these first two conditions are obtained, but a pinkish glow is present in the outlet, the mechanical pump and its coupling should be checked.

For new oil, or after an oil change, the pump will require about 24 hours of operation to condition the oil for optimum performance. Approximately 15 minutes heating time is required for the HV-1 to reach full efficiency from a cold start.

#### PRECAUTIONS

1—The vacuum system should not be opened "to air" when the diffusion pump is hot, to prevent oxidation of the pump oil. 2—If at any time a white vapor is visible in the HV-1, both pumps should be immediately shut off. The vapor is an indication of forepump failure or a very rapid leak. If the oil has become dark, the system may require complete cleaning. 3—Ground leads should be provided on both flange couplings to prevent the Tesla voltage from puncturing the Neoprene gaskets.

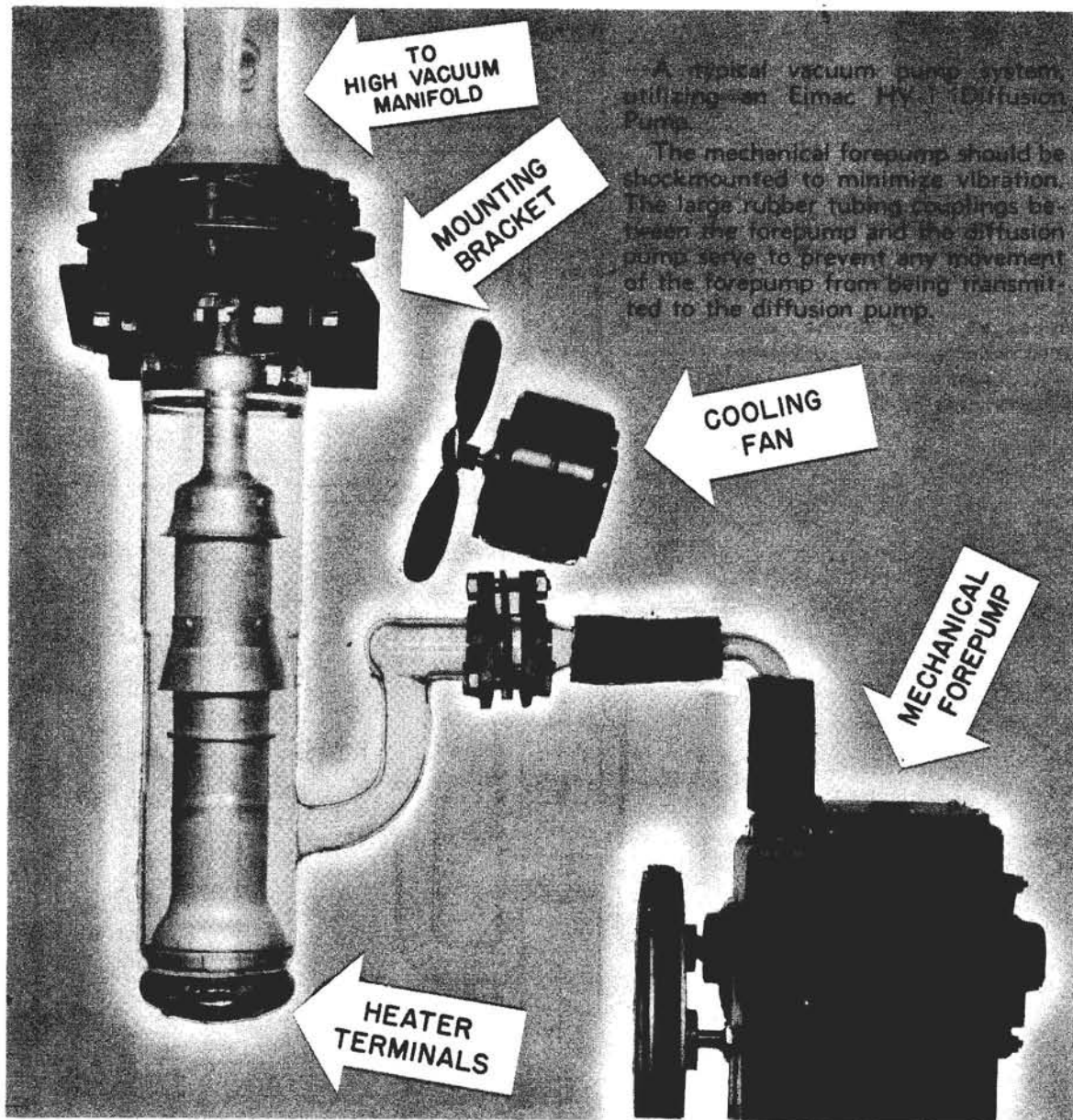
#### CLEANING

Diffusion pumps in continuous use should be cleaned at approximately one-month intervals. The materials and facilities required for cleaning are: Carbon tetrachloride and pentane (or acetone). An oven capable of temperatures up to 500° C will allow complete removal of carbonaceous deposits. The oven should be provided with an air inlet and outlet to allow the products of oxidation to be carried off. An accurate temperature control and indicator are advisable to prevent mishap to the glass parts. Where an oven is not available, steel wool, water and some abrasive cleanser such as diatomaceous earth

<sup>1</sup>"Bake-out" consists of surrounding the manifold and work to be evacuated with an oven. The temperature is then raised and held just under the annealing point for the "softest" glass being used in the system (approximately 500 degrees C for Pyrex). The temperature is maintained for thirty minutes to an hour, or at least until the new glass in the system shows no fluorescence on application of the Tesla voltage. This "cleans up" the glass-ware to a point where it will not normally release further gas. An accurate thermocouple type temperature indicator and heater control are advisable to prevent mishaps to the system during "bake-out."

<sup>2</sup>Contamination in the system such as decomposed oil, or a source of high vapor pressure in the load will give "virtual leaks" or unfavorable maximum vacuum readings.





A typical vacuum pump system utilizing an Eimac HV-1 Diffusion Pump.

The mechanical forepump should be shockmounted to minimize vibration. The large rubber tubing couplings between the forepump and the diffusion pump serve to prevent any movement of the forepump from being transmitted to the diffusion pump.

may be used. The procedure is given in the following paragraphs.

**GLASS HOUSING BARREL**—New housings should be given a rinse with a cup of pentane or acetone and then warm-air dried. (CAUTION: pentane and acetone are inflammable. Keep away from open flames.) Used, dirty housings should have the excess of oil fluid rinsed out with two or three flushings of about one cup (per rinse) of carbon tetrachloride. The last rinse may be saved for the first wash of the following pieces. To remove adhering carbonaceous matter after draining, the housing should be baked out in an oven up to 500° C. If the housing is not too caked, a rinse with pentane or acetone and gentle drying with warm air (in place of baking out in the oven) is sufficient.

**ALUMINUM JET ASSEMBLY**—The jet assembly may be cleaned at the same time that the glass housing barrel is cleaned by inserting the assembly into the glass housing, pouring in the rinse solution and closing the top opening with a stopper. Agitate the solution by tilting and shaking

the pump so that all parts are well washed over. Always remove the stopper and jet assembly after washing, prior to draining, baking or air drying. To further remove hard carbonaceous material, the assembly, less baffle, should be placed in an annealing oven and heated carefully to 475° C, then allowed to cool slowly in air.

**BAFFLE**—The baffle should be disassembled and all parts rinsed three times with pentane or acetone; the last two rinsings must be with clean solution. Follow with warm-air drying.

**NEOPRENE GASKETS**—Wash the gaskets in carbon tetrachloride or alcohol, then wipe with a clean cloth in place of warm-air drying.

**GLASS MANIFOLDS**—Use the same procedure as for the glass housing barrel when feasible. However, usually washing with pure water and alcohol, followed by warm-air drying, may be sufficient because there is less formation of carbonaceous matter here than in the case of the pump housing.



