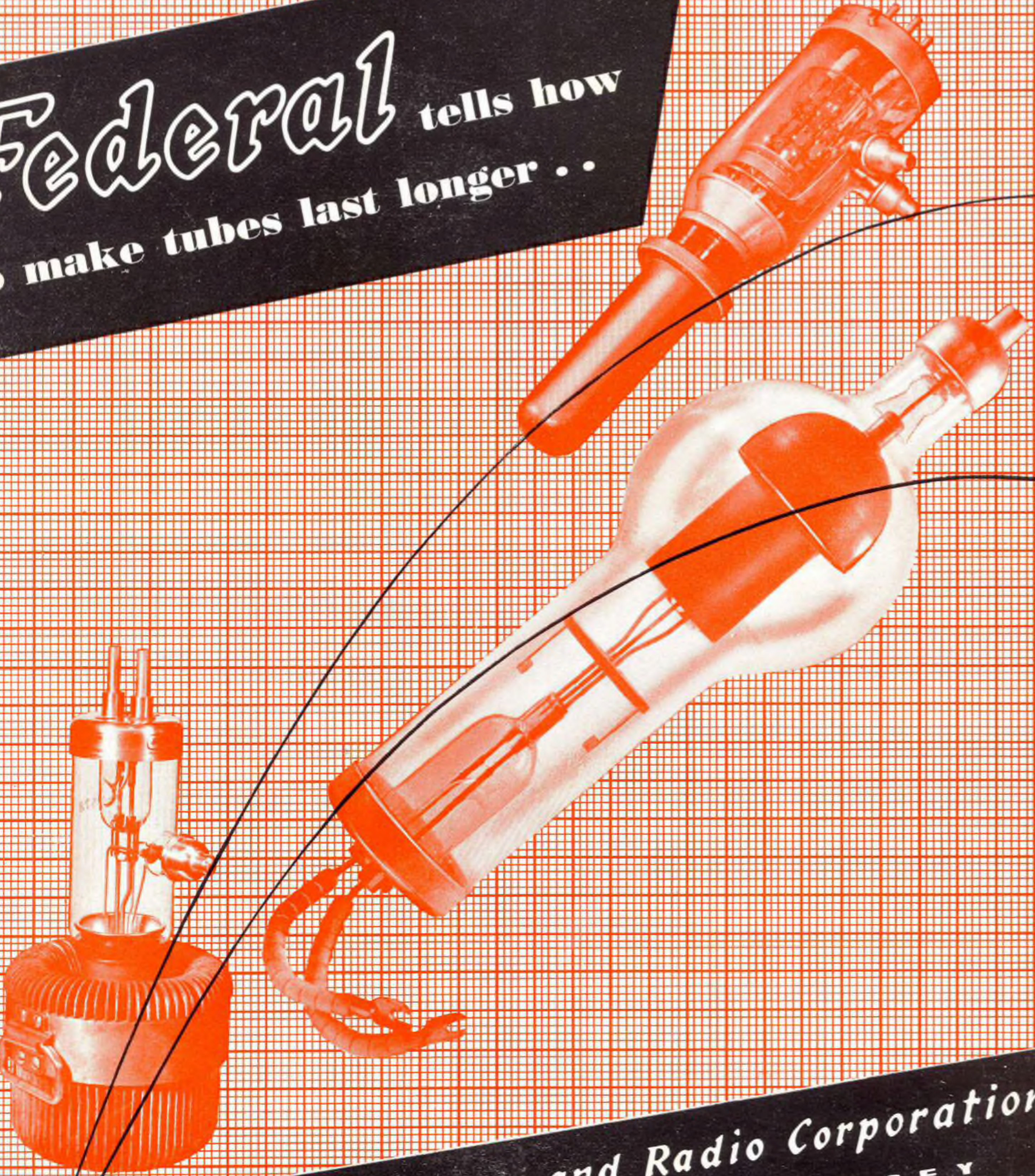
Federal tells how to make tubes last longer . .



Federal Telephone and Radio Corporation

NEWARK AN IT&T ASSOCIATE NEW JERSEY

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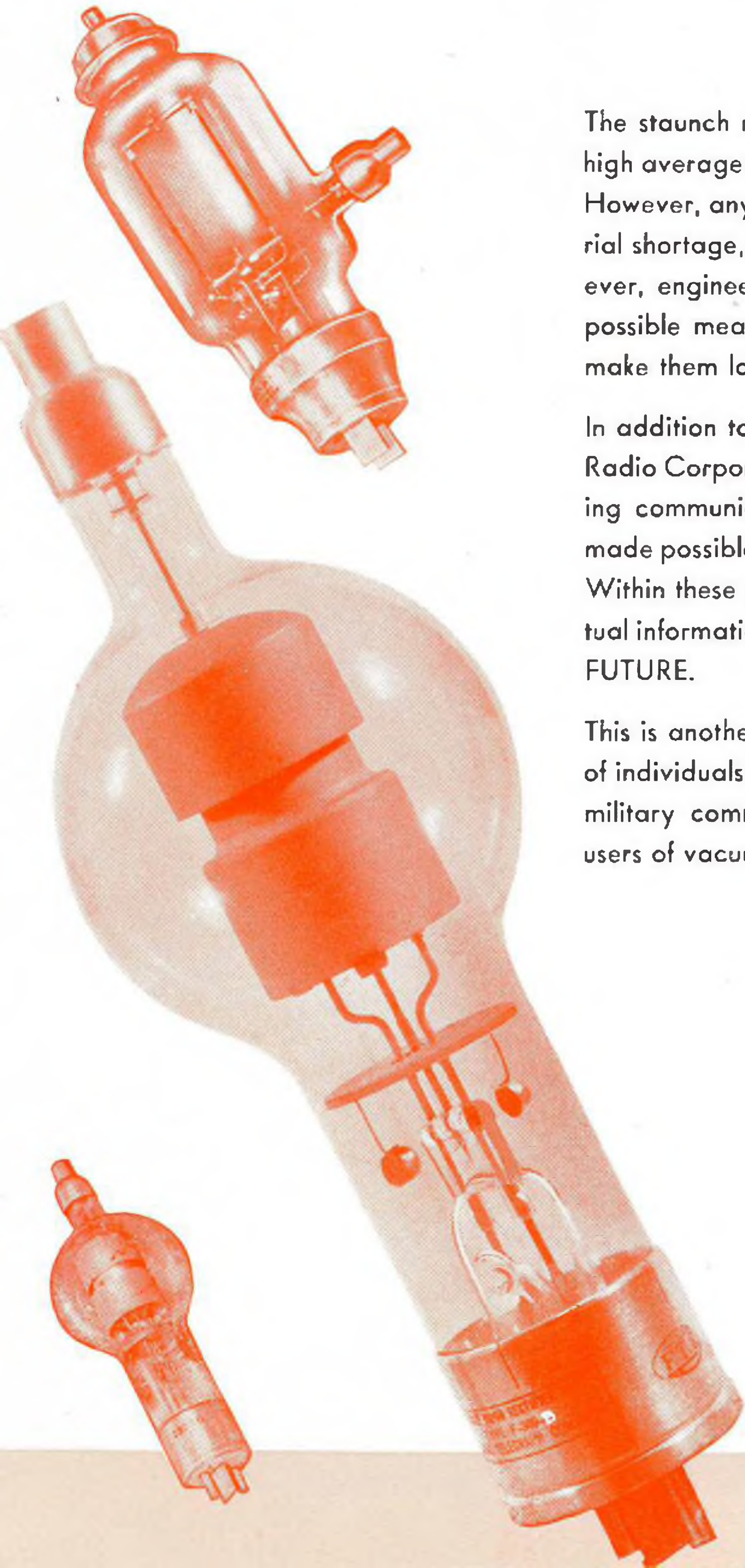
tubes can last longer



The staunch reliability of Federal Vacuum Tubes and their high average of watt-hours in actual performance is famous. However, any emergency, especially that of a critical material shortage, is a great teacher. In recent times, more than ever, engineers have been stimulated to search for every possible means to extend the life of vacuum tubes and to make them last much longer.

In addition to this modern impetus, Federal Telephone and Radio Corporation's background of thirty-seven years building communications equipment and component parts has made possible the compilation and presentation of this book. Within these pages will be found worth-while hints and factual information for the extension of tube life, now, and in the FUTURE.

This is another Federal service, designed for the assistance of individuals in the fields of broadcasting, commercial and military communications, industrial heating, or any other users of vacuum tubes.


that the filament
may live!

PURE TUNGSTEN FILAMENT:

Thousands of hours may be added to the life of tubes now in use if simple precautionary rules are followed. The life expectancy of pure tungsten filament tubes increases very rapidly as filament voltage is reduced. With the following precautions, the filament life may be substantially extended.

FILAMENT VOLTAGE CONTROL:

Pure tungsten filament should not operate above voltage needed to get required performance. The lower you run it, the longer it will last.

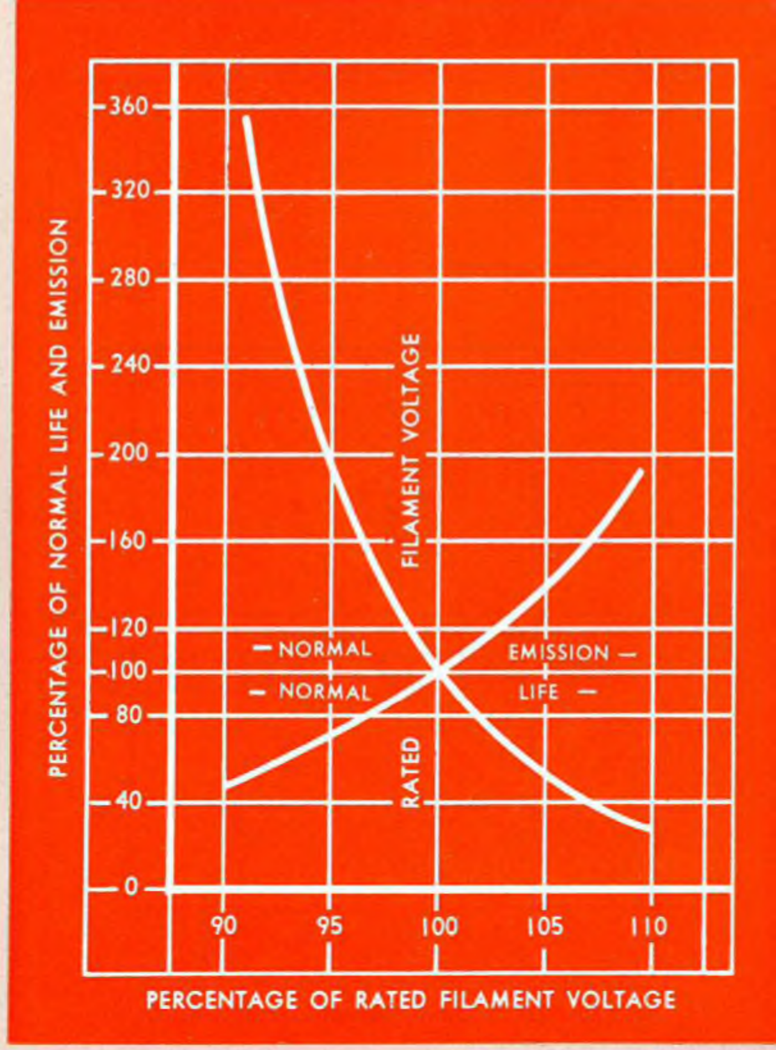
Peak space currents equal to the total available filament emission may be drawn without damage to the filament.

SAVINGS MADE POSSIBLE BY REDUCING FILAMENT VOLTAGE:

Because a five per cent increase in filament voltage reduces the total hours of usefulness fifty per cent and increases the unit cost per hour one hundred per cent, it is very evident that precautions should be taken to accurately control voltage.

By reducing the filament voltage five per cent, the total hours of usefulness are increased ninety-four per cent, and the unit cost per hour is reduced nearly fifty per cent.

	Filament Voltage	Total Hours of Useful Life	Unit Cost per Hour
	90%	400%	25%
	95%	194%	52%
Normal	100%	100%	100%
	105%	52%	200%
	110%	26%	4.5%



Effect of change in filament voltage upon the life and emission of bright tungsten filament.

THORIATED TUNGSTEN IS DIFFERENT:

Keep at rated voltage; never deviate more than ±5% for maximum life.

(a) Source of emission is a monatomic layer of thorium on filament surface.

(b) Thorium is constantly evaporated from the filament surface at a rate determined by the wire temperature and replenished from within the wire, also at a rate determined by wire temperature.

(c) Therefore, balance of loss and replacement requires that the filament temperature be within a comparatively narrow range.

(d) Drastic life shortening may result from the operation of thoriated filament much below or above rated values.

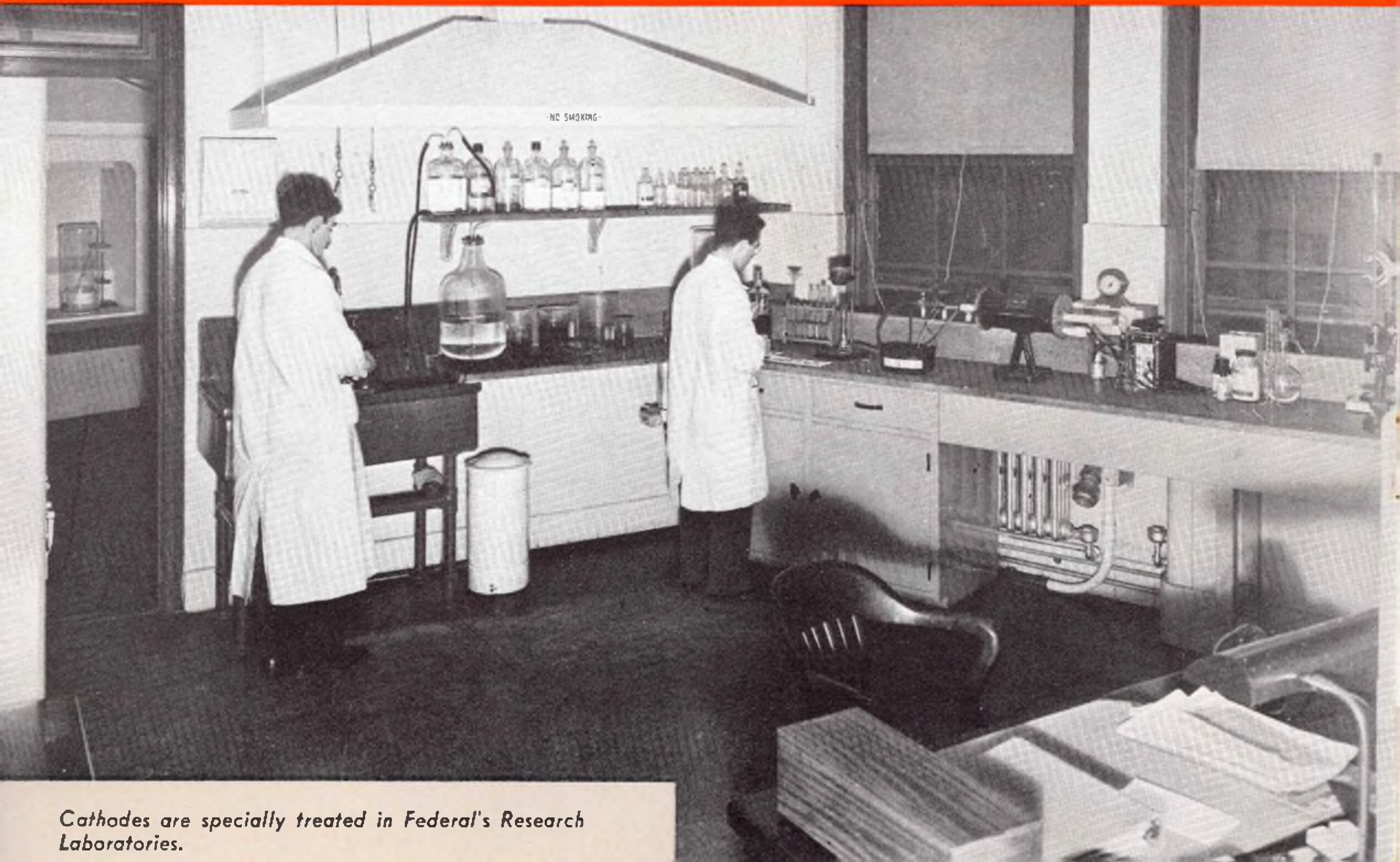
(e) Unlike bright tungsten filament, thoriated tungsten filaments should never be operated at or near saturation.

Tube Conservation Recommendations

Percentages of rated normal filament voltages to be used under various operating and stand-by conditions to give maximum filament life.

Tube Type by Kind of Filament or Cathode	Operating Conditions		Recommended Stand-by Conditions (% of Normal Operating Voltage)			
	Normal Load Operation	Light Load May Increase Life	Under 15 Minutes	15 Minutes to 2 Hours	2 to 12 Hours	Over 12 Hours
1. Pure Tungsten filament (small and medium types)	100*	Reduce	80	80	off	off
2. Pure Tungsten filament (large types)	100*	Reduce	80	80	80	off
3. Thoriated-Tungsten filament (small and medium types)	100	95-100	80	off	off	off
4. Thoriated-Tungsten filament (large types)	100	95-100	80	80	off	off
5. Oxide-coated filament (small and medium gas vapor)	100	100	100	100	off	off
6. Oxide-coated filament or cathodes (large gas vapor)	100	100	100	100	100	off
7. Oxide-coated cathodes (high vacuum)	100	95-100	100	off	off	off
8. Oxide-coated filaments (high vacuum quick heating)	100	95-100	80	off	off	off

**Normal load operation may be less than 100% as recommended in instructions.*



Cathodes are specially treated in Federal's Research Laboratories.

maximum ratings for tube operation

With an eye to utmost in performance, and to contribute to a long and useful life, Federal engineers have made careful analyses to establish:

Maximum Ratings for Tube Operation

Maximum ratings are ratings within which all tubes of a given type should give satisfactory operation, and long life.

MAXIMUM PLATE VOLTAGE RATING:

The maximum DC voltage which may be impressed safely between the plate and other elements of a water cooled tube is determined from these considerations:

FUNDAMENTALLY:

Highest instantaneous voltage value would be voltage at which insulation breaks down or spurious emissions, either from soft X-rays or of spontaneous origin, become apparent

ACTUALLY:

Because no such thing as a perfect vacuum or other ideal condition within the tube is possible, the real value is lower than the theoretical limit.

THEREFORE:

Maximum rated value must be made lower than the theoretical maximum to provide safe operation. Increased tube life can frequently be realized by reduction of plate voltage below the rated maximum.

MAXIMUM PLATE CURRENT RATING:

The fundamental limitation on plate current is the total emission available from the filament. In the case of pure tungsten filament, the limit is determined by satisfactory operation in terms of power output and distortion, since no sacrifice in life results from utilization of all of the filament emission.

MAXIMUM PLATE DISSIPATION:

The plate dissipation rating of water cooled tubes is so dependent upon conditions outside of the tube proper, and beyond the control of the manufacturer, that it might almost be said to be arbitrary, based as it is upon the effective anode area.

Any scale formation on the anode itself will reduce its ability to dissipate heat, resulting both from the fact that scale is a poor conductor, and that its comparatively rough surface tends to break up the smooth sheet of water flowing over the anode and creates pockets where localized boiling may occur.

MAXIMUM GRID CURRENT RATINGS:

The limitations placed upon DC grid current are primarily for the purpose of avoiding excessive heating of the grid structure. Although the fundamental limitation is in terms of power dissipation, the current value is used because it can be observed more readily.

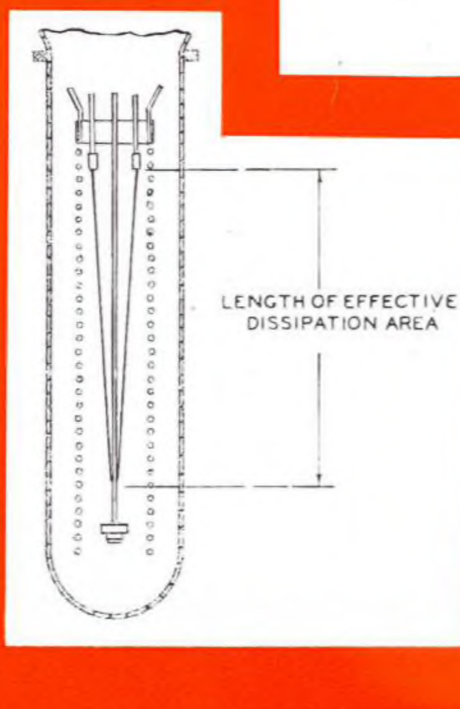
As frequencies are increased, it becomes necessary to pay more attention to the I^2R loss in the grid lead. In the absence of convenient measuring facilities, observations of the copper to glass grid seal may serve as an indication of safe operation. A marked change in the color of the seal itself would indicate excessive heating from high current or from poor electrical contact with the external connection.

THORIATED FILAMENTS—AIR COOLED TUBES:

While the foregoing applies generally to water cooled tubes, additional considerations apply to air cooled tubes using thoriated filaments. The most important consideration is the fact that the thoriated filament is much more sensitive to positive ion bombardment than the pure tungsten filament. There is no such thing as a perfectly gas-free vacuum tube. Consequently, the residual molecules of gas are ionized by collision with the electrons flowing to the plate, resulting in the production of positive ions which are accelerated toward any element which is negative with respect to the anode. Some of these will, therefore, strike the filament, and depending upon their number and velocity, will tend to destroy the thin film of thorium from which the filament derives its emission.

As the velocity of the ions varies with the potential difference, it is obvious that higher plate voltages increase the likelihood of impaired emission.

In air cooled tubes, plate dissipation limitations are based almost entirely on considerations within the tube. Assuming that adequate air circulation is provided for external cooling of tube envelope and seals, the design, material and processing of the anode itself control the amount of wattage it is capable of dissipating. Mere observation of the color of the plate is not a safe indication upon which to base safe dissipation values. The material used and especially the processing in manufacture are such important factors that one of two plates, of apparently identical design, might safely operate at a considerably higher temperature than the other.



Cross-section of typical water cooled triode.

proper care of metal to glass seals

That the glass must "wet" the metal is the primary requirement in a metal to glass seal. In the strictest sense, glass will not "wet" a pure clean metal surface. If the surface is oxidized, however, the glass will bond with it and form a seal.

ADHESION:

The glass adheres to the oxide by dissolving a portion of its surface and the oxide in turn adheres to the metal by the nature of that particular oxide, and its method of formation. Consequently, the metal oxide provides a cement bond between the metal and the glass. This principle applies to all classes of seals.

EXPANSION:

There are two major classifications, namely: (1) seals in which the materials have similar coefficients of expansion; (2) seals in which flexibility is provided in the metal to allow for a differential in the expansion coefficient.

Common examples of the first group are the lead-in wires brought in through presses or button seals in lamps and vacuum tubes. Of the second type is the familiar copper-to-glass seal used at the anodes of water cooled tubes, and in some cases at the grid and filament leads as well.

Under the first classification the seal generally used in most transmitting tubes is made between tungsten and "hard glass". Among the "hard glass" formulas there are several which will seal to tungsten. The coefficient of expansion of all "hard glasses", however, increases with temperature so that seals of this type can be operated only up to a certain maximum temperature where the difference in expansion between the metal and the glass does not create a stress greater than the strength of either the glass or its bond to the metal.

CAUTION:

A method of cooling such a seal is shown in the diagram. If too much cooling is applied, a strain may be set up in the region designated by "X" in drawing.

ALLOY SEALS:

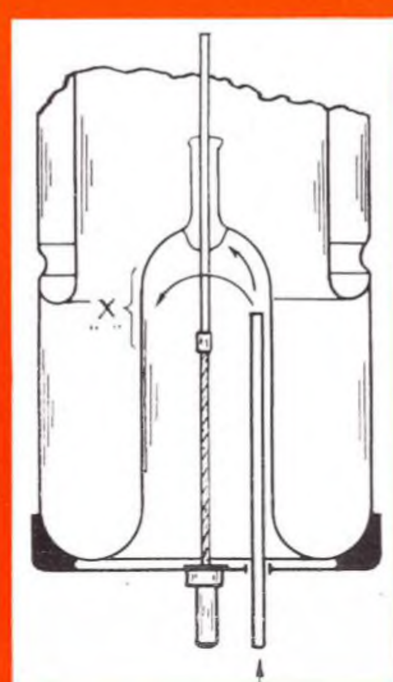
Bonding technique and limitations in alloy seals are similar to those which apply to tungsten, and similar precautions must be observed.

COPPER-TO-GLASS SEALS:

The expansion coefficient of copper differs so widely from that of glass that rupture would be certain unless some flexibility were provided. The high ductility and low yield point of copper make it possible to fulfill the condition that stresses from expansion and contraction must not exceed the tensile strength of the glass. The thin copper required, results in a certain amount of mechanical weakness, and while the copper seals used in transmitting tubes today are sufficiently rugged to withstand normal handling and usage, they may still be said to be the weakest point on the exterior of the tube.

Sustained high temperatures will tend to destroy the bond. Fortunately, there is a visible indication of excessive temperature. As the temperature is increased, the normal red color will become greenish, progressing to a sooty black. Particularly in the case of internal seals which are not required to hold vacuum, the greenish stage may represent the safe limit of operation.

Little concern need be given to the temperature of the common copper-to-glass seal between the envelope and anode of water cooled tubes. Here the thermal conductivity of the copper is sufficient to keep the seal at a safe temperature when adequate cooling is applied to the anode.



Method of air cooling filament seal.

mercury vapor rectifier tubes last. IF...

Several operating precautions, given careful consideration, will materially lengthen the life of rectifier tubes. For example, when tubes are first received, it may be noticed that shipment handling has caused mercury deposits to collect on tube parts.

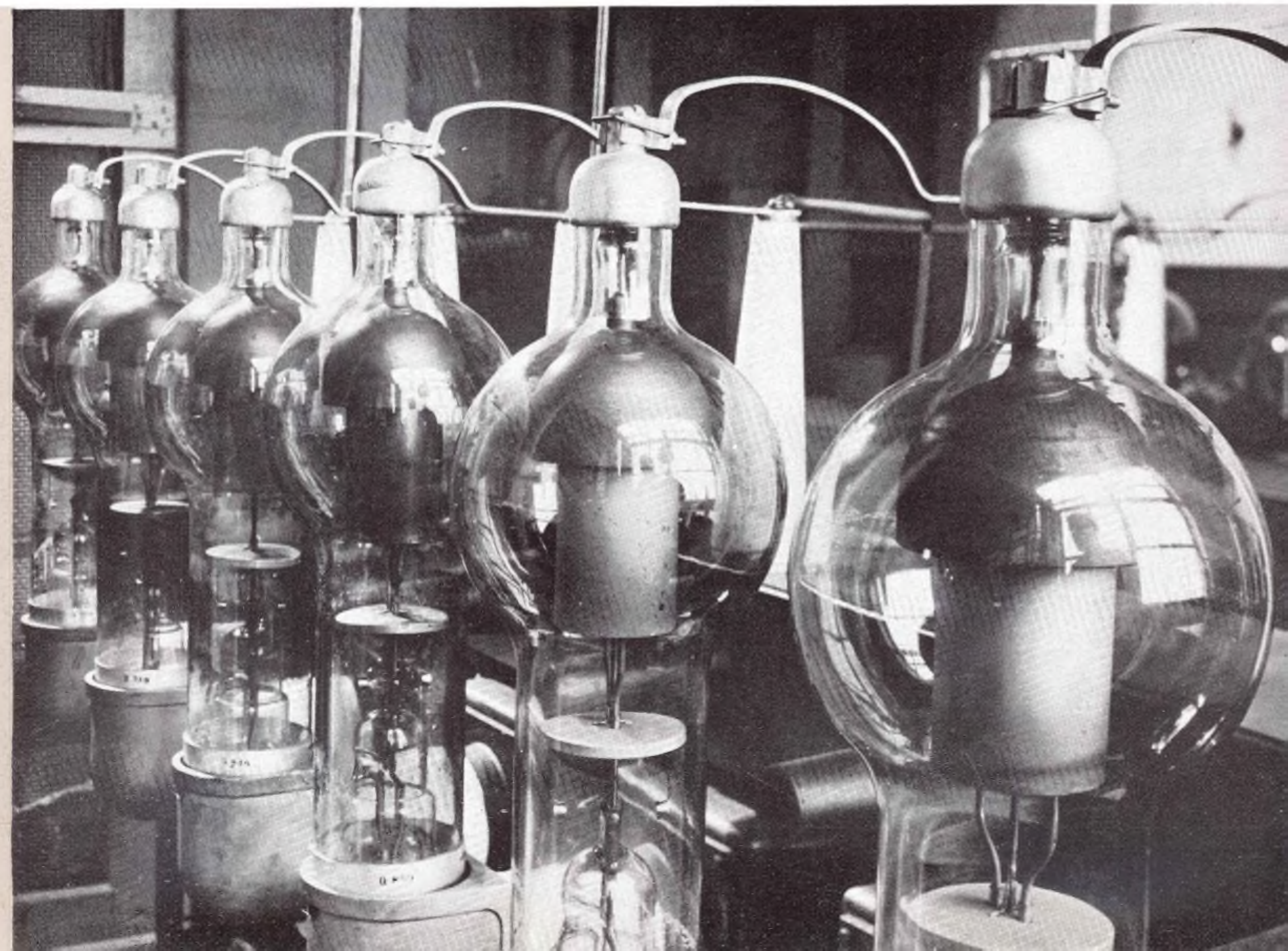
This condition materially reduces the tube's ability to withstand high inverse plate voltage. In order to distribute the mercury properly in the tube, the filament must be lighted at rated voltage for fifteen minutes before plate voltage is applied.

BEFORE INSTALLATION:

Clean bulb before installing tube to prevent resultant heating effects or leakage.

Mount in vertical position with filament (large base) down.

Protect tubes from mechanical shocks or vibration.



OPERATION:

Know the ambient temperatures and conditions of ventilation.

Keep rectifier tubes within specified temperature limits.

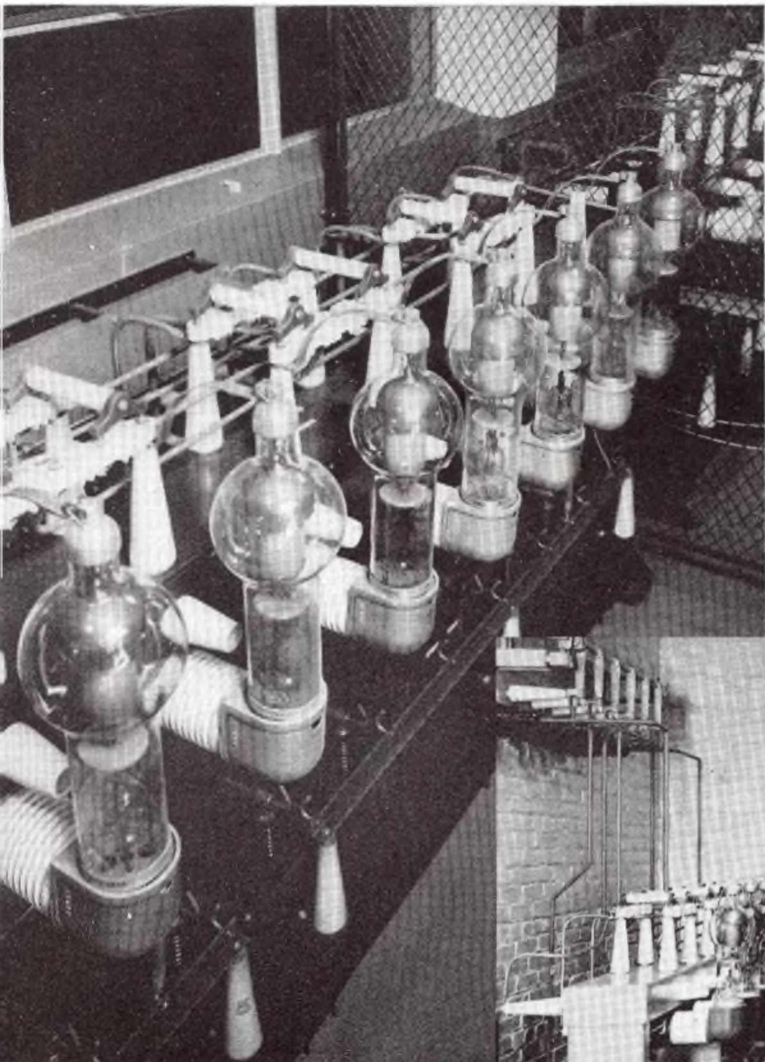
CAUTION:

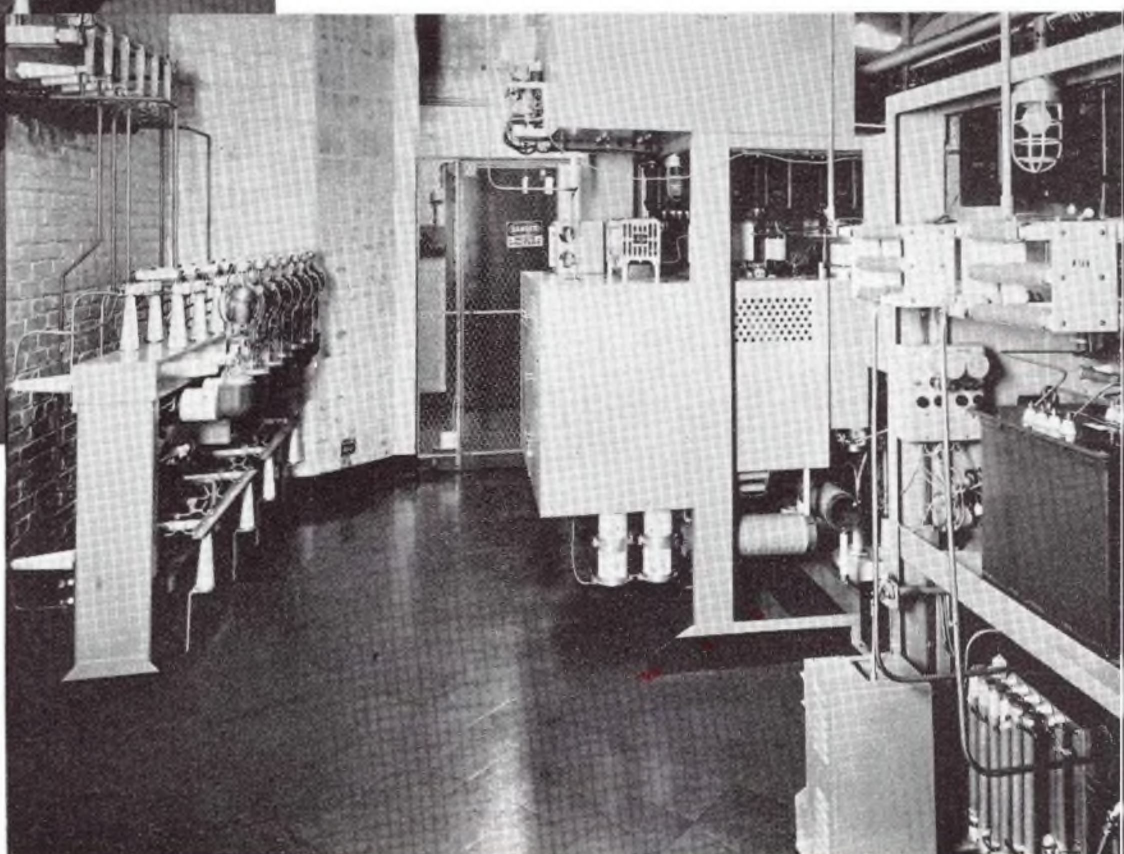
Pre-heat filaments of tubes; lighted first, they will insure proper mercury pressure and aid longer life of tube.

Do not apply high voltage until filaments reach normal operating temperature.

TUBE DROP:

The tube drop (a constant voltage difference between anode and cathode in the conducting direction) increases with age. Keep day-to-day record. When tube drop reaches 18 to 20 volts with space current adjusted to rated peak value, the end of the tube's life is approaching.



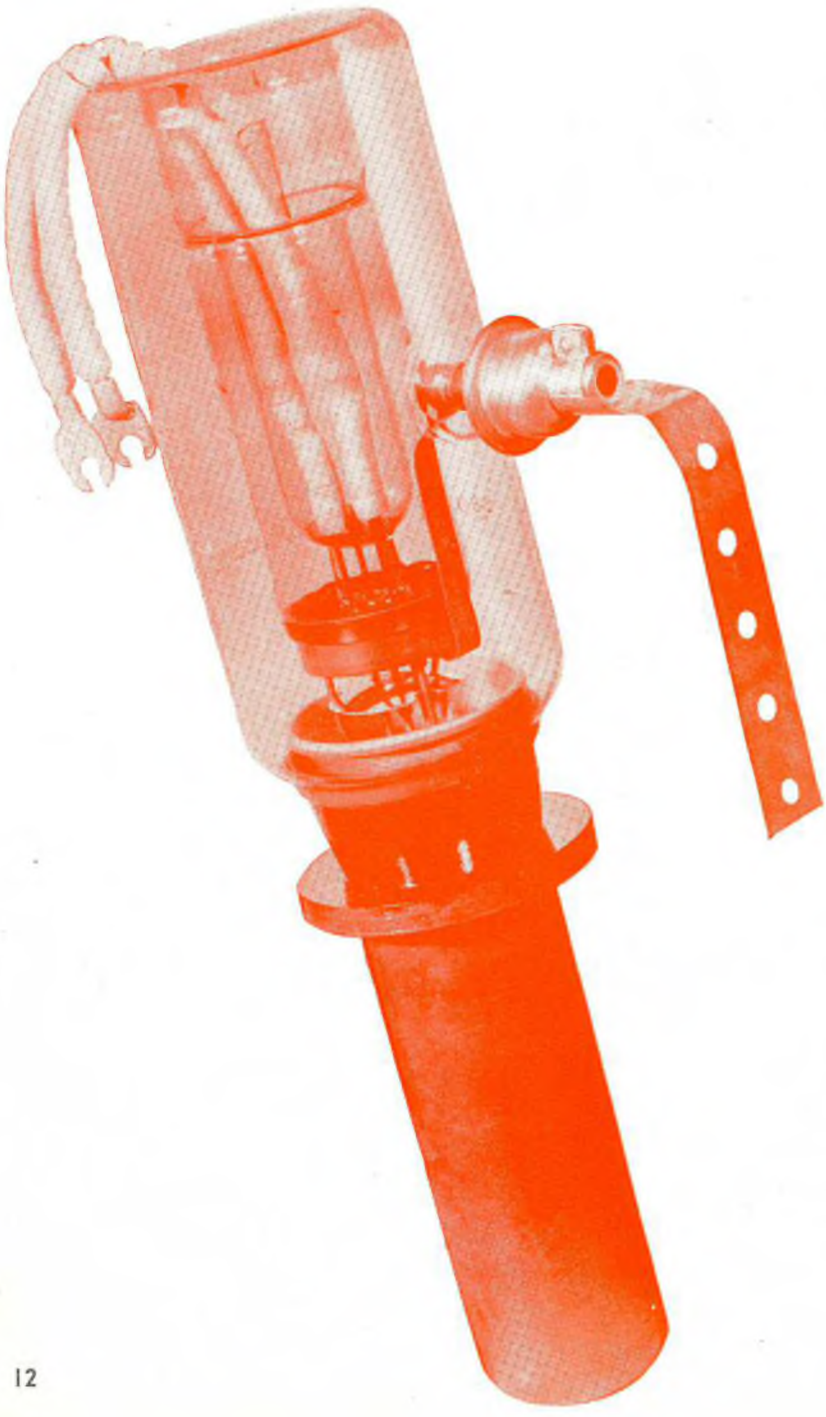


Federal tubes installed in a broadcasting station.

Interior of a broadcasting station where Federal rectifier tubes are operated on a "long life schedule".

Rectifier tubes in the Federal Laboratory are tested for long life.

operating temperatures



CONTROL TO TEMPERATURE LENGTHENS TUBE LIFE:

Upper temperature limits of any tube must not be exceeded. Incorrect temperature conditions will impair the delicate filament. It is the evaporation rate of the tungsten filaments which determines the service life of both water cooled and forced air cooled tubes. With both, the most important secondary limitation is abnormal anode dissipation.

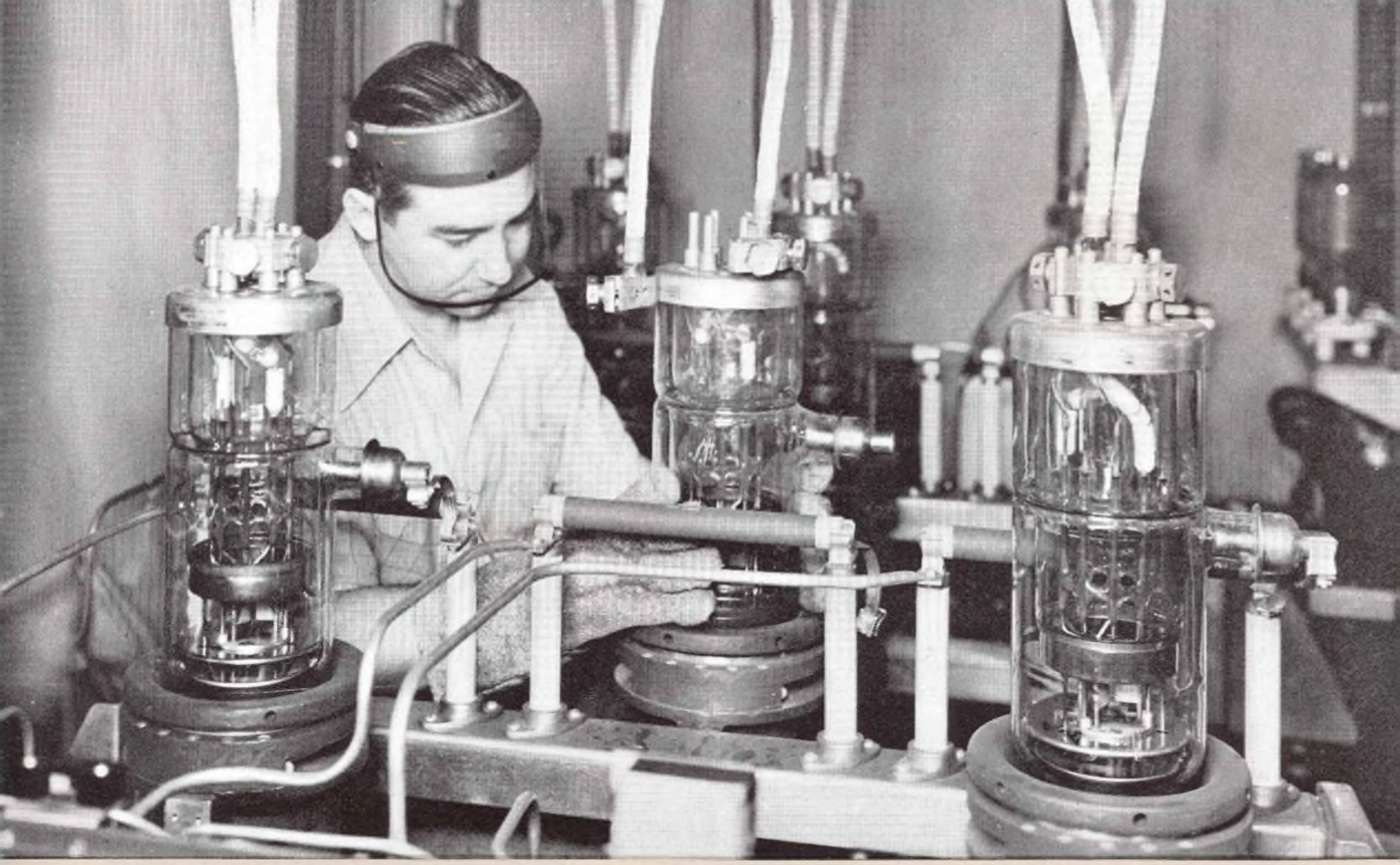
In water cooled tubes, excessive dissipation results in boiling water and the formation of steam bubbles on the anode. Anode puncture is a consequent danger.

In forced air cooled tubes, excessive dissipation may result in melting of the film of solder between anode and radiator surfaces. Crystallization or chemical decomposition and impairment of its thermal conductivity will result.

The proper installation and maintenance of cooling systems is very important in realizing the maximum tube life. These factors are explained under the separate headings of Water Cooling and Air Cooling.

Although contact surfaces on bases and caps are designed large enough to provide for carrying currents (radio frequency and direct current) within the rating of the tube, sufficient current carrying capacity should be allowed in connections to prevent undue heating.

Good electrical contact and clean terminals are necessary for long life.



Federal water cooled tubes are carefully installed in an international broadcasting transmitter.

water cooling

In addition to the previously explained precautions, the following observations relative to water cooled tubes are important.

Place tube carefully in water-jacket and turn gently so flange will seat properly in jacket.

Tighten clamp adequately to prevent water leaks.

Avoid strain to seal in making filament and grid connections.

Oil moving parts of water-jacket to prevent corrosion and sticking.

Remember to disconnect leads before unclamping tubes for removal from water-jacket.

To avoid formation of scale, cooling water should not have a hardness greater than ten grains per gallon. Distilled water, or rain water caught in a storage tank are highly recommended.

Avoiding formation of scale on anode prevents danger of breakage, when removing tubes from water-jackets for cleaning.

Flow of water over anode should be fast enough to prevent steam bubbles from forming. Water temperature should not exceed 70° C. at water outlet. Localized boiling may be detected by a singing noise.

Filament and plate supply should be inter-connected with water supply to remove voltages from tubes in the event of water failure, and to prevent their applications without adequate water flow.

Glass bulb of tube should not be near any metallic body, or inflammable material, nor subjected to liquid drops or spray.

Allow tube to cool before removal from socket.

Do not place on metallic, cold or heat-conducting surface. Sudden temperature change sometimes causes cracking.

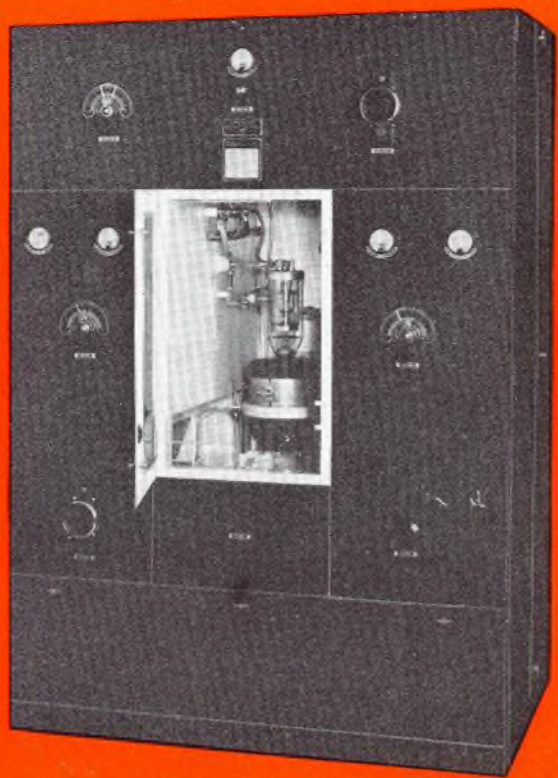
air cooling

Because of high ambient temperatures, air cooling of tubes is often employed: Two methods are available for air cooling:

1. Forced draft from fan directed to cool entire tube uniformly.
2. Ventilation ducts which take advantage of chimney effect of heat from tube.

When forced draft cooling is employed, the following precautions should be observed:

1. Prevent localizing draft to one area by proper placement of the fans.



2. Screen fans with fine mesh wire to keep dirt from blowing on tubes.
3. Dust collected on tubes should be removed regularly.
4. Use clips and sockets designed to provide good contact without undue force being applied during installation or removal of tube.

Front view of modulator showing Federal air cooled tubes.

tubes take "NAPS" for longer life

The practice of maintaining tubes at full filament voltage, when not operating, may cause unnecessary shortening of tube life. It is not always convenient to rest the tubes when stand-bys are short, but long periods definitely should be organized to put the tubes "at ease". It will pay dividends in additional operating hours per tube.

Reduction of filament voltage to 80% of normal, rather than turning the tubes off, is good practice. Complete shut-down for short periods cause unnecessary mechanical stress in the filament. Reducing the current, rather than turning it off, keeps the filament hot for quick returns to operating temperature. Gradual but complete shut-downs are advisable for stand-by periods of fifteen minutes or more.

CAUTION:

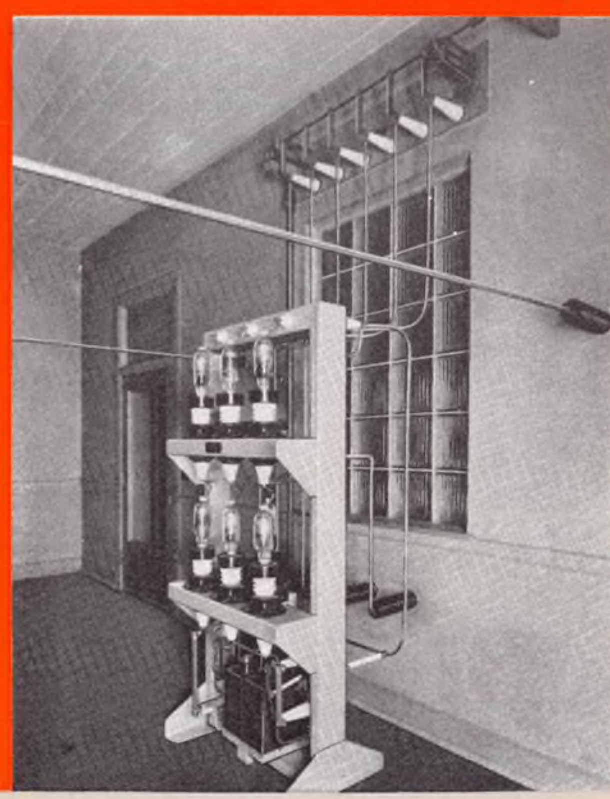
When operation is resumed circuit design should be such that the momentary filament current will not exceed 150% of its normal value. (Further information may be had by writing to Federal Telephone & Radio Corporation for specific recommendations.)

STORAGE OF TUBES:

Care of tubes to preserve their usefulness includes adequate storage facilities to keep tubes in upright position, protected from vibration, moisture, and extreme temperature changes.

As soon as tubes are received, they should be tested. Repeat regularly at three-month periods.

Tubes having flexible leads require thoughtful handling. Breakage may result if leads strike the glass.



Close-up of rectifying unit. Filament voltage is reduced during stand-by periods.

flash-arcs

The flash-arc is not to be confused with the low-voltage, power arc which follows it. The term "flash-arc" refers properly to an arc of high voltage-drop between electrodes of a high-vacuum tube which establishes conduction initially across the evacuated space.

While the flash-arc sometimes serves to establish the conduction path for a destructive power arc, it has insufficient energy alone, to damage the internal tube structure.

FEDERAL'S PROTECTION AGAINST FLASH-ARCS:

Metallurgical studies plus refinements in production methods—have brought about a tremendous reduction of flash-arcs and have produced a decidedly more rugged tube.

Now the balance of the responsibility remains with the circuit designer. With proper circuit conditions, flash-arcs may occur without being followed by power-arcs.

SUGGESTIONS FOR CIRCUIT DESIGN:

Hold to a minimum the immediately available charge at the tube anode. This may be accomplished by several circuit design principles, some of which follow:

Flash-arc markings on inside of anode and anode seal shield of high-power, water cooled vacuum tube.

1 The stored energy in the plate blocking-condensers should be made as small as possible:

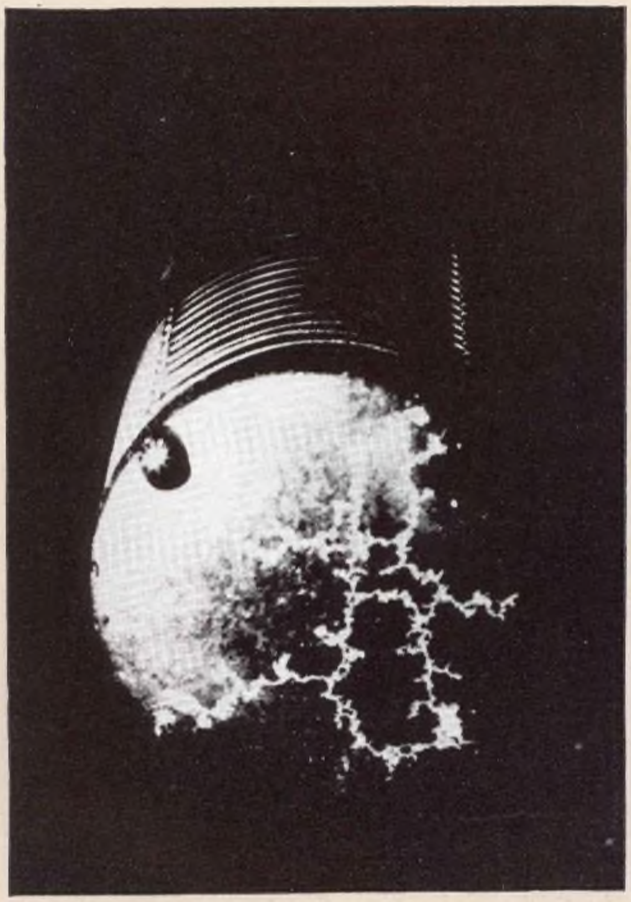
Amplifiers should use the smallest plate blocking-condenser consistent with other design requirements.

Banks of several tubes in parallel (where a rather large blocking capacity is required due to the low output impedance) should use for isolation purposes a separate condenser and radio frequency choke coil for each tube.

2 The radio frequency choke coil should be large:

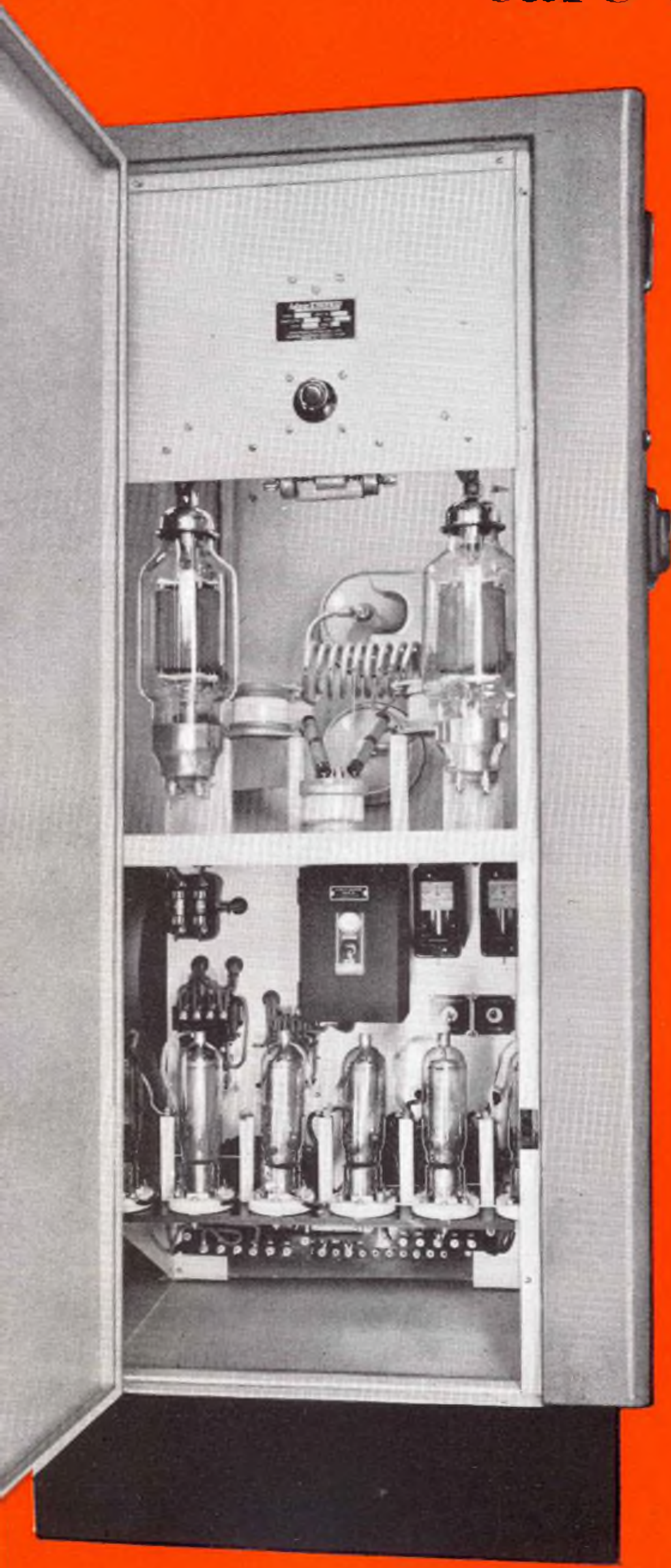
In high frequency telephone and telegraph, conditions are particularly favorable for the creation of a power arc where the series inductance between power supply filter condenser and tube (in either parallel—or series—feed type of circuits) may be inappreciable. It is advisable to insert either series inductance or resistance between filler condenser and tubes (depending upon the operational limitations).

Large water cooled tubes operating in a single-ended or two-tube, push-pull circuit (where the available energy of the plate blocking condenser is large and cannot be reduced), must rely on the regulatory effect of inductance or resistance in series with the power supply, plus rapid relay and circuit-breaker operation to limit the power arc surge current to a safe value.



Characteristic flash-arc on grid of high-power, water cooled vacuum tubes.

care of industrial tubes



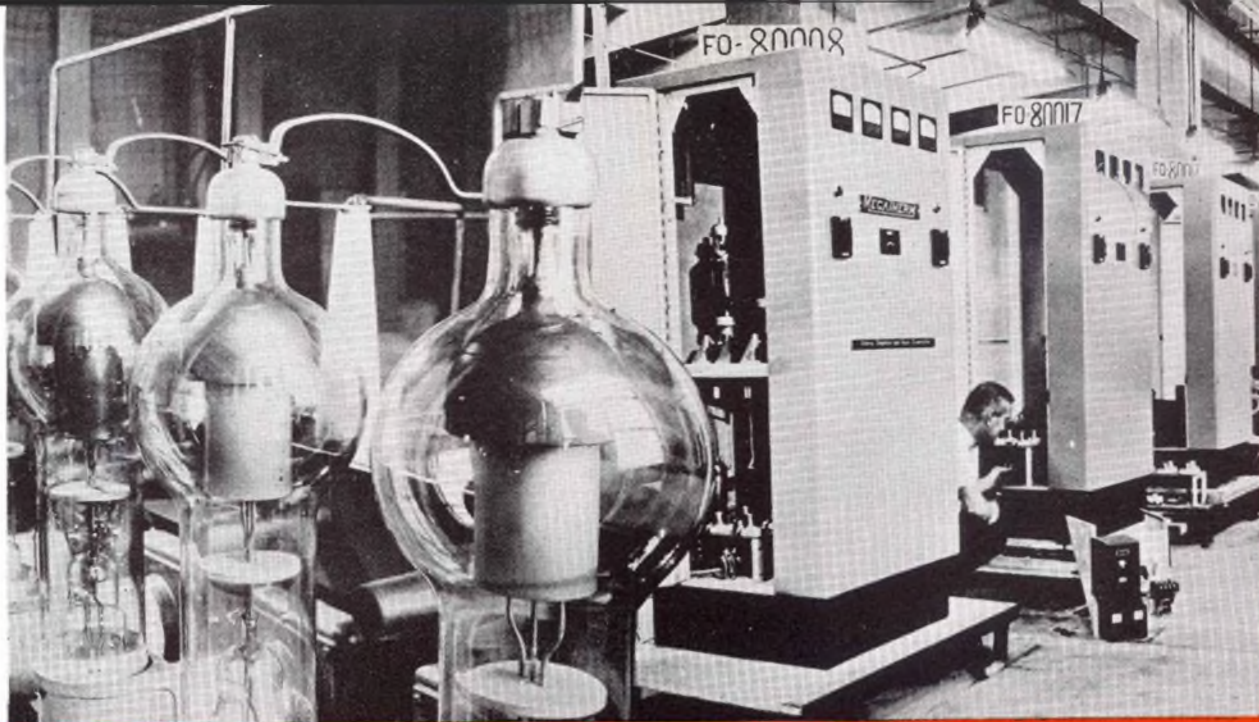
The tremendous variety of uses for tubes in industry has for some time out-weighed broadcasting in the percentage of tubes used. In this field, therefore, we find much opportunity for tube conservation. In fact, extra care is required because of the rigorous industrial operating conditions which frequently exist. MAXIMUM RATINGS MUST NOT BE EXCEEDED UNDER ANY LOAD CONDITION TO BE ENCOUNTERED. Keep the "normal load" set at a specific level considerably below the rated maximum. In practice, the actual level of operation below maximum ratings will be determined by the circuit design and its protective features.

SPECIAL PRECAUTIONS:

Limit grid current rise which occurs when plate circuit load is removed.

Limit plate dissipation to a value below the rated maximum for all load conditions to be encountered.

All induction heating units (both dielectric and induction types) are equipped with Federal's long-life power tubes. Six industrial type tubes are used in a three-phase, full-wave rectifier circuit.



Industrial tubes are given a wide margin of safety on maximum ratings.

Skilled craftsman building tubes for industrial use.

Induction heating power is furnished by vacuum tubes.

a product of

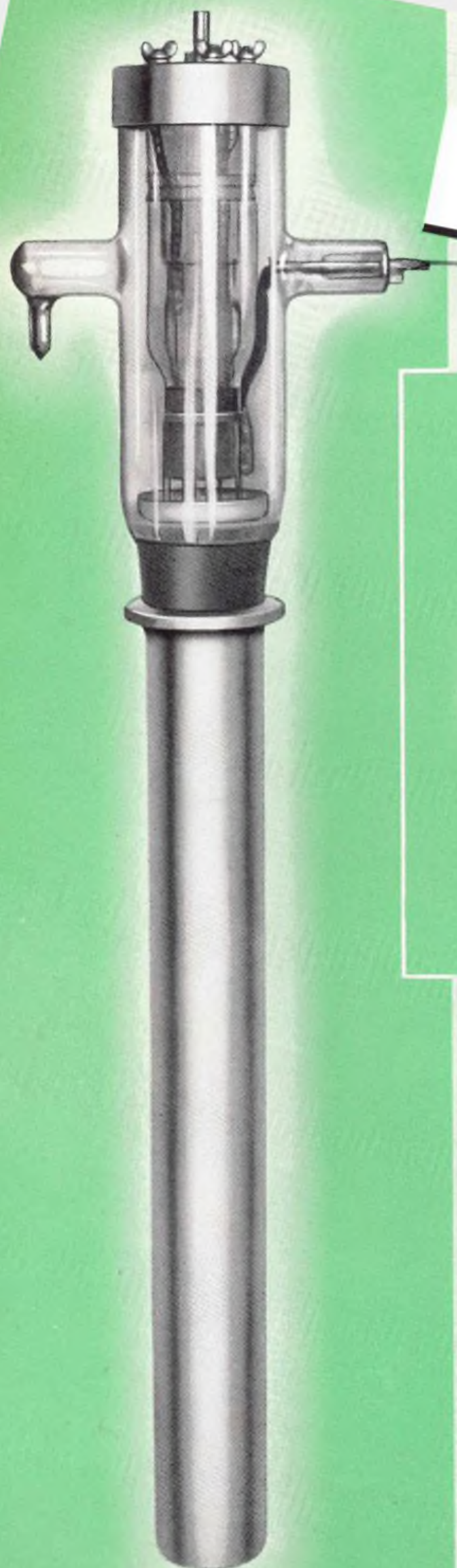
Federal Telephone and Radio Corporation

GEA-3927

HOW TO MAKE YOUR TRANSMITTING TUBES LAST LONGER

GENERAL ELECTRIC

PURE TUNGSTEN-



The Suggestions on the Opposite Page Apply to Such Tubes As These G-E Tungsten-filament Types:

GL-889R	GL-862
GL-891R	GL-880
GL-892R	GL-889
GL-893R	GL-891
GL-8002R	GL-892
GL-207	GL-893
GL-846	GL-898
GL-858	GL-8002
GL-8009	

FILAMENT TUBES

HERE'S HOW you can easily remove many of the causes of premature tube failure.

Here are a few suggestions for prolonging the life of pure-tungsten-filament tubes. Specific installation and operating instructions are available for *every* General Electric tube, as well as general instructions for water-cooled and air-cooled types. Send us a list of the G-E tubes you use. We shall be glad to furnish you with complete service information. A brief review of these instruction sheets will enable you in many cases to get thousands of extra hours from hard-to-get tubes.

1

Keep filament voltage as low as possible consistent with output and permissible distortion.

2

Minimize anode dissipation by careful tuning of transmitter.

3

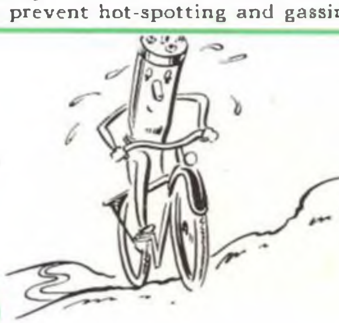
Be sure there is plenty of water flowing on water-cooled anodes and plenty of air on air-cooled anodes to prevent hot-spotting and gassing.

4

Keep plenty of air on the glass bulb —particularly on the seals where glass joins metal or leads go through —to reduce electrolysis and gas evolution from glass.

5

Switch leads every 500 hours, preferably once a week, when filaments operate on d-c.



6

During starting cycle be sure the instantaneous current does not exceed 150 per cent of normal current.

7

Raise plate voltage in easy steps when starting.

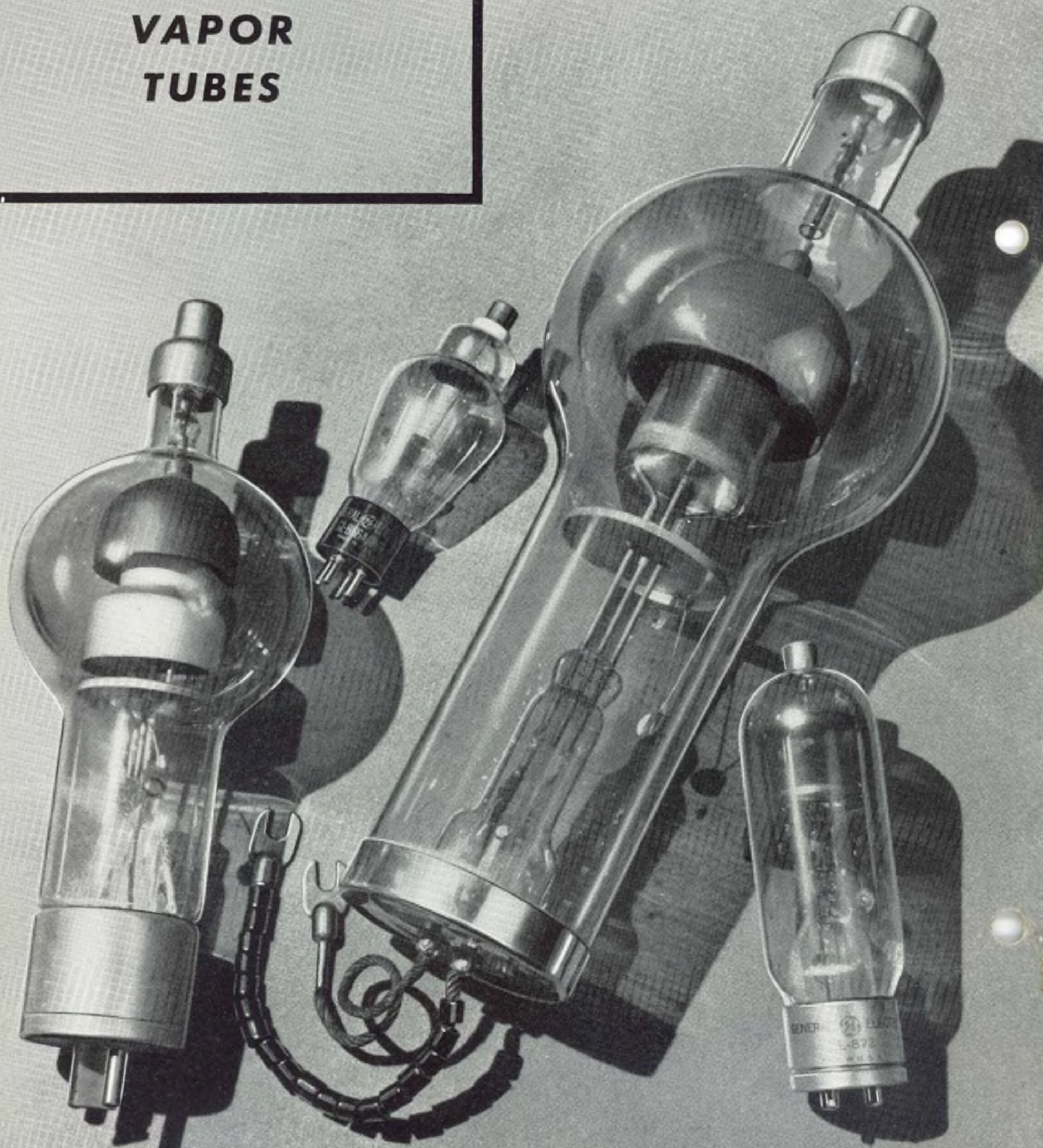
8

Prevent damage caused by overloading the plate circuit. Use protective devices such as a fuse or relay.

9

Hard water (over 10 grains per gallon) should not be used for water-cooling. Distilled water will reduce scale formation on anode.

MERCURY VAPOR TUBES



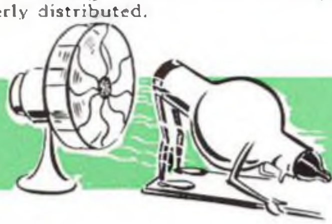
HOW TO GET LONGER LIFE FROM YOUR MERCURY-VAPOR TUBES

Here's a four-word formula to make your mercury-vapor tubes last longer—"Handle carefully; operate conservatively." Below are a few suggestions to help you put this formula into effect. They will help prevent many of the causes of tube failure, such as: loss of emission, high arc-drop, cathode bombardment, arc-backs, the liberation of gas, and cathode failure. These safeguards are applicable to such tubes as the following General Electric mercury-vapor rectifiers: GL-266B, GL-857B, GL-866A/866, GL-869B, GL-872, GL-872A. For more complete instructions on operation and handling, write for Bulletin GEH-977B. Also list the types of G-E mercury-vapor rectifiers you are now using. We shall be glad to send you complete service information to help you get the most out of your mercury-vapor tubes.

1 Keep tubes upright and avoid splashing mercury around. When tubes are first placed in operation, be sure to apply cathode voltage *alone* until mercury is properly distributed.

2 Keep condensed mercury temperature within limits recommended by tube manufacturer.

3 Be sure cathode base, not the anode end, is coolest part of tube. Don't let drafts blow on tubes. Never allow the mercury to condense at the anode end.



4 If you use forced air against the bottom of the tube, keep the blower on for a few minutes after shutting filaments down.

5 Allow plenty of filament warm-up time before applying anode voltage.

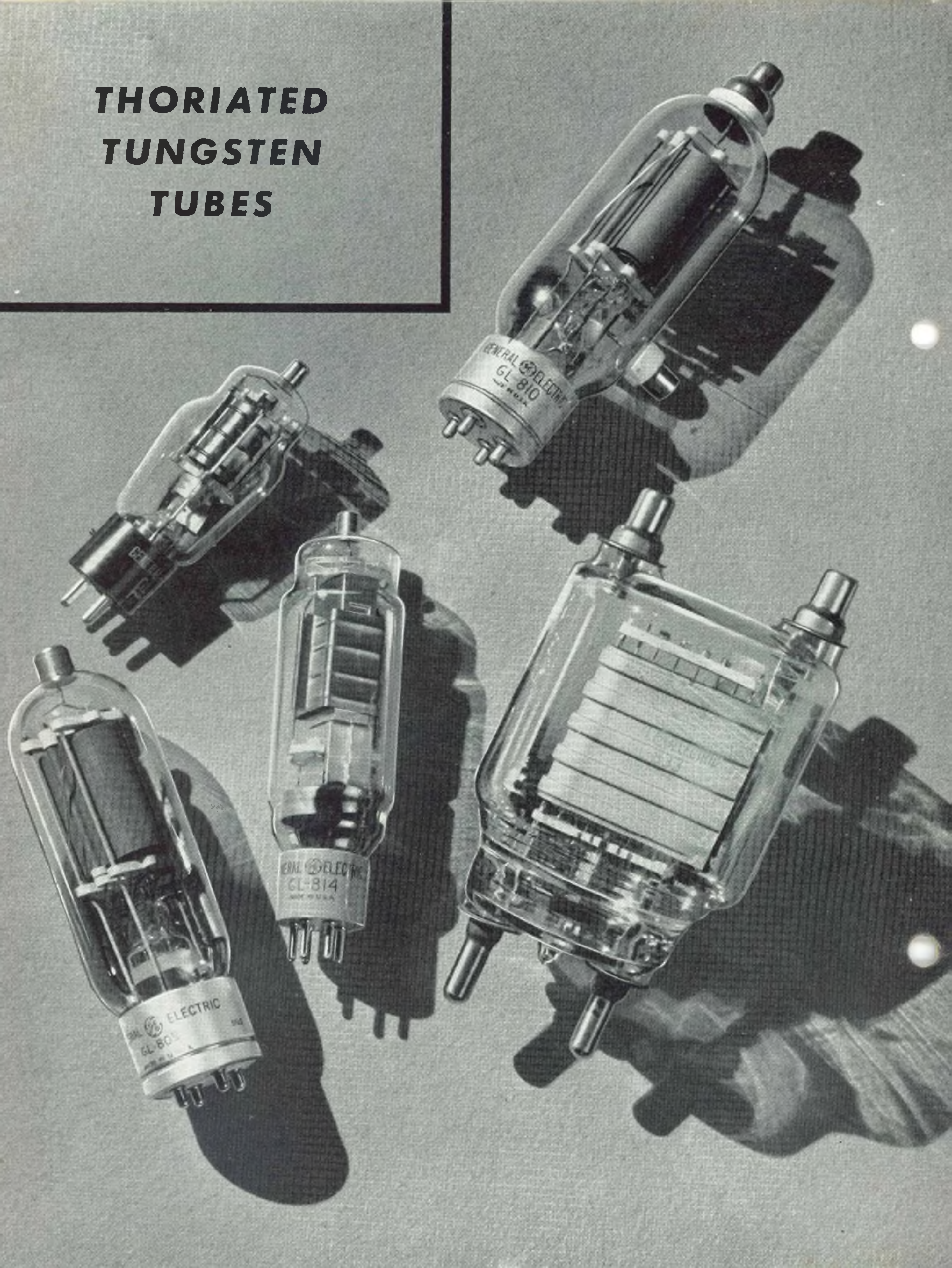
6 Keep peak inverse anode voltage and peak current as low as possible for satisfactory operation. Use adequate protective devices for overload and arc-back protection.

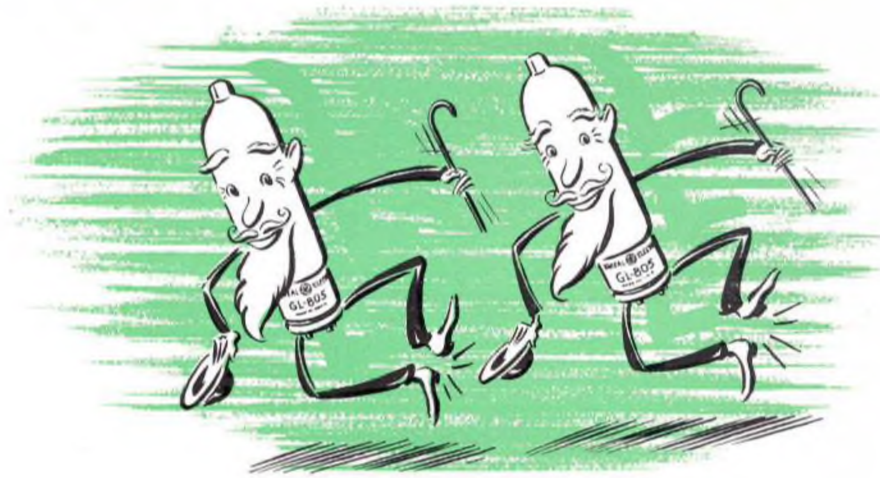
7 Do not allow the cathode voltage (measured at the pins) to deviate more than five per cent from the rated value.

8 Don't overload tubes, even for short periods. Maintain full cathode voltage during standby operation when tube is operated without load.

9 Protect the tubes adequately against the effects of r-f.

THORIATED TUNGSTEN TUBES





10 SUGGESTIONS TO MAKE YOUR THORIATED-TUNGSTEN-FILAMENT TUBES LIVE LONGER

1 Don't overload the tubes. Use adequate protective devices such as a fuse or relay. Heavy overloads are apt to evaporate the thorium surface from the filament, and permanently damage the tube.

2 Normal operating temperature for thoriated-tungsten-filament tubes is obtained by operating them at the *rated* filament voltage. Care should be taken to operate them *at this voltage* (except for standbys and when reactivating). Occasionally, under- or overvoltage will give longer life, but such operation should only be carried out after first consulting the tube manufacturer.

3 Tubes that have been momentarily overloaded, or run at subnormal filament temperature, can quite frequently be reactivated by following this simple procedure: Operate the filament at the rated voltage for ten minutes or more with no voltage on the plate or grid. This process can be accelerated by increasing the filament voltage to 20 per cent above the rated value for a few minutes.

4 Increase the filament voltage progressively (only a small percentage at a time) when a tube no longer responds to reactivation. New filament transformers may be necessary for such operation.

5 For tubes of *250-watt plate dissipation or higher,* when the load on the tube is intermittent, keep the filament at 80 per cent of normal voltage during standby periods of *less than two hours.* This helps keep the cathode surface replenished, and makes it more quickly available when raised to normal filament voltage. If the standby period is *more than two hours,* the filament current should be shut off.

6 For tubes of less than 250-watt plate dissipation, filament voltage should be removed for standbys of more than 15 minutes.

7 For all types of thoriated-tungsten-filament tubes if the off period is less than five minutes, operate the filament at full voltage continuously, as excessive heating and cooling cycles tend to distort this type of filament.

8 Keep tubes well ventilated—with fans or blowers, if necessary.

9 Run at lowest possible anode current and voltage.

10 Minimize plate dissipation by careful tuning of the transmitter.

These Suggestions Apply to Such Tubes As These G-E Thoriated-tungsten-filament Types:

GL-146	GL-810
GL-152	GL-811
GL-159	GL-812
GL-169	GL-813
GL-203A	GL-814
GL-204A	GL-833A
GL-211	GL-834
GL-217C	GL-835
GL-242C	GL-838
GL-276A	GL-845
GL-800	GL-849
GL-801	GL-851
GL-803	GL-860
GL-805	GL-861
GL-806	GL-865
GL-809	GL-1623
GL-1628	

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