Amperex®

PERMANENT SENSITIVITY
RADIATION COUNTER TUBES

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INDEX

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ANDREX

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GENERAL INFORMATION

The Geiger tube was first used in 1908 by Rutherford and Geiger who arranged a wire axially within a cylinder and applied a potential between these elements.

It was found to be the property of such an arrangement that an ionizing particle or radiation, when projected into the cylinder, caused an enormous increase in the space current.

Since that time, the basic geometric arrangement has remained unchanged. In 1928, Geiger and Muller produced effective counters with large sensitive areas and eventually the term "Geiger-Muller counter" became generally accepted.

While it is a fact that many successful counters were manufactured during the '30's, these were all specifically designed for cosmic ray work or some other specialized applications. At that time, the necessity did not exist for the mass production of larger numbers of Geiger-Muller tubes with identical characteristics.

In the early stages of World War II, wide-spread commercial applications of the Geiger-Muller tube became more pronounced. Mass production of quartz oscillator crystals necessitated a means of indicating extremely low intensity diffracted X-Ray beams.

The Geiger-Muller tube was the instrument of choice for this application but until that time was, unfortunately, a scientific curiosity of unpredictable behavior and with none of the recognized desirable features such as uniformity, stability, and unlimited life.

Intense research on the subject by AMPEREX and its affiliates eventually resulted in the mass production of radiation counter tubes with predictable characteristics as early as 1942. This accomplishment, to the best of our knowledge, was the beginning of routine, rigorously controlled production.

The next important step along the road was the development of the halogen-filled Geiger-Muller tube, the technical characteristics of which will be discussed later.

The first of these counter tubes for commercial and industrial applications were made with AMPEREX-manufactured shells in Government Research Laboratories in 1947. Manufacture and design of these tubes and control of production thereof was first engineered by AMPEREX and many thousands of these types and their variants are still in daily successful use.

The problem overcome in this regard included the pressures and proportions of the gas mixtures, choice of materials, methods of sealing, window material and window thickness calibration. Life testing of ultimate designs substantiated the "unlimited life" characteristic of the halogen tube.

Thus, when nuclear physics blossomed into practical use, AMPEREX was ready with a Geiger-Muller technology which assured the production of this necessary measuring device in all its forms.

As a result of the techniques employed in the production of these tubes, the gas amplification process was stabilized so that the reliability of the counters approached that of ionization chambers

without the attendant current amplification difficulties.

Standardization of characteristics far beyond those ever attained in the manufacture of counter tubes was achieved and then made available to instrument manufacturers.

Summarizing, it might be said that the incomparable research facilities available to this firm, the long history of our active association with the development of Geiger-Muller tubes and their application in research and production instruments are the finest guarantees the end user can be given of outstanding satisfactory service of the product.

CONSTRUCTION

AMPEREX counter tubes are ruggedly constructed of stainless steel and glass and are sealed with a special glass solder. New, exclusive AMPEREX techniques enable the mass production to uniform dimensions of the highly chemically resistant cathode shells.

All the mica windows are individually "weighed" by measuring their transmission of C_{14} beta rays and are fusion sealed with glass to the stainless steel cathodes.

The mechanically rugged based tubes are connected according to industry standards. The anode terminals on the unbased versions are either standard miniature caps or wire leads for alligator clip connection. Connection to the cathode of the latter type may be made with a metal clamp or copper strap. No attempt should be made to solder directly to the stainless steel cathode as this will destroy the tube.

The tube fillings consist of pure noble gasses together with a halogen quenching admixture and are all of the "self-quenching" variety.

STABILITY

The counting life of these halogen tubes is unlimited because the discharge action does not consume the quenching agent. The energy of the pulse is degraded to heat without triggering spurious counts because of the influence of the halogen quenching agent upon the work function of the cathode surface. In the limited-life, organic-quench type tubes, some of the pulse energy chemically breaks up the quench agent which, in time, completely decomposes with the discharge process and the tube does not operate.

AMPEREX halogen counters can be discharged above the end of the plateau without any damaging effect to the tube.

Over a period of years, tests being conducted with these tubes in our laboratories show counting lives over 5×10^{10} counts without any appreciable change in plateau, threshold or tube current. Continuous tests are made also as a check on production quality.

The shelf life stability of the Amperex counter tubes is maintained by special surface processing techniques that eliminate halogen quench "clean-up." This permits the tubes to be used for permanent calibration of radiation detection instruments and reproducible experimental results.

Since the plateau does not shorten or shift appreciably and the slope does not increase with time, the tubes may be operated at any point on the plateau. This is not the case with the conventional organic-quench type tubes. The "plateau length" criterion as a measure of the tube quality, therefore, is not significant in the AMPEREX tubes.

PLATEAU TESTS

Each counter tube is tested for plateau and background count before shipment. A plateau plot (see fig. 1 below) is made on an AMPEREX designed automatic plateau tracer.

The electrical characteristics of this unit are as follows:

0.3 volts sensitivity, 6 microseconds resolving time, 90 volts per minute supply voltage increase rate, 3 feet capacitive loading cable, and a 1 megohm tube series resistance to simulate typical operation.

The plateau slope of these tubes is not due mainly to an increase in spurious counts with voltage as in organic-quench tubes, but is a legitimate increase in volume sensitivity as the electric field overcomes the electron attachment of the halogen quench.

With the usual well regulated voltage supplies in most scalers and with corona regulators in portable equipments a plateau slope of 5% to 10% per 100 volts is no limitation on counting accuracy.

Thresholds are maintained in production to ±25 volts from the nominal value by special processing and filling techniques. As a result, the uniformity of the tubes is such that they can be operated in parallel at the operating voltage.

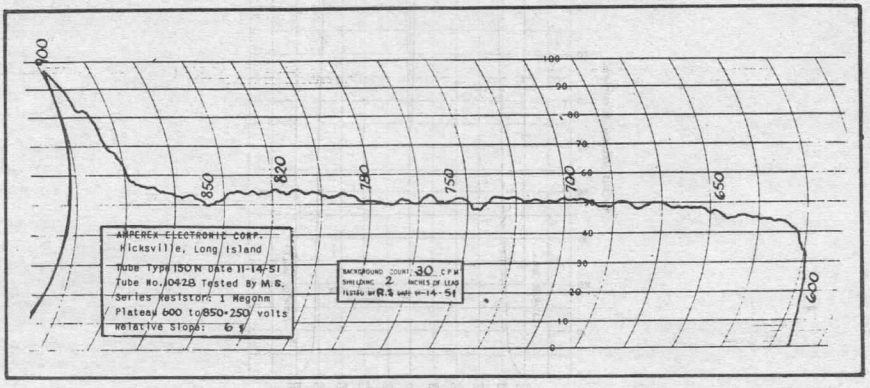


Figure 1. - Typical Plateau Curve

VOLUME SENSITIVITY

The volume sensitivity of halogen counters is necessarily less than the 99.5% with organic quenches. This is due to the electron capture of the halogens in weak electric fields. If we examine the field distribution in the Geiger counter structure we see that the field is weak directly at the cathode. In this region there is some electron capture. A typical radial sensitivity curve is shown

in Figure 2. This can be obtained by moving a fine collimated X-Ray beam across the diameter of the tube.

From the region away from the cathode by approximately 5% to 10% of the diameters, inward to the anode, the tube is 100% sensitive. It can be said therefore that a halogen counter is equal in sensitivity to an organic counter 80-95% of the diameter of the halogen tube.

AMPEREX counters are filled with the minimum halogen content necessary to insure stable operation so as to produce a maximum effective diameter.

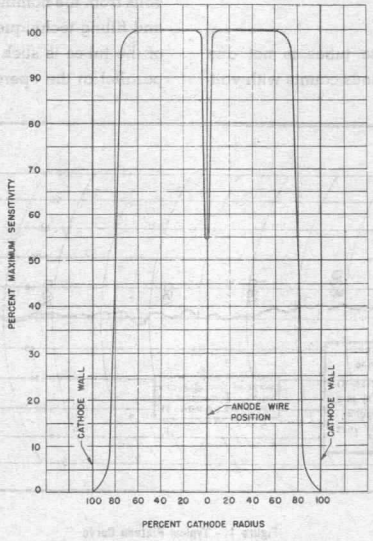
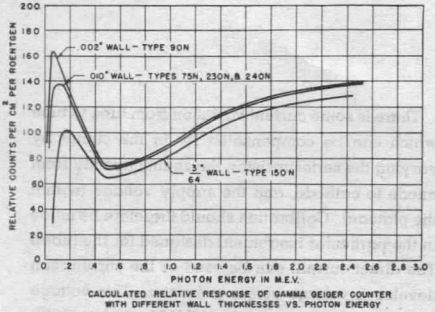


Figure 2. - Sensitivity Distribution Halogen Counter

ENERGY DEPENDENCE — GAMMA COUNTERS

The energy dependence for the gamma counters for a constant source spectrum is not significant since the tube can be calibrated for this spectrum. For general survey work the calculated energy dependence is given in the characteristic sheets for each tube type.

Heavy metal filters or shields can be used to modify the energy dependence to other characteristics.

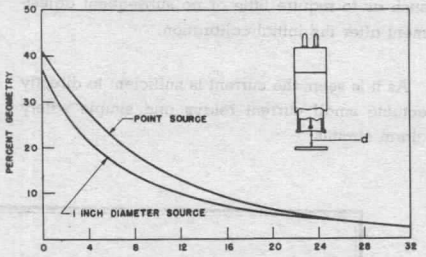


CALCULATED RELATIVE RESPONSE OF GAMMA GEIGER COUNTER WITH DIFFERENT WALL THICKNESSES VS. PHOTON ENERGY

Figure 3.

END MICA WINDOW COUNTERS

When end mica window tubes are used for counting low source activities, good geometry increases the counting rate and statistical accuracy. Figure 4 shows the effect of source-to-window distance. From this it is evident that the source should be as close to the window as possible. The transmission characteristics of the windows are given in the individual tube data sheets.



CALCULATED GEOMETRIES OF AMPEREX TYPES 100 AND 200 END MICA WINDOW COUNTERS

Figure 4. *Computed from data from E. Berne, "Review of Scientific Instruments"; Vol. 22, No. 7; July, 1951.*

APPLICATION DATA

The use of these tubes opens up fields of practical application which, heretofore, have been considered closed to Geiger counters because of lack of reliability and reproducibility.

As an indication of their reliability, AMPEREX Geiger counters are being used as unattended snow depth gauges and production thickness gauges.

In survey instruments using corona regulators, they enable almost permanent calibration. Instruments have been built around these tubes where the current through the tubes is used directly as an indication of Roentgen dosage.

Roentgen dosage vs. current curves are included in the individual tube characteristic sheets as examples of applications of the gamma counters for survey applications.

There is some current variation from tube to tube which can be compensated for in the circuit by varying the series resistor, the shunt capacity from anode to cathode, and the supply voltage (within the plateau). Calibration should therefore be made in the particular instrument designed for the tubes. The direct current can be used or the current can develop a voltage across a resistor. This voltage can then actuate a simple V.T.V.M. circuit. Sufficient adjustment must be built into the circuit to account for normal minor variations between tubes. The stability of these halogen counters is such as to require little or no subsequent adjustment after the initial calibration.

As it is seen, the current is sufficient to directly actuate small current relays and simple safety alarm circuits.

For pulse counting operation, the "Ideal Counting Rate" curves given for gamma counters are based on calibrations at low counting rates and are uncorrected for higher rates. A calculated "Dead Time Correction" curve is also given assuming that the tube dead time is the limit on maximum counting rate.

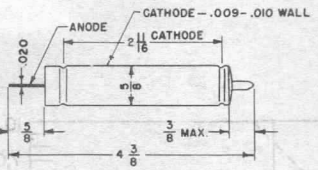
The purpose of this information is to give the approximate sensitivity range of each tube. Since the response, at high counting rates, is very much a function of the circuit used with the counter, the total response must be determined experimentally in the particular circuit.

The "maximum counting rate" in the individual tube data is computed as that counting rate for which the dead time correction is 20%, and is a guide for comparison purposes only.

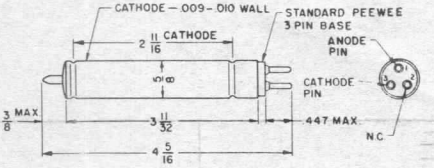
The AMPEREX Engineering Department is prepared to work closely with manufacturers in the design of equipment to utilize the advantages of these radiation counter tubes.

Amperex® TYPE 75 SERIES

Permanent Sensitivity GAMMA COUNTERS



75 N-6 • 75 N-7 • 75 N-9



75 NB 3-6 • 75 NB 3-7 • 75 NB 3-9

Description

The type 75 series are inexpensive, rugged gamma counters for survey, demonstration, or monitoring applications. The infinite-life, halogen filling gives these tubes an unusual electrical ruggedness to match their mechanical strength.

The absence of flanges or external glass structures enables these tubes to be bundled in multiple arrangements with good volumetric efficiency.

General Data

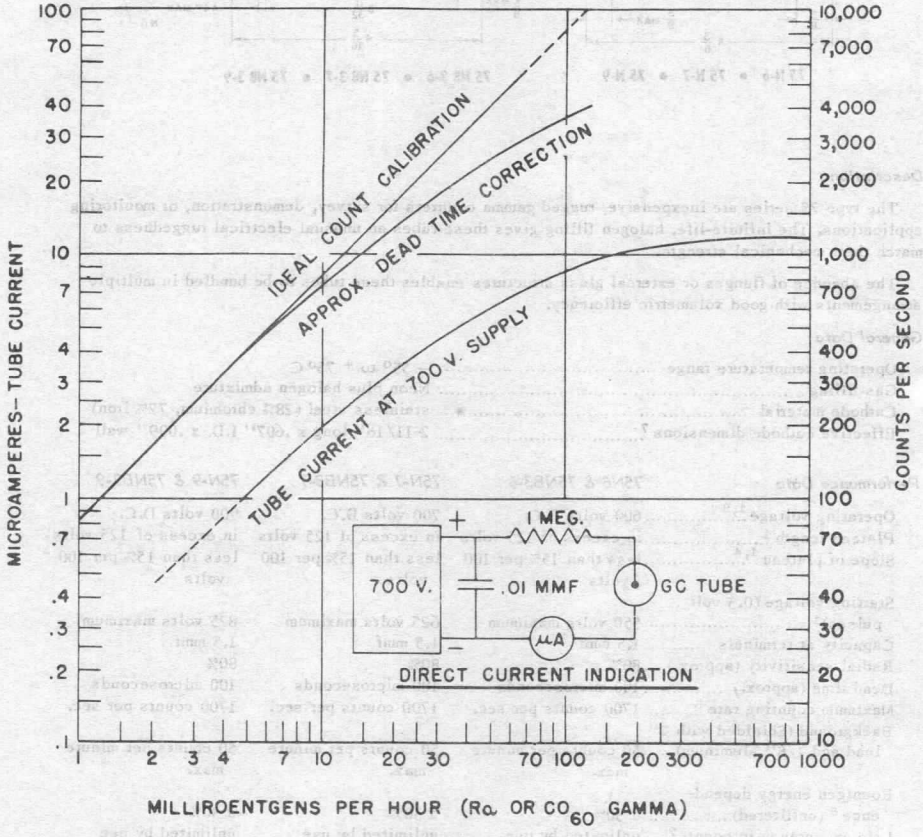
Operating temperature range	– 55° to + 75° C
Gas filling	Neon plus halogen admixture
Cathode material	stainless steel (28% chromium, 72% iron)
Effective cathode dimensions [7]	2-11/16" long x .607" I.D. x .009" wall

Performance Data	*75N6 & 75NB3-6*	*75N-7 & 75NB3-7*	*75N-9 & 75NB3-9*
Operating voltage [1,3]	600 volts D.C.	700 volts D.C.	900 volts D.C.
Plateau length [1]	in excess of 125 volts	in excess of 125 volts	in excess of 125 volts
Slope of plateau [1,4]	less than 15% per 100 volts	less than 15% per 100 volts	less than 15% per 100 volts
Starting voltage (0.3 volt pulses)[1]	550 volts maximum	625 volts maximum	825 volts maximum
Capacity at terminals	1.5 mmf	1.5 mmf	1.5 mmf
Radial sensitivity (approx.)	80%	80%	80%
Dead time (approx.)	100 microseconds	100 microseconds	100 microseconds
Maximum counting rate [5]	1700 counts per sec.	1700 counts per sec.	1700 counts per sec.
Background (Shielded with 2" lead and 1/8" aluminum)	50 counts per minute max.	50 counts per minute max.	50 counts per minute max.
Roentgen energy dependence [6] (unfiltered)	± 30%	± 30%	± 30%
Life expectancy in counts [2]	unlimited by use	unlimited by use	unlimited by use

Notes

1. This data is obtained from an automatic plateau trace run on each tube.
2. Guaranteed 5×10^{10} counts minimum.
3. These tubes will operate satisfactorily anywhere on the plateau.
4. At an average counting rate of 100 counts per second.
5. For 20% dead time correction (approx.)
6. Calculated value based on radiocobalt gamma center value with 100KV to 3 M.E.V. extremes.
7. These tubes are also available with an effective cathode length of 12" upon special request for cosmic ray research, oil well logging, and other applications

75 SERIES

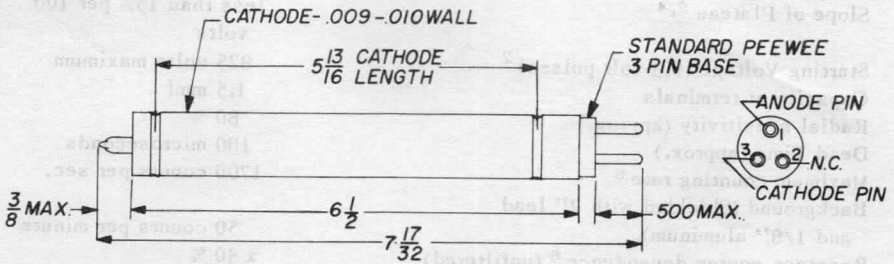


TYPICAL OPERATION

75 N-7 & 75 NB 3-7

Amperex® TYPE 76NB3

Permanent Sensitivity GAMMA COUNTER



Description

The 76NB3 is an inexpensive, rugged gamma counter for survey, demonstration, or monitoring applications. The infinite-life, halogen filling gives this tube an unusual electrical ruggedness to match its mechanical strength.

The absence of flanges or external glass structures enables these tubes to be bundled in multiple arrangements with good volumetric efficiency.

General Data

Operating Temperature Range	-55° to $+75^{\circ}$C
Gas Filling	Neon plus halogen admixture
Cathode Material	stainless steel (28% chromium, 72% iron)
Effective Cathode Dimensions [1]	5-13/16" long x 0.605" I.D. x .009" wall

[1] This tube is also available with an effective cathod length of 12" upon special request for cosmic ray research, oil well logging, and other applications.

76NB3

Performance Data

Operating Voltage [2,3]	900 volts D.C.
Plateau Length [2]	in excess of 125 volts
Slope of Plateau [2,4]	less than 15% per 100 volts
Starting Voltage (0.3 volt pulses) [2]	825 volts maximum
Capacity at terminals	1.5 mmf
Radial sensitivity (approx.)	80 %
Dead Time (approx.)	100 microseconds
Maximum counting rate [5]	1700 counts per sec.
Background (Shielded with 2" lead and 1/8" aluminum)	50 counts per minute
Roentgen energy dependence [6] (unfiltered)	± 30 %
Life expentance in counts [7]	unlimited by use

2 This data is obtained from an automatic plateau trace run on each tube.

3 This tube will operate satisfactorily anywhere on the plateau.

4 At an average counting rate of 100 counts per second.

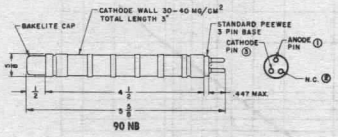
5 For 20% dead time correction (approx.)

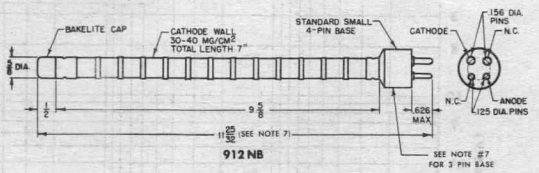
6 Calculated value based on radiocobalt gamma center value with 100KV to 3 M.E.V. extremes.

7 Guaranteed 5×10^{10} counts minimum.

Amperex® TYPES 90 NB 912 NB

Permanent Sensitivity BETA-GAMMA COUNTERS





Description

The types *90NB* and *912NB* are thin, stainless-steel wall counter tubes whose characteristics are similar to those of the 30 mg/cm² glass wall tubes. However, the materials used in these tubes and their special processing permits the use of the halogen-quenched Neon filling which has permanent characteristics. The metal wall of these tubes is also mechanically stronger than the fragile thin glass walls of comparative types.

These tubes are commonly used in survey instruments for Beta and Gamma detection and in hand and foot monitoring instruments where it is necessary to measure Beta in the presence of Gamma radiation. Due to the increased cathode length, greater sensitivity and pulse height are obtained from the type 912NB.

General Data

Operating temperature range	− 55° to + 75°C
Gas filling	Neon plus halogen admixture
Length of thin wall section (Cathode wall thickness 30-40 mg/cm²)	90NB - 3 inches total; 912NB - 8-11/16 inches total
Cathode material	stainless steel (28% chromium, 72% iron)
Overall cathode dimensions	90NB-912NB - 8-11/16" long x .607" I.D. (7" of 30-40 mg/cm² + 1-11/66" of 176 mg²) 3½ long x .607" I.D. (3" of 30-40 mg/cm² + ½" of 176 mg/cm²)

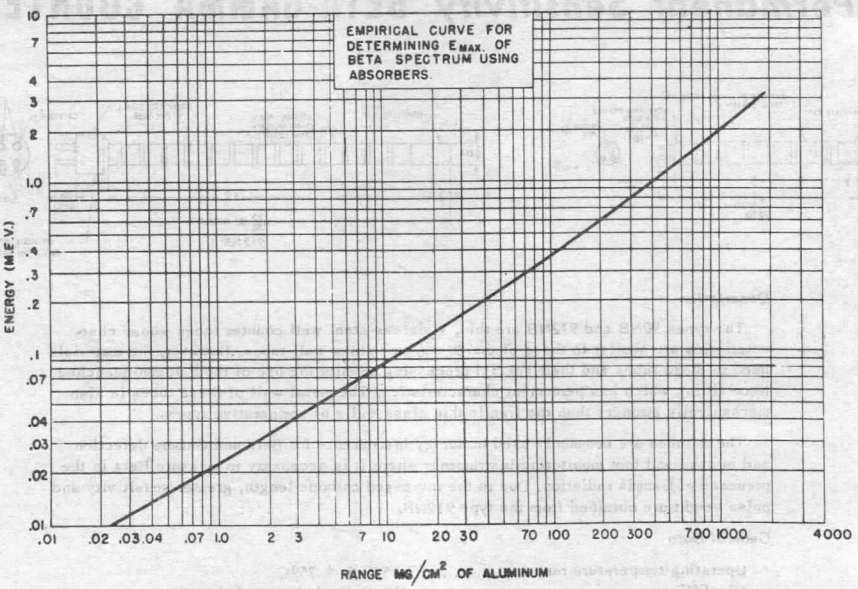
Performance Data

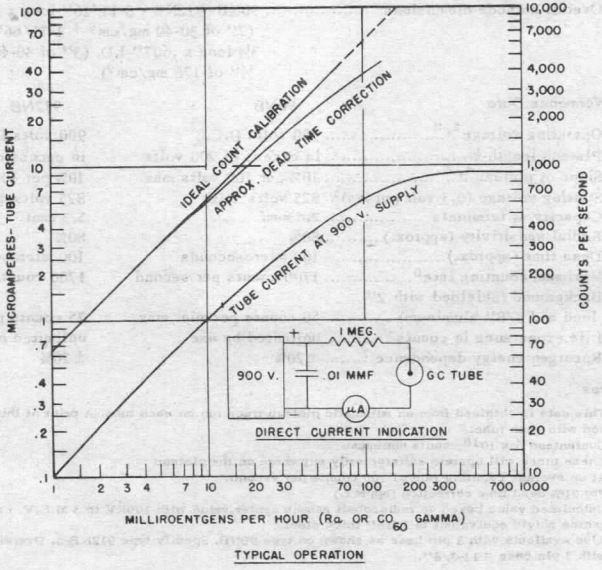
	90NB	912NB
Operating voltage[1,3]	900 volts D.C.	900 volts D.C.
Plateau length[1]	in excess of 200 volts	in excess of 200 volts
Slope of plateau[1,4]	10% per 100 volts max.	10% per 100 volts max.
Starting voltage (0.3 volt pulses)[1]	825 volts max.	825 volts max.
Capacity at terminals	2.4 mmf	5.3 mmf
Radial sensitivity (approx.)	80%	80%
Dead time (approx.)	100 microseconds	100 microseconds
Maximum counting rate[5]	1700 counts per second	1700 counts per second
Background (Shielded with 2" lead and 1/8" aluminum)	50 counts per min. max.	75 counts per min. max.
Life expectance in counts[2]	unlimited by use	unlimited by use
Roentgen energy dependence[7]	± 20%	± 20%

Notes

1 This data is obtained from an automatic plateau trace run on each tube. A print of this trace is shipped with each tube.
2 Guaranteed 5 x 10^{10} counts minimum.
3 These tubes will operate satisfactorily anywhere on the plateau
4 At an average counting rate of 100 counts per second.
5 For 20% dead time correction (approx.)
6 Calculated value based on radiocobalt gamma center value with 100KV to 3 M.E.V. extremes, with gamma shield equivalent to 1/16" thick steel.
7 Also available with 3 pin base as shown on type 90NB. Specify type 912NB-3. Overall tube length with 3 pin base = 11-3/8".

TYPES 90 NB – 912 NB

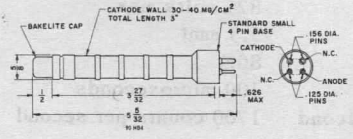


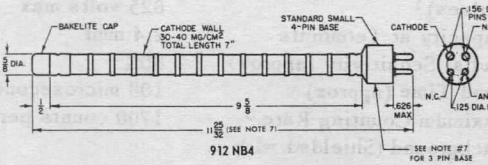


TYPICAL OPERATION

Amperex® TYPES 90 NB4 912 NB4

Permanent Sensitivity BETA-GAMMA COUNTERS





Description

The types 90NB4 and 912NB4 are thin, stainless-steel wall counter tubes whose characteristics are similar to those of the 30 mg/cm^2 glass wall tubes. However the materials used in these tubes and their special processing permits the use of the halogen-quenched Neon filling which has permanent characteristics. The metal wall of these tubes is also mechanically stronger than the fragil thin glass walls of comparative types.

These tubes are commonly used in survey instruments for Beta and Gamma detection and in hand and foot monitoring instruments where it is necessary to measure Beta in the presence of Gamma radiation. Due to the increased cathode length, greater sensitivity and pulse height are obtained from the type 912NB4.

General Data

Operating Temperature Range	-55° to $+75^{\circ}$ C
Gas Filling	Neon plus halogen admixture
Length of Thin Wall Section (Cathode Wall Thickness 30-40 mg/cm^2)	90NB4-3 inches total; 912NB4 8-11/16 inches total
Cathode Material	stainless steel (28% chromium, 72% iron)
Overall Cathode Dimensions	90NB4-912NB4 - 8-11/16" long x .607 I.D. (7" of 30-40 mg/cm^2 + 1-11/66" of 176 mg^2) 3½ long x .607" I.D. (3" of 30-40 mg/cm^2 + ½" of 176 mg/cm^2)

90 NB4 - 912 NB4

Performance Data	90NB4	912NB4
Operating Voltage [1,3]	900 volts D.C.	900 volts D.C.
Plateau Length [1]	in excess of 200 volts	in excess of 200 volts
Slope of Plateau [1,4]	10% per 100 volts max	10% per 100 volts max
Starting Voltage (0.3 volt pulses) [1]	825 volts max	825 volts max
Capacity at Terminals	2.4 mmf	5.3 mmf
Radial Sensitivity (approx)	80%	80%
Dead Time (approx)	100 microseconds	100 microseconds
Maximum Counting Rate [5]	1700 counts per second	1700 counts per second
Background (Shielded with 2" lead and 1/8" aluminum)	50 counts per min. max	75 counts per min. max
Life Expectance in Counts [2]	unlimited by use	unlimited by use
Roentgen Energy dependence [7]	±20%	±20%

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1 This data is obtained from an automatic plateau trace run on each tube. A print of this trace is shipped with each tube.

2 Guaranteed 5 x 10^{10} counts minimum.

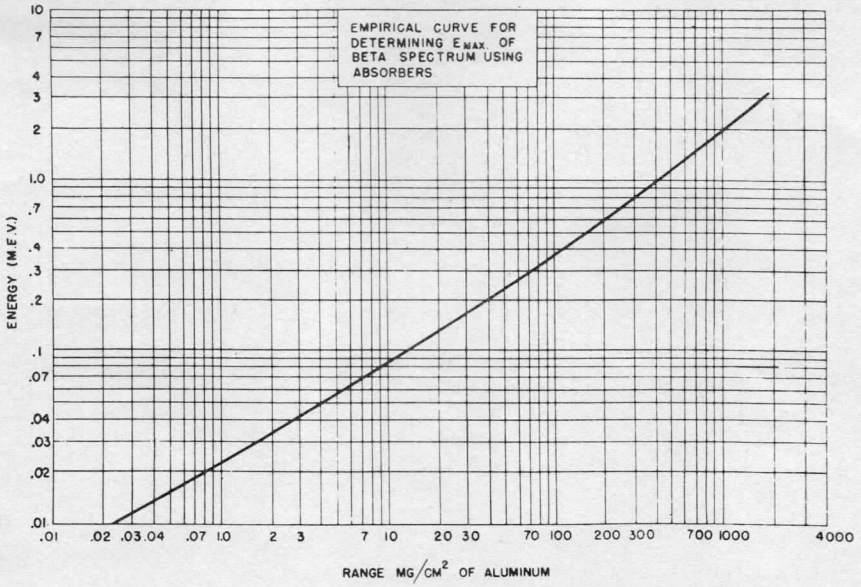
3 These tubes will operate satisfactorily anywhere on the plateau.

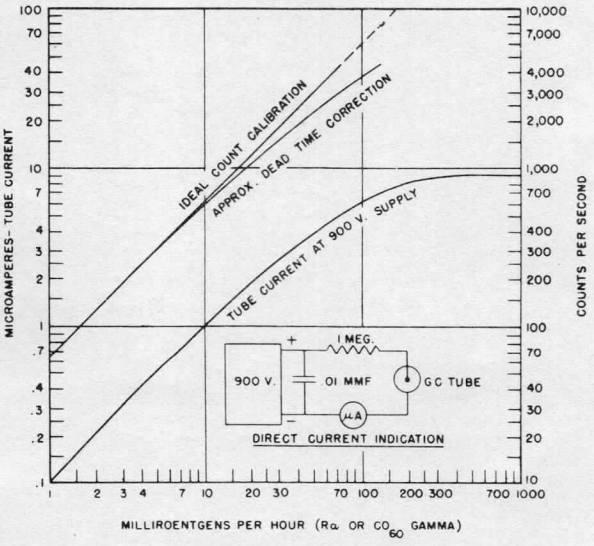
4 At an average counting rate of 100 counts per second.

5 For 20% dead time correction (approx.)

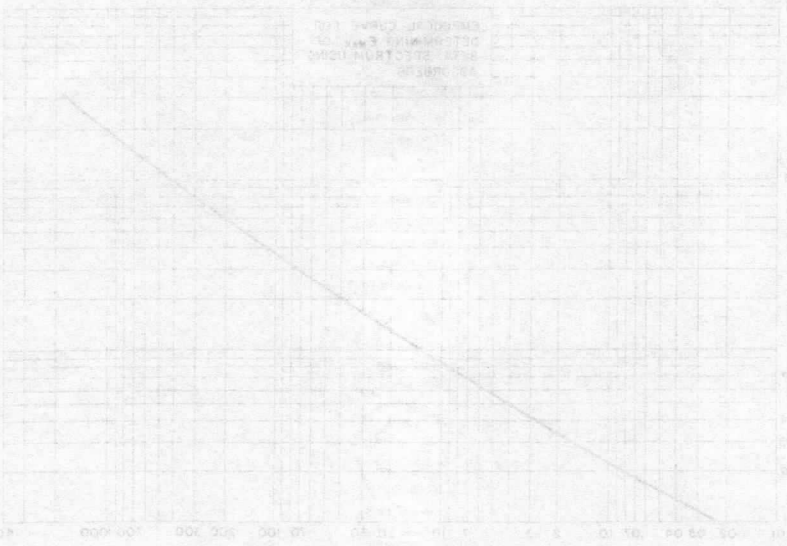
6 Calculated value based on radiocobalt gamma center value with 100 KV to 3 M.E.V. extremes, with gamma shield equivalent to 1/16" thick steel.

7 Also available with 3 pin base as shown on type 90NB4. Specify type 912NB-3. Overall tube length with 3 pin base = 11-3/8".



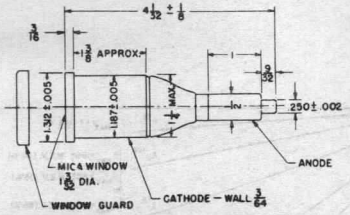


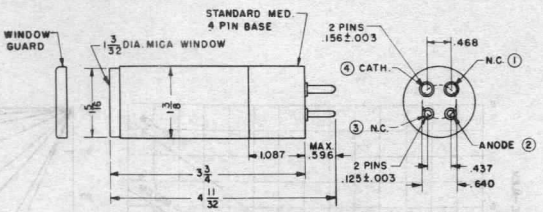
TYPICAL OPERATION



Amperex® TYPE 100 C/N AND 200 C/N SERIES

Permanent Sensitivity END MICA WINDOW, ALPHA-BETA COUNTERS





100 C • 100 N • 200 C • 200 N **100 CB • 100 NB • 200 CB • 200 NB**

Description

The type *100C* or *100CB* is a soft X-Ray and Beta counter with an Argon filling and a 3 to 4 mg/cm^2 end mica window[3].

The type *100N* or *100NB* is primarily a Beta counter with a low voltage Neon filling and a 3 to 4 mg/cm^2 window [3].

The type *200C* or *200CB* is a very soft X-Ray, Alpha and Beta counter with an Argon filling and a 1.4 to 2 mg/cm^2 window [3].

The type *200N* or *200NB* is an Alpha and Beta counter with a 1.4 to 2 mg/cm^2 window[3] and a low voltage, Neon filling.

Both the 100 and 200 series tubes are intended for use in general radioassay work and radio chemical analysis.

General Data

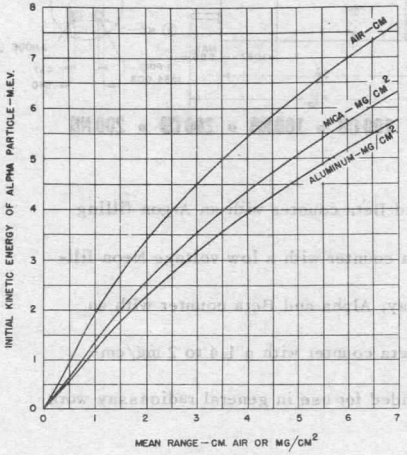
Operating temperature range	-55^{o} to + 75°C
Quenching agent	halogen admixture
Effective diameter of mica window	1-3/32"
Cathode material	stainless steel (28% chromium, 72% iron)
Effective cathode dimensions	1½" long x 1-3/16" O.D. x 3/64" wall

Performance Data	*100N, 100NB, 200N & 200NB*	*100C, 100CB, 200C & 200CB*
Operating voltage[1, 4]	700 volts D.C.[5]	1200 volts D.C.
Plateau length[1]	in excess of 200 volts	in excess of 300 volts
Slope of plateau[1, 6]	5% to 10% per 100 volts	5% to 10% per 100 volts
Starting voltage (0.3 volt pulses)[1]	625 volts D.C. max.	1075 volts D.C. max.
Capacity at terminals	1.0 mmf	1.0 mmf
Radial sensitivity (approx.)	85%-90%	80%-85%
Photosensitivity & hysteresis	none	none
Dead time (approx.)	200 microseconds	200 microseconds
Maximum counting rate [7]	830 counts per sec.	830 counts per sec.
Background (Shielded 2" lead and 1/8" aluminum)	50 counts per min. max	50 counts per min. max.
Life expectancy in counts[2]	unlimited by use	unlimited by use
Maximum operating altitude	25,000 feet	25,000 feet

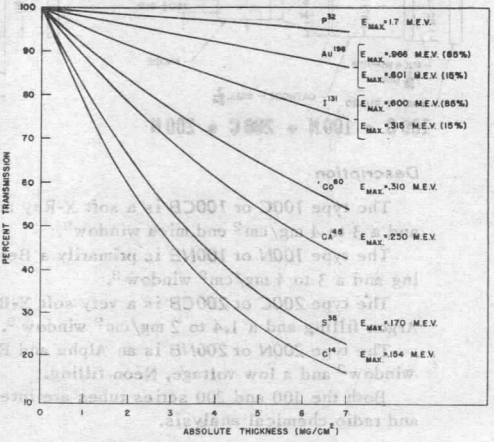
Notes

1 This data is obtained from an automatic plateau trace run on each tube. A print of this trace is shipped with each tube.
2 Guaranteed 5 x 10^{10} counts minimum.
3 1.4 mg/cm^2 mica = .0002 inch = 5.08 microns., 3.5 mg/cm^2 mica = .0005 inch = 12.70 micron
4 These tubes will operate satisfactorily anywhere on the plateau.
5 Also available upon request filled at 900 volts operating voltage.
6 At an average counting rate of 100 counts per second.
7 For 20% dead time correction (approx.).

TYPE 100 C/N AND 200 C/N SERIES

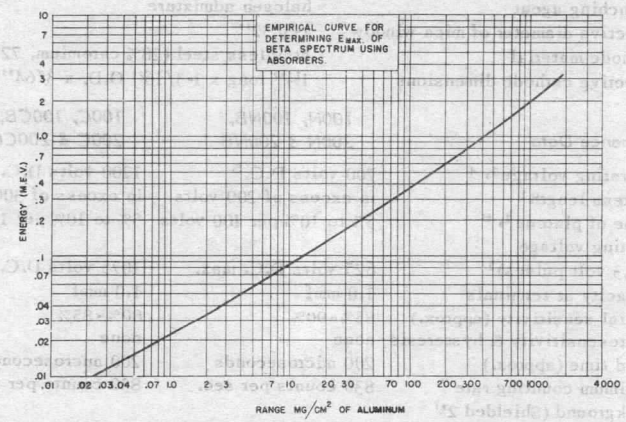


ALPHA PARTICLE MEAN RANGES.



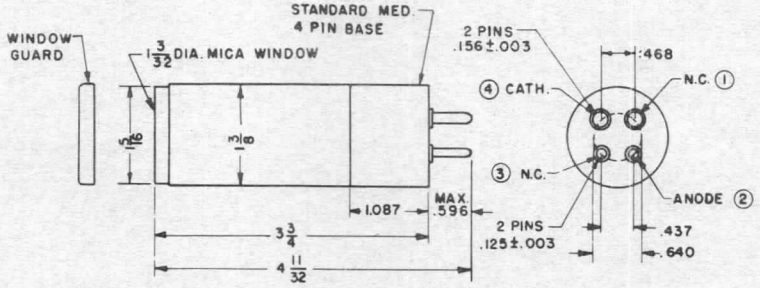
CALCULATED TRANSMISSION OF BETA SPECTRUM FROM SOME COMMON RADIOISOTOPES

Adapted from G. I. Gleason, et al — Nucleonics, Vol. 8, No. 5, 18 (1951)



Amperex® TYPES 100 HB 200 HB

END MICA WINDOW, ALPHA-BETA COUNTERS



Description

The type *100HB* is primiarily a Beta counter utilizing an organic quenching agent and a 3 to 4 mg/cm2 mica end window [1]. This tube is physically identical with the AMPEREX type *100CB* and *100NB*.

The type *200HB* is a low energy Beta and Alpha counter utilizing an organic quenching agent and a 1.4 to 2 mg/cm^2 mica end window. This tube is physically identical with the AMPEREX type *200CB* and *200NB*.

General Data

Operating temperature range	+ 15° to + 50°C
Gas Composition	Helium with organic quenching agent.
Effective diameter of mica window	1-3/32 inches
Effective cathode dimensions	1½" long x 1/3/16" O.D. x 3/32" wall
Cathode material	Stainless steel (28% chromium, 72% iron)

Performance Data

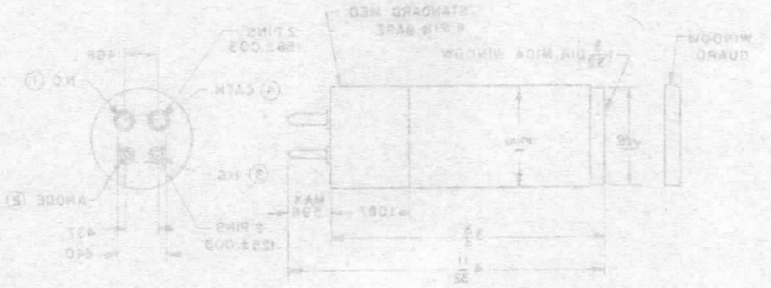
Operating voltage [2, 3]	1300 volts D.C.
Plateau length [2]	in excess of 250 volts
Slope of plateau [2, 4]	1.5% per 100 volts
Starting voltage [2] (1 volt pulses)	1180 volts max.
Capacity at terminals	1.0 mmf
Dead time (approx.)	150 microseconds
Life expectancy in counts	approx. 1.5 x 10^8
Maximum operating altitude	20,000 ft.
Background (shielded 2" lead)	50 counts per minute max.

Notes

1 1.4 mg/cm2 mica = .0002 inch = 5.08 microns.
3.5 mg/cm2 mica = .0005 inch = 12.70 microns
2 This data is obtained from an automatic plateau trace run on each tube. A print of this trace is shipped with each tube.
3 These tubes will operate satisfactorily anywhere on the plateau.
4 At an average counting rate of 100 counts per second.

AMPERTEX TYPES 100 HB 200 HB

END MICA WINDOW, ALPHA-BETA COUNTERS



Description

The type 100HB is primarily a Beta counter utilizing an organic quenching agent and a 3 to 4 mg/cm² mica end window. This tube is physically identical with the AMPERTEX type 100CB and 100NB.

The type 200HB is a low energy Beta and Alpha counter utilizing an organic quenching agent and a 1.4 to 2 mg/cm² mica end window. This tube is physically identical with the AMPERTEX type 200CB and 200NB.

General Data

Operating temperature range	+ 15° to + 50°C
Gas Composition	Helium with organic quenching agent.
Effective diameter of mica window	1-3/32 inches
Effective cathode dimensions	1½" long x 1/32" O.D. x 3/32" wall
Cathode material	Stainless steel (28% chromium, 72% iron)

Performance Data

Operating voltage [2]	1190 volts D.C.
Plateau length [3]	min. excess of 250 volts
Slope of plateau [3]	1.5% per 100 volts
Starting voltage [4] (1 volt pulses)	1180 volts max.
Capacity at terminals	1.0 mmf
Dead time (approx.)	150 microseconds
Life expectancy to counts	approx. 1.5×10^9
Maximum operating altitude	20,000 ft.
Background (shielded 2π) (Cad)	30 counts per minute max.

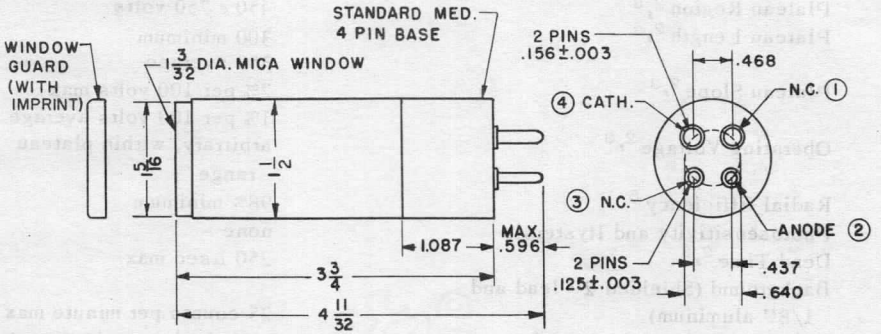
Notes

1. 1.4 mg per cm² mica = 1000 Å units = 5.05 microns
2. 3 mg per cm² mica = 2000 Å units = 12.36 microns
3. This data is obtained from an automatic plotting unit on each tube. A print of this curve is shipped with each tube.
4. The tube will operate satisfactorily at some or the plateau.
5. At an average counting rate of 100 counts per minute.

Amperex® TYPES 100 LB 200 LB

High Efficiency, Permanent Sensitivity

END MICA WINDOW, ALPHA-BETA COUNTERS



Description

The Amperex types 100 LB and 200 LB represent the most advanced developments in the field of halogen-quenched Geiger-Mueller tubes. They provide detection efficiencies previously attained only with organic quenched tubes and yet maintain the unlimited life characteristics of halogen-quenched tubes.

The inherent superiority of these tubes are characterized by low plateau slopes, long plateau regions, high detection efficiencies and unusual uniformity of characteristics from tube to tube.

In addition, they operate at low voltages, are extremely rugged mechanically and are unaffected by the accidental application of excessive voltages.

General Data

Operating Temperature Range	−55°C to + 75°C
Gas Filling	neon, argon with halogen quenching agent
Cathode Material	stainless steel (28% chromium, 72% iron)
Effective Cathode Dimensions	1.42" long x 1½" O.D. x 0.051" wall

100 LB AND 200 LB

Performance Data

Mica Window Thickness [1]	
100 LB	2.5 - 3.5 mg/cm^2
200 LB	1.4 - 2.0 mg/cm^2
Effective Mica Window Diameter	1.093 inches
Plateau Region [2,3]	450 - 750 volts
Plateau Length [2,3]	300 minimum
	350 average
Plateau Slope [2,3]	2% per 100 volts max
	1% per 100 volts average
Operating Voltage [2,3]	arbitrary, within plateau range
Radial Efficiency [5]	98% minimum
Photosensitivity and Hystersis	none
Dead Time [2,3]	250 μsec max
Background (Shielded 2" lead and 1/8" aluminum)	25 counts per minute max
Life Expectancy in Counts [4]	unlimited
Internal Series Anode Resistor	10 megohms (supplied as integral part of tube)

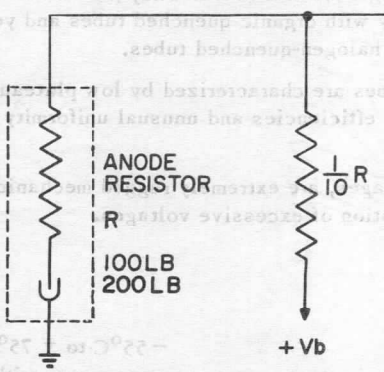


FIG. 1

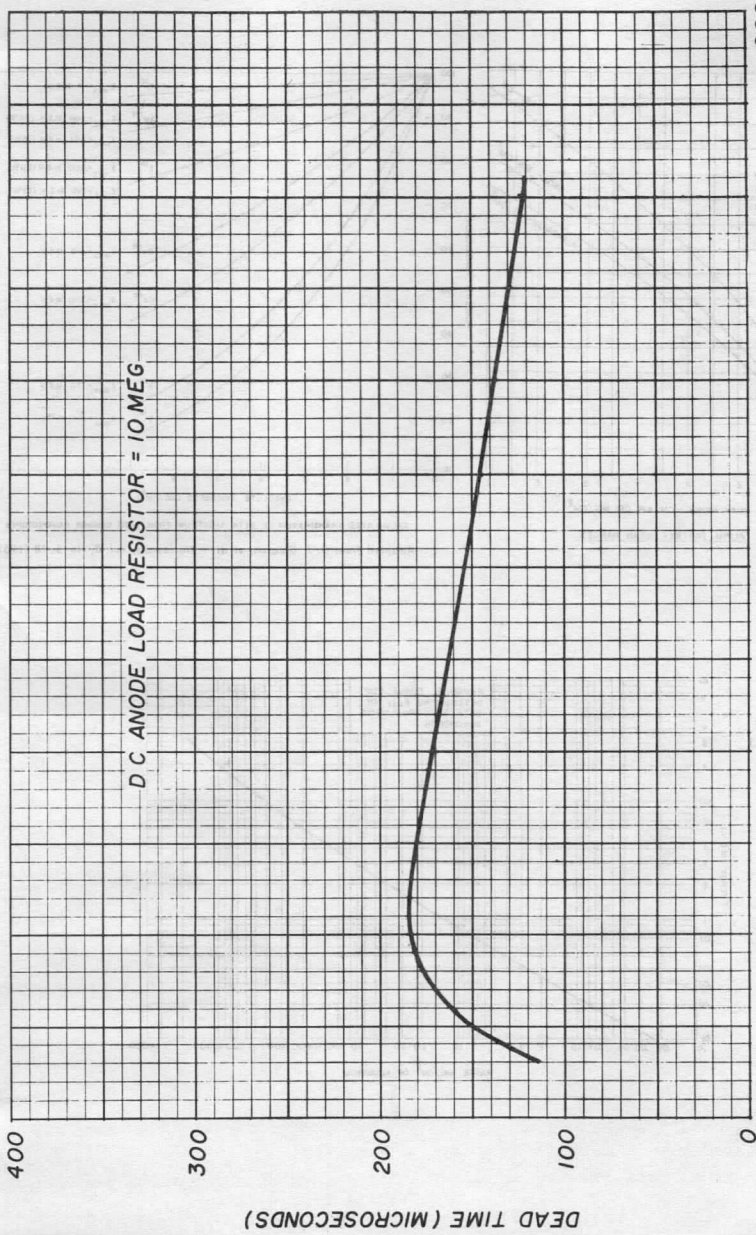
1 1.4 mg/cm^2 mica = 0.002 inches = 5.08 microns; 3.5 mg/cm^2 = 0.005 inches = 1.27 microns

2 At a counting rate of approximately 100 counts per second with recommended opera operating circuit.

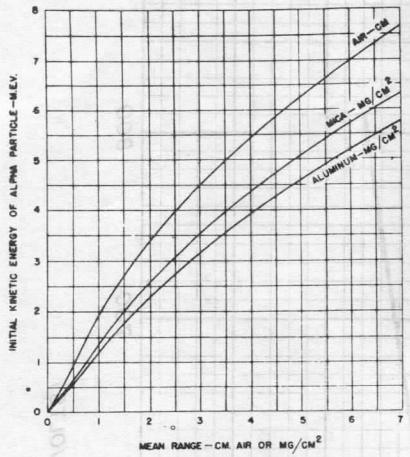
3 Recommended operating circuit See Figure 1, 10 megohm resistor is already supplied as integral part of the tube.

4 Guaranteed 5 x 10^{10} counts minimum.

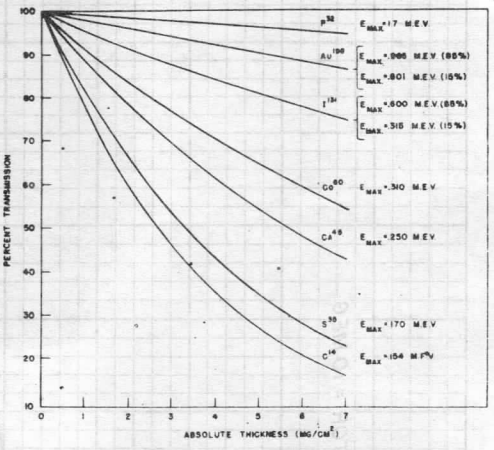
5 The probability that any ionizing particle within the sensitive volume will initiate a discharge.


D C ANODE LOAD RESISTOR = 10 MEG
DEAD TIME (MICROSECONDS)
400
300
200
100
0
300
400
500
600
700
800
900
ANODE VOLTAGE (VOLTS)

100 LB AND 200 LB

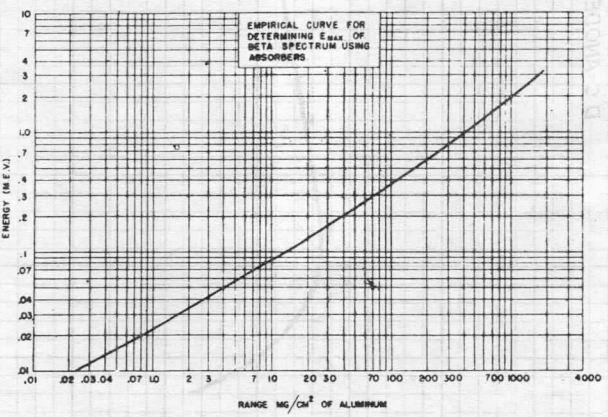


ALPHA PARTICLE MEAN RANGES.



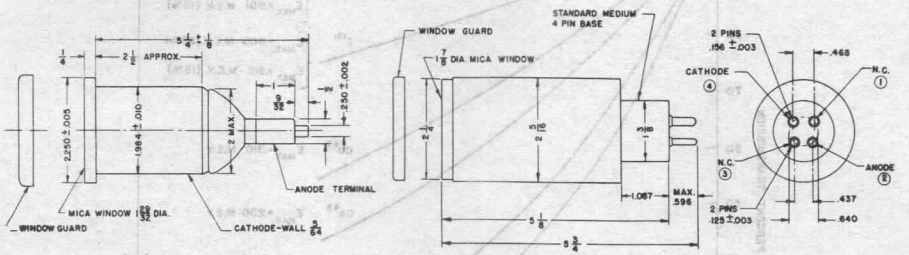
CALCULATED TRANSMISSION OF BETA SPECTRUM FROM SOME COMMON RADIOISOTOPES

Adapted from G. I. Gleason, et al — Nucleonics, Vol. 8, No. 5, 18 (1951)



Amperex® TYPE 120 SERIES

Permanent Sensitivity END MICA WINDOW, BETA COUNTERS



120 C • 120 N **120 NB**

Description

The type *120N* or *120NB* is a large end window Beta counter that allows very good counting geometries. It has a low voltage Neon gas filling and an average window thickness[4] of 5.6 mg/cm^2.

The type *120C* is filled with Argon and is useful as a Beta and X-Ray counter. It also has a window thickness[4] of 5.6 mg/cm^2.

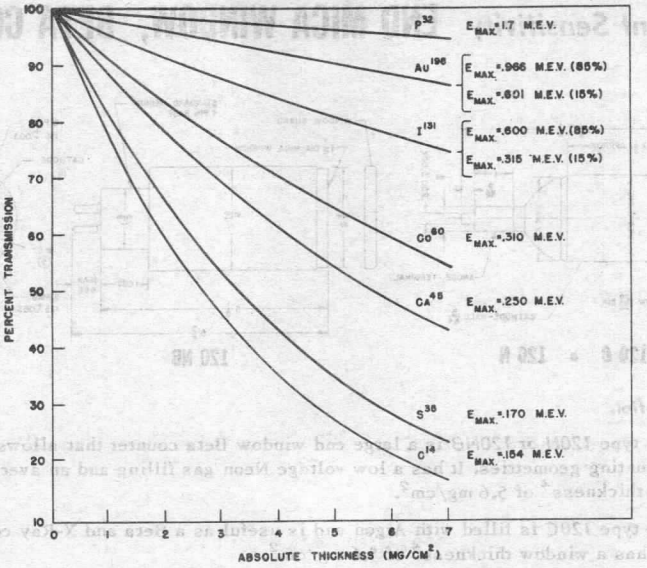
General Data

Operating temperature range	-55° to $+75^{\circ}$C
Quenching agent	halogen admixture
Effective diameter of mica window	1-29/32"
Cathode material	stainless steel (28% chromium, 72% iron)
Effective cathode dimensions	2-11/16" long x 2" O.D. x 5/64" wall

Performance Data	*120N & 120NB*	*120C*
Operating voltage[1,3]	700 volts D.C.	1200 volts DC
Plateau length[1]	in excess of 200 volts	in excess of 300 volts
Slope of plateau[1,5]	5% to 10% per 100 volts	5% to 10% per 100 volts
Starting voltage (0.3 volt pulses)[1]	625 volts max.	1075 volts max.
Capacity at terminals	1.0 mmf	1.0 mmf
Radial sensitivity (approx.)	80%	80%
Photosensitivity & hysteresis	none	none
Dead time (approx.)	300 microseconds	300 microseconds
Maximum counting rate[6]	550 counts per second	550 counts per second
Background (Shielded 2" lead and 1/8" aluminum)	100 counts per min. max	100 counts per min. max
Life expectancy in counts[2]	unlimited by use	unlimited by use
Maximum operating altitude	15,000 feet	15,000 feet

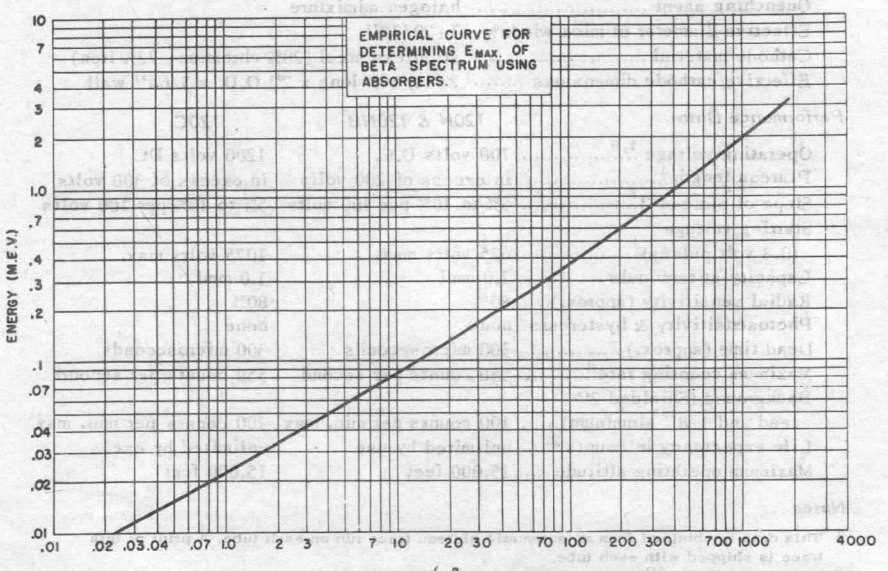
Notes

1 This data is obtained from an automatic plateau trace run on each tube. A print of this trace is shipped with each tube.
2 Guaranteed 5 x 10^{10} counts minimum
3 These tubes will operate satisfactorily anywhere on the plateau.
4 5.6 mg/cm^2 mica = .0008 inch = 20.32 microns
5 At an average counting rate of 100 counts per second
6 For 20% dead time correction (approx,).



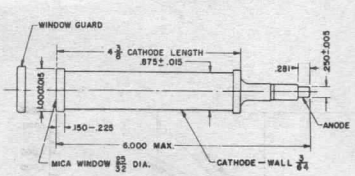
CALCULATED TRANSMISSION OF BETA SPECTRUM FROM SOME COMMON RADIOISOTOPES.

Adapted from G. I. Gleason, et al — Nucleonics, Vol. 8, No. 5, 18 (1951)

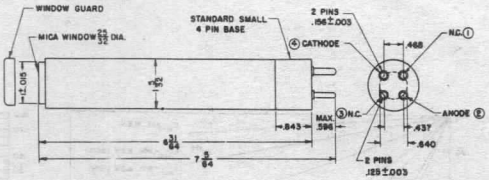


Amperex® TYPE 150 SERIES

Permanent Sensitivity END MICA WINDOW, BETA-GAMMA COUNTERS



150 N (U.S.N. Type BS-1/5979)



150 NB

Description

The type *150N* or *150NB* is a very sensitive, low voltage, halogen-quenched Geiger counter tube for use in survey instruments. Approximate response of this tube to hard Gamma radiation is given on reverse of this sheet. This tube meets the requirements of U.S. Navy specification type BS-1/5979. The mica Beta window[9] is 3 to 4 mg/cm^2. Upon special request a 1.4 to 2.0 mg/cm^2 window[9] is available.

General Data

Operating temperature range	-55° to $+75^{\circ}$C
Gas filling	Neon plus halogen admixture
Cathode material	stainless steel (28% chromium, 72% iron)
Mica window[9]	3 to 4 mg/cm^2
Mica window diameter	25/32"
Effective cathode dimensions	4-3/8" long x 7/8" O.D. x 3/64" wall

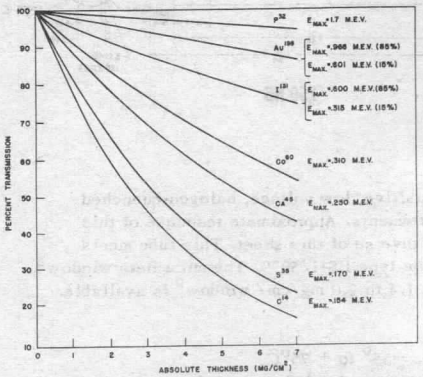
Performance Data

Operating voltage[1,3,4]	700 volts D.C.
Plateau length[1,8]	in excess of 180 volts
Slope of plateau[1,8,5]	10% per 100 volts max.
Starting voltage (0.3 volt pulses)[1]	620 volts max.
Capacity at terminals	2.4 mmf
Radial sensitivity (approx.)	80%
Photosensitivity & hysteresis	none
Dead time (approx.)	150 microseconds
Maximum counting rate[6]	1100 counts per second
Background (Shielded 2" lead and 1/8" aluminum)	75 counts per minute max.
Life expectancy in counts[2]	unlimited by use
Roentgen energy dependance[7] (unfiltered).	±20%

Notes

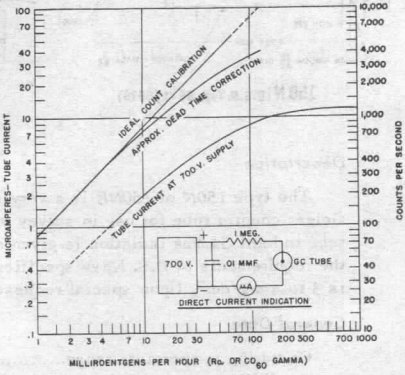
1. This data is obtained from an automatic plateau trace run on each tube. A print of this trace is shipped with each tube.
2. Guaranteed 5 x 10^{10} counts minimum.
3. These tubes will operate satisfactorily anywhere on the plateau.
4. Also available upon request filled at 900 volts operating voltage
5. At an average counting rate of 100 counts per second.
6. For 20% dead time correction (approx.).
7. Calculated value based on radiocobalt gamma center from 100KV to 3 M.E.V. extremes.
8. When tested according to the BS-1/5979 specification with a ratemeter with 1 volt sensitivity and 275 microseconds resolving time, this type has a minimum plateau length of 200 volts and maximum slope of 10% per 100 volts.
9. 1.4 mg/cm^2 mica = .0002 inch = 5.08 microns., 3.5 mg/cm^2 mica = .0005 inch = 12.70 microns

150 SERIES

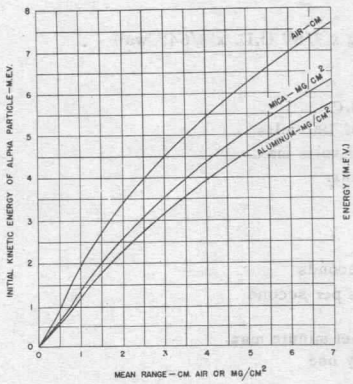


CALCULATED TRANSMISSION OF BETA SPECTRUM FROM SOME COMMON RADIOISOTOPES

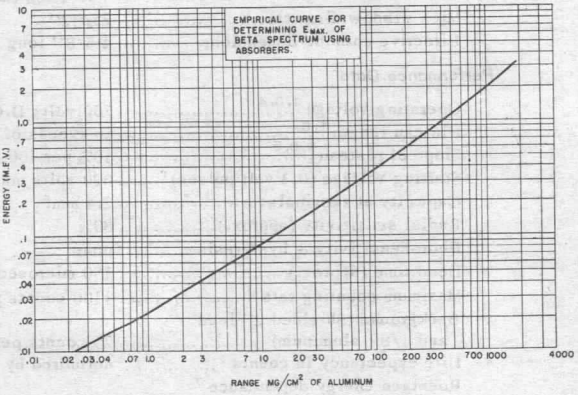
Adapted from G. I. Gleason, et al — Nucleonics, Vol. 8, No. 5, 18 (1951)



TYPICAL OPERATION

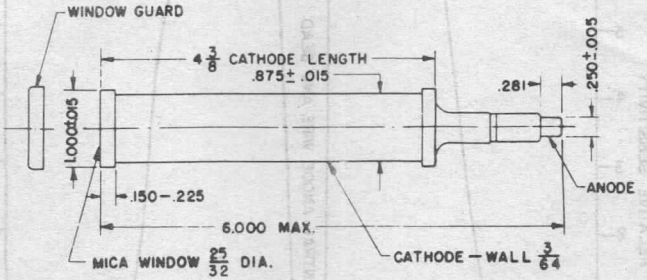


ALPHA PARTICLE MEAN RANGES.



Amperex® TYPE 153 C

Permanent Sensitivity X-RAY COUNTER



Description

The type 153C is an optimum design for an end mica window, X-Ray diffraction and fluorescence analysis counter. It has maximum sensitivity to the characteristic radiation of the usual X-Ray diffraction targets. The infinite-life, halogen filling allows the exposure of the tube to the direct X-Ray beam without any adverse effect.

General Data

Operating temperature range	-55° to $+75^{\circ}$C
Gas Filling	Argon plus halogen admixture
Cathode material	stainless steel (28% chromium, 72% iron)
Mica window [6]	3 to 4 mg/cm^2
Mica window diameter	25/32"
Length of sensitive gas path	100 mm
Recommended X-Ray beam width	1.2 cm
Effective cathode dimensions	4-3/8" long x 7/8" O.D. x 3/64" wall

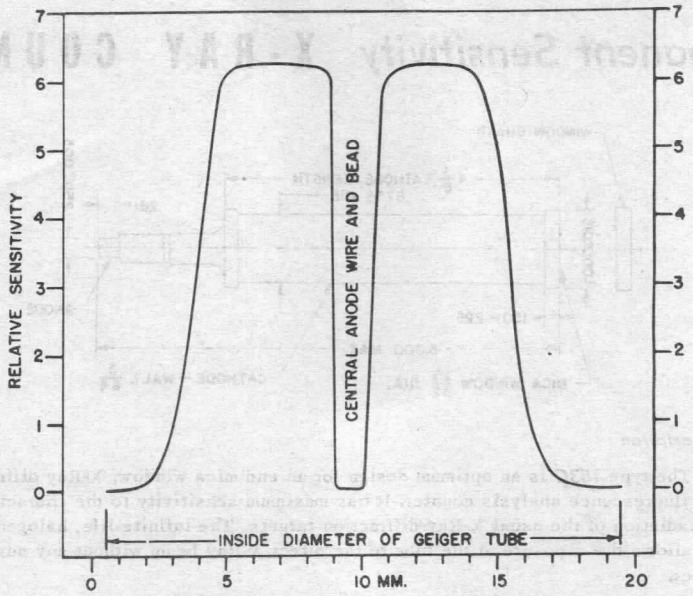
Performance Data

Operating voltage [1, 3]	1500 volts D.C.
Plateau length [1]	in excess of 400 volts
Slope of plateau [1, 4]	3% to 8% per 100 volts
Starting voltage (0.3 volt pulses) [1]	1300 to 1400 volts
Capacity of terminals	2.4 mmf
Radial sensitivity	65% to 70%
Dead time (approx.)	150 microseconds
Maximum counting rate [5]	1100 counts per second
Background (Shielded 2" lead and 1/8" aluminum)	60 counts per minute max.
Life expectancy in counts [2]	unlimited by use

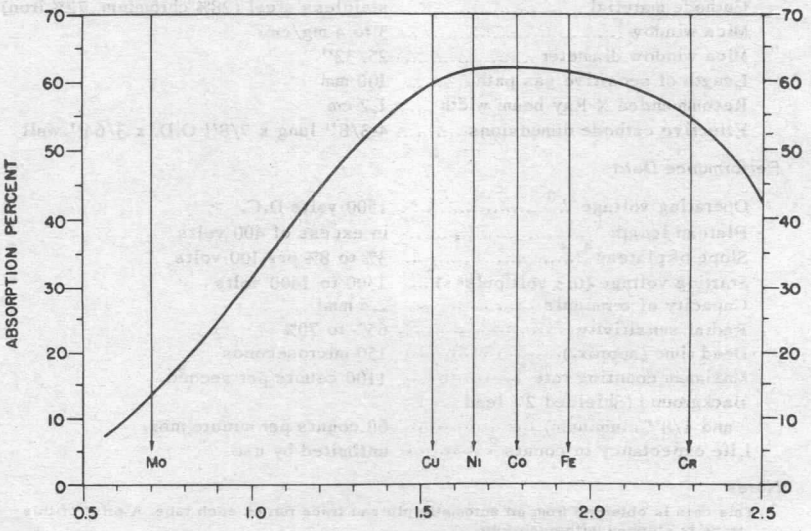
Notes

1 This data is obtained from an automatic plateau trace run on each tube. A print of this trace is shipped with each tube.
2 Guaranteed 5×10^{10} counts minimum.
3 These tubes will operate satisfactorily anywhere on the plateau.
4 At an average counting rate of 100 counts per second.
5 For 20% dead time correction (approx.).
6 3.5 ng/cm^2 mica = .0005 inch = 12.70 microns.

153 C



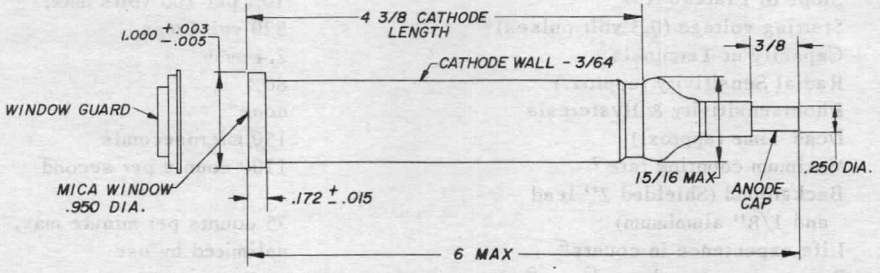
RADIAL SENSITIVITY OF TYPE 153-C GEIGER COUNTER TUBE



QUANTUM EFFICIENCY OF TYPE 153-C GEIGER COUNTER TUBE

Amperex® TYPE 155N

Permanent Sensitivity END MICA WINDOW, BETA-GAMMA COUNTER



Description

The Amperex type 155N is a highly sensitive, halogen quenched Geiger counter tube for the detection of gamma and beta radiations. Because of its geometery, the tube is well suited for use in survey instruments.

Upon special request, the 155N can be supplied at an operating voltage of 700 volts. A mica window [1] of 3 - 4 mg/cm^2 can also be provided if desired.

General Data

Operating Temperature Range	-55°C to $+75^{\circ}$C
Gas Filling	Neon plus halogen admixture
Cathode Material	stainless steel (28% chromium, 72% iron)
Mica Window [1]	1.4 - 2.0 mg/cm^2
Mica Window Diameter	.950 inches
Effective Cathode Dimensions	4-3/8" long x 7/8" O.D. x 3/64" wall

[1] 1.4 mg/cm^2 mica = .0002 inch = 5.08 microns, 3.5 mg/cm^2 mica = .0005 inch = 12.70 microns.

155N

Performance Data

Operating Voltage [2,3,4]	900 volts D.C.
Plateau length [1,5]	in excess of 180 volts
Slope of Plateau [1,5,6]	10% per 100 volts max.
Starting voltage (0.3 volt pulses) [2]	820 volts max
Capacity at Terminals	2.4 mmf
Radial Sensitivity (approx.)	80%
Photosensitivity & Hysteresis	none
Dead Time (approx.)	150 microseconds
Maximum counting rate [7]	1100 counts per second
Background (Shielded 2" lead and 1/8" alumimum)	75 counts per minute max.
Life expectance in counts [8]	unlimited by use
Roentgen energy dependance [9] (unfiltered)	±20%

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2 This data is obtained from an automatic plateau trace run on each tube. A print of this trace is shipped with each tube.

3 This tube will operate satisfactorily anywhere on the plateau.

4 Also available upon request filled at 700 volts operating voltage

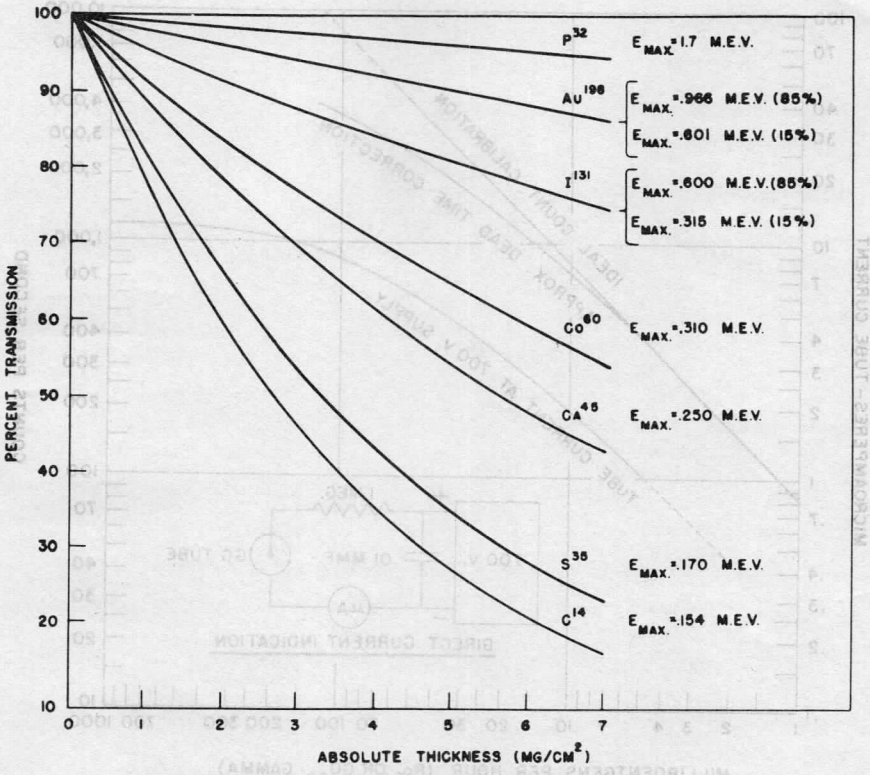
5 When tested according to the BS-1/5979 specification with a ratemeter with 1 volt sensitivity and 275 microseconds resolving time, this type has a minimum plateau length of 200 volts and maximum slope of 10% per 100 volts.

6 At an average counting rate of 100 counts per second.

7 For 20% dead time correction (approx)

8 Guaranteed 5×10^{10} counts minimum

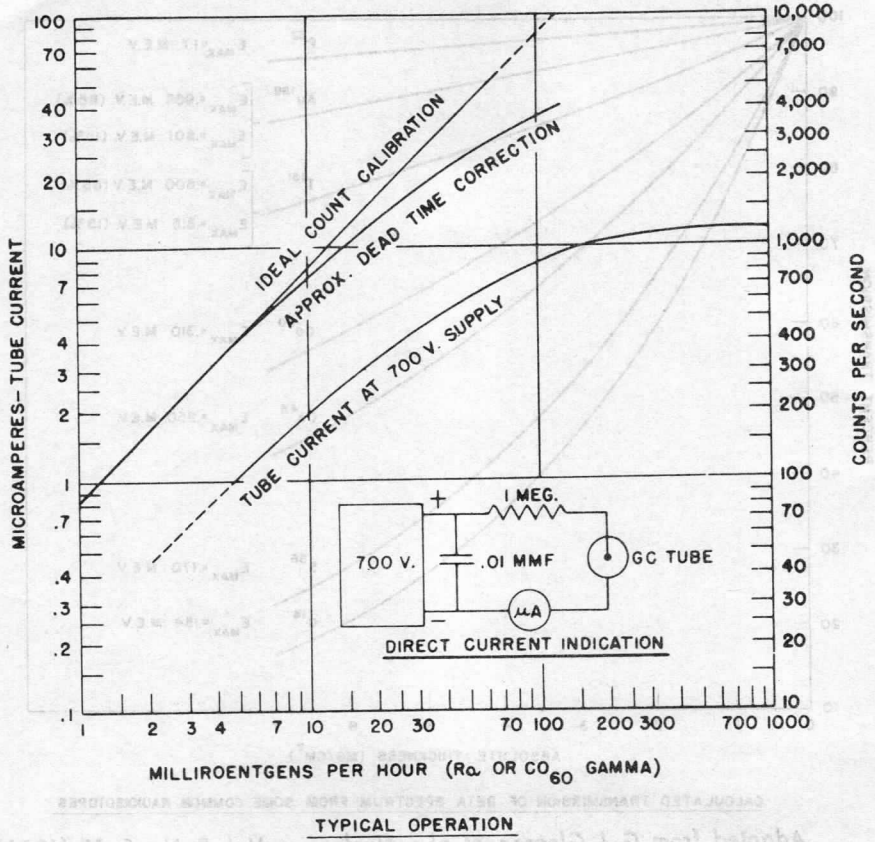
9 Calculated value based on radiocobalt gamma center from 100KV to 3 M.E.V. extremes



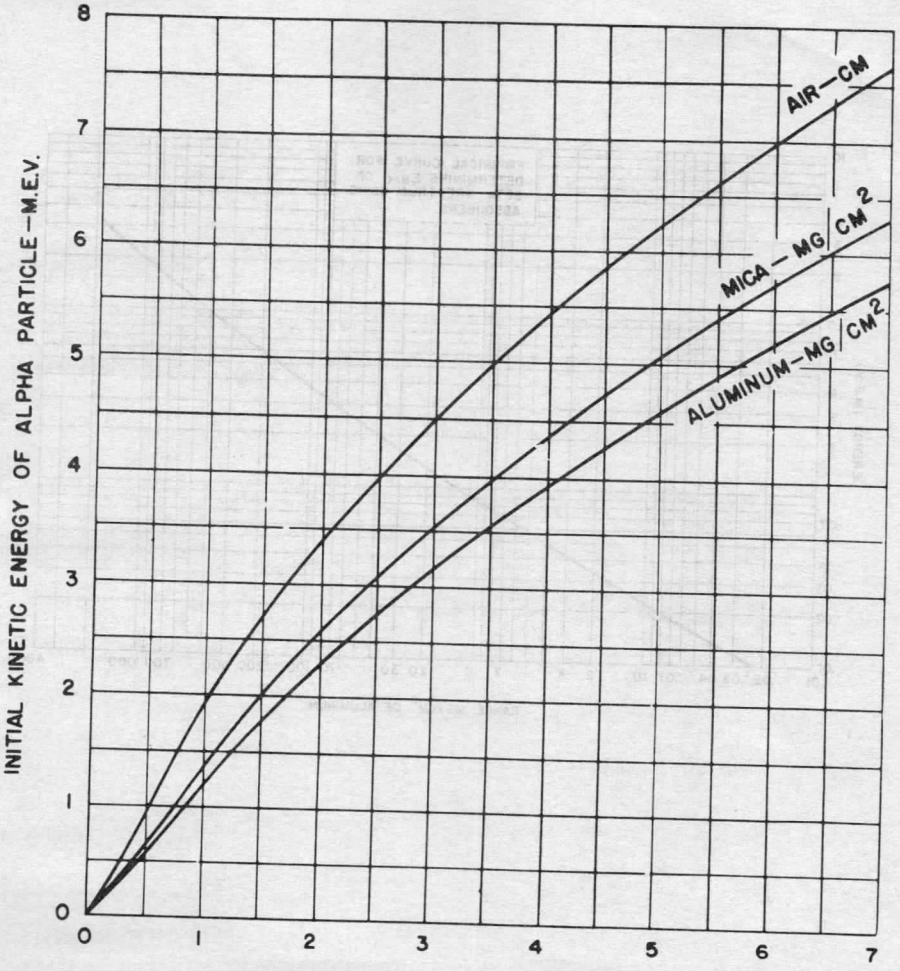
CALCULATED TRANSMISSION OF BETA SPECTRUM FROM SOME COMMON RADIOISOTOPES

Adapted from G. I. Gleason, et al — Nucleonics, Vol. 8, No. 5, 18 (1951)

155N

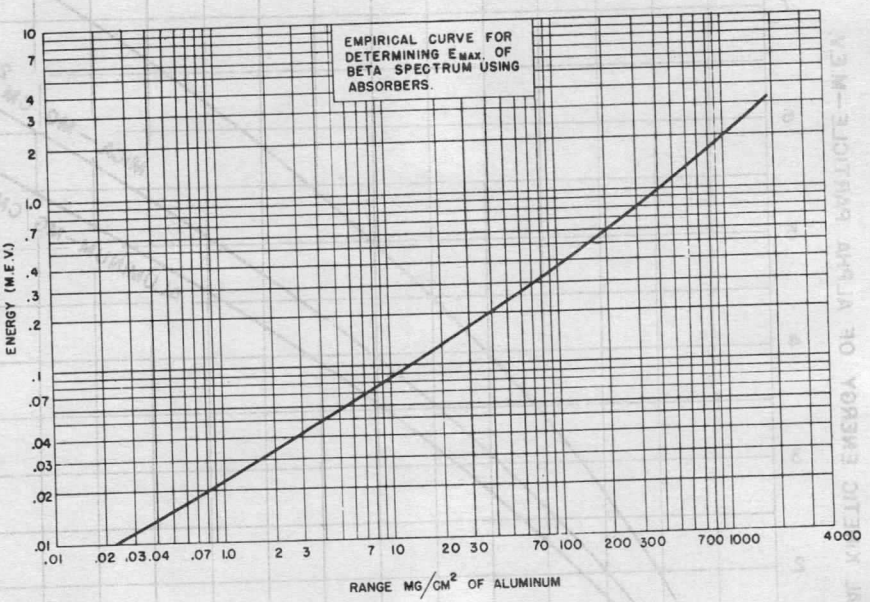


TYPICAL OPERATION



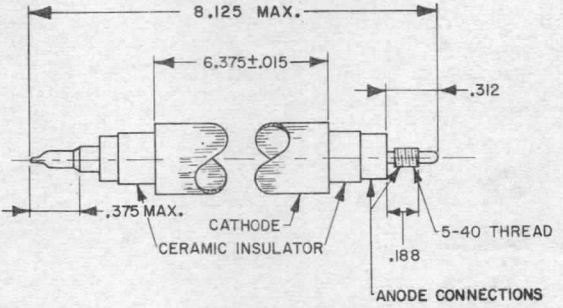
ALPHA PARTICLE MEAN RANGES.

155N


EMPIRICAL CURVE FOR DETERMINING $E_{MAX.}$ OF BETA SPECTRUM USING ABSORBERS.
ENERGY (M.E.V.)
10
7
4
3
2
1.0
.7
.4
.3
.2
.1
.07
.04
.03
.02
.01
.01
.02
.03
.04
.07
1.0
2
3
7
10
20
30
70
100
200
300
700
1000
4000
RANGE MG/CM^2 OF ALUMINUM

Amperex® TYPE 160-G

Permanent Sensitivity GAMMA COUNTER



Description

The type 160G is a highly sensitive gamma counter tube which can be operated at temperatures up to 175°C with virtually no change in characteristics. The infinite-life halogen filling gives the tube an unusual electrical ruggedness to match its mechanical strength.

General Data

Operating temperature range	−55° C to + 175° C
Gas filling	neon plus halogen admixture
Cathode material	stainless steel (28% chromium, 72% iron)
Effective cathode dimensions	.410" O.D. x 6.3" long x 0.20" wall

Performance Data

Starting voltage [1]	590 - 630 volts
→ Plateau	680 - 780 volts
Slope of Plateau [2] (−55°C to + 175°C)	15% per 100 volts max.
Background [3] (shielded with .025" aluminum inside 2" lead)	40 counts per minute
Pulse Amplitude [4]	120 volts min.

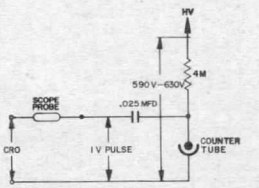
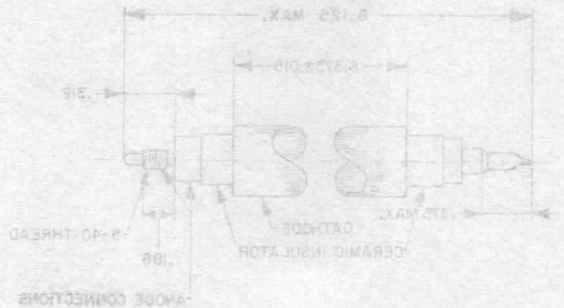


FIG. 1, TEST CIRCUIT FOR MEASUREMENT OF STARTING VOLTAGE AND PULSE AMPLITUDE

[1] See Test Circuit. The recommended starting voltage is that which produces uniform 1 volt pulses at the input to the oscilloscope probe. Between 25C and 150C the maximum increase in starting voltage should never be more than 20 volts.
[2] At a nominal counting rate of 100 counts per second.
[3] When operating at 700 volts, 25° C.
[4] When operating at 700 volts.

Amperex® TYPE 160-G

Permanent Sensitivity GAMMA COUNTER



Description

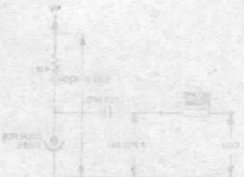
The type 160G is a highly sensitive gamma counter tube which can be operated at temperatures up to 175°C with virtually no change in characteristics. The inflating halogen filling gives the tube an unusual electrical ruggedness to match its mechanical strength.

General Data

Operating temperature range	−55°C to + 175°C
Gas filling	neon plus halogen admixture
Cathode material	stainless steel (28% chromium, 72% iron)
Effective cathode dimensions	.410" O.D. x 6.3" long x 0.20" wall

Performance Data

Starting voltage [1]	
Plateau	590 - 630 volts
Slope of Plateau [2] (−55°C to + 175°C)	680 + 780 volts
Background [3] (shielded with .027" aluminium inside 2" lead)	15% per 100 volts max.
	40 counts per minute
Pulse Amplitude [4]	120 volts min.



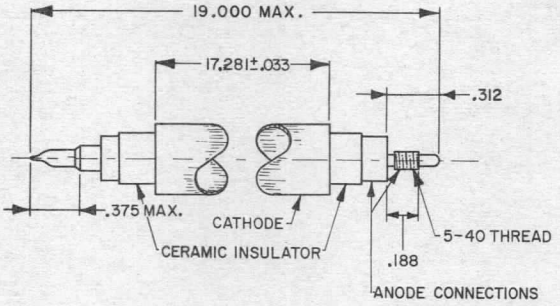
[1] See Test Circuit. The recommended starting voltage is that which produces uniform 1 volt pulses at the input to the oscilloscope probe. Between 25°C and 150°C the maximum increase in starting voltage should never be more than 20 volts.

[2] At a nominal counting rate of 100 counts per second.

[3] When operating at 700 volts, 25°C.

Amperex® TYPE 170-G

Permanent Sensitivity GAMMA COUNTER



Description

The type 170G is a highly sensitive gamma counter tube which can be operated at temperatures up to 175°C with virtually no change in characteristics. The infinite-life halogen filling gives the tube an unusual electrical ruggedness to match its mechanical strength.

General Data

Operating temperature range	−55°C to + 175°C
Gas filling	neon plus halogen admixture
Cathode material	stainless steel (28% chromium, 72% iron)
Effective cathode dimensions	.410" O.D. x 17" long x 0.20" wall

Performance Data

Starting voltage [1]	590 - 630 volts
→ Plateau	680 - 780 volts
Slope of plateau [2] (−55°C to + 175°C)	15% per 100 volts max
Background [3] (shielded with .025" aluminum inside 2" lead)	80 counts per minute
Pulse Amplitude [4]	120 volts min.

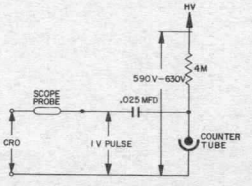
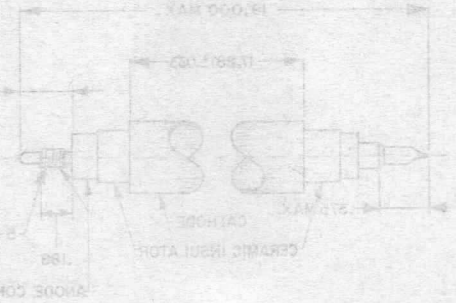


FIG. 1, TEST CIRCUIT FOR MEASUREMENT OF STARTING VOLTAGE AND PULSE AMPLITUDE

[1] See Test Circuit. The recommended starting voltage is that which produces uniform 1 volt pulses at the input to the oscilloscope probe. Between 25C and 150C the maximum increase in starting voltage should never be more than 20 volts.
[2] At a nominal counting rate of 100 counts per second.
[3] When operating at 700 volts, 25°C.
[4] When operating at 700 volts.

Amperex® TYPE 170-G

Permanent Sensitivity GAMMA COUNTER



Description

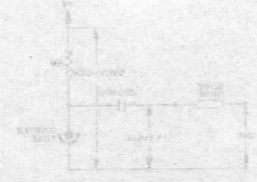
The type 170G is a highly sensitive gamma counter tube which can be operated at temperatures up to 175°C with virtually no change in characteristics. The infinite-life halogen filling gives the tube an unusual electrical ruggedness to match its mechanical strength.

General Data

Operating temperature range	−55°C to + 175°C
Gas filling	neon plus halogen admixture
Cathode material	stainless steel (28% chromium, 72% iron)
Effective cathode dimensions	.410" O.D. x 1.7" long x 0.20" wall

Performance Data

Starting voltage [1]	
— Plateau	590 - 630 volts
Slope of plateau [2] (−55°C to + 175°C)	680 - 780 volts
Background [3] (shielded with .025"	15% per 100 volts max
aluminium inside 2" lead)	80 counts per minute
Pulse Amplitude [4]	120 volts min.



[1] See Test Circuit. The recommended starting voltage is that which produces unitons 1 volt pulses at the input to the oscilloscope probe. Between 25C and 150C the maximum increase in starting voltage should never be more than 20 volts.

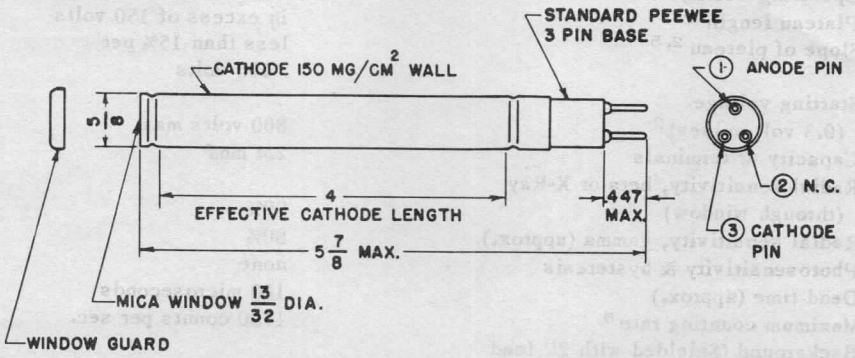
[2] At a nominal counting rate of 100 counts per second.

[3] When operating at 700 volts, 25°C.

[4] When operating at 700 volts.

Amperex® TYPE 240N

Permanent Sensitivity ALPHA-BETA GAMMA, X-RAY COUNTER



Description

The type 240N is a probe tube with a long cathode that makes it sensitive to Gamma radiation at tolerance dosage levels. The 1.4 to 2 mg/cm², mica window [1] on a tube of this general size and shape gives Alpha and Beta sensitivity to survey instruments using this tube in place of similar Gamma tube types. The 3 pin base fits into a standard socket and makes the tube readily interchangeable with other types.

General Data

Operating temperature range	-55° to $+75^{\circ}$C
Gas filling	Neon plus halogen admixutre
Cathode material	stainless steel (28% chromium, 72% iron)
Mica window [1]	1.4 to 2 mg/cm²
Mica window diameter	13/32"
Effective cathode dimensions	4" long x .605" I.D. x .010" wall

[1] 1.4 mg/cm² mica = .0002 inch = 5.08 microns.

240N

Performance Data

Operating Voltage[2,3,4]	850-900 volts D.C.
Plateau length [2]	in excess of 150 volts
Slope of plateau [2,5]	less than 15% per 100 volts
Starting voltage (0.3 volt pulses) [2]	800 volts max.
Capacity at terminals	2.4 mmf
Radial sensitivity, beta or X-Ray (through window)	99%
Radial sensitivity, gamma (approx.)	80%
Photosensitivity & hysteresis	none
Dead time (approx.)	100 microseconds
Maximum counting rate [6]	1700 counts per sec.
Background (Shielded with 2" lead and 1/8" aluminum)	50 counts per min. max.
Roentgen energy dependance [7]	± 20%
Life expectancy in counts [8]	unlimited by use

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2 This data is obtained from an automatic plateau trace run on each tube. A print of this trace is shipped with each tube.

3 This tube will operate satisfactorily anywhere on the plateau.

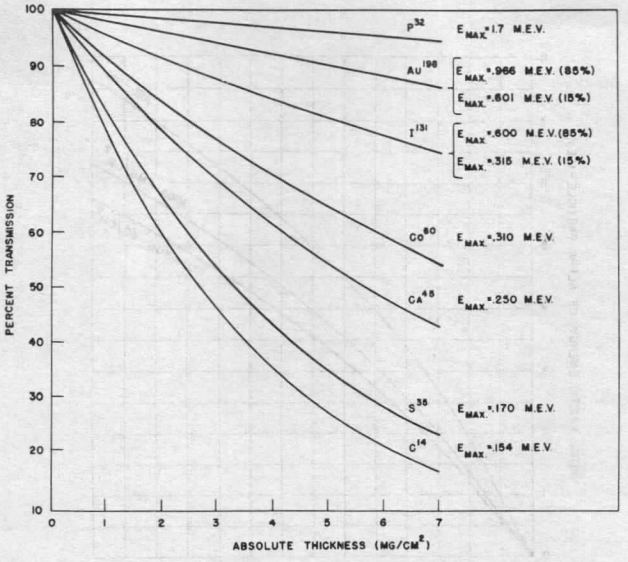
4 Also available at 700 volts operating voltage upon special request.

5 At an average counting rate of 100 counts per second.

6 For 20% dead time correction (approx.)

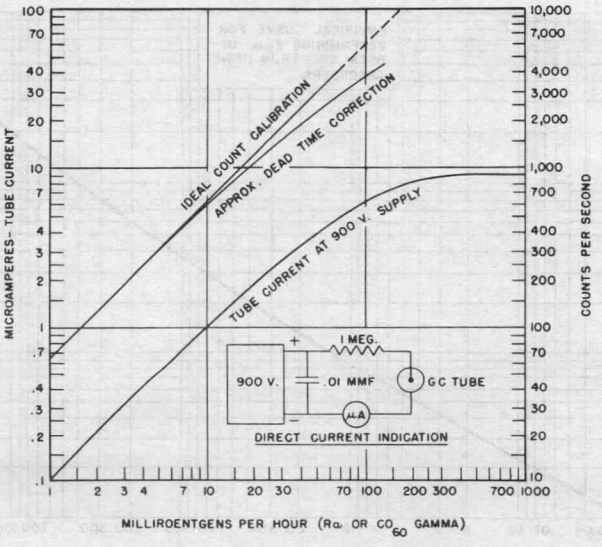
7 Calculated value based on radiocobalt gamma center value with 100KV to 3 M.E.V. extremes.

8 Guaranteed 5×10^{10} counts minimum.

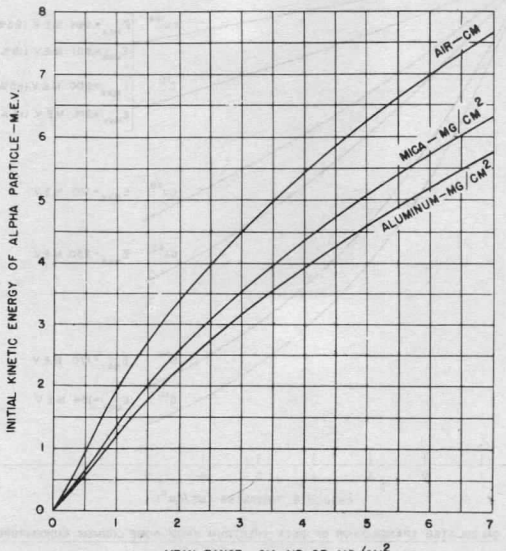


CALCULATED TRANSMISSION OF BETA SPECTRUM FROM SOME COMMON RADIOISOTOPES

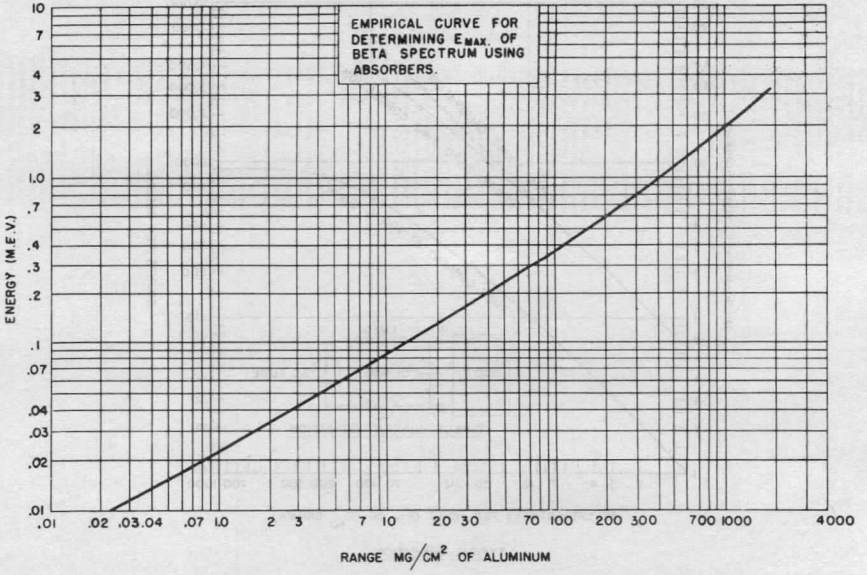
Adapted from G. I. Gleason, et al — Nucleonics, Vol. 8, No. 5, 18 (1951)



TYPICAL OPERATION

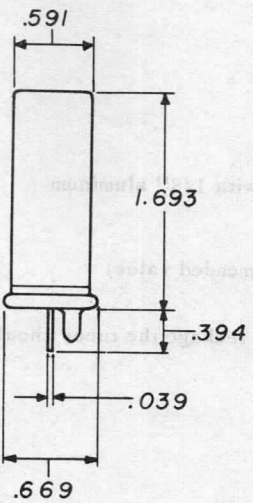


ALPHA PARTICLE MEAN RANGES.



Amperex® TYPE 18503

Permanent Sensitivity GAMMA COUNTER



Description

The Amperex type 18503 is a halogen quenched geiger tube for the detection and measurement of gamma radiation. Because of its mechanical ruggedness and excellent plateau characteristics, namely a long plateau region with a low slope and relatively low operating voltage, it is ideally suited for applications in portable survey and monitoring equipment. These characteristics permit considerable simplification in associated transistorized power supplies.

The tube is unusually stable with extremely small variations in characteristics from tube to tube.

General Data

Operating Temperature Range	$-55^{\circ}C$ to $+75^{\circ}C$
Gas Filling	neon, argon plus halogen quenching agent
Cathode Material	stainless steel (28% chromium, 72% iron)
Cathode Wall Thickness	250 mg/cm^2
Capacity at Terminals	2 $\mu\mu f$ (approx)
Mounting	see note 1

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[1] Low capacity mounting of the counter tube is required. (Shortest possible connector between anode and anode circuit is required for low capacity.)

18503

Performance Data

Starting Voltage	275 volts min 325 volts max
Plateau Length [2]	225 volts min 250 volts average
Plateau Slope [2]	0.01 %/volt average 0.02 %/volt max
Beginning of Plateau [2]	425 volts max
Background (shielded with 1/8" aluminum and 2" lead) [2]	10 counts/minute max
Dead Time [2]	100 μsec max
Anode Resistor (recommended value)	10 megohms
Recommended Circuit	see figure 1

Note: In order to prevent leakage the tubes should be kept dry and well cleaned.

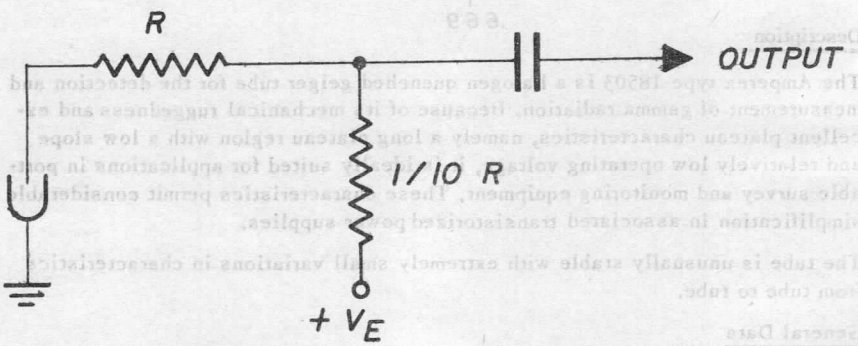
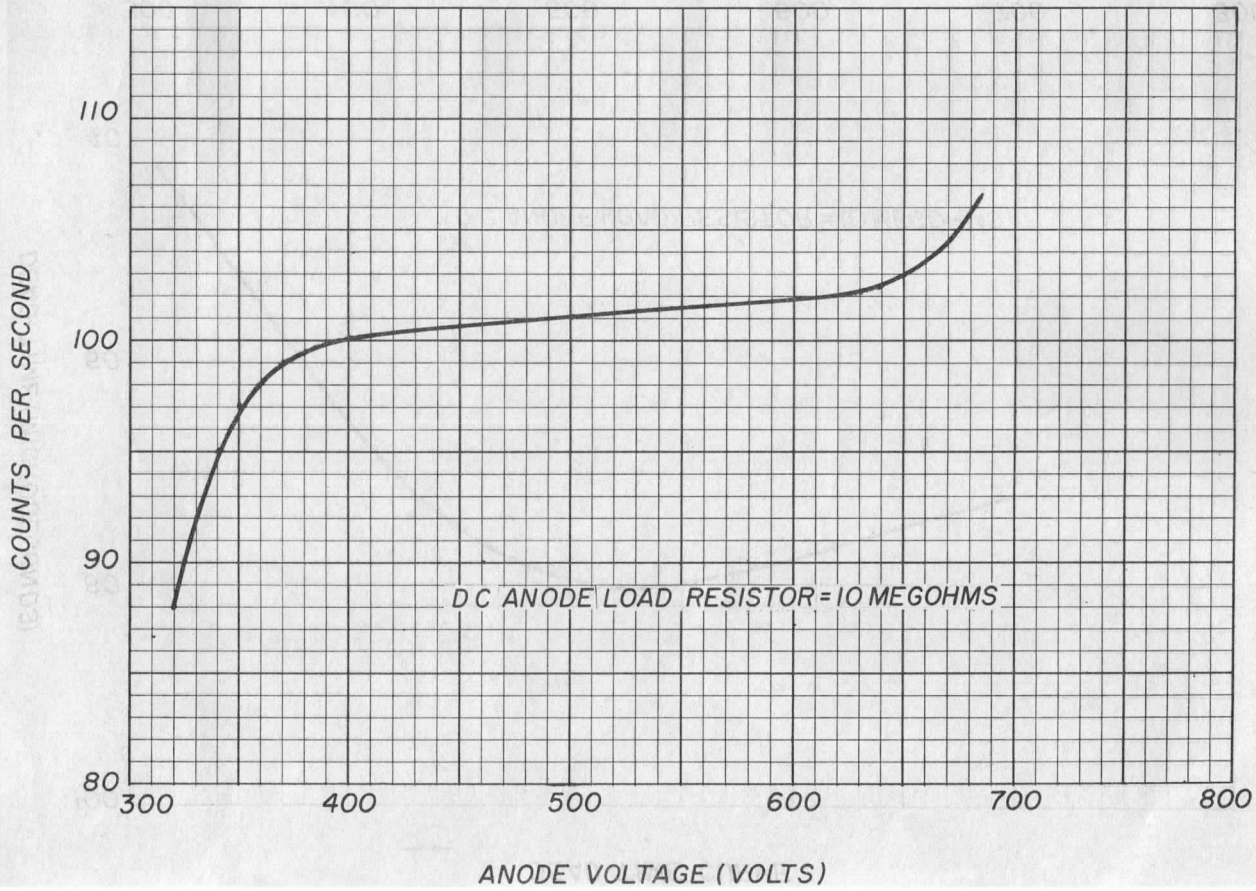


FIG. 1

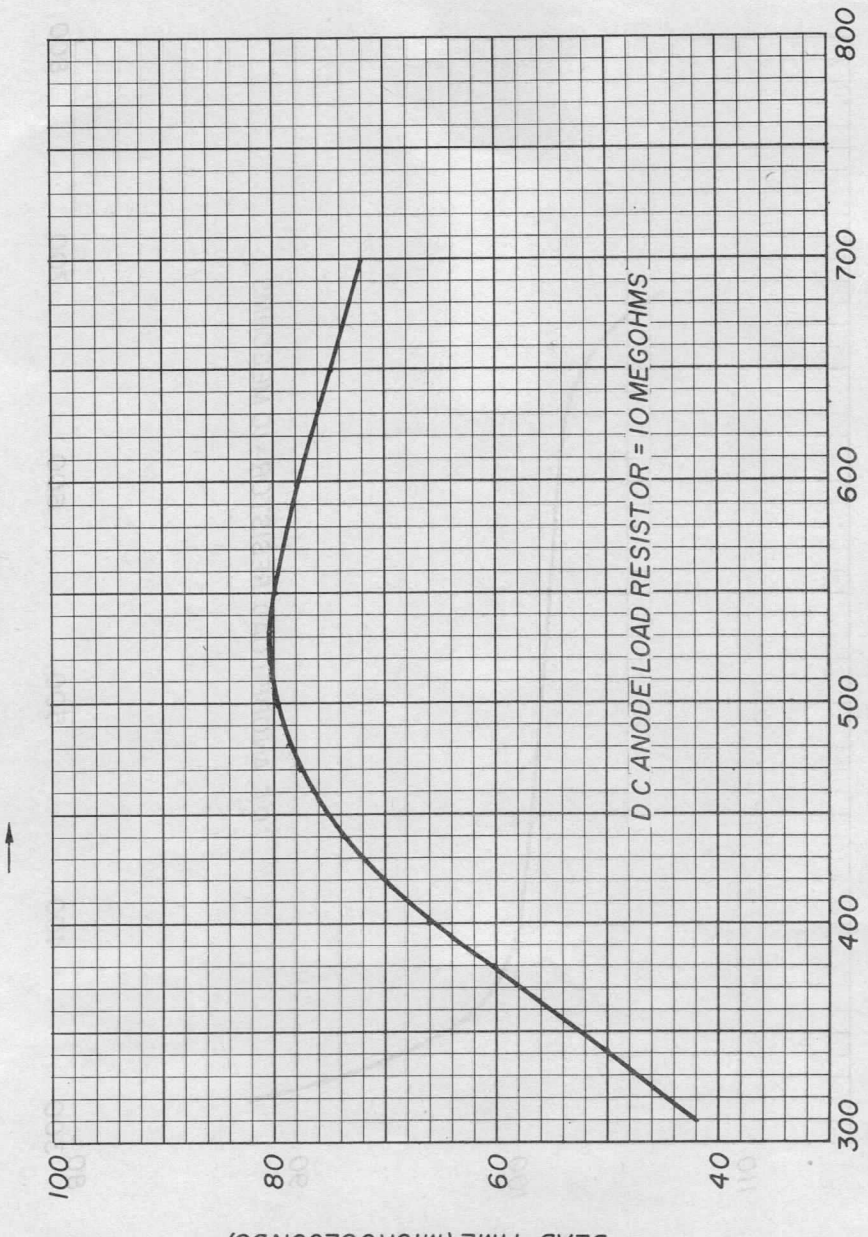
[2] At about 100 counts/sec and R = 10 meghoms; operating voltage arbitrary within plateau.

PLATEAU CURVE



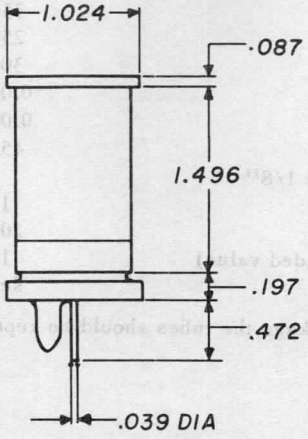
18503

18503


DEAD TIME CURVE
DEAD TIME (MICROSECONDS)
100
80
60
40
D C ANODE LOAD RESISTOR = 10 MEGOHMS
300
400
500
600
700
800
ANODE VOLTAGE (VOLTS)

Amperex® TYPE 18505

Permanent Sensitivity END MICA WINDOW, BETA-ALPHA-GAMMA COUNTER



Description

The Amperex type 18505 is a mica end window, halogen quenched geiger tube for the detection and measurement of beta, alpha and gamma radiation. Because of its mechanical ruggedness and excellent plateau characteristics, namely a long plateau region with a low slope and relatively low operating voltage, it is ideally suited for applications in portable survey and monitoring equipment. These characteristics permit considerable simplification in the associated transistorized power supplies. As a result of its small size, it is easily incorporated in probe type instruments.

The tube is unusually stable with extremely small variations in characteristics from tube to tube.

General Data

Operating Temperature Range	$-55^{\circ}C$ to $+ 75^{\circ}C$
Gas Filling	neon, argon plus halogen quenching agent
Cathode Material	stainless steel (28% chromium, 72% iron)
Mica Window Thickness	1.5 - 2 mg/cm^2
Cathode Wall Thickness	0.047 inches
Capacity at Terminals	2.5 $\mu\mu f$ (approx)
Mounting	see note 1

[1] Low capacity mounting of the counter tube is required. (Shortest possible connector between anode and anode circuit is required for low capacity.

18505

Performance Data

Starting Voltage	300 volts min 350 volts max
Plateau Length [2]	250 volts min 300 volts average
Plateau Slope [2]	0.01 %/volt average 0.02 %/volt max
Beginning of Plateau [2]	450 volts max
Background (shielded with 1/8" aluminum and 2" lead) [2]	15 counts/minute max.
Dead Time [2]	200 μsec max
Anode Resistor (recommended value)	10 megohms
Recommended Circuit	see figure 1

Note: In order to prevent leakage the tubes should be kept dry and well cleaned.

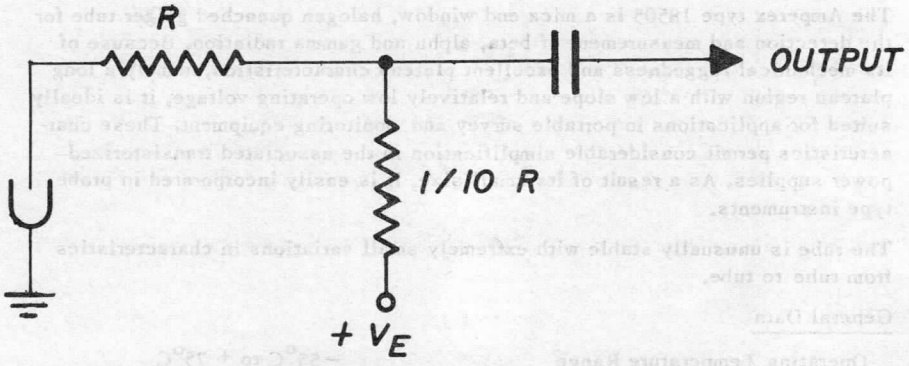
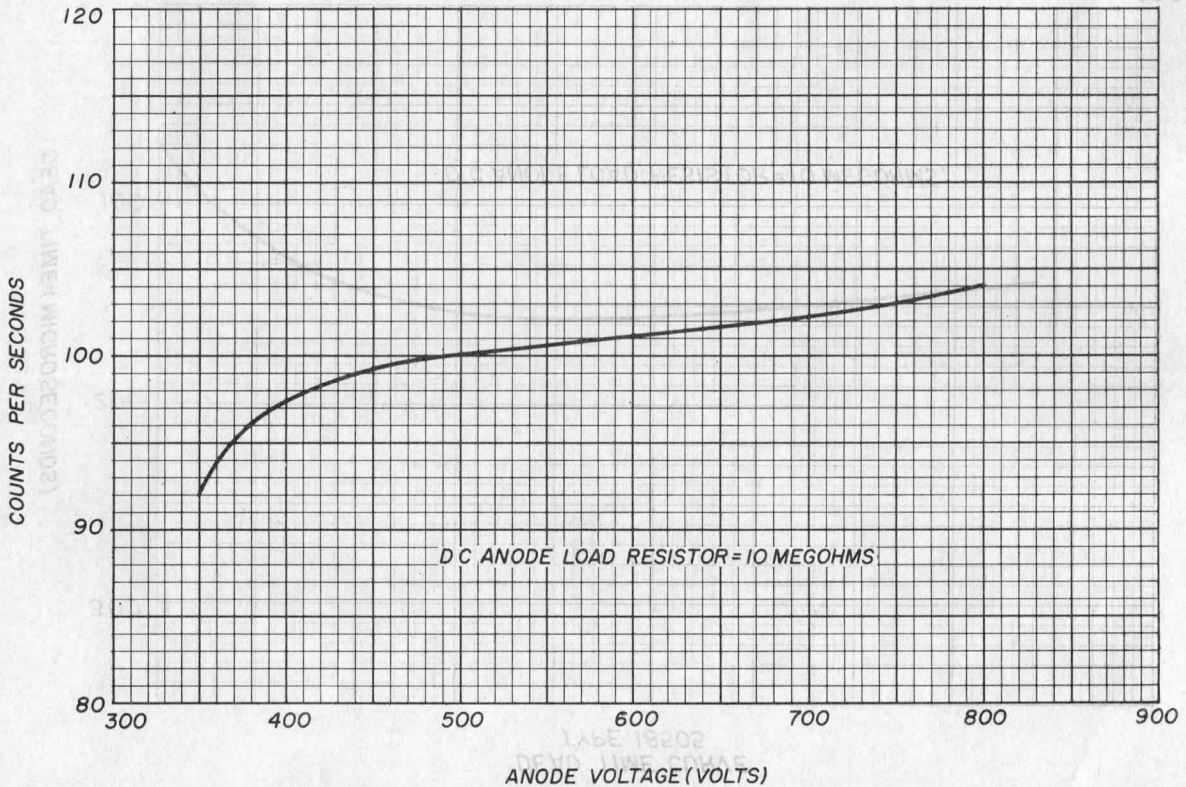


FIG. 1

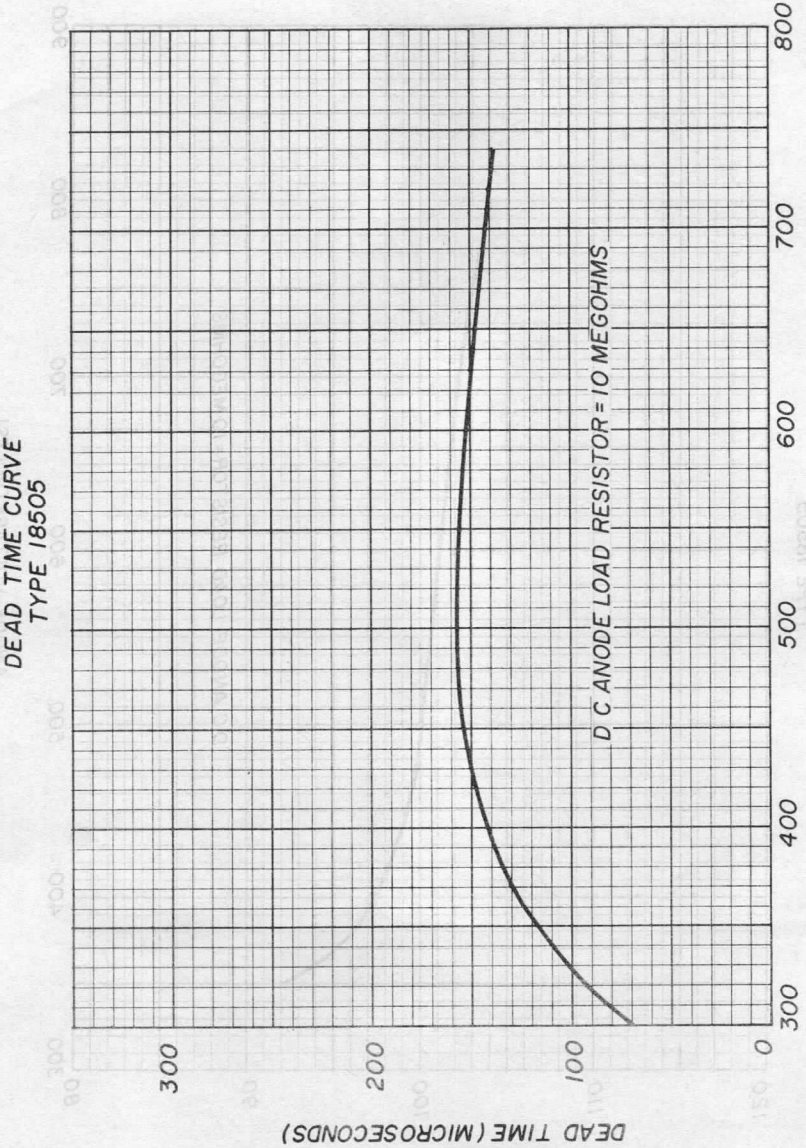
[2] At about 100 counts/sec and R = 10 megohms; operating voltage arbitrary within plateau.

PLATEAU CURVE
TYPE 18505



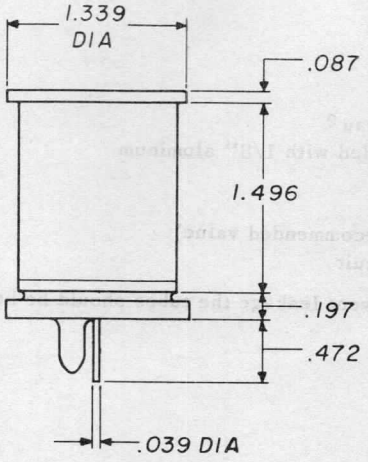
18505

18505


DEAD TIME CURVE
TYPE 18505
D C ANODE LOAD RESISTOR = 10 MEGOHMS
DEAD TIME (MICROSECONDS)
0
100
200
300
ANODE VOLTAGE (VOLTS)
300
400
500
600
700
800

Amperex® TYPE 18506

Permanent Sensitivity END MICA WINDOW, BETA-ALPHA-GAMMA COUNTER



Description

The Amperex type 18506 is a mica end window, halogen quenched geiger tube for the detection and measurement of beta, alpha and gamma radiation. Because of its mechanical ruggedness and excellent plateau characteristics, namely a long plateau region with a low slope and relatively low operating voltage, it is ideally suited for applications in portable survey and monitoring equipment. These characteristics permit considerable simplification in the associated transistorized power supplies. As a result of its small size, it is easily incorporated in probe type instruments.

The tube is unusually stable with extremely small variations in characteristics from tube to tube.

General Data

Operating Temperature Range	$-55^{\circ}C$ to $+75^{\circ}C$
Gas Filling	neon, argon plus halogen quenching agent
Cathode Material	stainless steel (28% chromium, 72% iron)
Mica Window Thickness	2.5 - 3.5 mg/cm^2
Cathode Wall Thickness	0.051 inches
Capacity at Terminals	3.5 $\mu\mu$f (approx)
Mounting	see note 1

[1] Low capacity mounting of the counter tube is required. (Shortest possible connector between anode and anode circuit is required for low capacity.)

18506

Performance Data

Starting Voltage	325 volts min 375 volts max
Plateau Length [2]	300 volts min 350 volts average
Plateau Slope [2]	0.01 %/volt average 0.02 %/volt max
Beginning of Plateau [2]	450 volts max
Background (Shielded with 1/8" aluminum and 2" lead) [2]	25 counts/minute max
Dead Time [2]	250 μsec max
Anode Resistor (recommended value)	10 megohms
Recommended Circuit	see figure 1

Note: In order to prevent leakage the tubes should be kept dry and well cleaned.

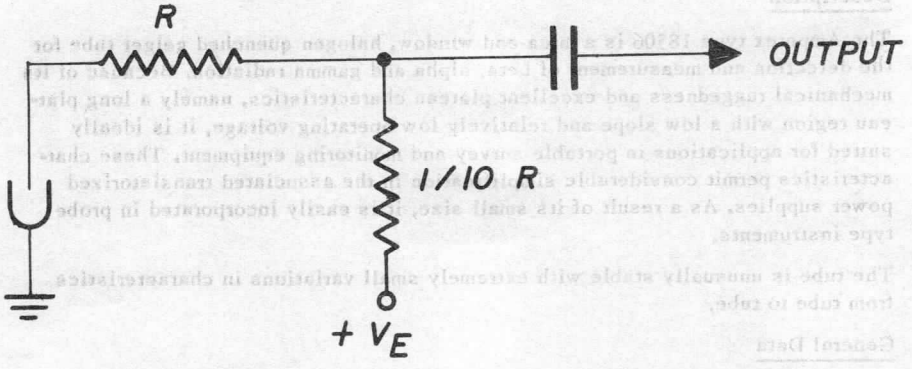
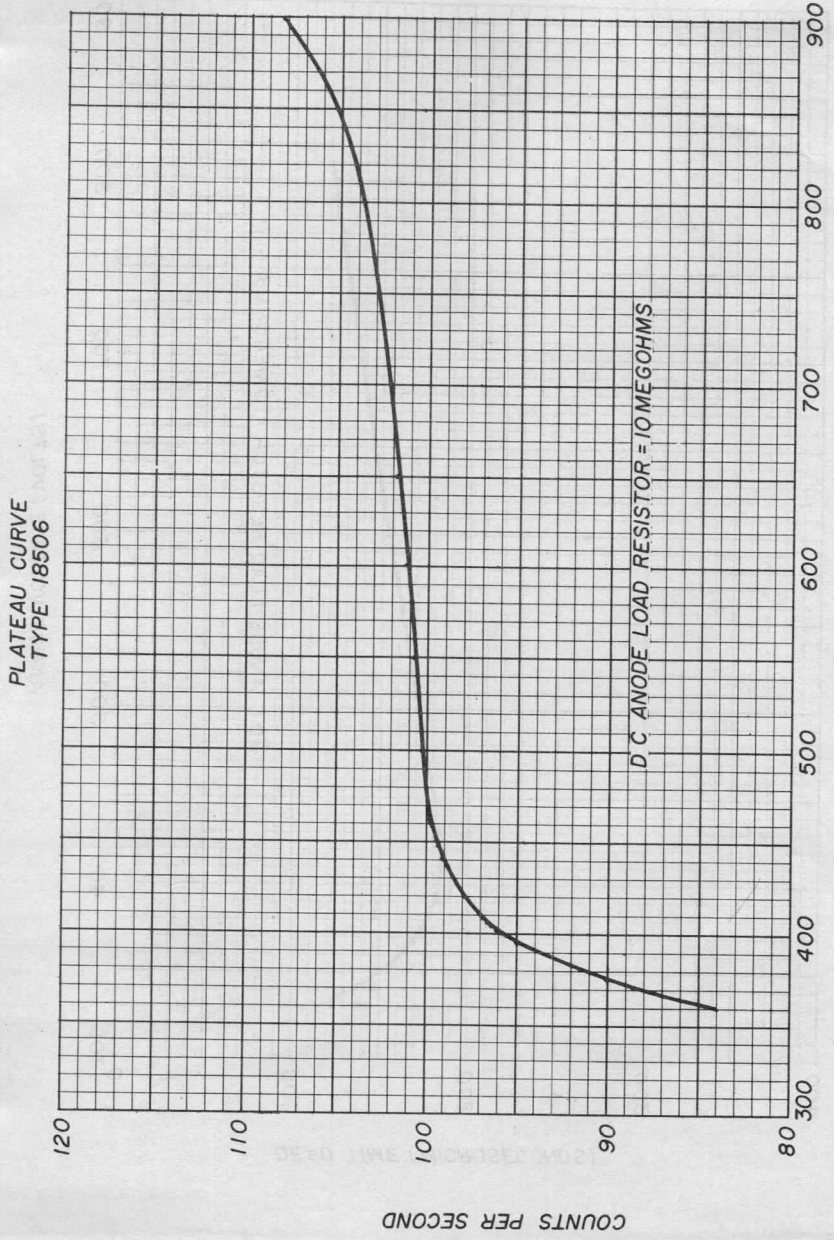


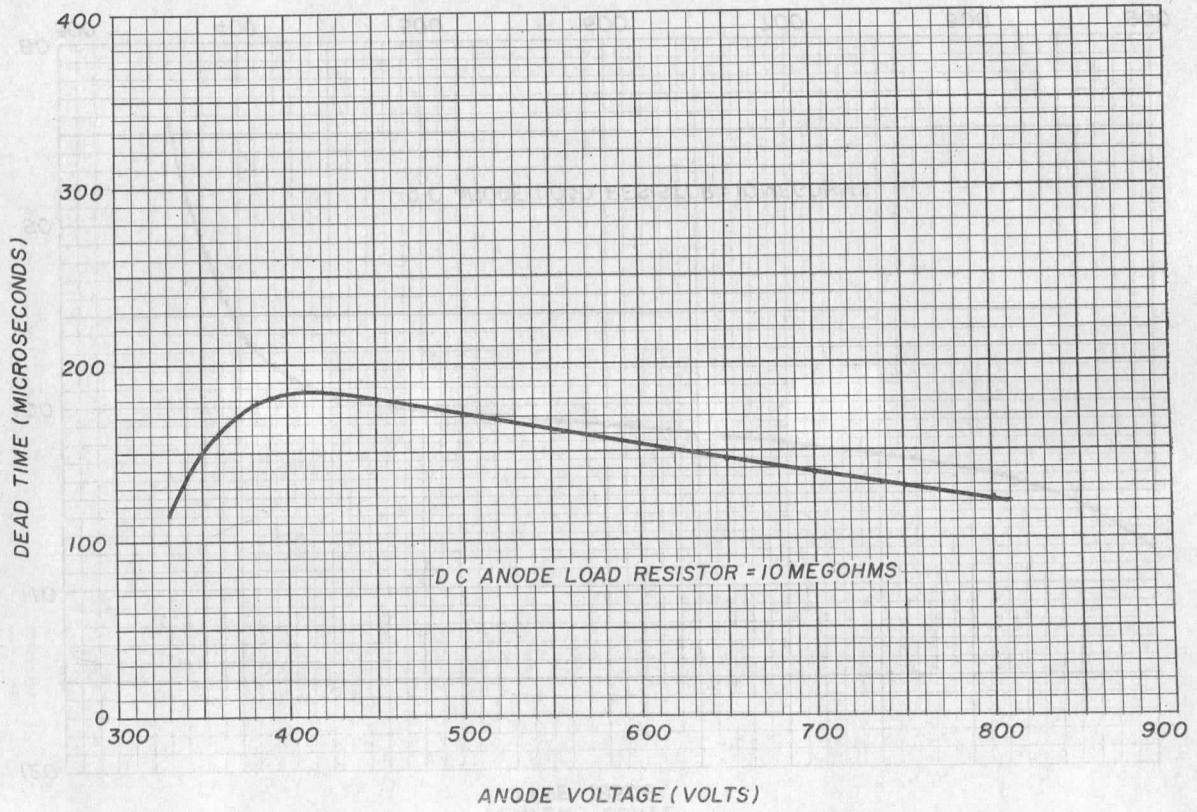
FIG. 1

[2] At about 100 counts/sec and R = 10 megohms; operating voltage arbitrarty within plateau.


PLATEAU CURVE
TYPE 18506
D C ANODE LOAD RESISTOR = 10 MEGOHMS
COUNTS PER SECOND
120
110
100
90
80
300
400
500
600
700
800
900
ANODE VOLTAGE (VOLTS)

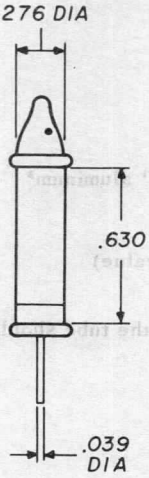
18506

DEAD TIME CURVE
TYPE 18506



Amperex® TYPE 18509

Permanent Sensitivity GAMMA COUNTER



Description

The 18509 is a halogen quenched geiger tube for the detection and measurement of gamma radiation. Because of its small size and unique characteristics it has found wide application in portable survey and monitoring equipment.

The tube is capable of operation throughout a wide range of radiation field intensities. In low intensity radiation fields it can be used as a conventional geiger tube. In higher fields, the tube can be used as a current integrating device in that the current flowing through the tube can be fed directly to a meter or other indicating device. In this manner, the tube will provide a semi-logarithmic response up to fifty microamperes in fields as high as 200 roentgens per hour.

General Data

Operating Temperature Range	$-55^{\circ}C$ to $+75^{\circ}C$
Gas Filling	neon, argon plus halogen quenching agent
Cathode Material	stainless steel (28% chromium, 72% iron)
Cathode Wall Thickness	80 - 100 mg/cm^2
Capacity at Terminals	1 $\mu\mu f$ (approx)
Mounting	see note 1

---

[1] Low capacity mounting of the counter tube is required. (Shortest possible connector between anode and anode circuit is required for low capacity.)

18509

Performance Data

Starting Voltage	295 volts min 335 volts max
Plateau Length [2]	150 volts min 175 volts average
Plateau Slope [2]	0.07 %/volt average 0.15 %/volt max
Beginning of Plateau [2]	375 volts max
Background (shielded with 1/8" aluminum and 2" lead) [2]	2 counts/minute max
Dead Time [2,3]	60 μsec max
Anode Resistor (recommended value)	10 megohms
Recommended Circuit	see figure 1

Note: In order to prevent leakage the tube should be kept dry and well cleaned.

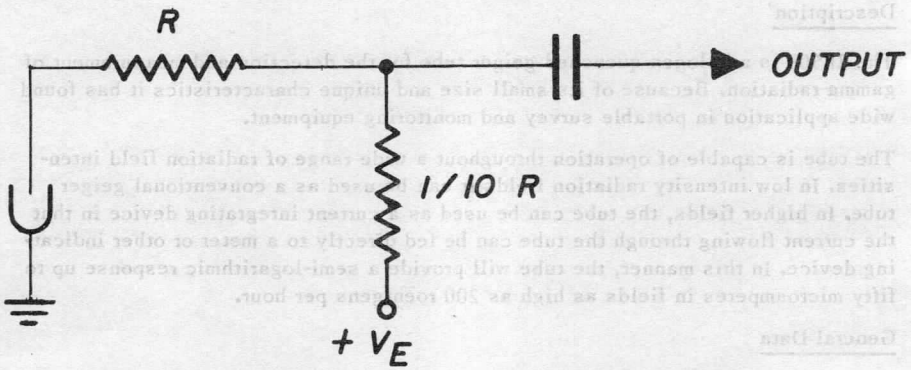
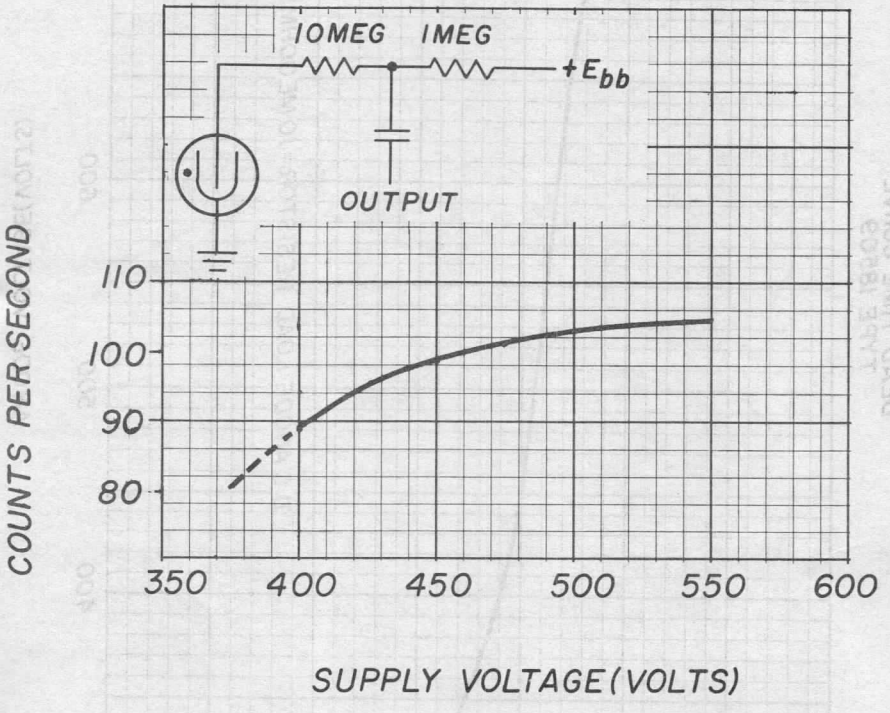


FIG. 1

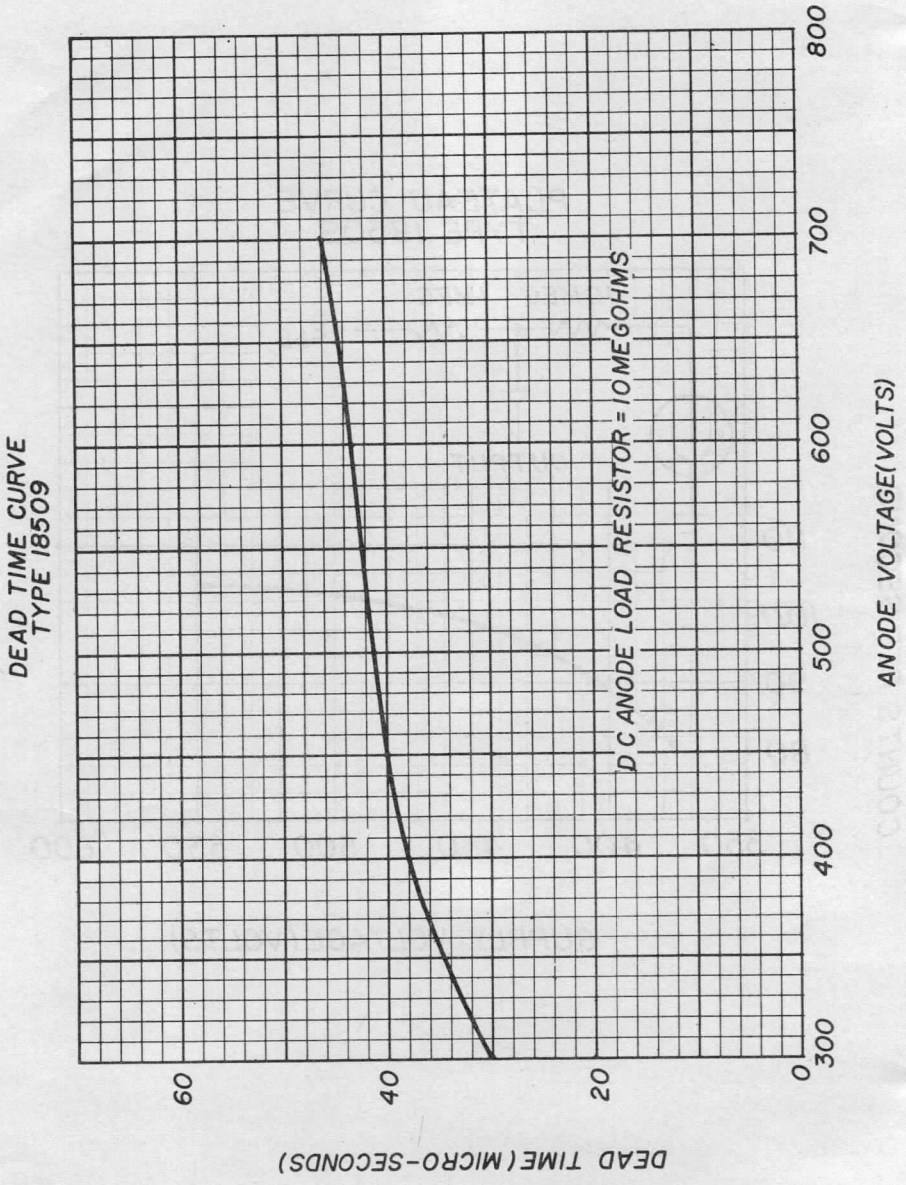
[2] At about 100 counts/sec and R = 10 megohms; operating voltage arbitrary within plateau.

[3] With R = 2 megohms, dead time is 20 μsec max.

PLATEAU CURVE
TYPE 18509

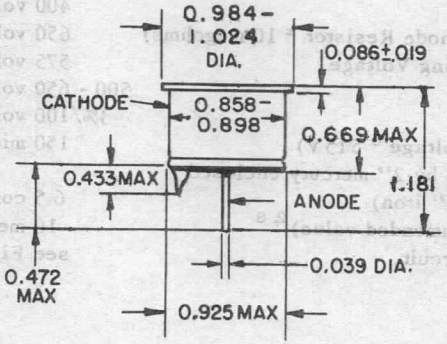


18509


DEAD TIME CURVE
TYPE 18509
DC ANODE LOAD RESISTOR = 10 MEGOHMS
DEAD TIME (MICRO-SECONDS)
0
20
40
60
300
400
500
600
700
800
ANODE VOLTAGE (VOLTS)

Amperex® TYPE 18515

Permanent Sensitivity END MICA WINDOW, BETA COUNTER



Description

The Amperex type 18515 is a halogen quenched geiger tube for the detection and measurement of beta radiation. Its unique design provides for a beta detection efficiency that is virtually the same as that obtained by organic quenched tubes and exceeds that of other halogen quenched tubes previously available.

The 18515 is especially designed to be used with guard tube counter type 18517 for low background measurements. For this application special materials and processing have been utilized to reduce the effects of radioactive contamination.

General Data

Operating Temperature Range	$-50^{\circ}C$ to $+75^{\circ}C$
Gas Filling	neon, argon, plus halogen quenching agent
Cathode Material	stainless steel (28% chromium, 72% iron)
Effective Cathode Dimensions	
Wall Thickness	0.047 inches
Inside Diameter	0.78 inches
Effective Length	0.51 inches
Mica window Dimensions	
Thickness	1.5 - 2.0 mg/cm^2
Effective Diameter	0.78 inches
Capacity at Terminals	1.5 $\mu\mu$f
Weight	0.53 ounces
Mounting	See Note 1

---

[1] Low capacity mounting of the counter tube is required. (Shortest possible connection between anode and anode circuit is required for low capacity.)

18515

Performance Data

Ambient Temperature	25°C
Starting Voltage	400 volts max
Operating Voltage (Anode Resistor = 10 megohms)	650 volts max
Recommended Operating Voltage	575 volts
Plateau Range	500 - 650 volts
Slope of Plateau	3%/100 volts max
Dead Time (Anode Voltage = 515V)	150 microseconds max
Background (shielded by 2" mercury enclosed within 4" iron)	6.5 counts/minute max
Anode resistor (recommended value)[2, 3]	10 megohms
Typical Operating Circuit	see Figure 1

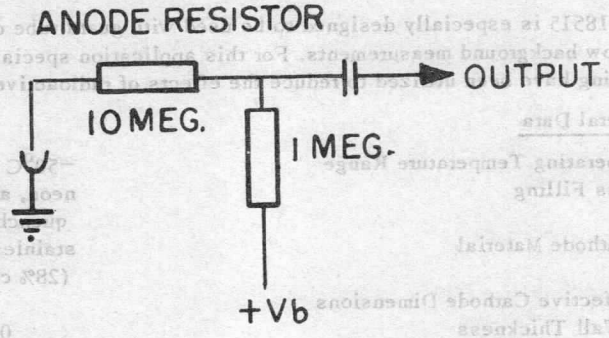


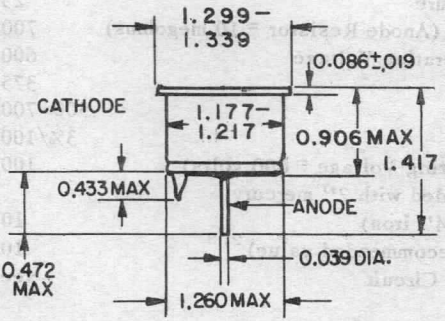
FIG. 1

[2] Minimum anode resistor = 5 megohms

[3] See Figure 1

Amperex® TYPE 18516

Permanent Sensitivity CHROMIUM - IRON END WINDOW, BETA COUNTER



Description

The Amperex type 18516 is a halogen quenched geiger tube for the detection and measurement of beta radiation. Its unique design provides for a beta detection efficiency that is virtually the same as that obtainted by organic quenched tubes.

The 18516 is specially constructed to fit with guard tube counter type 18518 for low background measurement. For this application special materials and processing have been utilized to reduce the effects of radioactive contamination.

General Data

Operating Temperature Range	−50°C to + 75°C
Gas Filling	neon, argon, plus halogen quenching agent
Cathode Material	stainless steel (28% chromium 72% iron)
Effective Cathode Dimensions	
Length	0.71 inches
Inner Diameter	1.09 inches
Wall Thickness	0.05 inches
End Window Dimensions	
Thickness	10 mg/cm^2
Effective Diameter	1.09 inches
Area	2.40 inches^2
Weight	0.8 ounces
Mounting	see Note 1
Capacity at terminals	1.5 $\mu\mu$f

---

[1] Low capacity mounting of the counter tube is required. (Shortest possible connector between anode and anode circuit is required for low capacity.)

18516

Performance Data

Ambient Temperature	25°C
Operating Voltage (Anode Resistor = 10 megohms)	700 volts max
Recommended Operating Voltage	600 volts
Starting Voltage	375 volts max
Plateau Range	500 - 700 volts
Slope of Plateau	3%/100 volts max
Dead Time (Operating Voltage = 600 volts)	100 microseconds max
Background (shielded with 2" mercury with 4" iron)	10 counts/minute max
Anode Resistor (recommended value) [2, 3]	10 megohms
Typical Operating Circuit	see Figure 1

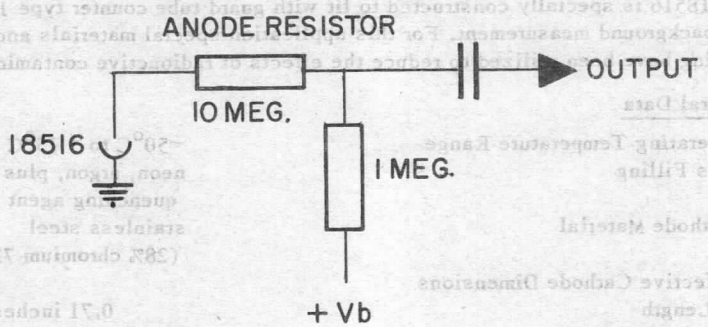


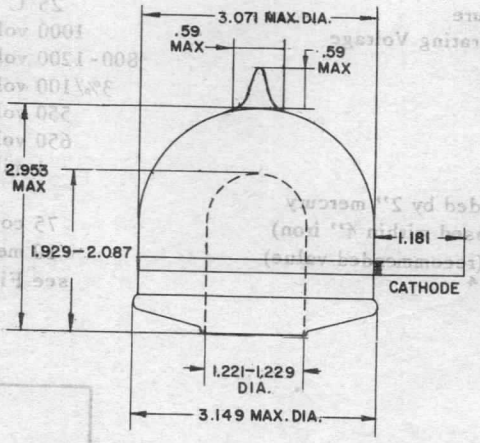
FIG. 1

[2] Minimum anode resistor = 5 megohms

[3] See Figure 1

Amperex® TYPE 18517

Permanent Sensitivity COSMIC RAY GUARD COUNTER



Description

The Amperex type 18517 is a halogen quenched geiger tube for measurements requiring a low background and is used as a complete anti-coincident guard assembly for the beta counter 18515. Due to its unique geometry and special filling it has a cosmic ray efficiency of virtually 100%.

General Data

Operating Temperature Range	$-50^{\circ}C$ to $+75^{\circ}C$
Gas Filling	neon, argon, plus halogen quenching agent
Cathode Material	stainless steel (28% chromium, 72% iron)
Cathode Dimensions	
Wall Thickness	0.04 inches
Other Dimensions	see outline drawing
Weight	6.17 ounces
Mounting	see Note 1
Capacity at terminals	5.5 $\mu\mu$f

---

[1] Low capacity mounting of the counter tube is required. (Shortest possible connection between anode and anode circuit is required for low capacity.)

18517

Performance Data

Ambient Temperature	25°C
Recommended Operating Voltage	1000 volts
Plateau Range	800 - 1200 volts
Slope of plateau [2]	3%/100 volts max
Starting Voltage	550 volts min
	650 volts max
Dead Time	1 millisecond max
Background (shielded by 2" mercury enclosed within 4" iron)	75 counts/minute max
Anode Resistor [3] (recommended value)	10 megohms
Measuring Circuit [4]	see Figure 1

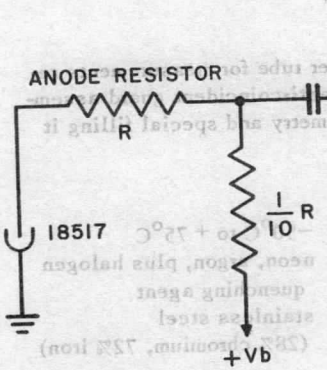


FIG.1

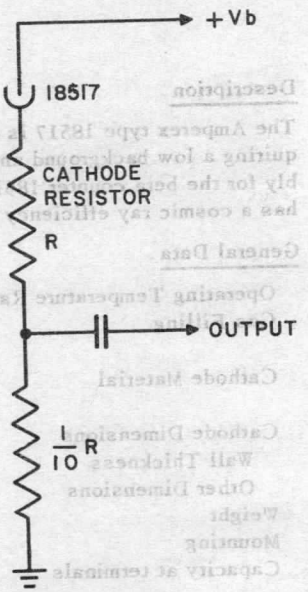


FIG.2

---

2 Measured at 50 c/s frequency and 10 megohms anode resistor

3 See Figure 1

4 When used in anti-coincident circuit it is recommended that pulse be taken from cathode as shown in Figure 2.

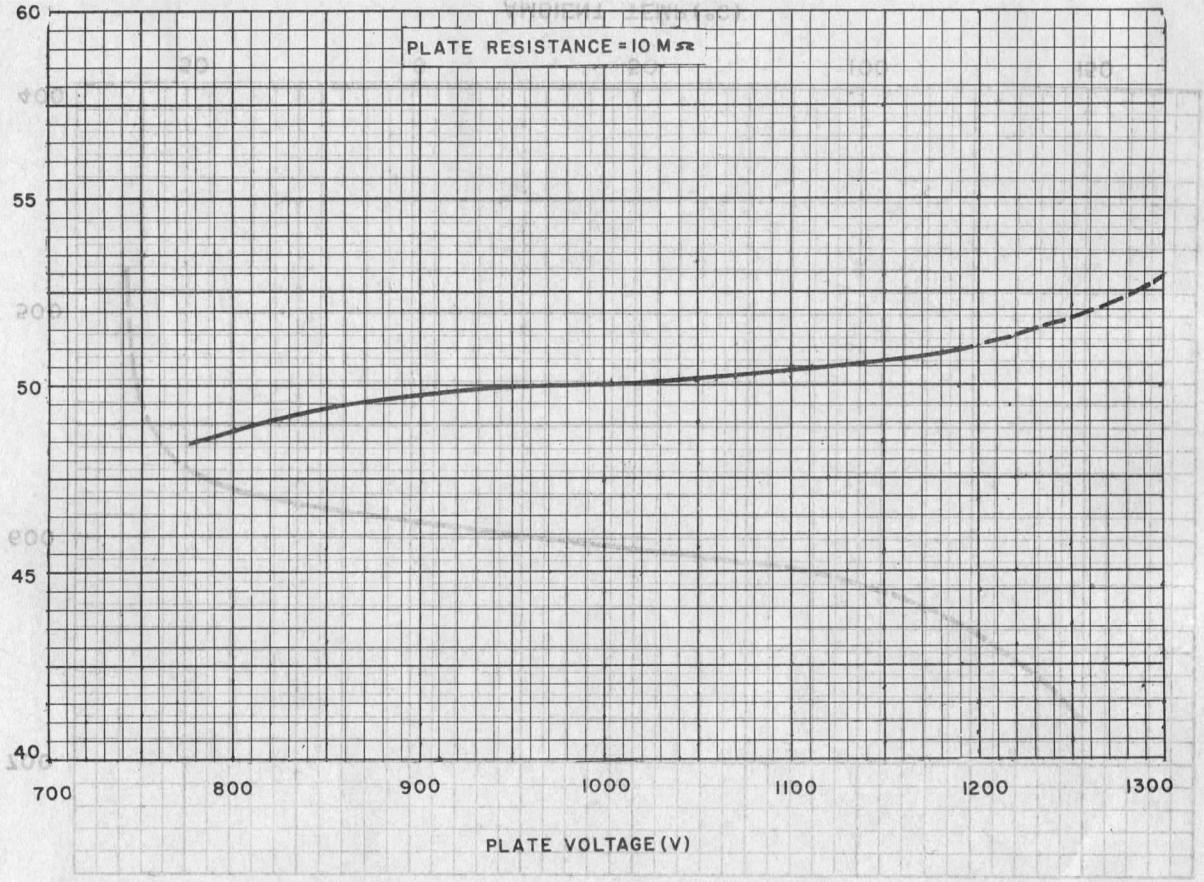
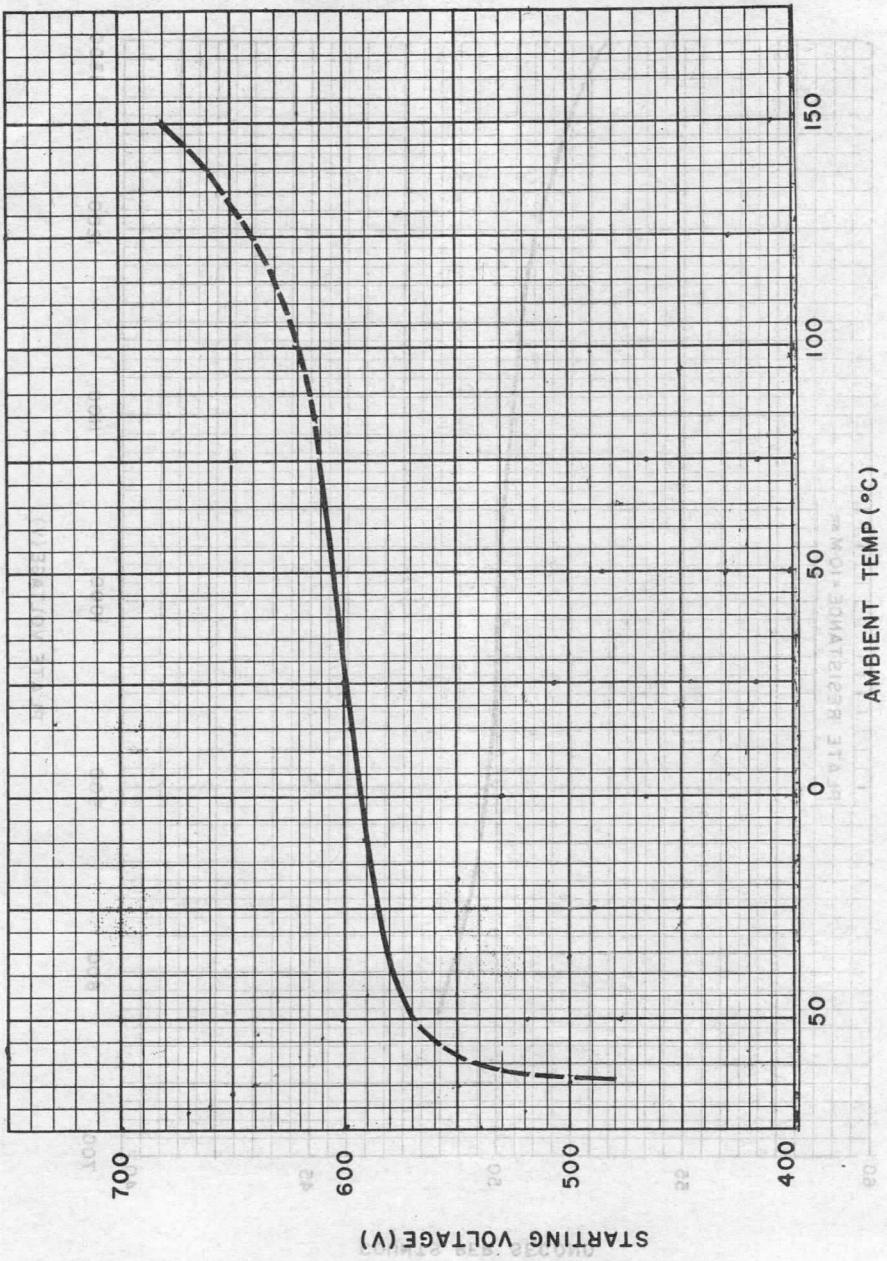


PLATE RESISTANCE = 10 MΩ
COUNTS PER SECOND
60
55
50
45
40
700
800
900
1000
1100
1200
1300
PLATE VOLTAGE (V)

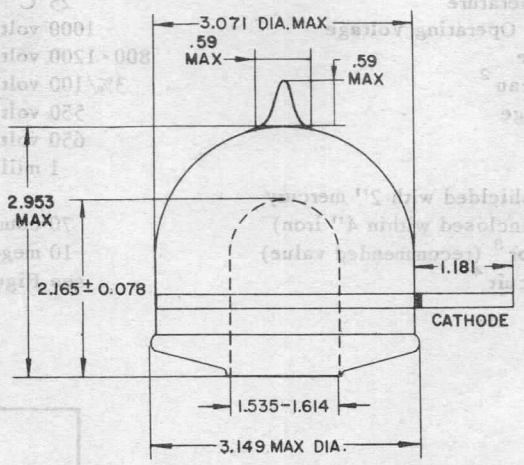
18517

18517


700
600
500
400
STARTING VOLTAGE (V)
-50
0
50
100
150
AMBIENT TEMP (°C)

Amperex® TYPE 18518

Permanent Sensitivity COSMIC RAY GUARD COUNTER



Description

The Amperex type 18518 is a halogen quenched geiger tube for measurements requiring low background. It serves as a complete anti-coincident guard assembly for the beta counter 18516 and contains a special filling which insures a cosmic ray efficiency of virtually 100%.

General Data

Operating Temperature Range	$-50^{\circ}C$ to $+75^{\circ}C$
Gas Filling	neon, argon, plus halogen quenching agent
Cathode Material	stainless steel (28% chromium 72% iron)
Cathode Dimensions	
Wall Thickness	0.04 inches
Other Dimensions	see outline drawing
Mounting	see Note 1
Capacity at terminals	8 $\mu\mu$f
Weight	6.9 ounces

---

[1] Low capacity mounting of the counter tube is required. (Shortest possible connection between anode and anode circuit is required for low capacity.

18518

Performance Data

Ambient Temperature	25°C
Recommended Operating Voltage	1000 volts
Plateau Range	800 - 1200 volts
Slope of Plateau [2]	3%/100 volts max
Starting Voltage	550 volts min
	650 volts max
Dead Time	1 millisecond max
Background (shielded with 2" mercury enclosed within 4" iron)	70 counts/minute max
Anode Resistor [3] (recommended value)	10 megohms
Measuring circuit [4]	see Figure 1

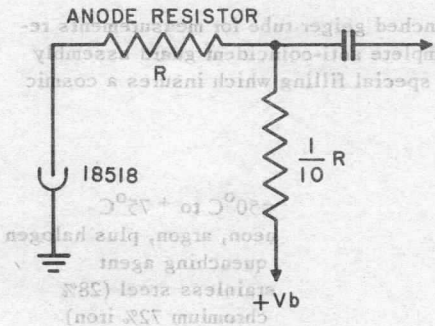


FIG. 1

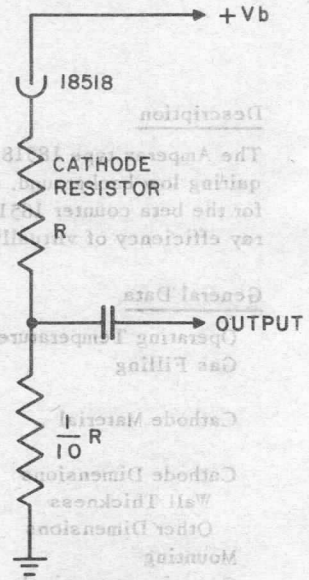


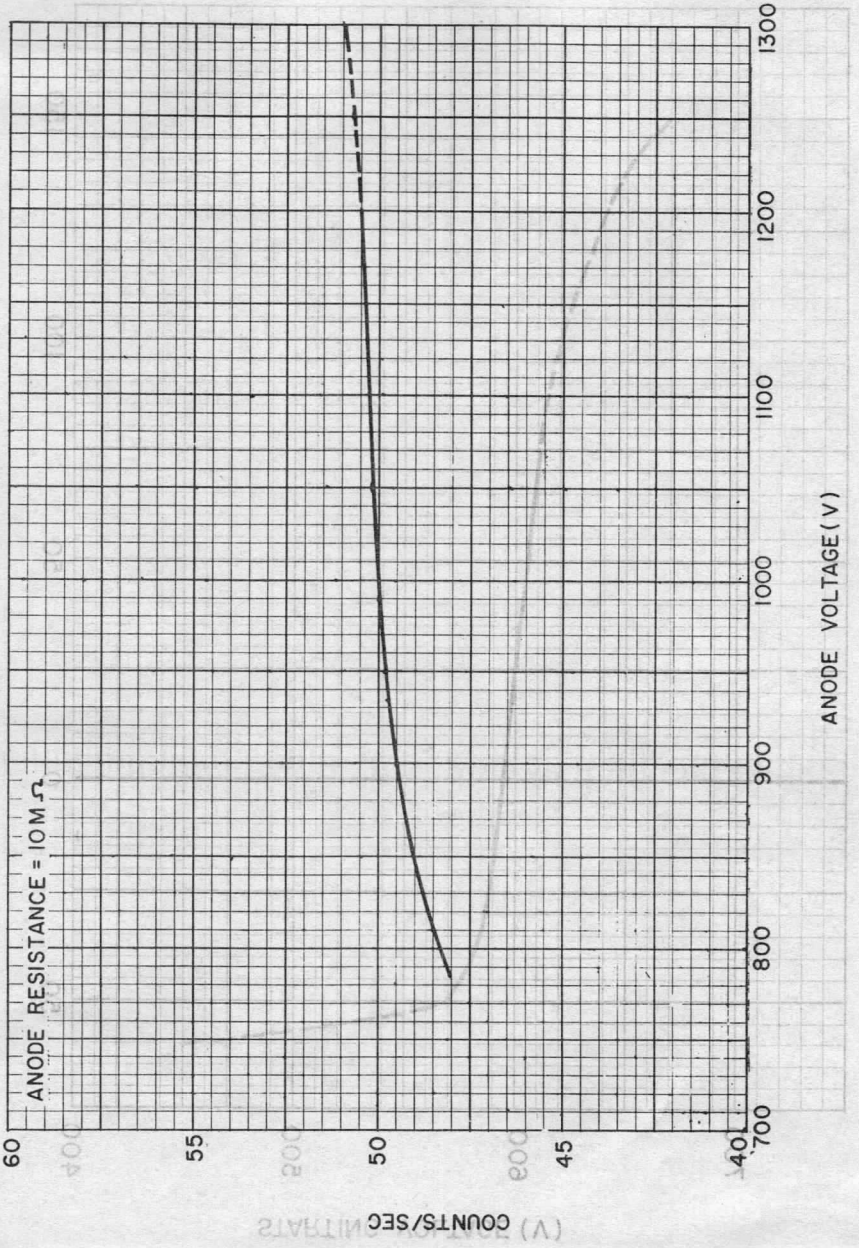
FIG. 2

---

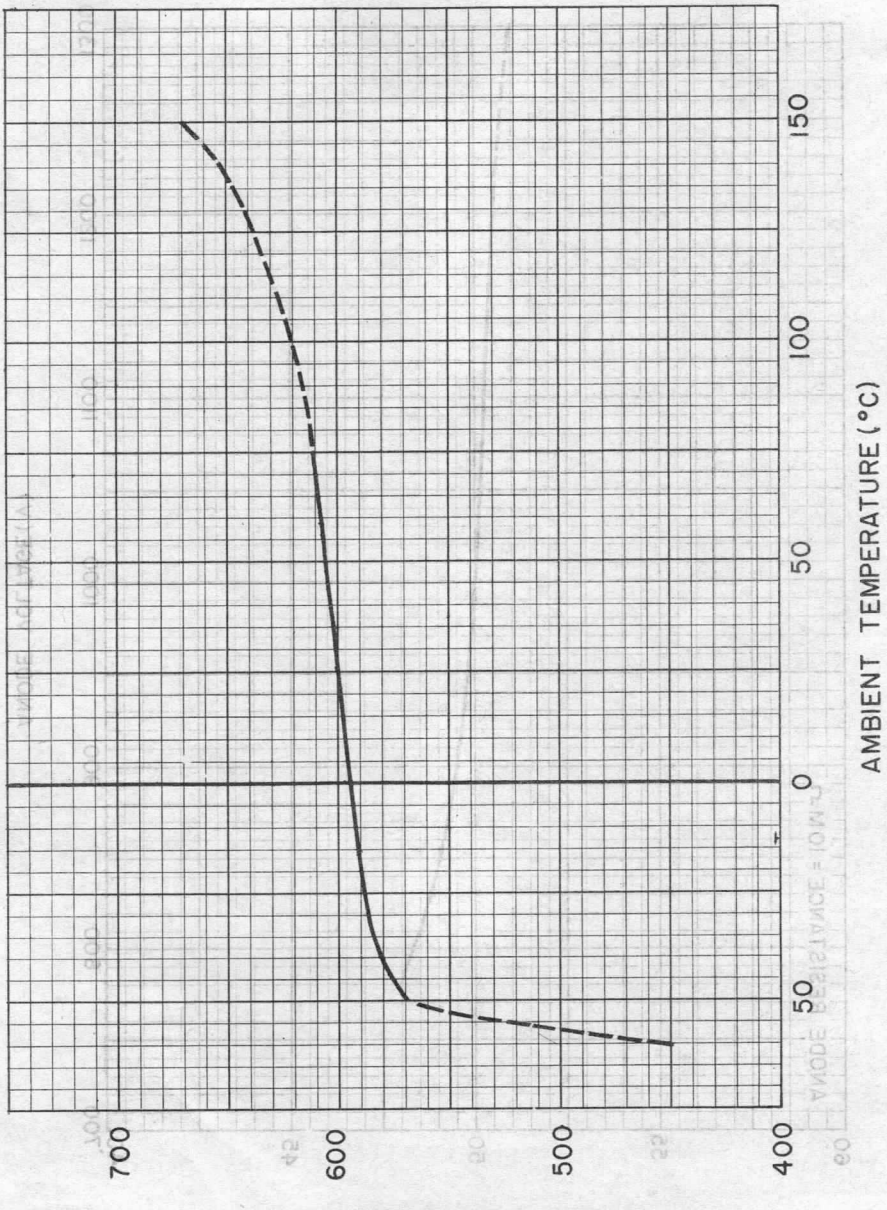
[2] Measured at 50 c/s and 10 megohms anode resistor

[3] See Figure 1

[4] When used in anit-coincident circuit it is recommended that pulse be taken from cathode as shown in Figure 2.


ANODE RESISTANCE = 10MΩ
COUNTS/SEC
ANODE VOLTAGE (V)
60
55
50
45
40
700
800
900
1000
1100
1200
1300

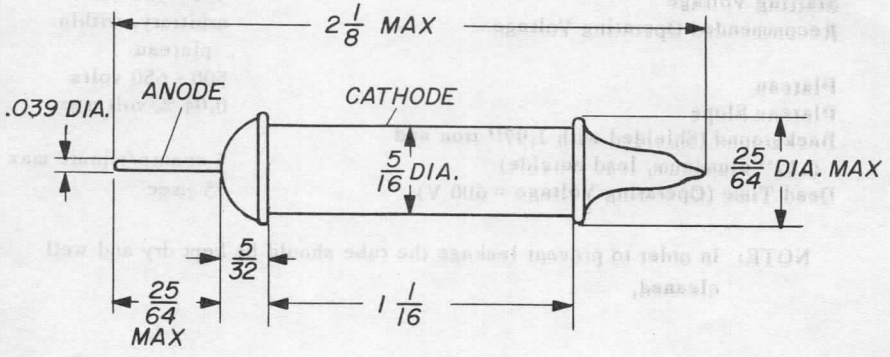
18518



Revised 4/60

Amperex® TYPE 18550

Permanent Sensitivity MINIATURIZED HALOGEN-QUENCHED GEIGER TUBE



Description

The Amperex type 18550 is a miniaturized halogen-quenched Geiger tube designed to detect and measure gamma and medium energy beta radiation. Its size, ruggedness and excellent plateau characteristics make it ideal for use in portable instrumentation and for the monitoring of relatively high intensity radiation fields.

General Data

Ambient Temperature	-50°C min $+75^{\circ}$C max
Gas Filling	neon, argon plus halogen quenching agent
Cathode Material	stainless steel (28% chromium, 72% iron)
Effective Cathode Dimenstions	
Wall Thickness	36 ± 4 mg/cm^2
Inside Diameter	0.31 inches
Effective Length	1.06 inches
Mounting	see note 1
Weight	0.04 ounces
Capacity at Terminals	1.1 $\mu\mu$f

[1] Low capacity mounting of the counter tube is required (shortest possible connection between anode and anode resistor and small capacity of anode to ground). See recommended circuit, Fig. 1.

18550

Performance Data (Ambient Temperature = 25°C)

Anode Resistor (See Figure 1)	2 megohms min 5 megohms average
Operating Voltage	700 volts max
Starting Voltage	330 - 380 volts
Recommended Operating Voltage	arbitrary, within plateau
Plateau	500 - 650 volts
Plateau Slope	0.04 %/volt max
Background (Shielded with 1.97" iron and 0.12" aluminum, lead outside)	5 counts/minute max
Dead Time (Operating Voltage = 600 V)	75 μsec

NOTE: In order to prevent leakage the tube should be kept dry and well cleaned.

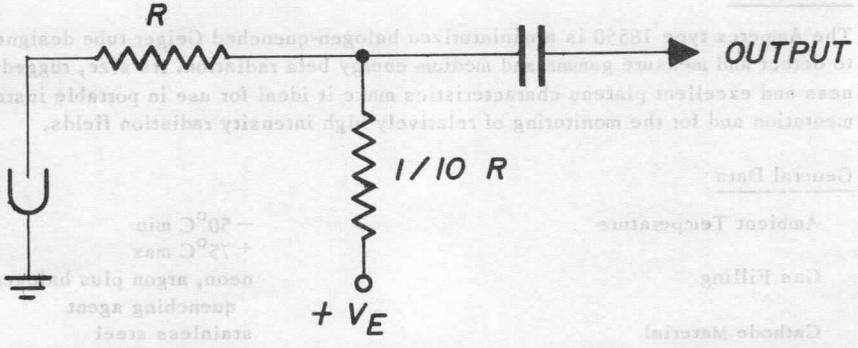
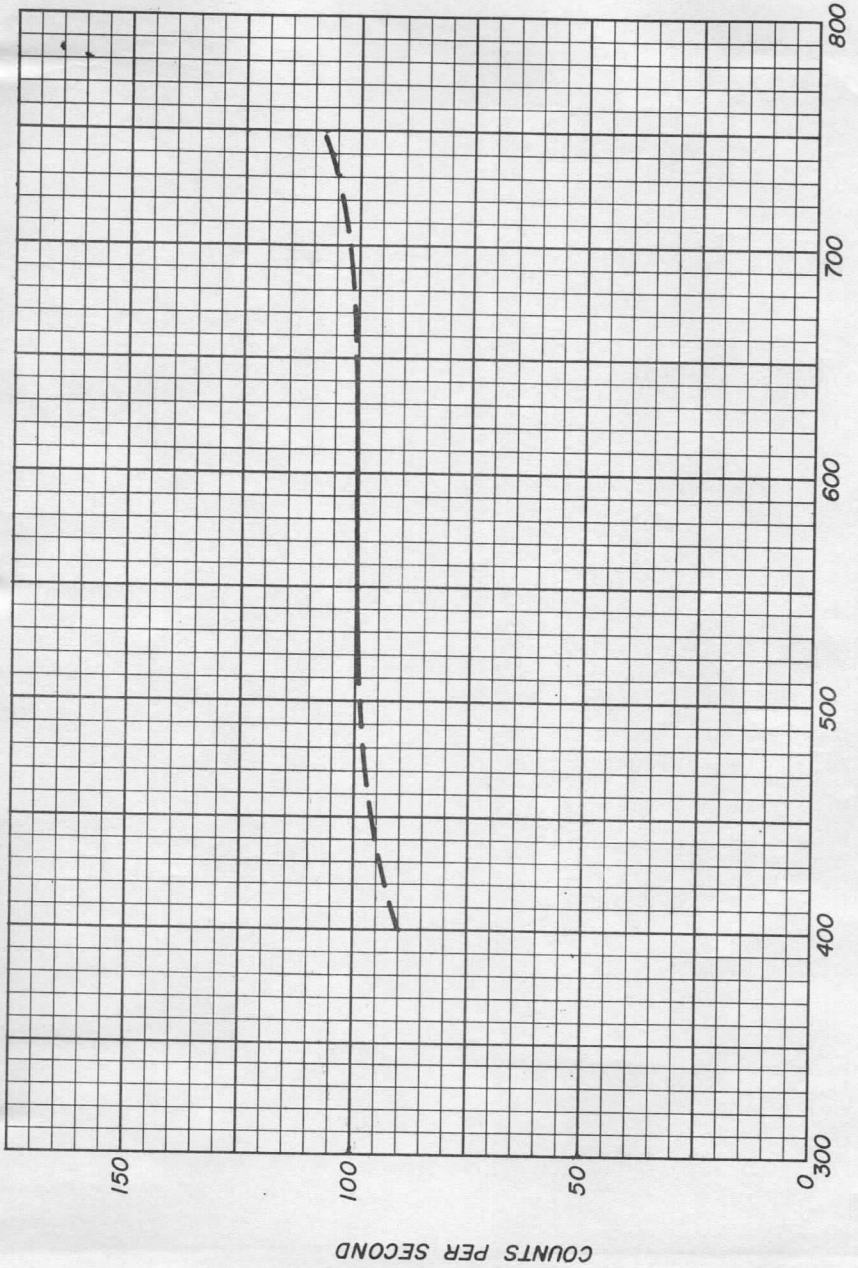


FIG. 1

18550


800
700
600
500
400
300
ANODE VOLTAGE (VOLTS)
150
100
50
0
COUNTS PER SECOND

18550

800
600
400
200
0
50
100
150
ANODE VOLTAGE (VOLTS)
COUNTS PER SECOND

T.B.D.

Amperex

RECTIFIER TUBES

Amperex

MERCURY VAPOR HIGH VOLTAGE RECTIFIER TUBES

GENERAL INFORMATION AND APPLICATION NOTES

THESE TUBES are half-wave rectifiers for use singly or in various combinations for the conversion of an alternating circuit supply to a direct current supply for the operation of medium and high power radio transmitting tubes.

These rectifiers are characterized by a very low and relatively constant voltage drop and the ability to rectify high values of peak and average current at high applied voltages. They provide an economical and efficient means for obtaining D.C. voltages of 1000 to 20,000 volts at average currents of from ½ to 60 amperes, from A.C. power supplies.

The high efficiency of these tubes is due primarily to the use of ionized mercury vapor as the current conducting medium. The positive mercury ions produced during the conducting half cycles, neutralize the negative electron space charge and allow the passage of high currents with the expenditure of a relatively low voltage drop across the tube. In order to realize fully the advantages of mercury vapor rectifiers and to obtain long life, the cathode must be amply proportioned and capable of supplying, with a conservative margin, sufficient electron emission for the peak current demand. The physical size and configuration of the bulb must be such as to allow the condensed mercury to assume a proper temperature in order to maintain a sufficient density of mercury vapor for complete space charge neutralization of the high-extracted currents; yet the density must not be so high as to make possible "arc-backs" under conditions of high voltage operation, under practical operating conditions. The tubes must be entirely free from any foreign gases or vapors which may limit the mercury vaporized to an amount insufficient for space charge neutralization and force operation with higher voltage drops and increased probability of "arc-back."

Amperex Mercury Vapor Rectifier tubes embody details of design and processing which assure the fullest realization of the advantages of this class of tube plus extraordinary life capabilities.

The cathodes are oxide coated special alloy filaments that possess an unusually high electron emission efficiency. This cathode area is large and the operating temperature low. The current density through the tubes is therefore reduced; consequently the tolerance for temperature variations of the filament and condensed mercury and resultant variations in vapor density is increased, as well as the tolerance of the tubes for handling high inverse voltage without arc-back. In Amperex shielded type of mercury vapor tubes, cathode configurations that may restrict the free passage of ions, with consequent failure to provide space charge neutralization for all portions of the cath-

ode, are avoided. This assures uniform current distribution over the entire cathode and also reduces the ignition-voltage and average arc-drop. For these reasons remarkable life may be realized even under conditions of very low temperature and high supply frequency operation.

Complete de-gassing of elements, evacuation equal to those demanded in high vacuum tubes, complete filament coating conversion, distilling of required amount of pre-distilled mercury into the finished tube, are details of processing that decrease the rate of "blackening" in service and further help maintain the high inverse voltage handling ability of Amperex Rectifier tubes for many thousands of hours of peak-rating service.

MOUNTING AND CIRCUIT REQUIREMENTS

Mercury vapor rectifier tubes must be mounted in a vertical position with filament terminals at the bottom.

Air Circulation

To prevent undue temperature rise of the bulb there should be free air circulation around the rectifier tubes. To this end the tubes should be well separated from each other and all surrounding apparatus, and the bottom, sides and top of their enclosure should be perforated or supplied with ventilation openings. The tubes should be protected from rising hot currents from other heat dissipating portions of the same equipment. To minimize the probability of arc-backs and premature failure due to artificial rise in ignition voltage, the tubes should be isolated from high voltage or radio frequency fields.

Automatic Time Delay

Equipments using mercury vapor rectifier tubes should provide an automatic time delay of a period specified in the individual tube rating, between the application of filament voltage and plate voltage, to allow the filament temperature and the mercury vapor pressure to come up to a normal operating condition.

Filament Starter

In addition, an automatic or manual filament starter is required for the types 869 and 857 and larger tubes, which will allow a gradual building up of voltage across the filaments of the tubes and limit the initial rush of filament current through the cold filament to a value not in excess of 200% of the rated filament current.

Protecting Equipment

To minimize the probability of permanently damaging the rectifiers or associated equipment it is advisable to fuse the individual rectifier tube plate leads or to provide a quick acting circuit breaker in the primary of the plate supply.

Temperature

In the case of the larger rectifiers it is sometimes necessary to provide artificial cooling in order to maintain the condensed mercury temperature within the range specified for peak rating operation. In such cases, an air stream should be directed against the lower end of the neck of the tube in the vicinity of and slightly above the filament base.

The temperature of the air stream should be controlled to a temperature of approximately 30° C. and a flow of about 10 to 15 cubic feet per minute per tube. This will maintain the condensed mercury temperature within the limits of 30° to 40° C. and allow continuous maximum rating operation.

OPERATING INSTRUCTIONS

When first placed in service, all types of mercury vapor tubes should be operated with filament alone for a period of 30 to 60 minutes, to allow the vaporization and redistribution of any mercury adhering to the filament, anode, filament shield or anode supports. After this pre-heating, the full normal operating voltage may be applied only if the resulting peak inverse voltage is less than 6000 volts. For higher voltage operation the initially applied plate voltage should be reduced to a value which will not allow the peak inverse voltage per tube to exceed 6000 volts and the tube allowed to operate for about 5 minutes. The plate voltage should then be gradually increased over a period of about 15 minutes until normal plate voltage is reached. If persistent arcing occurs before normal voltage is reached, the tube should be kept for a while at a voltage just below the arc-back voltage and then increased at a more gradual rate to normal voltage. Refusal of a tube to take the full nor-

mal voltage after the specified treatment may be indicative of too high a condensed mercury temperature, due either to improper ventilating conditions or abnormal temperature rise due to numerous arc-backs and consequent temporary impairment of filament emission.

In such cases the tube should be allowed to cool by opening the plate and filament circuits and the above process repeated with an increased period of 6000 volt operation before the voltage is increased.

In subsequent operation the pre-heating period with filament alone may be reduced to values of from 15 seconds to about 10 minutes in accordance with the individual tube ratings. The normal plate voltage may then be applied directly without building up.

When mercury vapor-rectifier tubes are used to supply a radio transmitter that is operated intermittently, the filaments of the rectifiers should be maintained at normal voltage except when pauses between operations are of long duration. The frequent starting and stopping of the filament may cause its premature failure by breakage and is further undesirable because of the delay required for filament pre-heating.

OPERATING RATINGS

The limiting factors to the safe use of any mercury vapor rectifier tubes are given in terms of "Maximum Ratings" as regards the "Peak Inverse Voltage," "Peak Plate Current," "Average Current."

Peak Inverse Voltage

The "Peak Inverse Voltage" is the maximum instantaneous voltage appearing across a rectifier tube during its non-conducting half cycle when the anode is negative with respect to its cathode.

The maximum inverse voltage that a mercury tube can handle without arc-back is a function of the tube configuration, the vapor pressure of the mercury, the magnitude of current density during its conductive half-cycles, the frequency of supply voltage alternations and numerous design and processing details as they may affect the electron emissivity of the anode and deposits on the bulb, and the susceptibility of the tube to external ionizing influences. The "Maximum Peak Inverse Ratings" of the various types of rectifier tubes described in this catalog are based upon the above considerations with a conservative allowance as a factor of safety. To assure of satisfactory service, this rating should never be exceeded. A tabulation of the relationship of the "Peak Inverse Voltage," the D.C. output voltage and the R.M.S. value of the A.C. input voltage will be found under "Application Notes."

Maximum Peak Plate Current

The ratings as to "Maximum Peak Plate Current" represent the highest instantaneous value of current that may safely be carried through the tube during its conductive half cycle. This value depends upon the total electron emission available from the cathode, and where the cathode is a filamentary type this value further depends upon the phase of the filament excitation with respect to the phase of its plate supply voltage, and on the operating filament voltage.

The normal rating assumes in-phase excitation. With the filament supply in phase with the plate supply, the maximum plate current demand coincides with the maximum voltage across the filament, with the result that the maximum current density, and therefore emission demand, occurs at the positive end of the filament.

In tubes having a five volt filament, like types 872-A, 575-A, 869-B and others, the emission demand at the positive end of the filament may be twice the average emission demand, and the rated maximum peak current must therefore be held down to approximately half the value that could be supported if the current density, and therefore emission demand, were uniformly distributed across the filament.

A more uniform distribution may be obtained by exciting the filament out of phase with respect to the plate supply. With the ideal or 90° phase difference between the plate and filament supplies, the instance of peak current, and therefore peak emission demand, coincides with the instance of zero voltage across to filament, and therefore gives best uniformity. With the 60° or 120° phase difference more readily available with 3 phase power supplies, the voltage across the filament at the

instance of maximum current demand, though not zero, is nevertheless low enough to result in a close to optimum uniformity in distribution of current density.

Such out-of-phase filament excitation therefore makes allowable higher "maximum peak plate current" ratings.

Maximum Average Plate Current

To the degree that the maximum "average plate current" rating is dependent on the allowable maximum "peak plate current rating," the average current rating may also be increased with out-of-phase excitation. Inasmuch, however, as an increased average plate current results in increased operating temperatures of the anode and the tube, the allowable inverse voltage rating must be somewhat reduced when the *normal* (or in-phase) maximum average plate current rating is exceeded.

The rating as to "Maximum Average Plate Current" represents the highest average current that may safely be carried through the tube. This rating is a function of many design factors of which the most important are the allowable internal power dissipation rise, the anode temperature rise and the cathode temperature change due to the current conducted through the tube. The value of average plate current is directly measurable by conventional D.C. ammeter when the average load is steady. With a fluctuating load, the current should be averaged over a period of time that is related to the thermal inertia of filament. The averaging period should be short for the smaller tubes (about 5 to 10 seconds for types 866A and 872A) and should be increased for larger tubes.

The value of peak plate current should be measured directly by a peak-indicating meter or an oscillograph when there is likelihood that the ratio of peak to average current is abnormally high. Such conditions are likely to occur only if the rectifiers are followed by a filter circuit utilizing large input condensers, or when a rectifier is used to charge a high voltage battery. When a load is purely resistive and the current sinusoidal the relationship between peak and average currents is readily calculable and is given in the tabulation under "Application Notes." The use of a choke input filter following the rectifier tubes minimizes the ratio of peak to average plate current and is the recommended practice in rectifying equipment design.

APPLICATION NOTES

Mercury Vapor Rectifier tubes are generally used in either single phase or three phase circuits. Diagrams of typical circuit arrangements together with their characteristics are given in Figures 1 to 5. The specified relationships of voltages, currents and ripple amplitude, are based on the assumption that the supply voltage is sinusoidal in wave-form, the load pure resistance and the tube voltage drop zero. Tabulations of actual D.C. voltages and allowable average D.C. currents that may be obtained for the various types of tubes in these typical rectifier circuits, will be found on the individual tube rating sheets. These tabulated values assume a sine-wave supply voltage and the use of a choke input filter circuit. When calculating the approximate output voltages for conditions of lower input A.C. voltages than that given in the individual tube tabulations, the theoretical ratios shown in figures 1 to 5 may be used.

In the circuits of Figure 2 and Figure 5 two tubes are always in series during both the conductive and non-conductive cycles. The resulting division of the inverse voltage per tube allows the doubling of the possible D.C. voltage that may be obtained from the various types of tubes. In addition the circuit of Figure 5 raises the major ripple frequency to six times the supply frequency and diminishes the ripple magnitude to approximately 4% of the output voltage and thus minimizes the filter requirements where a substantially pure D.C. voltage is required.

Frequently where the output voltage requirements may be met by the use of the smaller type of rectifier tubes, but the output current requirements are in excess of the tube rating, it is more economical to use the smaller tubes in parallel rather than to use the large size tubes. In such cases provision must be made to insure an equal distribution of load current between the paralleled tubes. Either individual reactors or ballast resistors of suitable size should be placed in series with each anode.

AMPEREX TUBE TYPE 857-B

FILAMENT

A.C. Voltage	5.0
Current (amperes)	30.0
Preheating Period (seconds)[1]	60

[1] Before plate voltage is applied.

MAXIMUM RATINGS

For Operation at Supply Frequency Up to 150 Cycles

	Condensed Mercury Temperature Range	
	25°C. to 60°C.	30°C. to 49°C.
Peak Inverse Voltage	10000	22000
Peak Plate Current (amperes)	40.0	40.0
Average Plate Current (amperes)[1]	10.0	10.0
Surge Plate Current (amperes)[2]	400	400
Approx. Tube Voltage Drop	10	10

[1] Averaged over period of 30 seconds.
[2] For design only, max. duration of surge 0.2 second.

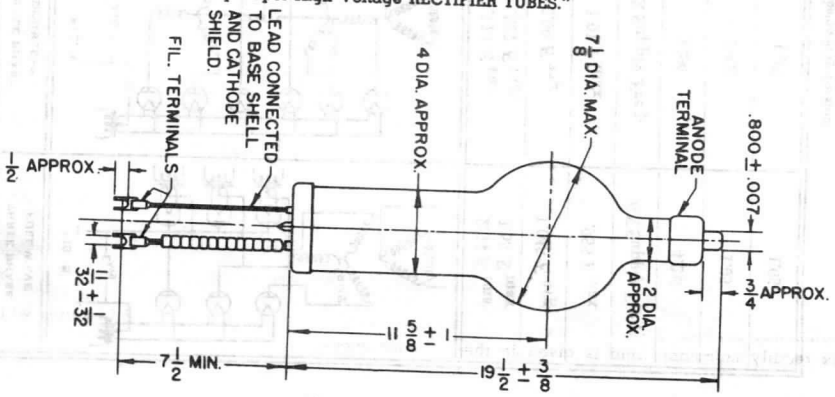
NOTE: For peak inverse voltages in excess of 10,000 volts, temperature-regulated forced-air cooling must be employed. 5 cu. ft. per min. at 35°C from 1 inch nozzle located ½ inch above filament base will maintain condensed mercury temperature of 40°C at full load.

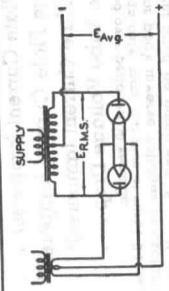
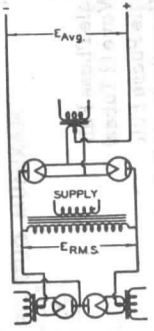
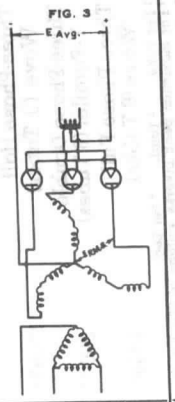
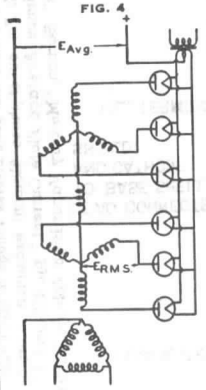
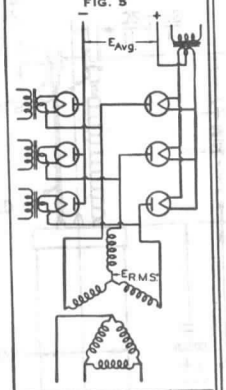
MAXIMUM OUTPUTS IN TYPICAL CIRCUITS

	A.C. Input Volts R.M.S.[4]	D.C. Output Volts to Filter	Max. D.C. Load Current Amperes
Single-Phase Full Wave (2 Tubes)	7750[1]	7000	20
Single-Phase Full Wave Bridge (4 Tubes)	15500[2]	14000	20
Three-Phase Half Wave (3 Tubes)	10300[3]	10500	30
Three-Phase Double Y-Parallel (6 Tubes)	9000[3]	10500	60
Three-Phase Full Wave (6 Tubes)	9000[3]	21000	30

[1] Per Tube. [2] Total. [3] Per Leg.
[4] For maximum peak inverse voltage of 22000 volts.

NOTE: For out-of-phase filament excitation information see "Maximum Peak Plate Current" and "Maximum Average Plate Current," pp. 453 and 454, "General Information and Applications Notes" Section, "Mercury Vapor High Voltage RECTIFIER TUBES."



RECTIFIER CIRCUIT	SINGLE PHASE FULL-WAVE 2 TUBES	SINGLE PHASE FULL-WAVE 4 TUBES	THREE PHASE HALF-WAVE ZIG ZAG	THREE PHASE DOUBLE-Y	THREE PHASE FULL-WAVE
Conditions assumed for following relations 1. Sine-Wave Supply 2. Balanced Phase Voltages 3. Zero Tube Drop 4. Pure Resistance Load 5. No Filter Used NOTE: All rectifier filaments supplied by single phase transformers, with secondaries insulated for voltages greater than the Maximum Peak Inverse Voltage.	FIG. 1 	FIG. 2 	FIG. 3 	FIG. 4 	FIG. 5 
E Average	.450 E rms .318 E max	.900 E rms .636 E max	1.015 E rms .718 E max	1.170 E rms .827 E max	2.34 E rms 1.65 E max
E Inverse	3.14 E avg	1.57 E avg	2.09 E avg	2.09 E avg	1.045 E avg
I Average	.636 I max	.636 I max	.718 I max	1.91 I max	.955 I max
Ripple Frequency	2 X Supply Freq.	2 X Supply Freq.	3 X Supply Freq.	6 X Supply Freq.	6 X Supply Freq.
Ripple Voltage (Rms)	48.3%	48.3%	18.3%	4.2%	4.2%
[1] Ratio $\frac{\text{Secondary Kva}}{\text{D.C. Output-Kw}}$	1.57	1.11	1.71	1.48	1.05
[1] Ratio $\frac{\text{Primary Kva}}{\text{D.C. Output-Kw}}$	1.11	1.11	1.21	1.05	1.05

[1] These ratios assume that a choke input filter is used to maintain the output current substantially constant.

AMPEREX TUBE TYPE 866 AX

FILAMENT

A.C. Voltage	2.5
Current (amperes)	5.0
Preheating Period (Seconds)*	30

*Before plate voltage is applied.

MAXIMUM RATINGS

	For Operation At Supply Frequency Up to 150 Cycles With Condensed Mercury Temperature Range		For Operation At Supply Frequency Up to 1000 Cycles With Condensed Mercury Temperature Range
	25°C. to 60°C.	25°C. to 70°C.	25°C. to 70°C.
Peak Inverse Voltage	10000	2000	5000
Peak Plate Current (ampere)	1.0	2	1.0
Average Plate Current (ampere)*	.25	0.5	.25
Approx. Tube Voltage Drop	15	15	15

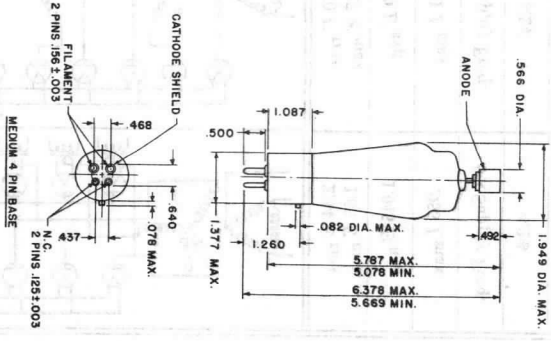
*Averaged over period of 10 seconds.

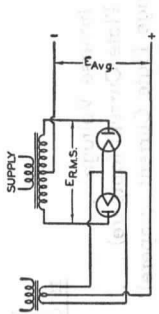
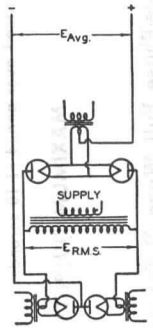
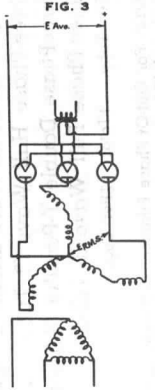
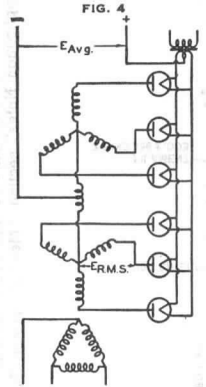
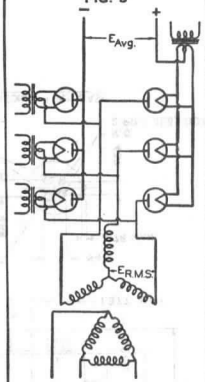
MAXIMUM OUTPUTS IN TYPICAL CIRCUITS

	A.C. Input Volts R.M.S.	D.C. Output Volts to Filter	Max. D.C. Load Current Amperes
Single-Phase Full Wave (2 Tubes)	3535*	3180	.5
Single-Phase Full Wave Bridge (4 Tubes)	7070†	6360	.5
Three-Phase Half Wave (3 Tubes)	4710‡	4780	.75
ThreePhase Double Y-Parallel (6 Tubes)	4080‡	4780	1.5
Three-Phase Full Wave (6 Tubes)	4080‡	9570	.75

*Per Tube. †Total ‡Per Leg.

NOTE: For Out-Of-Phase Filament Excitation information see "Maximum Peak Plate Current" and "Maximum Average Plate Current", pp. 3 and 4, "General Information and Application Notes" section, "Mercury Vapor High Voltage RECTIFIER TUBES".



RECTIFIER CIRCUIT	SINGLE PHASE FULL-WAVE 2 TUBES	SINGLE PHASE FULL-WAVE 4 TUBES	THREE PHASE HALF-WAVE ZIG ZAG	THREE PHASE DOUBLE-Y	THREE PHASE FULL-WAVE
Conditions assumed for following relations 1. Sine-Wave Supply 2. Balanced Phase Voltages 3. Zero Tube Drop 4. Pure Resistance Load 5. No Filter Used NOTE: All rectifier filaments supplied by single phase transformers, with secondaries insulated for voltages greater than the Maximum Peak Inverse Voltage.	FIG. 1 	FIG. 2 	FIG. 3 	FIG. 4 	FIG. 5 
E Average	.450 E rms .318 E max	.900 E rms .636 E max	1.015 E rms .718 E max	1.170 E rms .827 E max	2.34 E rms 1.65 E max
E Inverse	3.14 E avg	1.57 E avg	2.09 E avg	2.09 E avg	1.045 E avg
I Average	.636 I max	.636 I max	.718 I max	1.91 I max	.955 I max
Ripple Frequency	2 X Supply Freq.	2 X Supply Freq.	3 X Supply Freq.	6 X Supply Freq.	6 X Supply Freq.
Ripple Voltage (Rms)	48.3%	48.3%	18.3%	4.2%	4.2%
† Ratio $\frac{\text{Secondary Kva}}{\text{D.C. Output-Kw}}$	1.57	1.11	1.71	1.48	1.05
† Ratio $\frac{\text{Primary Kva}}{\text{D.C. Output-Kw}}$	1.11	1.11	1.21	1.05	1.05

† These ratios assume that a choke input filter is used to maintain the output current substantially constant.

AMPEREX TUBE TYPE 869-B

FILAMENT

A.C. Voltage	5.0
Current (amperes)	18.0
Preheating Period (seconds)[1]	60

[1] Before plate voltage is applied.

MAXIMUM RATINGS

For Operation at Supply Frequency Up to 150 Cycles

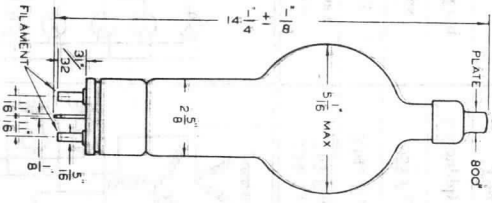
	Filament Excitation In Phase Condensed Mercury Temperature Range		Filament Excitation Out of Phase (90° ± 30°) Condensed Mercury Temperature Range
	30°C. to 40°C.	25°C. to 60°C.	30°C. to 40°C.
Peak Inverse Voltage	20000	15000	15000
Peak Plate Current (amperes)	10.0	10.0	15.0
Average Plate Current (amperes)[1]	2.5	2.5	5.0
Approx. Tube Voltage Drop	10.0	10.0	10.0

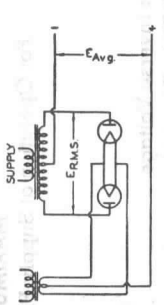
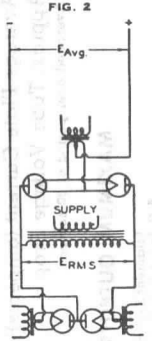
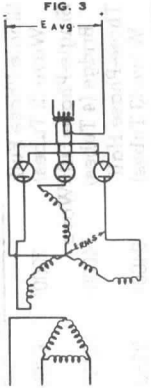
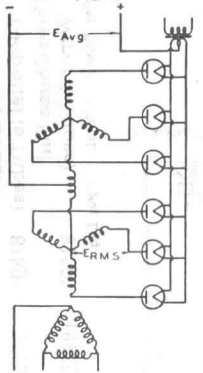
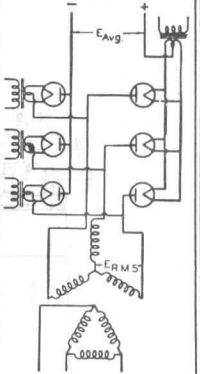
[1] Averaged over period of 30 seconds.

MAXIMUM OUTPUTS IN TYPICAL CIRCUITS

	Filament Excitation in Phase			Filament Excitation Out of Phase		
	A.C. Input Volts R.M.S.	D.C. Output Volts to Filter	Max. D.C. Load Current Amperes	A.C. Input Volts R.M.S.	D.C. Output Volts to Filter	Max. D.C. Load Current Amperes
Single-Phase Full Wave (2 Tubes)	7000[1]	6300	5.0	5250[1]	4725	10.0
Single-Phase Full Wave Bridge (4 Tubes)	14000[2]	12600	5.0	10500[2]	9450	10.0
Three-Phase Half Wave (3 Tubes)	9400[3]	9550	7.5	7050[3]	7150	15.0
Three-Phase Double Y-Parallel (6 Tubes)	8150[3]	9550	15.0	6100[3]	7150	30.0
Three-Phase Full Wave (6 Tubes)	8150[3]	19100	7.5	6100[3]	14300	15.0

[1] Per Tube. [2] Total. [3] Per Leg.



RECTIFIER CIRCUIT	SINGLE PHASE FULL-WAVE 2 TUBES	SINGLE PHASE FULL-WAVE 4 TUBES	THREE PHASE HALF-WAVE ZIG ZAG	THREE PHASE DOUBLE-Y	THREE PHASE FULL-WAVE
Conditions assumed for following relations 1. Sine-Wave Supply 2. Balanced Phase Voltages 3. Zero Tube Drop 4. Pure Resistance Load 5. No Filter Used NOTE: All rectifier filaments supplied by single phase transformers, with secondaries insulated for voltages greater than the Maximum Peak Inverse Voltage.	FIG. 1 	FIG. 2 	FIG. 3 	FIG. 4 	FIG. 5 
E Average	.450 *E* rms .318 *E* max	.900 *E* rms .636 *E* max	1.015 *E* rms .718 *E* max	1.170 *E* rms .827 *E* max	2.34 *E* rms 1.65 *E* max
E Inverse	3.14 *E* avg	1.57 *E* avg	2.09 *E* avg	2.09 *E* avg	1.045 *E* avg
I Average	.636 *I* max	.636 *I* max	.718 *I* max	1.91 *I* max	.955 *I* max
Ripple Frequency	2 X Supply Freq.	2 X Supply Freq.	3 X Supply Freq.	6 X Supply Freq.	6 X Supply Freq.
Ripple Voltage (Rms)	48.3%	48.3%	18.3%	4.2%	4.2%
[1] Ratio $\frac{\text{Secondary Kva}}{\text{D.C. Output-Kw}}$	1.57	1.11	1.71	1.48	1.05
[1] Ratio $\frac{\text{Primary Kva}}{\text{D.C. Output-Kw}}$	1.11	1.11	1.21	1.05	1.05

[1] These ratios assume that a choke input filter is used to maintain the output current substantially constant.

AMPEREX TUBE TYPE 869-BL

FILAMENT

A.C. Voltage	5.0
Current (amperes)	18.0
Preheating Period (seconds)[1]	60

[1] Before plate voltage is applied.

MAXIMUM RATINGS

For Operation at Supply Frequency Up to 150 Cycles

	Filament Excitation In Phase Condensed Mercury Temperature Range 30°C. to 40°C.	Filament Excitation In Phase Condensed Mercury Temperature Range 25°C. to 60°C.	Filament Excitation Out of Phase (90° ± 30°) Condensed Mercury Temperature Range 30°C. to 40°C.
Peak Inverse Voltage	20000	15000	15000
Peak Plate Current (amperes)	10.0	10.0	15.0
Average Plate Current (amperes)[1]	2.5	2.5	5.0
Approx. Tube Voltage Drop	10.0	10.0	10.0

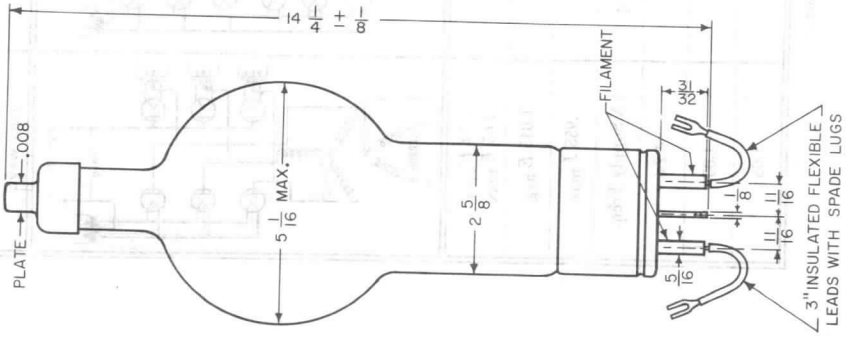
[1] Averaged over period of 30 seconds.

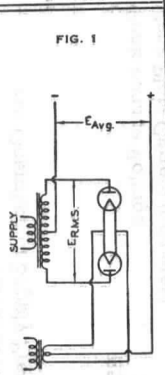
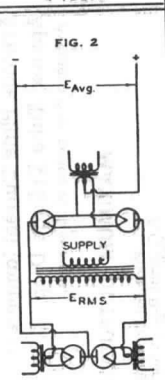
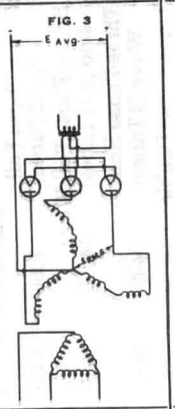
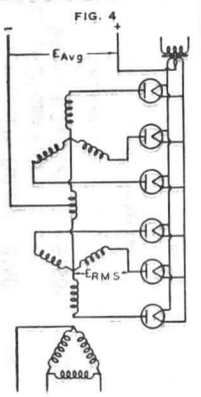
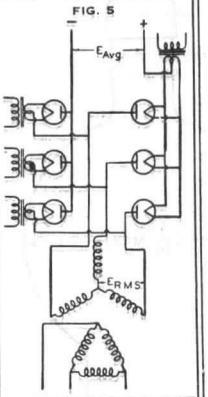
MAXIMUM OUTPUTS IN TYPICAL CIRCUITS

	Filament Excitation in Phase A.C. Input Volts R.M.S.	D.C. Output Volts to Filter	Max. D.C. Load Current Amperes	Filament Excitation Out of Phase A.C. Input Volts R.M.S.	D.C. Output Volts to Filter	Max. D.C. Load Current Amperes
Single-Phase Full Wave (2 Tubes)	7000[1]	6300	5.0	5250[1]	4725	10.0
Single-Phase Full Wave Bridge (4 Tubes)	14000[2]	12600	5.0	10500[2]	9450	10.0
Three-Phase Half Wave (3 Tubes)	9400[3]	9550	7.5	7050[3]	7150	15.0
Three-Phase Double Y-Parallel (6 Tubes)	8150[3]	9550	15.0	6100[3]	7150	30.0
Three-Phase Full Wave (6 Tubes)	8150[3]	19100	7.5	6100[3]	14300	15.0

Socket . . . . . Johnson 124-215

[1] Per Tube. [2] Total. [3] Per Leg.



RECTIFIER CIRCUIT	SINGLE PHASE FULL-WAVE 2 TUBES	SINGLE PHASE FULL-WAVE 4 TUBES	THREE PHASE HALF-WAVE ZIG ZAG	THREE PHASE DOUBLE-Y	THREE PHASE FULL-WAVE
Conditions assumed for following relations 1. Sine-Wave Supply 2. Balanced Phase Voltages 3. Zero Tube Drop 4. Pure Resistance Load 5. No Filter Used NOTE: All rectifier filaments supplied by single phase transformers, with secondaries insulated for voltages greater than the Maximum Peak Inverse Voltage.	FIG. 1 	FIG. 2 	FIG. 3 	FIG. 4 	FIG. 5 
E Average	.450 *E* rms .318 *E* max	.900 *E* rms .636 *E* max	1.015 *E* rms .718 *E* max	1.170 *E* rms .827 *E* max	2.34 *E* rms 1.65 *E* max
E Inverse	3.14 *E* avg	1.57 *E* avg	2.09 *E* avg	2.09 *E* avg	1.045 *E* avg
I Average	.636 *I* max	.636 *I* max	.718 *I* max	1.91 *I* max	.955 *I* max
Ripple Frequency	2 X Supply Freq.	2 X Supply Freq.	3 X Supply Freq.	6 X Supply Freq.	6 X Supply Freq.
Ripple Voltage (Rms)	48.3%	48.3%	18.3%	4.2%	4.2%
[1] Ratio $\frac{\text{Secondary Kva}}{\text{D.C. Output-Kw}}$	1.57	1.11	1.71	1.48	1.05
[1] Ratio $\frac{\text{Primary Kva}}{\text{D.C. Output-Kw}}$	1.11	1.11	1.21	1.05	1.05

[1] These ratios assume that a choke input filter is used to maintain the output current substantially constant.

AMPEREX TUBE TYPE 872-AX

FILAMENT

A.C. Voltage	5.0
Current (amperes)	7.5
Preheating Period (Seconds)[1]	30

[1]Before plate voltage is applied.

MAXIMUM RATINGS

For Operation at Supply Frequency Up to 150 Cycles

	Condensed Mercury Temperature Range 20°C. to 70°C.[1]	20°C. to 60°C.[1]
Peak Inverse Voltage	5000	10000
Peak Plate Current (amperes)	5.0	5.0
Average Plate Current (amperes)[2]	1.25	1.25
Surge Plate Current (amperes)[3]	50	50
Approx. Tube Voltage Drop	10	10

[1]Recommended condensed mercury temperature 40° ± 5°C.

[2]Averaged over period of 15 seconds.

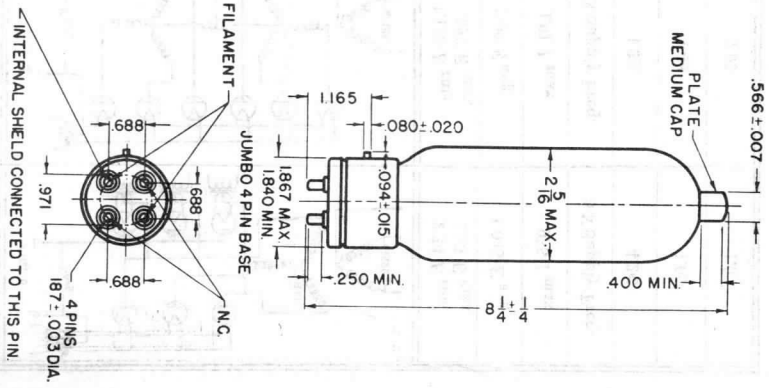
[3]For design only, max. duration of surge 0.2 second.

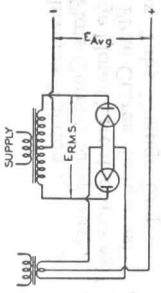
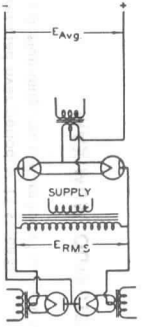
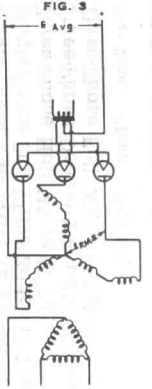
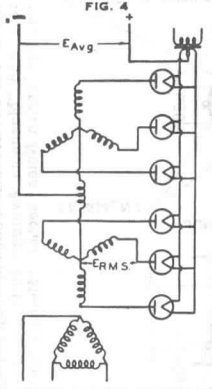
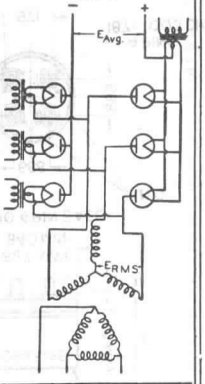
MAXIMUM OUTPUTS IN TYPICAL CIRCUITS

	A.C. Input Volts R.M.S.	D.C. Output Volts to Filter	Max. D.C. Load Current Amperes
Single-Phase Full Wave (2 Tubes)	3535[1]	3180	2.5
Single-Phase Full Wave Bridge (4 Tubes)	7070[2]	6360	2.5
Three-Phase Half Wave (3 Tubes)	4710[3]	4780	3.75
Three-Phase Double Y-Parallel (6 tubes)	4080[3]	4780	7.50
Three-Phase Full Wave (6 Tubes)	4080[3]	9570	3.75

[1]Per Tube. [2]Total [3]Per Leg.

NOTE: For Out-Of-Phase Filament Excitation information see "Maximum Peak Plate Current" and "Maximum Average Plate Current", pp. 453 and 454 "General Information and Application Notes" section, "Mercury Vapor High Voltage RECTIFIER TUBES".



RECTIFIER CIRCUIT	SINGLE PHASE FULL-WAVE 2 TUBES	SINGLE PHASE FULL-WAVE 4 TUBES	THREE PHASE HALF-WAVE ZIG ZAG	THREE PHASE DOUBLE-Y	THREE PHASE FULL-WAVE
Conditions assumed for following relations 1. Sine-Wave Supply 2. Balanced Phase Voltages 3. Zero Tube Drop 4. Pure Resistance Load 5. No Filter Used NOTE: All rectifier filaments supplied by single phase transformers, with secondaries insulated for voltages greater than the Maximum Peak Inverse Voltage.	FIG. 1 	FIG. 2 	FIG. 3 	FIG. 4 	FIG. 5 
E Average	.450 *E* rms .318 *E* max	.900 *E* rms .636 *E* max	1.015 *E* rms .718 *E* max	1.170 *E* rms .827 *E* max	2.34 *E* rms 1.65 *E* max
E Inverse	3.14 *E* avg	1.57 *E* avg	2.09 *E* avg	2.09 *E* avg	1.045 *E* avg
I Average	.636 *I* max	.636 *I* max	.718 *I* max	1.91 *I* max	.955 *I* max
Ripple Frequency	2 X Supply Freq.	2 X Supply Freq.	3 X Supply Freq.	6 X Supply Freq.	6 X Supply Freq.
Ripple Voltage (Rms)	48.3%	48.3%	18.3%	4.2%	4.2%
[1] Ratio $\frac{\text{Secondary Kva}}{\text{D.C. Output-Kw}}$	1.57	1.11	1.71	1.48	1.05
[1] Ratio $\frac{\text{Primary Kva}}{\text{D.C. Output-Kw}}$	1.11	1.11	1.21	1.05	1.05

[1] These ratios assume that a choke input filter is used to maintain the output current substantially constant.

AMPEREX TUBE TYPE 6339

The 6339 is a high vacuum, external anode clipper diode and rectifier tube which is only 2 inches long (without leads) and 3/4 inch in diameter. A miniaturized and ruggedized version of the 3B29, the 6339 operates under more stringent conditions than its prototype. It is designed to be enclosed in a complete liquid cooled package including power supply and pulse modulator components.

Operation in air at reduced ratings is allowed for applications where oil cooling is not necessary or required.

Although developed primarily for radar applications, it shows interesting possibilities for use in high voltage circuitry where space requirements are critical

GENERAL CHARACTERISTICS

ELECTRICAL DATA

	MIN.	BOGEY	MAX.	
Filament Voltage	5.7	6.3	6.9	volts
Filament Current at Bogey Voltage	1.40	1.55	1.70	amps
Filament Warm-up Time	60	--	--	sec.
Peak Cathode current [1]	--	--	8.0	amps
Peak Inverse Voltage	--	--	16.0	KV
Plate-Cathode Capacity	--	2.2	--	uuf

MECHANICAL DATA

Mounting Position . . . . . any

Cooling . . . . . liquid immersion (silicone oil)[2]

Coolant Temperature Range . . . . . -65° to $+165^{\circ}$ C

Shock Resistance . . . . . 300 G impact

Vibration Resistance . . . . . 10 – 60 cycles per sec. 0.080 inches total displacement.

Dimensions (without leads)

Length . . . . . 2 1/16 inches

Diameter . . . . . 13/16 inches

Length of leads (approx.) . . . . . 1 1/2 inches

Lead Connections - Heavy . . . . . Heater, cathode terminal

Thin . . . . . Heater terminal

Socket for anode end . . . . . Standard 60 amp. fuse clip or equal

Connection (filament leads) . . . . . Lugs as shown or banana plug optional

Weight (approx.) . . . . . 1 1/2 oz.

[1] Represents maximum useable cathode current for any condition of operation.

[2] Dow Corning #510 fluid, viscosity 50 - 60 centistokes, or an equivalent. For air cooling see data following.

Revised 6/55

6339

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

RECTIFIER (In Oil)

(Maximum ratings, absolute values)

Peak Inverse Voltage	10,000	16,000 volts
Peak Current	400	250 mA
Average Current	100	65 mA dc
Silicone Oil Coolant Temp.	-65° C to + 165° C	

Typical Operation (In Oil)

One Tube, Half-wave, Capacitor-Input Filter

Peak Inverse Voltage	10,000	16,000 volts
Peak Current	400	250 mA
Average Current - Load Current	100	65 mA
Load Voltage (approx.)	3300	5500 volts

Two Tubes, Single Phase, Full wave

Choke Input Filter

Peak Current (per tube)	200	130 mA
Average Current (per tube)	100	65 mA
Peak Inverse Voltage	10,000	16,000 volts
Load Current	200	130 mA
Load Voltage	2900	4900 volts

Three Phase Operation

Choke Input Filter

	Half Wave	Double Y	Bridge
No. of Tubes	3	6	6
Peak Inverse Voltage	10,000	10,000	16,000 volts
Peak Anode Current	300	300	195 mA
Average Anode Current (per tube)	100	100	65 mA dc
Output Voltage	4500	4500	14,000 volts dc
Ouptut Current	300	600	195 mA dc

RECTIFIER - (In Air)

(Maximum ratings, absolute values - air cooled at sea level)

	Without Auxiliary Cooler	With Auxiliary Cooler	
Peak Inverse Voltage	12,000	12,000	volts
Peak Current	200	400	mA
Average Current	50	100	mA dc
Ambient Temperature	−55 to + 85	−55 to + 85	°C

Typical Operation In Air
Without Auxiliary Cooler

	Single Phase Operation Choke Input Filter	Three Phase Operation Choke Input Filter		
	Full Wave	Half Wave	Bridge	
No. of Tubes	2	3	6	
Peak Inverse Voltage	12,000	10,000	12,000	volts
Peak Anode Current	100	150	100	mA
Average Anode Current (per tube)	50	50	33	mAdc
Output Voltage	3500	4500	10,500	volts dc
Output Current	100	150	100	mAdc

With Auxilary Cooler

No. of Tubes	2	3	6	
Peak Inverse Voltage	12,000	10,000	12,000	volts
Peak Anode Current	200	300	200	mA
Average Anode Current (per tube)	100	100	67	mAdc
Output Voltage	3500	4500	10,500	volts dc
Output Current	200	300	200	mAdc

6339

SHUNT DIODE (In Oil)

(Maximum ratings, absolute values)

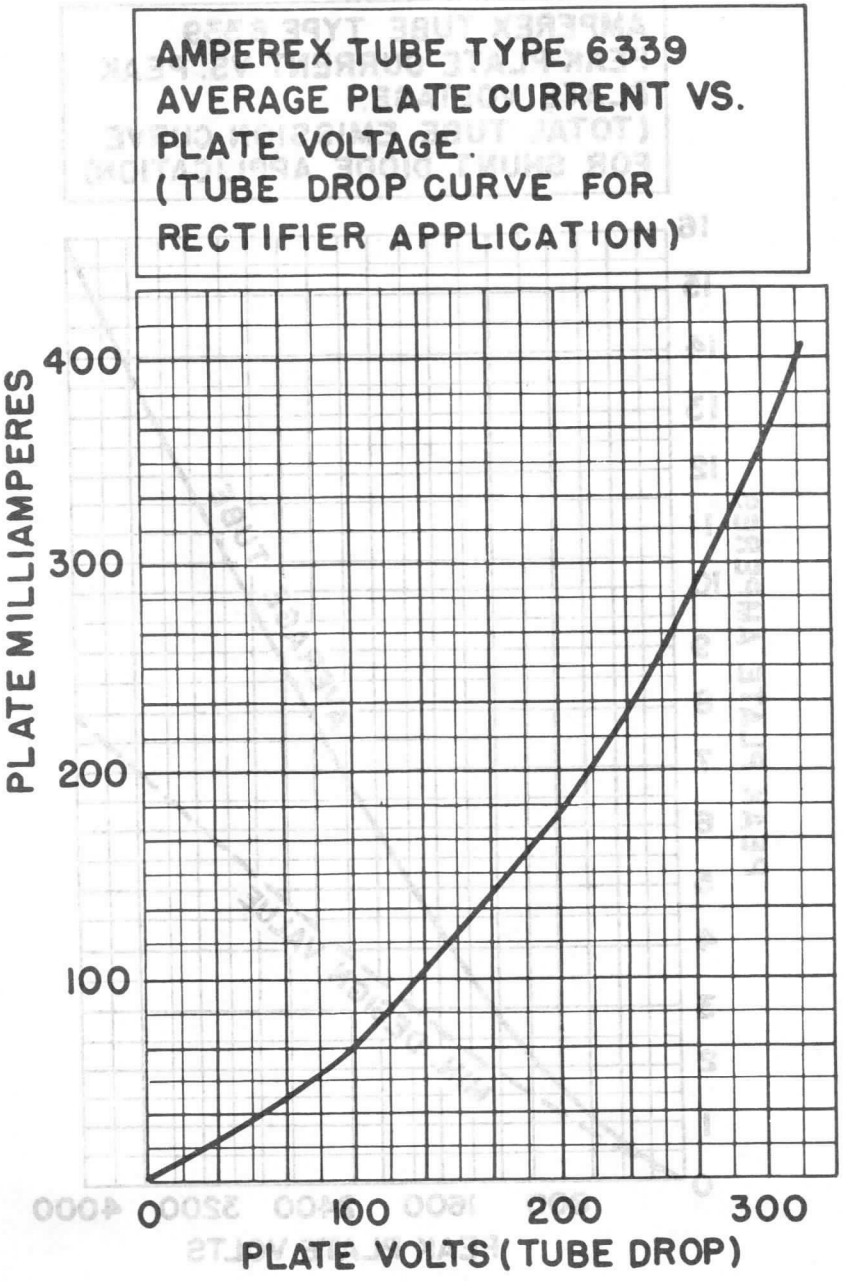
Peak Inverse Voltage	10,000 volts
Peak Current	8 amps
Average Current	18 mA
Pulse Duration in 100 microsecond interval	25 microseconds

Typical Operation (In Oil)

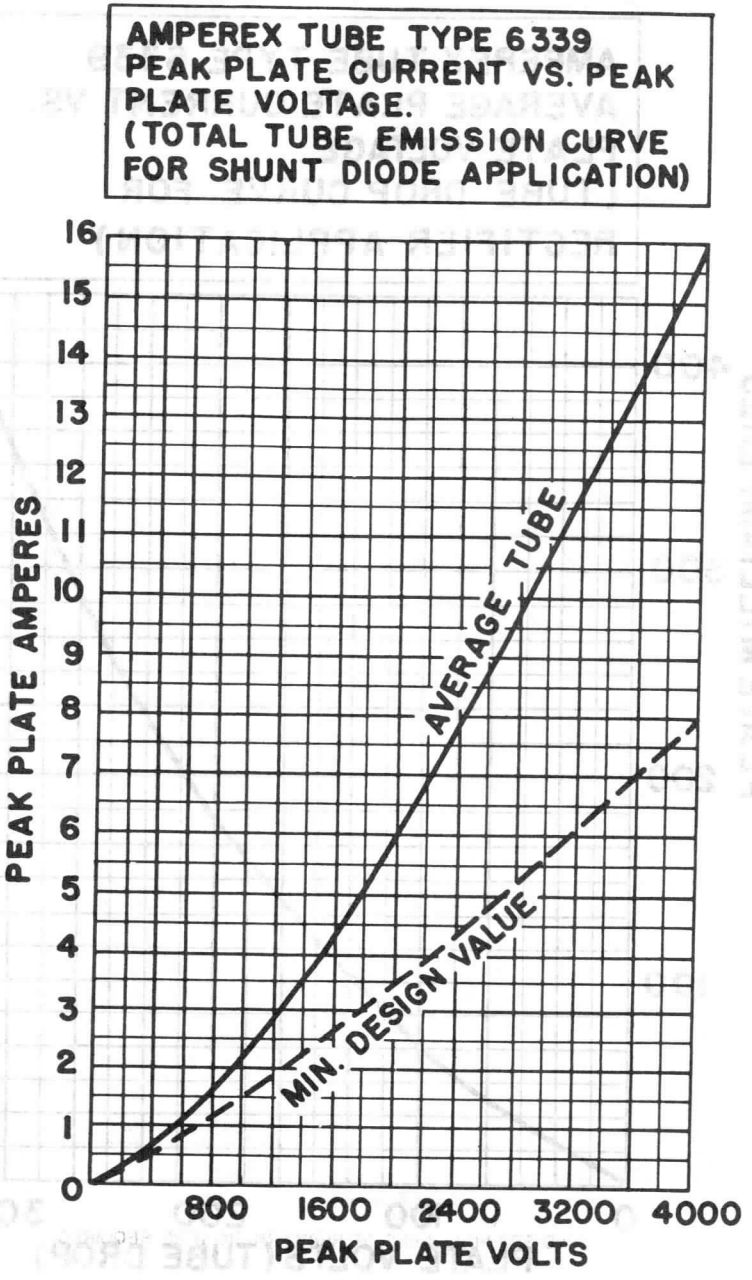
(One tube in hydrogen thyratron modulator circuit)

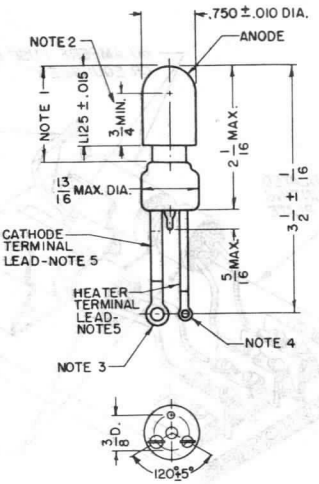
Pulse Time	1.0 microsecond
Network Impedance	50 ohms
Peak Thyratron Forward Voltage	10 KV
Repetition Rate	280 pulses per sec.
Diode Series Resistor	1000 ohms
Load Resistor[3]	0 ohms
Average Current Plate[3]	22 mA dc

[3] This load resistor represents a short circuit or arc in the load. As a result, the average diode plate current of 22 MA, D.C. will momentarily exceed the maximum rating of 18 MA, D.C. This circuit should be so designed that the high voltage will automatically shut off if continual short circuit exists in the load. The 6339 will operate, however, for longer than 500 hours under short circuit conditions which produce the average current as shown.


AMPEREX TUBE TYPE 6339
AVERAGE PLATE CURRENT VS.
PLATE VOLTAGE.
(TUBE DROP CURVE FOR
RECTIFIER APPLICATION)
PLATE MILLIAMPERES
400
300
200
100
0
100
200
300
PLATE VOLTS (TUBE DROP)

6339


AMPEREX TUBE TYPE 6339
PEAK PLATE CURRENT VS. PEAK PLATE VOLTAGE.
(TOTAL TUBE EMISSION CURVE FOR SHUNT DIODE APPLICATION)
PEAK PLATE AMPERES
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
AVERAGE TUBE
MIN. DESIGN VALUE
800
1600
2400
3200
4000
PEAK PLATE VOLTS

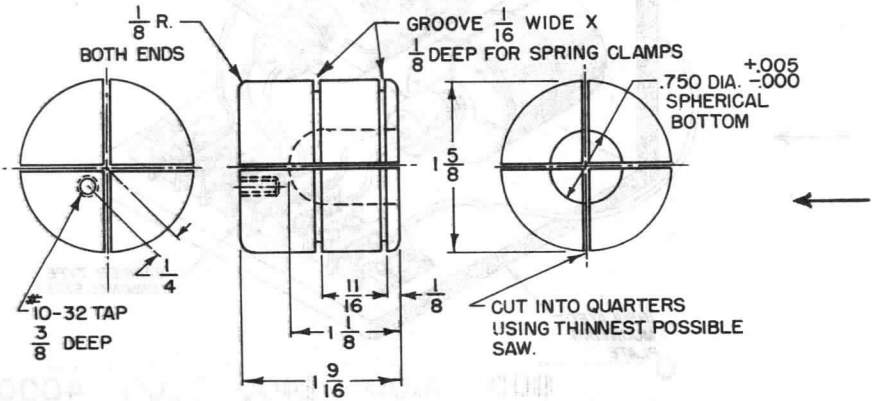


NOTES:
1. THIS SURFACE SILVER-PLATED.
2. SURFACE AVAILABLE FOR SUPPORT.
3. TINNED LUG FOR NO.8 SCREW-CRIMPED AND SOLDERED.
4. TINNED LUG FOR NO.6 SCREW-CRIMPED AND SOLDERED.
5. FLEXIBLE LEAD-INSULATED WITH FIBERGLASS.

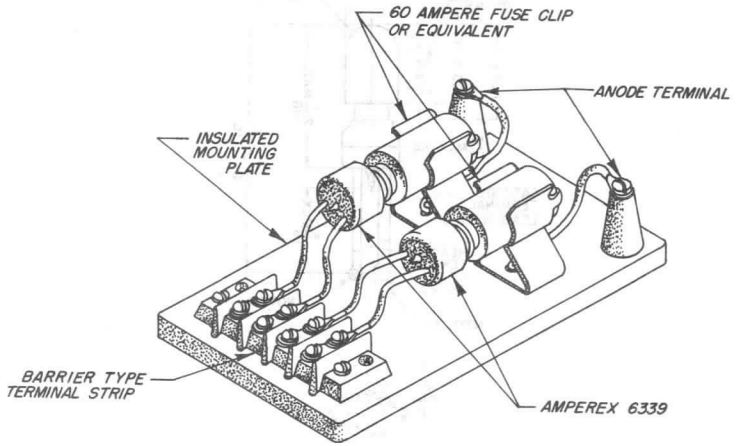
RECOMMENDED DESIGN

6339 ANODE HOLDER
(AUXILIARY COOLER)

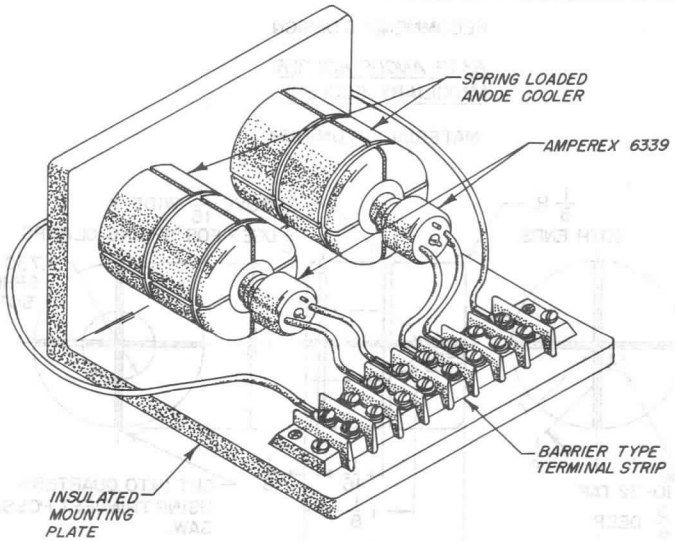
MATERIAL: ALUMINUM



TWO SPRING CLAMPS OF HEAVY MUSIC WIRE REQUIRED.



SUGGESTED MOUNTING FOR 6339 AIR COOLED OR LIQUID COOLED.



SUGGESTED MOUNTING FOR 6339 WITH AUXILIARY COOLER

AMPEREX TUBE TYPE 6508

The 6508 is a two electrode mercury-vapor rectifier tube and is designed for rectifier application of relatively high voltage and current. The cathode is directly heated, oxide coated. The physical design of this tube is similar to the popular AMPEREX types 5869 and 5870 thyratrons. The top bakelite cup is intended to prevent mercury condensation on the anode and thus eliminates arc-back.

Maximum Ratings, Absolute Values

Peak Inverse Voltage (max.)	21,000	15,000	10,000	volts
Condensed Mercury Temperature Limits	+25 to +45	+25 to +50	+25 to +60	°C
Maximum plate current				
Peak		10 amps		
Average (Averaging time max. 30 sec)		2.5 amps		
Surge, for design only (Maximum duration 0.1 second)		100 amps		
Frequency Range		25 - 150 cps		

Electrical Data

	Min.	Bogey	Max.	
Filament Voltage	4.75	5.0	5.25	volts
Filament Current at 5.0 volts	—	12.5	13.7	amps
Filament Heating Time (Note 3) (before applying plate voltage)	90	—	—	seconds
Tube Voltage Drop (Output current = 2.5 amps)	—	12	—	volts

Operating Conditions for 21 KV, Peak Inverse Voltage

Circuit	Input Voltage rms value kv	DC Output voltage to filter kv	DC Output current amp
Single-phase full-wave 2 tubes	7.4	6.7	5
Three-phase half-wave 3 tubes	8.6	10	7.5
Three-phase, double Y 6 tubes parallel	8.6	10	15
Four-phase half-wave 4 tubes	7.4	9.5	10
Single-phase full-wave 4 tubes	14.8	13.4	5
Three-phase full-wave 6 tubes	14.8	20	7.5
Four-phase full-wave 8 tubes	14.8	19	10

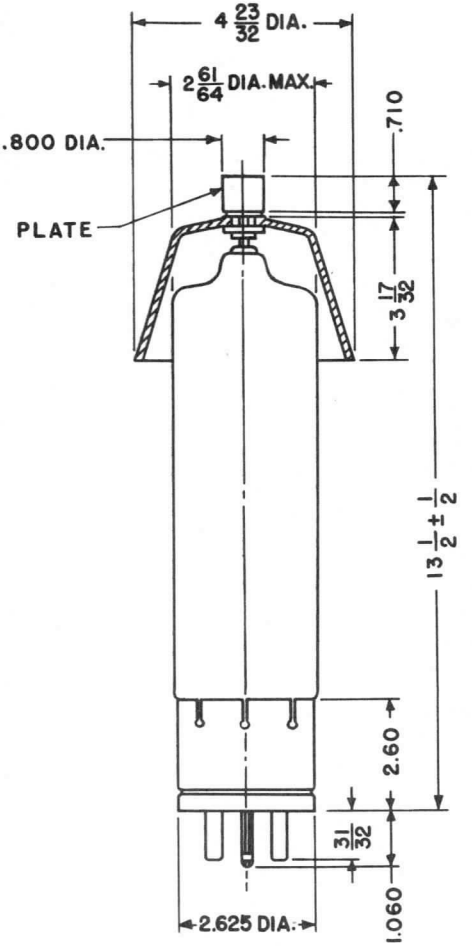
6508

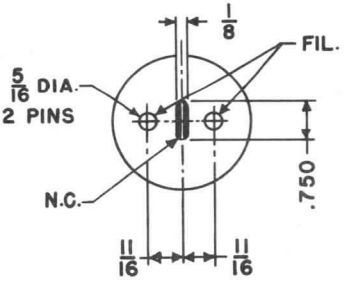
Mechanical Data

Type of cooling	Convection
Equilibrium Condensed-Mercury Temperature Rise	
At Full Load, approximate	$+15^{\circ}C$
At No Load, approximate	$+13^{\circ}C$
Socket	Johnson 124-215 or equal
Mounting position	Vertical with base down
Net weight (approximate)	25 ounces

NOTES:

1. **In order to obtain maximum life it is recommended that a filament voltage phase shift of $90^{\circ} \pm 30^{\circ}$ with respect to plate voltage be applied.**
2. **The tube should always be used with the bakelite cap attached.**
3. **The minimum heating time refers only to the filament. Sufficient additional time must be allowed to permit the condensed mercury temperature to rise to the minimum condensed mercury temperature limit and to permit all the mercury to condense on the lower part of the bulb.**
4. **The metallic shell of the base should not be allowed to reach a potential different from the cathode potential.**


4 23/32 DIA.
2 61/64 DIA. MAX.
.800 DIA.
.710
PLATE
3 17/32
13 1/2 ± 1/2
2.60
31/32
1.060
2.625 DIA.


1/8
FIL.
5/16 DIA.
2 PINS
.750
N.C.
11/16
11/16

AMPEREX TUBE TYPE 6693

TENTATIVE DATA

The 6693 is a single anode, high voltage, mercury vapor rectifier having ratings intermediate between the standard tube types 575A and 869B. It is particularly suitable for use in conjunction with modern power oscillator and amplifier tubes operating at high currents and lower voltages.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode	Directly heated, oxide coated
Filament Voltage	5 volts [1]
Filament Current	11.5 amps
Heating Time (minimum)	60 sec. [2]
Tube Voltage Drop	12 volts [3]
Equilbrium condensed mercury temperature rise over ambient (see curve)	
No Load	19° C
Full Load	21° C

MECHANICAL

Mounting Position	Vertical, base down
Max. Overall Length	12 inches
Max. Seated Height	11 5/16 inches
Max. Diameter	2 27/32 inches
Plate Cap	Medium
Base	Super Jumbo, 4 pin with bayonnet
Socket	Johnson 123-206 or equal

[1] For optimum performance, a phase shift of 90° ± 30° between the anode and filament voltages and use of a center tapped filament transformer are recommended.

[2] For average conditions, e.g. temperatures within limits and proper distribution of mercury. To insure proper distribution of mercury, upon installation and after a long interruption of service, a longer heating time is required before anode voltage is applied. In general, a time of 30 minutes will be sufficient.

[3] Measured at an average anode current of 3 amps.

Revised 7/55

6693

MAXIMUM RATINGS

Peak Inverse Anode Voltage [4]	15	2.5	max. KV
Average Anode Current [5]	3	5	max. amps
Peak Anode Current	12	20	max. amps
Surge Anode Current for max. of 0.1 second	120	200	max. amps

Relation Between Condensed Mercury Temperature, Ambient Temperature and Peak Inverse Voltage [6] (see curve)

Peak Inverse Anode Voltage	15	10	2.5 KV
Condensed Mercury Temp.	25-55	25-60	25-75 °C
Ambient Temp. [7]	15-35	15-40	15-55 °C

MAXIMUM OPERATING CONDITIONS

PEAK INVERSE ANODE VOLTAGE = 15 KV

(Transformer regulation and tube voltage drop are not included)

Circuit Diagram	Type of Circuit	Max transformer sec. rms voltage (Vtr) KV	DC output voltage to filter (Vo) KV	Max DC output current to filter (Io) Amps	Max DC output to filter (Wo) KW
a.	Single-phase, full-wave, 2 tubes	5.3	4.8	6	28.8
b.	Single-phase, full-wave, 4 tubes	10.6	9.6	6	57.6
c.	Three-phase, half-wave, 3 tubes	6.1	7.2	9	64.8
d.	Three-phase, full-wave, 6 tubes	10.6	14.4	9	129.6
e.	Three-phase, double Y, 6 tubes parallel	5.3	6.2	18	111.6
f.	Four-phase, half-wave, 4 tubes	5.3	6.7	12	80.4
g.	Four-phase, full-wave, 8 tubes	10.6	13.5	12	162.0

[4] For supply frequency up to 150 cycles per second.

[5] Averaged over 10-sec. interval

[6] If the equipment is started at most twice daily is is permissable to apply high voltage at a condensed mercury temperature of 20° C.

[7] With natural cooling, approx. values.

PEAK INVERSE VOLTAGE = 2.5 KV

(Transformer regulation and tube voltage drop are not included)

Circuit Diagram	Type of Circuit	Max transformer sec. rms voltage (Vtr) KV	DC output voltage to filter (Vo) KV	Max DC output current to filter (Io) Amps	Max DC output to filter (Wo) KW
a.	Single-phase, full-wave, 2 tubes	0.88	0.79	10	7.9
b.	Single-phase, full-wave, 4 tubes	1.76	1.58	10	15.8
c.	Three-phase, half-wave, 3 tubes	1.02	1.19	15	17.9
d.	Three-phase, full wave, 6 tubes	1.76	2.38	15	35.8
e.	Three-phase, double Y, 6 tubes	0.88	1.03	30	30.9
f.	Four-phase, half-wave, 4 tubes	0.88	1.13	20	22.6
g.	Four-phase, full-wave, 8 tubes	1.76	2.26	20	45.2

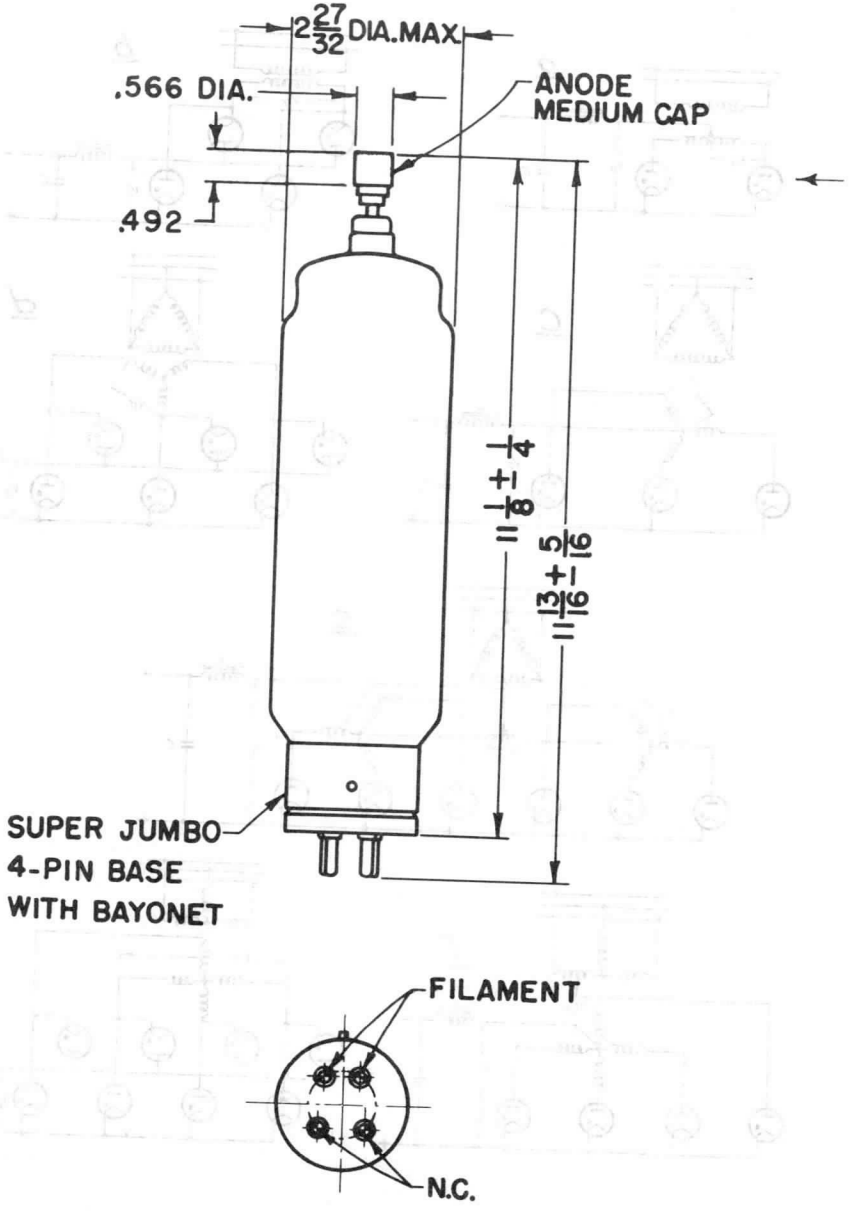
TYPICAL OPERATING CONDITIONS

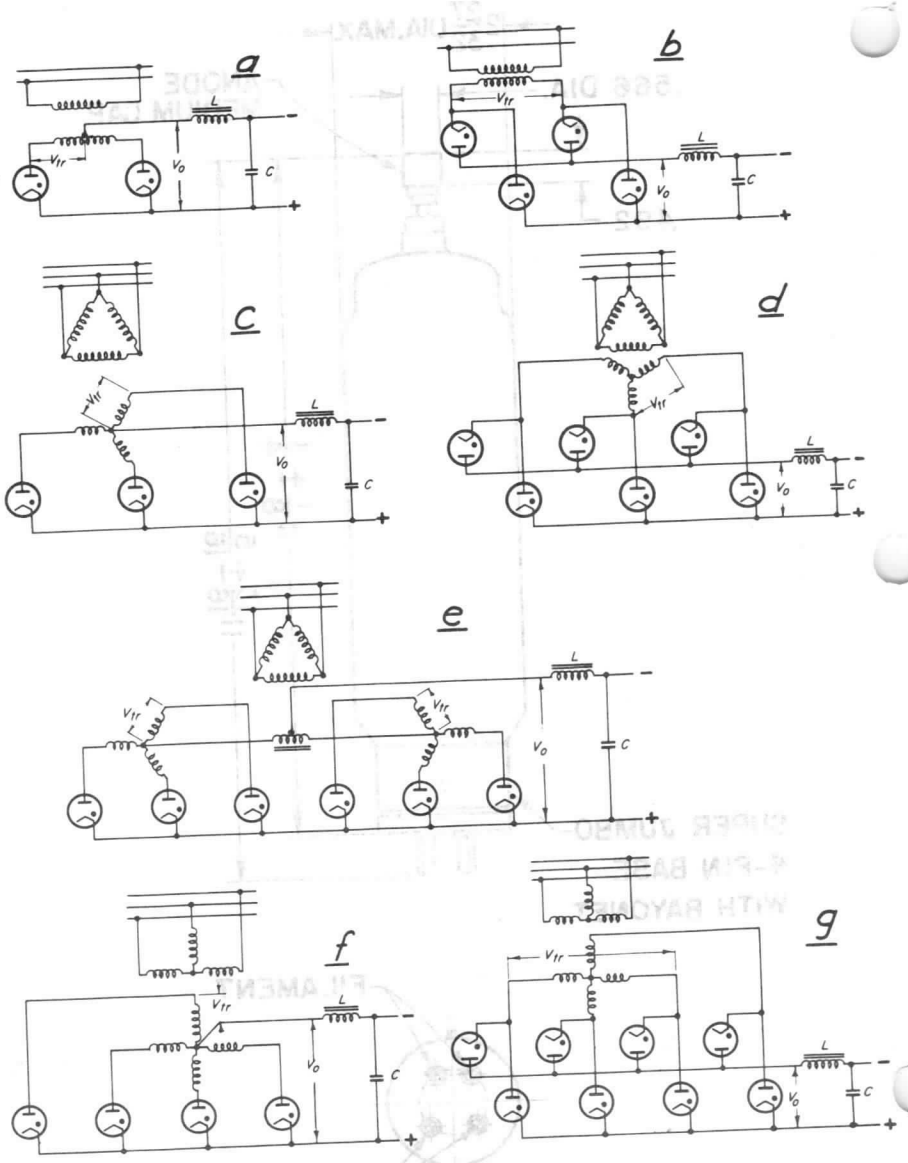
PEAK INVERSE VOLTAGE = MAX. 15 KV

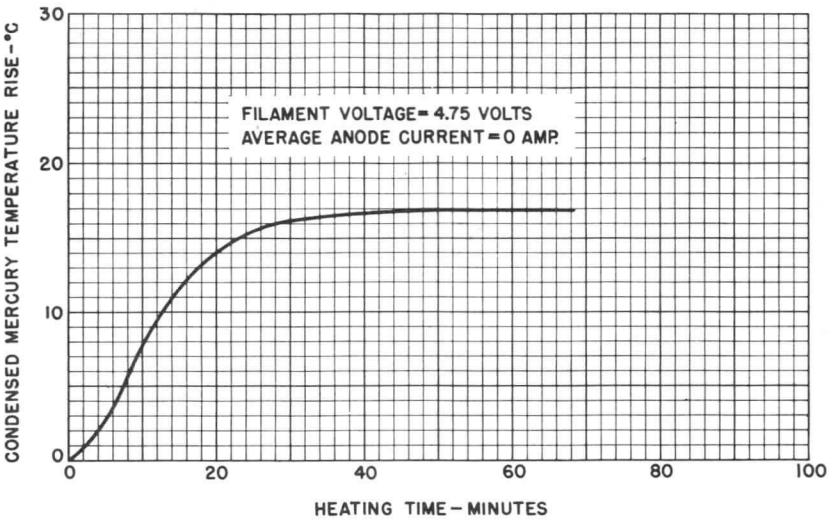
Circuit Diagram	Type of Circuit	No load transformer sec. rms voltage (Vtr) KV	DC output voltage to load [9] (Vo_1) KV	Max DC output current (Io) Amps	DC output to load (Wo_1) KW
a.	Single-phase, full-wave, 2 tubes	4.80	4.0	6	24
b.	Single-phase, full-wave, 4 tubes	9.60	8.0	6	48
c.	Three-phase, half-wave, 3 tubes	5.55	6.0	9	54
d.	Three-phase, full-wave, 6 tubes	9.60	12.0	9	108
e.	Three-phase, double Y, 6 tubes	4.80	5.15	18	93
f.	Four-phase, half-wave, 4 tubes	4.80	5.6	12	67
g.	Four-phase, full-wave, 8 tubes	9.60	11.2	12	134

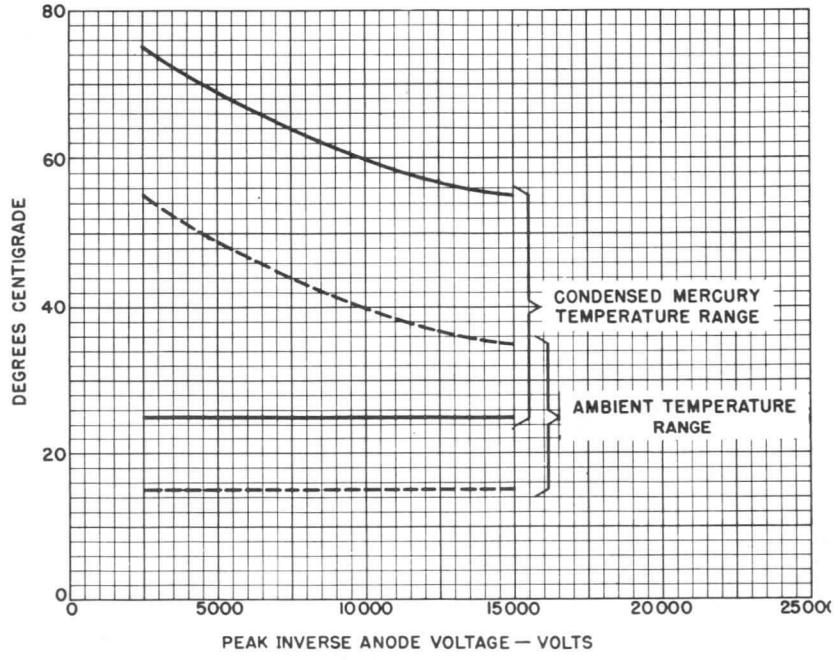
[8] This value corresponds with a nominal peak inverse anode voltage of 13.6 KV, allowing a line fluctuation of ± 10%.

[9] Tube voltage drop and losses in transformer, filter, ammeter, etc. amounting to 8% of Vo_1 have already been deducted.


2 27/32 DIA. MAX.
.566 DIA.
ANODE
MEDIUM CAP
.492
4 1/8 ± 1/16
5 13/16 ± 1/16
SUPER JUMBO
4-PIN BASE
WITH BAYONET
FILAMENT
N.C.


a
b
c
d
e
f
g
L
C
V_{rr}
V_o
+
-


CONDENSED MERCURY TEMPERATURE RISE - °C
30
20
10
0
FILAMENT VOLTAGE = 4.75 VOLTS
AVERAGE ANODE CURRENT = 0 AMP.
0
20
40
60
80
100
HEATING TIME — MINUTES


DEGREES CENTIGRADE
80
60
40
20
0
CONDENSED MERCURY TEMPERATURE RANGE
AMBIENT TEMPERATURE RANGE
0
5000
10000
15000
20000
25000
PEAK INVERSE ANODE VOLTAGE — VOLTS

AMPEREX TUBE TYPE 7136

The 7136 is a single anode, high-voltage, mercury vapor rectifier having plate current ratings intermediate between the standard types 575A and 6693. It has a cathode and anode design similar to the 6693 and is based for the 575A socket. It is recommended for use as a replacement for the 575A in existing equipment when greater reliability is desired. For new equipment design, the use of the Amperex 6693 is preferred.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode	Directly heated, oxide coated
Filament Voltage	5 volts [1]
Filament Current	11.5 amps
Heating Time (minimum)	60 sec. [2]
Tube Voltage Drop	12 volts [3]
Equilbrium condensed mercury temperature rise over ambient (see curve)	
No Load	19° C
Full Load	21° C

MECHANICAL

Mounting Position	Vertical, base down
Max. Overall Length	11 9/16 inches
Max. Diameter	2 27/32 inches
Plate Cap	Medium
Base	Jumbo, 4 pin with bayonnet
Socket	Johnson 123-211-100 or equal

[1] For optimum performance, a phase shift of 90° ± 30° between the anode and filament voltages and use of a center tapped filament transformer are recommended,

[2] For average conditions, e.g. temperatures within limits and proper distribution of mercury. To insure proper distribution of mercury, upon installation and after a long interruption of service, a longer heating time is required before anode voltage is applied. In general, a time of 30 minutes will be sufficient,

[3] Measured at an average anode current of 3 amps.

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MAXIMUM RATINGS

Peak Inverse Anode Voltage [4]	15 max. KV
Average Anode Current [5]	2.5 max. amps
Peak Anode Current	12 max. amps.
Surge Anode Current for max. of 0.1 second	120 max. amps

Relation Between Condensed Mercury Temperature, Ambient Temperature and Peak Inverse Voltage [6] (see curve)

Peak Inverse Anode Voltage	15	10	2.5 KV
Condensed Mercury Temp.	25-55	25-60	25-75 °C
Ambient Temp. [7]	15-35	15-40	15-55 °C

MAXIMUM OPERATING CONDITIONS
PEAK INVERSE ANODE VOLTAGE = 15 KV

(Transformer regulation and tube voltage drop are not included)

Circuit Diagram	Type of Circuit	Max transformer sec. rms voltage (Vtr) KV	DC output voltage to filter (Vo) KV	Max DC output current to filter (Io) Amps	Max DC output to filter (Wo) KW
a.	Single-phase full-wave, 2 tubes	5.3	4.8	5	24
b.	Single-phase full-wave, 4 tubes	10.6	9.6	5	48
c.	Three-phase half-wave, 3 tubes	6.1	7.2	7.5	54
→ d.	Three-phase, double Y, 6 tubes parallel with balance coil	5.3	6.2	15	93
→ e.	Three-phase full-wave, 6 tubes	10.6	14.4	7.5	108

[4] For supply frequency up to 150 cycles per second.

[5] Averaged over 10-sec. interval.

[6] If the equipment is started at most twice daily it is permissable to apply high voltage at a condensed mercury temperature of 20°C.

[7] With natural cooling, approx. values.

(Replaces old page no. 477-S)

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TYPICAL OPERATING CONDITIONS
PEAK INVERSE VOLTAGE = MAX. 15 KV [8]

Circuit Diagram	Type of Circuit	No load transformer sec. rms voltage (Vtr) KV	DC output voltage to load [9] (Vo_1) KV	Max DC output current (Io) Amps	DC output to load (Wo_1) KW
a.	Single-phase full-wave, 2 tubes	4.80	4.0	5	20
b.	Single-phase full-wave, 4 tubes	9.60	8.0	5	40
c.	Three-phase, half-wave, 3 tubes	5.55	6.0	7.5	45
→ d.	Three-phase, double Y, 6 tubes	4.80	5.15	15	77.25
→ e.	Three-phase full-wave, 6 tubes	9.60	12.0	7.5	90

[8] This value corresponds to a nominal peak inverse anode voltage of 13.6 KV, allowing a line fluctuation of ± 10%.

[9] Tube voltage drop and losses in transformer, filter, ammeter, etc. amounting to 8% of Vo_1 have already been deducted.

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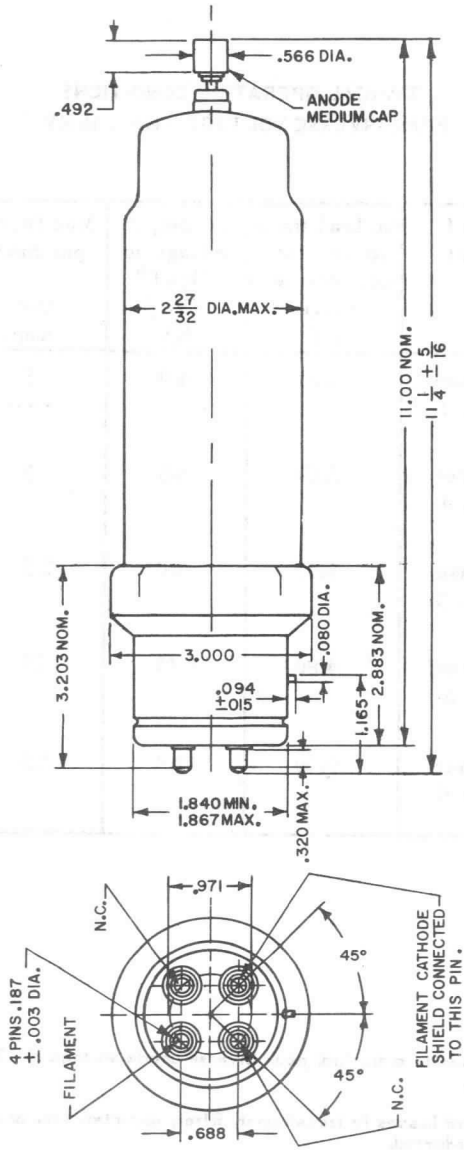
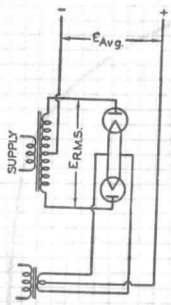
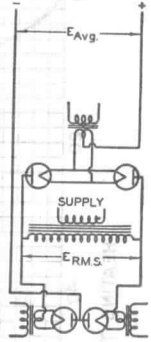
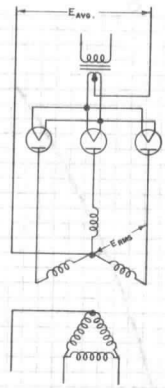
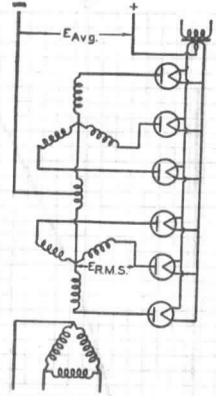
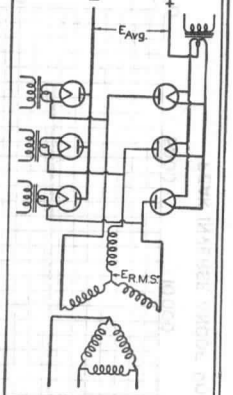


JUMBO 4 PIN BASE

7136

RECTIFIER CIRCUIT	SINGLE PHASE FULL-WAVE 2 TUBES	SINGLE PHASE FULL-WAVE 2 TUBES	THREE PHASE HALF-WAVE	THREE PHASE DOUBLE-Y WITH BALANCE COIL	THREE PHASE FULL-WAVE
Conditions assumed for following relations 1. Sine-Wave Supply 2. Balanced Phase Voltages 3. Zero Tube Drop 4. Pure Resistance Load 5. No Filter Used NOTE: All rectifier filaments supplied by single phase transformers, with secondaries insulated for voltages greater than the Maximum Peak Inverse Voltage.	FIG. A 	FIG. B 	FIG. C 	FIG. D 	FIG. E 
E Average	.450 E rms .318 E max	.900 E rms .636 E max	1.170 E rms .827 E max	1.170 E rms .827 E max	2.34 E rms 1.65 E max
E Inverse	3.14 E avg	1.57 E avg	2.09 E avg	2.09 E avg	1.045 E avg
I Average	.636 I max	.636 I max	.718 I max	1.91 I max	.955 I max
Ripple Frequency	2 X Supply Freq.	2 X Supply Freq.	3 X Supply Freq.	6 X Supply Freq.	6 X Supply Freq.
Ripple Voltage (Rms)	48.3%	48.3%	18.3%	4.2%	4.2%
† Ratio $\frac{\text{Secondary Kva}}{\text{D.C. Output-Kw}}$	1.57	1.11	1.71	1.48	1.05
† Ratio $\frac{\text{Primary Kva}}{\text{D.C. Output-Kw}}$	1.11	1.11	1.21	1.05	1.05

† These ratios assume that a choke input filter is used to maintain the output current substantially constant.

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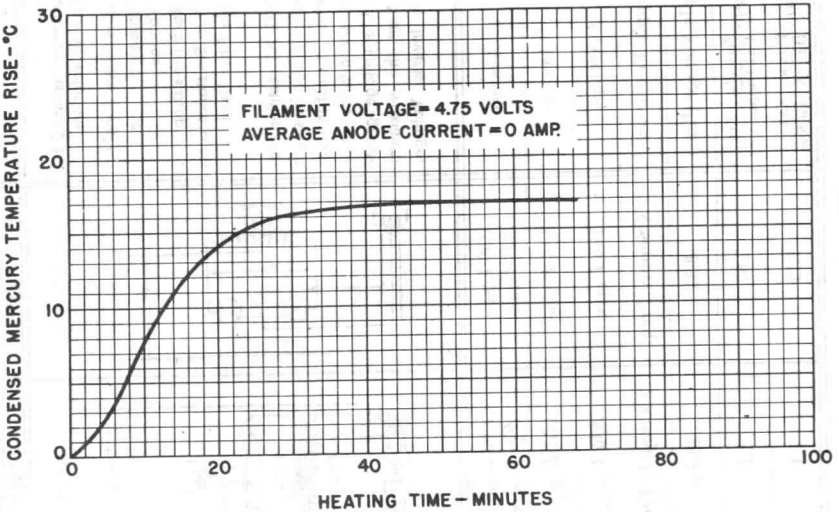
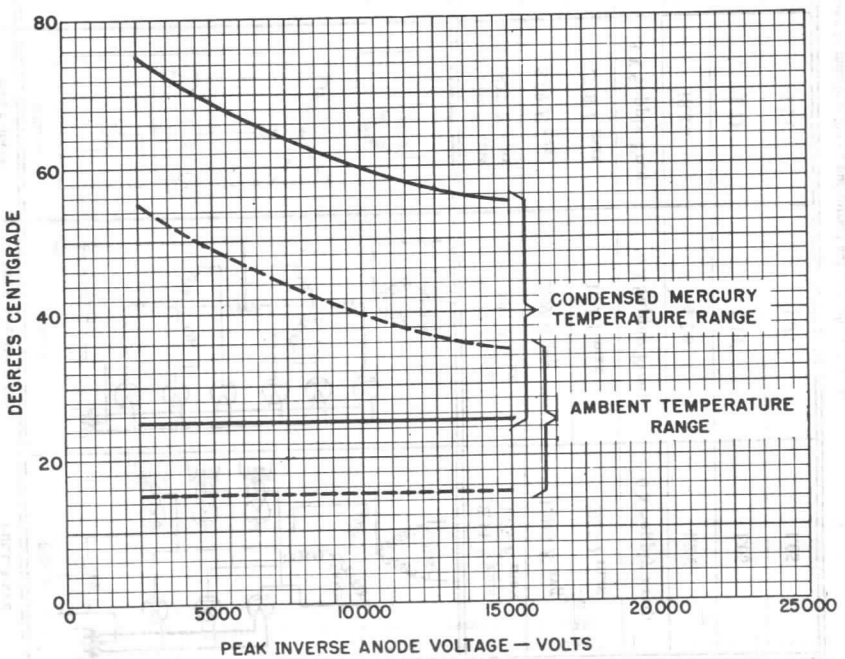

CONDENSED MERCURY TEMPERATURE RISE - °C
30
20
10
0
FILAMENT VOLTAGE = 4.75 VOLTS
AVERAGE ANODE CURRENT = 0 AMP.
0
20
40
60
80
100
HEATING TIME — MINUTES


DEGREES CENTIGRADE
80
60
40
20
0
CONDENSED MERCURY TEMPERATURE RANGE
AMBIENT TEMPERATURE RANGE
0
5000
10000
15000
20000
25000
PEAK INVERSE ANODE VOLTAGE — VOLTS

AMPEREX TUBE TYPE 8270

TENTATIVE DATA

The Amperex 8270 is a grid controlled mercury vapor half wave rectifier. It has a maximum PIV of 21 kv at an average anode current of 2.5 amps. At a PIV below 15 kv the anode current may rise to 3 amps. Six of these tubes in a three phase full wave circuit provide 12 kv at 9 amps.

MECHANICAL

Mounting Position	vertical, base down
Base	Super Jumbo, 4 pins, with bayonet
Accessories	
Socket	S-31747
Anode Connector	S-31748
Anode Cap (Supplied with the Tube)	S-31749 [1]
Dimensions	See outline drawing
Weight	
Net Weight	1 lb. 1 oz.
Shipping Weight	5 lbs. 1 oz.

ELECTRICAL

Filament	Oxide-Coated
Heating	Direct
Filament Voltage [2]	5 volts
Filament Current	13.0 amps
Filament Warm-Up Time, Minimum [3]	90 sec
Capacitances	
Anode to Grid	4 pf
Grid to Cathode	13 pf
Typical Characteristics	
Ionization Time	10 μsec max
Deionization Time	500 μsec max
Tube Voltage Drop (I_b = 3 amps)	12 volts

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[1] This cap must always be mounted on the tube, also during preheating.

[2] A phase shift of 90° ± 30° between E_b and E_f and/or use of a center-tapped filament transformer is recommended.

[3] For average conditions, i.e. temperature within limits and proper distribution of mercury, See Table I.
After transport, a storage period, and also after a long interruption of operation a longer warm-up time is required before anode voltage may be applied. In general a time of 60 minutes will be sufficient to ensure proper distribution of the mercury.

MAXIMUM RATINGS, ABSOLUTE VALUES

Frequency	150	150	150 cps
Peak Anode Voltage			
Inverse	21	15	2.5 kv
Forward	21	15	2.5 kv
Anode Current			
Average	2.5	3	5 amps [4]
Peak	10	12	20 amps
Surge	100	120	200 amps [5]
Grid Bias	300	300	300 volts [6]
Grid Resistance	100	100	100 k ohms max [7]
Grid Resistance	10	10	10 k ohms min [7]

TABLE I

Peak Inverse Voltage	21	15	10	2.5	kv
Temperature of Condensed Mercury [8]	25-45	25-55	25-60	27-75	°C
Ambient Temperature [9, 10]	15-30	15-35	15-40	15-55	°C

TYPICAL OPERATION [11]

Grid Voltage (E_b peak inverse 21 kv)	E_{c1}	− 100 volts
(E_b peak inverse 10 kv)	E_{c1}	− 50 volts
Grid Current	I_{c1}	2 ma

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4 Averaging time T_{av} = max. 30 sec.

5 Max duration 0.1 sec.

6 Direct voltage, before conduction.

7 Recommended value: 33 k ohms

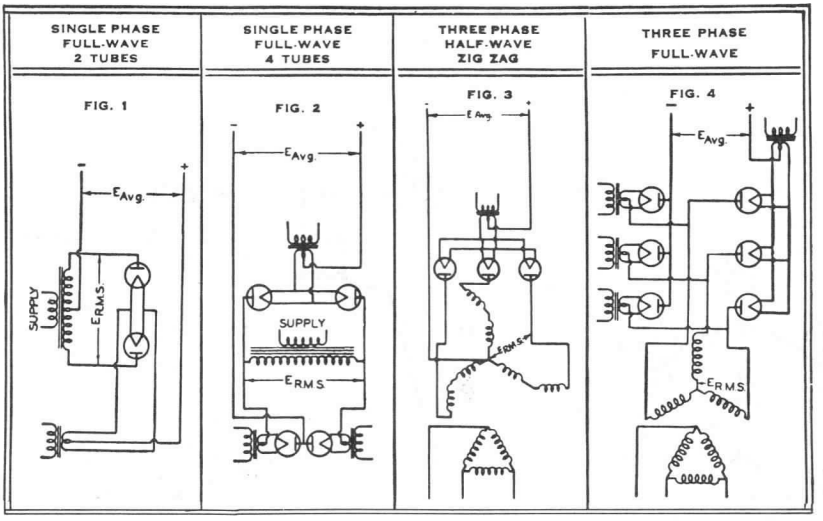
8 If the equipment is started not more than twice daily, it is permissible to apply high voltage at a condensed-mercury temperature which is 5°C lower than the values mentioned in the table.

9 With natural cooling, approximate values.

10 The ambient temperature is defined as the temperature of the surrounding air and should be measured under the following conditions:

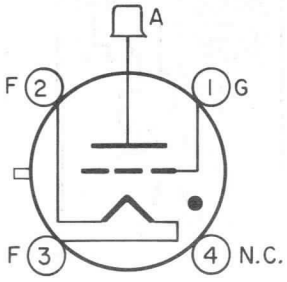
a. Normal atmospheric pressure
b. The tube should be adjusted to the worst possible operating conditions.
c. The temperature should be measured when thermal equilibrium is reached.
d. The distance from the thermometer to the outside of the envelope should be 3 inches (measured in a plane perpendicular to the main axis of the tube at the height of the condensed-mercury boundary).
e. The thermometer should be shielded against direct heat radiation.

11 Transformer losses and voltage drops in tubes are neglected.



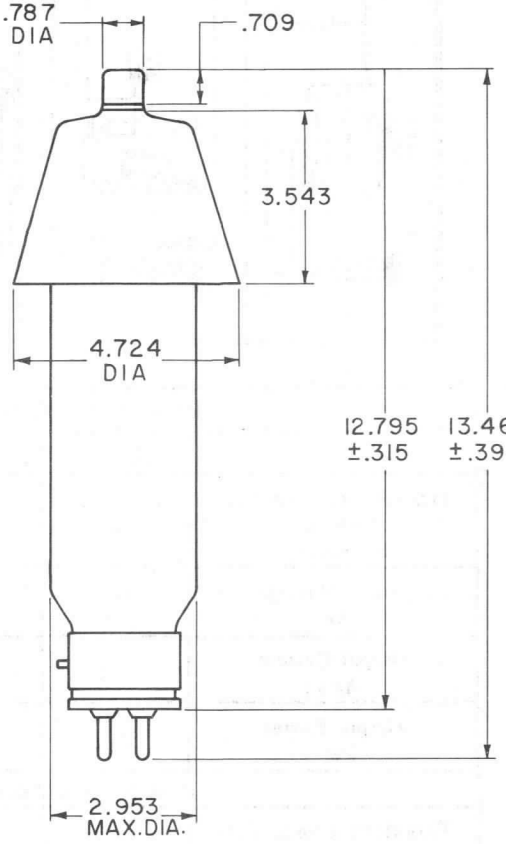
Peak Inverse Voltage = 21 KV				
	FIG. 1	FIG. 2	FIG. 3	FIG. 4
Transformer secondary Voltage kv. r.m.s.	7.4	14.8	8.5	14.8
Output Voltage kv	6.7	13.4	10	20
Output Current Amps	5	5	7.5	7.5
Output Power kw	33.5	67	75	150
Peak Inverse Voltage = 15 KV				
Transformer Secondary Voltage kv r.m.s.	5.3	10.6	6.1	10.6
Output Voltage kv	4.8	9.6	7.2	14.4
Output Current Amps	6	6	9	9
Output Power kw	28.8	57.6	64.8	130

8270



PIN CONNECTIONS

1. GRID
2. FILAMENT
3. FILAMENT
4. NO CONNECTION
CAP – ANODE



AMPEREX

MICROWAVE TUBES
and
COMPONENTS

Amperex

MAGNETRONS

GENERAL INFORMATION AND NOTES ON OPERATION

MAGNETRON OSCILLATORS are two-element high-vacuum tubes widely used for the generation of continuous-wave or pulsed signals in the higher frequency bands. The normal operating wavelengths of this type of oscillator are approximately 30 cm and less. Magnetrons are essentially rugged, high-efficiency, high-power devices, and they therefore find numerous applications as radar transmitters and wherever high-power oscillations at high frequencies are required. Owing to the short wavelengths involved, the resonant system of this type of oscillator is placed within the vacuum envelope of the tube and is thus an integral part of the device.

A magnetron operates by virtue of the presence of crossed electric and magnetic fields in its cathode-anode interaction space. Owing to the magnetic field, the electrons emitted by the cathode, instead of following radial paths to the anode, tend to follow cycloidal trajectories, some of them returning to the cathode, others reaching the anode after tracing a number of cusps in their paths, depending on their phasing with respect to the rf cycle. By proper design of the anode structure and adjustment of the magnitudes of the electric and magnetic fields, the electrons can be made to give up some of their energy to the electromagnetic wave established in the cathode-anode interaction space. This useful power output can then be coupled out to an external high-frequency transmission line.

RESONANT SYSTEM

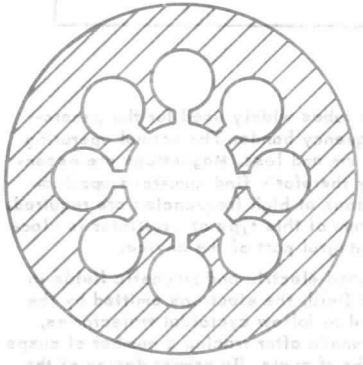
The tuned circuits of the magnetron usually take the form of a number of cavity resonators arranged symmetrically around the cathode. These resonators may be of various shapes, the most commonly used today being the "hole-and-slot" arrangement, in which the capacitive ("slot") and inductive ("hole") parts of the tuned circuit are more distinctly separated; the "vane" type, in which a number of flat vanes are used to form the resonant cavities; and the "rising sun" system, employed at the shorter wavelengths (3 cm and less), consisting of two groups of cavities of different sizes, arranged alternately around the cathode. (See Fig. 1) A particular tube type, with identical mechanical characteristics, may be constructed with different anode arrangements, and as a consequence the tubes of different manufacturers may exhibit various sensitivities to imposed conditions, such as time-of-rise of the pulse voltage, changes in plate voltage, etc., even though they are tested to identical electrical test specifications.

An infinite number of "modes" of oscillations can be supported by a given arrangement of magnetron resonators of a particular geometry, and the resonant structure has to be carefully designed to favor the desired mode of oscillations and suppress all others. Magnetrons

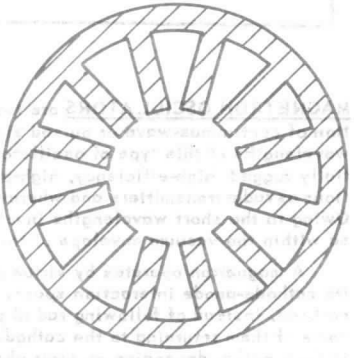
are normally operated in the "principal" or π - mode, in which successive anode segments are always at opposite phases of the rf cycle (π electrical degrees apart). The wavelength of the undesired modes are moved to values substantially different from that of the principal-mode by proper anode design and the use of various types of "strapping", by which is meant an arrangement of electrical conductors connecting alternate anode segments.

Various strapping schemes have been developed for magnetron anodes. "Echelon" strapping refers to an arrangement in which short wires are used to connect every other anode segment. In "single-ring" strapping, a continuous ring is brazed to alternate vanes, while in "double-ring" strapping, two rings are used, the second ring connecting the anode segments not "strapped" by the first. In addition, "double-ended" or "single-ended" strapping may be used, depending on whether both sides of the anode cylinder are strapped or only one side (the latter being used chiefly for thin anodes).

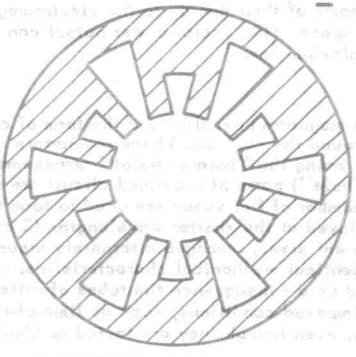
In strapped anodes, particularly in those using the more involved strapping arrangements, the strap-to-strap and strap-to-vane capacitances become major contributing factors to the total equivalent capacitance of the resonant circuit. The vane-to-vane (or "slot", in the hole-and-slot anode) and the anode-segment fringe capacitances are the other factors contributing to the total capacitance, while the resonator-to-cathode capacitances usually provide the coupling capacitance between the individual cavity resonators.



A. HOLE & SLOT ANODE



B. VANE-TYPE ANODE



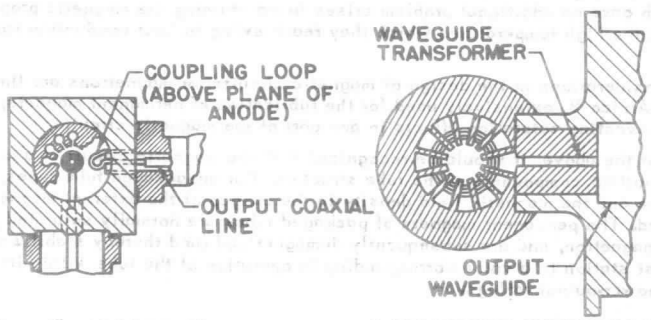
C. RISING SUN ANODE

FIGURE 1: TYPICAL MAGNETRON ANODE STRUCTURES

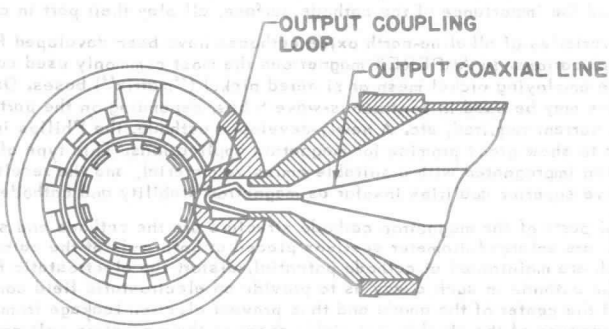
ENERGY-COUPLING SYSTEMS

The rf energy generated by the magnetron can be coupled to an outside load by means of any of several arrangements. Capacitive (probe) or inductive (loop) coupling devices can be used, and the impedance transformation from the outside transmission device (which in itself can be coaxial line or waveguide) to the magnetron output impedance can also be accomplished in a variety of ways.

The most commonly used coupling devices are inductive loops and slots. The former, employed in conjunction with coaxial output lines, can be placed inside one of the cavity resonators ("in-cavity-loop") or at one end of the anode block, in line with one of the resonators (" halo loop"). The slot coupling, normally used in conjunction with waveguide matching sections and waveguide output transmission lines, is usually placed at a high current point in the back of a resonator. (See Fig. 2) Other, less commonly used energy-coupling devices, include arrangements employing metallic posts attached to the straps or vanes ("strap- or vane-fed outputs"). A scheme frequently used combines a coaxial-line output with a coaxial-to-waveguide adapter, all within the tube package, so that a loop coupler can be used even though the output of the magnetron is in rectangular waveguide.



A. "HALO" LOOP (2J48) B. WAVEGUIDE OUTPUT (4J57)



C. "IN-CAVITY" LOOP (5586)

FIGURE 2: TYPICAL MAGNETRON OUTPUT STRUCTURES

MAGNETIC CIRCUIT

The magnetic circuit in a magnetron must be such that a uniform field be produced in the cathode-anode interaction space, and that the magnetic field density be of the proper magnitude to sustain oscillations in the desired mode. In magnetrons using a permanent magnet as an integral part of the tube ("packaged magnetrons"), the magnitude of the required field density determines the minimum weight and size requirements of the tube. In tubes designed for operation with external magnets ("unpackaged magnetrons"), the magnetic circuit within the tube must be designed so that it can be easily attached to, and forms a logical extension of, the external magnet.

The requirement of uniformity of the magnetic field in the interaction space, although not too difficult from the strictly magnetic design point of view, causes some involvements in most practical cases owing to the normal tube assembly techniques. Thus, in the case of axial-mounted cathodes, for example, either one or both magnetic pole pieces have holes exceeding the diameter of the cathode to facilitate proper cathode mounting and axial positioning. The presence of these comparatively large holes in the pole pieces causes a distortion ("anti-barrelling") of the magnetic field lines in the interaction space, which is usually counteracted by shaping the pole pieces to cause "barrelling" of the field. A more involved arrangement uses magnetic materials located on the cathode support for shaping the magnetic field, in which case an additional problem arises in maintaining the magnetic properties of these parts at the high temperatures which they reach owing to heat conduction from the cathode itself.

Other considerations in the design of magnetic circuits for magnetrons are the physical properties of Alnico V, extensively used for the fabrication of permanent magnets; and a concern for preventing saturation effects in any part of the magnetic circuits.

In view of the above, it should be recognized that the magnetic circuit of a magnetron is one of the important components of the tube structure. For unpackaged tube types, both the physical shape and the magnetic field density in the air-gap of the external magnet are usually specified. The permanent magnets of packaged tubes are normally saturated prior to the aging of the magnetron, and are subsequently demagnetized (and thereby stabilized) on the production test station to a value corresponding to operation of the tube within its voltage, current, and power-output ratings.

CATHODE STRUCTURE

The design of magnetron cathodes must take into consideration the particular characteristics of magnetron operation. Thus, the large percentage of secondary emission, the high peak currents required (in pulsed magnetrons), the shape of the electric field in the interaction space, and the importance of the cathode surface, all play their part in cathode design.

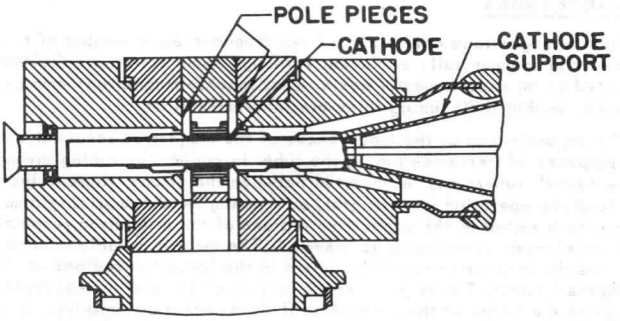
Several varieties of alkaline-earth oxide cathodes have been developed for pulsed-magnetron applications. In AMPEREX magnetrons the most commonly used cathodes of this type are those employing nickel mesh or sintered nickel ("matrix") bases. Oxide-coated or thoria cathodes may be used in continuous-wave tubes, depending on the particular application, cathode current required, etc. A newly-developed cathode, the Philips impregnated type, appears to show great promise for magnetron applications. This type of cathode uses porous tungsten impregnated with a suitable emissive material, and the resulting structure appears to have superior qualities insofar as magnetron stability and cathode life are concerned.

Essential parts of the magnetron cathode structure are the cathode end shields (or "end hats"), which are enlarged-diameter sections placed at both ends of the cathode. These shields, which are maintained at cathode potential, distort the electrostatic field lines near the ends of the cathode in such a way as to provide an electrostatic field component directed inward toward the center of the anode and thus prevent electron leakage from the interaction space. The presence of the shields materially changes the magnetron volt-ampere characteristic, and is essential for proper tube operation.

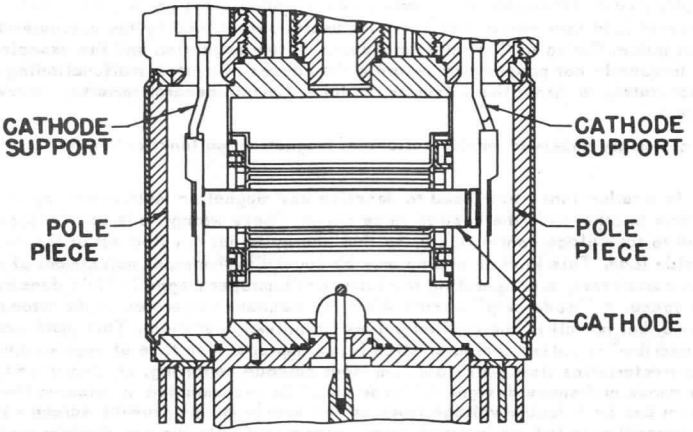
Both the size and the centering of the magnetron cathode are of great importance to proper tube functioning. Small changes in cathode diameter not only change the magnetron plate voltage (for a given magnetic field), but may also greatly affect the efficiency of the tube. Radial off-centering of the cathode may lead to serious malfunctioning of the magnetron, such

as deterioration of the spectrum (in pulsed tubes) or wrong-mode operation; while axial off-centering causes a decrease in magnetron efficiency or, again "moding" of the tube.

Either axial or radial supports can be used for magnetron cathodes (See Fig. 3). In either case, the thermal expansion of the cathode has to be considered, and cathodes are mounted in such a manner that after expansion they are properly centered. The sensitivity of the magnetron cathode to precise centering is reflected in the assembly procedures of most magnetrons, since in fixing the order of assembly of tube components it becomes important to allow for the inclusion of carefully designed cathode-centering fixtures.



A. AXIAL SUPPORT (4J52)



B. RADIAL SUPPORT (4J47)

FIGURE 3: TYPICAL CATHODE-MOUNTING ARRANGEMENTS FOR MAGNETRONS

The electron trajectories in a magnetron are such that the cathode is subjected to a considerable amount of back bombardment during normal tube operation, which, in turn, tends to heat up the cathode to excessive temperatures. It is for this reason that it becomes necessary to reduce the filament power once the magnetron starts oscillating and the back-bombardment power increases. Filament power reduction schedules aim at the maintenance of an approximately constant cathode temperature throughout the operating range of the tube. Some megnetrons, notably some of the 3-cm tubes, operate entirely on secondary cathode emission; in these tubes the heater is used only to bring the cathode up to temperature during the initial warm-up period, after which all filament power is discontinued.

TUNABLE MAGNETRONS

In addition to magnetrons operating at fixed frequencies, a number of tunable types have been developed and commercially produced. Although some electronically-tuned tubes have been constructed on an experiemental basis, most tunable magnetrons employ mechanical tuning elements, so that their tuning rates are inherently slow.

Either the capacitances or the inductances of the magnetron resonant structure can be changed for purposes of frequency-tuning the tube. In capacitive tuning arrangements, a flat ring ("cookie cutter" tuner) may be inserted between the straps, thereby increasing the capacitance (and the operating wavelength); or a tuning head comprising a multiplicity of flat strips may be inserted in the capacitive regions of the magnetron resonators, again increasing the wavelength as the tuner is inserted. The most commonly used inductive tuning scheme involves the insertion of metallic posts in the inductive regions of the resonators ("crown-of-thorns" tuner). These pins, which may be of circular or trapezoidal cross-section depending on the shape of the resonators (hole-and-slot or vane-type anode), decrease the inductance and consequently the resonant wavelength of the structure as the tuner is inserted into the resonators. Schemes have also been evolved using a combination of both capacitive and inductive tuning.

MALFUNCTIONING OF MAGNETRONS

As has already been mentioned, the operation of a magnetron is greatly influenced both by the external load into which it delivers its useful output, and by the characteristics of the input pulse. Owing to this interdependence of the magnetron and the associated circuitry, it is frequently not possible to separate the causes of system malfunctioning and ascribe them accurately to either the pulser or the tube. Certain general remarks, however, may be of interest.

The most commonly observed manifestations of magnetron malfunctioning are "moding" and arcing.

"Moding" is a rather loose term used to describe any magnetron malfunctioning in which oscillations in other than the desired mode occur. These wrong-mode oscillations can be observed to take place continuously, so that energy is not coupled out of the magnetron to the outside load. This kind of moding may be caused by improper adjustment of the magnetron input parameters, e.g. operating the tube with improper magnetic field density in the interaction space. A "mode skip" occurs when the magnetron operates in the wrong mode during some, but not all of the applied pulses (in pulsed operation). This malfunctioning is usually ascribed to pulser characteristics (e.g., improper rise time of applied pulse), poor cathode characteristics (low emission), improper cathode centering, or, sometimes, poor end-hat or anode end-space design. A "mode skip" is accompanied by missing lines in the rf spectrum and by a double voltage trace on the synchroscope viewing screen - the two traces corresponding to the two voltage levels associated with the two distinct modes of operation. A "mode shift" is a condition in which the tube oscillates in the proper mode during part (usually the beginning) of the pulse, and in a higher-voltage mode during another part of the pulse. In this type of moding no missing lines are present in the spectrum analyzer display but the rf spectrum broadens (since the pulse duration is effectively shortened). A "mode shift" is usually associated with improper loading of the magnetron, but other factors (such as e.g., cathode-surface conditions) may also come into play.

Arcing of a magnetron is usually defined as any condition during which the tube draws higher-than-normal plate current. Arcing is usually related to the finish of the anode segments, the surface condition of the cathode, and the ultimate pressure in the tube. It may also be caused by improper pulser and load characteristics.

A certain amount of arcing normally occurs during the aging period of a new magnetron and in the starting of a tube after prolonged inactivity, but excessive arcing may permanently damage the tube. From an application point of view, starting the magnetron with insufficient filament warm-up time is conducive to destructive arcing.

OPERATING CURVES FOR MAGNETRONS

It has been found convenient to present magnetron operational data by means of two special forms of charts, the Rieke Diagram and the Performance Chart.

The Rieke Diagram is arranged to permit a study of the effects of load variations on magnetron frequency and power output under the conditions of fixed input conditions and a fixed magnetic field. A typical Rieke Diagram shows power and frequency contours for a tube operating into a suggested load (such as a waveguide of a specified type) with the magnitude of the standing-wave ratio varied over practical limits and its phase angle varied over 180 electrical degrees. From the diagram, the resulting frequency "pulling," a factor that indicates the deviation in the magnetron frequency resulting from a mismatch in the output transmission line, can be readily determined. The "pulling" factor of a tube usually gives the value of the maximum frequency variation that results from a VSWR of 1.5:1 in the output transmission line.

A magnetron Performance Chart corresponds most closely to the typical characteristic curves of other types of tubes - that is, voltage-current plots. Curves representing a series of typical values of magnetic field, power output and efficiency are plotted in a system of voltage-current coordinates. Voltage and field strength are the controlled variables which together determine the current. The resulting efficiency and output power are indicated for a given load impedance, which usually represents the matched-transmission-line condition. Most magnetron performance charts exhibit a region of improper operation and poor efficiency at low magnetic field densities and low values of current. In general, one should not attempt to operate a magnetron at other than within the limits of its published performance chart conditions.

ELECTRICAL CHARACTERISTICS

Absolute Ratings: The absolute ratings published in this catalog represent extreme (maximum or minimum) operating values of the various tube parameters that must not be exceeded. The published absolute ratings are not intended to be applied simultaneously. Thus if, for instance, the maximum allowable current under certain conditions cannot be reached without exceeding the maximum allowable voltage, a lower current must be used, so that the "absolute maximum" voltage rating will not be exceeded.

Typical Operation: Conditions described under this heading usually represent the specifications to which Amperex magnetrons are tested after manufacture. In general, whenever operation at conditions materially different from those described is contemplated, the Amperex Application Engineering Department should be consulted.

The following notes apply to the quantities which appear in the Typical Operation sections of the catalog data sheets.

In pulsed operation:

$$\text{Duty cycle} = \text{pulse width} \times \text{pulse repetition frequency}$$

$$\text{Peak (pulsed) power} = \frac{\text{average power}}{\text{Duty cycle}}$$

$$\text{Peak (pulsed) plate current} = \frac{\text{average plate current}}{\text{Duty cycle}}$$

The average power is normally measured by calorimetric methods. In this arrangement, the heating effect (average power) of the magnetron output signals is measured by measuring the difference in temperature of a column of water at constant flow rate (gradually introduced into a waveguide to produce a matched load for the magnetron), at the points of incidence and

emergence from the guide. This temperature difference is directly related to the magnetron average power output.

Pulse voltage can be measured in a variety of ways. The arrangements most commonly used make use of a capacitive voltage divider for displaying and measuring a known fraction of the pulse voltage on a synchroscope screen; or, apply the full pulse voltage directly to a peak-reading voltmeter. The pulse current, on the other hand, cannot be measured conveniently; rather, the average plate current is measured by means of a pulse-stretching (averaging) network and a suitable milliammeter.

Pulse width is usually measured either at half-amplitude of the current pulse (which can be viewed by placing a non-inductive current-viewing resistor between the non-pulsed magnetron electrode and ground) or at 50% of the amplitude of the detected rf output envelope when measured with a square-law detector.

The rate of rise of the voltage pulse is an important factor in some magnetrons, as both too slow and too fast a rise time may lead to poor magnetron operation. Usually too high a rate of rise is the more serious offender, because under this condition the magnetron tends to operate in a higher-voltage mode. Thus, maximum rates of rise (measured in kilovolts/microsecond) are usually specified. A good definition for maximum rate of rise is the maximum slope of the voltage pulse above the 80% level of the voltage pulse amplitude. Oscilloscope photography can be used to advantage in the measurement of this quantity.

The shape of the rf spectrum is of importance in pulsed-magnetron applications, since broad rf spectra usually lead to poor operation of the radar receiver AFC systems. The rf bandwidth is measured on a spectrum analyzer display, and is defined as the width of the spectrum at the half-power level (3 db down from maximum if a square-law detector is used as the spectrum analyzer mixer).

The pulling factor of a magnetron is a measure of the tube's sensitivity to changes in load conditions. Usually the pulling factor is defined as the maximum frequency variation of the magnetron when a mismatch of 1.5:1 in VSWR is introduced in the output transmission line and varied over all phases (180 electrical degrees). A knowledge of the magnetron pulling factor thus permits the system designer to predict transmitter frequency changes for various values of antenna mismatch, and aids him in establishing proper design specifications for the load components, such as rotary joints, feed lines, antenna matching devices, etc. It should be recognized that the degree of coupling used in the magnetron output is, of necessity, a compromise between adequate power output and comparative insensitivity to external load variations (low pulling factors).

HANDLING AND OPERATING PRECAUTIONS

Complete mechanical protection of leads is needed, to insure completely vacuum-tight seals and to prevent even small alignment shifts of the cathode.

The preliminary cathode heating time that is specified for each type must be maintained before power is applied.

Power should never be applied with the magnetic field absent.

If the heater current is to be reduced after an initial period, the specified schedule should be followed exactly.

Recommended cooling must be maintained.

Recommended duty cycle in pulsed operation should not be exceeded. If it is necessary to exceed the specified duty cycle, check with the AMPEREX Application Engineering Department for best operating levels consistent with satisfactory life.

The filament should not be operated from power sources substantially higher than 400 cycles, without checking with the AMPEREX Application Engineering Department. If the mechanical vibration period of the filament approaches resonance conditions with the filament current frequency, shortened life may result.

Magnetic materials should be kept at least 2 inches away from field magnets to avoid demagnitization.

Operation must be kept within maximum ratings.

Symbols and abbreviations used in the Amperex Magnetron data sheets conform to those used in Specification MIL-E-1B

AMPEREX MAGNETRONS 4J57•4J58•4J59

GENERAL DESCRIPTION

The types 4J57, 4J58 and 4J59 are packaged, fixed-frequency, pulsed magnetron oscillators designed for operation in the 4.5 cm. band. The output of these tubes is in 1½ by ¾ inch rectangular waveguide. The operating frequencies under matched-load conditions are as follows:

Tube Type	*Frequency (megacycles per second)*
4J57	*6475 to 6575*
4J58	*6375 to 6475*
4J59	*6275 to 6375*

GENERAL CHARACTERISTICS

ELECTRICAL DATA

Absolute Ratings

Filament Voltage (max.)	12.6 + 10% volts
Plate Voltage (max.)	25 KV
Plate Current (max.)	35 amps.
Power Input—peak (max.)	600 KW
Power Input—average (max.)	400 watts
Duty Cycle Product (max.)	.001
Pulse Duration (max.)	2.5 microseconds
Filament Warm-up Time (minimum)	120 seconds
Anode Temperature (max.)	100° C.

MECHANICAL DATA

Dimensions	see outline dwg.
Mounting Position	any
Mounting Method	output plate (see dwg.)
Weight (approx.) (with magnet)	12 lbs.

Typical Operation

Frequency	see "General Description"
Power Output—pulsed	210 KW
Power Output—average	210 watts
Pulse Voltage	16 to 19 KV.
Plate Current—pulsed	30 amps.
Plate Current—average	30 ma.
Pulse Width	1 microsecond
Duty Cycle Product	.001
R.F. Bandwidth (max.)	3 mc./sec.
Pulling Factor (max.)	15 mc./sec.
Life (min.)	500 hrs.
Filament Voltage—start	12.6 volts
Filament Current	3.25 to 4.0 amps.

NOTES ON OPERATION

1. Forced-air cooling is required on the anode to keep its temperature below approximately 100° C.

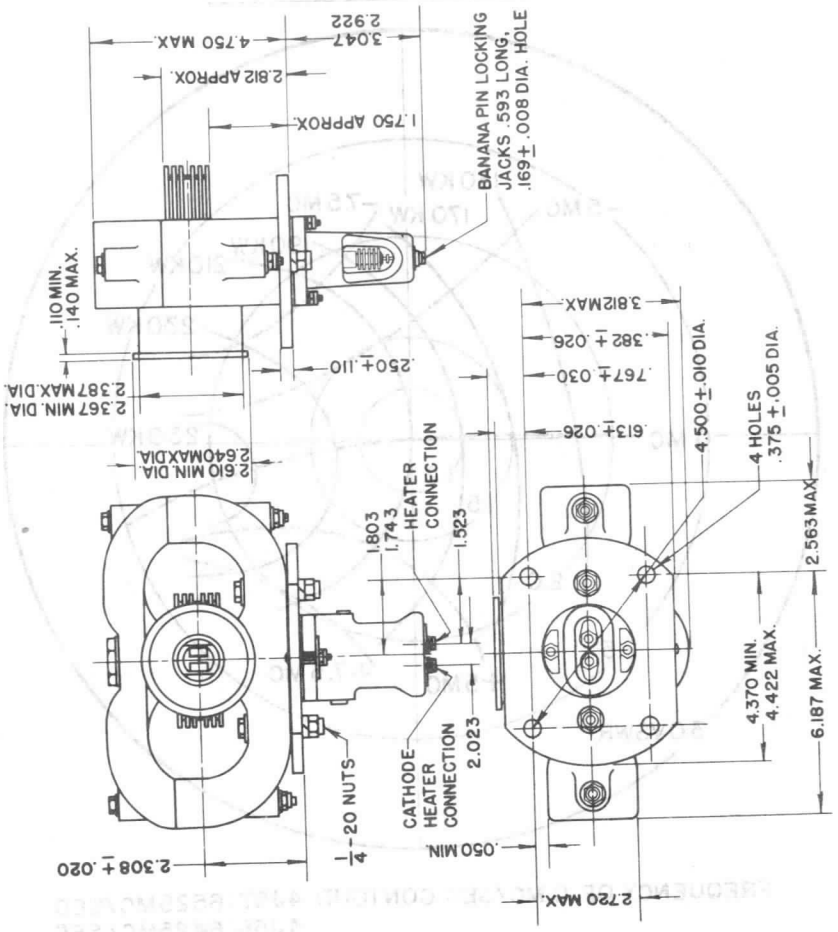
2. The temperature of the cathode support must not exceed 275° C. It is advisable to cool the cathode radiator fins by means of forced air.

3. The heater voltage should be reduced following the application of high voltage, as per the following schedule:

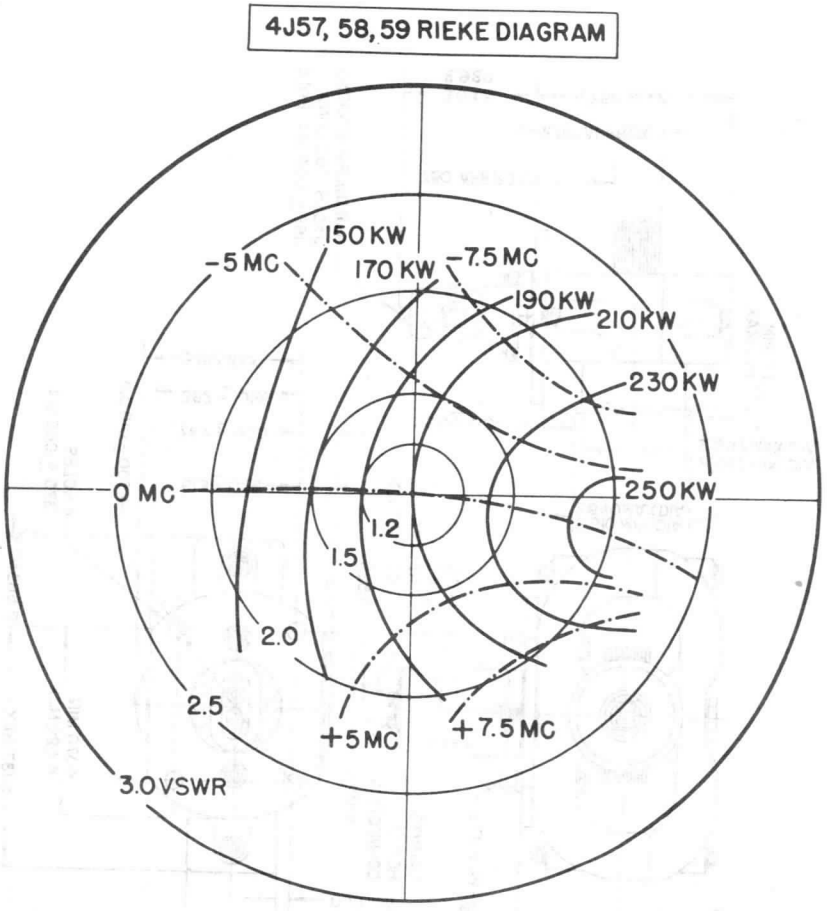
Average Power Input	*Filament Volts*
850	0
800-850	2.0
750-800	3.5
700-750	4.0
650-700	5.0
600-650	5.5
550-600	6.0
500-550	6.5
450-500	7.0
400-450	7.5

4. Magnetic materials should be kept away from the permanent magnet a distance of at least 3 inches.

5. The AMPEREX Application Engineering Department should be consulted whenever it is contemplated operating the tube at conditions substantially different from those given above.


4.750 MAX.
3.047
2.922
2.812 APPROX.
1.750 APPROX.
BANANA PIN LOCKING JACKS .593 LONG, .169±.008 DIA. HOLE
.110 MIN.
.140 MAX.
2.387 MIN. DIA.
2.387 MAX. DIA.
2.610 MIN. DIA.
2.640 MAX. DIA.
.250±.110
3.812 MAX.
.382±.026
.767±.030
.613±.026
4.500±.010 DIA.
4 HOLES .375 +.005 DIA.
1.803
1.743
HEATER CONNECTION
1.523
2.563 MAX.
4.370 MIN.
4.422 MAX.
6.187 MAX.
CATHODE HEATER CONNECTION
2.023
1/4-20 NUTS
2.308±.020
.050 MIN.
2.720 MAX.

4J57•4J58•4J59



FREQUENCY OF 0 MC/SEC CONTOUR 4J57: 6525 MC/SEC
4J58: 6425 MC/SEC
4J59: 6325 MC/SEC

AMPEREX MAGNETRON TYPES 5586•5657

GENERAL DESCRIPTION

The Amperex types 5586 and 5657 are identical in physical appearance and electrical performance, except for frequency coverage and pulse voltage.

These are unpackaged, tunable, pulsed magnetron oscillators designed for operation in the 10 cm. region of the electromagnetic frequency spectrum. They are used with an external magnet having an air gap of 1.8 inches and a magnetic field density of 2700 gauss. The output of the tubes is in 1⅝" coaxial transmission line. The frequency ranges of these tube types are as follows:

Tube Type	*Frequency (megacycles per second)*
5586	*2700 - 2900*
5657	*2900 - 3100*

GENERAL CHARACTERISTICS

ELECTRICAL DATA

Absolute Ratings

Filament Voltage (max.)	16.0 + 10% volts
Plate Voltage (max.)	30 KV
Plate Current (max.)	70 amps.
Plate Input—peak (max.)	2000 KW
Power Input—average (max.)	1200 watts
Filament Warm-up Time (minimum)	120 seconds
Duty Cycle Product (max.)	.001
Pulse Duration (max.)	2.5 microseconds
Anode Temperature (max.)	100° C.

MECHANICAL DATA

Dimensions	see outline dwg.
Mounting Position	any
Weight (approx.)	5 lbs.

5586•5657

Typical Operation

Frequency (tunable)	5586	2700-2900 mc./sec.
	5657	2900-3100 mc./sec.
Power Output—pulsed		800 kw
Average Power		400 watts
Pulse Voltage	5586	27 to 32 kv
	5657	27.5 to 32.5 kv
Plate Current—pulsed		70 amps.
Plate Current—average		35 ma.
Pulse Width		1 microsecond
Duty Cycle Product		.0005
Magnetic Field		2700 gauss
R.F. Bandwidth (max.)		2.5 mc./sec.
Pulling Factor (max.)		15 mc./sec.
Life (min.)		500 hrs.
Filament Voltage—start		16 volts
Filament Current (at 16.0 volts)		2.8 to 3.4 amps.

NOTES ON OPERATION

1. During high voltage operation, it is essential to operate the heater according to the following schedule:

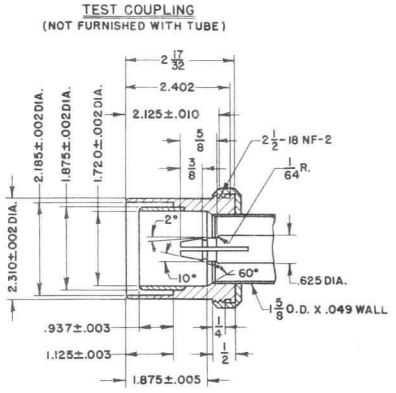
Pi (watts)	*Ef (volts)*
1000-1200	8
800-1000	10.5
600-800	13
400-600	15
Less than 400	16

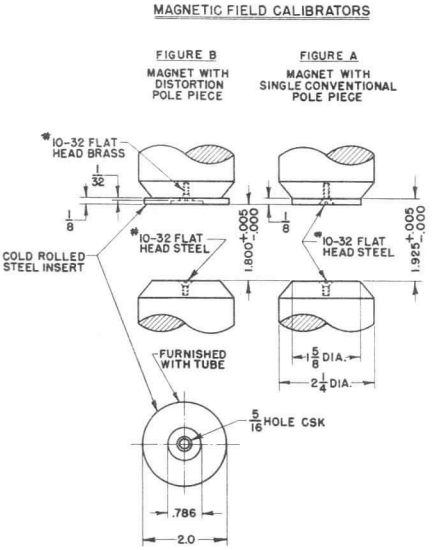
The above schedule is valid only for repetition rates of 300 pps or greater.

2. For the calibration procedure of the magnetic field see Spec. JAN-1A-5586 or JAN-1A-5657 or communicate with the AMPEREX Application Engineering Department.

3. The output of the tube can be maintained at a pressure of 40-45 lbs./sq. inch.

4. The AMPEREX Application Engineering Department should be consulted whenever it is contemplated operating the tube at conditions substantially different from those given above.

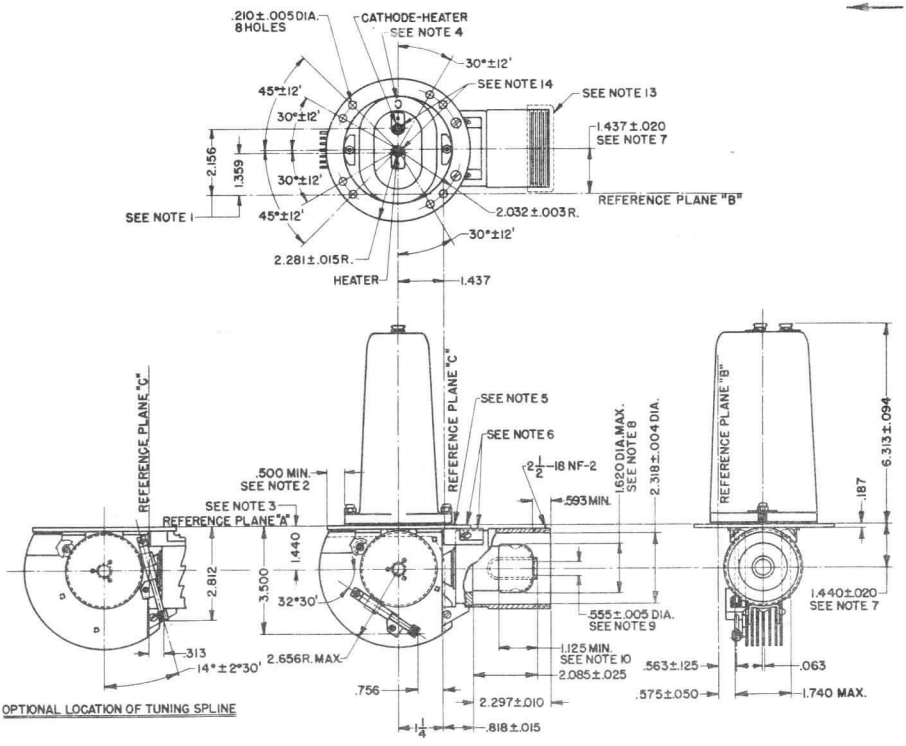




DRAWINGS REFERENCES

1. The center of the jack holes shall be within a radius of .100 of the location specified, but shall be spaced .797 ±.015 with respect to each other.
2. This anular area shall be flat within .015 (a thickness gage .125 wide shall not enter more than .250).
3. The periphery of the anode shall lie within a 2.160 dia. circle located as specified for non-tunable side of anode.
4. Common cathode connection marked with letter C.
5. Input flange can be pressurized.
6. Tube may be supported by mounting plate or guard pipe.
7. Applies to location of centerline of guard pipe only.
8. Centerline of max. dia. is concentric with centerline of guard pipe to within .040.
9. Applies to inner conductor insert only. Centerline of inner conductor insert is concentric with centerline of guard pipe to within .025.
10. Applies to straight portion of inner conductor wall.
11. Tube can be supplied with spline located as shown when specified by customer.
12. Tuning mechanism will provide full range of tuning with 110 complete revolutions of tuning spline.
13. Protective guard for shipping purposes.
14. Hex locking head banana pin jack' 19/32 long hole. .169 ±.005 dia.

5586•5657



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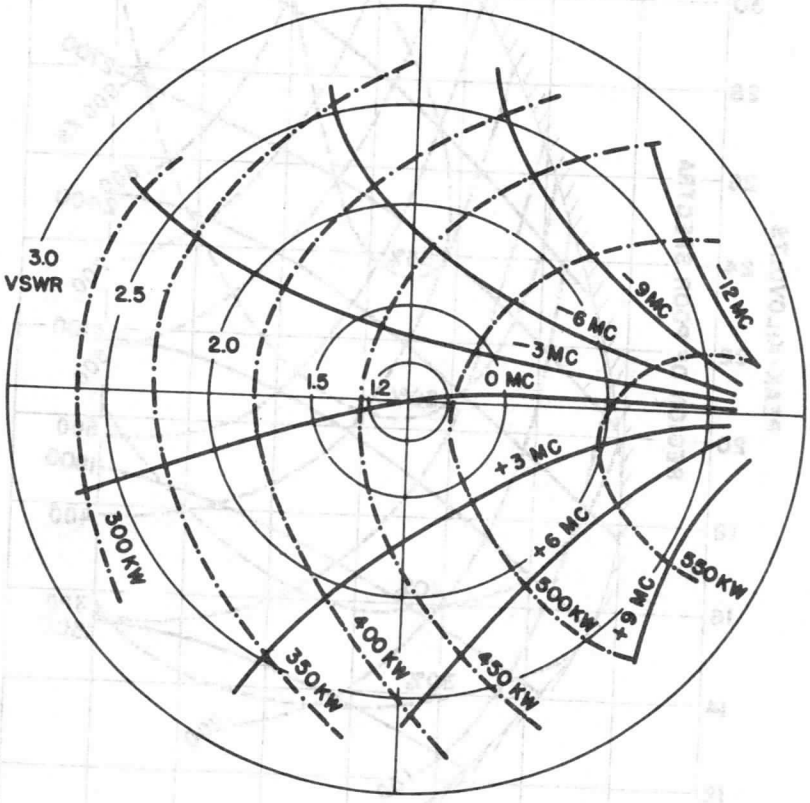
Revised 3/59

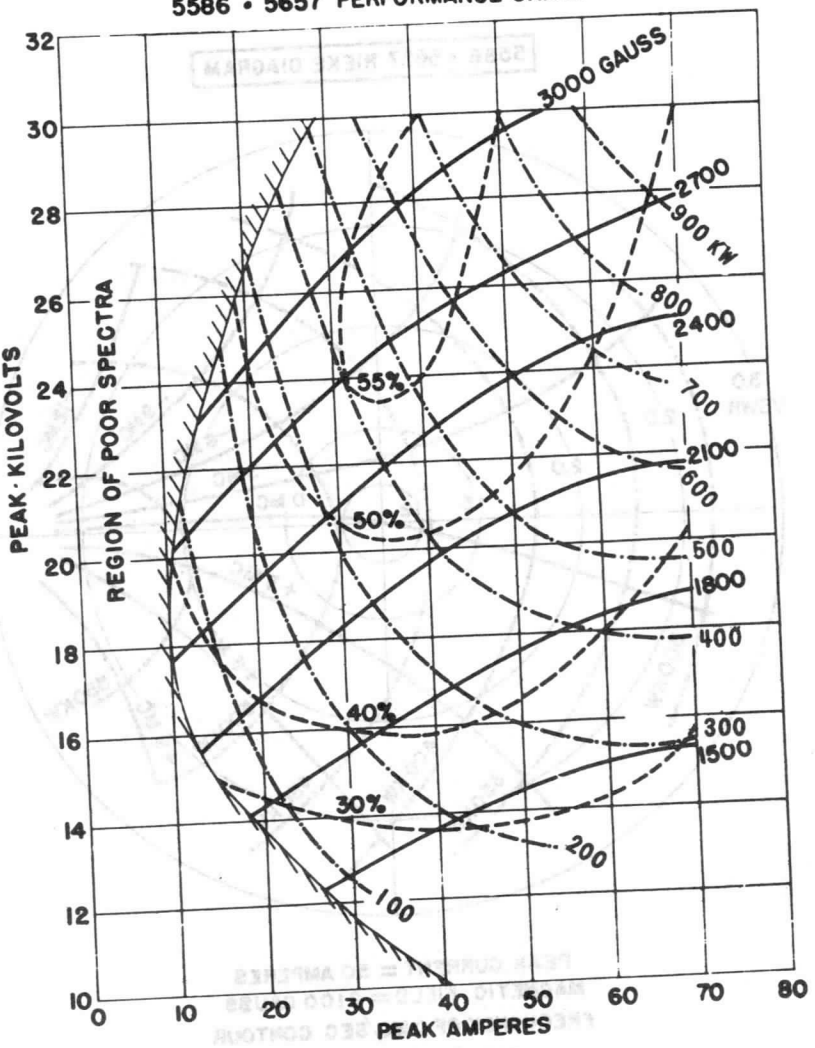
5586 • 5657 RIEKE DIAGRAM



PEAK CURRENT = 50 AMPERES
MAGNETIC FIELD = 2100 GAUSS
FREQUENCY OF 0 MC/SEC CONTOUR
5586 = 2800 MC/SEC
5657 = 3000 MC/SEC

5586•5657

5586 • 5657 PERFORMANCE CHART



PULLING FIGURE = 13 MC/SEC

FREQUENCY

5586 = 2800 MC/SEC

5657 = 3000 MC/SEC

AMPEREX TUBE TYPE 8108

The Amperex 8108 is a disc seal triode designed for use as a CW amplifier, oscillator, frequency doubler or frequency tripler to frequencies over 6000 mc/sec. The 8108 delivers a saturation power of more than 2 watts with an operating voltage of only 180 volts. Amplifier gain of 19 db or more can be achieved. In suitable cavity circuits the 8108 can operate at full power with sink cooling or free-air convection cooling. Life expectancy is 10,000 hours. For further circuit information contact Amperex Applications Engineering Department.

GENERAL CHARACTERISTICS

MECHANICAL

Dimensions	see outline drawing
Base	OCTAL
Mounting [1]	any
Seal Temperatures	
Anode [2]	150° C max
Grid [2]	75° C max
Cathode [2]	75° C max

ELECTRICAL

Heater Voltage	6.3 volts ac or dc parallel supply
Heater Current	0.735 amps
Direct Interelectrode Capacitances [3]	
Anode to Grid	1.4 $\mu\mu$f
Anode to Cathode	0.035 $\mu\mu$f
Grid to Cathode	3.0 $\mu\mu$f

	Min.	Nom.	Max.	
Anode Voltage	-	180	-	180 volts
Anode Current	-	60	-	30 ma
Negative Grid Voltage	0	1.25	2.5	2.8 volts
Transconductance	15,000	21,000	-	18,000 micromhos
Amplification Factor	33	43	52	43

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[1] Special attention should be paid to the mounting of the tube in those cases where it is used in portable equipment. Shocks, especially in a direction perpendicular to the axis of the tube should be avoided.

[2] A low velocity air flow may be necessary.

[3] Measured with 6.3 volts on the heater under conditions where no cathode current is drawn.

8108

MAXIMUM RATINGS, ABSOLUTE VALUES

Anode Voltage (Cut-Off Condition)	500 volts max
Anode Voltage	300 volts max
Anode Dissipation	10 watts max
Negative Grid Voltage	50 volts max
Positive Grid Voltage	0 volts max
Grid Current	10 ma max
Grid Dissipation	200 milliwatts max
Grid Input Power (f = 4000 mc) (Grounded Grid Circuit)	1 watt max
Cathode Current	70 ma max
Cathode-Heater Voltage	50 volts max
Heater Voltage	6.3 ± 2% volts max

MAXIMUM CIRCUIT VALUES

External Cathode-Heater Resistance	20,000 ohms max
External Grid Lead Resistor [4]	3000 ohms max

TYPICAL CHARACTERISTICS AS AMPLIFIER (Frequency = 4000 mc)

Anode Supply Voltage, E_{bb} (See Figure 3)	200	200 volts
Grid Supply Voltage, E_{cc} (See Figure 3)	+20	+20 volts
Cathode Resistor [5]	-	-
Anode Current	60	30 ma
Bandwidth [6]	50	50 mc
Power Output (Power Gain = 8 db)	1.8 [7]	- watts
Power Output (Power Gain = 6 db)	-	0.5 [8] watts
Power Gain (Power Input = 1 mw)	13 [9]	13 [9] db

---

[4] This value can be multiplied by the dc inverse feedback factor to a maximum of 25,000 ohms.

[5] A variable resistor of 500 ohms max (at an anode current of 60 ma) or 1000 ohms max (at an anode current of 30 ma) is to be used. It should be adjusted for the desired anode current. See Figure 3.

[6] The quoted value is the bandwidth between the 0.1 db points of the flattened response curve. See Figure 4.

[7] 1.5 watts min.

[8] 0.35 watts min.

[9] 10 db min.

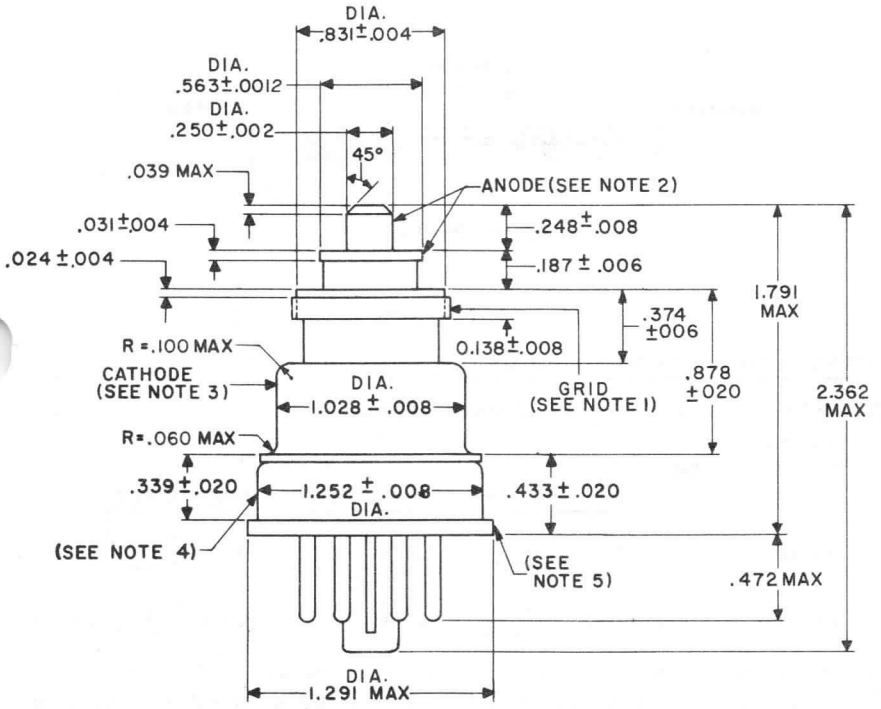
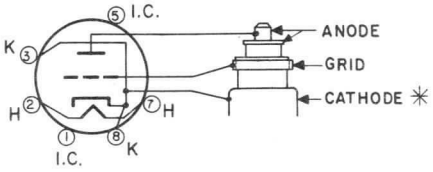

DIA.
.831±.004
DIA.
.563±.0012
DIA.
.250±.002
45°
.039 MAX
ANODE (SEE NOTE 2)
.031±.004
.248±.008
.024±.004
.187±.006
1.791
MAX
.374
±006
R=.100 MAX
0.138±.008
CATHODE
(SEE NOTE 3)
DIA.
1.028±.008
GRID
(SEE NOTE 1)
.878
±020
2.362
MAX
R=.060 MAX
.339±.020
1.252±.008
DIA.
.433±.020
(SEE NOTE 4)
(SEE
NOTE 5)
.472 MAX
DIA.
1.291 MAX

FIG. 1



✳ CATHODE R.F. AND D.C. CONNECTION. PINS 3 AND 8 ARE CONNECTED INTERNALLY TO THIS TERMINAL.

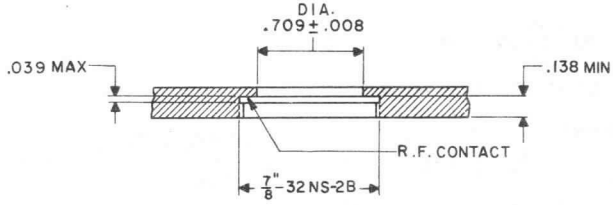


FIG. 2
RECOMMENDED MOUNT

NOTES: OUTLINE DRAWING (FIGURES 1 AND 2

Thread of the Grid Disc and of Recommended Mount
32 turns per inch
Thread angle = 60°

	Minor Diameter	Major Diameter	Pitch Diameter
Figure 1	$0.835\ ^{+0}_{-0.006}$	$0.874\ ^{+0}_{-0.006}$	$0.854\ ^{+0}_{-0.0035}$ inches
Figure 2	$0.847\ ^{+0}_{-0.006}$	0.874 min	$0.858\ ^{+0}_{-0.0047}$ inches

Note 1: The eccentricities are given with respect to the axis of the threaded hole (see Figure 2) in which the tube is screwed firmly against the flange, the inner diameter of which is 0.709 inches.

Note 2: Eccentricity of the axis of the anode = 0.006 inches max.

Note 3: Eccentricity of the axis of the cathode = 0.008 inches max.

Note 4: The tolerance of the eccentricity of the axis of the base is such, that this base fits into a hole with a diameter of 1.280 inches, provided this hole is correctly centered with respect to the axis of the hole of Figure 2.

Note 5: The tolerance of the eccentricity of the axis of the base flange is such, that this flange fits into a hole with a diameter of 1.319 inches, provided this hole is correctly centered with respect to the axis of the hole of Figure 2.

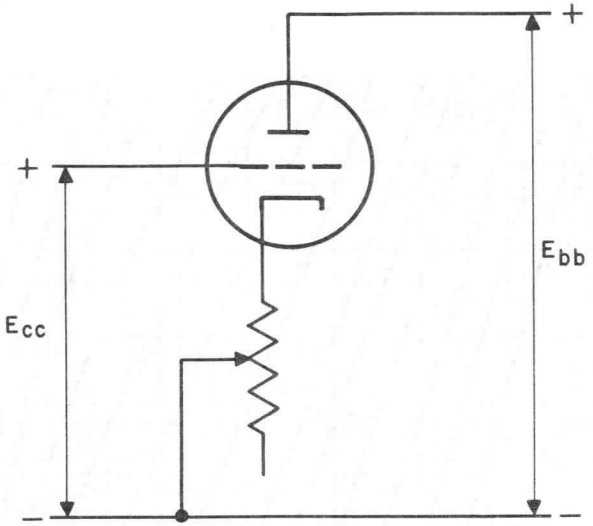


FIG. 3
RECOMMENDED D.C. CIRCUIT

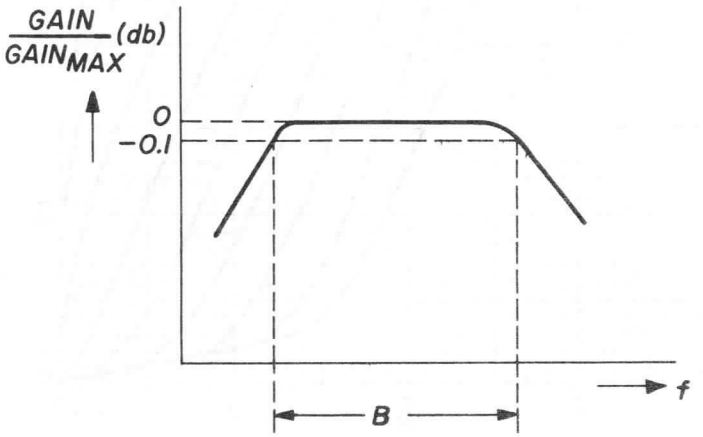
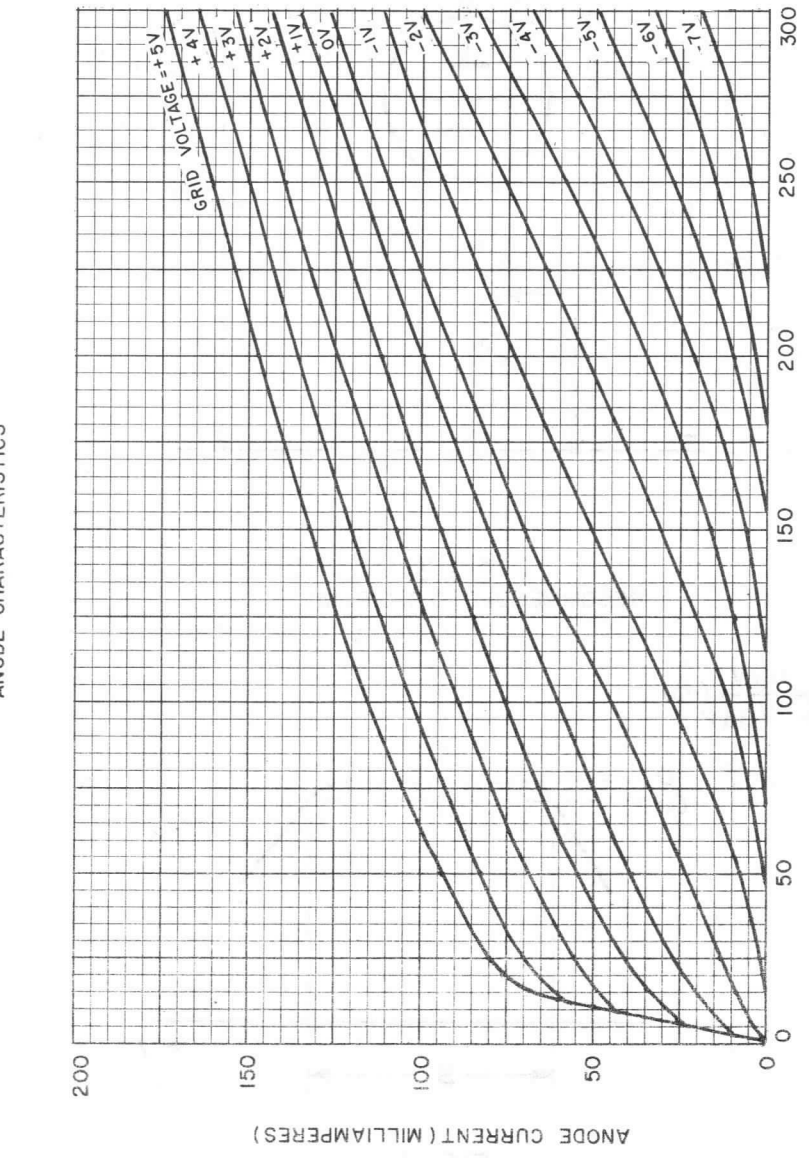
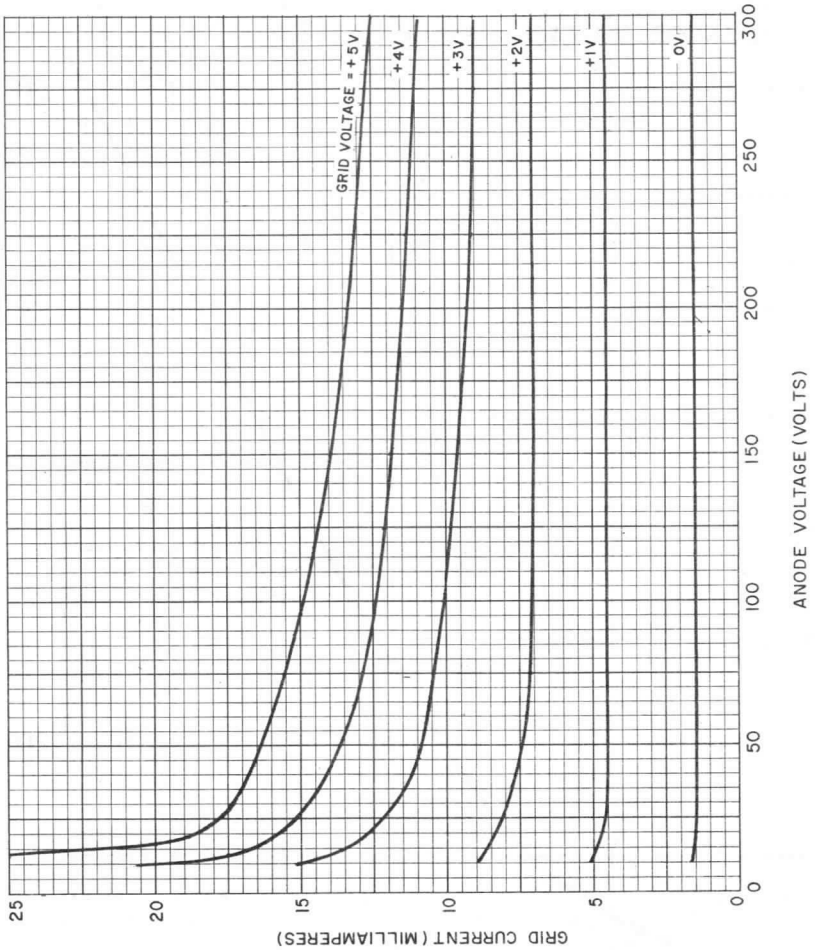


FIG. 4

8108

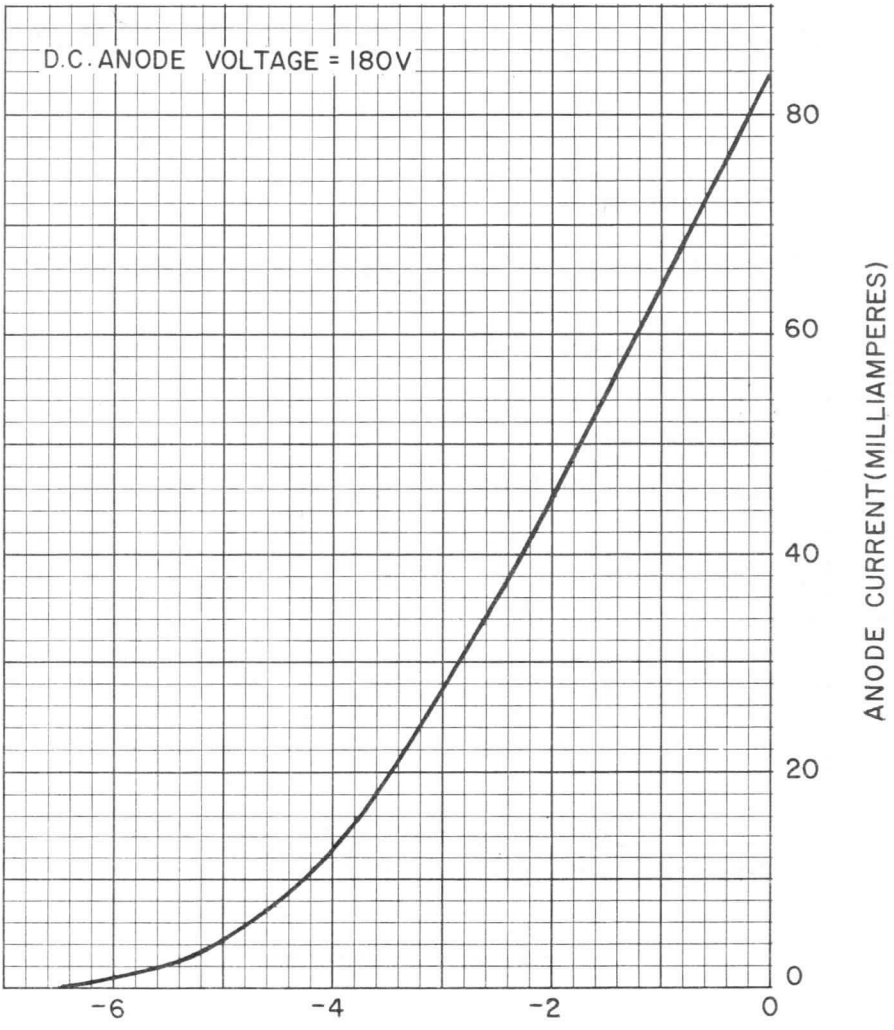

ANODE CHARACTERISTICS
GRID VOLTAGE = +5V
+4V
+3V
+2V
+1V
0V
-1V
-2V
-3V
-4V
-5V
-6V
-7V
ANODE CURRENT (MILLIAMPERES)
200
150
100
50
0
0
50
100
150
200
250
300
ANODE VOLTAGE (VOLTS)

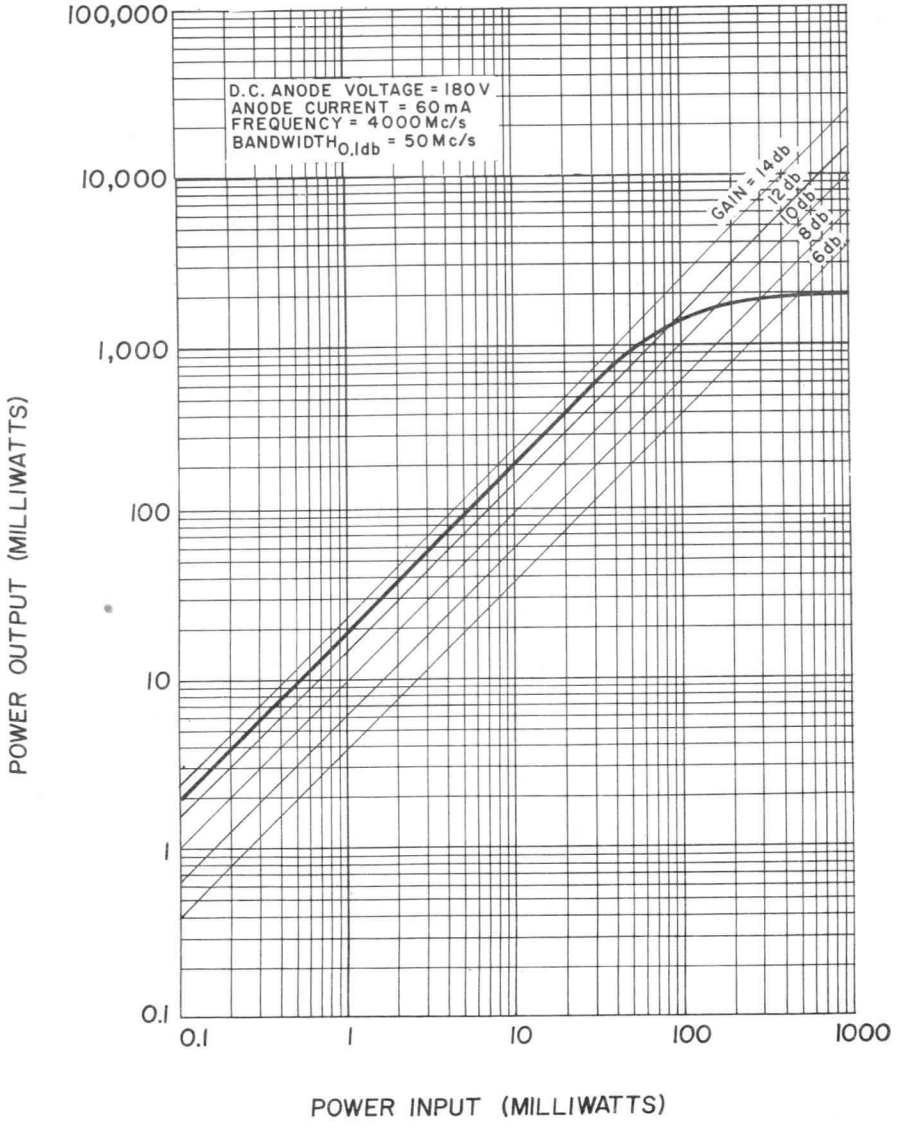
GRID–ANODE TRANSFER CHARACTERISTICS



8108

ANODE CURRENT AS A FUNCTION OF GRID VOLTAGE




D.C. ANODE VOLTAGE = 180 V
ANODE CURRENT = 60 mA
FREQUENCY = 4000 Mc/s
BANDWIDTH 0.1db = 50 Mc/s
GAIN = 14 db
12 db
10 db
8 db
6 db
100,000
10,000
1,000
100
10
1
0.1
0.1
1
10
100
1000
POWER OUTPUT (MILLIWATTS)
POWER INPUT (MILLIWATTS)

AMPEREX TUBE TYPE EC157

The Amperex EC157 is a disc seal triode designed for use as a CW amplifier, oscillator, frequency doubler or frequency tripler to frequencies over 6000 mc/sec. The EC157 delivers a saturation power of more than 2 watts with an operating voltage of only 180 volts. Amplifier gain of 19 db or more can be achieved. In suitable cavity circuits the EC157 can operate at full power with sink cooling or free-air convection cooling. Life expectancy is 10,000 hours. For further circuit information contact Amperex Applications Engineering Department.

GENERAL CHARACTERISTICS

MECHANICAL

Dimensions	see outline drawing
Base	OCTAL
Mounting [1]	any
Seal Temperatures	
Anode [2]	150° C max
Grid [2]	75° C max
Cathode [2]	75° C max

ELECTRICAL

Heater Voltage	6.3 volts ac or dc parallel supply
Heater Current	0.735 amps
Direct Interelectrode Capacitances [3]	
Anode to Grid	1.4 $\mu\mu$f
Anode to Cathode	0.035 $\mu\mu$f
Grid to Cathode	3.0 $\mu\mu$f

	Min.	Nom.	Max.	
Anode Voltage	-	180	-	180 volts
Anode Current	-	60	-	30 ma
Negative Grid Voltage	0	1.25	2.5	2.8 volts
Transconductance	15,000	21,000	-	18,000 micromhos
Amplification Factor	33	43	52	43

---

1 Special attention should be paid to the mounting of the tube in those cases where it is used in portable equipment. Shocks, especially in a direction perpendicular to the axis of the tube should be avoided.

2 A low velocity air flow may be necessary.

3 Measured with 6.3 volts on the heater under conditions where no cathode current is drawn.

EC157

MAXIMUM RATINGS, ABSOLUTE VALUES

Anode Voltage (Cut-Off Condition)	500 volts max
Anode Voltage	300 volts max
Anode Dissipation	10 watts max
Negative Grid Voltage	50 volts max
Positive Grid Voltage	0 volts max
Grid Current	10 ma max
Grid Dissipation	200 milliwatts max
Grid Input Power (f = 4000 mc) (Grounded Grid Circuit)	1 watt max
Cathode Current	70 ma max
Cathode-Heater Voltage	50 volts max
Heater Voltage	6.3 ± 2% volts max

MAXIMUM CIRCUIT VALUES

External Cathode-Heater Resistance	20,000 ohms max
External Grid Lead Resistor [4]	3000 ohms max

TYPICAL CHARACTERISTICS AS AMPLIFIER (Frequency = 4000 mc)

Anode Supply Voltage, E_{bb} (See Figure 3)	200	200 volts
Grid Supply Voltage, E_{cc} (See Figure 3)	+20	+20 volts
Cathode Resistor [5]	-	-
Anode Current	60	30 ma
Bandwidth [6]	50	50 mc
Power Output (Power Gain = 8 db)	1.8 [7]	- watts
Power Output (Power Gain = 6 db)	-	0.5 [8] watts
Power Gain (Power Input = 1 mw)	13 [9]	13 [9] db

---

[4] This value can be multiplied by the dc inverse feedback factor to a maximum of 25,000 ohms.

[5] A variable resistor of 500 ohms max (at an anode current of 60 ma) or 1000 ohms max (at an anode current of 30 ma) is to be used. It should be adjusted for the desired anode current. See Figure 3.

[6] The quoted value is the bandwidth between the 0.1 db points of the flattened response curve. See Figure 4.

[7] 1.5 watts min.

[8] 0.35 watts min.

[9] 10 db min.

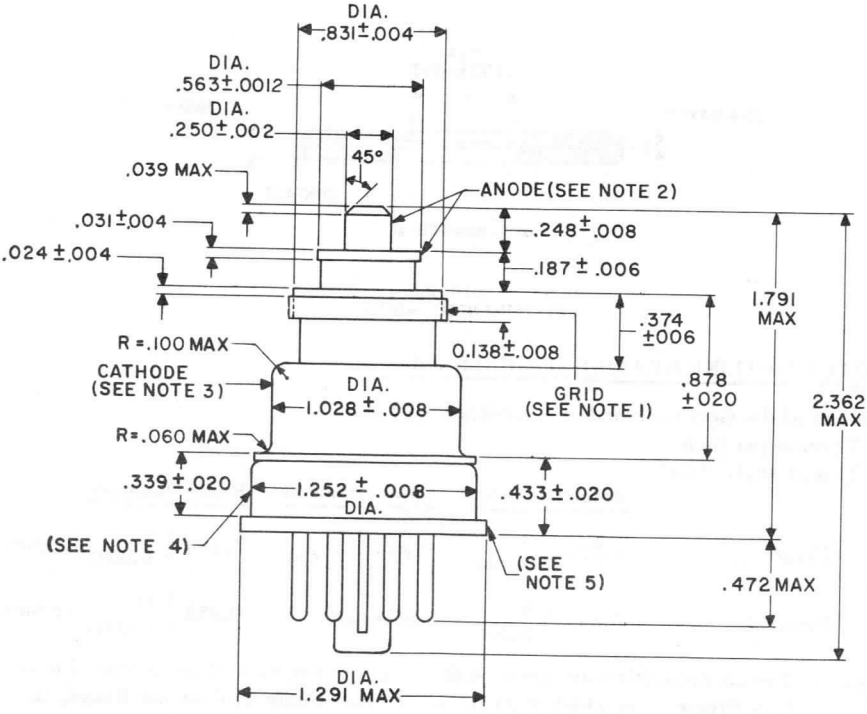
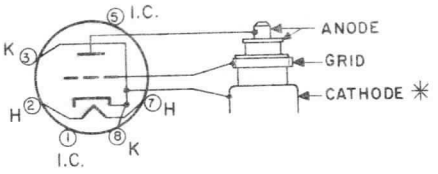

DIA.
.831±.004
DIA.
.563±.0012
DIA.
.250±.002
45°
.039 MAX
.031±.004
.024±.004
ANODE(SEE NOTE 2)
.248±.008
.187±.006
1.791
MAX
.374
±006
0.138±.008
R=.100 MAX
CATHODE
(SEE NOTE 3)
DIA.
1.028±.008
GRID
(SEE NOTE 1)
.878
±020
2.362
MAX
R=.060 MAX
.339±.020
1.252±.008
DIA.
.433±.020
(SEE NOTE 4)
(SEE
NOTE 5)
.472 MAX
DIA.
1.291 MAX

FIG. 1

EC157



✳ CATHODE R.F. AND D.C. CONNECTION. PINS 3 AND 8 ARE CONNECTED INTERNALLY TO THIS TERMINAL.

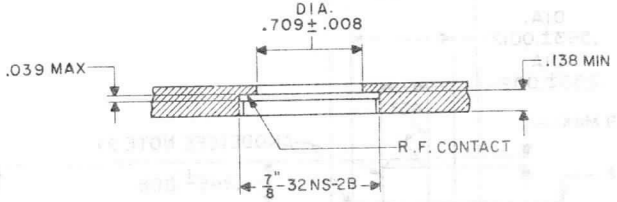


FIG. 2
RECOMMENDED MOUNT

NOTES: OUTLINE DRAWING (FIGURES 1 AND 2

Thread of the Grid Disc and of Recommended Mount
32 turns per inch
Thread angle = 60°

	Minor Diameter	Major Diameter	Pitch Diameter
Figure 1	$0.835\ ^{+0}_{-0.006}$	$0.874\ ^{+0}_{-0.006}$	$0.854\ ^{+0}_{-0.0035}$ inches
Figure 2	$0.847\ ^{+0}_{-0.006}$	0.874 min	$0.858\ ^{+0}_{-0.0047}$ inches

Note 1: The eccentricities are given with respect to the axis of the threaded hole (see Figure 2) in which the tube is screwed firmly against the flange, the inner diameter of which is 0.709 inches.

Note 2: Eccentricity of the axis of the anode = 0.006 inches max.

Note 3: Eccentricity of the axis of the cathode = 0.008 inches max.

Note 4: The tolerance of the eccentricity of the axis of the base is such, that this base fits into a hole with a diameter of 1.280 inches, provided this hole is correctly centered with respect to the axis of the hole of Figure 2.

Note 5: The tolerance of the eccentricity of the axis of the base flange is such, that this flange fits into a hole with a diameter of 1.319 inches, provided this hole is correctly centered with respect to the axis of the hole of Figure 2.

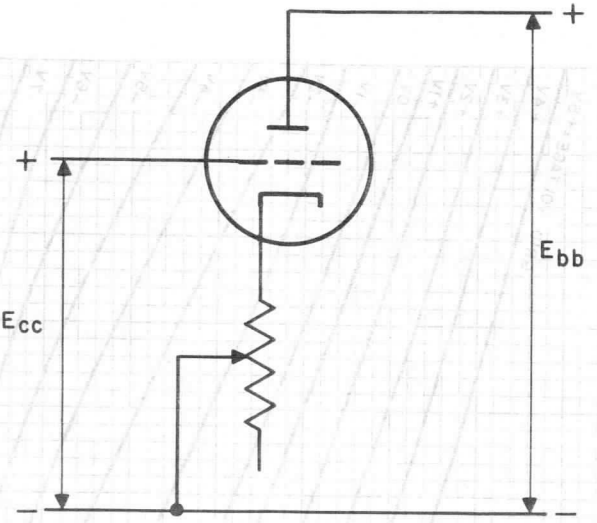


FIG. 3
RECOMMENDED D.C. CIRCUIT

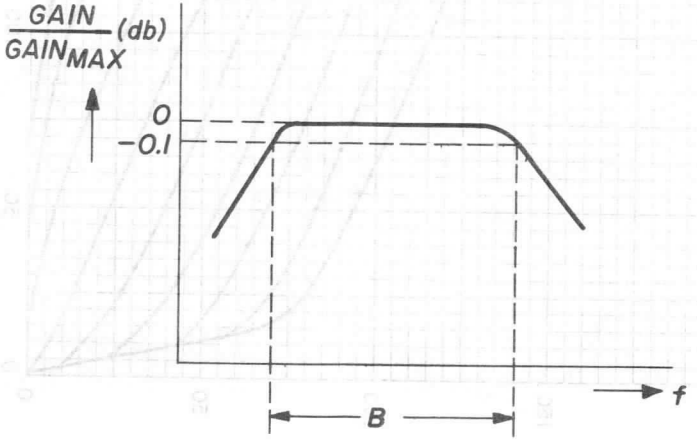
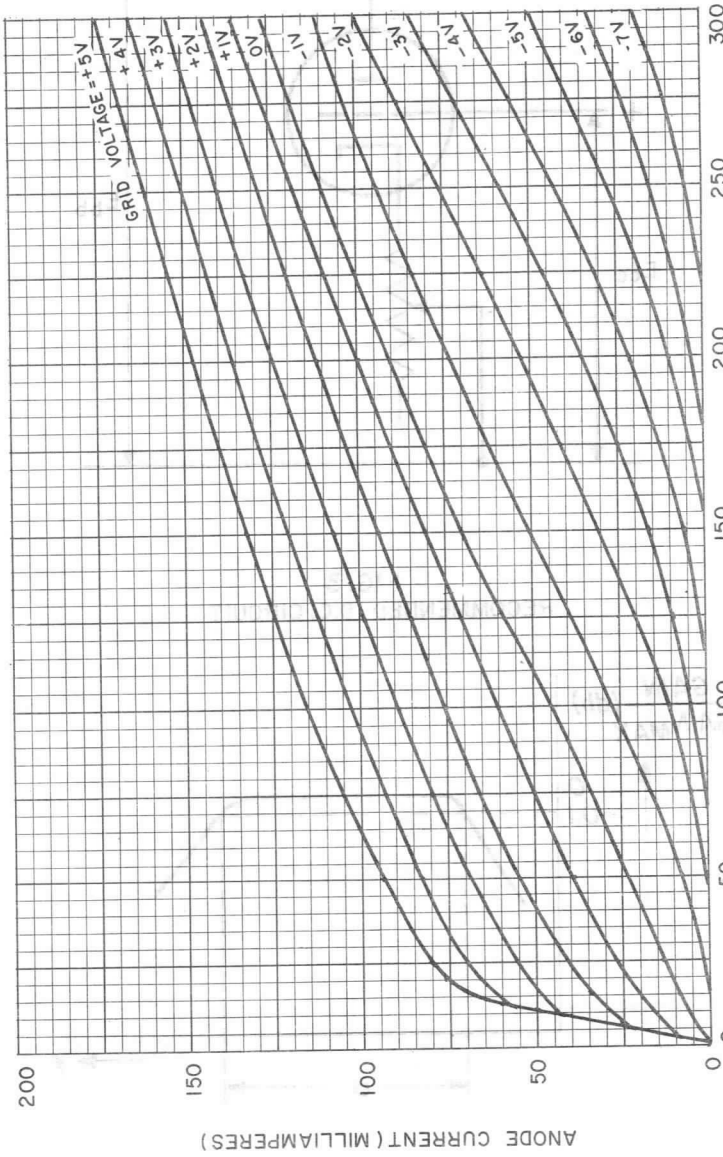


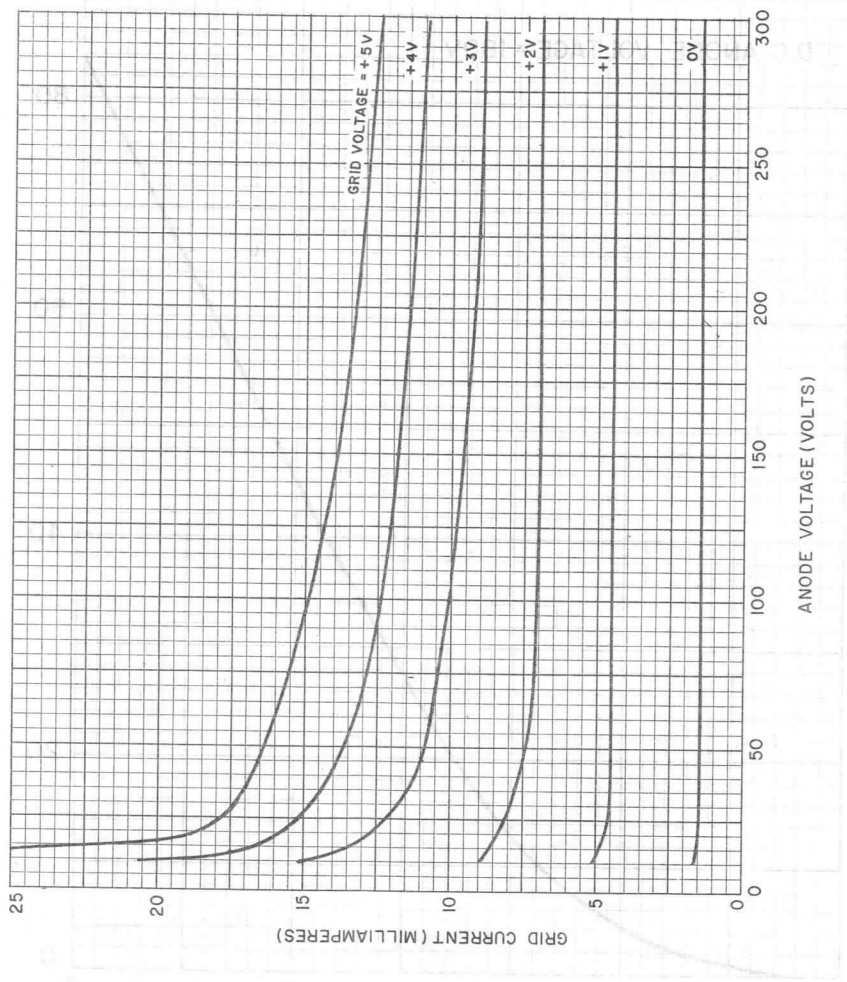
FIG. 4

EC157

ANODE CHARACTERISTICS

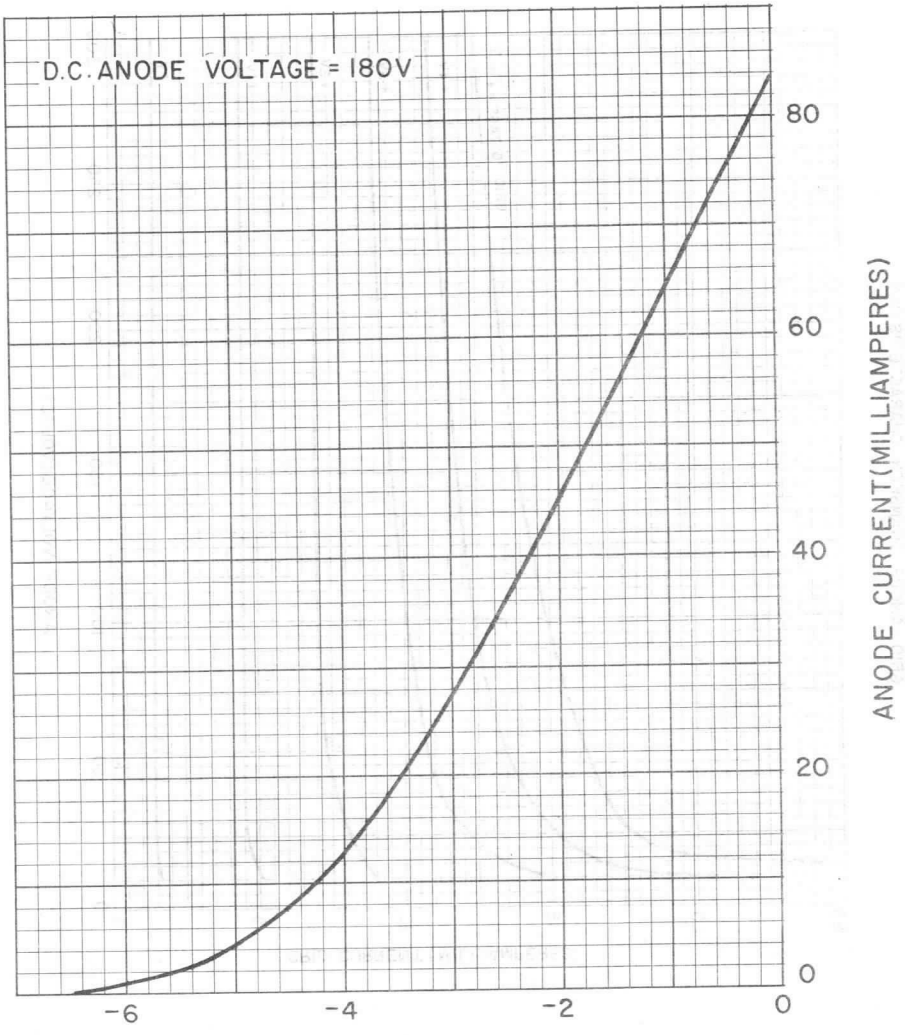


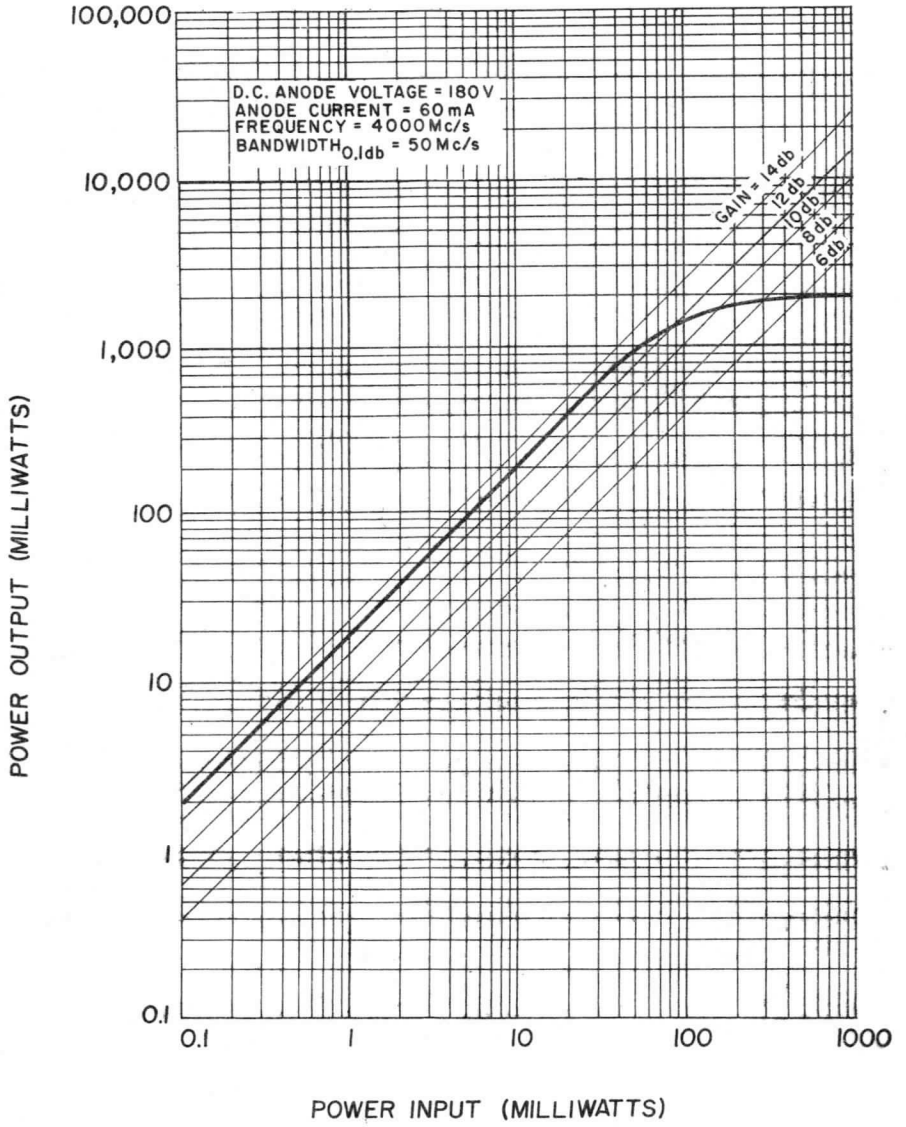
GRID–ANODE TRANSFER CHARACTERISTICS

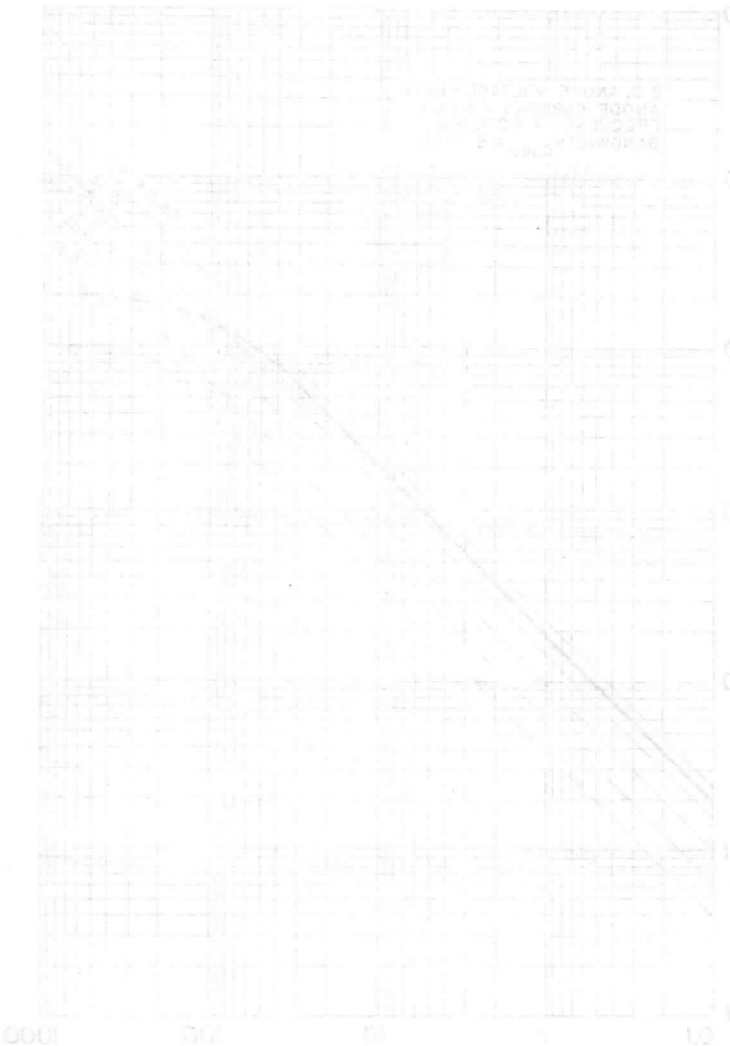


EC157

ANODE CURRENT AS A FUNCTION OF GRID VOLTAGE




D.C. ANODE VOLTAGE = 180V
ANODE CURRENT = 60mA
FREQUENCY = 4000Mc/s
BANDWIDTH 0.1db = 50Mc/s
GAIN = 14db
12db
10db
8db
6db
100,000
10,000
1,000
100
10
1
0.1
0.1
1
10
100
1000
POWER OUTPUT (MILLIWATTS)
POWER INPUT (MILLIWATTS)



Amperex

THYRATRONS

AMPEREX THYRATRON TYPE 2D21

The AMPEREX 2D21 is an inert-gas-filled thyratron of the tetrode type with negative control characteristic. The cathode is indirectly heated.

The tube features a high control ratio independent of temperature over a wide range, low anode-to-grid capacitance and very low grid current. Because of its low capacitance, the operation of the 2D21 is not appreciably affected by line voltage surges, and the low grid current permits it to be used with a high value of resistance in the grid circuit. This results in a high circuit sensitivity so that the tube can be operated directly from a high-vacuum photo cell for example.

The AMPEREX 2D21 can be used in relay circuits, grid controlled rectifier applications, the stabilization of A.C. output, in electronic timers and in grid circuits of power thyratrons.

The type 2D21 is interchangeable with the following tube types:

GL-2D21, 20A2 and 4G/280K

MAXIMUM RATINGS

Absolute Values

Maximum peak anode voltage

Inverse	1300 volts
Forward	650 volts

Maximum cathode current

Peak	0.5 amp
Average	0.1 amp
Max. averaging time	30 seconds

Maximum negative control-grid voltage

Before conduction	−100 volts
During conduction	−10 volts

Maximum positive control-grid current (average value)

Anode positive	0.01 amp
Anode negative	0.01 amp

2D21

Maximum negative shield-grid voltage

Before conduction	−100 volts
During conduction	−10 volts

Maximum positive shield-grid current

Anode positive	0.01 amp
Anode negative	0.01 amp

Maximum heater-cathode voltage

Heater negative	−100 volts
Heater positive	−25 volts

Maximum external resistance between control-grid and cathode . . . . . 10 megohms

Ambient Temp. limits . . . . . −70° to + 90°C

GENERAL ELECTRICAL DATA

Heater Voltage	$6.3 \pm 10\%$ volts
Heater Current (E_f = 6.3 volts)	0.6 amp
Cathode heating time required	10 seconds

Capacitances

Input	2.4 uuf
Output	1.6 uuf
Anode to control-grid	0.026 uuf

Mechanical Data

Mounting position	any
Base	miniature button, 7 pin
Net weight (approx.)	0.3 oz.

TYPICAL CHARACTERISTICS

Ionization Time

(DC anode voltage = 100 volts
Peak anode current during conduction = 0.5 amp.
Grid overvoltage (square pulse) = 50 volts) . . . . . 0.5 microseconds

Max. critical grid current

(AC anode voltage = 46 volts rms
Average anode current = 0.1 amp) . . . . . 0.5 micro amps

GENERAL CHARACTERISTICS

Arc Voltage . . . . . 8 volts

Control ratio between anode and control-grid
at striking point (Control-grid resistor = 0 megohms
Screen-grid voltage = 0 volts) 250

Control ratio between anode and screen-grid
at striking point (Control-grid resistor = 0 megohms
Screen-grid resistor = 0 megohms
DC control-grid voltage = 0 volts) 1000

OPERATING CHARACTERISTICS FOR RELAY SERVICE

A.C. anode voltage	117	400	volts rms
Screen-grid voltage	0	0	volts
A.C. grid bias voltage (phase difference between D.C. control-grid voltage and anode voltage approx. 180°)	5	---	volts rms
D.C. control grid voltage	---	−6	volts
Peak control-grid signal voltage	5	6	volts
Anode resistor	1.2	2.0	megohms
Grid resistor	1.0	1.0	megohms

APPLICATION NOTES

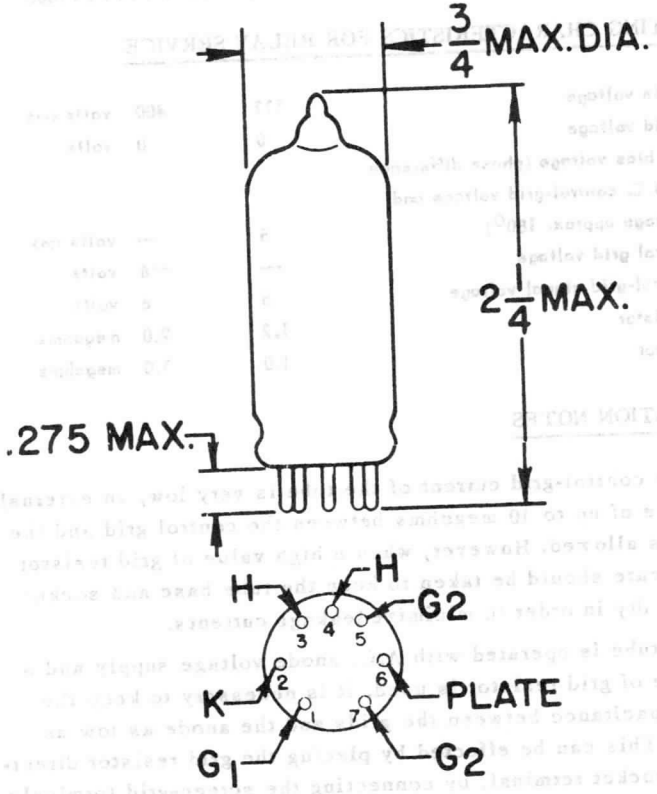
Since the control-grid current of the tube is very low, an external resistance of up to 10 megohms between the control grid and the cathode is allowed. However, when a high value of grid resistor is used, care should be taken to keep the tube base and socket clean and dry in order to minimize leakage currents.

When the tube is operated with A.C. anode voltage supply and a high value of grid resistor is used, it is necessary to keep the circuit capacitance between the grids and the anode as low as possible. This can be effected by placing the grid resistor directly at the socket terminal, by connecting the screen-grid terminals (pins 5 and 7) to the cathode (pin 2) at the socket, and by using a closefitting shield connected to the cathode terminal.

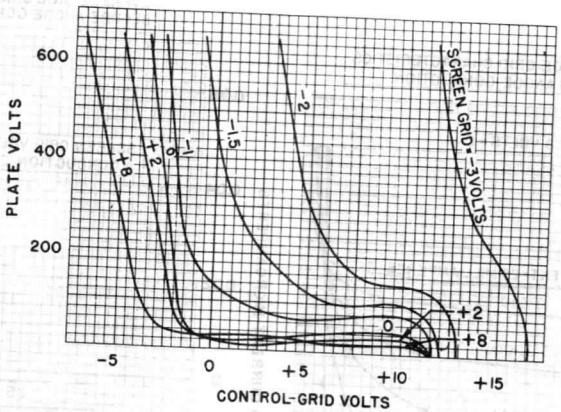
The screen grid is normally connected to the cathode but it can also be used to shift the control characteristic of the tube. When

the screen grid is made negative the control-grid characteristic is shifted in the positive direction. The use of the screen grid as control electrode has the advantage of increased sensitivity. However, in this case the pre-conduction current and the capacitance to anode will be higher.

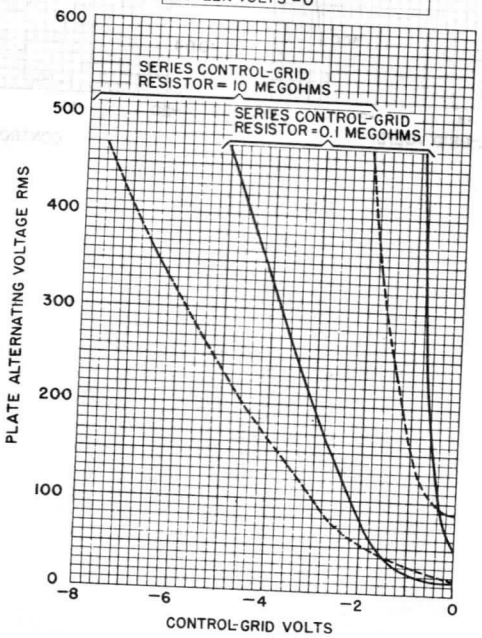
The tube can be employed under constant blocked condition, i.e. nonconductive, while heating current is continuously flowing. The life will thereby be practically unlimited provided every three months the full-load current is passed through the tube for a few minutes..



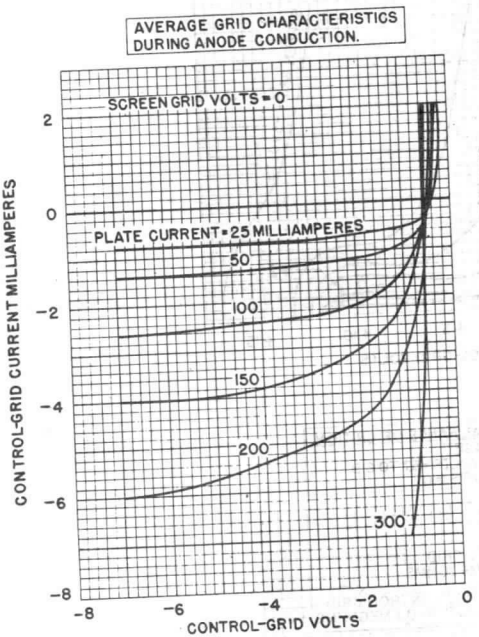
AVERAGE CONTROL CHARACTERISTICS
SERIES CONTROL-GRID RESISTOR = 0 OHMS
SERIES SCREEN-GRID RESISTOR = 0 OHMS

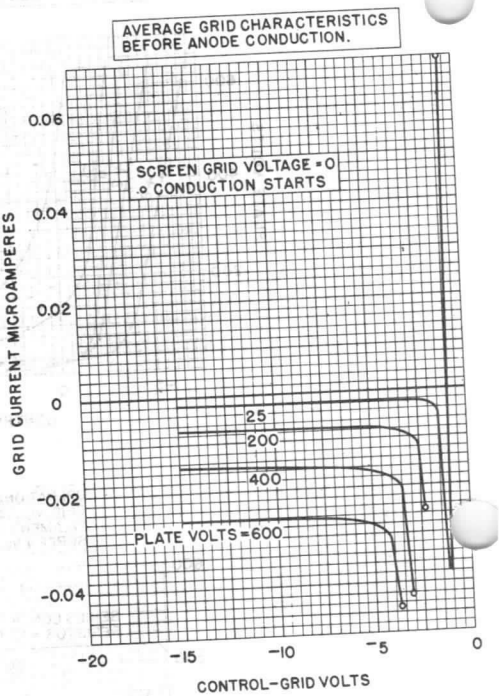


OPERATIONAL RANGE OF CRITICAL GRID VOLTAGE
FILAMENT VOLTS = 5.7 TO 6.9
SCREEN VOLTS = 0



2D21


AVERAGE GRID CHARACTERISTICS
DURING ANODE CONDUCTION.
SCREEN GRID VOLTS = 0
PLATE CURRENT = 25 MILLIAMPERES
50
100
150
200
300
CONTROL-GRID CURRENT MILLIAMPERES
2
0
-2
-4
-6
-8
-8
-6
-4
-2
0
CONTROL-GRID VOLTS


AVERAGE GRID CHARACTERISTICS
BEFORE ANODE CONDUCTION.
SCREEN GRID VOLTAGE = 0
∘ CONDUCTION STARTS
25
200
400
PLATE VOLTS = 600
GRID CURRENT MICROAMPERES
0.06
0.04
0.02
0
-0.02
-0.04
-20
-15
-10
-5
0
CONTROL-GRID VOLTS

AMPEREX THYRATRON TYPES

C3J/5632 • C3JA/5684

The Amperex tube types C3J/5632 and C3JA/5684 are three-electrode, xenon filled thyratrons with negative-control characteristics. They are designed for use in relay service, motor control and ignitor firing service.

GENERAL CHARACTERISTICS [1]

MECHANICAL

Overall Dimensions	see outline drawing
Base	medium, 4 pin with bayonet (A4-1C)
Mounting Position	any
Net Weight (approx)	4 ounces

ELECTRICAL

Cathode	directly heated
Heater Voltage	2.5 volts
Heater Current	8.5 amps
Recommended Heating Time [2]	60 seconds
Interelectrode Capacitances	
Plate to Grid	3 $\mu\mu$f
Grid to Cathode	14 $\mu\mu$f
Arc Voltage Drop	10 volts
Ionization Time	10 microseconds
Deionization Time	1 millisecond

[1] All values given apply to both tube types unless otherwise specified.

[2] Minimum heating time is 30 seconds.

C3J/5632 • C3JA/5684

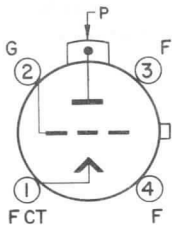
MAXIMUM RATINGS, ABSOLUTE VALUES [1]

Max Peak Anode Voltage	
Forward	
C3J/5632	900 volts
C3JA/5684	1000 volts
Inverse	1250 volts
Grid Voltage (before conduction) [3]	300 volts
Grid Voltage (during conduction)	10 volts
Peak Cathode Current	30 amps
Average Cathode Current (averaging time = 5 secs.)	2.5 amps
Fault Current (0.1 sec. max) [4]	300 amps
Grid Current (averaged over one cycle)	0.1 amp
Peak Grid Current	0.5 amp
Grid Resistance [5]	10 - 100 kilohms
Ambient Temperature Range	-55°C to $+75^{\circ}$C
Commutation Factor	0.7 V/μsec x A/μsec

[3] At plate voltage = 900 volts and grid resistance = 50 - 100 kilohms, the grid voltage can be 400 volts max.

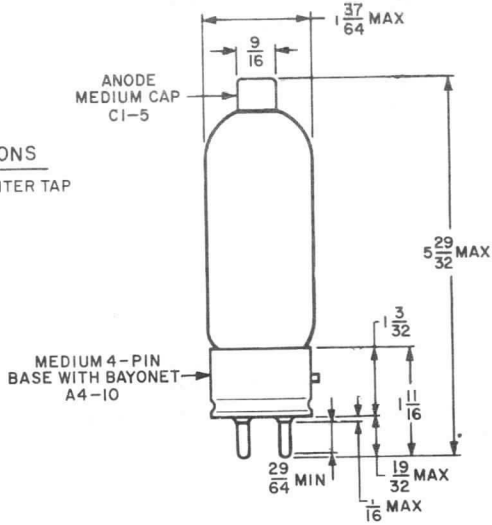
[4] Maximum anode fuse = 10 amps. Recommended anode fuse = 6 amps.

[5] Recommended value = 33 kilohms.

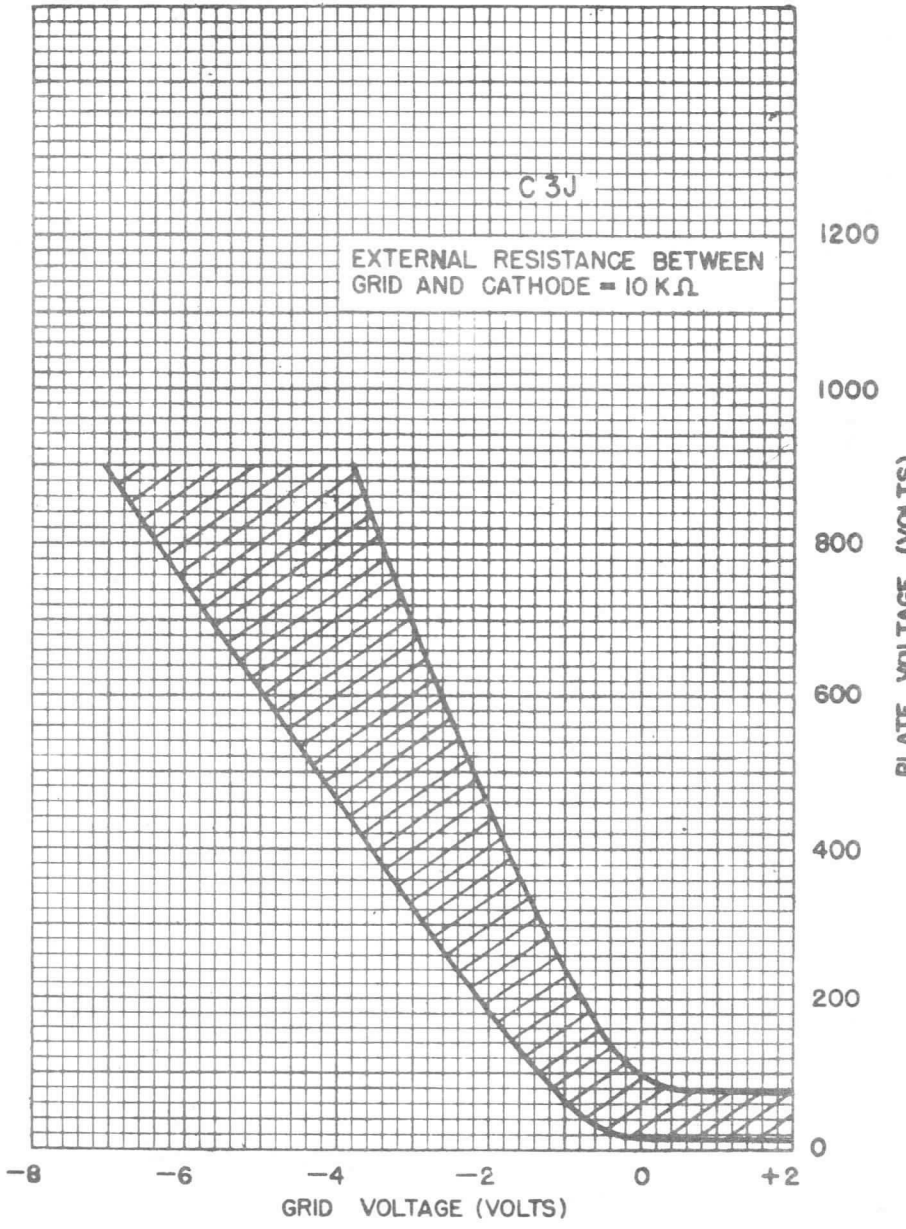


PIN CONNECTIONS

1- FILAMENT CENTER TAP
2- GRID
3- FILAMENT
4- FILAMENT
CAP - PLATE

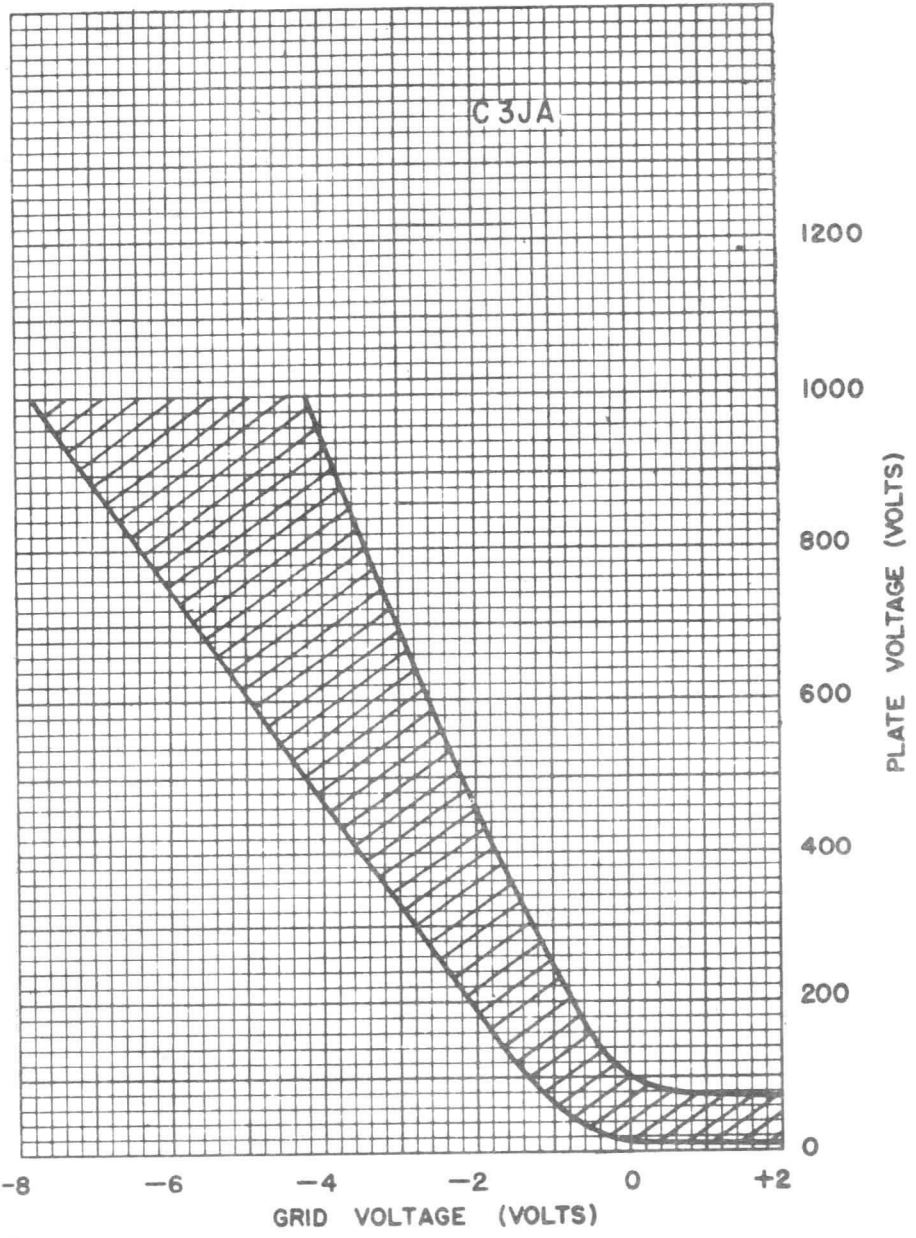


GENERAL CONTROL CHARACTERISTICS



C3J/5632 • C3JA/5684

GENERAL CONTROL CHARACTERISTICS



AMPEREX THYRATRON TYPE AX-105

The AX-105 is a four electrode, mercury vapor Thyratron with a negative control characteristic. The tube is designed for relay and grid control rectifier applications.

GENERAL CHARACTERISTICS

Number of Electrodes 4

ELECTRICAL

	Continuous Service		Intermittent Service		
Cathode—Indirectly heated:					
Voltage	5.0		5.5	5.0	volts
Current (approx.)	10.0		11.0	10.0	amps
Heating Time, typical . . .	5		5	5	minutes
Peak Voltage Drop, typical .	16		16	16	volts
Approx. Control Characteristics:					
Anode voltage	100	1000	100	1000	volts
Shield-grid voltage . . .	0	0	0	0	volts
Control-grid voltage . . .	+1.0	—9.0	+1.0	—9.0	volts
Anode to control grid capacitance (approx.) . . .	0.3		0.3	0.3	$\mu\mu f$
Ionization time (approx.) . .	10		10	10	μsec.
Deionization time (approx.) . .	1000		1000	1000	μsec.

MECHANICAL

Mounting Position . . . . . Vertical, base down

Net Weight (approx.) . . . . . 19 ounces

AX-105

MAXIMUM RATINGS

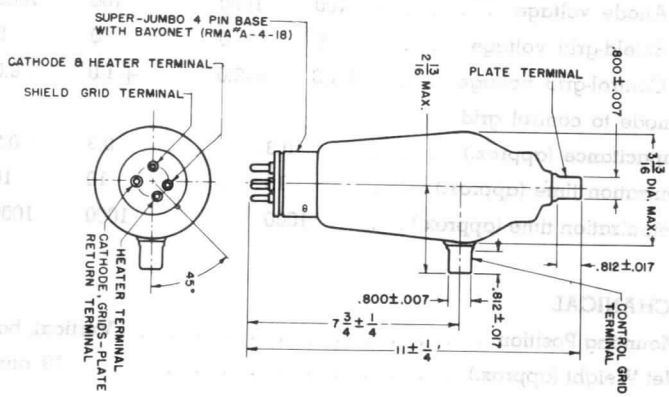
	Continuous Service	Intermittent Service [1]	
Max. peak anode voltage:			
Inverse	2500	750	10,000 volts
Forward	2500	750	10,000 volts
Max. negative control-grid voltage:			
Before conduction	1000	1000	1000 volts
During conduction	10	10	10 volts
Max. negative shield-grid voltage:			
Before conduction	500	500	500 volts
During conduction	10	10	10 volts
Max. anode current:			
Instantaneous, 25 cycles and above	40	77	16 amps
Instantaneous, below 25 cycles	12.8	5.0	8.0 amps
Average	6.4	2.5	4.0 amps
Surge, for design only	400	400	160 amps
Duration of surge current	0.1	0.1	0.1 sec.
Max. control-grid current:			
Instantaneous	1.0	1.0	1.0 amp
Average	0.25	0.25	0.25 amp
Max. shield-grid current:			
Instantaneous	2.0	2.0	2.0 amps
Average	0.50	0.50	0.50 amps
Max. time of averaging current	15	5	15 sec.
Temperature limits, condensed mercury	+40 to +80	+30 to +95	+25 to +50 degrees C
Recommended temperature, condensed mercury	40	40	40°C

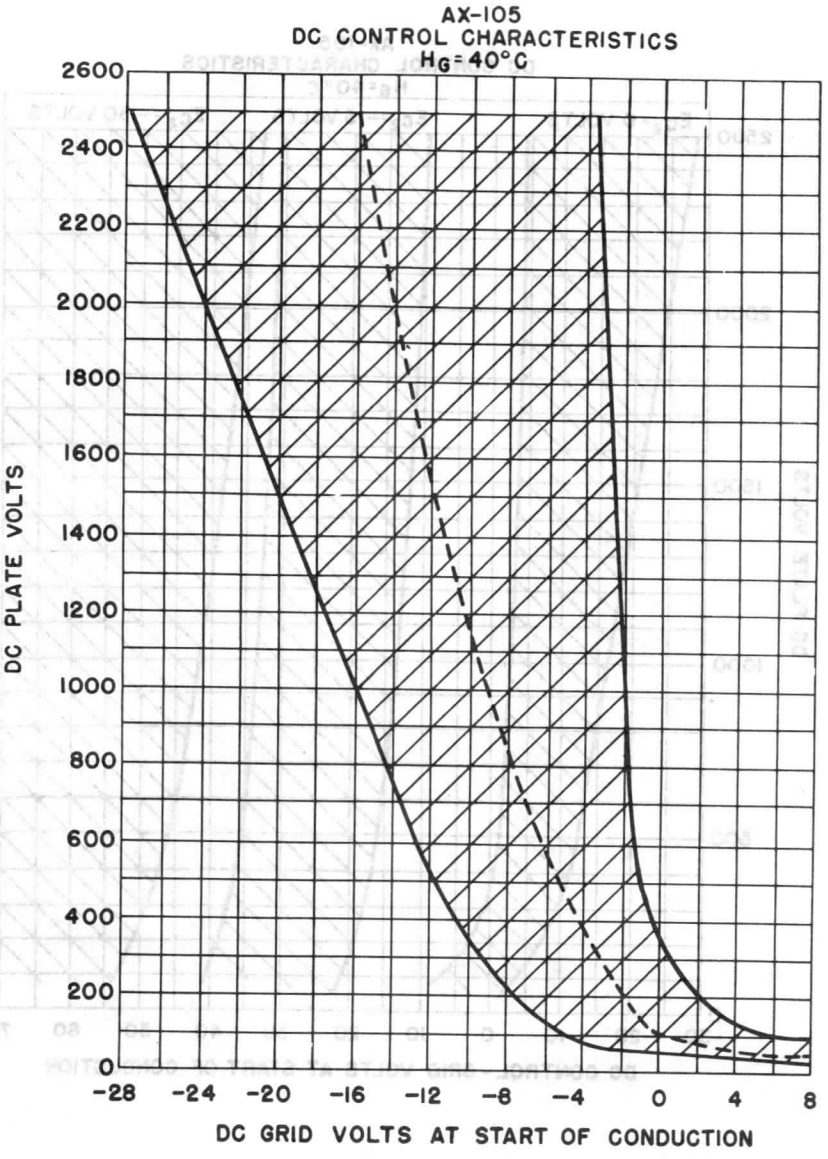
[1] Interpolate linearly for values of anode current and temperature for operation at voltages between 2500 and 10,000 volts.

GENERAL APPLICATIONS

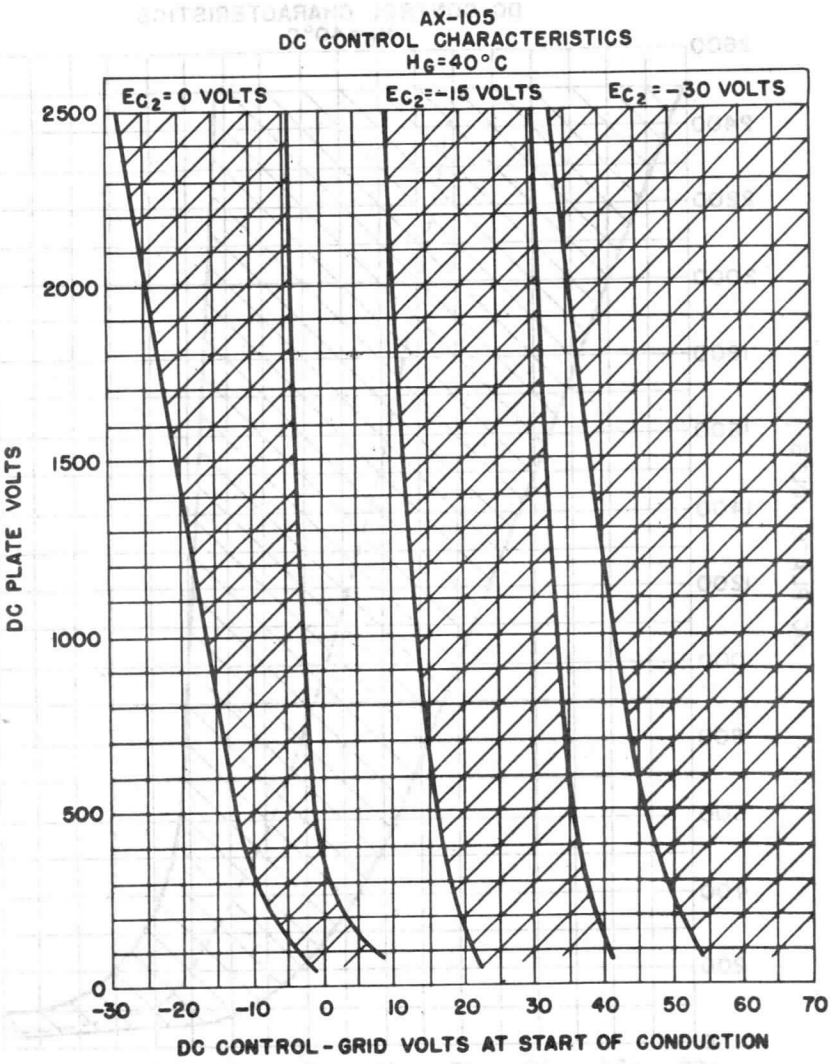
D-C For use as battery charger, electronic switch, rectifier with variable or stabilized output voltage and for electronic D-C motor speed regulation.

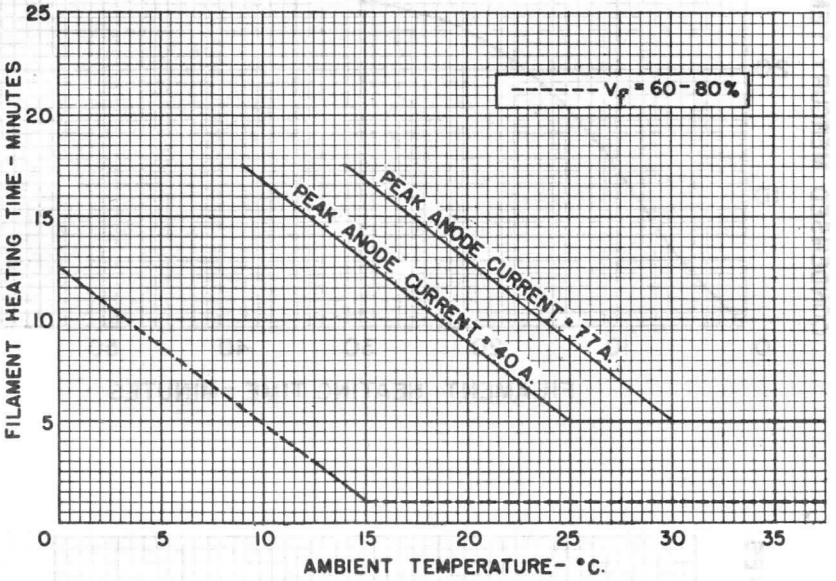
A-C For use as electronic switch and control of ignitron circuits; control of A-C motor speed and light intensity of discharge lamps by 2 tubes in inverse parallel circuit; control of A-C power by two tubes used as the load of a series transformer in the supply circuit.




AX-105
DC CONTROL CHARACTERISTICS
HG=40°C
DC PLATE VOLTS
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
-28
-24
-20
-16
-12
-8
-4
0
4
8
DC GRID VOLTS AT START OF CONDUCTION

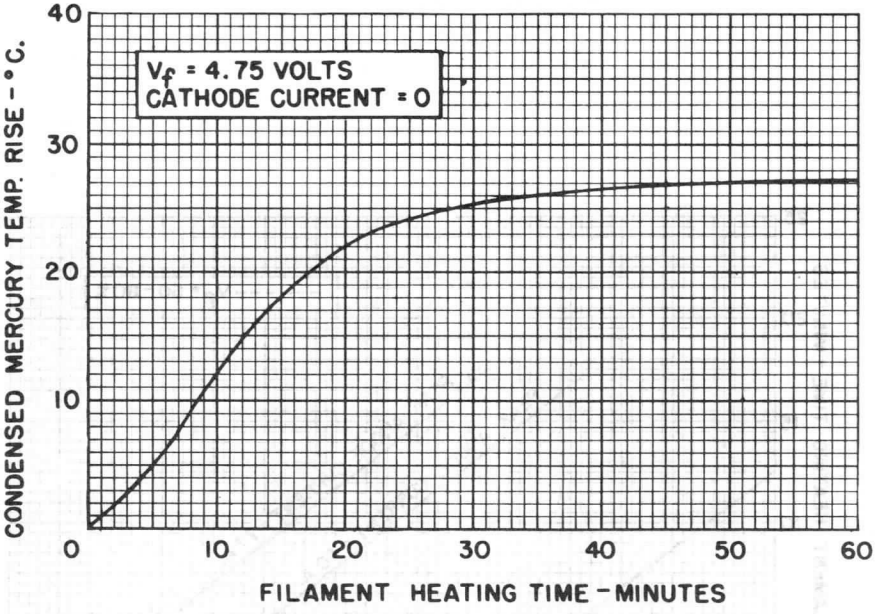
AX-105

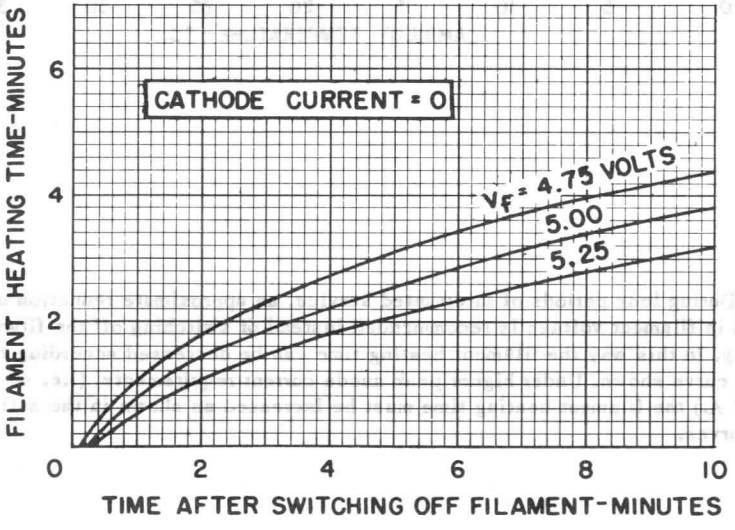

AX-105
DC CONTROL CHARACTERISTICS
H_G=40°C
E_{C_2}= 0 VOLTS
E_{C_2}=-15 VOLTS
E_{C_2} =-30 VOLTS
DC PLATE VOLTS
2500
2000
1500
1000
500
0
-30
-20
-10
0
10
20
30
40
50
60
70
DC CONTROL-GRID VOLTS AT START OF CONDUCTION



During long periods of interrupted service, an approximate reduction of 60 to 80% in filament voltage is recommended instead of switching off the filament entirely. In this way the filament heating time can be decreased according to the dotted curve shown. Under higher peak anode current requirements, (i.e. 40 A. and 77 A.) the filament heating time must be increased as shown in the solid line curves.

AX-105


V_f = 4.75 VOLTS
CATHODE CURRENT = 0
CONDENSED MERCURY TEMP. RISE - °C.
40
30
20
10
0
10
20
30
40
50
60
FILAMENT HEATING TIME - MINUTES


CATHODE CURRENT = 0
V_f = 4.75 VOLTS
5.00
5.25
FILAMENT HEATING TIME-MINUTES
6
4
2
0
2
4
6
8
10
TIME AFTER SWITCHING OFF FILAMENT-MINUTES

AMPEREX THYRATRON TYPE AX255

The AX255 is a mercury vapor thyratron designed for controlled rectifier applications. It is particularly suitable for heavy-duty motor control and A.C. welder service.

In motor control applications, the tube can be operated up to 2500 volts peak inverse, and at an average cathode current of 12.5 amperes. The corresponding peak current under this condition is 80 amperes.

A particular feature of this tube is its extreme overload characteristic. For 5 seconds in each 5 minutes, the tube may be overloaded up to cathode currents of 160 amperes peak, 20 amperes average and 50 amperes RMS.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode	indirectly heated
Heater Voltage	5.0 volts
Heater Current	16 amperes
Cathode Heating Time - minimum	5 minutes
Interelectrode Capacitances	
Anode to Control Grid	8 uuf
Control Grid to Cathode	30 uuf
Deionization Time	1000 microseconds
Ionization Time	10 microseconds
Anode Voltage Drop	12 volts
Maximum Frequency	150 cps.

MECHANICAL

Cooling	convection
Mounting Position	vertical, base down
Overall Dimensions	
Max. Tube Length	13 1/8 inches
Max. Base Width	5 3/4 inches
Max. Diameter of Bulb	4 inches
Net Weight (approx.)	1 lb., 12 oz.

AX255

MAXIMUM RATINGS, Absolute Values

MOTOR CONTROL - CONTINUOUS OPERATION

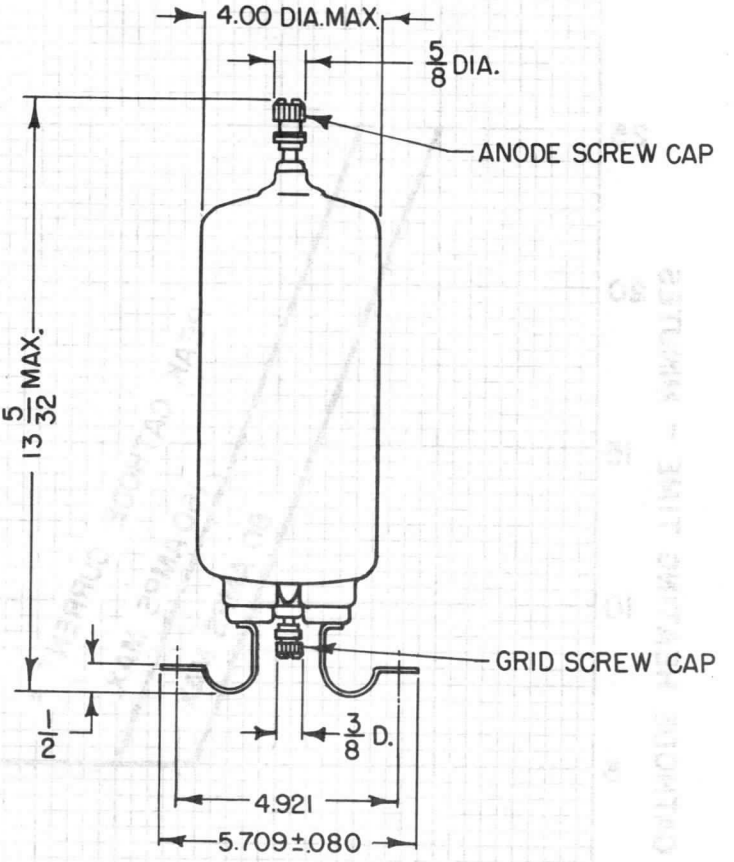
Maximum Peak Anode Voltage			
Inverse		2500	volts, max.
Forward		1500	volts, max.
Maximum Cathode Current			
Peak [1]	80	100	amperes
Average [1]	12.5	10	amperes
RMS [1]		30	amperes
Max. Averaging Time		15	seconds
Fault Current (Max. duration = 0.1 sec.)		1500	amps. max.
Maximum Negative Control - Grid Voltage			
Before Conduction		300	volts max.
During Conduction		10	volts max.
Average Grid Current		0.25	amperes max.
Peak Grid Current	min. 0.5 ma;	max. 1.0	amperes
Grid Circuit Return Resistor	max. 50; recommended	10	K ohm
Condensed Mercury Temperature		35° to 75°	C
Recommended Mercury Temperature		60°	C

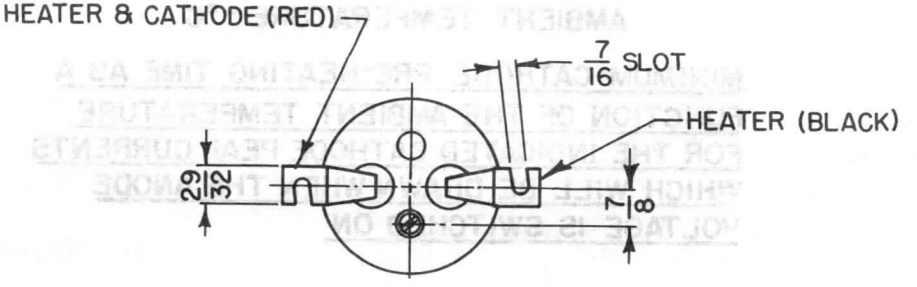
A.C. WELDER CONTROL

Two Tubes in Inverse Parallel

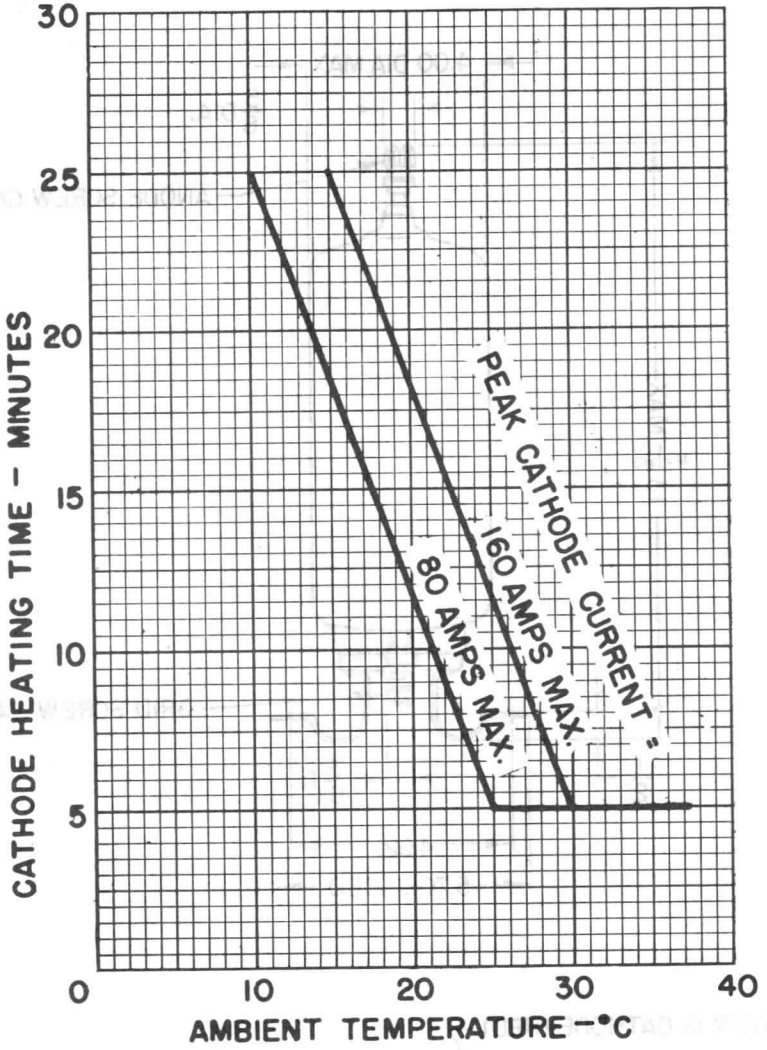
Maximum Peak Anode Voltage				
Inverse			750	volts
Forward			750	volts
Maximum Cathode Current				
Duty Cycle	10	50	100	%
Peak	156	78	39	amperes
Average	5	12.5	12.5	amperes
RMS	110	55	27.5	amperes
Maximum Averaging Time	5	5	15	seconds
Fault Current (Maximum duration = 0.1 sec.)			1500	amperes
Maximum Negative Control - Grid Voltage				
Before Conduction			300	volts
During Conduction			10	volts
Average Grid Current			0.25	amperes
Grid Circuit Return Resistor	max. 50; recommended		10	K ohm
Condensed Mercury Temperature			40° C to 80°	C
Recommended Mercury Temperature			60°	C

[1] For maximum 5 seconds in each 5 minute period, the tube may be overloaded up to cathode currents of 160 amperes peak, 20 amperes average and 50 amperes RMS. Under these conditions the condensed mercury temperature = 40° C minimum.


4.00 DIA.MAX.
5/8 DIA.
ANODE SCREW CAP
13 5/32 MAX.
GRID SCREW CAP
1/2
3/8 D.
4.921
5.709±.080

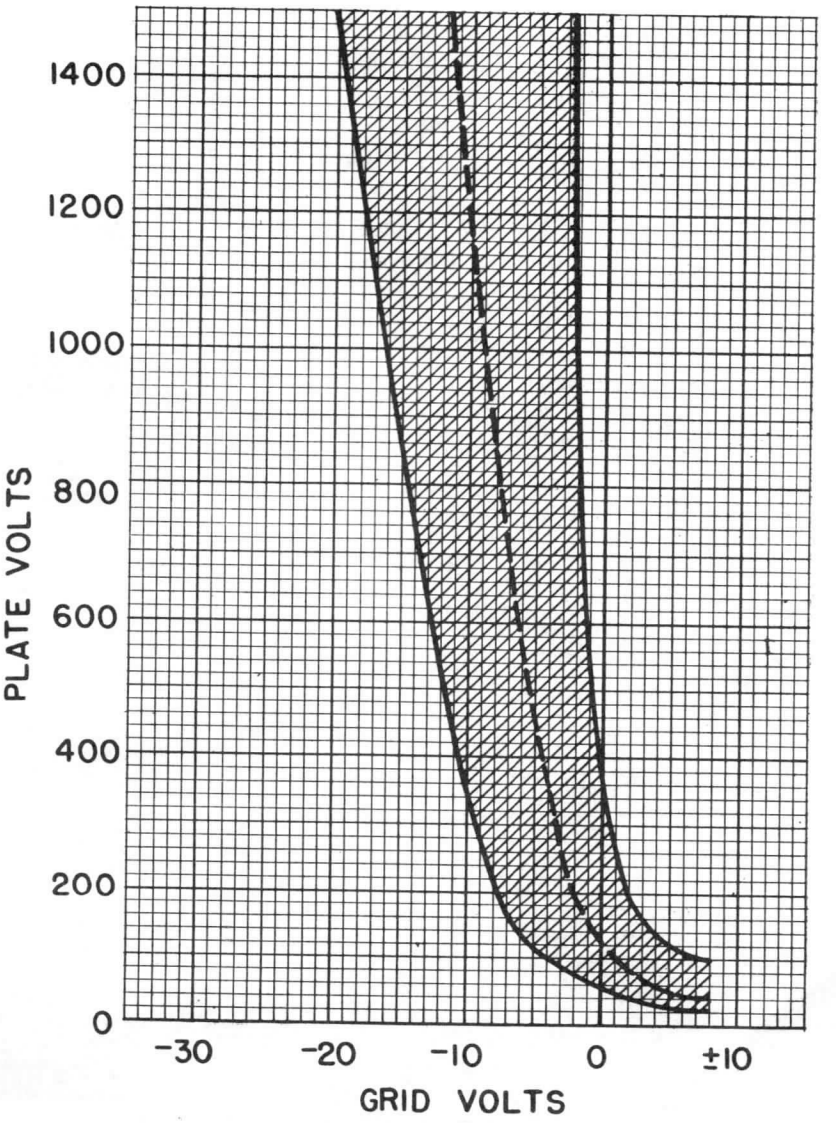

HEATER & CATHODE (RED)
7/16 SLOT
HEATER (BLACK)
29/32
7/8

AX255



MINIMUM CATHODE PRE-HEATING TIME AS A FUNCTION OF THE AMBIENT TEMPERATURE FOR THE INDICATED CATHODE PEAK CURRENTS WHICH WILL BE DRAWN WHEN THE ANODE VOLTAGE IS SWITCHED ON

CONTROL CHARACTERISTIC



AMPEREX THYRATRON TYPE AX-260

The AX260 is a mercury vapor thyratron designed for controlled rectifier applications. It is particularly suitable for heavy-duty motor control and A.C. welder service.

In motor control applications, the tube can be operated up to 2500 volts peak inverse, and at an average cathode current of 25 amperes. The corresponding peak current under this condition is 160 amperes.

A particular feature of this tube is its extreme overload characteristic. For 5 seconds in each 5 minutes, the tube may be overloaded up to cathode currents of 300 amperes peak, 40 amperes average and 100 amperes RMS.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode	indirectly heated
Heater Voltage	5.0 volts
Heater Current	bogey 25 amps; max. 27.5 amps
Cathode Heating Time - minimum	10 minutes
Interelectrode Capacitances	
Anode to Control - Grid	15 uuf
Control-Grid to Cathode	60 uuf
Deionization Time	1000 microseconds
Ionization Time	10 microseconds
Anode Voltage Drop	10 volts
Maximum Frequency	150 cps.

MECHANICAL

Cooling [1]	convection
Mounting Position	vertical, base down
Overall Dimensions	
Max. Tube Length	16 inches
Max. Base Width	5 3/4 inches
Max. Diameter of Bulb	5 inches
Net Weight (approx.)	3 1/2 lbs.

[1] Under normal operating conditions (heater voltage = 5 volts, cathode current = 25 amps.) the difference between the condensed mercury temperature and the ambient temperature is approximately 35° to 40° C. When the ambient temperature is 35° C or higher, it may be necessary to cool the tube with a low velocity air flow.

AX-260

MAXIMUM RATINGS, Absolute Values

MOTOR CONTROL, CONTINUOUS OPERATION

Maximum Peak Anode Voltage			
Inverse			2500 volts max.
Forward			1500 volts max.
Maximum Cathode Current			
Peak [2]	160	200	amps
Average [2]	25	20	amps
RMS [2]			60 amps
Max. Averaging Time			15 sec.
Fault Current (Max. duration = 0.1 sec.) [3]			2500 amps max.
Maximum Negative Control - Grid Voltage			
Before Conduction			300 volts max.
During Conduction			10 volts max.
Average Grid Current [4]			0.25 amps max.
Peak Grid Current	min. 0.3 ma; max.		1.0 amps
Grid Circuit Return Resistor	max. 20; recommended		10 Kilohms
Condensed Mercury Temperature			35° to 75° C
Recommended Mercury Temperature			60° C

A.C. WELDER CONTROL

Two Tubes in Inverse Parallel

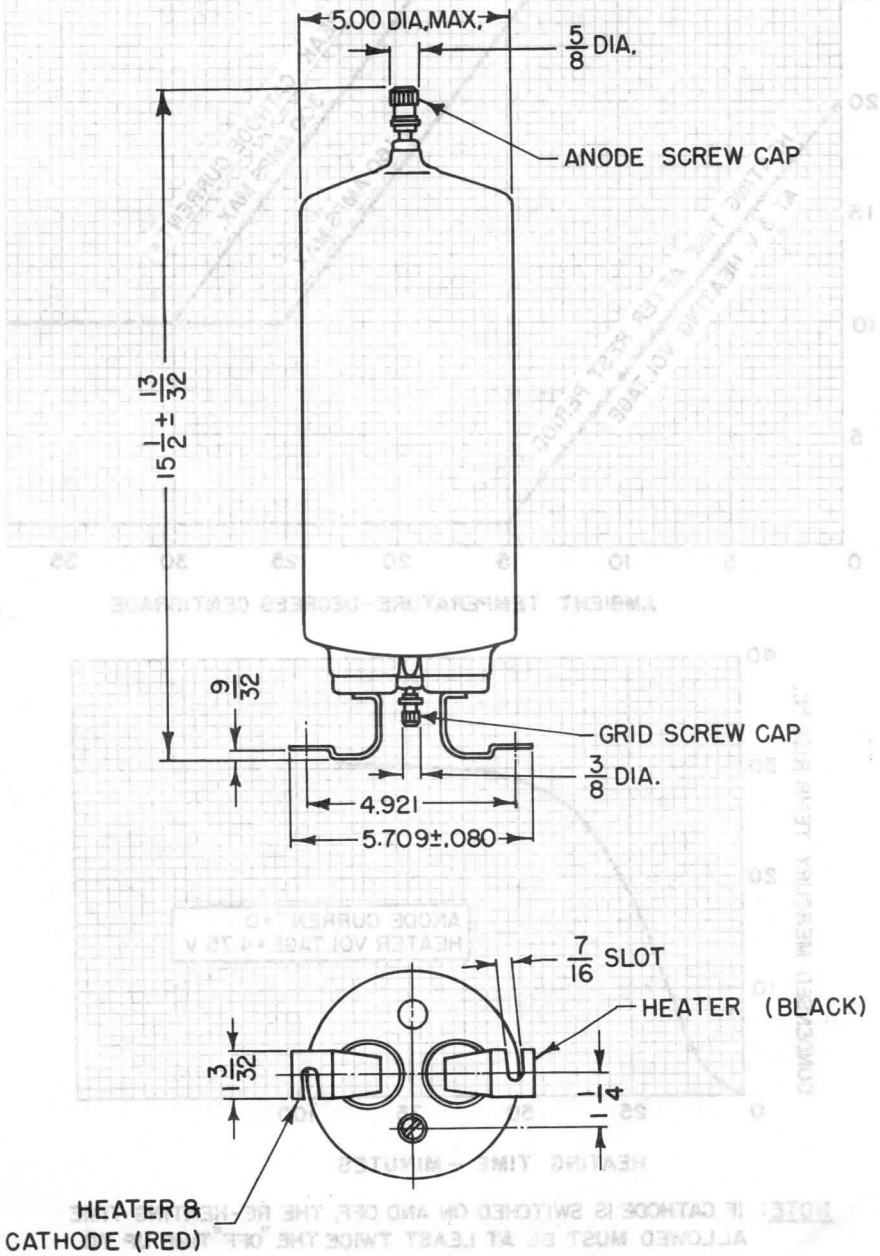
Maximum Peak Anode Voltage			
Inverse			750 volts
Forward			750 volts
Maximum Cathode Current			
Duty Cycle	10	50	100 %
Peak	285	156	78 amps
Average	9	25	25 amps
RMS	200	110	55 amps
Max. Averaging Time	5	5	15 seconds
Fault Current (Max. duration = 0.1 sec)			2500 amps
Max. Negative Control - Grid Voltage			
Before Conduction			300 volts
During Conduction			10 volts
Average Grid Current [4]			0.25 amps
Grid Circuit Return Resistor	max. 20; recommended		10 K ohm
Condensed Mercury Temperature			40° C to 80° C
Recommended Mercury Temperature			60° C

[2] For maximum 5 seconds in each 5 minutes period, the tube may be overloaded up to cathode currents of 300 amps peak, 40 amps average and 100 amps RMS. Under these conditions the condensed mercury temperature = 40° C minimum.

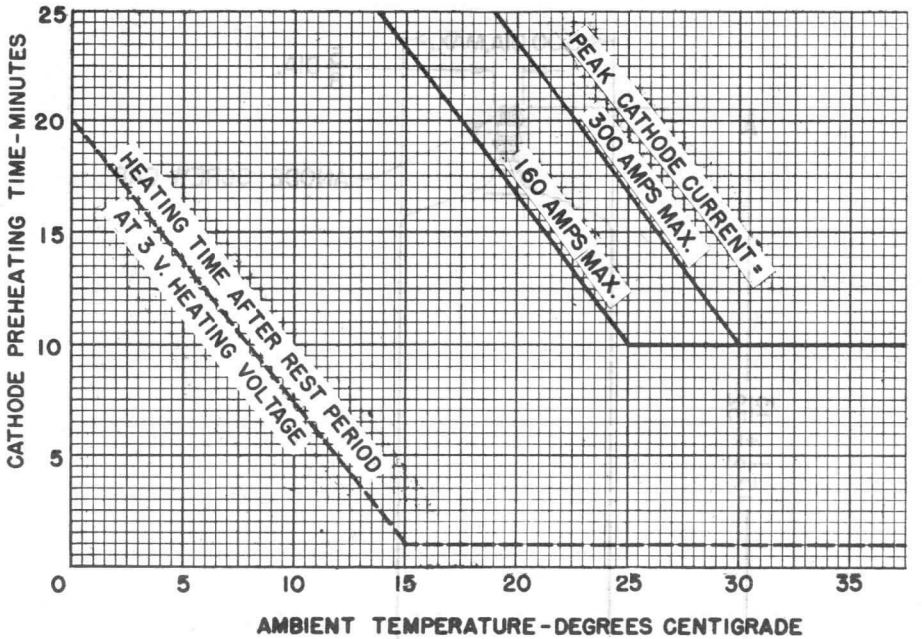
[3] Anode fuse max. = 80 amps. Recommended = 60 amps.

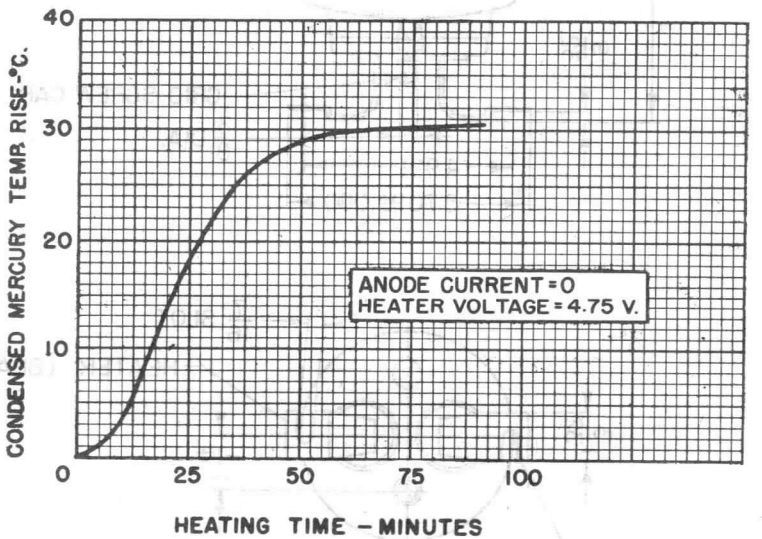
[4] In order to obtain low anode ignition voltages, a positive grid current of a least 3 ma is necessary. The use of a fixed negative grid bias and a sharp grid pulse is recommended. The bias voltage should be 30 to 50 volts d.c. for output voltages of 220-600 volts d.c. The grid pulse voltage should be from 100 to 130 volts if a grid series resistor of 10 Kohms is used, and the pulse transformer impedance is 10 Kohms, maximum.

If a sine wave is used for driving the grid, the voltage should be at least 60 volts RMS. The impedance of the bias source should be low compared to the individual grid series impedance.

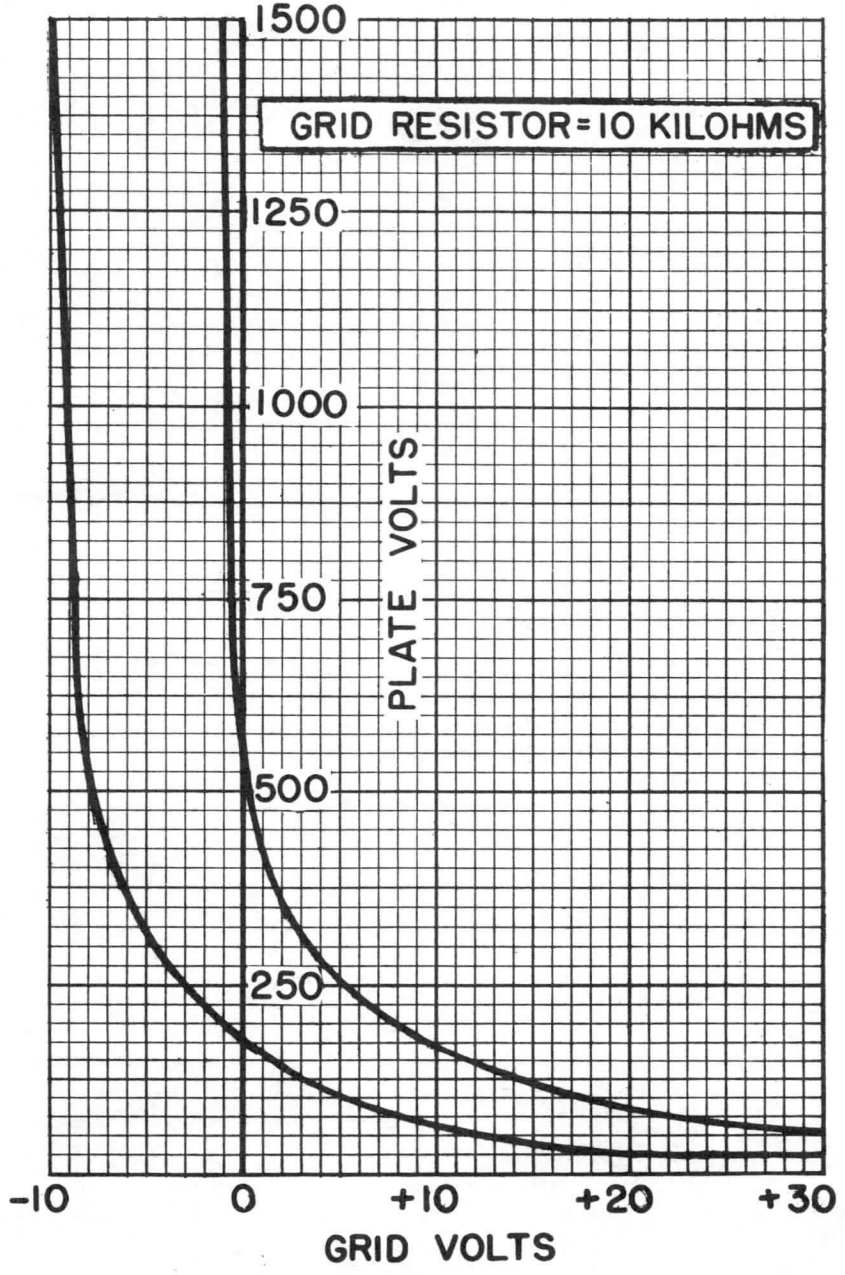

5.00 DIA.MAX.
5/8 DIA.
ANODE SCREW CAP
15 1/2 ± 13/32
9/32
GRID SCREW CAP
3/8 DIA.
4.921
5.709±.080
7/16 SLOT
HEATER (BLACK)
3/32
1/4
HEATER & CATHODE (RED)

AX-260





NOTE: IF CATHODE IS SWITCHED ON AND OFF, THE RE-HEATING TIME ALLOWED MUST BE AT LEAST TWICE THE "OFF" TIME UP TO A MAXIMUM OF 10 MINUTES.


1500
GRID RESISTOR=10 KILOHMS
1250
1000
750
500
250
PLATE VOLTS
-10
0
+10
+20
+30
GRID VOLTS

GRID RESISTOR=10 KILOHMS
1500
1250
1000
750
500
250
PLATE MA.
-10
0
+10
+20
+30
GRID VOLTS

AMPEREX THYRATRON TYPE 1701 (5557/FG17)

GENERAL CHARACTERISTICS

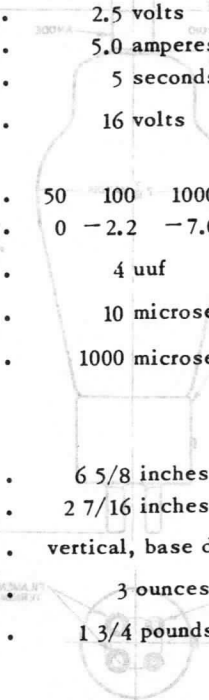
TRIODE THYRATRON

ELECTRICAL

Filament	oxide coated
Voltage	2.5 volts
Current	5.0 amperes
Preheating Time	5 seconds
Peak Voltage Drop	16 volts
Control Characteristics (approx.)	
Anode Voltage	50 100 1000
Grid Voltage	0 −2.2 −7.0
Anode to Grid Capacitance (approx.)	4 uuf
Ionization Time	10 microseconds
Deionization Time	1000 microseconds

MECHANICAL

Overall Dimensions	
Maximum Length	6 5/8 inches
Maximum Diameter	2 7/16 inches
Mounting Position	vertical, base down
Net weight (approx.)	3 ounces
Shipping Weight (approx.) (one tube)	1 3/4 pounds



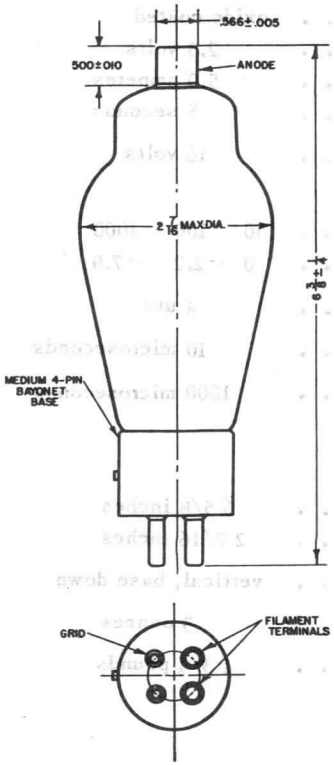
1701 (5557/FG17)

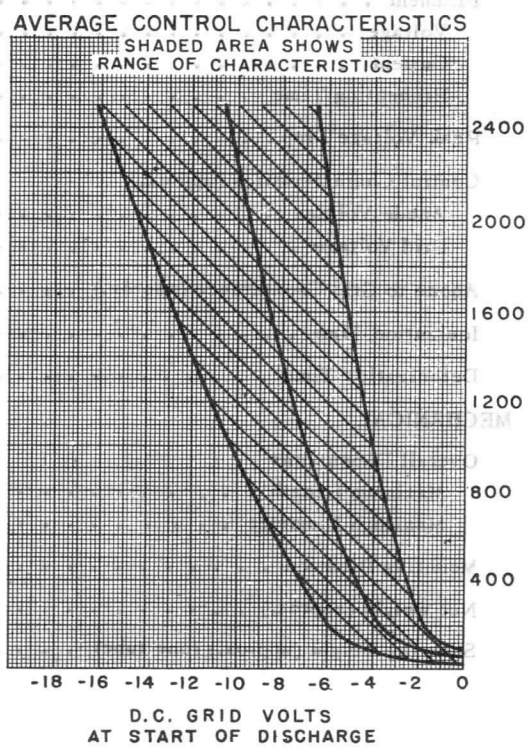
MAXIMUM RATINGS

MAXIMUM PEAK ANODE VOLTAGE	
Inverse	5000 volts
Forward	2500 volts
MAXIMUM NEGATIVE GRID VOLTAGE	
Before Conduction	500 volts
During Conduction	10 volts
MAXIMUM ANODE CURRENT	
Instantaneous, above 25 cycles	2.0 amperes
Instantaneous, below 25 cycles	1.0 ampere
Average	0.5 ampere
Surge, for design only	40 amperes
Duration of Surge Current	0.1 second
MAXIMUM GRID CURRENT	
Instantaneous	0.25 ampere
Average	0.05 ampere
Max. Time of Averaging Current	15 seconds

Condensed Mercury Temperature Range . . . +40° to +80° cent.

Recommended Condensed Mercury Temperture . +40° cent.





AMPEREX THYRATRON TYPE AX-5544

The AMPEREX thyratron type AX-5544 is a three electrode, Xenon filled tube which allows reliable operation over a wide temperature range. It is interchangeable in every respect with tubes of the same RETMA designation.

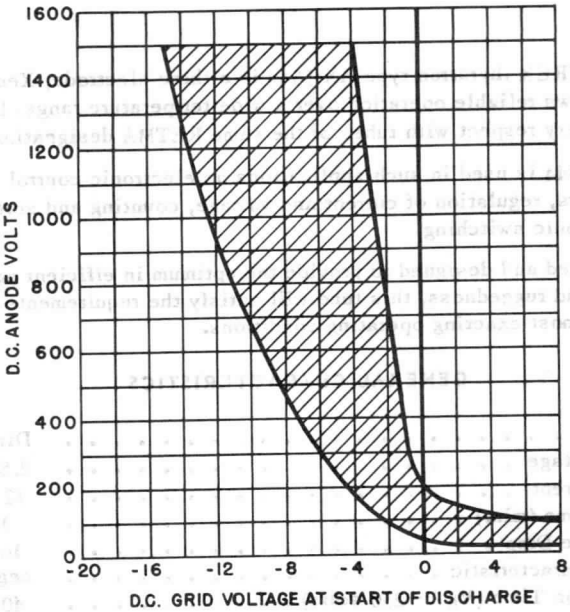
The AX-5544 is used in such applications as electronic control of the speed of D.C. motors, regulation of current and voltage, counting and sorting devices and electronic switching

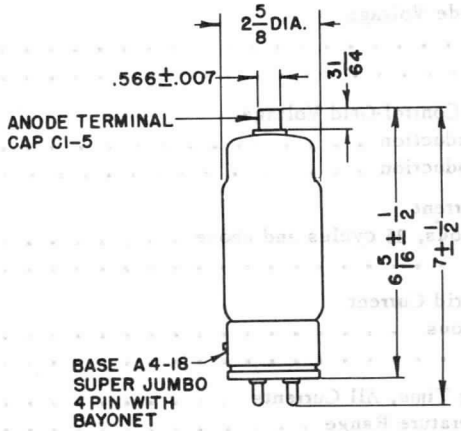
Manufactured and designed to provide the optimum in efficient performance, reliability and ruggedness, this tube will satisfy the requirements of long life under the most exacting operating conditions.

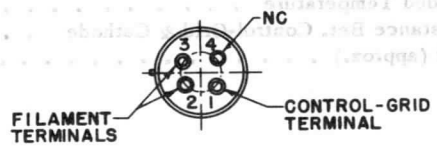
GENERAL CHARACTERISTICS

Cathode	Directly heated
Heater Voltage	2.5 volts
Heater Current	12 amps
Heating Time (min.)	1 minute
Arc Voltage Drop	16 volts
Control Characteristic	neg./pos.
Deionization Time (V_g = −250 volts)	40 microsec.
(V_g = − 12 volts)	400 microsec.
Max. Peak Anode Voltage	
Inverse	1500 volts
Forward	1500 volts
Max. Negative Control-Grid Voltage	
Before conduction	250 volts
During conduction	10 volts
Max. Anode Current	
Instantaneous, 25 cycles and above	40 amps
Average	3.2 amps
Max. Control-Grid Current	
Instantaneous	2.5 amps
Average	0.2 amps
Max. Averaging Time, All Currents	15 sec.
Ambient Temperature Range	−55° to + 70°C
Recommended Temperature	20°C
Max. Resistance Bet. Control-Grid & Cathode	0.1 megohm
Net Weight (approx.)	9½ oz.

AX-5544


1600
1400
1200
1000
800
600
400
200
0
D.C. ANODE VOLTS
-20
-16
-12
-8
-4
0
4
8
D.C. GRID VOLTAGE AT START OF DISCHARGE


2 5/8 DIA.
.566±.007
31/64
ANODE TERMINAL
CAP C1-5
6 5/16 ± 1/2
7 ± 1/2
BASE A4-18
SUPER JUMBO
4 PIN WITH
BAYONET


NC
3
4
2
1
FILAMENT
TERMINALS
CONTROL-GRID
TERMINAL

AMPEREX THYRATRON TYPE AX-5545

The AMPEREX thyratron type AX-5545 is a three electrode, Xenon filled tube which allows reliable operation over a wide temperature range. It is interchangeable in every respect with tubes of the same RETMA designation.

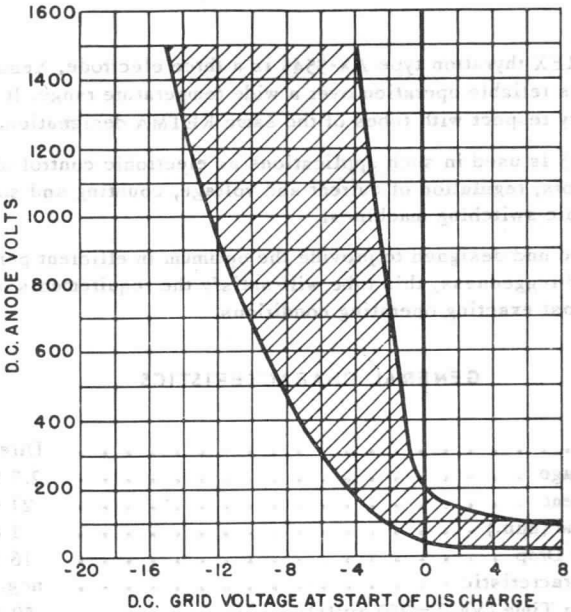
The AX-5545 is used in such applications as electronic control of the speed of D.C. motors, regulation of current and voltage, counting and sorting devices and electronic switching machines.

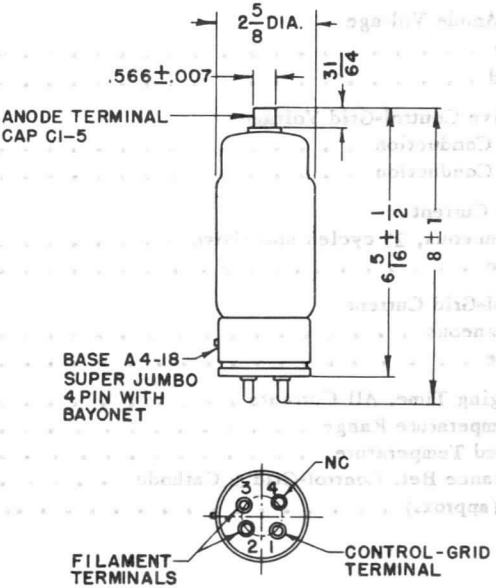
Manufactured and designed to provide the optimum in efficient performance, reliability and ruggedness, this tube will satisfy the requirements of long life under the most exacting operating conditions.

GENERAL CHARACTERISTICS

Cathode	Directly heated
Heater Voltage	2.5 volts
Heater Current	21 amps
Heating Time (min.)	1 minute
Arc Voltage Drop	16 volts
Control Characteristic	neg./pos.
Deionization Time ($V_g = -250$ volts)	50 microsec.
($V_g = -12$ volts)	500 microsec.
Max. Peak Anode Voltage	
Inverse	1500 volts
Forward	1500 volts
Max. Negative Control-Grid Voltage	
Before Conduction	250 volts
During Conduction	10 volts
Max. Anode Current	
Instantaneous, 25 cycles and above	80 amps
Average	6.4 amps
Max. Control-Grid Current	
Instantaneous	2.5 amps
Average	0.2 amps
Max. Averaging Time, All Currents	15 sec.
Ambient Temperature Range	−55° to +70°C
Recommended Temperature	20°C
Max. Resistance Bet. Control-Grid & Cathode	0.1 megohm
Net Weight (approx.)	10½ oz.

AX-5545


1600
1400
1200
1000
800
600
400
200
0
D.C. ANODE VOLTS
-20
-16
-12
-8
-4
0
4
8
D.C. GRID VOLTAGE AT START OF DISCHARGE


2 5/8 DIA.
.566±.007
31/64
ANODE TERMINAL
CAP CI-5
1 1/2
6 5/16 ± 1/16
8 ± 1
BASE A4-18
SUPER JUMBO
4 PIN WITH
BAYONET
NC
3
4
2
1
FILAMENT
TERMINALS
CONTROL-GRID
TERMINAL

AMPEREX THYRATRON TYPE 5559

The AMPEREX 5559 is a mercury vapor triode with a negative control characteristic. The cathode is indirectly heated. Even though a screen grid is not present, the anode-to-grid capacitance has been kept low (4uuf) so that there is little risk of influence from anode voltage surges into the grid circuit.

The AMPEREX type 5559 is interchangeable with the following tube types:

1257	WL 5559/57
WL631	GL 5559/FG57
MT-57	

The AMPEREX 5559 requires relatively little grid power and is suitable for application in relay circuits, control of D.C. motor speed, variable and stabilized D.C. output rectifiers, and in automatically operated battery charges. In anti-parallel circuits the tube can also be used for controlling and switching A.C. power. Other applications are:

Firing tube for ignitrons in resistance welding machines.
Stage lighting control
Register controls
Servo mechanisms

GENERAL CHARACTERISTICS

ELECTRICAL DATA

Cathode	indirectly heated
Voltage	5.0 ± 5% volts
Current	4.5 amps
Heating time (min.)	5 minutes *
Peak Voltage Drop (typical)	16 volts

Approx, Control Characteristics

D.C. Anode Voltage	60	100	1000	volts
D.C. Grid Voltage	0	−1.75	−6.5	volts

* Heating time on initial installation - approx. 30 minutes.

5559

Anode to grid capacitance	4 uuf
Ionization time	10 microseconds
Deionization time	1000 microseconds

MECHANICAL

Mounting position	base up or down
Base	medium 4 pin with bayonner
Net weight (approx.)	5¼ ounces

MAXIMUM RATINGS

Max. peak anode voltage

Inverse	1500 volts
Forward	1000 volts

Maximum negative grid voltage

Before conduction	500 volts
During conduction	10 volts

Maximum anode current

Peak (under 25 c/s)	5 amps
Peak (25 c/s and above)	15 amps
Average (averaging time = max. 15 sec.)	2.5 amps

Maximum grid current

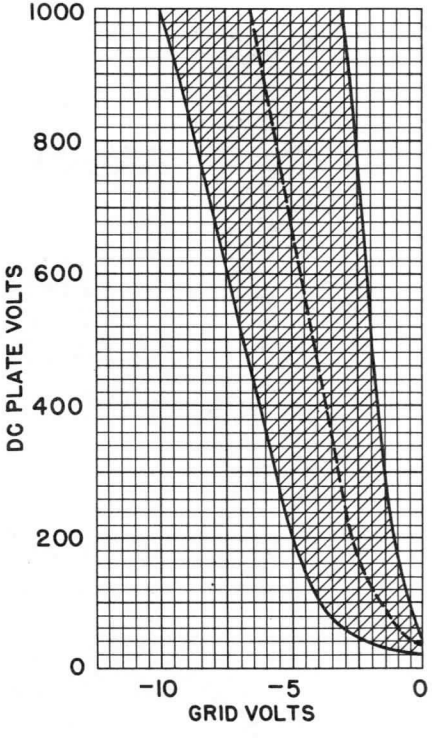
Peak	1.0 amp
Average (averaging time = max. 15 sec.)	0.25 amp

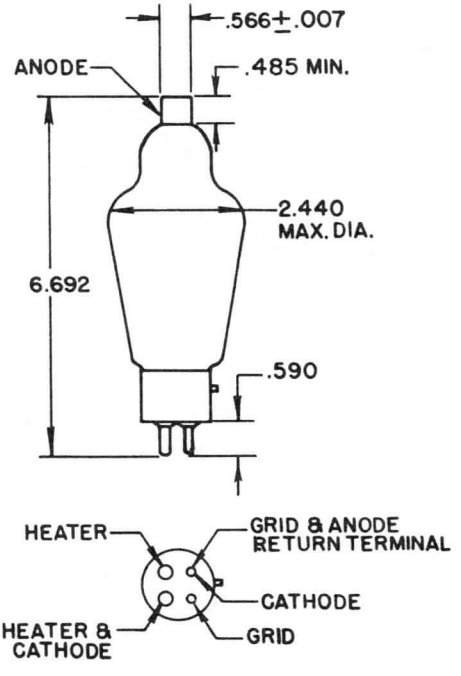
External resistance between grid and cathode	10,000 -50,000 ohms
Temperature limits, condensed mercury	+ 40 to + 75°C
Recommended Temperature, condensed mercury	+ 45°C

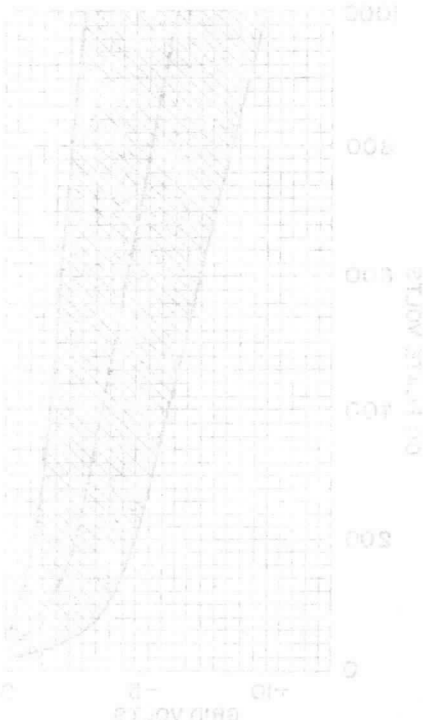
* Max. 1000 volts for temperature range = + 75 to + 80°C

Notes

After a shutdown of the supply lasting less than 1 minute, full load can again be applied to the tube immediately. For every additional 5 minutes of shutdown, 1 minute of pre-heating is necessary, until 5 minutes pre-heat is reached.


1000
800
600
400
200
0
DC PLATE VOLTS
-10
-5
0
GRID VOLTS


.566±.007
ANODE
.485 MIN.
2.440
MAX. DIA.
6.692
.590
HEATER
GRID & ANODE
RETURN TERMINAL
CATHODE
HEATER &
CATHODE
GRID



AMPEREX THYRATRON TYPE AX-5727

The AX5727 is an inert-gas filled tetrode thyratron with negative control characteristics. It is a ruggedized version of the standard type 2D21 thyratron and is designed to assure dependable life and reliable operation in relay and servo-control applications under the most exacting conditions encountered in mobile and aircraft equipment.

The tube features a high control ratio independent of temperature over a wide range, low anode-to-grid capacitance and very low grid current.

The AX5727 heater-cathode construction has been designed to give the tube a high degree of mechanical strength combined with high dependability of electrical characteristics to withstand the vigorous requirements of intermittent operation.

This tube will meet all electrical and mechanical tests prescribed in the MIL specifications.

GENERAL CHARACTERISTICS

ELECTRICAL DATA

Heater Voltage	6.3	volts
Heater current	0.60	ampere
Cathode heating time	10	seconds
Anode-to-control-grid capacitance	0.026	uuf
Control-grid to cathode and shield-grid capacitance	2.4	uuf
Deionization time, approximate		
Ebb = 125 volts d-c, Ib = 0.1 ampere d-c		
Ec_1 = −100 volts d-c	35	microseconds
Ec_1 = −11 volts d-c	75	microseconds
Ionization time, approximate	0.5	microseconds
Anode voltage drop	8	volts
Critical grid current, Ebb = 460 volts rms	0.5	microamp

MECHANICAL DATA

Type of cooling		air
Mounting position		any
Net weight, maximum	0.3	ounce

MAXIMUM RATINGS (absolute values)

GRID CONTROLLER RECTIFIER SERVICE

Maximum peak anode voltage		
Inverse	1300	volts
Forward	650	volts
Maximum cathode current		
Peak	0.5	ampere
Average	0.1	ampere
Maximum averaging time	30	seconds
Fault, maximum duration 0.1 second	10	amperes

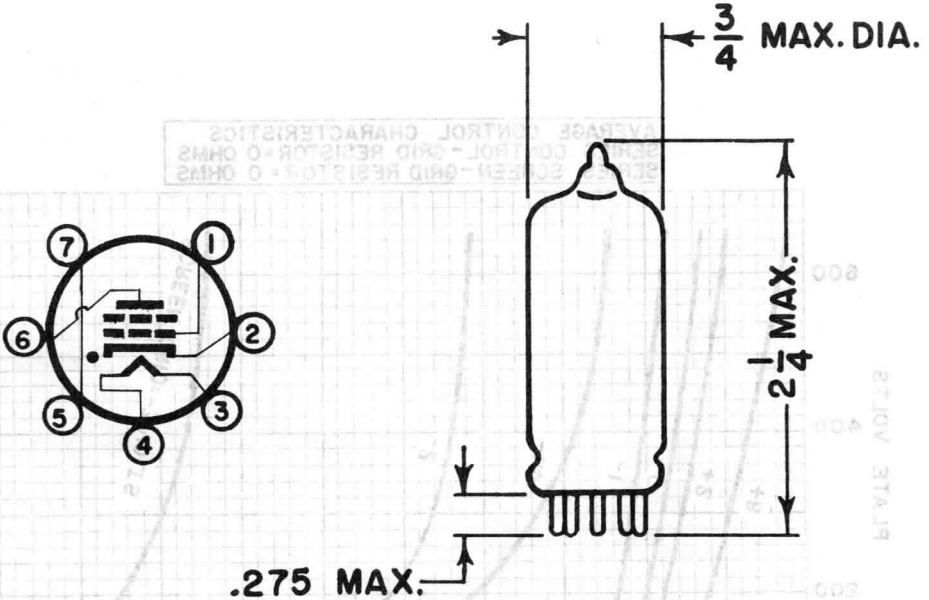
AX-5727

Maximum negative control-grid voltage	
Before conduction	− 100 volts
During conduction	− 10 volts
Maximum positive control-grid current	
Average, (averaging time one cycle)	10 milliamperes
Maximum negative shield-grid voltage	
Before conduction	− 100 volts
During conduction	− 10 volts
Maximum positive shield-grid current	
Average, (averaging time one cycle)	10 milliamperes
Maximum heater-cathode voltage	
Heater negative	− 100 volts
Heater positive	+ 25 volts
Maximum control-grid circuit resistance	0.1 megohm
Ambient temperature limits	−75 to + 90°C

PULSE-MODULATOR SERVICE:

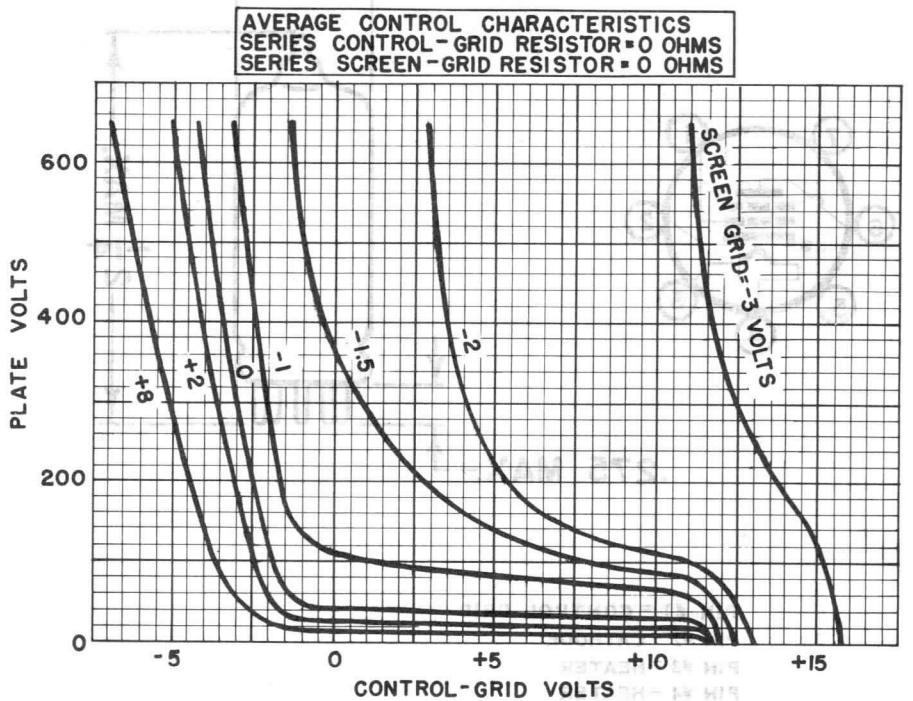
Maximum Peak Anode voltage	
Inverse	100 volts *
Forward	500 volts
Maximum cathode current	
Peak	10 amperes
Average	0.01 ampere
Maximum negative control-grid voltage	
Before conduction	− 100 volts
During conduction	− 10 volts
Maximum positive control-grid current	
Peak	20 milliamperes
Maximum negative shield-grid voltage	
Before conduction	− 50 volts
During conduction	− 10 volts
Maximum positive shield-grid currend	
Peak	20 milliamperes
Maximum pulse duration	5 microseconds
Maximum pulse recurrence rate	500 pulses per sec.
Maximum duty cycle	0.001
Maximum rate of change of cathode current	100 amperes per microsecond
Maximum heater-cathode voltage	0 volt
Maximum shield-grid circuit resistance	25000 ohms
Minimum shield-grid circuit resistance	2000 ohms
Maximum control-grid circuit resistance	0.5 megohm
Ambient temperature limits	−75 to + 90°C
Maximum impact acceleration in any direction	750 g.

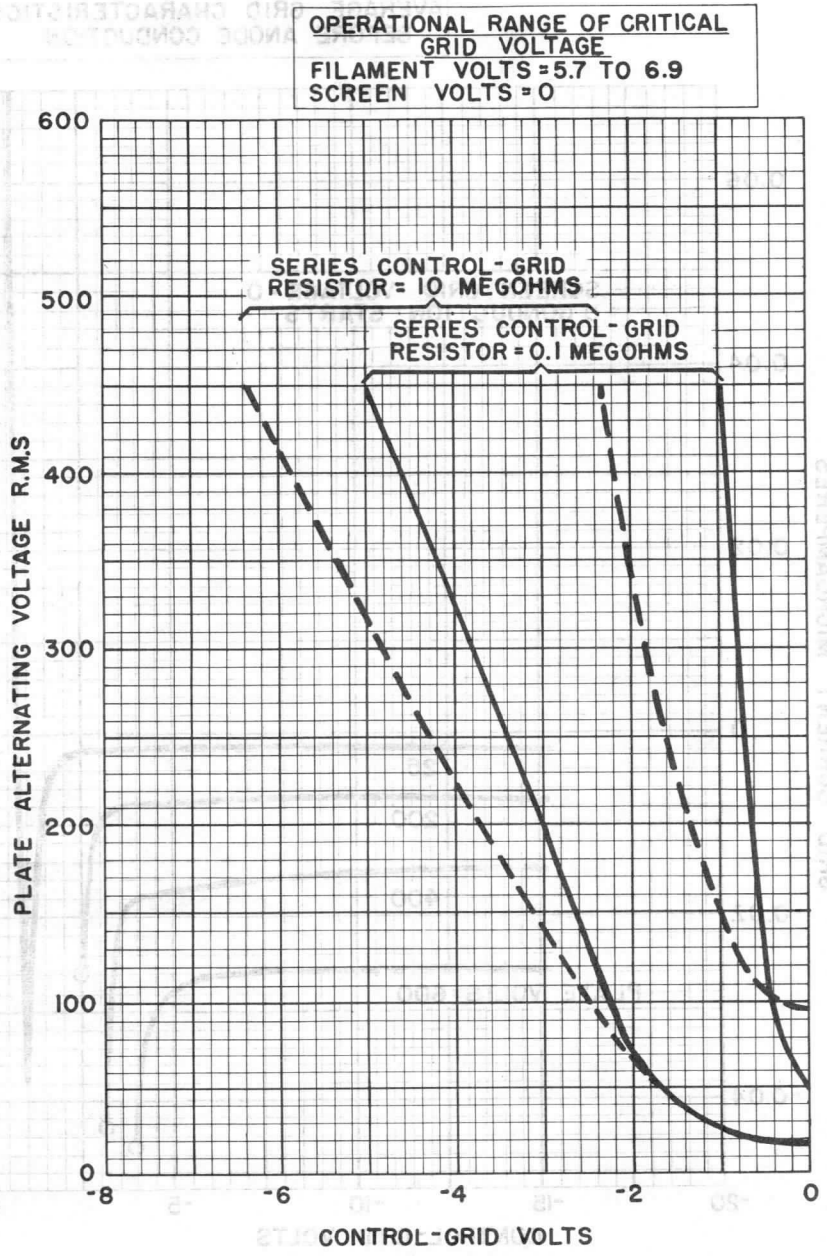
* After the completion of a pulse, a 20-microsecond delay is required before a positive voltage of more than 10 volts is applied to the tube.



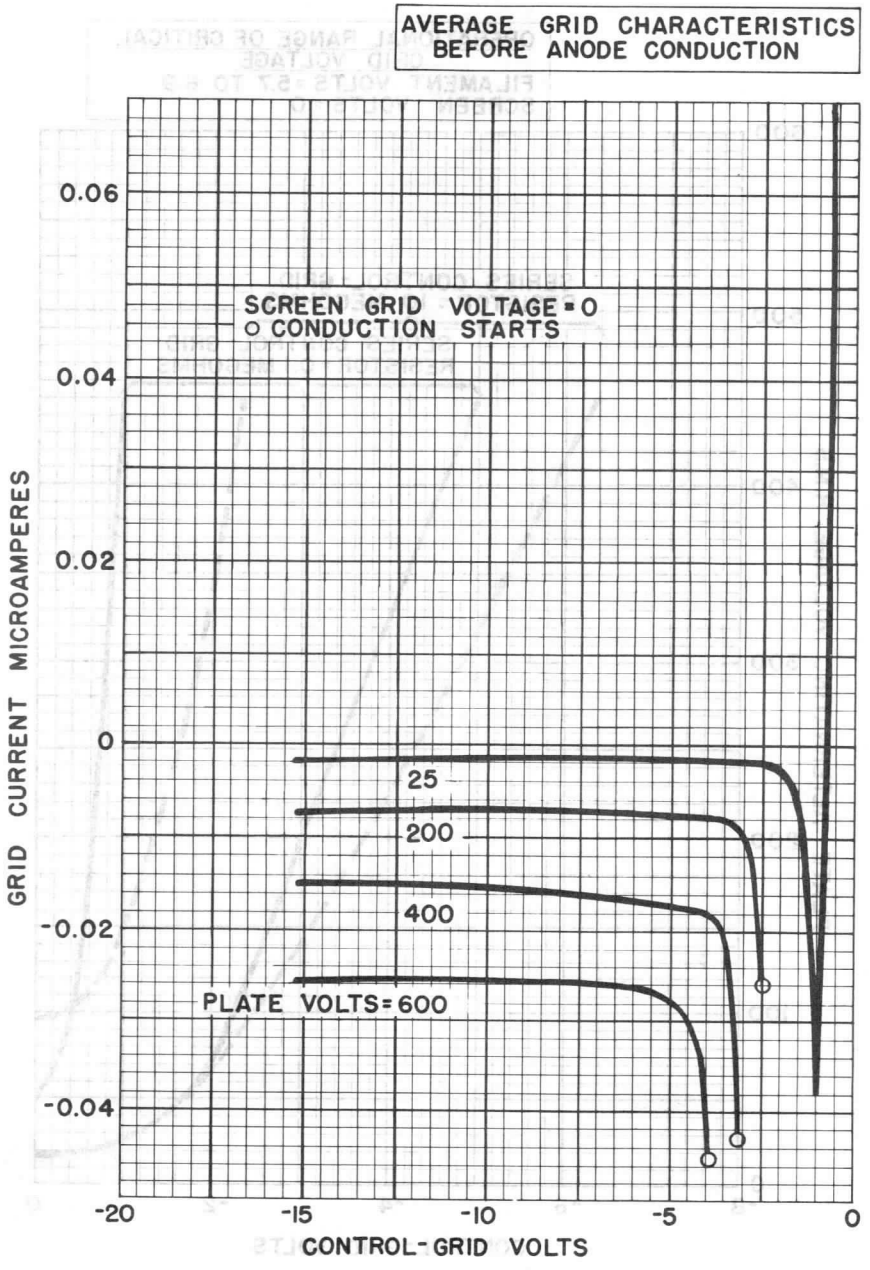
PIN #1 = CONTROL GRID
PIN #2 = CATHODE
PIN #3 = HEATER
PIN #4 = HEATER
PIN #5 = SCREEN GRID
PIN #6 = ANODE
PIN #7 = SCREEN GRID

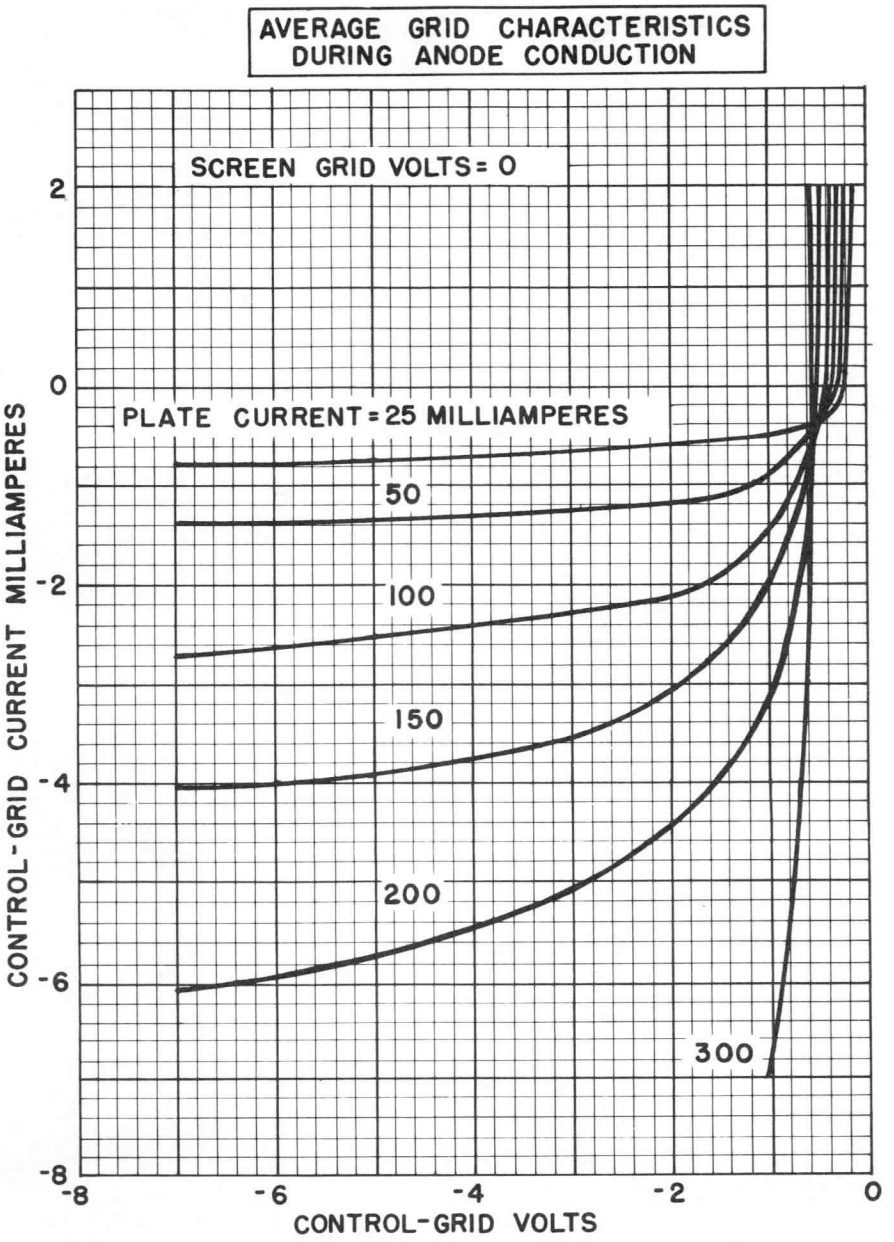
AX-5727


AVERAGE CONTROL CHARACTERISTICS
SERIES CONTROL-GRID RESISTOR = 0 OHMS
SERIES SCREEN-GRID RESISTOR = 0 OHMS
PLATE VOLTS
600
400
200
0
-5
0
+5
+10
+15
CONTROL-GRID VOLTS
+8
+2
0
-1
-1.5
-2
SCREEN GRID=-3 VOLTS


OPERATIONAL RANGE OF CRITICAL GRID VOLTAGE
FILAMENT VOLTS = 5.7 TO 6.9
SCREEN VOLTS = 0
SERIES CONTROL-GRID RESISTOR = 10 MEGOHMS
SERIES CONTROL-GRID RESISTOR = 0.1 MEGOHMS
PLATE ALTERNATING VOLTAGE R.M.S
600
500
400
300
200
100
0
-8
-6
-4
-2
0
CONTROL-GRID VOLTS

AX-5727


AVERAGE GRID CHARACTERISTICS
BEFORE ANODE CONDUCTION
SCREEN GRID VOLTAGE = 0
○ CONDUCTION STARTS
0.06
0.04
0.02
0
-0.02
-0.04
25
200
400
PLATE VOLTS = 600
GRID CURRENT MICROAMPERES
-20
-15
-10
-5
0
CONTROL-GRID VOLTS


AVERAGE GRID CHARACTERISTICS
DURING ANODE CONDUCTION
SCREEN GRID VOLTS = 0
PLATE CURRENT = 25 MILLIAMPERES
50
100
150
200
300
CONTROL-GRID CURRENT MILLIAMPERES
2
0
-2
-4
-6
-8
-8
-6
-4
-2
0
CONTROL-GRID VOLTS

AVERAGE GRID CHARACTERISTICS
DURING ANODE CONDUCTION

SCREEN GRID VOLTS= 0

PLATE CURRENT = 25 MILLIAMPERES

300

200

150

100

50

0

-2

-4

-6

-8

CONTROL-GRID VOLTS

SCREEN-GRID CURRENT MILLIAMPERES

AMPEREX THYRATRON 5869/AGR-9950

The 5869/AGR-9950 is a three-electrode mercury-vapor rectifier with negative control characteristics. This tube is designed for grid-control rectifier applications of relatively high voltage and current. The cathode is directly heated, oxide-coated.

GENERAL CHARACTERISTICS

ELECTRICAL DATA

Filament Voltage [1]	5.0±5% volts
Filament Current at 5.0 Volts	avg. 6.5, max 7.5 amps
Filament Heating time [2] (before applying Plate Voltage)	min. 60 seconds
Anode-to-control-grid capacitance	3 $\mu\mu$f
Control-grid-to-cathode capacitance	8 $\mu\mu$f
Deionization Time, approximately	250 μseconds
Ionization Time, approximately	10 μseconds
Typical Bias at 13,000 volts	−100 volts
Typical Bias at 10,000 volts	− 50 volts
Typical Grid Current (Average)	1 ma
Typical Grid Resistance	20,000 ohms
Tube Voltage Drop (Output current = 1 amp)	13 volts

MECHANICAL DATA

Type of cooling - Convection	
Equilibrium Condensed-Mercury Temperature Rise	
At Full Load, approximately	+25°C
At No Load, approximately	+22°C
Mounting position	Vertical with base down
Socket	Johnson 123-211 or equal
Net weight, approximately	8.5 ounces

[1] In order to obtain maximum life from the tube it is recommended that a filament voltage phase shift of 90° ±30° with respect to plate voltage be applied.

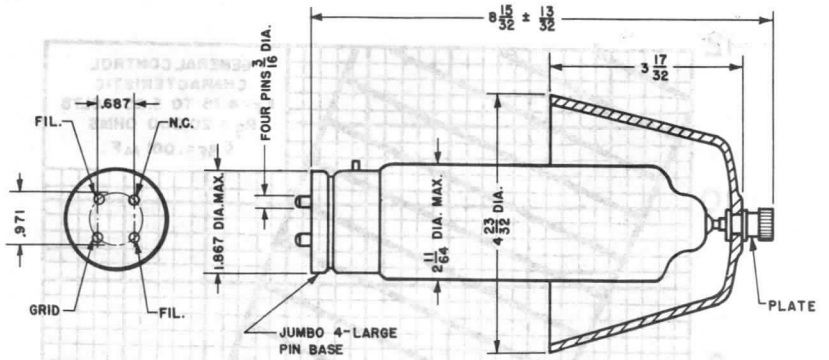
[2] The minimum heating time refers only to the filament. Sufficient additional time must be allowed to permit the condensed mercury temperature limit to rise to the minimum condensed mercury temperature limit and to permit all the mercury to condense in the lower part of the tube. Particular attention must be paid to tubes which have been in storage for extended periods and tubes initially placed in service. Tubes which have been stored or handled must be placed in a vertical base down position to allow time for the mercury to become distributed in the tubes.

MAXIMUM RATINGS, ABSOLUTE VALUES

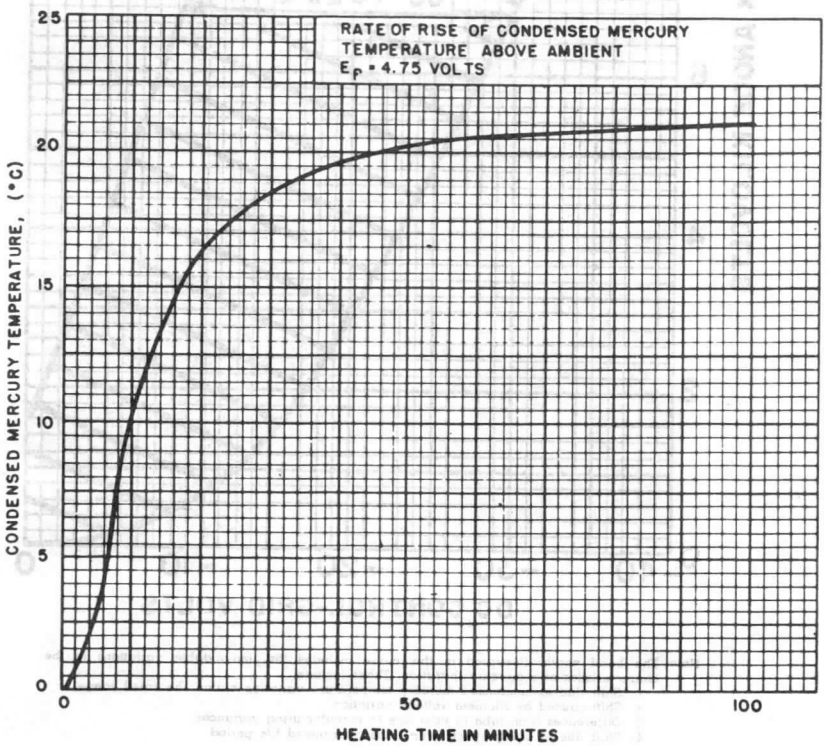
Maximum Peak Anode Voltage			
Inverse	13,000		10,000 volts
Forward	13,000		10,000 volts
Condensed Mercury			
Temperature Limits	+25° to +55°		+25° to +60°C
Maximum Plate Current			
Peak		4.0	amp
Average (Averaging time max. 10 sec.)		1.0	amp
Surge, for design only		40	amp
(Maximum duration 0.1 second)			
Maximum Negative Control-Grid Voltage			
Before Conduction		300	volts
Maximum Positive Control-Grid Current			
Average (Averaging time max. 10 sec.)		10	ma
Peak		50	ma
Maximum Grid Resistance		0.1	megohms
Frequency Range		25 — 150	cps

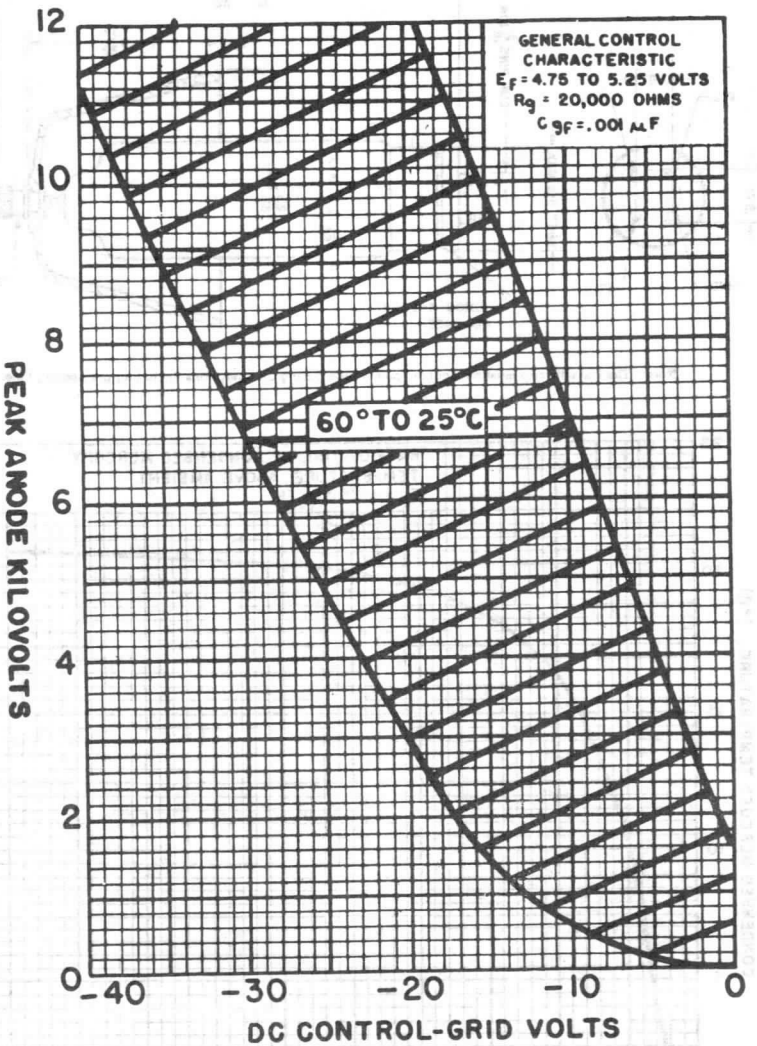
Circuit	Input Voltage rms value kv	D.C. Output Voltage to filter kv	D.C. Output Current amp
* Single-phase, full-wave — 2 tubes	4.6	4.1	2
Three-phase, half wave — 3 tubes	5.3	6.2	3
Three-phase, double-Y parallel — 6 tubes	2x5.3	6.2	6
Four-phase, half-wave — 4 tubes	4.6	5.8	4
Single-phase, full-wave — 4 tubes	9.2	8.3	2
Three-phase, full-wave — 6 tubes	9.2	12.4	3
Four-phase, full-wave — 8 tubes	9.2	11.7	4

* Voltage across one half of transformer.



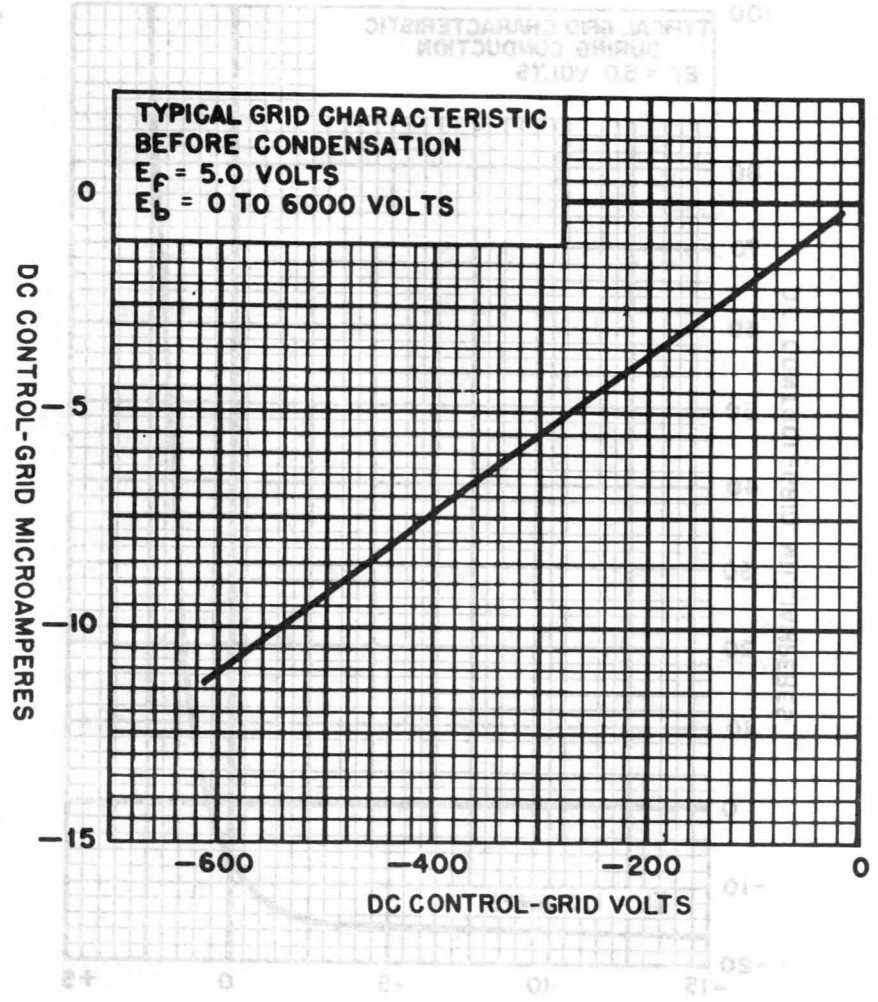
Note: The bakelite cap must be mounted on the tube during all operations, including pre-heating time.



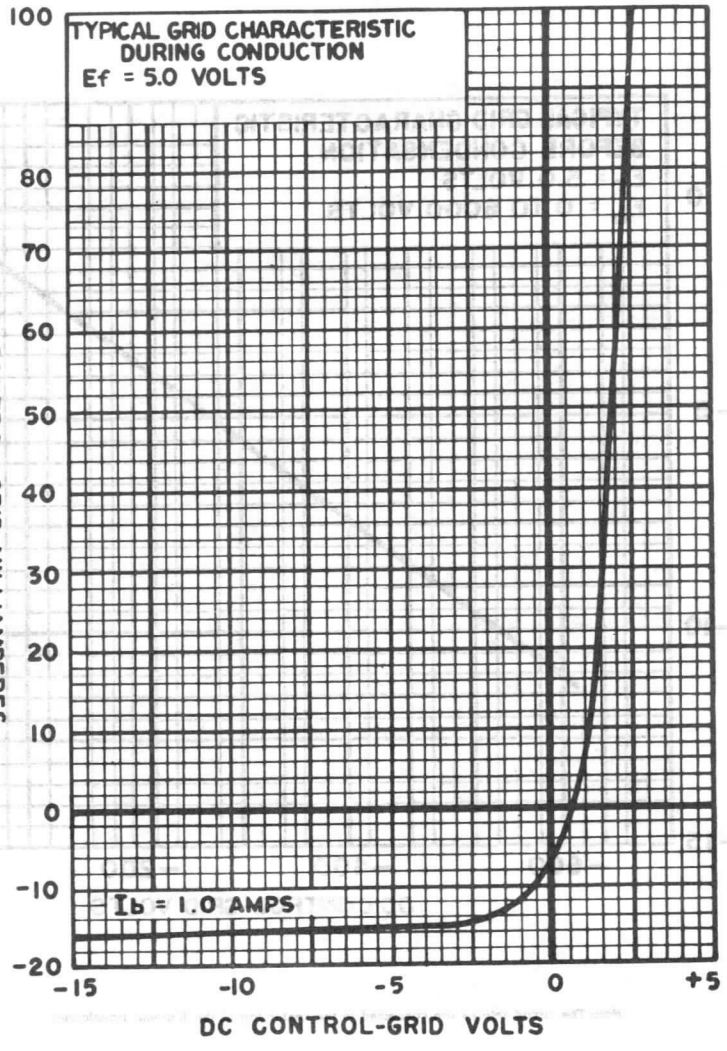


Note: The band width illustrated in this curve includes the unavoidable variations in the characteristics of a mercury thyratron. These include:

1. Shift due to condensed mercury temperature variation within the rated range.
2. Shift caused by filament voltage variation.
3. Differences from tube to tube due to manufacturing variances.
4. Shift due to aging effects within the guaranteed life period.



Note: The circuit returns are connected to the center tap of the filament transformer.



Note: The circuit returns are connected to the center tap of the filament transformer.

AMPEREX THYRATRON 5870/AGR-9951

The Amperex 5870/AGR-9951 is a three-electrode mercury-vapor rectifier with negative control characteristics. This tube is designed for grid-control rectifier applications of relatively high voltage and current. The cathode is directly heated, oxide-coated.

GENERAL CHARACTERISTICS

MECHANICAL

Type of cooling	convection
Equilibrium condensed-mercury temperature rise	
At full load (approx)	+ 15° C
At no load (approx)	+ 13° C
Mounting position	vertical, with base down
Accessories	
Socket	Johnson #124-215 or equal
Top cap	S-25818 ←
Plate cap	S-25819 ←
Net weight (approx)	1-3/4 lbs.

ELECTRICAL

Filament	oxide coated
Filament voltage [1]	5.0 volts
Filament current at 5 volts	13.5 amps
Filament heating time [2] (before applying plate voltage)	90 seconds min
Direct Interelectrode Capacitances	
Plate to control grid	4 μμf
Control grid to cathode	13 μμf
Deionization time	500 microseconds
Ionization time	10 microseconds
Tube voltage drop (Output current = 2.5 amps)	12 volts

NOTES

[1] In order to obtain maximum life from the tube it is recommended that a filament voltage phase shift of 90° ± 30° with respect to plate voltage be applied.

[2] The minimum heating time refers only to the filament. Sufficient additional time must be allowed to permit the condensed mercury temperature limit to rise to the minimum condensed mercury temperature limit and to permit all the mercury to condense in the lower part of the tube. Particular attention must be paid to tubes which have been in storage for extended periods and tubes initially placed in service. Tubes which have been stored or handled must be placed in a vertical base down position to allow time for the mercury to become distributed in the tube. ←

Maximum Ratings, Absolute Values

Peak Inverse plate voltage (f = 150 c/s max)	27,000 volts max
Peak forward plate voltage	27,000 volts max
Peak plate current	10 amps max
Output current	2.5 amps max
Surge current, for design only (maximum duration 0.1 second)	100 amps max
Negative control grid voltage (before conduction)	300 volts max
Control grid current (averaging time = 30 sec max)	25 mA max
Peak control grid current	125 mA max
Grid resistance	0.1 megohm max
Frequency range	25 - 150 cps

Temperature range

Peak inverse plate voltage (KV)	27	21	15	13	10
Condensed mercury temperature (°C)[3]	30-40	30-45	25-50	25-55	25-60
Ambient temperature (°C)[4]	20-25	20-30	15-35	15-40	15-45

Maximum Operating Conditions
(Peak Inverse plate voltage = 27,000 volts)

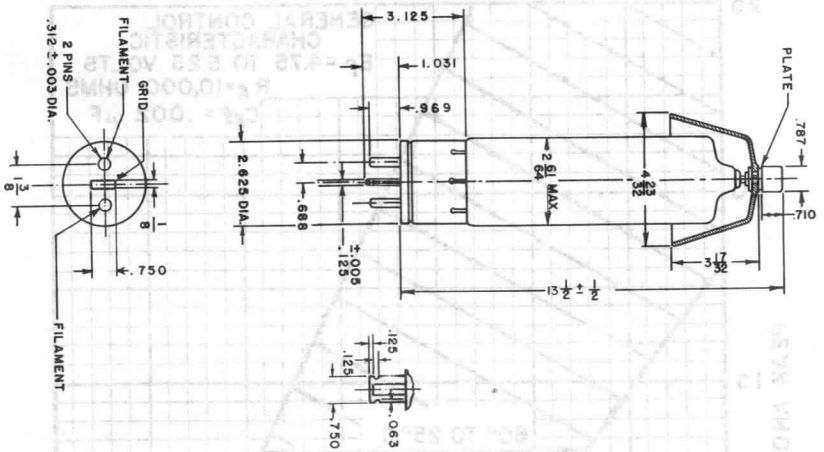
Circuit	Input Voltage rms value kV	D-C Output Voltage To Filter kV	D-C Output Current amp	D-C Output Power kW
Single-phase, full wave 2 tubes	9.5	8.6	5	43
Three-phase, half wave 3 tubes	11	12.9	7.5	97
Three-phase, double-Y parallel 6 tubes	9.5	11.2	15	168
Four-phase, half wave 4 tubes	9.5	12.1	10	121
Single-phase, full wave 4 tubes	19.1	17.2	5	86
Three-phase, full wave 6 tubes	19.1	25.8	7.5	194
Four-phase, full wave 8 tubes	19.1	24.3	10	243

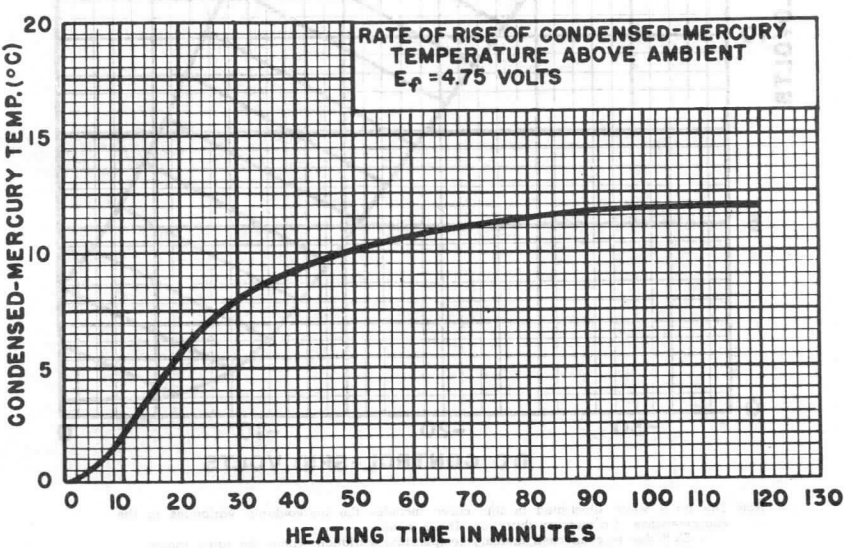
Typical Operation

Negative grid voltage at 27,000 volts	100 volts
Negative grid voltage at 10,000 volts	50 volts
Grid current (average)	2 mA
Grid resistance	10,000 ohms

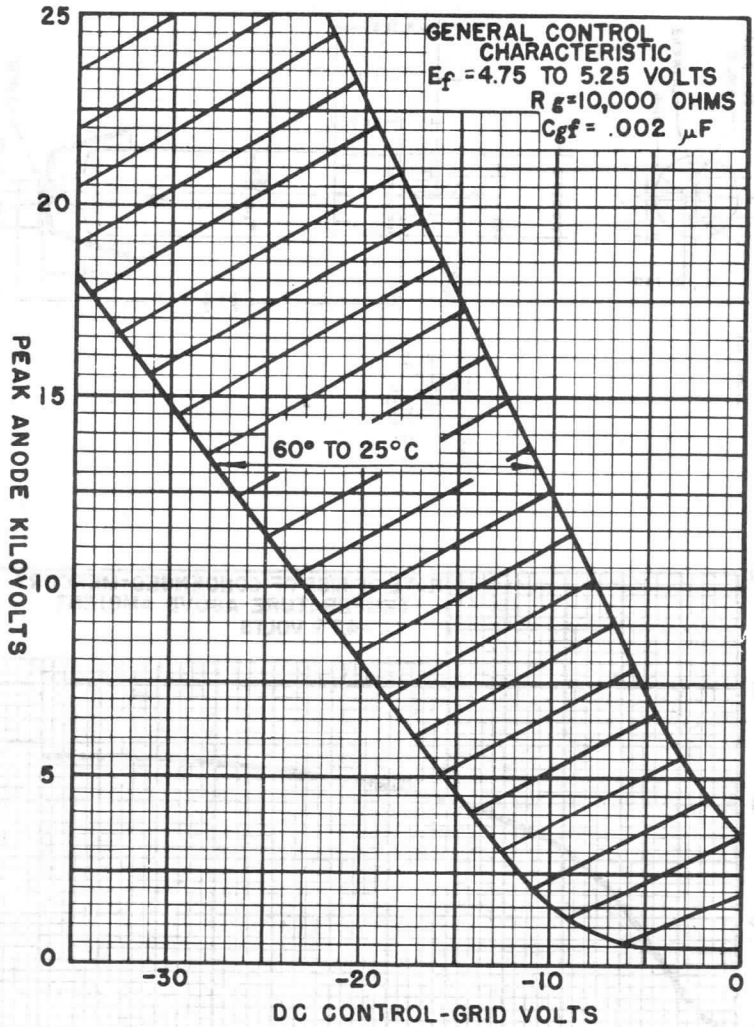
[3] If the equipment is started not more than twice daily, application of high voltage at a condensed mercury temperature 5°C less than the values mentioned is permitted.

[4] With natural cooling; approximate values


2 PINS .312 ±.003 DIA.
FILAMENT
GRID
FILAMENT
.750
3.125
1.031
.969
2.625 DIA.
.688
±.005 -.125
2 51/64 MAX
4.625 -.032
PLATE
.787
.710
3 17/32
13½ ± ½
.125
.125
.750
.063

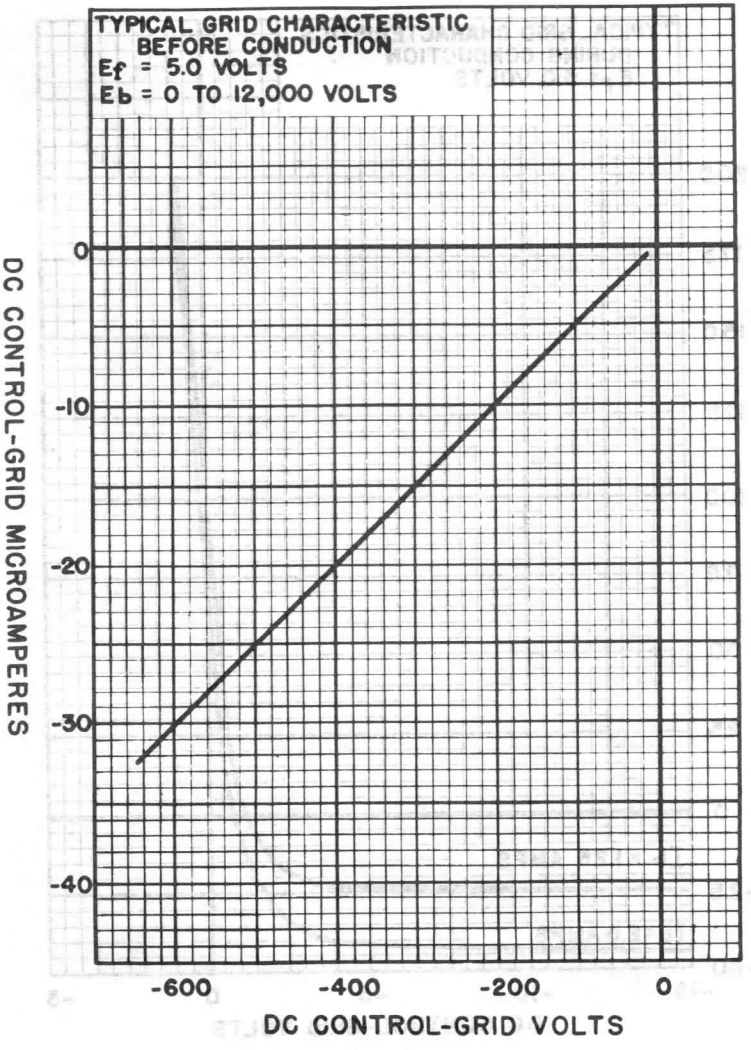

RATE OF RISE OF CONDENSED-MERCURY TEMPERATURE ABOVE AMBIENT
Ef = 4.75 VOLTS
CONDENSED-MERCURY TEMP. (°C)
0
5
10
15
20
0 10 20 30 40 50 60 70 80 90 100 110 120 130
HEATING TIME IN MINUTES

5870/AGR-9951

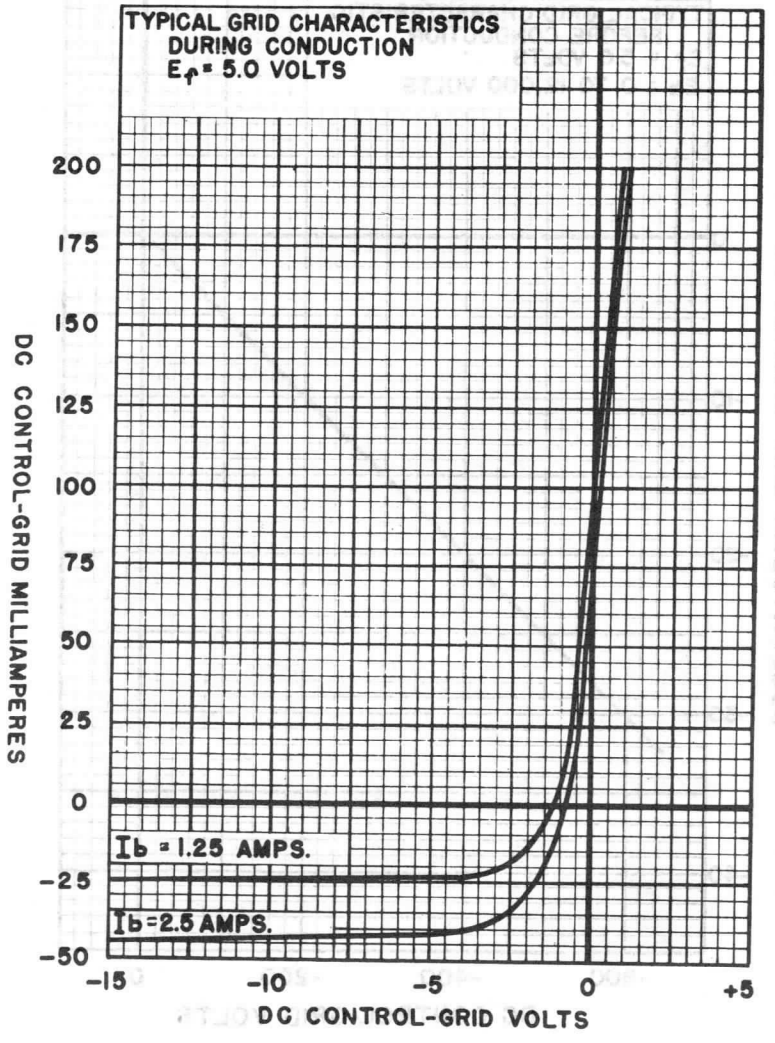


Note: The band width illustrated in this curve includes the unavoidable variations in the characteristics of a mercury thyratron. These include:

1. Shift due to condensed mercury temperature variation within the rated range.
2. Shift caused by filament voltage variation.
3. Differences from tube to tube due to manufacturing variances.
4. Shift due to aging effects within the guaranteed life period.



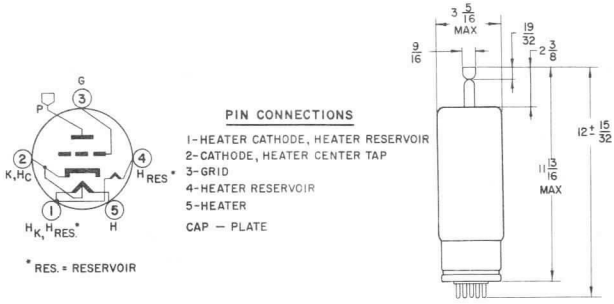
Note: The circuit returns are connected to the center tap of the filament transformer.



Note: The circuit returns are connected to the center tap of the filament transformer.

AMPEREX THYRATRON TYPE 5949/1907

The 5949/1907 is an indirectly heated hydrogen thyratron especially designed for use in pulse modulator circuits of microwave radar systems. The electrical midpoint of the heater is connected to the cathode in order to minimize jitter. The tube has a positive control characteristic and allows high peak currents at high working voltages with a high pulse repetition rate. In pulse forming network discharge service, it is capable of producing a pulse output power of more than 6 MW at an average power level of more than 6 KW.



GENERAL CHARACTERISTICS

MECHANICAL DATA

Dimensions	see outline drawing
Envelope	see outline drawing
Plate Cap [1]	see outline drawing
Base	medium shell, giant 5 pin bayonet
Mounting Position	any [2]
Cooling [3]	radiation
Max Plate Terminal Temperature	200°C
Net Weight	20 ounces

ELECTRICAL DATA [4]

Heater Voltage	6.3 ± 5%
Heater Current	15 - 22 amperes
Reservoir Voltage [5]	3 - 5.5 volts
Reservoir Current	2 - 5 amperes
Minimum Heating Time (cathode + reservoir)	15 minutes

1 The anode cap should be connected to its cable with a solder suitable for operation at temperatures up to 200°C.
2 Vertical position with base down is recommended.
3 Cooling of the anode lead may be accomplished by directing a stream of air on it. However, care should be exercised to avoid having this stream of air come into contact with the glass envelope.
4 In order to prevent uncontrolled emission due to ionization of the hydrogen filling, the tube should be kept away from strong fields.
5 The optimum value of reservoir voltage must not vary more than ±5% of the value stamped on the base.

5949/1907

MAXIMUM RATINGS, ABSOLUTE VALUES

Plate Supply Voltage	5000 volts min
Peak Plate Voltage [6]	25,000 volts max
	10,000 volts min
Peak Plate Inverse Voltage [7]	25,000 volts max
	0.05 e_p min
Peak Plate Current	500 amps max
Average Plate Current	0.5 amps max
Peak Grid Voltage [8]	1000 volts max
	550 volts min
Peak Grid Inverse Voltage [8]	450 volts max
Grid Circuit Impedance [8,9]	50 - 200 ohms
Grid Pulse Time [8]	2 microseconds
Operating Factor [10]	6.25×10^9
Rate of Plate Current Rise	2500 amps/microsecond max
Rate of Grid Voltage Rise [8]	1800 volts/microsecond min
Plate Time Jitter	0.01 microsecond
Ambient Temperature	$-55^{\circ}C$ to $+75^{\circ}C$

TYPICAL OPERATION
(Pulse Modulator)

Peak Plate Voltage	25,000	20,000 volts
Peak Plate Current	500	200 amps
Grid Pulse Time	2	1 microsecond
Grid Pulse Frequency	500	1200 c/s

WARNING

High voltage thyratrons emit X-rays which can be extremely harmful. The intensity of these X-rays is maximum in a narrow beam emanating in a circle from the grid-plate region. Adequate shielding should therefore be provided personnel operating or testing these tubes.

[6] Instantaneous starting is not recommended. However, if absolutely necessary, the maximum permissable peak anode voltage is 18 KV reached in 0.04 seconds minimum.

[7] In pulse operation the peak plate inverse voltage should not exceed 5 KV during the first 25 microseconds after pulse (except with a spike of max 0.05 microseconds duration).

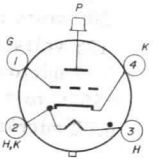
[8] Measured at socket with grid disconnected.

[9] Impedance of grid drive.

[10] Operating factor = e_b (volts) x i_b (amps) x grid pulse frequency (c/s). (This relationship holds true for a repetition rate of up to 2000 pps).

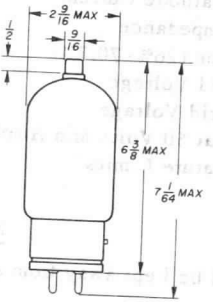
AMPEREX THYRATRON TYPE 6268

The Amperex 6268 is a three electrode, hydrogen filled thyratron with a self-contained and self-regulating source of hydrogen. This tube has a positive control characteristic and is designed for long-life pulse modulator applications. The life expectancy of this tube is over 1000 hours. It is completely interchangeable in every respect with the standard type 4C35 tube.



PIN CONNECTIONS

1 - GRID
2 - HEATER, CATHODE
3 - HEATER
4 - CATHODE
TOP CAP - PLATE



GENERAL CHARACTERISTICS

MECHANICAL

Heating	direct
Dimensions	see outline drawing
Mounting Position	any
Base	Standard jumbo 4 pin with bayonet (A4-18)
Cooling	see note 1
Clamping	see note 2
Weight (approx)	7 ounces

ELECTRICAL

	Min	Bogey	Max
Heater Voltage	5.8	6.3	6.6 volts
Heater Current (at 6.3 Volts)	5.5	6.1	6.7 amps
Cathode Heating Time Required	180		seconds
Tube Drop (egk)			150 volts
Trigger Voltage (source unloaded)	130		volts
Trigger Width (70%)	2.0		microseconds
D-C Plate Striking Voltage at 130 Volts Peak Trigger Voltage			1500 volts
Plate Delay Time (from 26% of Trigger Pulse to Start of Current Pulse)			0.6 microseconds
Plate Delay Time Drift			0.15 microseconds
Waiting Time	3		minutes

[1] Cooling of the plate lead is permissible, but there shall be no air blast directly on the bulb.

[2] Clamping is permissible at the base.

Revised 2/61

6268

Maximum Ratings, Absolute Values

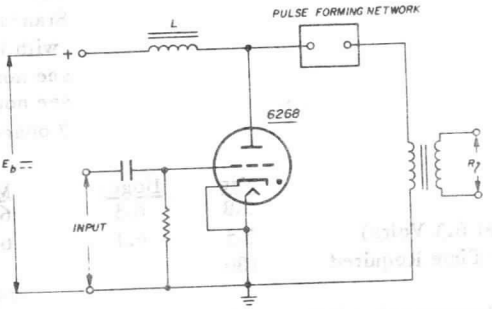
Supply Voltage	2500 volts min
Peak Inverse Plate Voltage [3]	8000 volts max
Peak Forward Plate Voltage [4]	8000 volts max
Plate Current	100 mA max
Peak Plate Current	90 amps max
Operating Factor [5]	2.0×10^9
Rate of rise of Cathode Current	1000 amps/microsec max
Trigger Source Impedance	1500 ohms max
Trigger Rise Time (26%- 70.7%)	0.5 microsec max
Peak Inverse Grid Voltage	200 volts max
Peak Forward Grid Voltage	175 volts min
Pulse duration (at 50 Volts Min Amplitude)	2 microsec min
Ambient Temperature Limits	$-55^{\circ}C$ to $+ 90^{\circ}C$
Time Jitter [6]	0.02 microsec max

NOTE

The tube should be kept away from strong fields which could ionize the gas in the tube.

The return lead of the plate and grid circuits should be connected to pin 4.

TYPICAL MODULATOR CIRCUIT



3 For instantaneous starting applications where plate voltage is applied instantaneously, the maximum permissible forward voltage is 7000 volts and shall not be attained in less than 0.04 seconds.

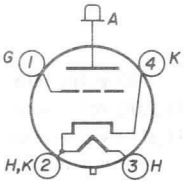
4 In pulsed operation, the peak inverse voltage, exclusive of spike of 0.05 microsecond maximum duration shall not exceed 2500 volts during the first 25 microseconds after the pulse.

5 Operating factor = the value of peak forward voltage x the pulse repetition rate x peak plate current. The stated maximum value applies to pulse repetition rates which are not far in excess of 2800 pulses per second. For considerably higher values consult Amperex "Applications Engineering".

6 Measured at 3000 volts in typical circuit. Under practical operating conditions the average value of plate time jitter is 0.004 microseconds.

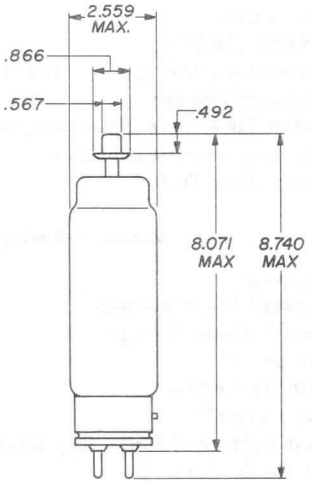
AMPEREX THYRATRON TYPE 6279

The Amperex 6279 is a three electrode, hydrogen filled thyratron with a self-contained and self-regulating source of hydrogen.[1] This tube has a positive control characteristic and is designed for long-life pulse modulator applications. The life expectancy of this tube is over 1000 hours. It is completely interchangeable in every respect with the standard type 5C22 tube.



PIN CONNECTIONS
1. GRID
2. HEATER, CATHODE
3. HEATER
4. CATHODE

CAP–ANODE



GENERAL CHARACTERISTICS

MECHANICAL

Dimensions	see outline drawing
Mounting Position	any
Base	Standard Jumbo 4 pin with Bayonet (A4-18)
Cooling	See Note 2
Clamping	See Note 3
Weight (approx)	9½ ounces

---

1 The tube should be kept away from strong fields which could ionize the gas in the tube.

2 Cooling of the plate lead is permissible, but there shall be no air blast directly on the bulb.

3 Clamping is permissible at the base and/or the bulb in the area up to 4¼ inches above the top of the base only.

6279

ELECTRICAL

Heater Voltage	6.3 volts ± 7.5%
Heater Current at 6.3 Volts	9.6 amps min
	11.6 amps max
Cathode Heating Time Required	5 minutes min
Tube drop (egk)	175 volts max
Trigger Voltage (source unloaded)	200 volts min
Trigger rise time	0.5 microsec max
Trigger Width (70.7%)	2.0 microsec min
DC Plate Striking Voltage at 150 Volts Peak Trigger Voltage	2500 volts max
Plate Delay Time (from 26% of trigger pulse to start of current pulse)	1.0 microsec max
Plate Delay Time Drift	0.15 microsec max

Maximum Ratings, Absolute Values

Supply Voltage	4500 volts min
Peak Forward Plate Voltage [4]	16,000 volts max
Peak Inverse Plate Voltage [5]	16,000 volts max
Cathode Current	200 mA max
Peak Cathode Current	325 amps max
Operating Factor [6] (Forward Voltage X Pulse Repetition Rate X Peak Current)	3.2×10^9
Plate Time Jitter [7]	0.02 microsec max
Rate of Rise of Cathode Current	1500 amps/microsec max
Trigger Source Impedance	500 ohms max
Trigger Rise Time (26% - 70.7%)	0.5 microsec max
Trigger Pulse Duration [8]	2 microsec max
Peak Inverse Grid Voltage	200 volts max
Peak Forward Grid Voltage	200 volts max
Ambient Temperature Limits	$-50^{\circ}C$ to $+90^{\circ}C$

---

[4] In pulsed operation, the peak inverse voltage, exclusive of spike of 0.05 microseconds max duration, shall not exceed 5,000 volts during the first 25 microseconds after the pulse.

[5] For instantaneous starting applications where plate voltage is applied instantaneously, (use time = 0.04 sec.) the maximum permissible peak plate voltage is 13,500 volts.

[6] This value applies to pulse repetition rates which are not far in excess of 1000 pulses per second. For considerably higher values consult Amperex "Applications Engineering".

[7] Measured at 5000 volts in typical circuit. Under practical conditions the average value of the plate time jitter is approx 0.004 microsec.

[8] At 50 volts min amplitude.

AMPEREX THYRATRON TYPE 6786

TENTATIVE DATA

The type 6786 is a mercury vapor thyratron with a peak inverse rating of 15 KV and an average plate current of 10 amperes. For intermittent operation, a maximum plate current of 15 amperes may be used.

The 6786 is designed for high current power supplies in industrial R.F. generators and radio transmitters.

Under normal ambient temperature conditions, no forced air cooling is required or necessary. In addition to the unusual high current characteristics which make this tube unique in its class, the grid control offers the following advantages:

IN INDUSTRIAL R.F. GENERATORS

1. The grid control is a special advantage for the rapid protection of the equipment in case of load arc-overs or short circuits.
2. The tube can be used where accurate stabilization of the R.F. current is required. The grid control features make it unusally suitable for accurate control of R.F. output by phase shifting the grid voltage.
3. For intermittent industrial applications, the 6786 allows for electronic control of the time of "on" and "off" cycles without the need for any mechanical components and associated relays.

IN RADIO TRANSMITTERS

4. The use of this tube allows the plate voltage to be brought up slowly, thus increasing the life of the associated equipment and R.F. power tubes. In addition the grid control may be used to stabilize or adjust the plate voltage of the transmitter.
5. The grid control may be used as a protection device for the equipment. It allows for ultra rapid switching-off of the high voltage and subsequently, a rapid "come-back" with minimum "off-the-air" time.

The tube has a convenient "plate" type mounting support base and ceramic insulated flexible leads which make installation in equipment rapid and simple.

GENERAL CHARACTERISTICS

ELECTRICAL	
Cathode	indirectly heated, oxide coated
Heater Voltage	5 volts
Heater Current	20 amperes max.
Heating Time, minimum [1]	10 minutes
Tube Voltage Drop [2]	12 volts
Equilibrium condensed mercury temperature rise over ambient	
No Load	27° C
Full Load	30° C
Direct Interelectrode Capacitances	
Grid to Plate	8 $\mu\mu$f
Grid to Cathode	35 $\mu\mu$f
MECHANICAL	
Mounting Position	vertical, anode terminal up
Max. Overall Length (without leads)	15 1/4 inches
Max. Diameter	4 5/8 inches
Net Weight (approx.)	2 lbs, 9 ozs.

[1] **For average conditions; temperature within limits and proper distribution of mercury. After transportation and also long interruption of service, a longer heating time is required before the anode voltage is applied, to insure proper distribution of the mercury. In general, a period of 45 minutes is sufficient. In addition 10 minutes after the heater voltage is applied, preheating of the anode must be started by connecting the anode to a supply voltage of max. 500 volts via a resistor limiting the anode current to 6 amperes.**

[2] **Measured at an average current of 15 amperes.**

Revised 1/57

MAXIMUM RATINGS

Peak Inverse Anode Voltage [3]	15 KV max.
Peak Forward Anode Voltage	15 KV max.
Average Anode Current [4]	
Continuous Operation	10 amps. max.
Intermittent Operation	15 amps. max.
Peak Anode Current	45 amps. max.
Surge Anode Current (max. 0.1 sec.)	600 amps. max.
Peak Grid Voltage	600 volts max.
Grid Resistance	20,000 ohms max.

Relation Between Condensed Mercury Temperature, Ambient Temperature and Peak Inverse Voltage [5]

Peak Inverse Anode Voltage	15	10 KV
Condensed Mercury Temp.	25-60	25-65 °C
Ambient Temp. [6]	10-30	10-35 °C

MAXIMUM OPERATING CONDITIONS
PEAK INVERSE ANODE VOLTAGE = 15 KV

(Transformer regulation and tube voltage drop are not included)

Circuit Diagram	Type of Circuit	Max transformer sec. rms voltage (Vtr) KV	DC output voltage to filter (Vo) KV	Max DC output current to filter (Io) Amps	Max DC output to filter (Wo) KW
a.	Single-phase, full-wave, 2 tubes	5.3	4.8	20	96
b.	Single-phase, full-wave, 4 tubes	10.6	9.6	20	192
c.	Three-phase, half-wave, 3 tubes	6.1	7.2	30	216
d.	Three-phase, full-wave, 6 tubes	10.6	14.4	30	432
e.	Three-phase, double Y, 6 tubes parallel	5.3	6.2	60	372
f.	Four-phase, half-wave, 4 tubes	5.3	6.7	40	268
g.	Four-phase, full-wave, 8 tubes	10.6	13.5	40	540

[3] For frequencies up to 150 cps.

[4] Averaged over 10 second interval.

[5] If the equipment is started at most twice daily, it is permissible to apply high voltage at a condensed mercury temperature of 20° C.

[6] With natural cooling, approximate values. The tube may be operated at higher ambient temperatures than the maximum values given when the difference between the ambient and condensed mercury temperature (28° C with natural cooling) is reduced by an air flow directed on the bulb just above the base. A reduction to less than 10° C can easily be obtained with a simple air jet.

When a tube must be operated instantly, a reduction is recommended in heater voltage to 60-80% of the given nominal value for stand-by periods of more than 30 minutes.

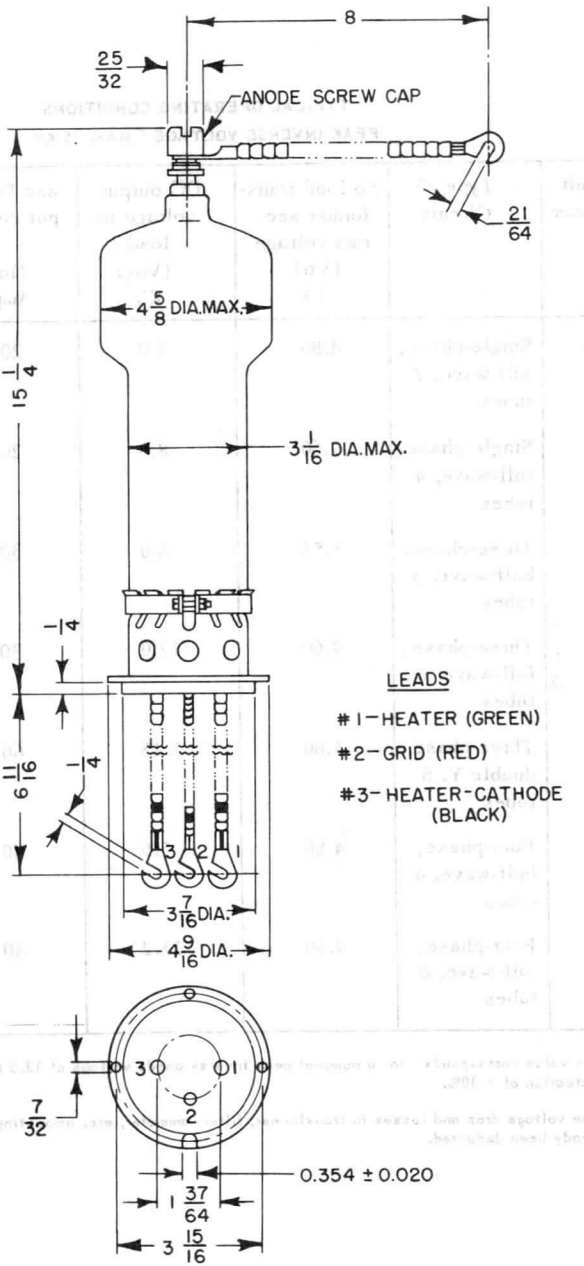
TYPICAL OPERATING CONDITIONS
PEAK INVERSE VOLTAGE = MAX. 15 KV [7]

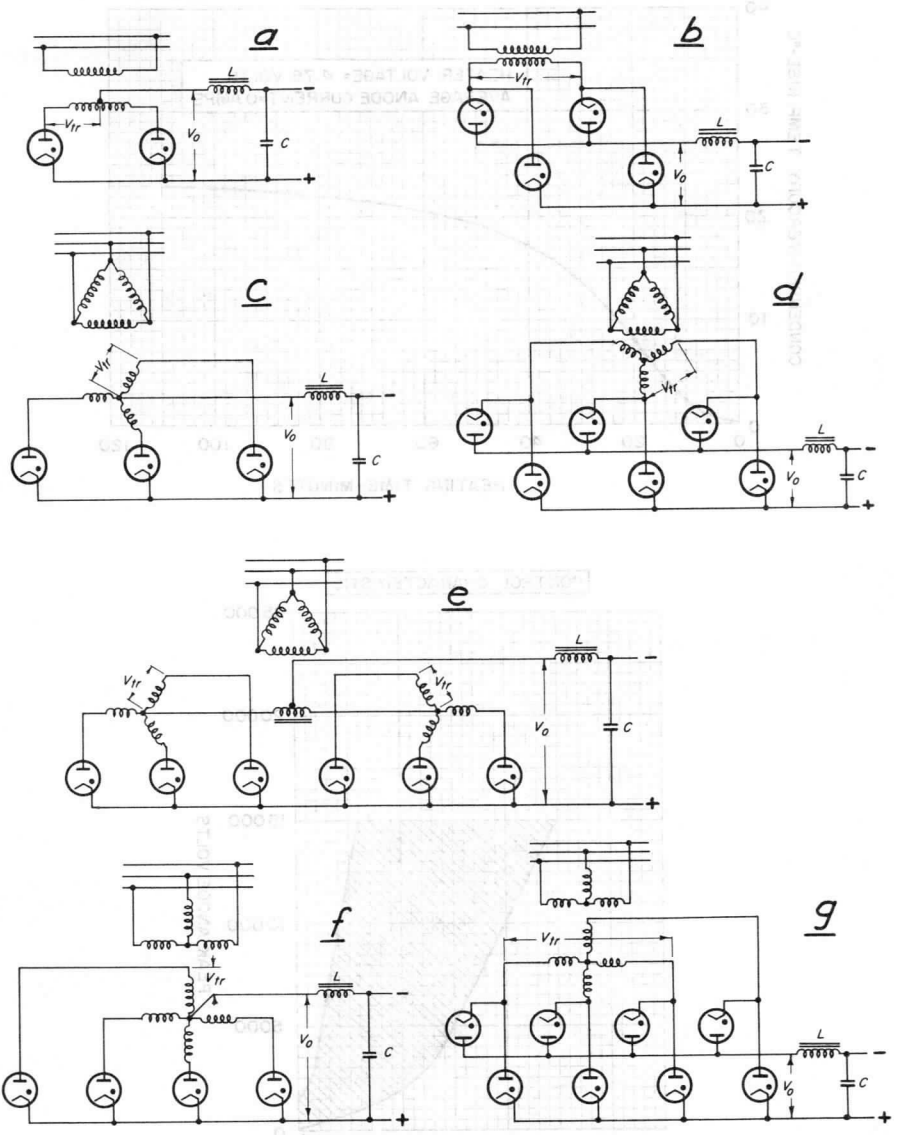
Circuit Diagram	Type of Circuit	No load transformer sec. rms voltage (Vtr) KV	DC output voltage to load [8] (Vo_1) KV	Max DC output current (Io) Amps	DC output to load (Wo_1) KW
a.	Single-phase, full-wave, 2 tubes	4.80	4.0	20	80
b.	Single-phase, full-wave, 4 tubes	9.60	8.0	20	160
c.	Three-phase, half-wave, 3 tubes	5.55	6.0	30	180
d.	Three-phase, full-wave, 6 tubes	9.60	12.0	30	360
e.	Three-phase, double Y, 6 tubes	4.80	5.15	60	309
f.	Four-phase, half-wave, 4 tubes	4.80	5.6	40	224
g.	Four-phase, full-wave, 8 tubes	9.60	11.2	40	448

[7] This value corresponds to a nominal peak inverse anode voltage of 13.6 KV, allowing a line fluctuation of ± 10%.

[8] Tube voltage drop and losses in transformer, filter, ammeter, etc. amounting to 8% of Vo_1 have already been deducted.

6786


8
25/32
ANODE SCREW CAP
21/64
4 5/8 DIA.MAX.
15 1/4
3 1/16 DIA.MAX.
1/4
6 11/16
1/4
LEADS
#1-HEATER (GREEN)
#2-GRID (RED)
#3-HEATER-CATHODE (BLACK)
3 7/16 DIA.
4 9/16 DIA.
3
2
1
7/32
0.354 ± 0.020
1 37/64
3 15/16


a
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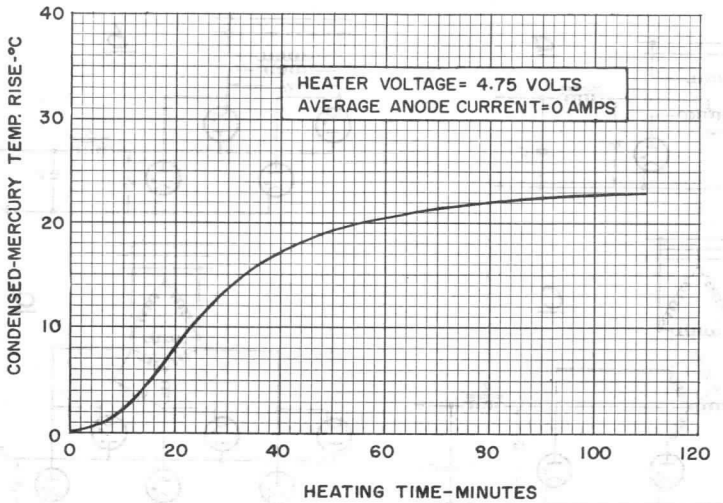
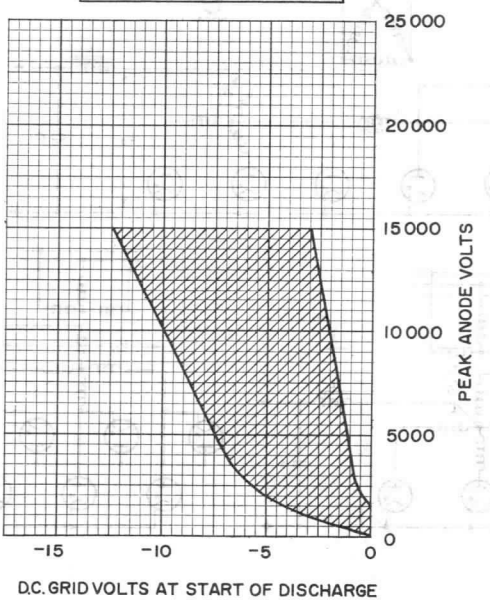
RATE OF RISE OF CONDENSED-MERCURY TEMPERATURE



CONTROL CHARACTERISTIC



Amperex

IGNITRONS

AMPEREX IGNITRON TYPE AX5551-A

GENERAL DESCRIPTION

The type AX5551-A is a water-cooled ignitron equipped with a sensing plate for mounting a thermostatic control assembly.

The tube is designed for both single phase and three phase welder control applications or similar heavy duty switching or control service. Thermostat assemblies are available in two types and must be ordered separately -

a) S-17024 - water saver thermostat assembly
b) S-17025 - overload protection thermostat assembly

When equipped with (a), the tube may be so connected that water flow is started only when required, thereby preventing waste of large water volumes.

Alternately, when equipped with (b), the tube may be protected from overload by interruption of the control circuits. (see instruction sheet)

Both functions may be achieved in a pair of tubes connected in inverse parallel by equipping one tube with water saver thermostat and the other with overload protection thermostat.

GENERAL CHARACTERISTICS

ELECTRICAL DATA

Cathode excitation	cyclic
Cathode spot starting	ignitor
Number of electrodes	
Main anodes	1
Main cathodes	1
Ignitors	1
Cathode excitation requirements	
Min. ignitor voltage required to fire	200 volts
Min. ignitor current required to fire	30 amps
Typical value of starting time at required min. voltage or current	100 u sec.

MECHANICAL DATA

Envelope material	Stainless steel internal housing
Max. overall length without anode connector	13 inches
Max. overall width	5 3/4 inches
Mounting Position	Vertical anode, connection up
Net Weight	3 lbs. 12 oz.

AX5551-A

THERMAL DATA

Type of Cooling		water	
Pressure drop at water flow of 1 gallon per min.	max.	1.8	pounds per square inch
Water temperature rise at water flow of 1 gallon per minute	max.	4° C	

A. With Thermostatic Control

Inlet water temperature, minimum	10° C
Inlet water temperature, maximum	40° C
Outlet water temperature, maximum	45° C
Minumum water flow at maximum demand, solenoid valve open	1 gal. per min.

B. Without Thermostatic Control

Inlet water temperature, minimum	10° C
Outlet water temperature, maximum	40° C
Minimum water flow at maximum demand	1 gal. per min.

Note: When the cooling systems of the tubes are connected in series the maximum values of the inlet and outlet water temperatures hold for the last tube in the water circuit.

MAXIMUM RATINGS, Absolute Values

(Frequency 25 - 60 cycles per sec.)

A.C. CONTROL SERVICE,[3] TWO TUBES IN INVERSE PARALLEL

Voltage	220	250 to 600	volts rms
Maximum demand [1]	530	600	KVA
Average current at maximum demand	30.2	30.2	amps
Maximum average current	56	56	amps
Demand at maximum average current [1]	180	200	KVA
Maximum averaging time at 220 - 250 volts rms [2]	18	18	sec.
Maximum averaging time at 600 volts rms [2]	—	7.5	sec.
Maximum surge current at 220 - 250 volts	6720	6720	amps
Maximum surge current at 600 volts	—	2800	amps
Maximum duration of surge current	0.15	0.15	sec.

Note: The demand voltage, current and KVA demand are on the basis of full-cycle conduction (no phase delay), regardless of whether or not phase control is used.

[1] For other values of the demand versus average current, see curves.

[2] For intermediate values of the demand voltage, the maximum averaging time is inversely proportional to the voltage.

[3] When operating at maximum demand with water-saver thermostat, it is recommended that an auxiliary switch be shunted across the thermostat and operated by the weld initiating switch so that water flows momentarily with every weld.

Revised 10/55

MAXIMUM RATINGS, Absolute Values (Con't)

INTERMITTENT RECTIFIER SERVICE

(Frequency 50 - 60 cycles per sec.)

Peak forward anode voltage		1200	1500	volts
Peak inverse anode voltage		1200	1500	volts
Peak anode current	max.	600	480	amps
Corresponding average anode current		5	4	amps
Average anode current	max.	22.5	18	amps
Corresponding peak anode current		135	108	amps
Averaging time	max.	10	10	sec.
Ratio of average to peak anode current (averaging time 0.2 sec.)	max.	0.166	0.166	
Ratio of surge to max. peak current	max.	12.5	12.5	
Duration of surge current	max.	0.15	0.15	sec.

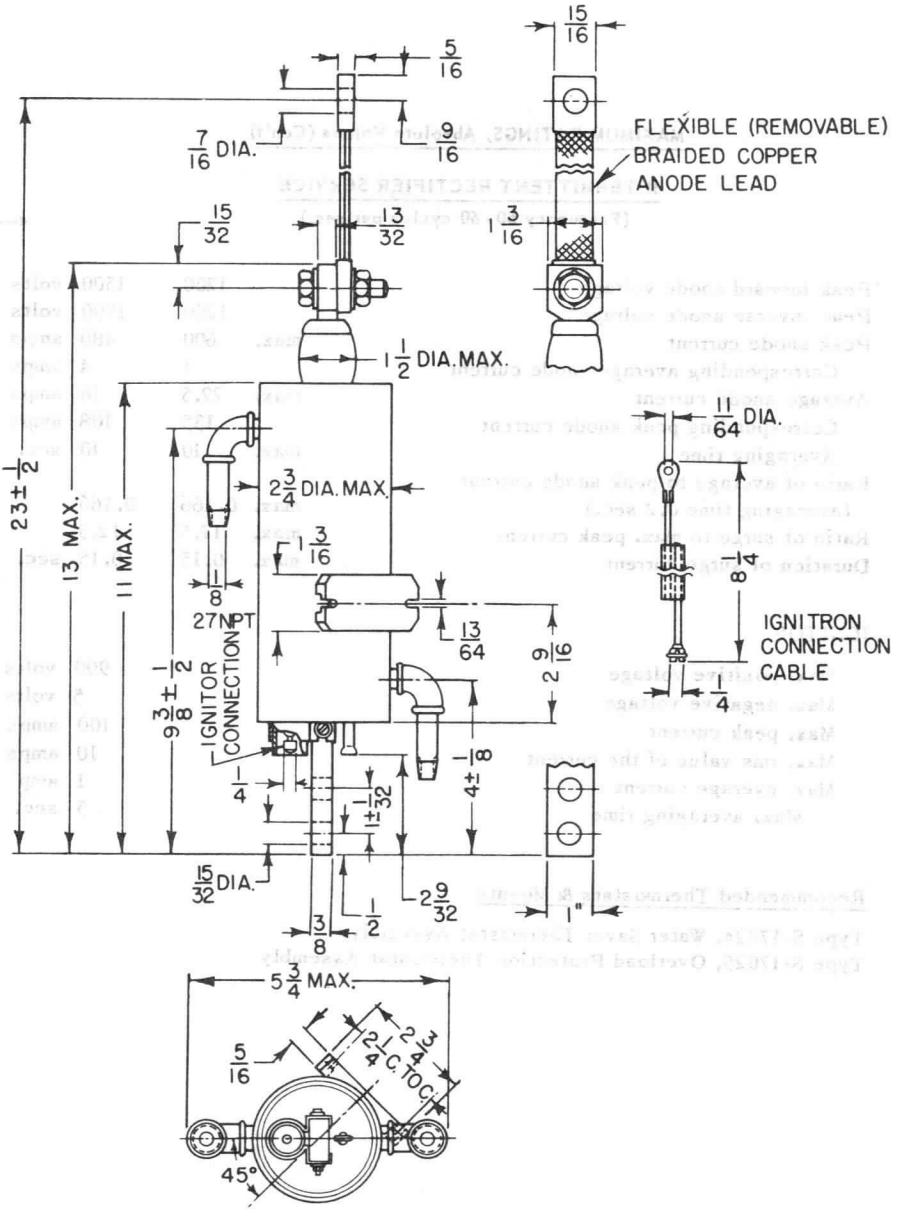
IGNITOR

Max. positive voltage		900	volts
Max. negative voltage		5	volts
Max. peak current		100	amps
Max. rms value of the current		10	amps
Max. average current		1	amp
Max. averaging time		5	sec.

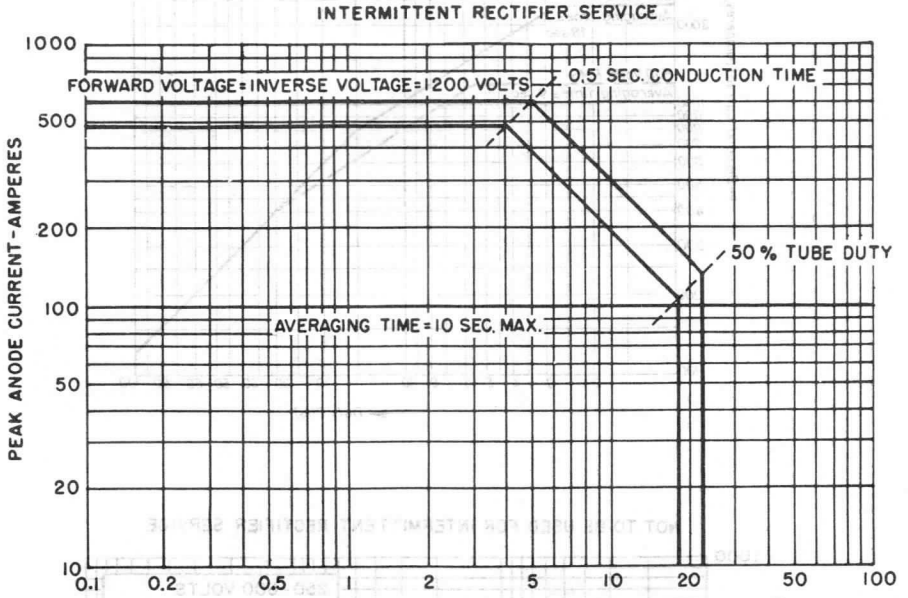
Recommended Thermostats & Mounts

Type S-17024, Water Saver Thermostat Assembly
Type S-17025, Overload Protection Thermostat Assembly

AX5551-A



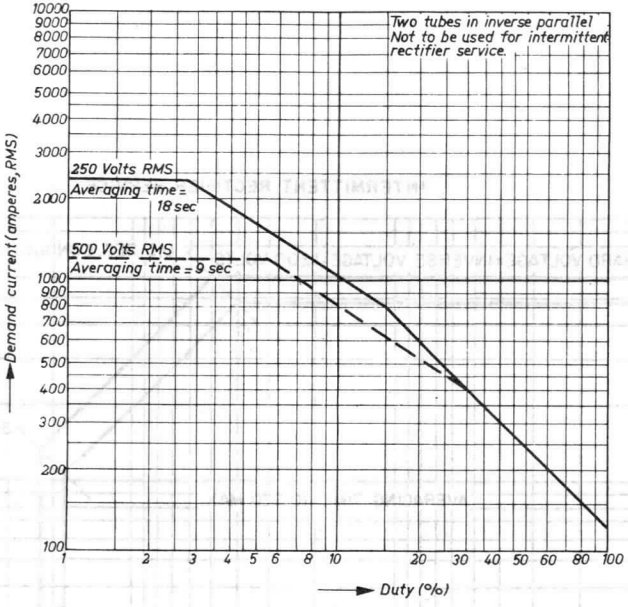
MOUNTING POSITION: VERTICAL, ANODE CONNECTION UP



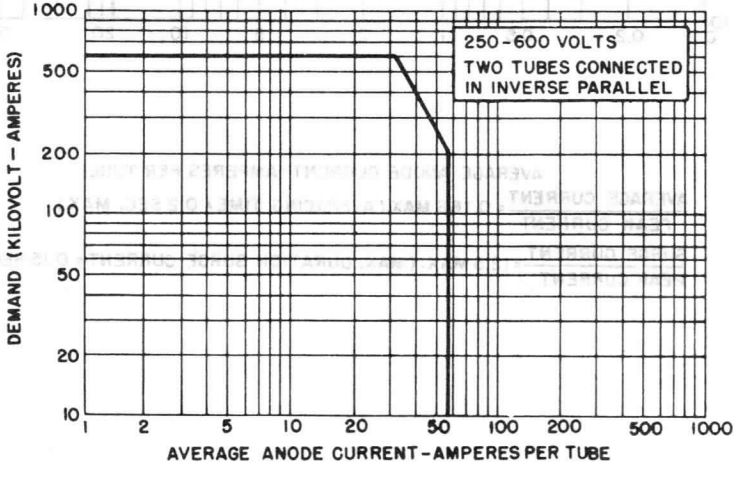
$\frac{\text{AVERAGE CURRENT}}{\text{PEAK CURRENT}}$ = 0.166 MAX. (AVERAGING TIME = 0.2 SEC. MAX.)

$\frac{\text{SURGE CURRENT}}{\text{PEAK CURRENT}}$ = 12.5 MAX. (MAX. DURATION SURGE CURRENT = 0.15 SEC.)

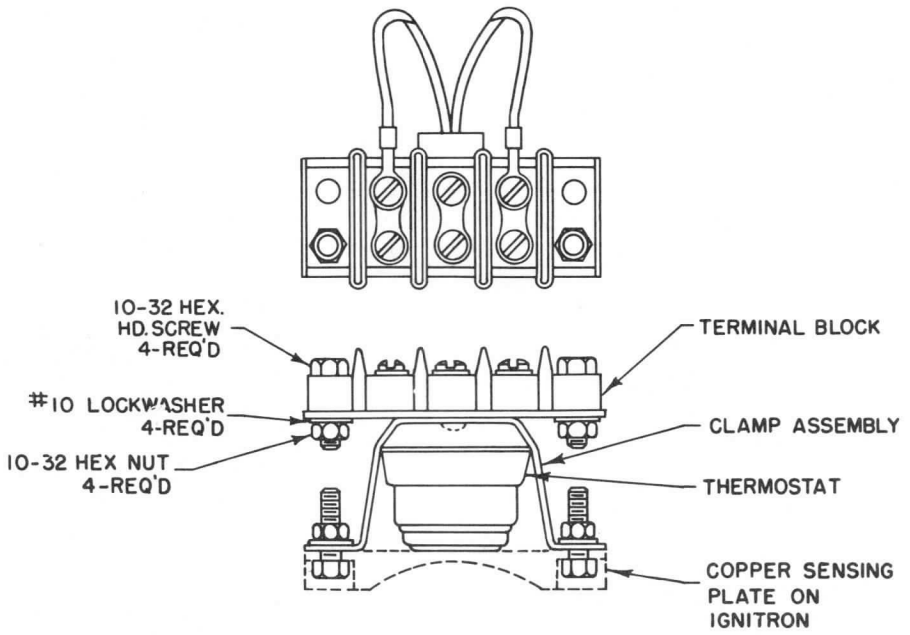
AX5551-A



NOT TO BE USED FOR INTERMITTENT RECTIFIER SERVICE



INSTRUCTION SHEET FOR S-17024 & S-17025



MOUNTING PROCEDURE:

1. MOUNT CLAMP LOOSELY ON SENSING PLATE WITH SCREWS, NUTS, AND WASHERS.
2. PLACE THERMOSTAT UNDER CLAMP WITH LEADS UPRIGHT.
3. TIGHTEN SCREWS TO RETAIN THERMOSTAT. MAKE SURE THAT DIMPLE ON CLAMP ENGAGES DEPRESSION IN RUBBER.
4. MOUNT TERMINAL BLOCK AS SHOWN.

NOTE: S-17024 UNIT CONTAINS WATER SAVER THERMOSTAT #C-4391-7-51
S-17025 UNIT CONTAINS OVERLOAD PROTECTION THERMOSTAT #C-4391-7-52

AMPEREX IGNITRON TYPE AX5552

GENERAL DESCRIPTION

Application: This stainless steel-jacketed ignitron can carry the high peak current for short periods encountered in welder control service. Two tubes in inverse parallel connection can control up to 1200 kva at line voltages between 250 and 600 V rms.

This tube can also be used for power rectification in intermittent rectifier service, such as rectifiers in the energy storage system of resistance welding.

The type AX-5552 ingitron features an improved ignitor conducive to long tube life and a heavy-duty, braided anode connector which may be removed from the tube proper.

GENERAL CHARACTERISTICS

Peak voltage drop, approximate	12 volts
Net weight, approximate	9 lbs.
Type of cooling	water
Maximum outlet water temperature	40 °C
Minimum flow	1.5 gal. per min.
Minimum inlet water temperature	10 °C
Pressure drop per tube at minimum flow	4.5 lbs. per sq. inch
Temperature rise at minimum flow, approximate (average current 100 amperes per anode)	6° C

MAXIMUM RATINGS

A-C Welder-Control Service-Frequencies from 25 to 60 cycles.
Ratings are for any voltage from 250 to 600 Volts rms 1 2
Two tubes in inverse parallel

Maximum demand	1200 kva
Corresponding average anode current	75.6 amperes
Maximum average anode current	140 amperes
Corresponding demand	400 kva
Maximum time of averaging anode current 1	
At 600 volts rms	5.8 seconds
At 250 volts rms	14 seconds
Maximum surge current, peak amperes	280 % of max. rms demand current

Rectifier Service - Frequencies from 25 to 60 cycles

Maximum peak anode voltage	
Inverse	500 volts
Forward	500 volts

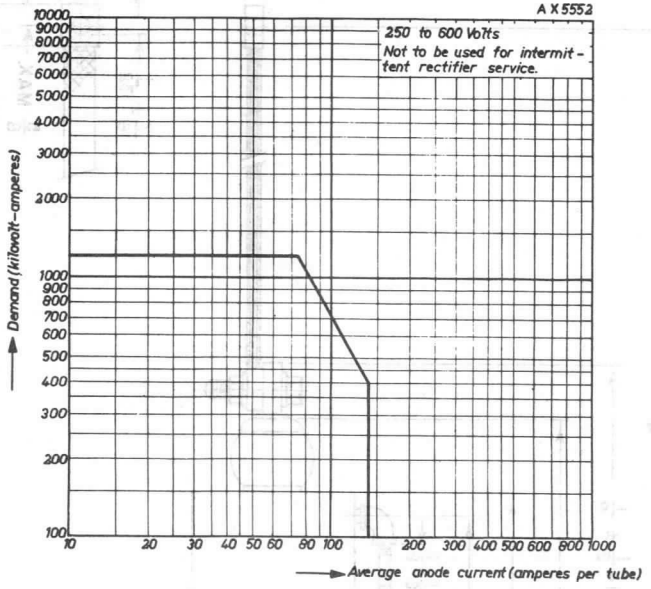
Maximum anode current	
Instantaneous	1600 amperes
Average, per tube	100 amperes
Averaging time	6 seconds
Surge, peak amperes, max. duration 0.15 second	6000 amperes

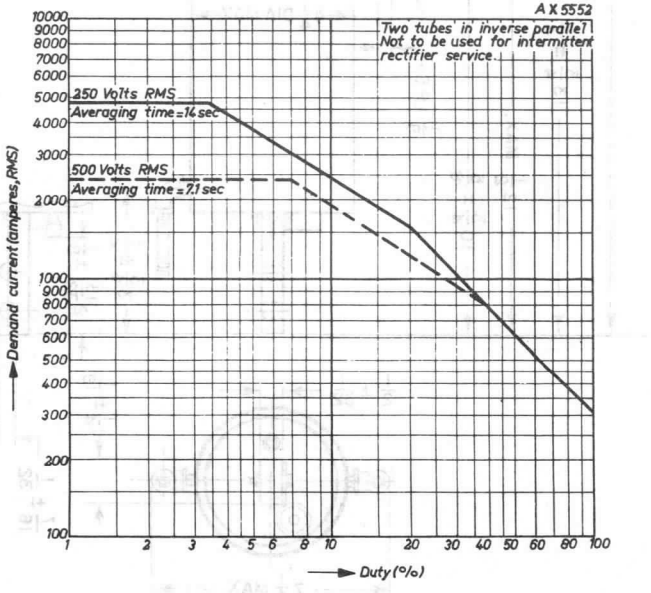
Ignition Requirement (same for both classes of service)

Ignitor voltage	
Maximum instantaneous allowed, ignitor positive	900 volts
Minimum instantaneous required, ignitor positive	200 volts ←
Maximum instantaneous allowed, ignitor negative	5 volts
Ignitor current	
Maximum instantaneous allowed	100 amperes
Minimum instantaneous required	30 amperes ←
Maximum average allowed	1 ampere
Ignitor ignition time, maximum	100 microseconds
Ignitor current averaging time	5 seconds

1 With the use of log-log paper, straight line interpolation between the two points tabulated may be used to determine other detailed ratings.

2 Rms demand voltage, current, and kva are all on the basis of full-cycle conduction (no phase delay) regardless of whether or not phase control is used. For voltages below 250 volts, use the 250 volt rating.


AX5552
250 to 600 Volts
Not to be used for intermittent rectifier service.
Demand (kilovolt-amperes)
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
900
800
700
600
500
400
300
200
100
10
20
30
40
50
60
80
100
200
300
400
500
600
800
1000
Average anode current (amperes per tube)


AX5552
Two tubes in inverse parallel
Not to be used for intermittent rectifier service.
250 Volts RMS
Averaging time = 14 sec
500 Volts RMS
Averaging time = 7.1 sec
Demand current (amperes, RMS)
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
900
800
700
600
500
400
300
200
100
1
2
3
4
5
6
8
10
20
30
40
50
60
80
100
Duty (%)

AX5552

1 1/16 MAX.
1/2 ± 1/16
7/16 ± 1/32
5/8 MAX.
2 MAX.
26 ± 3/4
14 1/2 ± 1/8
13 3/4 ± 1/4
12 1/2 MAX.
10 3/4 ± 5/8
1 1/2 ± 1/2
1/8 I.P.S.
4 1/4 DIA. MAX.
3 3/4 ± 1/2
2 13/32
1/8 ± 1/8
3 1/32 ± 1/16
5/8 ± 1/16
1 ± 1/32
7/16 ± 1/32
2 1/2 ± 1/32
1 1/4 ± 1/16
7 1/4 MAX.

AMPEREX IGNITRON TYPE AX5555

GENERAL DESCRIPTION

Application: This stainless steel-jacketed ignitron is specially designed for rectifier service in the 125, 250, 600 and 900 volt D.C. power fields.

In this service size tubes will rectify 300 KW at 300 V D.C. and 500 KW at 600 and 900 Volts D.C.

This Tube is also rated for 2400 Volts for welder control service. Two tubes in inverse parallel have a capacity of 2400 KVA in this service.

The type AX-5555 ignitron features an improved ignitor conducive to long life and a heavy-duty, braided anode connector which may be removed from the tube proper.

GENERAL CHARACTERISTICS

ELECTRICAL DATA

Cathode excitation	cyclic
Cathode spot starting	ignitor
Number of electrodes	
Main anodes	1
Main cathodes	1
Auxiliary anodes	1
Ignitors	2
Arc drop at 600 peak amperes	16.2 $\pm$ 0.5 volts
Cathode excitation requirements	
Ignitor voltage required to fire	150 volts
Ignitor current required to fire	
Minimum peak	40 amperes
Excitation arc current required, minimum	8 amperes
Excitation arc-drop voltage	9 $\pm$ 0.5 volts
Excitation arc open-circuit voltage, minimum	55 volts A.C.

MECHANICAL DATA

Envelope material	metal
Net weight	22 lbs.
Type of cooling	water
Characteristics for water cooling	
Water temperature rise, maximum	5°C
Pressure drop at 3 gallons per minute, maximum	8 lbs per sq inch

AX5555

THERMAL

Water cooling

Maximum outlet water temperature	
Peak inverse anode voltage = 900	60°C
Peak inverse anode voltage = 2100	45°C
Minimum inlet water temperature	6°C
Minimum water flow at continuous rated average current	3 gals. per min.
Minimum water flow at no load	1 gal. per min.

MAXIMUM RATINGS

As power rectifier tube [1]

Maximum peak anode voltage		
Inverse	900	2100 volts
Forward	900	2100 volts
Maximum anode current		
Peak	1800	1200 amperes
Average		
Continuous	200	150 amperes
Surge	12000	9000 amperes
Maximum duration of surge current		0.15 seconds
Frequency range		25 to 60 c.p.s.

[1] Ratings are for zero phase-control angle.

As A.C. control tube

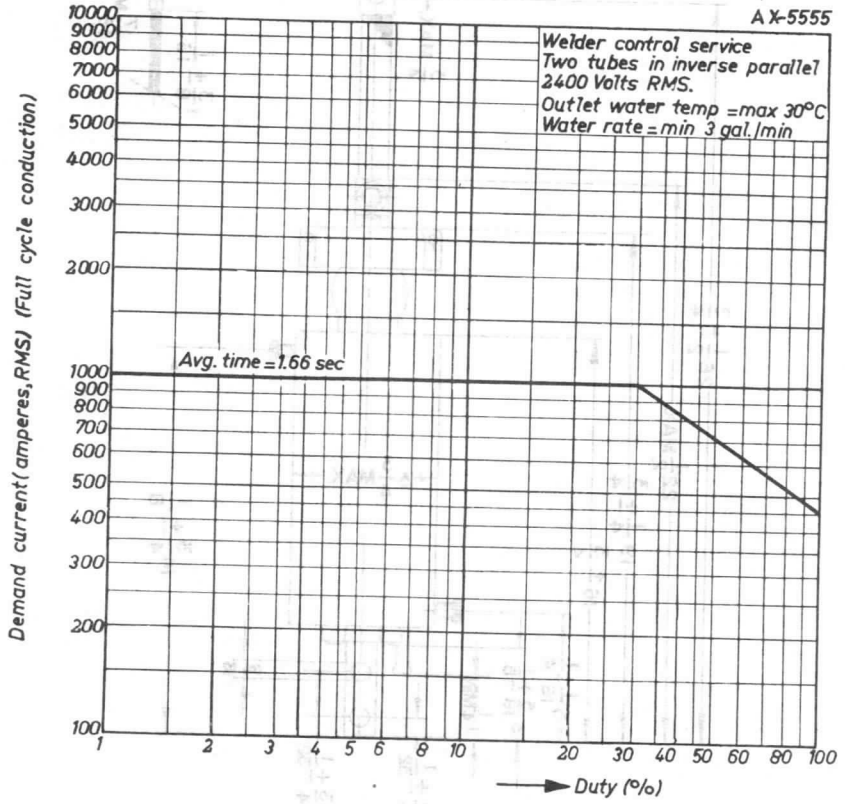
Two tubes in inverse parallel	
Voltage	2400 rms volts
Maximum demand	2400 K V A
Average current at maximum demand	135 amperes
Maximum average current	207 amperes
Demand at maximum average current	1105 K V A
Maximum averaging time at 2400 volts rms	1.66 seconds
Maximum surge current, max. duration 0.15 sec.	6000 peak amperes

Ignitor

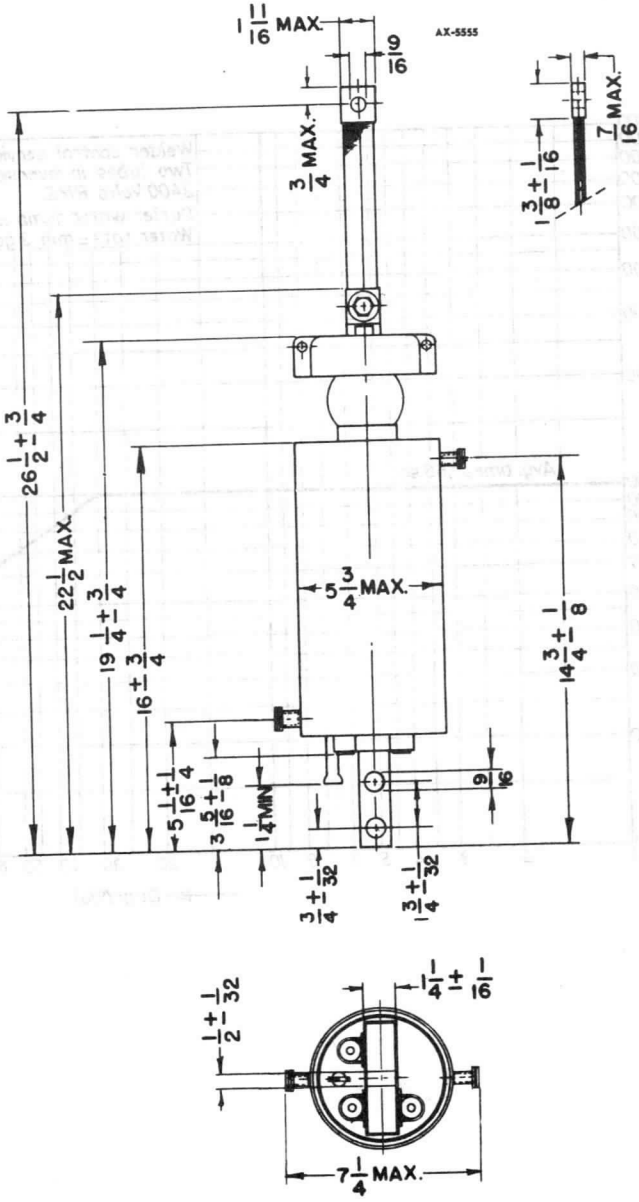
Maximum voltage	
Positive	anode voltage
Negative	5 volts
Maximum current	
Peak	100 amperes
Root mean square	15 amperes
Average	2.0 amperes
Maximum averaging time	10 seconds
Starting time at required voltage or current	100 microseconds

Auxiliary Anode

Maximum current	
Peak	20 amperes
Average	5 amperes
Maximum averaging time	10 seconds
Rms	10 amperes
Maximum peak forward voltage	160 volts
Maximum peak inverse voltage	
Main anode conducting	25 volts
Main anode not conducting	160 volts


AX-5555
Welder control service
Two tubes in inverse parallel
2400 Volts RMS.
Outlet water temp =max 30°C
Water rate = min 3 gal./min
Avg. time = 1.66 sec
Demand current (amperes, RMS) (Full cycle conduction)
Duty (%)
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
900
800
700
600
500
400
300
200
100
1
2
3
4
5
6
8
10
20
30
40
50
60
80
100

AX5555


AX-5555
1 11/16 MAX.
9/16
3/4 MAX.
7/16 MAX.
1 3/8 ± 1/16
26 1/2 ± 3/4
22 1/2 MAX.
19 1/4 ± 3/4
16 ± 3/4
5 3/4 MAX.
14 3/4 ± 1/8
5 1/16 ± 1/4
3 5/16 ± 1/8
1/4 MIN
9/16
3/4 ± 1/32
1 3/4 ± 1/32
1/2 ± 1/32
1 1/4 ± 1/16
7 1/4 MAX.

AMPEREX IGNITRON TYPE AX5822

GENERAL DESCRIPTION

Type: Watercooled ignitron
Principal Application: Frequency changer resistance welding control
Description: The AX-5822 ignitron is a sealed, stainless steel jacketed, water cooled, mercury pool tube designed primarily for control of frequency change resistance welders. The tube contains baffles required for proper performance in this application. The ignitor is adapted to intermittent service.

The Type AX-5822 ignitron features an improved ignitor conducive to long tube life and a heavy-duty, braided anode connector which may be removed from the tube proper.

GENERAL CHARACTERISTICS

ELECTRICAL DATA

Cathode excitation-Cyclic	
Cathode spot starting-Ignitor	
Number of electrodes	
Main anodes	1
Main cathodes	1
Ignitors	1
Arc drop at 1500 amperes peak	25 volts
Cathode excitation requirements	
Ignitor voltage required to fire	200 volts
Ignitor current required to fire	30 amperes
Starting time at required voltage or current	100 microseconds

MECHANICAL DATA

Envelope material-Metal	
Net weight (approx.)	9 lbs.
Type of cooling	water
Characteristics for water cooling	
Water temperature rise, maximum	6°C
Pressure drop at 1.5 gallons per minute, (max.)	5 lbs. per sq. inch

THERMAL

Water cooling	
Maximum outlet water temperature	35°C
Minimum inlet water temperature	10°C
Minimum water flow at continuous rated average current	1.5 gals. per min.
Minimum water flow at no load	0.5 gals. per min.

AX5822

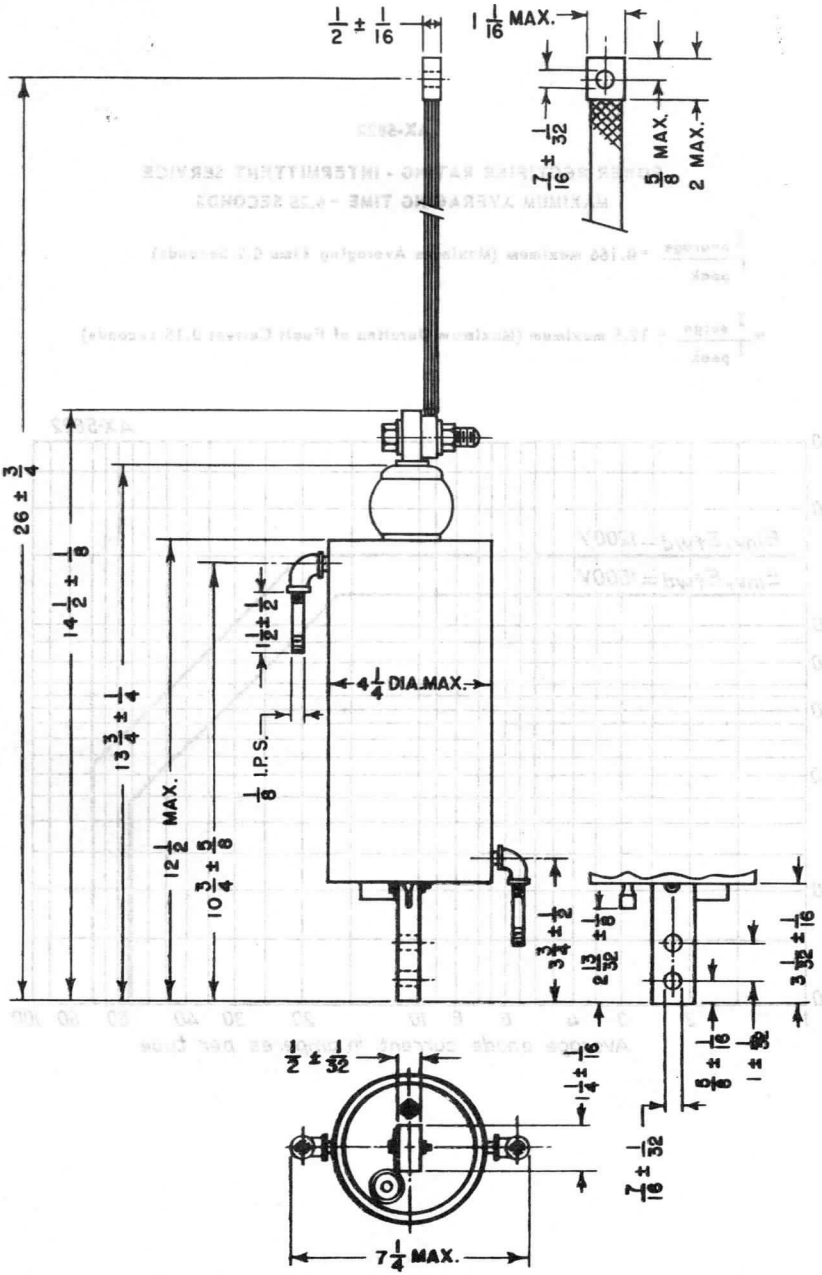
MAXIMUM RATINGS

Maximum peak anode voltage		
Inverse	1200	1500 volts
Forward	1200	1500 volts
Maximum anode current [1]		
Peak	1500	1200 amperes
Corresponding average	20	16 amperes
Average	70	56 amperes
Corresponding peak	420	336 amperes
Maximum averaging time	6.25	6.25 seconds
Ratio of average to peak current, maximum averaging time 0.2 second	0.166	0.166
Ratio of surge to peak current	12.5	12.5
Maximum duration of surge current	0.15	0.15 second
Frequency range	.50 to 60	50 to 60 c.p.s.

Ignitor

Maximum voltage	
Positive	Anode volts
Negative	5 volts
Maximum current	
Peak	100 amperes
Rms	10 amperes
Average	1 ampere
Maximum averaging time	5 seconds

[1] Straight line interpolation on log-log paper is allowed between corresponding points. Ratings are for zero phase-control angle.


1/2 ± 1/16
1 1/16 MAX.
7/16 ± 1/32
5/8 MAX.
2 MAX.
26 ± 3/4
14 1/2 ± 1/8
13 3/4 ± 1/4
12 1/2 MAX.
10 3/4 ± 5/8
1/2 ± 1/32
1/8 I.P.S.
4 1/4 DIA. MAX.
3 3/4 ± 1/2
2 13/32 ± 1/8
3 3/32 ± 1/16
1/2 ± 1/32
1/4 ± 1/16
5/8 ± 1/16
1 ± 1/32
7/16 ± 1/32
7 1/4 MAX.

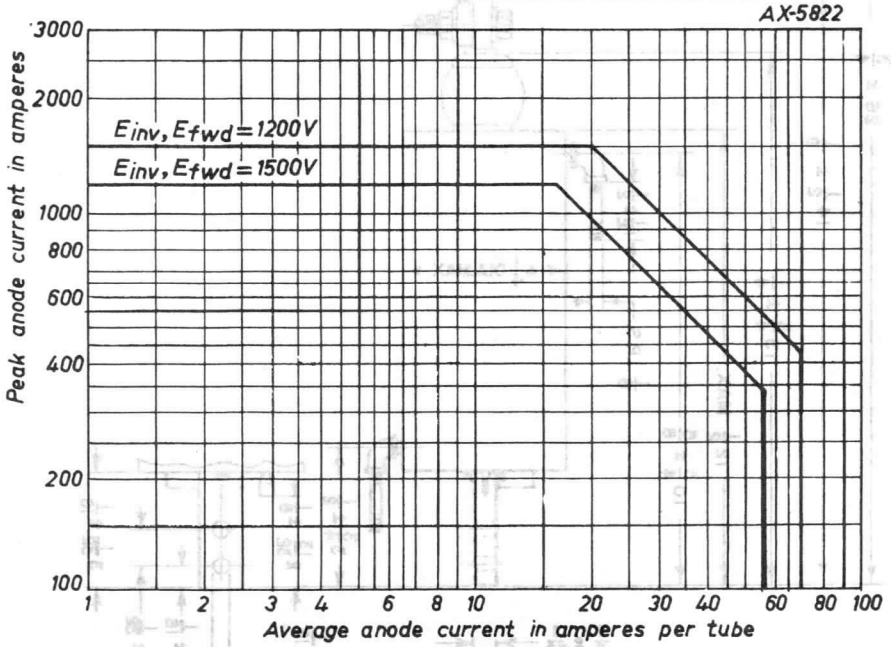
AX5822

AX-5822

POWER RECTIFIER RATING - INTERMITTENT SERVICE
MAXIMUM AVERAGING TIME = 6.25 SECONDS

$\frac{I_{average}}{I_{peak}}$ = 0.166 maximum (Maximum Averaging Time 0.2 Seconds)

$= \frac{I_{surge}}{I_{peak}}$ = 12.5 maximum (Maximum Duration of Fault Current 0.15 seconds)



Amperex

TUBE ACCESSORIES

Amperex

Accessories

The AMPEREX accessories data illustrated on the following pages is provided for the purpose of assisting equipment manufacturers and designers in the selection of the proper tube fittings for their applications.

These accessories were designed with the same exacting care and are fabricated with the same fine workmanship and materials as the electronic tubes upon which the "AMPEREX QUALITY" reputation has been established so well among equipment manufacturers and users. Because they are standard, they are suitable for use with any other tubes of the same types.

The line has been made as complete as possible and should cover most requirements.

All of the accessories are stock items and are normally available for immediate delivery.

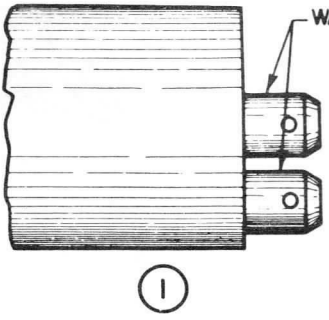
AMPEREX TUBE ACCESSORIES

TYPE NO.	Water Jacket	Gasket	Stand off Insulator	External Grid Connector	External Fil. Connector	External Plate Connector	Socket Assembly
DM70/1M3	—	—	—	—	—	—	S-19883
EIT	—	—	—	—	—	—	S-13264
EFP60	—	—	—	—	—	—	S-13211
ZB3200	—	—	SI-5005	I-66	—	—	—
4CX250B ' 4CX250F	—	—	—	—	—	—	(See note 11)
4X150A	—	—	—	—	—	—	(See note 11)
4X250B	—	—	—	—	—	—	(See note 11)
4-125A	—	—	—	—	—	S-25671	Johnson 122-275 or equal
4-250A	—	—	—	—	—	S-25671	Johnson 122-275 or equal
4-400A	—	—	—	—	—	S-25671	Johnson 122-275 or equal
502	DW-2200	I-55	SI-5002	—	—	—	—
750-TL	—	—	—	—	—	—	Johnson 124-214 or equal
833-A	—	—	—	I-65	—	I-65	I-64
880	S-13240	I-9859 [12]	—	—	—	—	—
889-A	DW-2100	I-52	SI-5001	S-13483	S-13484	—	—
889-RA	—	—	—	S-13483	S-13484	—	—
891	DW-1580	I-53	SI-5000	I-66	I-62 & I-63	—	—
891-R	—	—	—	I-66	I-62 & I-63	—	—
892	DW-1580	I-53	SI-5000	I-66	I-62 & I-63	—	—
892-R	—	—	—	I-66	I-62 & I-63	—	—
5604	—	—	—	S-13483	S-13484	—	—
5619 [6]	S-17427	S-19863	—	S-13483	S-13484	—	—
5658	S-13240	I-9859 [12]	—	—	—	—	—
5666 [6]	S-13241	S-19863	—	S-13483	S-13484	—	—
5667	—	—	—	S-13483	S-13484	—	—
5771	S-13240	I-9859 [12]	—	S-13483	S-13484	—	—
5868/AX-9902	—	—	—	—	—	S-3702	S-3703
5870/AGR-9951	—	—	—	—	—	—	Johnson 124-214 or equal
5894	—	—	—	—	—	S-3712	Johnson 122-105 or equal
5923/AX-9904	S-3737	S-17432	—	S-3706	S-3707	—	—
5924/AX-9904R [1]	—	—	—	S-3706	S-3707	—	—
5924A [1]	—	—	—	S-3706	S-3707	—	—
6075/AX-9907	S-3737	S-17432	—	S-3706	S-3707	—	—
6076/AX-9907R [3]	—	—	—	S-3706	S-3707	—	—
6077/AX-9906 [5]	S-3738	—	—	—	S-3739	—	—
6078/AX-9906R [2]	—	—	—	—	S-3739	—	—
6079/AX-9908	—	—	—	—	—	S-3702	S-3703
6083/AX-9909	—	—	—	—	—	—	Johnson 122-105 or equal
6155	—	—	—	—	—	S-25671	Johnson 122-275 or equal
6156	—	—	—	—	—	S-25671	Johnson 122-275 or equal
6252/AX-9910	—	—	—	—	—	S-3712	Johnson 122-105 or equal
6333	DW-1580	I-53	—	Y-13326 [4]	S-13484	—	—
6445	—	—	—	Y-13326 [4]	I-62 & I-63	—	—
6446 [6]	S-15096	S-19863	—	Y-13326 [4]	S-13484	—	—
6447	—	—	—	Y-13326 [4]	I-62 & I-63	—	—
6693	—	—	—	—	—	—	Johnson 123-206 or equal
6756	S-15096	—	—	Y-13326 [4]	—	—	—
6757	—	—	—	Y-13326 [4]	—	—	—
6758	S-3737	S-17432	—	S-17288	—	—	—
6759 [1]	—	—	—	S-17288	—	—	—
6800	S-17427	S-19863	—	S-13483	S-13484	—	—
6907	—	—	—	—	—	S-3712	Johnson 122-105 or equal
6960	S-3737	S-17432	—	S-17288 [9] S-3706 [10]	S-3707 S-21000 [8]	—	—
6961 [1]	—	—	—	S-17288 [9] S-3706 [10]	S-3707 S-21000 [8]	—	—
6979	—	—	—	—	—	—	(See note 11)
7092	—	—	—	—	—	S-3702	S-21421
7136	—	—	—	—	—	—	Johnson 123-211-100 or equal
7237 [1]	—	—	—	S-17288 [9] S-3706 [10]	S-3707 S-21000 [8]	—	
7377	—	—	—	—	—	—	S-25230
7527	—	—	—	—	—	S-25671	Johnson 122-275 or equal

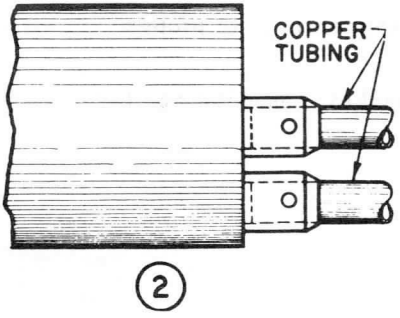
[1] Airflow Chamber S-3705
[2] Airflow Chamber S-3740
[3] Airflow Chamber S-11882
[4] Supplied with each tube without charge
[5] Key for water jacket, S-13209
[6] Water Jacket mounting clamp S-17463
Water Jacket mounting plate S-17464
[7] Airflow Chamber S-19489
[8] Filament Center pin connector
[9] For use up to 30 Mc.
[10] For Use above 30 Mc.
[11] Socket with built-in condenser S-11520
Socket without condenser S-11521
[12] This tube uses either gasket no. shown or "O" ring Amperex number S-19866

(Replaces old page no. 548, "Accessories" section)

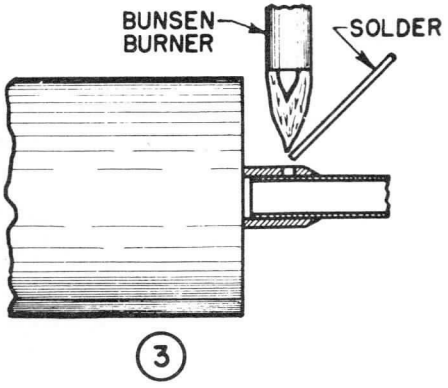
SOLDERING AMPEREX WATER JACKET CONNECTIONS



1. CLEAN INSIDE OF WATER JACKET TERMINALS THOROUGHLY WITH STEEL WOOL, AND DEGREASE WITH CARBON TETRACHLORIDE OR ALCOHOL.



2. CLEAN OUTSIDE SURFACE OF THE COPPER TUBING AND INSERT AS SHOWN.



SOLDER WITH BUNSEN BURNER OR TORCH USING 60-40[1] SOLDER ALLOY.

FOR BEST RESULTS DO *NOT* USE SOLDERING IRON.

[1] 60% Tin
40% Lead

For information concerning the proper

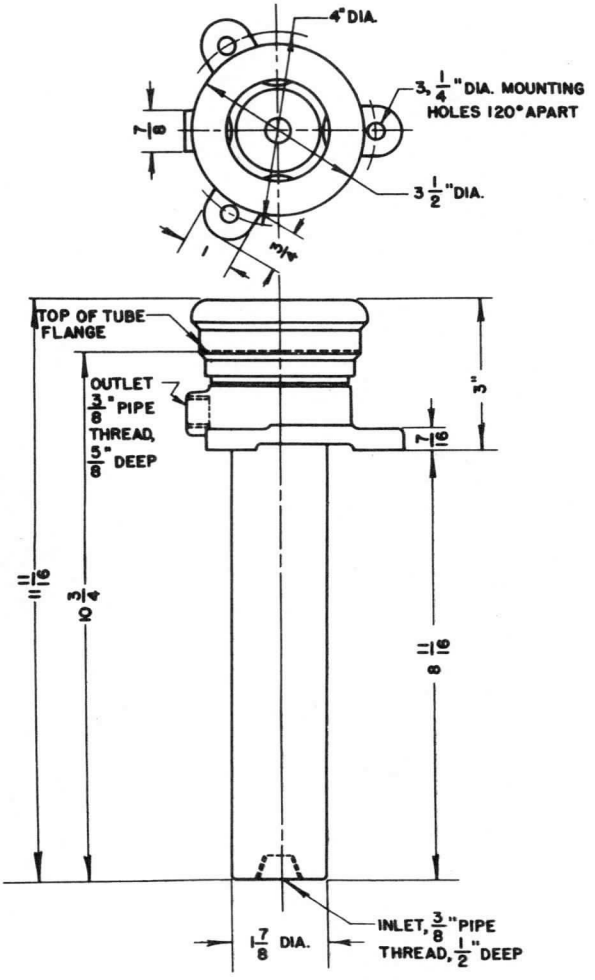
Amperex water jacket gasket, see page no. 1

(old page no. 548)

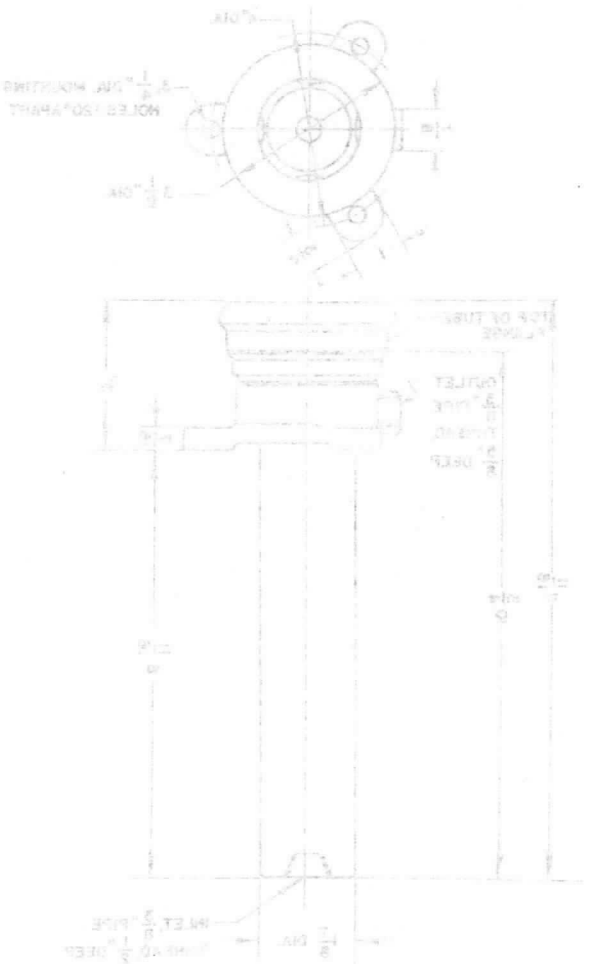
AMPEREX WATER JACKET TYPE DW-1580

For Tube Types

207 891 892 6333 6445

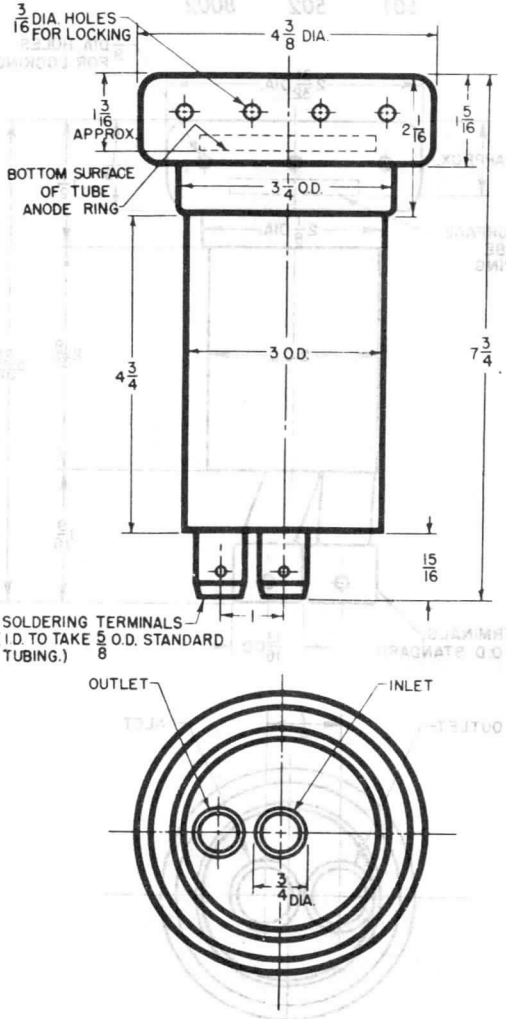


FOR COMPLETE WATER FLOW DATA SEE INDIVIDUAL TUBE TI SHEETS.



AMPEREX WATER JACKET TYPE DW-2100

For Tube Type 889A

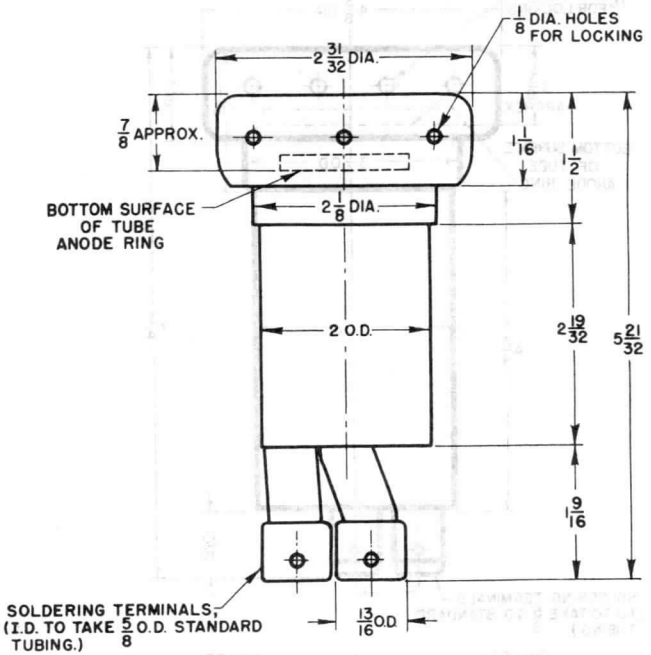


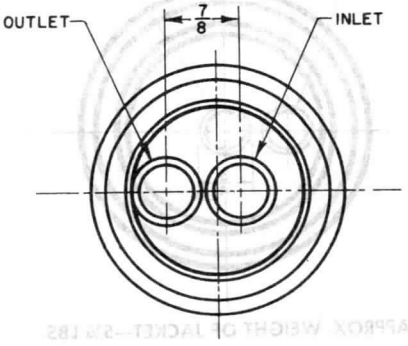
APPROX. WEIGHT OF JACKET—5¾ LBS.

1. STAND-OFF INSULATOR FOR THIS WATER JACKET—AMPEREX TYPE SI-5001.
2. FOR COMPLETE WATER FLOW DATA SEE INDIVIDUAL TUBE TI SHEETS.

AMPEREX WATER JACKET TYPE DW-2200

For Tube Types
501 502 8002





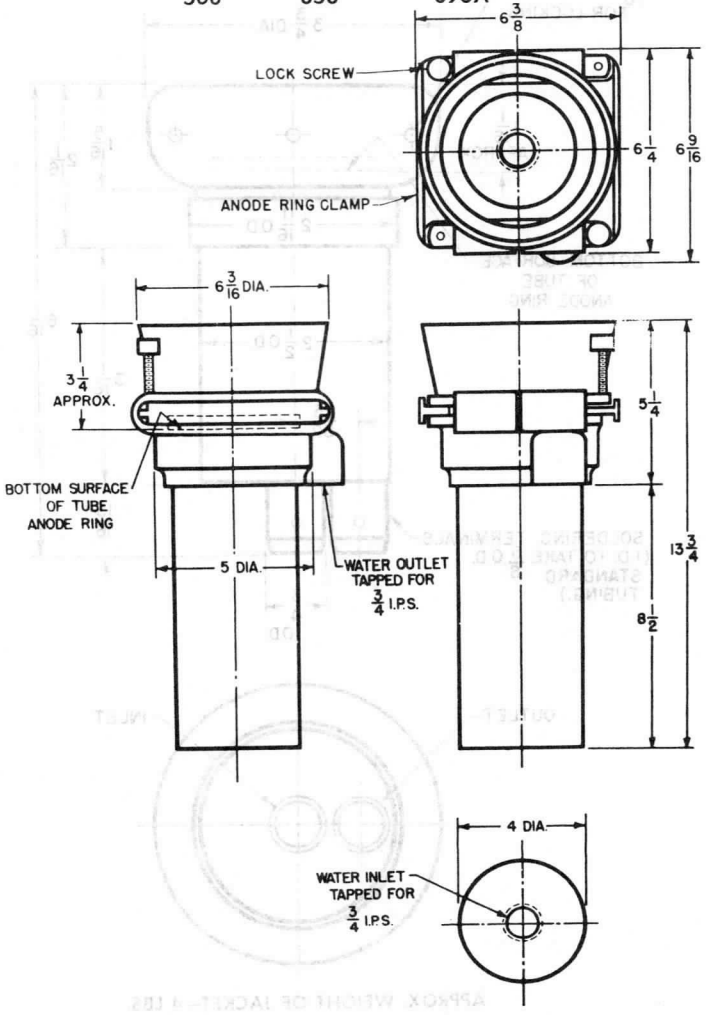
APPROX. WEIGHT OF JACKET—2 LBS.

1. STAND-OFF INSULATOR FOR THIS WATER JACKET—AMPEREX TYPE SI-5002.
2. FOR COMPLETE WATER FLOW DATA SEE INDIVIDUAL TUBE TI SHEET.

AMPEREX WATER JACKET TYPE DW-2500

For Tube Types

498	*562A*	*859*
508	*858*	*893A*

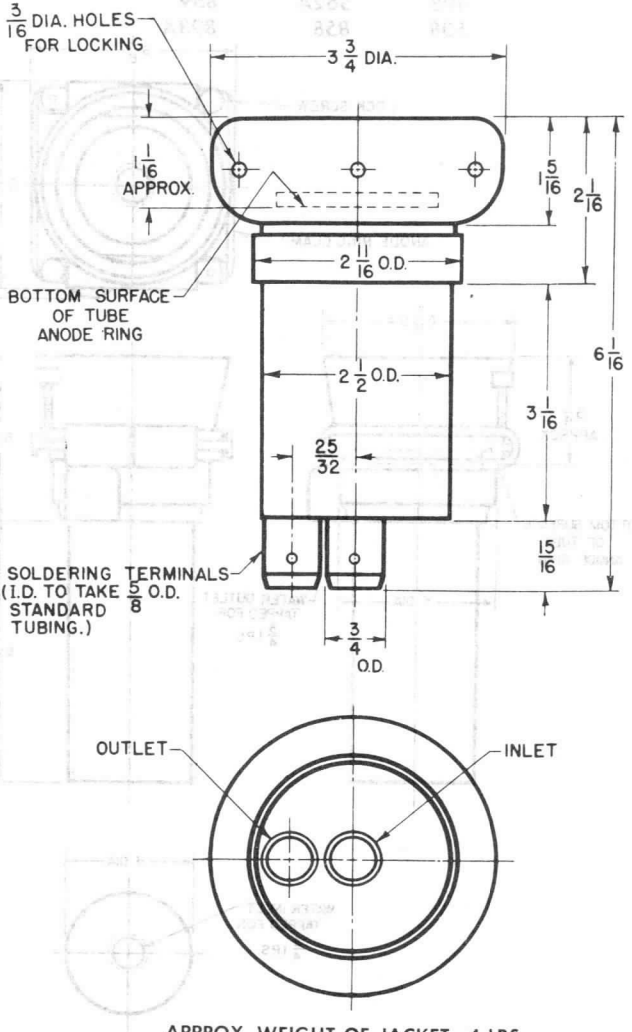


APPROX. WEIGHT OF JACKET—15½ LBS.

1. STAND-OFF INSULATOR FOR THIS WATER JACKET--AMPEREX TYPE SI-5003.
2. FOR COMPLETE WATER FLOW DATA SEE INDIVIDUAL TUBE TI SHEETS.

AMPEREX WATER JACKET TYPE DW-2600

For Tube Type 846



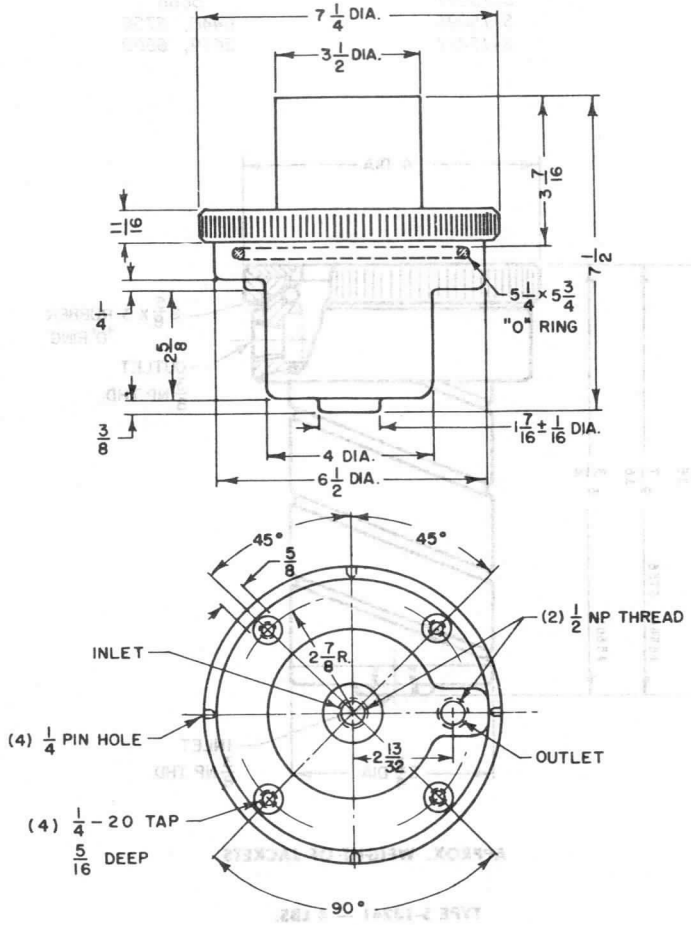
APPROX. WEIGHT OF JACKET—4 LBS.

1. STAND-OFF INSULATOR FOR THIS WATER JACKET—AMPEREX TYPE SI-5004.
2. FOR COMPLETE WATER FLOW DATA SEE INDIVIDUAL TUBE TI SHEET.

AMPEREX WATER JACKET TYPE S-13240

For Tube Types

880 *5771*



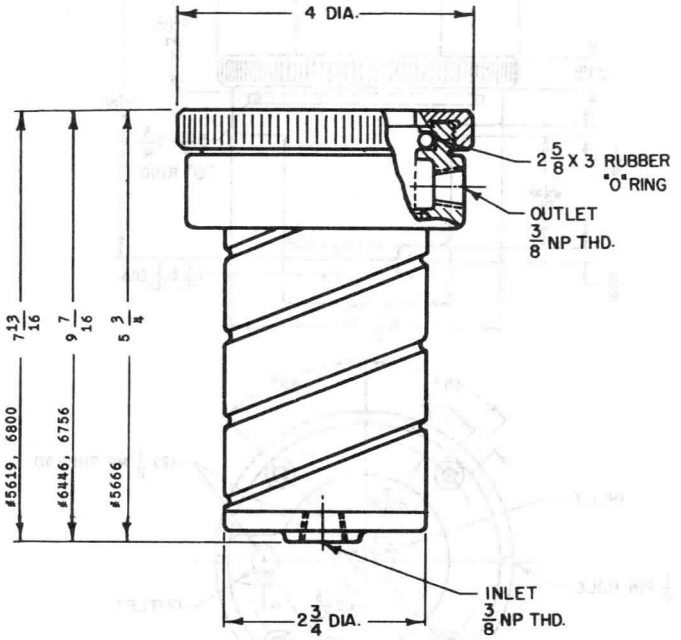
APPROX. WEIGHT OF JACKET— 14 LBS.

FOR COMPLETE WATER FLOW DATA SEE INDIVIDUAL TUBE TI SHEETS.

Revised 5/55

AMPEREX WATER JACKETS TYPES S-13241 S-15096 S-17427

Water Jacket Type	Used for Type
S-13241	5666
S-15096	6446, 6756
S-17427	5619, 6800



APPROX. WEIGHT OF JACKETS

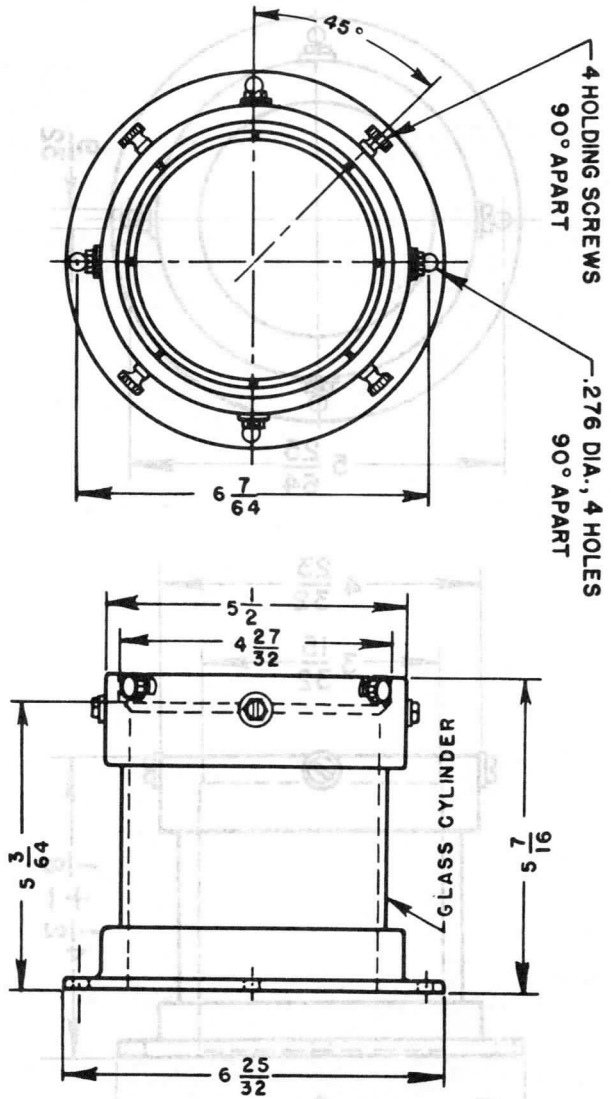
TYPE S-13241 — 4 LBS.
TYPE S-15096 — 4½ LBS.
TYPE S-17427 — 4 1/3 LBS.

1. **FOR COMPLETE WATER FLOW DATA SEE INDIVIDUAL TUBE TI SHEETS.**

2. **FOR WATER JACKET SUPPORTS SEE AMPEREX ACCESSORIES S-17463 and S-17464.**

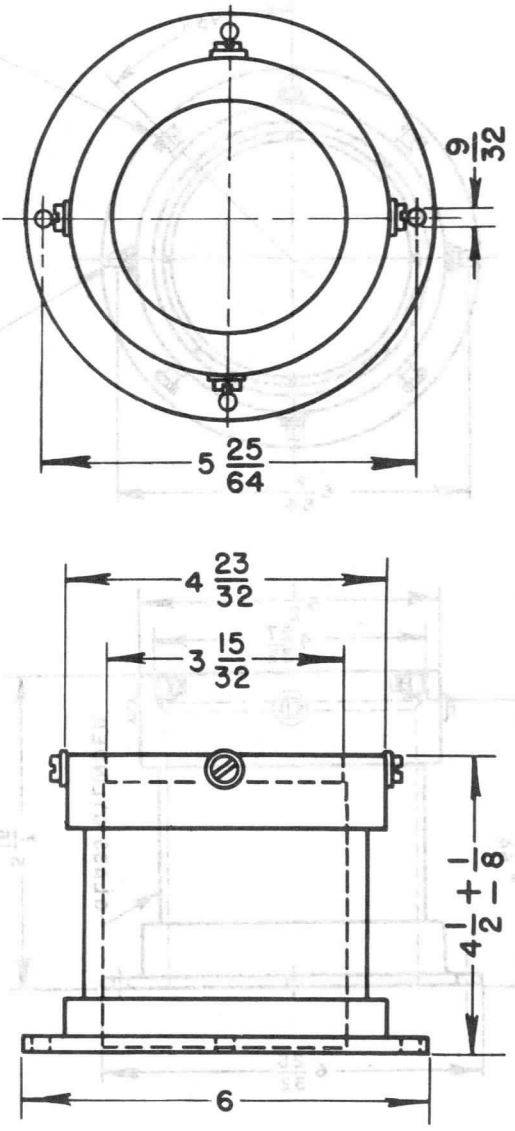
AMPEREX AIR FLOW CHAMBER S-3705

For Tube Type 5924/AX9904R, 6759



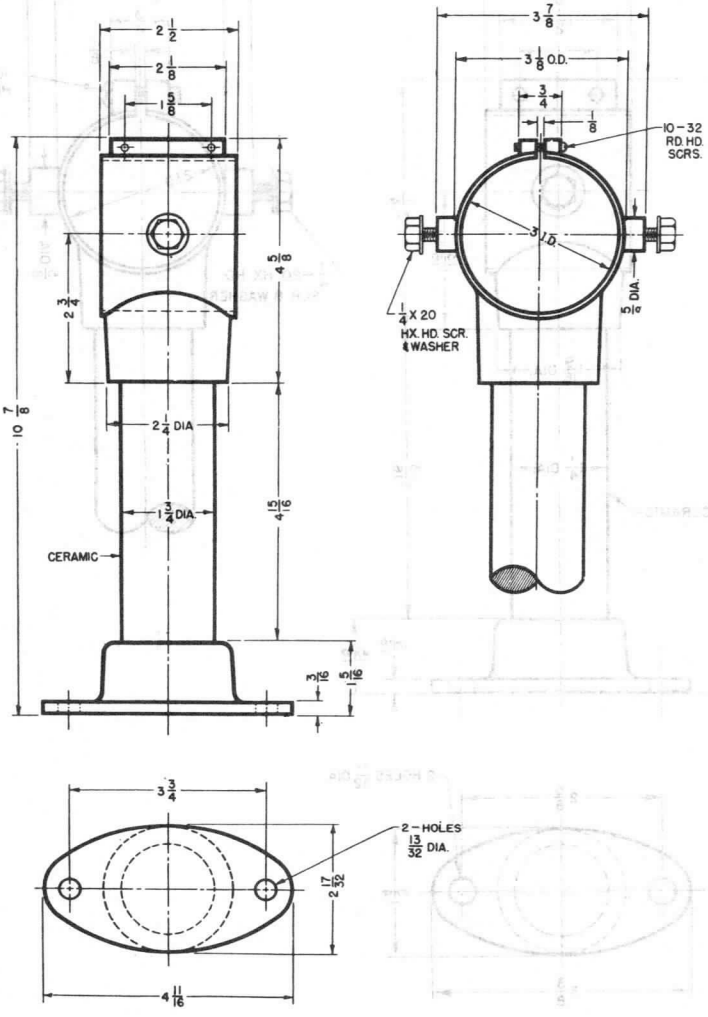
AMPEREX AIR FLOW CHAMBER S-11882

For Tube Type 6076/AX-9907R



AMPEREX STAND-OFF INSULATOR TYPE SI-5001

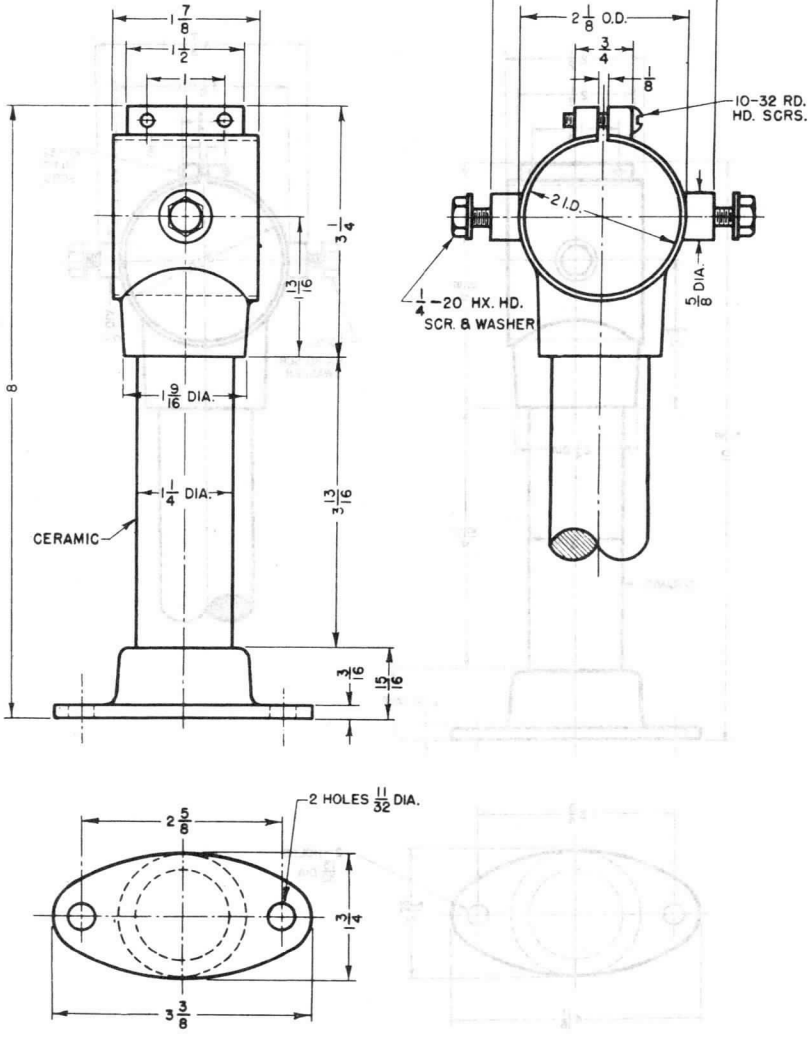
Used with Tube Type	For Amperex Water Jacket Type
889A	DW-2100



Revised 2/55

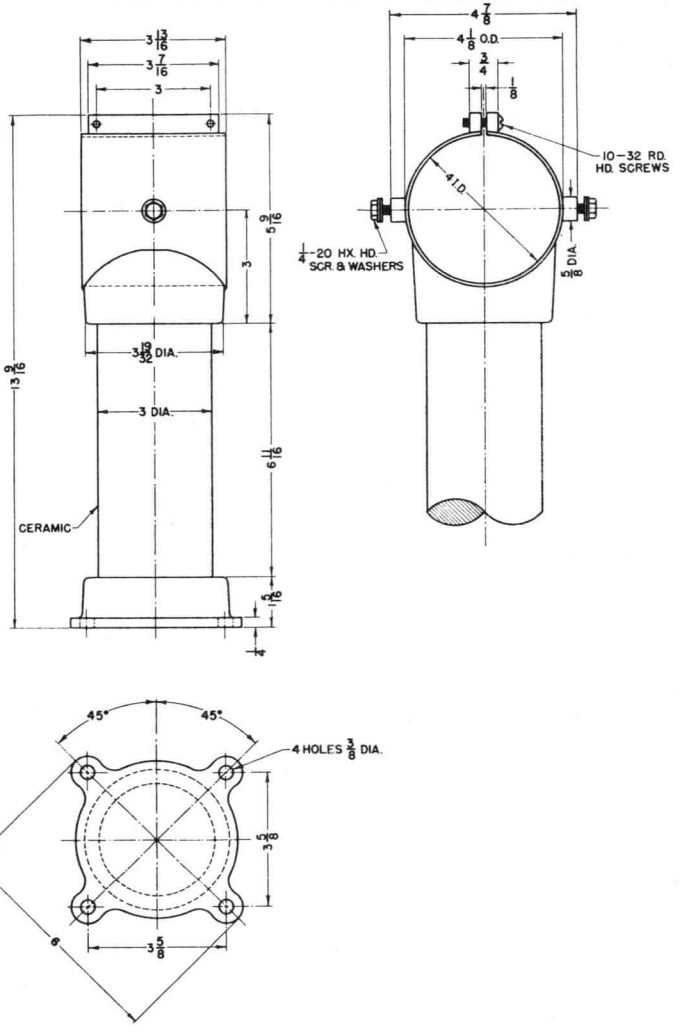
AMPEREX STAND-OFF INSULATOR TYPE SI-5002

Used with Tube Type	For Amperex Water Jacket Type
502	DW-2200



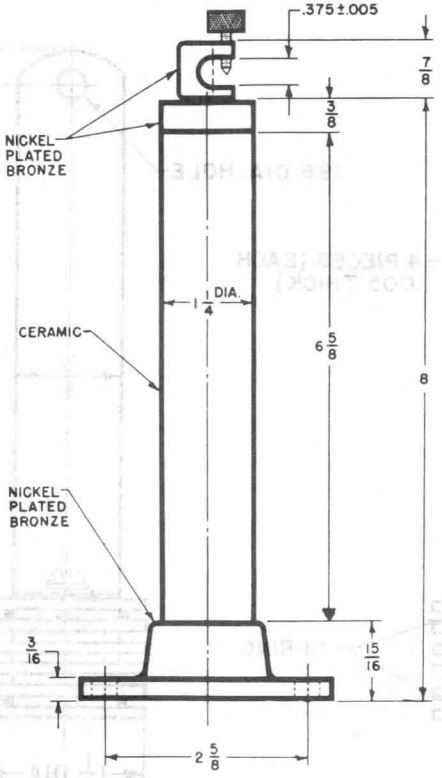
AMPEREX STAND-OFF INSULATOR TYPE SI-5003

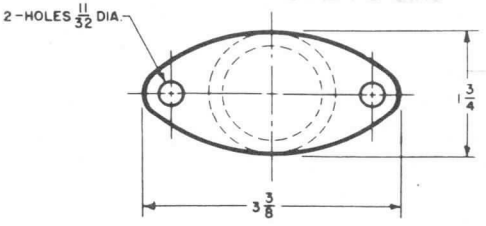
Used with Tube Type	For Amperex Water Jacket Type
498	DW-2500
508	DW-2500
562A	DW-2500
858	DW-2500
859	DW-2500
893A	DW-2500



AMPEREX STAND-OFF INSULATOR TYPE SI-5005

For Tube Types
HF-3000 ZB-3200

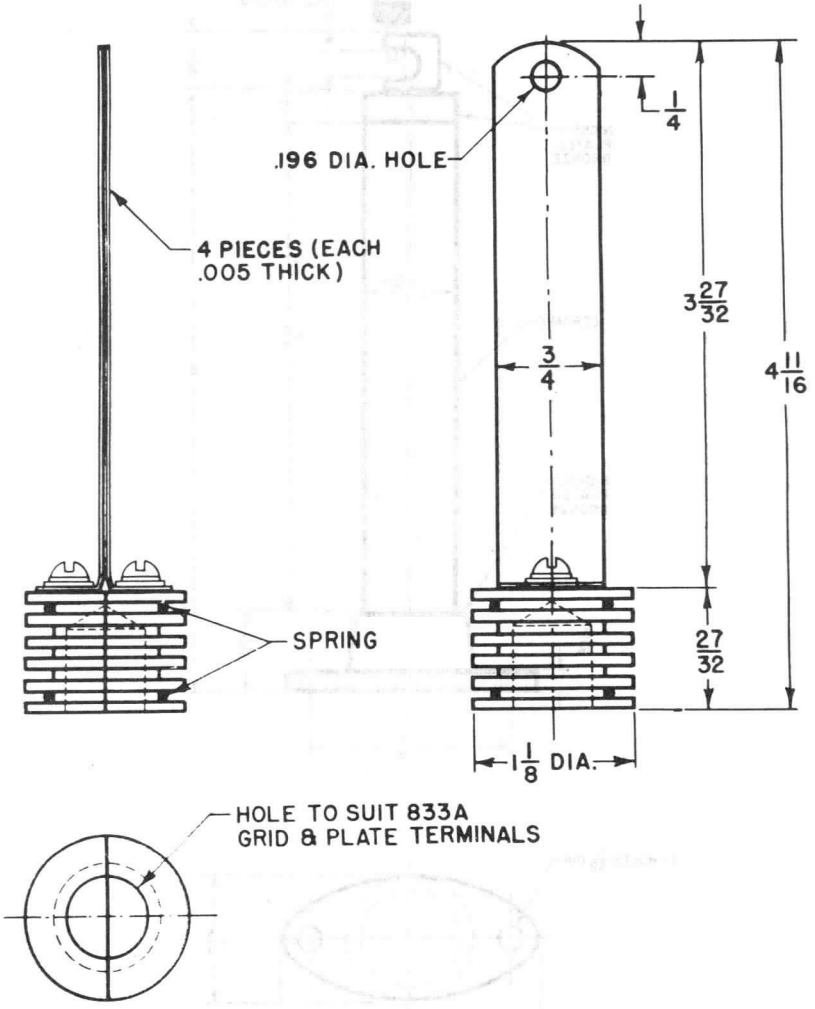




AMPEREX EXTERNAL PLATE AND GRID CONNECTOR TYPE I-65

For Tube Type 833A

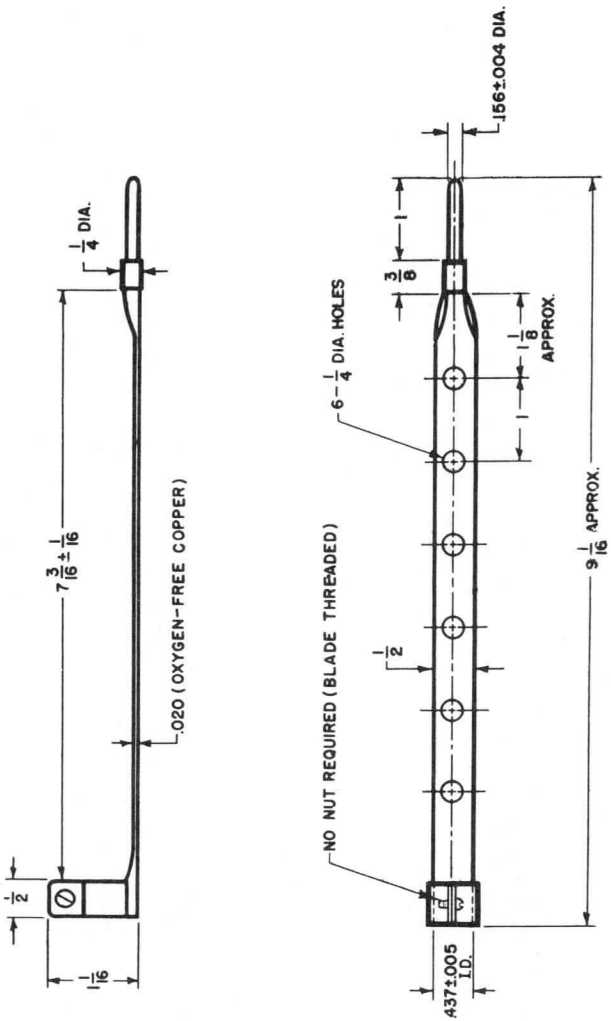
(2 required for each tube)



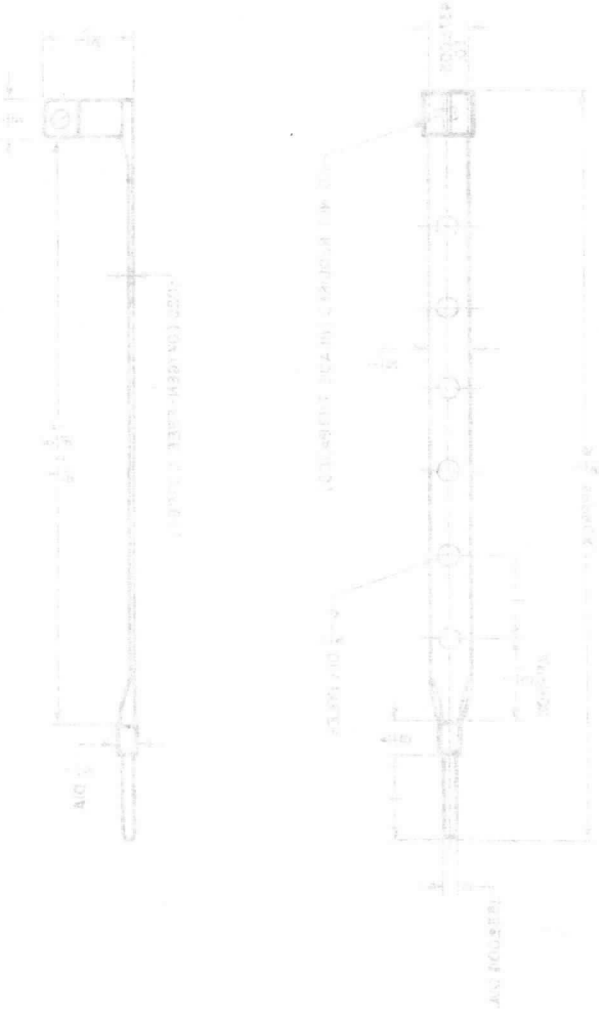
AMPEREX EXTERNAL GRID CONNECTOR TYPE I-66

For Tube Types

508 891R 892R ZB-3200 220C 342A 891 892 ←



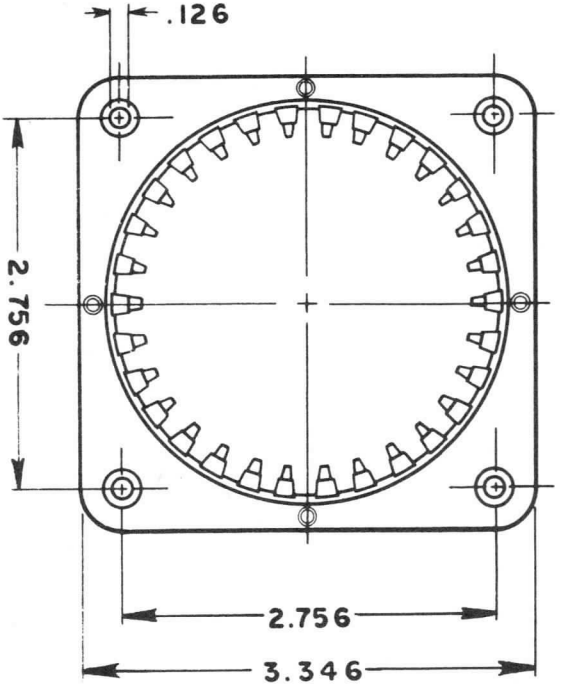
Revised 2/55

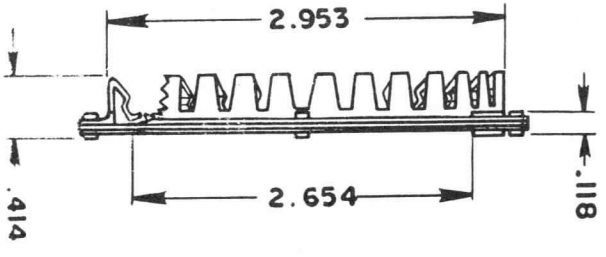


AMPEREX EXTERNAL GRID CONNECTOR TYPE S-3706

For Tube Types

5923/AX-9904	*6075/AX-9907*	*5924A*
5924/AX-9904R	*6076/AX-9907R*	*6960*
		6961

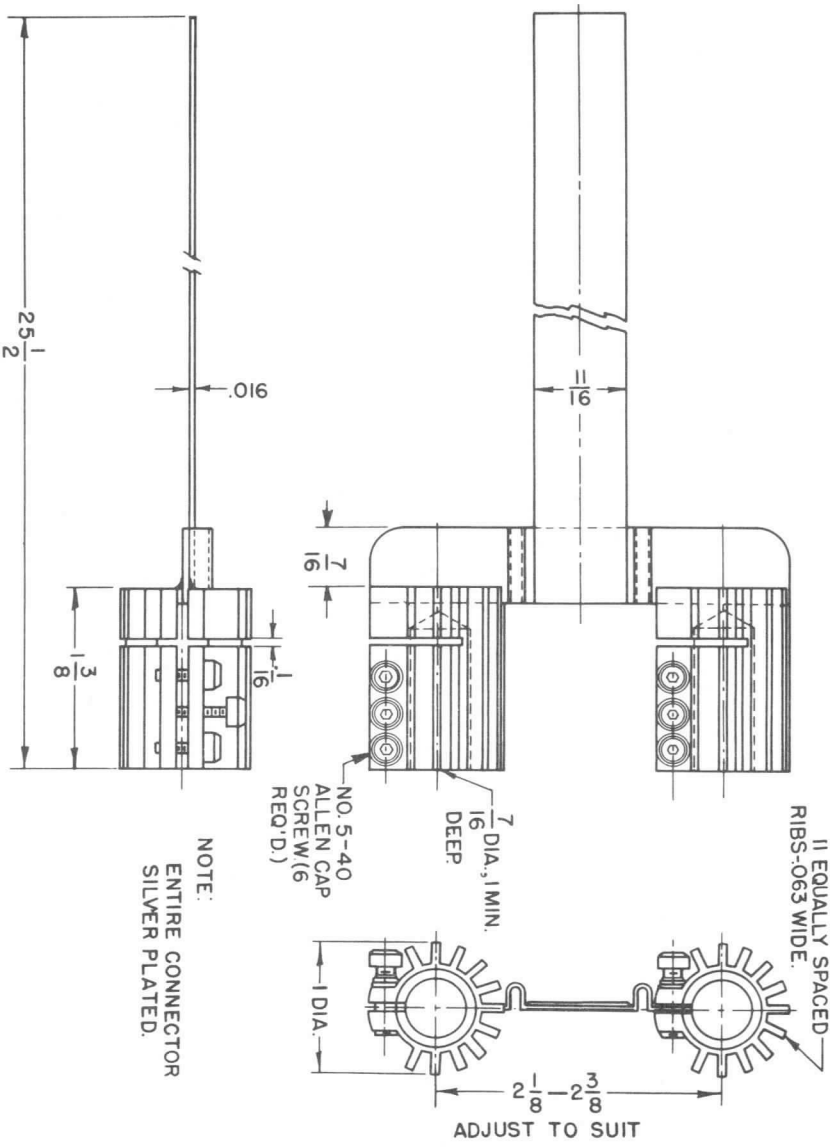




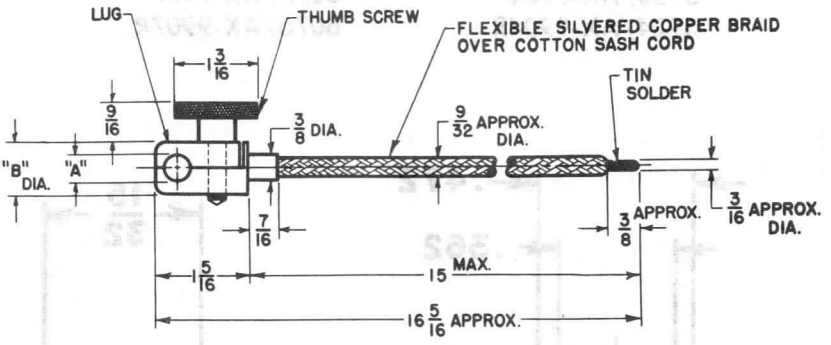
AMPEREX EXTERNAL GRID CONNECTOR TYPE S-13483

For Tube Types

880	*889AR*	*5619*	*5666*	*5771*
889A	*5604*	*5658*	*5667*	*6800*



AMPEREX EXTERNAL FILAMENT LEADS I-61, I-62, I-63

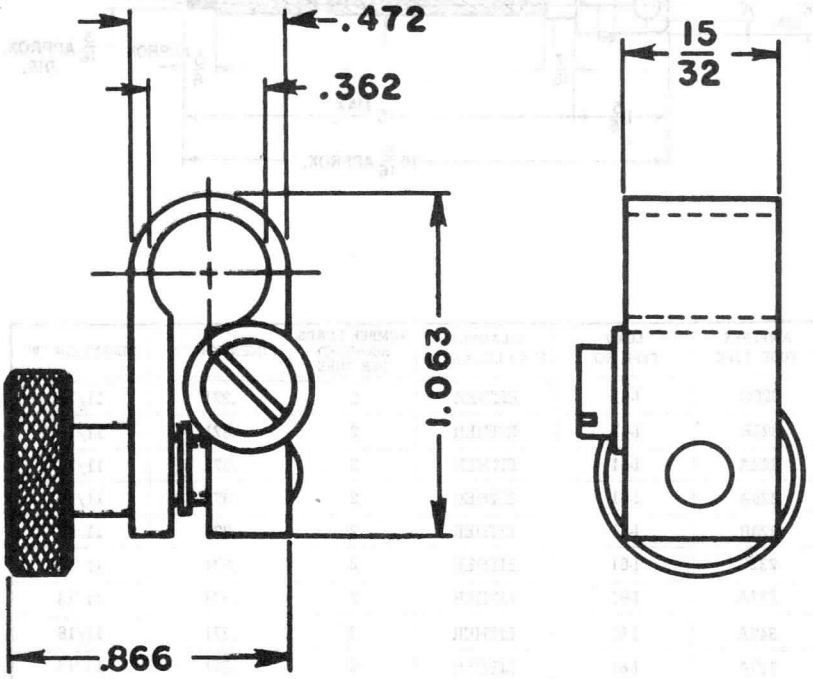


AMPEREX TUBE TYPE	LEAD TYPE NO.	FILAMENT LEAD LOCATION	NUMBER LEADS REQUIRED PER TUBE	DIMENSION "A"	DIMENSION "B"
220C	I-61	EITHER	2	.371	11/16
220R	I-61	EITHER	2	.371	11/16
222A	I-61	EITHER	2	.371	11/16
228A	I-61	EITHER	2	.371	11/16
228R	I-61	EITHER	2	.371	11/16
232C	I-61	EITHER	2	.371	11/16
237A	I-61	EITHER	2	.371	11/16
342A	I-61	EITHER	2	.371	11/16
343A	I-61	EITHER	2	.371	11/16
891	I-62	CENTER	1	.496	3/4
891	I-63	SIDE	2	.433	3/4
891R	I-62	CENTER	1	.496	3/4
891R	I-63	SIDE	2	.433	3/4
892	I-62	CENTER	1	.496	3/4
892	I-63	SIDE	2	.433	3/4
892R	I-62	CENTER	1	.496	3/4
892R	I-63	SIDE	2	.433	3/4

AMPEREX FILAMENT CONNECTOR TYPE S-3707

For Tube Types

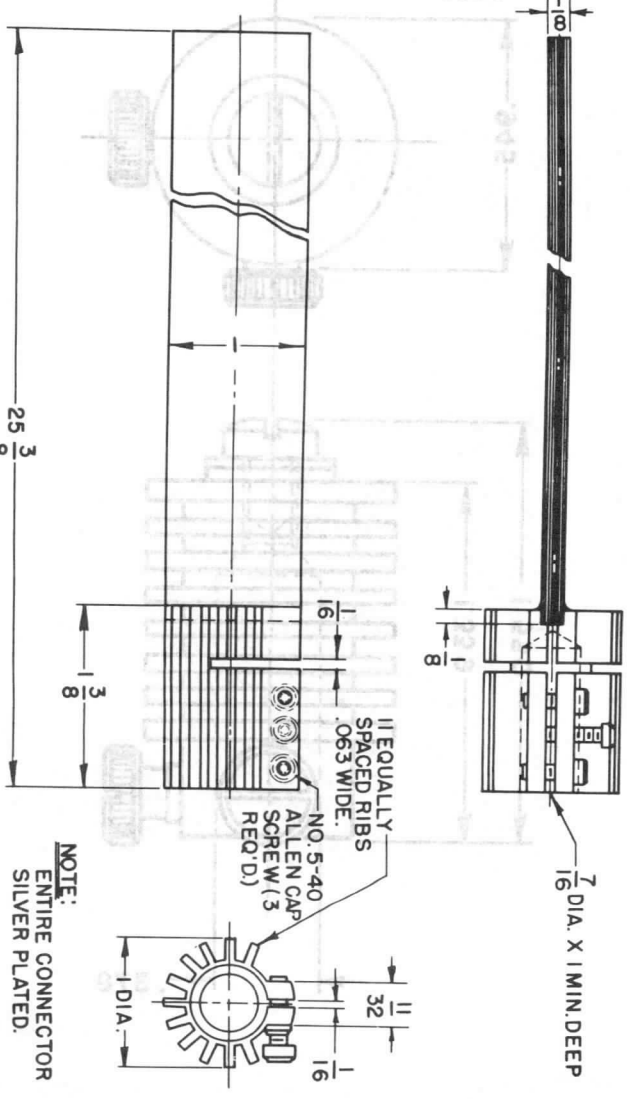
5923/AX-9904
5924/AX-9904R
6075/AX-9907
6076/AX-9907R



AMPEREX FILAMENT CONNECTOR TYPE S-13484

For Tube Types

880	5604	5666
889	5619	5667
889AR	5658	6333

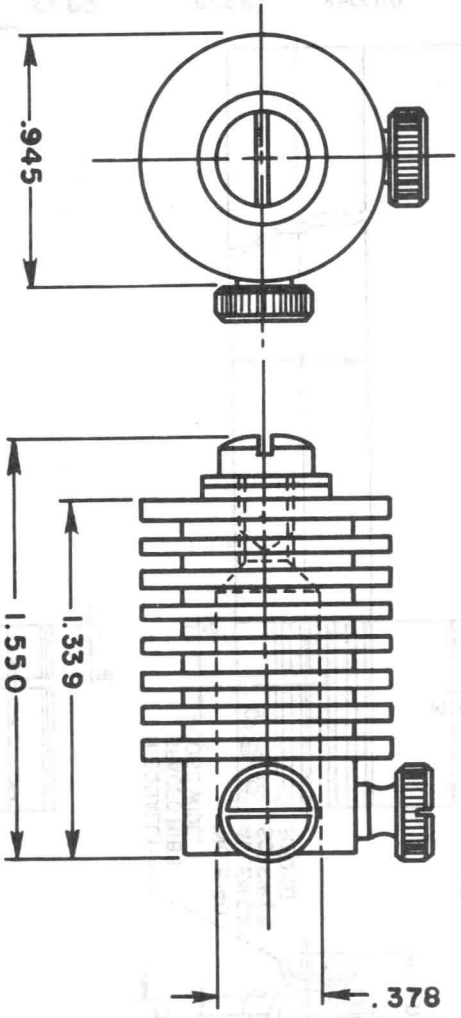


AMPEREX EXTERNAL PLATE CONNECTOR TYPE S-3702

For Tube Types

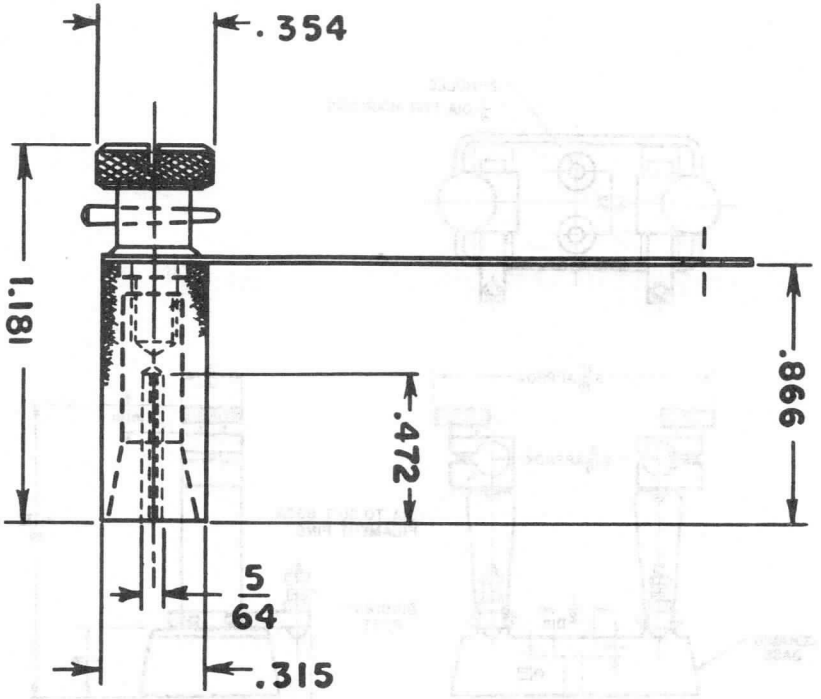
6079/AX-9908
6155/4-125A

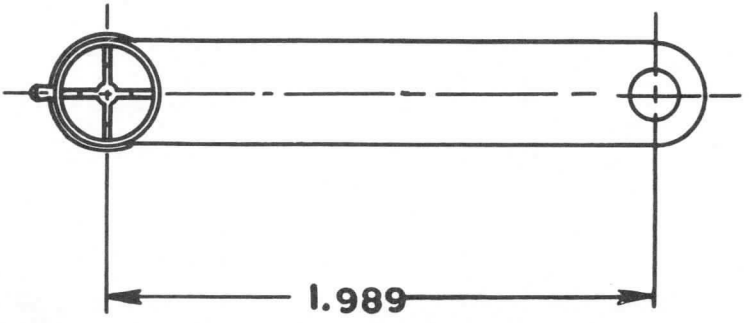
5868/AX-9902
6156/4-250A



AMPEREX EXTERNAL PLATE CONNECTOR TYPE S-3712

For Tube Types 5894 & 6252

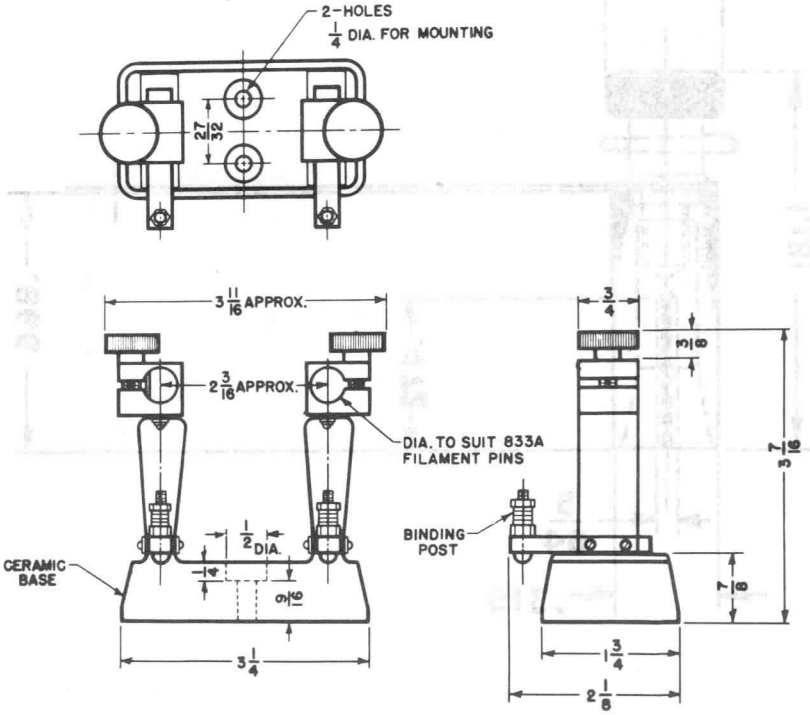




Revised 2/55

AMPEREX SOCKET ASSEMBLY TYPE I-64

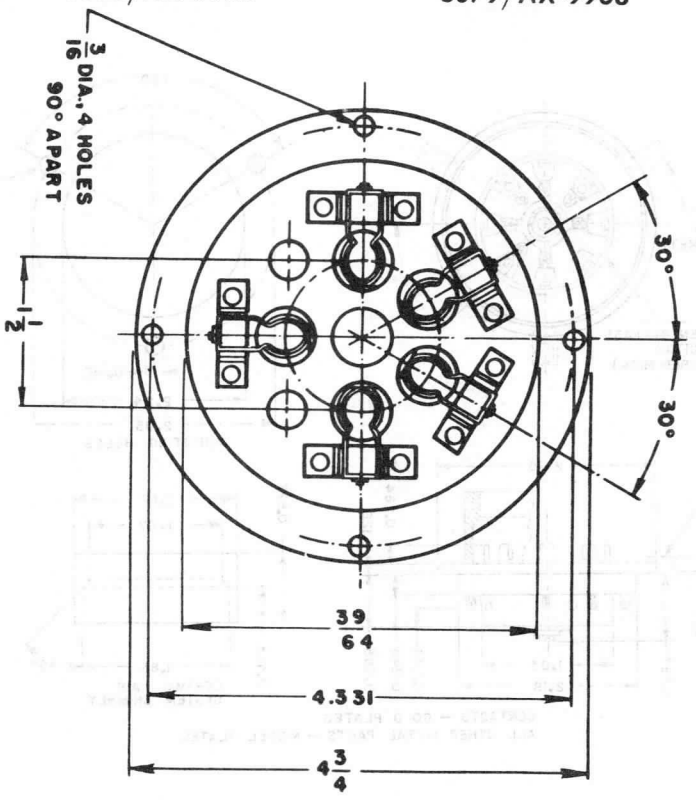
For Tube Type 833A

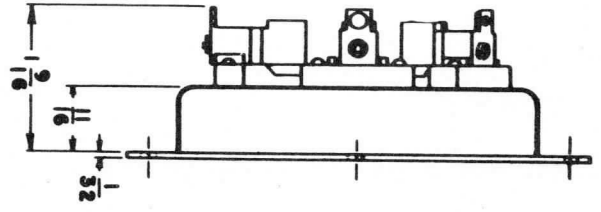


AMPEREX SOCKET ASSEMBLY TYPE S-3703

For Tube Types

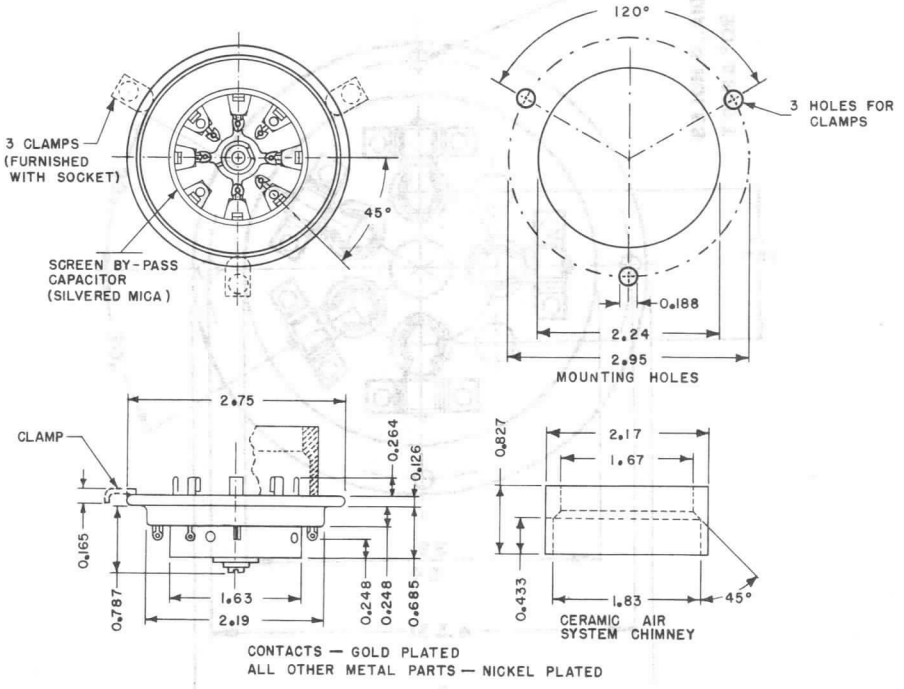
5868/AX-9902 6079/AX-9908





AMPEREX SOCKET ASSEMBLY TYPE S-19931

For Tube Type 4X150A, 4X250B



CONTACTS — GOLD PLATED
ALL OTHER METAL PARTS — NICKEL PLATED

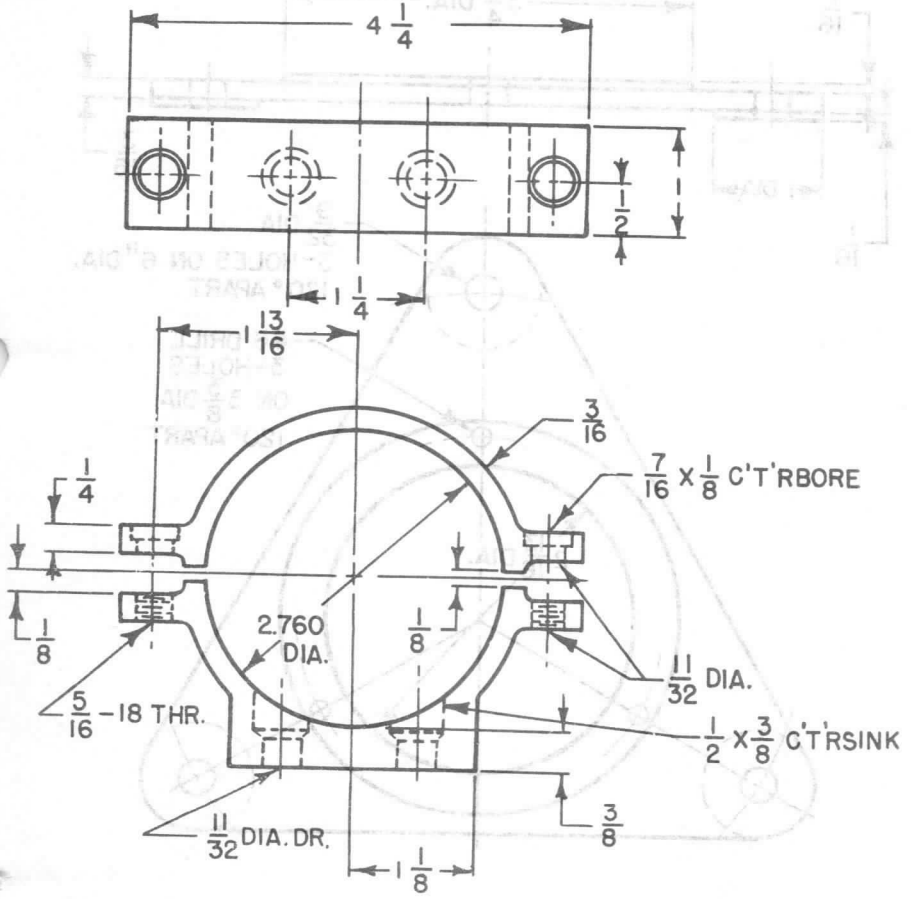
AMPEREX MOUNTING CLAMP TYPE S-17463

Used For Tube Type

5666
6446, 6756
5619

Used with Water Jacket Type

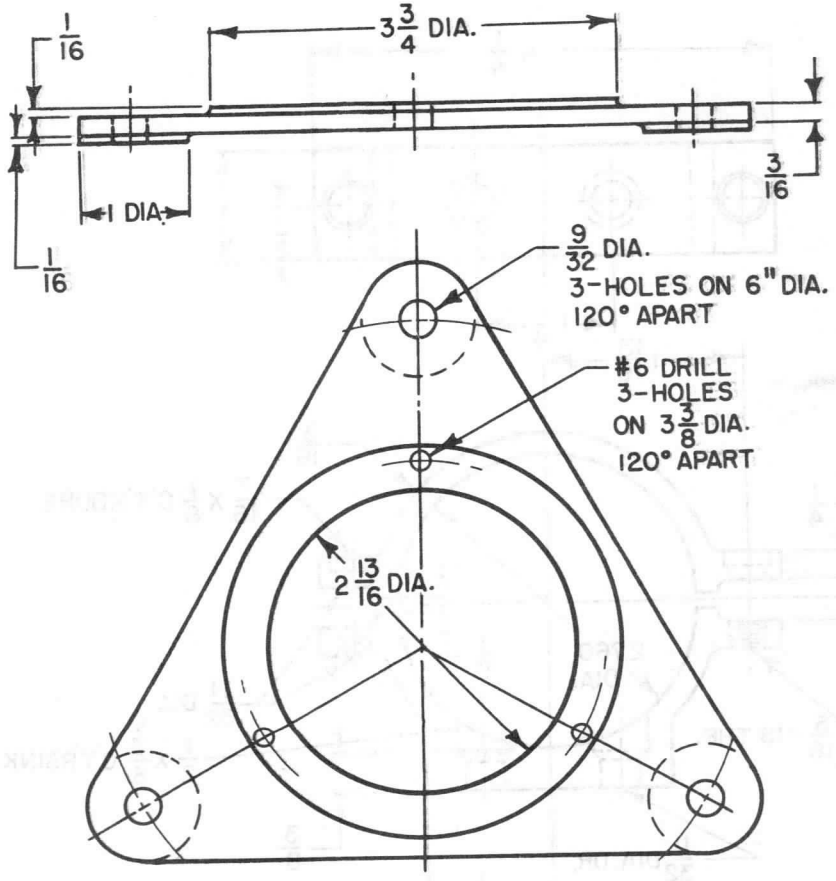
S-13241
S-15096
S-17427



CAST BRONZE

AMPEREX MOUNTING PLATE TYPE S-17464

Used For Tube Type	*Used with Water Jacket Type*
5666	S-13241
6446, 6756	S-15096
5619	S-17427



CAST BRONZE

Revised 4/57