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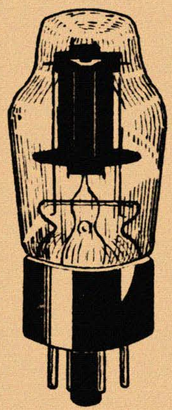
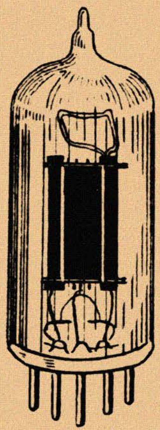
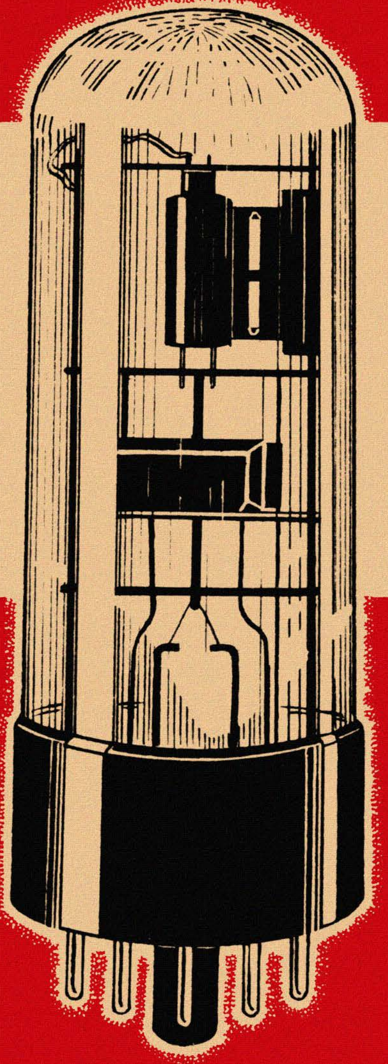
RECEIVING TUBE SUBSTITUTION GUIDE BOOK







BY H. A. MIDDLETON

FIRST EDITION

RECEIVING TUBE SUBSTITUTION GUIDE BOOK

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JOHN F. RIDER PUBLISHER, INC.
480 CANAL STREET NEW YORK 13, N. Y.

First Printing, December, 1950
Second Printing, December, 1950

Printed in the United States of America

FOREWORD

Receiving Tube Substitution Guide Book is a greatly enlarged and revised edition of the book *Wartime Radio Service* published in 1944. This new book lists about 750 receiving tube types and their bases, including all of the following series:

- 4, 5, 6, 7, and 7L old-style base series
- Octal base series
- Loctal base series
- 7-pin miniature series
- 9-pin-noval series
- Subminiature series.

During the past eight years we have made many tube substitutions. Most of them were easy to make and all resulted in from excellent to reasonable performance. The majority of substitutions shown here have actually been tried. We are passing this information on to you in the belief that it will save you many hours and enable you to make necessary repairs to electronic equipment in spite of shortages. Also, when shortages no longer exist, you will again save time in restoring equipment to its original condition after substitutions have been made.

All substitutions listed here describe in detail the necessary data for changing or rewiring the sockets. It is recommended that in making the circuit changes listed you follow the sequence exactly as indicated in order to avoid any errors in rewiring.

You will note that a few types have no substitutes listed. We do not presume to be infallible. We may have omitted some tube substitutions. If you know of tube substitutions which have been omitted we would like to hear from you about them.

Besides a tube substitution listing we have included other important information that will make this book even more useful as a substitution guide. In Section 3 we offer a compilation of television receiver filament circuit arrangements including various filament diagrams. These were compiled by John F. Rider Publisher, Inc., to whom we owe thanks for their contribution. The information was taken from the five presently existing Rider TV Manuals. It is hoped that this information will not only aid tube substitution operations, but will prove helpful in connection with TV servicing in the home. A group of servicing suggestions are also included to help in repairing the filaments of burned-out tubes, making adapters, and for the change over of battery-operated radios to electric operation.

Most significant is the last section of this book which covers different charts and tables. A complete listing of the characteristics of receiving tubes and bases and cathode-ray tubes and bases are included in this section. Thus this book, besides serving as a tube substitution guide, also functions as a tube handbook.

We wish to express our appreciation to the American Radio Relay League for their cooperation in permitting us to reprint their receiving tube characteristics charts from their ARRL handbook. In our estimation these are the most complete charts available at this time. To Tung-Sol Lamp Works, Inc., for supplying us with the data on tube classifications, ballast tube and resistor numbering codes, and RTMA resistor, capacitor, and transformer color codes our thanks; also to Sylvania Electric Products, Inc., for supplying us with the data on cathode-ray-tube characteristics; to Federal Telephone and Radio Corp. and Radio Receptor Corp. for their kind cooperation.

November, 1950

H. A. Middleton

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SECTION 1

THE BACKGROUND OF TUBE SUBSTITUTIONS

Were it not for the fact that tube development is a never-ending activity, there would be no purpose in describing the background of tube substitution. The substitution lists contained herein would suffice, for they include practically every tube which is used for receiving purposes serving many different electronic applications. These applications consist of radio receivers of all varieties (a-m, f-m, and TV), radar, facsimile (commercial and military), public address amplifiers, record changer amplifiers, test equipment, electronic computers — in fact every kind of equipment with the exception of transmitters, although even there, receiving tubes make their appearance in the speech amplifiers.

The basis of tube substitution is *similarity* or equivalence between the original and the substitute. The choice of these two words with different connotation is deliberate; similarity may mean equivalence in some respects but not in all. Thus if two tubes are similar (or identical) in electrical characteristics, one is the equivalent of the other. The use of two tubes, however, to replace one single tube which affords certain facilities, creates a state of equivalence rather than a state of similarity.

This is not intended as a play on words but deals with a very important situation that is developing fast in television receivers. Unwelcome as it may be, it means constructional modifications and even more important, a careful analysis of what suits the purpose. Any attempt to list all the substitutes within the meaning of equivalent as we have described it, would be a monumental task and would more than likely, never see the light of day. We hope, therefore, that the general details of the background of tube substitution given in this section combined with the tube substitution lists and the knowledge possessed by the technician who makes the change (and selects the substitutes) will result in satisfactory substitutions.

An examination of the tube substitution lists will disclose that the substitution of one type for another is not too frequently accomplished by a simple replacement of tubes. Differences in tube characteristics may demand some modifications in the circuit within the apparatus. Sometimes, only a change of socket is needed because of differences in the basing of the substitute tube. In other instances, definite restrictions are imposed relative to the heater circuits; some substitute tubes may be used only in parallel-wired heaters without any circuit changes, whereas in other instances, a tube substitution is applicable only to series-wired heaters. In some cases, a tube substitution may demand modifications in the cathode, control grid, plate, or screen circuits, or possibly in the power supply, so as to satisfy the needs of the substitute and accomplish the best possible performance. These circuit changes are not listed because they are peculiar to each system.

All of this means that although the lists in this Guide Book give the substitute or substitutes as the case may be, the final selection cannot be made without considering the conditions existing in the equipment which will receive the substitute. Where changes in heater or filament wiring are required, they are described. Changes necessary in the signal electrode circuits such as those of the control grid, screen grid, cathode, and plate so as to attain best possible performance become the function of the technician and are determined by the constants of the specific circuit in which the substitution is made.

As shown in the three series of Rider's Manuals (AM-FM, TV, and PA), many tens of thousands of models of receivers and amplifiers comprise the hundred odd million units which may require substitute tubes.

Fortunately, a certain amount of standardization does exist in receivers and other equipment designed to work with the tubes listed herein. This situation, together with the circuit and operating voltage details given in the above-mentioned manuals and manufacturers' literature affords the technician the opportunity of determining the operating conditions thereby enabling him to establish the correct voltages at the different signal electrodes. A familiarity with these techniques is not difficult to acquire, although we hasten to add that too many differences exist to permit circuit modifications based on guesswork or memory. Schematic wiring diagrams, operating voltage tables, and the tube characteristic charts demand attention if longest tube and component life are desired, and also, if best circuit performance is to be attained with the substitute tube.

Design engineers have their own ways of accomplishing performance with the standard run of tubes. Many substitutes are possible but all will not afford like performance. In listing the substitutions, only those substitutions considered practical, that is, which do not demand redesigning of circuits, were included. Many substitutes possess sufficient similarity to the original as to require no changes in either heater wiring or sockets. These are listed with the note "No changes." This does not mean, however, that the signal electrode operating conditions are identical for the original and the substitute. This should be checked in the tube characteristics chart contained in this Guide Book. It only requires a few minutes of time to do this and its results can be very gratifying.

If upon examination, the differences in electrical characteristics between the recommended substitute and the original are more than moderate, changes in the signal electrode operating circuits may be required. Since the plate voltage requirements for tubes in similar categories do not differ greatly, changes are not too frequent in the plate circuits. It is only when battery type and a-c operated tubes are being compared that one finds radical differences in plate and screen voltages. More critical points are the control grid and cathode bias — especially the latter. Small numerical differences in bias voltages (which are related to the plate current) produce great performance differences. For example, a change in bias from —2 volts to —4 volts is only 2 volts, but it represents a change of 100 per cent, and can very materially influence performance. A situation of this kind would demand a change in the value of the bias resistance.

A bias tube may be listed as the substitute for a zero bias tube. Reference to the electrical characteristics will disclose that the grid resistor must be changed; sometimes from 10 megohms to as low as 0.25 megohm. In addition, a cathode resistor of such ohmic value as will develop the bias shown in the tube characteristic chart must be added. Thus, the statement "No changes," does not refer to signal electrode operating conditions, rather to the fact that neither heater wiring nor socket changes are required.

Each substitution is an individual case requiring individual consideration, unless it is definitely known that the original and the substitute are identical in all respects other than heater voltage. Even then, if the substitution is made in a system which involves a state of resonance, realignment will be required. Similar tubes, even identical ones, do not possess identical values of interelectrode capacitance. This difference affects the final value of tuning capacitance. It is very important to bear this in mind when substitutions are made in wideband amplifiers particularly, since here, the interelectrode capacitance (direct and reflected) plays a paramount role in the peaking action. Examples are the video amplifiers in television receivers and the amplifiers in oscilloscopes and the like. In making substitutions it is often necessary to consider the function of the tube and its circuit so as to insure best performance in the circuit. The various types of circuits and functions will now be discussed.

Oscillator Systems

These may be heterodyning arrangements which involve tracking with other tuned circuits, such as in converter systems and separate oscillator and mixer circuits, or nontracking arrangements, such as beat-frequency oscillators. Also, there are the various kinds of multivibrator systems in television receivers. Each of these demands individual consideration.

Combination oscillators and mixers (converters) require substitutes which contain not only the identical number of electrodes as the original, but in addition, the functions of these electrodes must be the same. This immediately limits the number of possible substitutes. The list of tubes, classified by function found at the end of this section, is an aid in this respect. If the required substitutes can not be procured, it does not make sense to redesign the circuit so as to replace a single tube with two individual tubes. That is a design engineer's job. If the oscillator and mixer functions are performed by individual tubes in separate envelopes, then the latitude of substitution is greater, provided that the selection of the substitute tube is made carefully.

The higher the frequency of operation, the more critical is the choice. That is why new tubes are born as operating frequencies increase. Tubes designed for the broadcast band are frequently unsuited for use in the vhf band and most certainly not in the uhf band. Thus, in addition to recognizing the oscillator function, it is also imperative to pay heed to the frequency of operation. If a choice is available, the tube intended for a higher frequency is suitable for a lower frequency, but not vice versa with complete freedom.

Sometimes tubes specifically intended for use as oscillators will not perform properly in that position, it is difficult to account for this, but it is a fact nevertheless. This does not condemn the tube as a tube — it can still perform other functions — nor does it mean that another tube of like brand and type will behave in similar fashion. There is no remedy for such failure to function properly — it is simply a statement of fact.

What should be examined when comparing tubes intended for oscillators? Neglecting heater or filament ratings for the moment, these being assumed to be suitable and assuming that the number of circuit electrodes of the substitute original are the same, such details as the grid bias, the plate (and screen) voltages, the plate (and screen) currents, and the transconductance are paramount factors. If the exact duplicate is not available, the substitute tube which requires lower plate and screen voltages (differing only moderately from the original) is preferable to the substitute tube which requires higher plate (and screen) voltages than the original. The tube with the higher transconductance is preferable to the tube with the lower transconductance, everything else being equal. These preferences are more apt to furnish heterodyning voltage over the entire band embraced by the receiver, especially if the bias resistor is modified to suit the specifications of the substitute.

R-F and I-F Amplifiers

The general run of r-f and i-f amplifiers utilize tetrodes and pentodes. Since pentodes used as triodes (in a-f amplifiers) are substitutes for triodes, it is important when selecting a substitute to know the manner in which the tube is used in the r-f or i-f amplifier. A triode is a poor substitute for a pentode; if a pentode is used, the substitute should be a pentode. However, if a tetrode is used, the substitute may be either a tetrode or a pentode. Care should be exercised to note if a shield is a part of the tube. An unshielded tube may be substituted for a shielded tube provided that an external shield is used and is grounded properly. Single-ended tubes may be substituted for double-ended tubes, but the reverse may be troublesome. Care must be exercised relative to the control-grid lead dress so as to minimize regeneration.

Sharp cutoff tubes should be replaced by similar tubes; similarly with remote cutoff tubes. However, sharp cutoff tubes may be replaced by remote cutoff types without too much trouble. The avc may be affected somewhat, but this does not interfere with the effectiveness of the receiver. When sharp cutoff tubes replace remote cutoff types, however, some minor problems may arise. Their best location would be in places where the signal level is lowest, for example, in the first stage in either an r-f or i-f amplifier. If distortion is severe on loud signals (due to rectification in the sharp cutoff stage), a divider network may be required so as to reduce the avc bias being applied to the sharp cutoff tube. This is best accomplished at the source of the avc, and might call for a separate avc line to the sharp cutoff tube. It might even be satisfactory to operate the sharp cutoff tube (if it is located at the point of lowest signal level in the amplifier) without any avc, using a low fixed bias.

Where there is a high input signal, sharp cutoff tubes must be used in place of remote cutoff tubes, an auxiliary volume control (or divider) at the front end of the receiver (perhaps in the antenna circuit) may be required. This would be operated only on those channels which cause trouble. A panel switch would control the operation of this signal control element.

Transconductance is the important electrical characteristic to consider in r-f and i-f amplifier substitutions. The higher the mutual conductance is relative to an r-f or i-f transformer the better, assuming that the plate and screen voltage conditions are satisfied or approached. Inability to equal the original tube in transconductance means reduced gain in the stage, but this seldom is a problem in a-m or f-m receivers because the average receiver has excess gain for the reception of chain or local broadcasts. The same can be said about television receivers, provided that the receiver is located in a primary service area. When such a receiver is relatively close to a station, the problem is too much rather than insufficient signal, so that a reduction in r-f or i-f amplification (unless it is too severe) usually can be tolerated. In fringe areas, the situation is different, especially when the received signal levels already border on the inadequate. There it becomes necessary to approach the original, and if this cannot be attained, then it is preferable to select tubes with higher than the original transconductance and to adjust the operating voltages accordingly. General instructions of this kind are given elsewhere in this section.

Where r-f and i-f systems are subject to tube substitutions, realignment of the coupling transformers associated with the input and output circuits of the substitute stage are imperative. Sometimes it may appear that proper performance is being secured without realignment. This should not be accepted as fact without a test to establish if the circuits are peaked properly.

Whether the shift in frequency peaking is upward or downward depends upon the direction of the capacitance change. A reduction in distributed capacitance, which includes the plate-to-cathode (or control grid-to-cathode) capacitance tends to cause peaking at a higher frequency, whereas an increase in distributed capacitance tends to cause peaking at a lower frequency.

Many i-f transformers and some r-f transformers are permeability tuned, utilizing the related distributed capacitance including the tube capacitance to provide the *C* for the tuned circuit. Because of this, changes in distributed capacitance, due to different tube electrode capacitances, can cause major variations in operating conditions. Whenever possible, substitute tubes should approximate the input-output capacitance of the original tube. This data is found in the tube specification charts of Section 5.

Exception to the need for realignment of r-f and i-f coupling systems is found in those equipments which employ *R-C* coupling between tubes. While not a common practice, it is to be found in receivers. Sometimes the coupling element consists of a resistive plate load and a tuned grid load for the succeeding tube. The resistive plate load on a substitute tube requires no readjustment, but if the substitution is made in that stage which has a tuned grid load, realignment will be required. Examples of such arrangements are listed elsewhere in this section in connection with r-f and i-f transformer replacement.

Audio Amplifiers

All types of tubes are found in audio amplifiers: triodes, tetrodes, pentodes, pentodes used as triodes, and various kinds of output-stage power amplifiers. Voltage amplifiers are, in the main, resistance-coupled systems, whereas power amplifiers are transformer-coupled. The difference between these two general categories is the plate circuit load, that is, load impedance, and the grid bias.

There are some differences between the signal electrode operating conditions in resistance-coupled amplifiers, their operating voltage or load resistance may differ, but many substitutions are possible without changes. A fair degree of similarity exists between the fundamental designs of these circuits so that it is possible to generalize concerning substitutions. Pentodes can be used in place of triodes and, in turn, triodes may replace pentodes or tetrodes. The load resistances are pretty much the same for all of these tubes since the limitation is set by the plate voltage supply, and this does not differ too greatly in like categories of equipment. Naturally, the ideal condition is when the substitute is used exactly as the original, or the substitute type is the same as the original type.

In the case of triode-type tubes used in audio amplifiers, with the exception of the output stage, the amplification constant of the tube is the pertinent factor. The higher the amplification constant, the higher the stage gain, provided that the internal plate resistance is not too high relative to the load resistance. The higher the internal plate resistance of the tube, relative to the load resistance, the less the amount of signal taken out of the tube will be. The portion of the available signal taken out of the tube is expressed as

$$\frac{R_l}{R_p + R_l}$$

where R_l is the load resistance in ohms and R_p is the internal plate resistance expressed in ohms.

Another matter of concern to keep in mind is that relating to grid bias. Quite a few tubes used in *R-C* coupled amplifiers as well as in *L-C* coupled systems are of the zero-bias type. When adequate substitutes are not available and a self-bias tube is used in place of a zero-bias one, provision for the bias must be made in the circuit. This can be in the form of a bypassed cathode resistor. In addition, the grid resistor (grid leak) of the substituted stage will require reduction to perhaps one-thirtieth or one-fortieth of its original value. Zero-bias tubes utilize grid resistors of from 5 to 10 megohms. Self-bias amplifier tubes utilize grid resistors of from 0.1 to perhaps 0.3 megohms. These bias- and grid-resistor references will be found to apply to pentodes and tetrodes as well as triodes. When a zero-bias tube is used in place of a self-bias tube, the above-required changes in circuits are reversed.

In the output stages, for that matter, also in driver stages in audio amplifiers, attention must be paid to the recommended load impedance represented by the output transformer. Not only does it determine output power, which may or may not be important, but it also determines the quality of reproduction. The latter is important.

To begin with, the recommended load impedance for substitute tubes should be the *same* or *less* than that for the original. By being less than the original a fair semblance of the original quality will be retained because the tubes are working into a higher impedance, that represented by the output transformer already in the device. Power output will be reduced somewhat but quality of reproduction will be retained. If it is impossible to find substitutes which require the same, or a lower load impedance than the original, then a higher rating will have to be accepted, but it should be the closest approximation to the original.

A receiver installation can afford to sacrifice some power for quality. In public address systems, it is a question of how the system is used. If its full-rated power output is seldom used, then it can sacrifice some output for quality. If it is used for the reproduction of speech only, it can afford a greater mismatch than systems which reproduce music and speech. In the last analysis it is a compromise and each individual requirement determines the choice.

In view of the power-handling requirements of the output stage, only those substitutes, both triodes and pentodes, are usable which can handle power. These are interchangeable but only on that basis.

When two individual tubes are used in a push-pull output stage and a substitution is being contemplated for one tube, it should be carried out for both. If the characteristics of the original and the substitute differ markedly, parasitic suppressors may be required in grid and plate leads (if they are not already in the circuit). Fifty-ohm resistors capable of handling the currents involved are adequate. If two individual tubes replace two tubes in a single envelope, such resistors may prove very important because the changes in wiring and lengthening of the leads may cause oscillation.

Negative feedback is used in many audio systems between the output power stage and a preceding stage. Tube substitutions can upset the feedback conditions, especially if the electrical characteristics of the substitute are unlike the original. If audio quality or power over-all gain seems to have suffered too much, the feedback circuit should be checked.

When tube substitutions in a-f driver stages are contemplated, the range of substitutes is more limited than in the case of voltage amplifiers. While tubes designed for the driver stages of a-f amplifiers may be used in other capacities, tubes designed for other functions very often are not usable in a driver stage. Because the tube grid in the driver stage is driven into the positive region during certain portions of the signal cycle, the tube which feeds the driver-stage input transformer must be of the correct type for operation with the driver-stage input transformer. In like manner, the driver stage is impedance-matched to the transformer which feeds the succeeding stage. This is another requirement that must be satisfied when the substitute tube is selected from a number of types which possess the required over-all similarity in electrical characteristics.

Phase-Inverter Stages

Phase-inverter stages present no serious problems in substitution except for the fact that differences between the original and the substitute may demand readjustment of the load resistor so as to arrange that the signals from the phase-inverter stage to the control grids of the succeeding push-pull stage are of like magnitude. If the phase-inverter stage serves just one function, inverting the signal to one of the succeeding push-pull stage tubes, and it is of the same type as its related amplifier tube which feeds the other succeeding push-pull tube, then it may be convenient to *substitute like tubes for the phase inverter and its related amplifier.*

Diode Rectifiers (Signal)

Too much need not be said about signal-rectifying diodes. One significant detail is that power rectifiers are not substitutes for signal rectifiers. (They are not shown as substitutes on the list, but the comment is still required.) There is very little to choose from between signal-rectifying diodes for virtually anyone will perform the functions of the others, except perhaps in connection with frequency of operation. The transit time (time taken for the electrons to advance from cathode to plate relative to the period of a cycle of the signal) limits the application of the tube in terms of frequency. Uhf diodes are suitable for operation at lower frequencies. On the other hand, the low or conventional frequency diodes are not suitable for the rectification of uhf and sometimes even vhf signals, unless so specified.

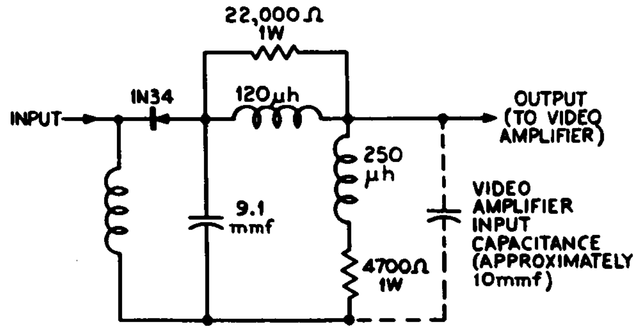
It is interesting to note that the equivalent of conventional signal-rectifying diodes may be formed out of conventional triodes by tying the grid and plate together thus forming one element, or by tying the plate to the cathode and using the control grid as the second element. Such equivalence is not indicated in the list of substitutions, but it should be kept in mind.

Sometimes multipurpose tubes used in receivers do not employ all of the electrodes. Quite frequently a duo-diode may have its two plates tied together forming a single diode to be used for a single purpose. It is well to try to disconnect one of the plates and to see if the operation is impaired; if not, then the other diode plate may, in conjunction with the common cathode, be used as the substitution diode. Whether or not such is possible depends upon the manner in which the common cathode is being used.

New advances in the design of germanium crystal diodes facilitate the use of these components as replacements for conventional diode tubes in signal-rectifying and detecting circuits. An important consideration in this connection is the fact that they require no heater supply and have an average life of over 10,000 hours.

Germanium crystal diodes are usable in vhf and even uhf circuits since their maximum operating frequency is about 500 Mc. They are rated for voltages of from 25 to 200 volts, with peak anode currents up to 200 ma. These components are particularly suitable for detector circuits where their low shunt capacities (of the order of 1 mmf) are advantageous.

The substitution of a crystal diode for a conventional-type tube is particularly simple because there is no need for a heater supply circuit. A typical use of a 1N34-type crystal diode is illustrated in Fig. 1-1.



Courtesy Sylvania Electric Products Inc.

Fig. 1-1. The use of a 1N34 type germanium crystal diode in the video detector circuit of a television receiver. Notice that the value of the circuit parameters are similar to those found in most video detector stages.

Here the component is shown being used in a video-detector circuit of the type common in most television receivers. The performance of the circuit with the 1N34-type crystal diode depends upon the proper choice of circuit parameters. In most circuits, however, it will be found that there need be no component modifications for good performance. Conventional-type tubes for which germanium crystal diodes are successful replacements are the 6AL5, 6H6, 6T8, and 12AL5. In the replacement of duo-diodes not only must the detector function be taken care of, but the sync limiter or other use must also be replaced. This is possible by using a 1N35-type matched duo-diode crystal component. See the table of geranium crystal diodes in Section 5.

For further information as to the use of germanium crystal diodes in video and f-m detector circuits as well as in other signal rectifiers, see *40 Uses for Germanium Diodes*, a booklet obtainable from Sylvania Electric Products, Inc.

Diode Rectifiers (Power)

Power rectifiers are of two types, high-vacuum and gaseous. Normally, high-vacuum rectifiers are interchangeable as are gaseous ones, within the limitations set by the current and voltage ratings of the device.

Gaseous-type rectifiers frequently may replace vacuum-type rectifiers provided that the electrical characteristics are the same and the related circuit requirements are satisfied. Replacement of high-vacuum rectifiers by the gaseous kind is not recommended except when high currents are involved and when a constant voltage drop in the rectifier is required; the need for high voltage alone is not sufficient.

To take a typical case, the mercury-vapor rectifier requires choke input instead of capacitor input in the filter system. The high current surges which occur with capacitor input would destroy the gaseous tube. Also, gaseous tubes are suitable for the rectification of medium voltages and higher (500 volts output and up) and they are intended for systems wherein high current loads exist and where the variations in current load are large. In the case of a-c—d-c receivers, there are no gaseous equivalents for the high-vacuum types used. Gaseous rectifiers, moreover, are a source of r-f "hash" and, therefore, are not suitable for use in close proximity to circuits susceptible to such radiations.

High-vacuum tubes, on the other hand, are suitable replacements for mercury-vapor rectifiers if the rectifier system can stand the increased voltage drop which occurs in the high-vacuum tube and if the electrical requirements are satisfied. As a rule, the heater current for high-vacuum rectifiers is less than that required for gaseous rectifiers of comparable d-c voltage and current output. Other important electrical requirements to consider are the a-c input voltage, output current, and inverse peak voltage. The last-named term expresses the ability of the tube to withstand the peak voltage between the anode and the cathode during the nonconducting portion of the cycle.

Assuming the lack of recommended substitutes, high-vacuum tubes are suitable for substitution in systems which operate at lower d-c output voltages and currents than the high-vacuum tubes are rated for, provided that the heater requirements are satisfied. Such substitution should be made only in extreme cases when no other means are possible and a system must be restored to operation. For that matter, in such an event, the mercury-vapor kind also can be used provided that there is a choke input in the filter system. This is a MUST condition.

The substitution of a filament-type rectifier for a cathode-type one introduces certain complications, especially when the remainder of the tubes in the system are of the cathode-heater variety. The difference in heating time would result in the very rapid build-up of the voltage output from the rectifier before the tubes receiving the plate and other voltages were in a conducting state. Thus, the rectifier would be operating for a period of time with practically no load. This results in a high output voltage — much higher than when the load is applied — and could very easily break down the filter capacitors and also some of the bypass capacitors in the equipment receiving its voltage from the rectifier. Replacing a filament-type rectifier with a heater type causes no complications of this sort.

From a practical viewpoint it seems worthwhile to go to no end of trouble to find a suitable filament-type substitute for a filament-type original. This seems easier than changing the voltage rating of all of the filter capacitors and the bypass capacitors for high working voltage units. Of course, if examination of the capacitor voltage ratings and measurement of the rectifier output voltage shows that the momentary peak is within the operating voltage rating of the capacitors, the change can be made without endangering the filter and bypass units. If this is not the case and replacement of the filter and bypass capacitors is not feasible, then the only alternative is to use an increased bleeder load and thus reduce the over-all output voltage from the power supply.

For medium- and low-voltage requirements, selenium rectifiers are far more suitable substitutes for high-vacuum rectifier tubes than are gaseous tubes. Miniature selenium rectifiers are available in various sizes rated from 50 to 500 ma. The 50-, 65-, 75-, and 100-ma sizes will, in most cases, best serve as replacements for half-wave rectifiers in a-c—d-c equipment.

Generally speaking, to replace the vacuum-tube rectifier in a phonograph oscillator, use the selenium rectifier rated for 50 ma, for three-tube amplifiers use the 65-ma size, for five- or six-tube receivers without a push-pull output, use the 75-ma rectifier, and for six-tube sets and up use the 100-ma rated one. To replace the 25Z5, 25Z6, 35W4, 35Y4, 35Z3, 35Z4, 35Z5, 45Z5, 50Y6, and 50Z7, use a 403D2625A type selenium rectifier with a rating of 100 ma.

When a rectifier tube is replaced by a selenium rectifier, a compensating resistor must be inserted into the filament circuit to make up for the resistance drop due to the elimination of the rectifier tube if its filament was in series with other filaments. The value of this compensating resistor depends upon the rectifying tube that has been replaced. The following table lists the resistance to be used for the tubes mentioned above.

TUBE	RESISTOR (ohms)	WATTS
25Z5	85	15
25Z6	85	15
35W4	230	10
35Y4	230	10
35Z3	230	10
35Z4	230	10
35Z5	230	10
45Z5	300	10
50Y6	330	15
50Z7	330	15
117Z3	none required	
117Z6	none required	

In some sets, the pilot light may be connected across a low-voltage tap on the rectifier tube filament. If this is so in the set in which the rectifier tube is being replaced, connect the pilot light across a tapped-down portion of the compensating resistor (about 10 to 25 ohms will do depending upon the current in the filament circuit). A No. 47 pilot light can be used in this case.

When replacing vacuum-tube rectifiers by selenium rectifiers in a-c—d-c portables using battery-type tubes that obtain filament voltages from B plus through a dropping resistor, reduce the value of the shunt resistor connected from the low end of the filament dropping resistor to the negative point. This will compensate for the increase in filament voltage.

In most cases, a protective resistor should be inserted in series with the selenium rectifier to protect the rectifier and filter capacitors from excessive current peaks during operation. The value of this resistor will vary from 5 to 50 ohms depending upon the current load of the rectifier; the higher the load, the smaller the protective resistor needed.

Manufactured adapters will probably be available for use with miniature selenium rectifiers in the future, in the meantime, they can be made fairly easily by using discarded tube bases. Following are instructions for making adapters for a few of the most popular rectifier tubes used in a-c—d-c equipment.

To make an adapter for the 35Z5 used in series circuits:

a) connect a 230-ohm, 10-w resistor from No. 2 to No. 7 on an octal base
b) connect a 20-ohm, ½-w resistor from No. 2 to No. 3
c) connect 25-ohm, ½-w resistor from No. 8 to positive side of rectifier
d) connect No. 5 to negative side of rectifier.

To make an adapter for a 35Z5 used by itself, follow the above steps but delete steps a) and b).

For the 25Z6, 25X6, 35Z6, 50AX6, 50Y6, and the 117Z6 when these tubes are used by themselves as half-wave rectifiers, make an adapter as follows:

a) connect a 25-ohm, ½-w resistor from Nos. 4 and 8 on octal base to the positive side of the rectifier
b) connect Nos. 3 and 5 to negative side of the rectifier.

If the filaments of these tubes are in a series circuit, then naturally a compensating resistor must be added with the selenium rectifier. This resistor, whose value may be obtained from the table given previously, will be connected between pins No. 2 and No. 7. No resistor is needed when the 117Z6 is replaced.

Wideband Amplifiers (Video and Others)

Although referred to earlier in this section, these systems are singled out for elaboration because of their seemingly peculiar conditions of operation. Examination will show that very low values of plate-load resistance are used and also that the applied plate voltage is very low, much lower than that shown in tube characteristic charts.

This is so because it is necessary to have wide frequency response. Gain in each stage is sacrificed for the attainment of low reflected capacitance and also the creation of suitable resonance.[1] By means of shunt or series peaking, or both, a wide band of frequencies can be amplified. (This is explained in detail in the book referred to in the footnote.)

Tube substitutions in wideband amplifiers, therefore, require very serious consideration. The substitute tube characteristics should approximate most closely the complete conditions existing in the original. Interelectrode capacitance is very important. Plate-current, grid-bias, and grid-circuit resistance ratings should be the same. Lead dress must be maintained as much as possible because changes in the position of leads will affect the frequency of resonance and thereby the over-all bandwidth of the system. This is very important if socket changes are required.

If possible, all stages should be replaced by like substitutes even if only one stage requires replacement. This is expensive but advantageous. If the facility to check frequency bandwidth exists, then it is possible to confine the replacement to only one stage, the one in which the original tube is bad. Make the frequency run, and if the response is satisfactory after the replacement in that stage, the other stages need not be changed. Such tests can be made by means of a square-wave generator or a sine-wave generator. Usually the limits of response are expressed by the lowest and highest frequency signals which are down not more than 3 db from the top. In some instances, the amplifier design is more critical and the over-all response is expressed in terms of only 1 db down from the top.

Utilization of Sections of Multifunction Tubes

A number of tubes found in television and other equipments combine three and four sets of electrodes in a single envelope, thus performing three or four different functions. Direct substitutions for these tubes may not be available. In that event it is necessary to utilize two individual tubes containing such electrodes as will furnish the facilities originally contained in the single tube which is being replaced. For example, a triple diode-triode such as the 6T8 may require replacement. If the original is not available, pairs of substitutes must be used, for example, a 6AL5 and a 12AV6 or a 6AL5 and 6AQ6. These are the recommended combinations, other combinations of a double-diode with a double-diode triode, or single diode-triode

[1] J. F. Rider and S. D. Uslan, *Encyclopedia on Cathode-Ray Oscilloscopes and Their Uses*, John F. Rider Publisher, Inc., New York, N. Y., 1950, pp. 389-401.

will function satisfactorily. One of these tubes takes over the function of two diodes in the 6T8 and the other tube takes over the function of the remaining diode-triode.

Substitution of two tubes for one is not easy; it means adding sockets and perhaps even changing sockets on crowded chassis where space is at a premium. This requires planning of the socket location and the location of shunt and series resistors, so as to keep connecting leads short. But it can be done, and it is a vivid example of how tubes with more electrodes (and capable of more functions) than the original may be used in replacements so long as only the necessary number of electrodes are utilized. Also it is an example of how it may be necessary to utilize several substitute tubes to perform the function of one original. Incidentally, pairs of tubes which can be used in place of other multifunction tubes are listed in an addendum to the tube substitution list. Which combination of substitute tubes fills the replacement of a single original is a matter of individual circuit design. Very many possible substitutions of this kind exist, especially in so far as signal diodes are concerned.

Tube Substitution Techniques

Heater circuits are very significant in connection with tube substitutions because tube types are organized in terms of heater voltage. Therefore, it is quite in order to show the techniques involved in arranging tube heater circuits so as to accommodate substitute tubes. Before discussing the methods, however, in fact even before speaking about heater ratings, it might be well to emphasis one very important point, *all heater ratings are interpretable in terms of resistance.* The ohmic value of a heater is the same when it is operated on direct current or alternating current. Any reference to heater voltage considers the d-c value and rms or effective a-c value as the same. Thus a tube heater rating of 6.3 volts means 6.3 volts d.c. or 6.3 volts rms a.c. The same applies to any other numerical rating. Note: *Many battery-operated tubes will not function properly on a.c.*

Heater current is treated in like fashion. A reference to 0.15 ampere or 150 ma means d.c. or a.c., the latter being the rms value. The rms value is used because it is responsible for the heating effect in filaments and to get equivalent heating in d.c. and a.c., the d-c value must equal the rms a-c value.

While the above statement is true in all conditions associated with resistance, it should not be assumed to apply to all a-c systems regardless of circumstances. For example, the d-c value of voltage is related to the peak value of an a-c voltage when insulation resistance is involved. This is important in the operation of capacitors and in connection with the insulation breakdown of rectifier tubes during the nonconducting portion of the cycle.

Heater Ratings versus Heater Circuits

It is common practice among electronic equipment manufacturers to use certain kinds of tubes for certain kinds of equipment. For example, in most a-c—d-c equipment, the tube heaters are connected in series across the line. The same is true when such equipment is intended for battery-operated portable use (the three-way portables). Other equipments are designed for operation from the a-c power lines only and the heaters are arranged in parallel chains. Still other equipments use a combination of series-parallel systems, as for example, a-c—d-c television receivers.

Sometimes the series chain is singular; sometimes there are a number of chains connected in series-parallel between different points as shown in the schematics at the end of Section 3. In the parallel systems, several independent parallel chains are used. Usually the rectifiers are wired individually and, in the true sense, are series circuits. The remainder of the tubes are, however, in parallel, all being on one chain or divided among a number of chains fed from individual voltage sources. These too are illustrated in Section 3. Incidentally, the receivers included in that section represent practically every one produced and sold in the years 1938 through October, 1950 as contained in Rider's TV Manuals Volumes 1 through 5.

Parallel Circuits

Parallel chains will accommodate tubes which require equal heater voltage; they will also accommodate tubes with heater voltage ratings with are *lower* than that being supplied to the remainder of the tubes. This is shown in Fig. 1-2. The current rating of the heater is a matter of secondary concern in parallel chains.

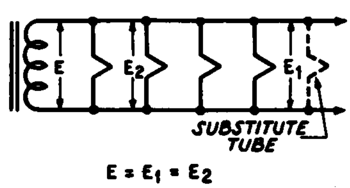


Fig. 1-2. Parallel connection of vacuum-tube heaters. The voltage drops across the heaters so connected are equal to the voltage across the secondary of the power transformer as shown.

If the supply voltage source (the heater transformer) is capable of supplying the required current at its rated output voltage, then any reasonable heater current requirement set by the substitute can be satisfied. The only limitation which exists relative to parallel connected heaters is that the output voltage rating of the heater transformer cannot be exceeded. The current through the parallel heater is determined by the resistance of the heater so that, if the voltage is correct, the current will be correct. If the current drain of the substitute heater added to the total current drain of the other tubes in the parallel chain exceeds the current output capabilities of the heater transformer, the voltage will fall on all the heaters. It is possible to operate all receiving tubes at perhaps ten per cent below the normal voltage and current ratings. In special cases this reduction can be exceeded but it is not recommended.

Tube substitutes which bear heater voltage ratings lower than that of the original tube can be applied readily to parallel circuits. All that is needed is to *drop* the supply voltage to the level demanded by the substitute. The correction must be applied directly in the circuit which feeds the substitute tube. This is shown by the location of R in Fig. 1-3. The amount of voltage to be dropped is the difference between the supply voltage E and the tube heater requirement E_1. Suppose we wish to substitute a 2B7 with a 2.5-volt heater for a 6B7 whose 6.3-volt heater drew its supply from a filament transformer with an output of 6.3 volts. The difference $E - E_1$ is 3.8 volts and this must be dropped at the heater current rating of the substitute tube, namely, 0.8 ampere. The value of the voltage-dropping resistor then is

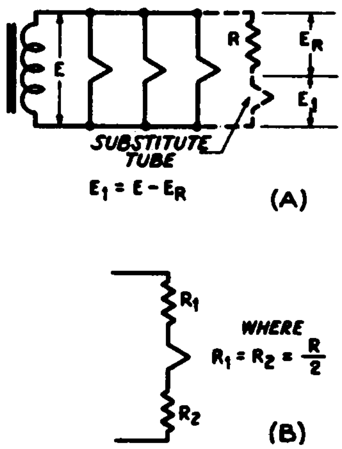


Fig. 1-3. When substituting a tube with lower voltage requirements than the original, a series resistor is added in the branch of the parallel feed in which the tube is placed. The resistor may be a single one as in (A), or two smaller ones as in (B).

$$R = \frac{E - E_1}{I} = \frac{3.8}{0.8}$$

or

$R = 4.75$ ohms or roughly 5 ohms.

The power rating of R is

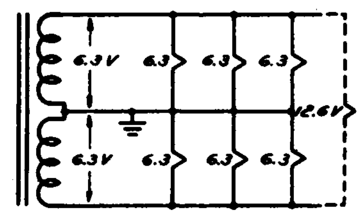
$$P = I^2R = 0.8^2 \times 4.75 = 3.204 \text{ watts.}$$

In the examples cited, the substitute imposes a load that is somewhat greater than the original; the power consumption of the 6B7 heater is 1.89 watts whereas that of the 2B7 is 2.0 watts. To this must be added the power dissipated across the voltage-dropping resistor R, for, after all, it is a part of the newly created load. Roughly, this amounts to 3 watts. So, the substitution of a 2B7 for a 6B7 means the imposition of a 5-watt load in place of the original 1.89 watts, or an increase in load of 150 per cent.

Normally, the addition of such a load will cause no trouble, but in the event that several tubes require substitution, the load may be increased to the extent that the voltage drop in the transformer secondary becomes excessive, and the voltage across all of the heaters will be lowered.

Some television receivers utilize a heater voltage supply which is the equivalent of two 6.3-volt windings in series, with the centertap grounded and acting as a common return path for two parallel chains of 6.3-volt heaters. This is shown in Fig. 1-4. Each winding furnishes 6.3 volts for its respective chain, but by virtue of a common center connection, the difference of potential between the extremes of the two windings is twice that of each, or 12.6 volts. Consequently, a 12.6-volt heater can be used by connecting it across the extremes of the windings.

Fig. 1-4. Filament circuit of the type found in many television receivers. The center tap between the two windings is grounded to serve as a return for the filaments in parallel, each of which receives 6.3 volts from its part of the secondary.



If necessary, more than one tube substitution can be handled in this way. The voltage between the extremes of the two windings is a maximum which cannot be exceeded, therefore, even such an arrangement does not permit the use of a tube which requires more than 12.6 volts (or whatever the voltage happens to be between the two extremes of the windings).

The number of 12.6-volt tubes which can be handled in the manner shown in Fig. 1-4 is not without limit. The power-handling capability of the two windings is the controlling factor. The substitution of a single 12.6-volt tube in place of a 6.3-volt tube is no problem especially when the power consumption is the same for both heaters; more than likely it will not cause any concern even if an increased load is created by the selection of some special type of 12.6-volt tube.

Series Circuits

The substitution of tubes in series-wired heater arrangements hinges upon the following fundamentals of Ohm's law relating to series circuits:

1. In a series circuit there is only one path for the current.
2. The current in a series circuit is equal to the applied voltage divided by the total resistance.
3. The sum of the individual voltage drops in a series circuit equals the applied voltage.

Illustrated in Fig. 1-5(A) are four tube heaters connected in series across a voltage supply source E. Only one path exists for the flow of current I, therefore, the current must be the same in all parts of the circuit, that is, in each heater. This immediately establishes the requirement that all heaters connected in series must have similar current ratings. A variation of 10 per cent in heater rating is permissible so long as the heater has a higher rating than the current required by the other heaters in the circuit.

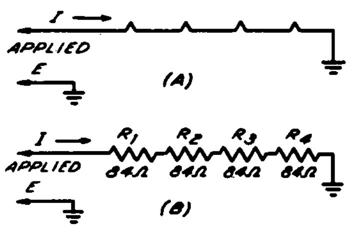


Fig. 1-5. Filaments connected in series (A) may be represented as individual resistances (B), each of which passes the same current determined by the applied voltage divided by the total resistance.

The numerical value of the current is dependent upon the applied voltage E and the total resistance R of all of the heaters, as stated in statement 2. above Since resistances connected in series are additive, the total heater resistance R, is equal to $R_1 + R_2 + R_3 + R_4$, as indicated in Fig. 1-5(B). If, for the moment, we assume that each heater is rated at 12.6 volts and 0.15 ampere (150 ma), then the resistance of each is 12.6 divided by 0.15 or 84 ohms. The four heaters in series, therefore, represent a total resistance of 336 ohms. Knowing the total R and the required current, the supply voltage necessary to limit the current to the required value is

$$E = IR$$

or

$$E = 0.15 \times 336 = 50.4 \text{ volts.}$$

If the voltage drops across each heater (or the voltage required across each heater) are aggregated, it is seen that the sum of the voltage drops equals the applied voltage. Thus are illustrated statements 1., 2., and 3.

In view of what follows it might be well to devote a little more time to the matter of voltage drops and applied voltage, or the possibilities of statement 3. Current flowing through a resistance will cause a voltage drop across that resistance. If the current flow is the rated value, then the voltage drop numerically is the same as the voltage rating of the resistance. If the resistance is the heater (or filament) of a tube, and the current through it is the rated value, then the voltage drop is equal to the voltage rating of the heater.

We have simplified the problem by deliberately making the applied voltage (which we also can identify as the line voltage) equal to the total of the voltage drops in the load. As a rule, this is not found in practice; the line voltage always exceeds the total of the voltage drops across the tube heaters. This excess voltage is dropped by means of a line voltage-dropping resistor across which there is a voltage drop equal to the difference between the sum of the tube heater voltage drops and the line voltage. For example, if the line voltage is 117 volts and the total of the tube heater voltage drops is 50.4 volts as in the above case, the line voltage-dropping resistor will drop 117 — 50.4 or 66.6 volts at the value of current which is flowing through the series chain.

Statement 3 still holds, except that now the series line voltage-dropping resistor has been added to the elements (heaters) which comprise the load. This action of the line voltage-dropping resistor may be considered from a different viewpoint. It is the means whereby the line voltage is dropped to that value which equals the sum of the voltage drops across the heater elements. This is not a play on words; it simply presents the relationship between the line voltage and the total heater drops from two angles relative to the purpose of the line voltage-dropping resistor. In one case, the line voltage-dropping resistor is considered a part of the load and, in the other, only the tube heaters are considered to comprise the load. Personally, we prefer the former and shall hold to it in these explanations.

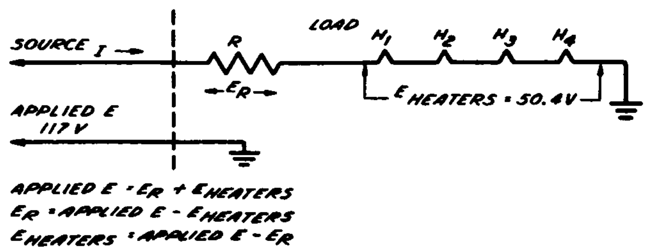


Fig. 1-6. A series chain of four filaments or heaters with a line voltage-dropping resistor. The voltage drop across the line voltage-dropping resistor makes up for the differences between the line voltage and the voltage required by the four heaters.

An example of the above is shown in Fig. 1-6. Here the elements of the load are shown to the right of the vertical dotted line and the applied voltage source is shown to the left. The series system indicates a total heater voltage drop of 50.4 volts at 0.15 ampere and a line voltage of 117 volts. The difference in voltage is dropped across the resistor R. Since the line voltage-dropping resistor is in series with the heater chain, the same current will flow through R as through the heaters. The voltage drop across this resistor is, therefore, a function of the current through it and its resistance. Since this voltage drop represents a dissipation of energy, the line voltage-dropping resistor bears a wattage rating in addition to its resistance rating. The power dissipation is a very important factor and must be taken into account in the event of any changes; in fact, it determines the type of resistor element which suits this purpose. The power dissipation in watts is expressed by either IE, I^2R, or by E^2/R, where I is the current in amperes, R is the resistance in ohms, and E is the voltage in volts, exactly the same units as are used for the other Ohm's law calculations.

The ohmic value of R is

$$R = \frac{117 - 50.4}{0.15}$$

$$= \frac{66.6}{0.15}$$

$$= 444 \text{ ohms.}$$

Its power dissipation is

$$P = E \times I$$

$$= 66.6 \times 0.15$$

$$= 9.99 \text{ watts (approx. 10 watts)}$$

or

$$P = I^2R$$

$$= 0.0225 \times 444$$

$$= 9.99 \text{ watts (approx. 10 watts).}$$

To prove these figures, the total resistance of the four heaters is 4 $\times$ 84 or 336 ohms; adding this to the 444 ohms resistance of the line voltage-dropping resistor results in a total circuit resistance of 780 ohms. With a current of 0.15 ampere flowing in the system, the applied voltage is $E = 0.15 \times (336 + 444) = 117$ volts.

Let us now examine the possible variables in a simple series chain of the kind shown in Fig. 1-6. Statement 3. of Ohm's law relates to an equality between the line voltage (applied voltage) and the total of the voltage drops in the load. No restriction is evident concerning the *number* of elements (tube heaters) which may comprise the load and across which the total of the heater drops will occur. In the system shown in Fig. 1-6, four elements comprise the heater load. These could be any number provided that the total voltage drop did not exceed the line voltage; if it equaled the line voltage, then the line voltage-dropping resistor (R in Fig. 1-6) would not be required in the circuit and the system would become the equivalent of Fig. 1-5(A), with more heaters than are shown there.

As a matter of fact, no matter what the total of the *rated* voltage drops across the heaters in the load is, this value can never exceed the applied (line) voltage, for statement 2. establishes that the current will adjust itself automatically in accordance with the total resistance and the total applied voltage. For example, if fourteen 12.6-volt, 0.15-ampere tubes were used in series across a 117-volt line, the total resistance would be 1,176 ohms. The current, therefore, would be

$$\frac{117}{1{,}176}$$

or 0.099 ampere, and the voltage drop across each heater would be 0.099 $\times$ 84 or 8.3 volts. It is obvious that the voltage across these heaters would be insufficient for proper operation of the tubes. Correction of this state would demand a revision of the circuit or an increase in the line voltage; the latter is impractical, so the former is the only solution. It will be treated later.

On the other hand, the need may arise to substitute a lower voltage rated heater for a higher rated one, such as a 6.3-volt tube for a 12.6-volt one. If the rated voltage drop across the series heaters is at least ten times the rated voltage drop across the substitute heater, the latter may be inserted into the string without requiring any correction. Thus, if the total rated voltage drop across the series heaters is 75 volts, and a 6.3-volt tube is a replacement for a 12.6-volt heater in the string, the replacement will be subject to a slightly higher voltage (and current) but it will do no harm.

For example, if the original series string consists of a 25-volt, 0.15-ampere tube and four 12.6-volt, 0.15-ampere tubes, the total resistance of these heaters is 502 ohms. Operation from a 117-volt line demands a dropping resistor of 227 ohms, making a total load resistance of 779 ohms. Substituting a 6.3-volt tube for the 12.6-volt one reduces the heater resistance to 460 ohms, and the total load to 737 ohms. This results in a circuit current of 0.158 ampere, and as a result, the 12.6-volt tubes are subjected to a voltage of 13.27 volts, the 6.3-volt tube to 6.6 volts, and the 25-volt tube to 26.4 volts. None of these voltages are so extreme as to endanger the tubes.

Battery tubes, however, should be treated with more care and every effort should be made to keep the voltage as close to the rated voltages as possible, especially when operation is intended on a-c lines.

Circuit conditions encountered in practice seldom are such that the total voltage drop across the heaters or filaments equals the applied or line voltage. The use of a line voltage-dropping resistor is very common, consequently, any change in the total voltage drop across the load caused by a substitution demands that the drop across the line voltage-dropping resistor be changed, and this means a change in its ohmic value. Whether the latter is done by shunting another resistor across it, by physically changing its length (as happens with line cords), or by substituting a new one of proper ohmic value for the original is determined by whichever is most convenient. If the total voltage drop across the heaters is *increased,* the drop across the line resistor must be *decreased,* and vice versa. A typical example follows.

Seven 6.3-volt heaters are in series with a 35-volt heater. All are rated at 0.3 ampere. The total voltage drop across the heaters is 79.1 volts and the total resistance of the heater load is 264 ohms as shown in Fig. 1-7(A). With a supply of 117 volts, 37.9 volts must be dropped across the line dropping resistor R. At 0.3-ampere current flow, the ohmic value of R must be 126 ohms and its power dissipation, therefore, is 11.3 watts.

Two 12.6-volt, 0.3-ampere tubes must be substituted for two of the 6.3-volt tubes. The modified circuit is shown in Fig. 1-7(B). Simple calculation of the total voltage drop across the heaters shows an increase of 12.6 volts, therefore, it is obvious that the value of R will have to be *decreased.* Its value may be determined in a number of ways, but a simple procedure is the following

$$R_{new} = \frac{\text{Original value of } E_R - \text{Increased voltage drop across heaters}}{\text{Current through the system}}$$
$$= \frac{37.9 - 12.6}{0.3}$$
$$= 84 \text{ ohms.}$$

The power dissipation in the new R is

$$P = I^2R$$
$$= 0.09 \times 84 = 7.5 \text{ watts.}$$

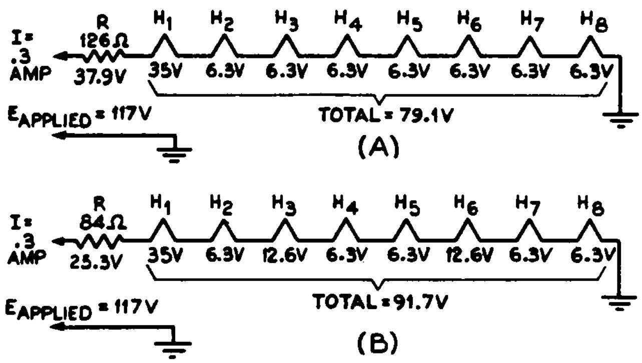


Fig. 1-7. In (A), a series chain of seven 6.3-volt heaters and one 35-volt heater requires a line voltage-dropping resistor R of 126 ohms to bring the applied voltage of 117 volts down to the value required by the heaters. When the total voltage drop across the heater is increased by 12.6 volts as in (B), the value of R must be decreased to 84 ohms.

Substituting Low-Current Rated Heaters for Higher-Current Heaters

Suppose that in the circuit of Fig. 1-7(A) two 12.6-volt heaters rated at 0.15 ampere must replace two of the 6.3-volt 0.3-ampere heaters. Let us select H_3 and H_6 as the specific heaters. How would this be accomplished? Two methods are practical, one being simpler than the other. Suppose we treat the more difficult one first.

Since the circuit current is 0.3 ampere and each substitute heater draws only 0.15 ampere, it stands to reason that they just cannot be connected into the circuit as is, otherwise each would be subject to a 100 per cent current overload. However, two such heaters connected in parallel would require 0.3 ampere, and because of the division of currents in a parallel circuit in accordance with the resistance of each branch, connecting these two tubes in parallel would result in 0.15 ampere flowing through each heater. Moreover, the voltage drop across two elements in parallel is the same as that across a single element and, since the total drop across the two 6.3-volt heaters which are being replaced equals 12.6 volts, the two 12.6-volt heaters in parallel can replace the two individual 6.3-volt heaters without changing the total voltage drop across the string of heaters. This is shown in Fig. 1-8(A). Note that the total drop across the string of 6.3-volt heaters originally [Fig. 1-7(A)] was 79.1 volts, and that the total drop across the heaters with the two parallel 12.6-volt substitutes is 79.1 volts. This means that the line dropping resistor R need not be changed since it is called upon to drop 37.9 volts at 0.3 ampere, the same as in the original circuit.

The other means of accomplishing the substitution is shown in Fig. 1-8(B). Instead of connecting the two

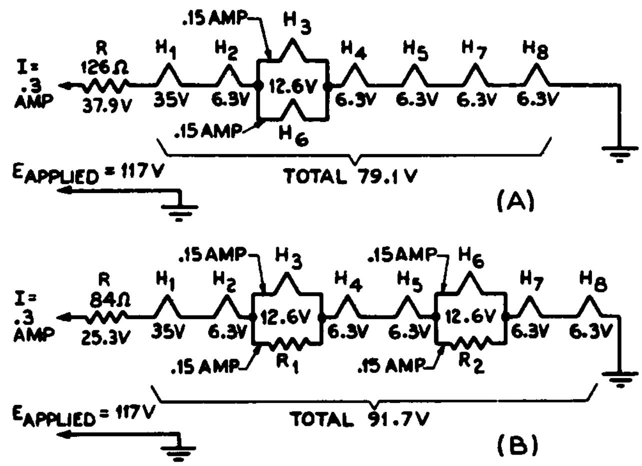


Fig. 1-8. Two methods of substituting 12.6 volt, 0.15-ampere heaters for 6.3-volt, 0.3-ampere ones are shown. In (A), both substitutes are paralleled together, splitting the current and keeping the voltage drop of the system intact; in (B), each heater has its own shunt, thereby drawing its rated current but increasing the total voltage drop of the heaters.

substitute heaters in parallel, they are treated individually and separate current shunts are connected across each one. Since it is desired to split the current equally between the heater and its shunt, the ohmic values of the shunts must equal the resistances which they shunt. This means that $R_1 = 84$ ohms and $R_2 = 84$ ohms, and each dissipates 1.89 watts. [See Fig. 1-8(B)].

However, handling these substitutions in this manner means that the total voltage drop across the string of heaters has been increased by 12.6 volts, since two 12.6-volt heaters in series total 25.2 volts, and two 6.3-volt heaters in series total only 12.6 volts. The increased drop of 12.6 volts must be compensated for by reducing the drop across the line resistor R. Figs. 1-7(A) and 1-8(A) are comparable, as are Figs. 1-7(B) and 1-8(B). In Figs. 1-8(A) and (B), the total line current of 0.3 ampere flows into the junctions of the parallel systems (the parallel heaters in (A), and the heaters paralleled by the shunt resistors in (B), divides equally between the two paths, and then recombines again to equal the 0.3-ampere line current. Thus, the 0.3-ampere, 6.3-volt heaters receive the proper current and so do the two 12.6-volt, 0.15-ampere heaters.

If four tubes required substitution and they were of like voltage ratings, two pairs of heaters could be paralleled as shown in Fig. 1-8(A). If there were an odd number of substitutions, two heaters could be located in parallel and the odd one would be operated with a shunt as shown in Fig. 1-8(B). As a matter of fact, it is the principle underlying these techniques rather than the actual number of tubes involved which is important. Once the principles are understood, it will be simple to apply them, and in general, the most convenient method should be used depending on the circuit and the components available. For example, the availability of resistors is a determining factor in deciding whether the line dropping resistor will be replaced or if two small resistors will be used for the current shunts. If the substitution demands new sockets, then paralleling of the heaters is no problem, but if the sockets do not require changing to accommodate the substitutes it is more convenient to use the current shunts.

Substituting Higher-Current Heaters for Low-Current Heaters

Suppose the requirement is for the use of higher current heaters in place of lower current heaters in a series circuit. A single 0.3-ampere heater is to replace one rated at 0.15 ampere in a series string of five 12.6-volt, 0.15-ampere heaters and one 25-volt, 0.15-ampere heater. This substitution is to occur at H_6 in Fig. 1-9(A). Several solutions are shown in Figs. 1-9(B) through (G). The choice is determined by which is most convenient and best fits the need. The one fundamental requirement created by such a substitution is that the total line current must be increased to 0.3 ampere so as to serve the increased current demand of the substitute tube. Whether this means that the line current will be limited to 0.3 ampere or increased above that value is determined by the organization of the heaters which form the load. One circuit system [Fig. 1-9(B) and (C)] needs 0.45-ampere line current, whereas other arrangements can be served by 0.3 ampere; there is no way, however, of satisfying the requirements of the 0.3-ampere tube with a line current of 0.15 ampere. For comparison, let us keep the constants of the original circuit [Fig. 1-9(A)] in mind. Here we have a total drop of 88 volts across the heaters, and 29 volts across the line dropping resistor at a current flow of 0.15 ampere.

One solution for the substitution is the use of two series paths, one for the 0.15-ampere heaters and the other serving the 0.3-ampere heater, as shown in Fig. 1-9(B). In order not to change the total voltage drop in the 0.15-ampere chain, a resistance (84 ohms) corresponding to that of the heater (H_6) which has been removed is inserted in its stead. This establishes the total voltage drop at the original value of 88 volts and

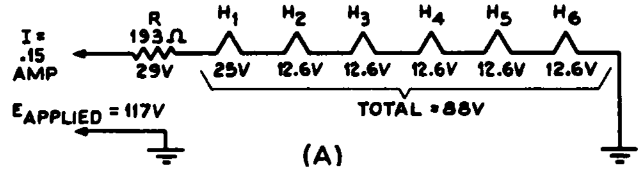


Fig. 1-9(A). A series chain of heaters each drawing 0.15 ampere in a circuit with a single voltage-dropping resistor.

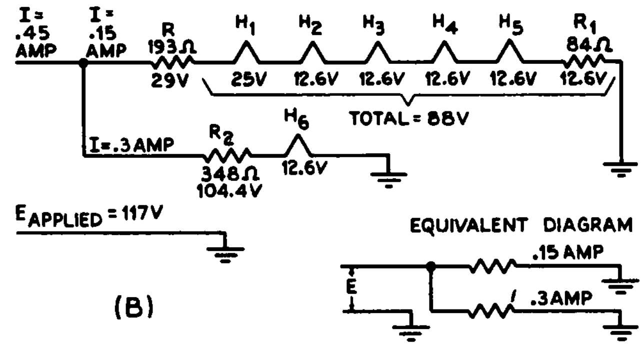


Fig. 1-9(B). H_6 of Fig. 1-9(A) has been replaced by a 12.6-volt, 0.3-ampere one requiring a separate series circuit and an increase in the current drawn from the line source. Now there are two dropping resistors, one in each branch of the circuit.

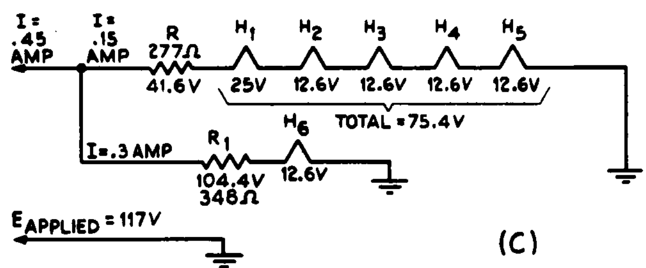


Fig. 1-9(C). Same as Fig. 1-9(B) except that the dropping resistor in the longer branch now is a combination of the dropping resistor R and the compensating resistor R_1 of the previous diagram.

the original line dropping resistor remains intact. Compare Figs. 1-9(A) and (B). Since the drop across the 0.3-ampere heater is 12.6 volts and the line voltage is 117 volts, a line dropping resistor must be added to this circuit. R_2 serves this purpose; its ohmic value (348 ohms) is such that it will drop 104.4 volts at 0.3 ampere.

Examination of the two series circuits of Fig. 1-9(B) shows that they are actually in parallel since each goes from the 117-volt line to ground. This is illustrated in the equivalent diagram in Fig. 1-9(B). The total resistance of each of the parallel branches is such that 0.15 ampere flows in one, whereas 0.3 ampere flows in the other.

The equivalent circuit in Fig. 1-9(B) is an important one to understand because it shows the application of two series circuits connected in parallel. Television receivers intended for use on a-c—d-c lines employ such circuit arrangements quite frequently, see Fig. 1-8 and the schematics at the end of Section 3.

A modification of Fig. 1-9(B) appears in (C). The substitution requirement remains the same, but this time the resistance equivalent of the heater which has been removed is not inserted. Instead, the line dropping resistor is changed in value so as to compensate for the reduced total voltage drop across the heaters. With one 12.6-volt heater removed, it has fallen to 75.4 volts from the original 88 volts. This necessitates an increase in the line resistor R from the original value of 193 ohms to 277 ohms. (This follows from the fact that the heater removed from the string had a resistance of 84 ohms, and in order to maintain the original amount of current in the circuit, this amount of resistance must be added to the line dropping resistor. The change is essentially the transposition of the resistor R_1' in Fig. 1-9(B) from its position at the grounded end of the string to the line dropping resistor.) Now the drop across the line dropping resistor is 41.6 volts, or the original 29.6 volts plus the 12.6 volts representing the displaced heater. The second series leg of the circuit is the same as shown in Fig. 1-9(B), because its demands have not been changed in any way by the modifications applied to the other series circuit.

Several other interesting details may be mentioned about the arrangements in Figs. 1-9(B) and (C). In the latter, the increase in the value of the line dropping resistor means an increase in power dissipation. The power dissipation in the resistor in (B) is 4.34 watts; the power dissipation in the resistor in (C) is 6.23 watts. However, it is necessary to add to the former the amount dissipated in the resistor R_1 which has replaced the heater. This power is 1.89 watts, which when added to the 4.34 watts, totals the same amount as is dissipated in the higher value of resistance used in Fig. 1-9(C). At first glance there may appear to be no difference between the two systems, yet there is a substantial difference. It is simply that two resistors, one of 4.34 watts and another of 1.89 watts rating (or whatever may be the wattage ratings selected to afford ample safety factor), are definitely more expensive than a single resistor of such wattage rating as will satisfy a power dissipation of 6.23 watts.

For purposes of comparison let us identify the power dissipation in the system shown in Fig. 1-9(C). The power dissipation in the 150-ma leg is 11.34 watts in the heaters and 6.18 watts in the line dropping resistor R, a total of 17.49 watts. The power dissipated in the 300-ma circuit is 3.78 watts in the heater and 31.32 watts in the line dropping resistor R_1, making a branch total of 35.10 watts. The dissipation in both circuits is the sum of the branch wattages or 52.59 watts.

A third possible arrangement for the substitution is shown in Fig. 1-9(D). In a way, this is a more practical way to connect a 12.6-volt, 0.3-ampere heater in place of a 0.15-ampere heater of like voltage rating. Only one series string is arranged, although it contains two parallel circuits. This system operates in a similar manner to that shown in Fig. 1-8. Of course, the ability to assemble such a circuit depends upon the number of heater elements present. The four heaters H_2, H_3, H_4, and H_5 are of like constants, therefore, two series pairs connected in parallel result in a system requiring 25.2 volts and 0.3 ampere. In order that heater H_1 draw only 150 ma, it is shunted with a resistance equal to its own resistance. Thus, the original six tubes now are arranged so that they can be assembled into a single series string and supplied with 0.3 ampere of current.

The rearrangement of the 150-ma tubes reduces the total voltage drop across the heaters because the paralleled pair of series heaters draws only 25.2 volts compared to its former 50.4 volts. The result is that the total drop across the heaters is reduced to 62.8 volts. This requires a change in the line dropping resistor to that ohmic value (181 ohms) which will draw 54.2 volts and so drop 117 volts to the 62.8 volts at 0.3 ampere required by the heaters. Relative to the power consumption in such a system, the four series-parallel

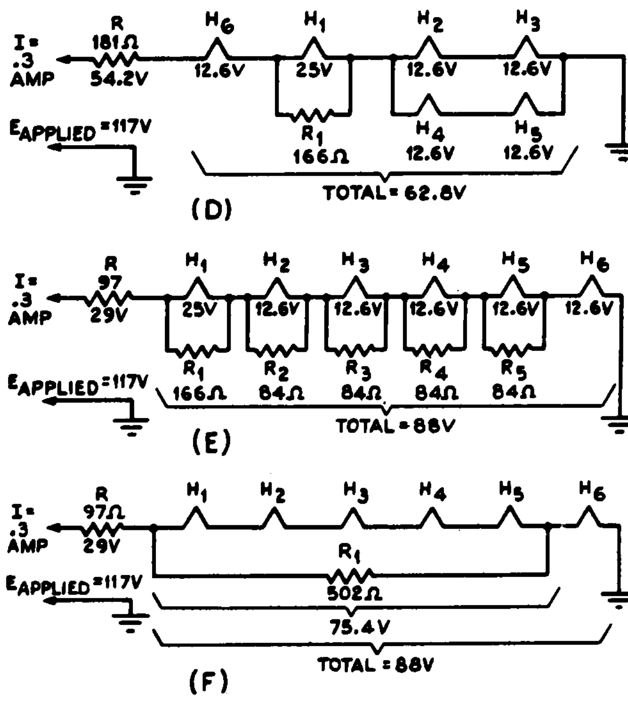
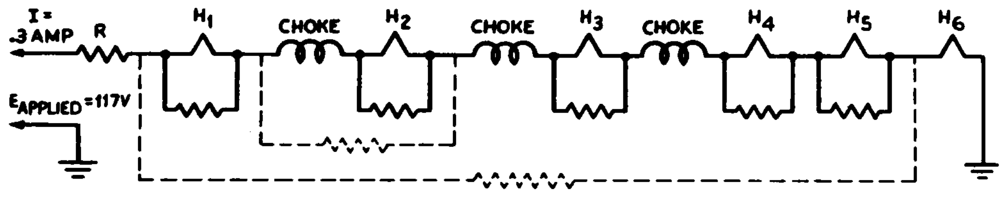


Fig. 1-9(D), (E), and (F). Various methods are shown here for shunting the heaters of the circuit shown in Fig. 1-9(A), after the substitution of a 12.6-volt 0.3-ampere heater for H_6, so that the voltage and current requirements of each heater are satisfied.

Fig. 1-9 (G). Part of a television receiver filament circuit showing the isolating chokes used between the heaters in the series chain. The shunts shown in dotted lines are unacceptable because they nullify the action of the chokes.



(G)

heaters dissipate 1.89 watts each for a total of 7.56 watts; the 25-volt heater H_1 with its shunt consumes 7.5 watts; the 12.6-volt 300-ma heater H_6 consumes 3.78 watts; and the line dropping resistor consumes 16.26 watts. The total power dissipation of the whole circuit is, therefore, 35.1 watts. A comparison between the total power consumption of the circuit in Fig. 1-9(D) and that in Fig. 1-9(C) illustrates the economy in power consumption possible by a choice of circuits.

A modification of the circuit in Fig. 1-9(D), designed to allow the replacement of a 150-ma heater tube with a 300-ma one, is shown in Fig. 1-9(E). Here, all the heaters are in a single chain with a current shunt across each 150-ma tube; the 300-ma heater H_6 does not require a shunt. The ohmic value of these shunts is equal to the resistance of each of the shunted heaters. The power consumption of the entire system totals 36 watts made up as follows: each of the shunted 12.6-volt heaters with its shunt consumes 3.8 watts, the unshunted 0.3-ampere tube requires approximately the same amount of power, the 25-volt shunted heater with its shunt consumes 7.5 watts, and the line dropping resistor consumes 8.7 watts, a total of 35.2 watts. This is slightly more than the consumption of the circuit of Fig. 1-9(D), but it is much less than that required by circuit 1-9(C). As to the relative ease of installation of circuits 1-9(D) or (E), it is a matter of specific circumstances, there being little to choose in terms of power saving.

The reduction of the line voltage-dropping resistor R, in Fig. 1-9(E) is significant. It means a smaller unit and one with lower power dissipation rating, making it more convenient to install than larger units.

A simplification of the shunted heaters is shown in Fig. 1-9(F). Instead of individual current shunts, a single shunt R_1 of suitable value (equal to the combined resistance of the shunted heaters) is connected across the 150-ma heaters, H_1 to H_5. As indicated in the diagram, this resistance amounts to 502 ohms, which is the aggregate of four heaters of 84 ohms each, and one heater of 166 ohms. The 300-ma heater H_6 requires no shunt, therefore, it is not included by the common shunt R_1.

The use of a common shunt across several tube heaters is not generally applicable to television receivers without taking special precautions. The reason for this is that it is common practice in series-wired television receivers to isolate one heater from the other by means of isolating chokes [see Fig. 1-9(G)]. These are part of the filament circuit, but their d-c resistance is extremely low. Any attempt to shunt current around these heaters must exclude the choke from the shunted circuit otherwise the effectiveness of the choke will be materially reduced, if not completely nullified. This means that the current shunts shown in dotted lines in Fig. 1-9(G) are undesirable, instead, each tube should be shunted separately and care must be exercised to see that the shunt is connected directly across the terminals of the related heater and does not include the associated choke.

Series-Parallel Circuits

Having described the parallel and the series systems separately, the organization of the series-parallel system should pose no problem. It is doubtful that the occasion will arise which requires the design of a complete new heater system, usually, the substitution involves one or two tubes at the most and these can be treated as illustrated in Figs. 1-9(B) through (G). An example of a series-parallel combination somewhat more complex than the usual is illustrated in Fig. 1-10. To simplify the treatment of this circuit, we will divide the heaters into two strings, and examine each separately.

In string 1, heaters H_1 and H_8 require heater current equal to the total line current entering the string. Heaters H_2 through H_7 are alike in their requirements for they draw the same current and voltage, however, the total current drawn by these heaters is less than I_1 because of the presence of the current shunt R_1. Furthermore, we note a number of voltage drops in string 1 indicated by the letter E with subscripts. Voltage drop E_1 appears across the extreme limits of the string and is equal to E, the line voltage. The presence of the line dropping resistor R in series with the heaters in string 1 indicates that the total voltage drop in the system E_{11} is less than the applied voltage. The latter is equal to the sum of E_{11} and E_{12}. In turn E_{11} is composed of the sum of the voltage drops E_a, E_b and E_c.

Suppose, for the moment, that heater H_1 is rated at 25 volts and 0.8 ampere, heater H_8 is rated at 12.6 volts and 0.8 ampere, and heaters H_2 through H_7 are rated at 12.6 volts and 0.15 ampere. This identifies E_b

as being 37.8 volts, and E_{11}, therefore, amounts to 25 + 12.6 + 37.8 or 75.4 volts. The line dropping resistor R, therefore, disposes of 41.6 volts at 0.8 ampere. The series-parallel arrangement of heaters H_2 through H_7, without the shunt R_1 requires only 0.3 ampere, however, the line current is 0.8 ampere. Therefore, shunt R_1 must bypass 0.5 ampere. Its value can be determined by $R = E/I$, where E is the voltage across the shunt, in this case E_b (37.8 volts), and I is the current to be shunted through the resistor (0.5 ampere). R_1, therefore, is equal to 75.6 ohms.

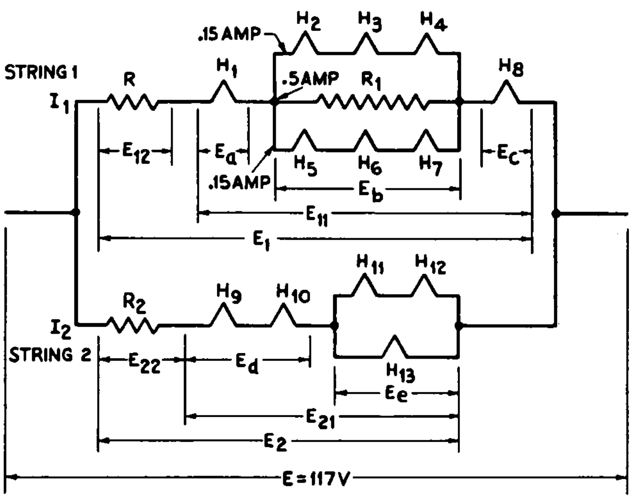


Fig. 1-10. In a series-parallel arrangement of tube heaters such as shown here, each string should be considered separately to find the requirements of each heater.

The distribution of voltages and currents in string 2 requires no special comment. What has been said so far will make the organization of this string easy to follow with the possible exception of the shunting of heater H_{13} across the series pair H_{11} and H_{12}. This is made possible by virtue of the relative voltage ratings of these three heaters; heaters H_{11} and H_{12} are rated at one-half of that of H_{13}, or the total drop across the series pair H_{11} and H_{12} equals the drop across H_{13}. The total current drawn by H_{11}, H_{12}, and H_{13} must equal the current flowing in the line through H_9 and H_{10}. Further examples of such circuits will be found in Section 3.

Dual-Heater Voltage and Current Tubes

Some tubes contain dual heaters which are connected in series and tapped at the midpoint, offering three points for connection. They bear one voltage rating when the two heaters are used in series and another voltage rating (half the previous value) when they are connected in parallel. Naturally, the parallel connection bears a current rating which is twice that of the series rating. Circuitwise, the heaters appear as shown in Fig. 1-11, and are listed in a tube characteristic chart as follows:

TUBE TYPE	FILAMENT VOLTAGE	OR	HEATER CURRENT
3E6	1.4		0.10 ampere
	2.8		0.05
12AT7	6.3		0.3
	12.6		0.15

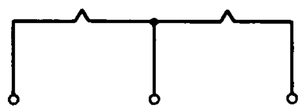


Fig. 1-11. Dual heaters such as appear in dual-heater tubes have their midpoint tapped. This makes it possible to connect the heaters either in series or in parallel with each other.

The use of such tubes in a system affords a more convenient means of substitution than the use of single rated heaters for, by simply arranging the heaters in parallel, they can be made to serve in circuits which require the lower of the two voltages and the higher of the two current ratings. By using the tube with series-connected heaters, it will suit the needs of circuits which require the higher voltage rating and the lower current rating.

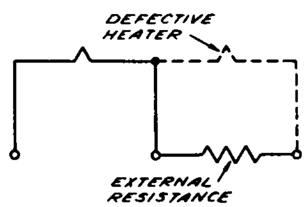


Fig. 1-12. A defective heater in a dual-heater tube may be replaced by an external resistor equal in resistance to the defective element.

Each of these dual heaters is a resistance and, when the heaters are used in parallel, the resultant resistance is half that of either. When they are used in series, the total resistance is equal to twice that of either. In the event of failure of either heater, the remaining heater is capable of causing sufficient electron emission from the cathode and the tube may be treated as if it had but one heater. If it is a matter of maintaining a certain voltage drop in a heater system, the defective heater may be replaced by an external resistance equal in value to that of the original heater. This is illustrated in Fig. 1-12. It must, of course, be understood that when this external resistance replaces the bad heater it will contribute nothing to the emission.

Resistor Substitution

A number of factors control the substitution of resistors, these are:

a. Type (wire or processed)
b. Ohmic value
c. Tolerance
d. Wattage rating.

Relative to the type, wire-wound resistors should not be used in frequency-sensitive circuits unless so stated. The reason for this is the winding has inductance and distributed capacitance. If a resonant peaking circuit contains a carbon resistor in series with the peaking coil, replacing that resistor with a wire-wound unit will change the frequency of resonance, and so alter the operation of the device. Such conditions will be found in wideband amplifiers. In general, therefore, replacement resistors should be of the *same type* as those which were removed. Carbon resistors are preferable in all high-frequency circuits, unless otherwise indicated. In circuits which are not frequency sensitive, the replacement of a processed resistor by a wire-wound one is satisfactory, except when wire resistors appear in both grid and plate circuits of the same tube. This may result in feedback and oscillation in amplifier circuits which handle reasonable amounts of power. Resonance may be created by means of the related distributed capacitance and the inductance of the resistor.

Concerning the ohmic value, it is assumed that the correct substitution will be made with whatever tolerance is indicated in the reference information that describes the constants of the circuit where the replacement is being made. Data concerning tolerance identifications on processed resistors will be found in Section 5.

Sometimes, a single resistor must be replaced by two resistors or a shunt must be added so as to change the ohmic value of a portion of the circuit in order to satisfy the requirements of a tube substitution. The equivalence between a single resistor and other combinations which can produce the same value is shown in Fig. 1-13.

When resistances are in series, the total resistance is equal to the sum of the individual resistances, no matter how many there are [Fig. 1-13(A)]. The resultant resistance of two resistances in parallel is equal to the product divided by the sum, see Fig. 1-13. The number of resistances which may be placed in parallel is limited by practical considerations. If more than two must be shunted in order to arrive at a certain resultant, the following equation should be used

$$\frac{1}{R} = \frac{1}{R_5} + \frac{1}{R_6} + \frac{1}{R_7} + \ldots \text{ [see Fig. 1-13(C)].}$$

For the case of three parallel resistors, the resultant reduces to the fraction shown in Fig. 1-13(C).

Sometimes the situation demands that a certain resistance be shunted by another to produce a certain final value. The ohmic value of the shunt is determined as follows

$$R_{\text{shunt}} = \frac{\text{desired resistance} \times \text{original resistance}}{\text{original resistance} - \text{desired resistance.}}$$

For example, a 100,000-ohm load resistance must be reduced to 30,000 ohms in order to suit the new tube used. What shall be the ohmic value of the shunt required for this job? Using the equation given above

$$R_{\text{shunt}} = \frac{30{,}000 \times 100{,}000}{100{,}000 - 30{,}000} = \frac{3{,}000{,}000{,}000}{70{,}000}$$

$$= 43{,}000 \text{ ohms (approx.).}$$

Tolerance ratings, expressed in percentage, are the amounts by which a rated resistance may differ from the actual resistance of the element. A plus tolerance means that the actual value may be higher than the rated value by some amount not exceeding the tolerance figure; a minus tolerance means that the actual value may be lower than the rated value by some amount not exceeding the tolerance. Thus, a 1-megohm resistor rated at + 5 per cent means that it may be as high as 1,050,000 ohms; if the tolerance was — 5 per cent, its value might be as low as 950,000 ohms. Combining a plus tolerance resistor with a minus one is a good way of arriving at a desired resultant when two of like value are not available. There are many resistors that have a plus and minus tolerance rating. Thus, a 1,000-ohm resistor of ± 10 per cent may be as high as 1,100 ohms, or as low as 900 ohms.

The power dissipation in a resistor carrying current may be expressed by any one of the following methods

$$P = I^2R = \frac{E^2}{R} = EI$$

where I is the current flowing through the resistor; R is its ohmic value, and E is the voltage drop *across* the resistor. In most cases, the wattage rating of a resistor is an important factor. In certain grid circuits, however, where the current is so small as to be negligible, the resistor's power dissipation value is not important. A half-watt rating will be found suitable for all such circuits. However, in those instances when

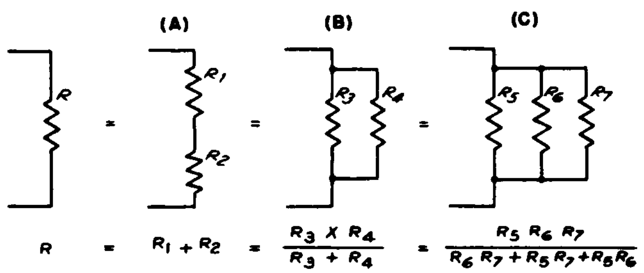


Fig. 1-13. The use of a combination of resistors to produce the same total resistance as a single one is shown in (A), (B), and (C). The total resistance of each of the combinations may be found from the formula beneath it and is equal to the single resistance R shown at the left.

grid current exists and is used to develop all or part of the grid bias, the wattage rating must be based upon the calculated power dissipation. In general, a maximum safety factor of 100 per cent should be allowed above the calculated value. This means that the wattage rating of the resistor chosen should be equal to twice the calculated power dissipation. Such a factor of safety is more than ample. For example, if the dissipation is 1.2 watts, use a 2-watt resistor; if it is 3 watts, use a 5-watt resistor; if it is 6 watts, use a 10-watt resistor; and if it is 13 watts, use a 20-watt resistor. Note that the required wattage is slightly less than double the calculated value in each case. Thus we see why a 100-per cent factor of safety is considered a maximum.

A consideration of moment is the possible tube damage resulting when a resistor burns out. If damage can result due to an excessive rise in plate current or voltage, in the event that a resistor burns out, it is advisable to use a resistor which has a higher wattage rating than the one being replaced.

If the occasion arises to replace a resistor in one leg of a balanced circuit, for example, in the plate or grid circuit of a push-pull stage, it may be necessary to replace the resistor in the other leg also so as not to disturb the balanced condition of the circuit elements. When a replacement is made in such a case, both resistors should have not only similar ohmic values, but should be of similar construction and have similar tolerances and wattage ratings as well.

Fixed Capacitor Substitution

The cardinal factors associated with fixed capacitors are the capacitance, d-c working voltage, and leakage resistance. The requirements relative to capacitor values are so obvious as to require no discussion other than to mention the equivalence between several arrangements, as shown in Fig. 1-14. Two like-value capacitors in series produce a resultant which is equal to one-half the capacitance of either one. Two or more unlike capacitors in series are treated the same as resistors in parallel. Capacitors in parallel are additive.

The d-c working voltage corresponds to the peak a-c voltage which may be applied to the capacitor. Practically speaking, d-c working voltage ratings are somewhat lower than can actually be applied to the capacitor because of the safety factor, but common sense dictates that operations should be carried on within the limits set by the rated working voltage. In view of this situation, care must be exercised against interpreting the d-c working voltage as being the equivalent of the rms or effective value of a-c voltage; if this is done, the probability exists that the peak a-c voltage in the circuit will puncture the capacitor. The correspondence between these different values of voltage is as follows

$$\text{D-C Working Voltage} = \text{Peak A-C Voltage} = 1.414 \times \text{RMS Voltage}.$$

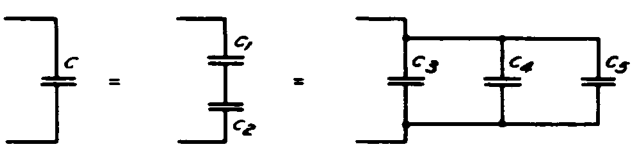
If by error the rms voltage in a circuit equals the d-c working voltage rating of the capacitors, the peak a-c voltage in those circuits (exclusive of surges) will be 1.414 times higher. If any question arises concerning the rms voltage and the d-c working voltage of a capacitor in a circuit, the rms voltage which is usable may be found from the following equation

$$\text{RMS Voltage} = \text{D-C Working Voltage} \times 0.707.$$

This is an important consideration in rectifier systems and wherever both a-c and d-c voltages are involved. The input capacitors in capacitance input filter systems should have a d-c working voltage rating which is somewhat higher than the peak voltage available from the plate winding of the power transformer. This will take into account possible surges which may occur. It is well to bear in mind that repeated failure of capacitors at one point in a system is proof of an insufficient voltage safety factor in the selection of the voltage rating. This is especially true when a substituted rectifier is of the filament type, whereas tubes which receive their voltage from the rectifier are of the heater type. In such cases, high voltages will prevail in the rectifier during the time required for the load tubes to reach the conducting state.

If parallel or series capacitor combinations are used as replacement for a single capacitor, care must be taken that the d-c working voltage across each part of the combination is its rated one. For example, if two capacitors are in series the voltage across each should be inversely proportional to their capacitances and together should equal the total voltage across them. When the combination is a parallel one, the same d-c working voltage will appear across each capacitor.

The d-c leakage in fixed capacitors is an important item in connection with substitution. For example, capacitors which are intended to isolate one point from another relative to d.c. should have low leakage, which means high insulation resistance. High leakage in coupling capacitors can very materially influence the bias on the grid of the tube connected to the resistor and adversely affect the performance of that tube. In this connection, electrolytic capacitors have the highest leakage, paper dielectric capacitors are lower, and mica or ceramic capacitors have the lowest leakage. Vacuum capacitors are, of course, ideal but their use is limited mostly to high-voltage points in transmitters and similar equipment.



$$C = \frac{C_1 C_2}{C_1 + C_2} = C_3 + C_4 + C_5$$

Fig. 14. Combinations of capacitors which give resultant capacitances equal to that of a single capacitor are shown here with the resultant capacitance of each combination listed below it.

When working in high-frequency circuits, the substitution should, if at all possible, be a duplicate of the capacitor being replaced, which in many cases will be a ceramic capacitor. If it is not available, then a mica is the next best choice.

As a means of conserving space, some ceramic capacitors are dual units, that is, the same housing includes a resistor (possibly more than one) which is associated with the operation of the device. Sometimes two such capacitors and a resistor, forming a complete load assembly, may be in one unit. These should be replaced as a unit, but in an emergency, a substitute may be used for only that part of the assembly which has failed. Note: an examination of a circuit may disclose more components than are present physically; some of these "missing" elements may be included in dual units.

I-F Transformer Substitution.

The replacement of i-f transformers is determined by circuit location and circuit constants. The location determines whether it falls within the category of an "input," "interstage," or an "output" transformer. These identifications are found in service notes and parts catalogs. With the exception of receivers which contain only a single stage of i-f amplification, all superheterodynes make use of the aforementioned three general types of transformers. The input and interstage kinds may be interchangable but the output transformer, which feeds a diode demodulator, is of a special design. Therefore, when it is necessary to replace the i-f transformer which feeds the signal to the diode demodulator, every effort should be made to secure a replacement which has been designed to perform that function.

Substantial differences may be found in the numerous varieties of i-f transformers which are employed by receiver manufacturers. Replacement of identical units is possible only by procuring the part from facilities related to the original receiver manufacturer. However, general replacement i-f transformers are suitable substitutes if the proper precautions are exercised when the substitution is made. For example, some i-f transformers used in combination a-m—f-m receivers are of the dual-frequency variety, that is, two different transformers contained in the same can. In other cases, trimmers, or filter elements related to the stage are contained in the same can with the transformers. Examples of these two are shown in Figs. 1-15(A) and (B).

The replacement of such devices by substitutes involves consideration of all of the factors involved. Two individual i-f transformers, an a-m and a separate f-m unit, may be connected externally to form the equivalent of the original shown in Fig. 1-15(A). However, if the original contains additional elements such as resistors and filter capacitors, these must be added in the substitution. The same is true of the replacements for either a-m or f-m transformers which contain special elements. We are referring particularly to units in which the trimmer capacitor is a combination element, part of it being used in the grid filter system of that stage. This may not become evident in a casual inspection of the device or the schematic, for the symbols representing the filter resistors and capacitors are not necessarily shown as a part of the trimmer. This calls for a careful examination of the transformer and the filter circuits. If the transformer is removed and with it all of the filter elements, then a substitution must consist of a corresponding number of units.

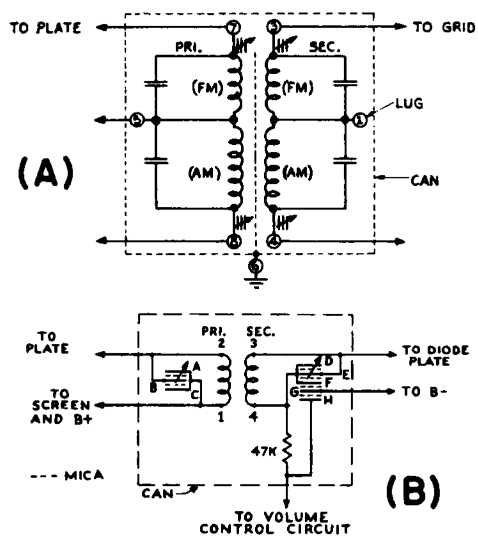


Fig. 1-15. (A) An i-f transformer of the dual-frequency variety found in a-m — f-m receivers. The a-m and f-m windings of the i-f transformer are in series and are contained in the same can; in (B) is shown a unit which contains, besides the i-f transformer, the filter capacitors and trimmers used in the associated circuit.

Relative to the general requirements of i-f transformers, those designed for use with pentodes will serve with any pentode or tetrode. The specific electrical characteristics of all pentode or tetrode i-f amplifiers are not alike, but the differences in i-f transformer performance due to this variable will not be significant if all other requirements are satisfied.

The intermediate frequency is another controlling factor in the selection of a substitute i-f transformer. Several broad categories exist, those used in a-m receivers, those in f-m receivers, and those in television receivers. In each group, the bandwidth requirement is pertinent to the selection of the replacement as is the specific intermediate frequency. Reference to the service data on the receiver is essential; the intermediate frequency used in a receiver does not disclose the specific bandwidth conditions in the i-f transformers. In some cases, all transformers are relatively broadband, being closely coupled. In other instances, the over-all broadbanding is accomplished by staggering the i-f peaks in the individual stages.

Concerning the center frequency, i-f transformers intended for a-m receivers have been standardized to four center frequencies, 130 kc, 175 kc, 262 kc, and 455 kc. From this point on, different types produced by different manufacturers afford different over-all frequency coverage. These vary from a low of about 5 per cent to a high of 40 per cent of the center frequency. For example, one manufacturer may produce an i-f transformer with a center frequency of 455 kc and an over-all tuning range of 50 kc, which is the equivalent of 25 kc each side of the rated center frequency. Some other manufacturer may design his transformers so that the over-all tuning range may be 200 kc, equal to about 40 per cent of the center frequency.

As a rule, the higher the center frequency, the wider is the over-all tuning range, but all makes of i-f transformers of like center frequency do not afford like frequency coverage. In other words, the selection of a transformer demands recognition of the bandwith requirements of the stage wherein it is to be used. Attention must also be paid to the tuning range of a unit if the intermediate frequency in the receiver is not the same as the center frequency of the transformer.

Concerning dual i-f transformers (a-m and f-m), the generally standardized frequencies found in the i-f systems of such receivers preclude any problems other than the one we referred to earlier, that is, to be certain that all of the filter components which exist inside of the original receiver manufacturer's unit appear in the receiver after the replacement has been made.

Up to this point we have neglected the factor of space relative to i-f transformer substitution. It can well be a problem. If the substitution is a transformer for a transformer, that is, single band for single band, it is not too difficult even if the substitute is larger than the original (which seldom is the case). If a dual band (single can) transformer must be replaced by two individual transformers, however, we have a problem. It is possible to find i-f transformers which are smaller than the usual variety. It takes effort to select the ones needed because several factors must be taken into account, but it can be done.

Power-Transformer Substitutions

The physical size and the electrical ratings are two dominant factors in such substitutions. The limitations caused by size are so obvious as to require no elaboration. Concerning electrical ratings, the first essential is that the transformer afford the same over-all capabilities as the original, that is, its windings should be equal in number to that of the original so as to duplicate the functions of the original. This statement is subject to some slight qualifications which will appear when we discuss the filament windings, but in general, it can be said that the maximum convenience in substitution is attained if the substitute has at least as many different windings of like electrical rating as the original.

So far as physical characteristics are concerned, if the original transformer is shielded completely, the substitution unit should be likewise. If the original employs vertical shield mounting, so should the substitute; if the original has horizontal shield mounting, the replacement should duplicate it. Such attention to shielding will result in freedom from field troubles. Open-core transformers can cause trouble if located close to grid and plate wiring. If they must be used because the exact replacement is not available, the possibility of hum troubles must be recognized.

Each winding bears a voltage and a current rating with supplementary identification concerning the center tap. Although a center tap can be arranged by means of a center-tapped resistor connected across an untapped winding, it is preferable if the tap is a part of the winding. A suitable value for a resistor to be used for a center tap is 100 ohms.

Increasing Heater Voltage Rating. Although it is best if the filament windings on the transformer are the same in number and rating as the original, it is very possible that such replacements will not be available. In that event, the following information will be useful. Filament windings when connected in series furnishes a resultant voltage which is the sum of the voltage ratings of the individual windings. A 2.5-volt winding in series with another of 5.0 volts will be the equivalent of a voltage source rated at 7.5 volts. Care must be exercised to see that the two windings are connected with the windings aiding each other. An a-c voltmeter connected across the combined windings will indicate if they are aiding or bucking. The current rating of a series winding of this kind is limited to the lower of the two ratings of the individual windings.

For example, if two 6.3-volt windings, each rated at 1.2 amperes are connected in series aiding, the voltage rating of the two windings is 12.6 volts at 1.2 amperes. If one of these is rated at 0.9 ampere and the other at 1.5 amperes, the current output of the series winding would be limited to 0.9 ampere.

Increasing Heater Current Rating. Windings may be connected in parallel so as to increase the current output rating, provided that each of the windings connected in parallel is rated at the *same* value of voltage. The current ratings need not be the same; the total current output will be the sum of the two individual current ratings. Care must be exercised to see that the two windings are connected in proper phase, otherwise they will buck each other. An a-c voltmeter connected across one winding while the other is being connected in parallel will show whether the phase is correct. If the voltage is reduced, they are bucking.

Relative to the center-tap connection, if two like voltage windings are connected in series, the junction between them can serve as the center tap; individual center taps on the two windings being disregarded. If two unlike voltage windings are connected in series, the midpoint of a 100-ohm resistor, shunted across the combined windings, can be used as the center tap.

If two windings are connected in parallel and each of them has a center tap, the two center taps may be connected together to serve as the combined center-tap connection. If only one of two windings in parallel has a center tap, it cannot be used as the center tap to serve both windings, a 100-ohm center-tapped resistor should be connected across the untapped winding and its midpoint joined to the other center tap, at which point the common connection can be made.

Substitute Heater Windings. If the replacement transformer does not contain all the required heater windings, a supplementary filament transformer, capable of furnishing the required voltage and current, can be used apart from the regular power transformer. Its primary should be connected in parallel with the other transformer.

Half-wave rectifier heater windings do not require center taps. Either end of the winding will serve as the positive output lead with a filament-type tube. Full-wave rectifiers should employ center-tapped heater windings even if the rectifiers are of the cathode type.

Heater-Winding Insulation

As a rule, the voltage breakdown requirements of most heater windings which are a part of the power transformer can be satisfied by a rating of about 2,000 volts since the highest voltage in the system is far less than this amount. In cathode-ray equipment and other systems, it is possible that the cathode may be as much as 4,000 volts above ground and, since it is connected to the center tap of the heater winding, the latter is also above ground by the corresponding amount. This demands that the heater voltage winding be so insulated as to withstand this difference of potential. Sometimes (although very seldom), this requirement may be stated in the specifications. If it is not, it becomes the province of the technician to decide the voltage breakdown requirements of the heater winding.

Rectifier Plate Windings

The conditions surrounding the selection of a substitute power transformer relative to the plate winding are varied, so much so, that it becomes necessary to examine several approaches to the subject. To begin with, the constants of a power transformer utilized in a receiver (or some other kind of equipment) may not be fully identified in service literature; a part number always is given, and sometimes, the current and voltage ratings of the heater windings are stated on the manufacturer's schematic. If this data is not given, the number required and the current rating of each become evident when reference is made to the schematic wiring diagram of the equipment in which the substitution is to be made. It discloses the number of heater or filament chains, and the voltage and current requirements of each. Summation of these indicates the minimum current ratings of the heater windings. The constants of the plate winding, however, are generally omitted. This means that some way must be found to ascertain the requirements of the plate winding so a proper substitute can be found in the event that an exact replacement from the original equipment manufacturer is not available.

The type of rectifiers and their ratings indicates the maximum voltage and current requirements of the plate winding. Seldom, if ever, are these tubes operated very close to their maximum ratings. Therefore, by noting the limits indicated in the tube characteristic chart, and the practical voltages being applied to the tubes in the system under consideration, it is possible to arrive at the voltage and current ratings of the plate winding. Whether it should be a full-wave winding, that is, center tapped, or a half-wave winding is indicated in the schematic of the equipment and by the organization of the rectifier system as a whole. But it is conceivable that there still may arise problems in establishing the voltage rating of the plate winding in view of the conditions experienced in choke- and capacitor-input filter systems, and because of the manner in which the parts catalogs describe the capabilities of the plate windings of power transformers. Generalizing, we can state that when the input of the power-supply filter system is capacitive, the voltage rating of each half of the power-supply plate winding in a full-wave system can be as much as 10 to 15 per cent lower than the d-c voltage output of the rectifier at the prescribed value of d-c load. This stems from the fact that the input filter capacitance can be charged to approximately the peak value of the a-c voltage applied to the rectifier tubes. Some parts catalogs state the voltage and current ratings based on full-wave operation of the rectifier with capacitance input, whereas many others show the a-c voltage across each half of the plate winding at certain d-c values in terms of choke input. This is a cause of confusion; in one case, the a-c voltage between the center tap and the extremes of the plate winding is less than the d-c voltage output from the rectifier by as much as 8 to 10 per cent, whereas in the other case, the a-c voltage rating of the plate winding may be as much as 10 to 15 per cent higher than the d-c voltage output from the rectifier.

What can be used as a guide in determining the basic requirements of the plate winding? The original schematic of the equipment should be the first source of information, especially when it is supplemented by a voltage chart which indicates the voltages being supplied by the power supply. If the plate-current requirements of the tubes are not shown in the voltage chart, a reasonable approximation of these current values can be developed from the tube characteristic charts contained herein. Then, allowing for a 10 per cent voltage drop in the filter system of the power supply and perhaps a loss of about 5 per cent of the total output current through the bleeder connected across the power supply, one can arrive at the total current load requirements of the system and the maximum a-c voltage required between the center tap and the extremes of the full-wave plate winding.

These data are naturally subject to variations, but the approach we have described is not too far off the path which must be followed. At least it suggests a way to gather the necessary information.

It may appear, because of the large number of commercial models, that receivers and amplifiers are distinctive in their general requirements. Such is not the case, for all fall into certain groupings and reflect certain general design considerations. It would be foolish to deny that such circuits as shown in Rider Manuals can serve as the guide for substitution requirements. So far as tube heater and signal electrode voltages and currents are concerned, there isn't much difference between the five- or six-tube table models produced by different manufacturers. Individuality appears in the number of tubes, the specific designs of the transformers, the combination of functions and the like, but these play very little part in establishing the requirements of a power supply.

Cathode-Ray-Tube Substitutions

Cathode-ray-tube substitutions are more involved than ordinary receiving tube substitutions, if for no other reason than that the physical dimensions of the various cathode-ray tubes differ, and the replacement of one by another may require substantial physical changes in the cabinet. Nevertheless, substitutions are possible and the following are offered as suggestions. They are to be used in conjunction with the cathode-ray-tube specifications contained in this Guide Book.

1. All picture tube phosphors must be number 4. This is the last digit in the tube type number.

2. Wholly electrostatically operated picture tubes must be replaced with similar tubes. Since these are restricted in screen size, replacement for 7- and 10-inch electrostatically deflected and focused picture tubes are very limited.

3. Tubes which employ magnetic deflection and electrostatic focusing have no substitutes among either completely electrostatic or magnetic types. The reverse is, of course, also true, a combination magnetic-deflection and electrostatic-focusing type tube cannot be a replacement for either an electrostatically or magnetically deflected and focused picture tube. Since the 7DP4, 9AP4, 10DP4, and 12AP4 are tubes of this type, they have no replacements except each other.

FOCUS COIL CURRENT RATINGS FOR MAGNETIC TYPE CATHODE-RAY TUBES

C-R Tube	Focus Coil Current (Ma)	C-R Tube	Focus Coil Current (Ma)	C-R Tube	Focus Coil Current (Ma)
10BP4	132	14CP4	115*	16MP4	110
10BP4A		14DP4	104	16MP4A	
10CP4	---	14FP4	115*	16QP4	125*
10DP4	---	15AP4	159	16RP4	100*
10EP4	132	15CP4	133	16SP4	110
10FP4	115	15DP4	140	16SP4A	
10MP4	---	16AP4	89	16TP4	115*
10MP4A		16AP4A		16UP4	100*
12JP4	158	16CP4	110	16VP4	110*
12KP4	140	16DP4	115*	16WP4	110*
12KP4A		16DP4A		16XP4	100*
12LP4	114	16EP4	105	16YP4	100*
12LP4A		16EP4A		17AP4	115*
12QP4	148	16FP4	140	19AP4	140
12QP4A		16GP4	100*	19AP4A	
12RP4	148	16HP4	110	19DP4	140
12TP4	114	16HP4A		19DP4A	
12UP4	114	16JP4	120	19EP4	140*
12UP4A		16JP4A		19FP4	97-126*
12VP4	---	16KP4	97*	19GP4	107-126*
12VP4A		16LP4	110	20BP4	122
14BP4	115	16LP4A		22AP4	108*
				22AP4A	

* Types employ RTMA Focus Coil #109, all others RTMA focus focus coil #106.

Courtesy DuMont Labs

4. Picture tubes differ in the focusing coil currents, consequently, in some instances the focusing coil for the substitute tube may require more current than for the original. This necessitates modification of the focusing current supply system. Conversely, some substitute tubes may require less current through the focusing coil than the original, in which case a resistor shunted across the coil will serve the purpose. This current shunt can be calculated using the d-c resistance of the focusing coil and the value of the current, just as in the case of heater current shunts. A variable resistance, 2,500-15,000 ohms, shunted across the coil can be used to determine the value for the fixed resistance shunt. The accompanying table lists the focusing-coil currents for the different magnetic-type cathode-ray tubes.

5. Replacing outside coated tubes with metal-cone types (or the reverse) requires care concerning the connection to the coating or the metal cone. The coating usually is connected to ground, whereas the metal cone usually is connected to a high voltage. The original receiver manufacturer's service notes must be consulted.

6. When a large tube is replaced by a smaller one, the characteristics of the substitute should be determined by reference to the characteristic chart; if the

conditions in the receiver exceed the maximum voltage ratings of the tube, these must be reduced in order to employ the substitute. Usually, those operations are too complicated for the average technician; such substitutions are not recommended.

7. All picture tubes do not utilize like tube basing. See the cathode-ray-tube basing chart in Section 5.

8. Bear in mind that the ion-trap magnets in magnetically focussed picture tubes are not all alike, some call for a single magnet, others for dual magnets; check the cathode-ray-tube characteristics in Section 5.

9. If tube characteristics indicate that the original tube has an external coating furnishing a certain amount of capacitance and the substitute tube does not, a corresponding value of capacitance should be added to the high-voltage power supply at the high-voltage output terminal. This capacitor must have the appropriate d-c working voltage rating.

10. If the ion-trap magnet for the original tube is of the electromagnetic type (coil) and the substitute utilizes a permanent magnet, the coil unit may be left intact (placed in a recess of the cabinet), or it may be replaced by an equivalent resistance of suitable wattage rating located as closely as possible to the power supply. It should not be disconnected without substituting the equivalent resistance into the current supply circuit.

FUNCTIONAL CLASSIFICATION OF TUBES

APPLICATION			HEATER VOLTAGES 1.4	2.0	2.5	6.3	12.6	150 MILLIAMPERE HEATER CURRENT	300 MILLIAMPERE HEATER CURRENT
RF - IF AMPLIFIERS	GENERAL PURPOSE	TRIODES	26 957* 958*	1H4G 30	27 56 485††	6AD4 6C4 6J4 6K4 6N4 7A4 37 76 955 9002 XXL	14A4	6AD4 6C4 955 9002	7A4 37 76
		DOUBLE TRIODES	3B7/1291		3B7/1291#	6AH7GT 6J6 7AF7 7F7 7F8	12AH7GT 12AT7 14AF7/XXD 14F7 19J6##	12AH7GT 12AT7 14AF7/XXD 14F7 19J6	6AH7GT 7AF7 7F7 7F8 12AT7
		TETRODES		1A4T 1D5GT 1E5GT 32	24 35	36			36
		PENTODES	1AB5** 1AD4 1AD5 1L4 1LC5 1LN5 1N5GT 1P5G 1P5GT 1SA6GT 1T4 1U4 1W5* 3E6 959*	1A4P 1B4P 1D5GP 1E5GP 15 34	3E6# 57 58	6AG5 6AH6 6AK5 6AU6 6BA5 6BA6 6BC5 6BD6 6BH6 6BJ6 6C6 6CB6 6D6 6E7 6J7 6J7G 6J7GT 6K7 6K7G 6K7GT 6S7 6S7G 6SD7GT 6SG7 6SG7GT 6SH7 6SH7GT 6SJ7 6SJ7GT 6SK7 6SK7GT 6SS7 6SS7GT 6U7G 6W7G 7A7 7AB7 7AD7 7AG7 7AJ7 7B7 7C7 7G7 7H7 7L7 7V7 39/44 77 78 954 956 9001 9003	12AU6 12AW6 12BA6 12BD6 12B7 12J7GT 12K7GT 12SG7 12SH7 12SH7GT 12SJ7 12SJ7GT 12SK7 12SK7GT 14A7/12B7 14C7 14H7	6BA5 6BH6 6BJ6 6S7 6S7G 6SS7 6SS7GT 6W7G 7AB7 7B7 7C7 12AU6 12AW6 12B7 12BA6 12BD6 12J7GT 12K7GT 12SG7 12SH7 12SH7GT 12SJ7 12SJ7GT 12SK7 12SK7GT 14A7/12B7 14C7 14H7 954 956 9001 9003	6AU6 6BA6 6BD6 6C6 6D6 6E7 6J7 6J7G 6J7GT 6K7 6K7G 6K7GT 6SD7GT 6SG7 6SG7GT 6SH7 6SH7GT 6SJ7 6SJ7GT 6SK7 6SK7GT 6U7G 7A7 7AG7 7AJ7 7H7 7L7 39/44 77 78
	TELEVISION	TRIODES				6AB4		6AB4	
		DOUBLE TRIODES				6J6 12AT7	12AT7 19J6##	12AT7 19J6	12AT7
		PENTODES				6AB7 6AC7 6AG5 6AK5 6AU6 6BC5 6BH6 6CB6	12AU6	6BH6 12AU6	6AG5 6AU6 6BC5 6CB6

* 1.25 V. ** 1.2 V. †† 3.0 V. # 2.8 V. ## 18.9 V.

Courtesy TUNG-SOL Lamp Works, Inc.

FUNCTIONAL CLASSIFICATION OF TUBES

	APPLICATION	HEATER VOLTAGES 1.4	2.0	2.5	5.0	6.3	12.6	150 MILLIAMPERE HEATER CURRENT	300 MILLIAMPERE HEATER CURRENT
AF AMPLIFIERS	TRIODES	1C3 1E4G 1G4GT 1LE3 26	1H4G 30	27 56 485††	01A	6AE5GT 6AD5G 6AF5G 6C5 6C5GT 6F5 6F5G 6F5GT 6J5 6J5GT 6K5G 6K5GT 6L5G 6P5GT 6SF5 6SF5GT 7A4 7B4 37 56 75S 76	12E5GT 12F5GT 12J5GT 12SF5 12SF5GT 14A4	6L5G 12E5GT 12F5GT 12J5GT 12SF5 12SF5GT 14A4	6AE5GT 6AF5G 6AD5G 6C5 6C5GT 6F5 6F5G 6F5GT 6J5 6J5GT 6K5G 6K5GT 6P5GT 6SF5 6SF5GT 7A4 7B4 37 56 75S 76
AF AMPLIFIERS	DOUBLE TRIODES			53		6A6 6AE7GT 6C8G 6F8G 6N7 6N7G 6SC7 6SC7GT 6SL7GT 6SN7GT 6Y7G 6Z7G 7AF7 7F7 12AU7 12AX7 12AY7 79	12AU7 12AX7 12AY7 12SC7 12SL7GT 12SN7GT 14AF7 14F7	12AU7 12AX7 12AY7 12SC7 12SL7GT 14AF7 14F7	6C8G 6SC7 6SL7GT 6Z7G 7F7 12AU7 12AX7 12AY7 12SN7GT
AF AMPLIFIERS	TETRODES		32	24		36			36
AF AMPLIFIERS	PENTODES	1L4 1LG5 1U4 959*	1B4P 1E5GP 15	57		6AU6 6BA5 6BH6 6C6 6J7 6J7G 6J7GT 6R6G 6SG7 6SG7GT 6SH7 6SH7GT 6SJ7 6SJ7GT 6W6GT 6W7G 7AB7 7AG7 7AH7 7C7 7E5 7G7 7L7 7T7 7V7 7W7 77 717A 954 956 9001 9003	12AU6 12J7GT 12SH7 12SH7GT 12SJ7 12SJ7GT 14C7 14V7	6BH6 6W7G 7AG7 7AH7 7C7 7E5 12AU6 12J7GT 12SH7 12SH7GT 12SJ7 12SJ7GT 14C7 954 956 9001 9003	6AU6 6C6 6J7 6J7G 6J7GT 6R6G 6SG7 6SG7GT 6SH7 6SH7GT 6SJ7 6SJ7GT 7L7 7T7 7W7 77
INDICATORS	TUNING INDICATORS			2E5 2G5		6AB5/6N5 6AD6G 6AF6G 6AL7GT 6E5 6G5 6T5 6U5/6G5		6AL7GT	6E5 6G5 6T5 6U5/6G5
INDICATORS	INDICATOR CONTROL					6AE6G		6AE6G	

†† 3.0 V. • 1.25 V.

Courtesy *TUNG-SOL Lamp Works, Inc.*

FUNCTIONAL CLASSIFICATION OF TUBES

APPLICATION			HEATER VOLTAGES										150 MILLI-AMPERE HEATER CURRENT	300 MILLI-AMPERE HEATER CURRENT
			1.4	2.0	2.5	5.0	6.3	12.6	18.9	25	35	50		
POWER AMPLIFIERS	GENERAL PURPOSE	TRIODES		1H4G 30 31	2A3 45	01A 12A 71A 183	6A3 50† 6A5G 6AC5GT 6B4G 6C4			25AC5GT				25AC5GT
POWER AMPLIFIERS	GENERAL PURPOSE	DOUBLE TRIODES	1G6GT 3C6/XXB	1J6G 19	53 3C6/XXB#		6A6 6Y7G 6AS7G 6Z7G 6E6 79 6N7 6N7GT							6Z7G
POWER AMPLIFIERS	GENERAL PURPOSE	TETRODES		49	46		6AL6G							
POWER AMPLIFIERS	GENERAL PURPOSE	PENTODES	1A5GT 3LE4 1AC5 3LF4 1C5GT 3V4 1LA4 3C5GT 1LB4 3Q4 1S4 3S4 1V5* 1W4 3A4 3D6	1F4 1F5G 1G5G 1J5G 33 950	2A5 3A4# 3C5GT# 3LE4# 3Q4 3S4# 3V4# 47 59	257	6A4/LA 6R6G 6AG7 7B5 6AK6 38 6AN5 41 6AR5 42 6F6 89 6F6G 6F6GT 6G6G 6K6GT	12A5		25A6 25A6GT 25B6G 43			6AK6 6G6G	6A4/LA 12A5 25A6 25A6GT 25B6G 38 43
POWER AMPLIFIERS	GENERAL PURPOSE	BEAM PENTODES	1Q5G 1Q5GT 1T5GT 3B5GT 3LF4 3Q5GT		3B5GT# 3LF4# 3Q5GT#		6AH5G 6V5GT 6AQ5 6V6 6AR6 6V6GT 6AS5 6W6GT 6L6 6Y6G 6L6G 7A5 6L6GA 7C5 6U6GT	12A6 12A6GT 14A5 14C5 1625		25C6G 25L6 25L6GT	35L6GT 35A5 35B5 35C5	50A5 50B5 50C5 50C6G 50L6GT	12A6 50L6GT 12A6GT 14A5 35A5 35C5 35C6GT 50B5 50C5 50C6G	25C6G 25L6 25L6GT
POWER AMPLIFIERS	GENERAL PURPOSE	DOUBLE PENTODES		1E7G				12L8GT					12L8GT	
POWER AMPLIFIERS	GENERAL PURPOSE	DIRECT COUPLED					6AB6G 6B5 6AC6GT 6N6G			25B5 25N6GT				25B5 25N6G
TELEVISION	HORIZONTAL DEFLECTION	BEAM PENTODES					6AU5GT 6BQ6GT 6AV5GT 6CD6G 6BG6G		19BG6G	25BQ6GT				19BG6G 25BQ6GT
TELEVISION	VERTICAL DEFLECTION	TRIODES OR TRIODE CONNECTED PENTODES					6AR5 6K6GT 6S4 6SN7GT 6W6GT 12AU7	12AU7 12SN7GT					12AU7	12AU7 12SN7GT

* 1.25 V. # 2.8 V. † 7.5 V.

Courtesy TUNG-SOL Lamp Works, Inc.

FUNCTIONAL CLASSIFICATION OF TUBES

MULTI-FUNCTION TUBES

APPLICATION	HEATER VOLTAGES 1.4	2.0	2.5	6.3	12.6	25	35	70	117	150 MILLIAMPERE HEATER CURRENT	300 MILLIAMPERE HEATER CURRENT
GATED BEAM DEFLECTION				6BN6	12BN6					12BN6	6BN6
DIODE TRIODES	1H5G 1H5GT 1LH4			6Q6G						6Q6G	
DOUBLE-DIODE TRIODES		1B5/25S 1H6G	2A6 55	6AQ6 6AQ7GT 6AT6 6AV6 6AW7GT 6B6G 6BF6 6BK6 6BT6 6BU6 6C7 6Q7 6Q7G 6Q7GT 6R7 6R7G 6R7GT 6SQ7 6SQ7GT 6SR7 6SR7GT 6ST7 6SZ7 6T7G 6V7G 7B6 7C6 7E6 7K7 7X7 75 85	12AT6 12AV6 12BF6 12BK6 12BT6 12BU6 12Q7GT 12SQ7 12SQ7GT 12SR7 12SR7GT 12SW7 14B6 14E6 14X7					6AQ6 6ST7 6SZ7 6T7G 7C6 12AT6 12AV6 12BF6 12BK6 12BT6 12BU6 12Q7GT 12SQ7 12SQ7GT 12SR7 12SR7GT 12SW7 14B6 14E6 14X7	6AQ7GT 6AT6 6AV6 6AW7GT 6BF6 6BK6 6BT6 6BU6 6C7 6Q7 6Q7G 6Q7GT 6R7 6R7G 6R7GT 6SQ7 6SQ7GT 6SR7 6SR7G 6V7G 7B6 7E6 7K7 7X7 75 85
TRIPLE-DIODE TRIODES				6R8 6S8GT 6T8	12S8GT	19T8##				12S8GT 19T8	6S8GT
DIODE PENTODES	1LD5 1Q6• 1S5 1SB6GT 1T6• 1U5			6SF7 6SF7GT 6SV7	12SF7GT					12SF7GT	6SF7 6SV7
DIODE POWER PENTODES	1N6G 1N6GT										
DOUBLE-DIODE PENTODES	1F6 1F7G 1F7GH		2B7	6B7 6B8 6B8G 6B8GT 7E7 7R7	12C8 14E7 14R7					12C8 14E7 14R7	6B7 6B8 6B8G 6B8GT 7E7 7R7
TRIODE PENTODES				6AD7G 6F7 6F7G 6P7G	12B8GT	25B8GT				25B8GT	6F7 6F7G 6P7G 12B8GT
DIODE TRIODE PENTODES	1B8GT 1D8GT 3A8GT		3A8GT#			25D8GT				25D8GT	
HALF-WAVE RECTIFIERS POWER PENTODES					12A7	25A7GT					12A7 25A7GT
HALF-WAVE RECTIFIERS BEAM PENTODES							32L7GT•	70A7GT 70L7GT	117L7/M7GT 117N7GT 117P7GT	70A7GT 70L7GT	32L7GT

• 1.25 V. # 2.8 V. ## 18.9 V. • 32.5 V.

Courtesy TUNG-SOL Lamp Works, Inc.

FUNCTIONAL CLASSIFICATION OF TUBES

APPLICATION			HEATER VOLTAGES 1.4	2.0	2.5	5.0	6.3	12.6	25	35	50	117	150 MILLIAMPERE HEATER CURRENT	300 MILLIAMPERE HEATER CURRENT
CONVERTERS	GENERAL PURPOSE	PENTAGRID HEPTODE OCTODE	1A7G 1L6 1A7GT 1LA6 1B7G 1LC6 1B7GT 1R5 1E8	1A6 1C6 1C7G 1D7G	2A7		6A7 6SA7 6A8 6SA7GT 6A8G 6SB7Y 6A8GT 7A8 6BA7 7B8 6BE6 7Q7 6D8G	12A8GT 12SY7 12BA7 12SY7GT 12BE6 14B8 12SA7 14Q7 12SA7GT					6D8G 12SY7 7A8 12SY7GT 12A8GT 14B8 12BA7 14Q7 12SA7GT	6A7 6SA7 6A8 6SA7GT 6A8G 6SB7Y 6A8GT 7B8 6BA7 7Q7 6BE6
CONVERTERS	GENERAL PURPOSE	TRIODE HEXODES TRIODE HEPTODES					6J8G 6K8 6K8G 6K8GT 7D7 7J7 7S7	12K8 12K8GT 14J7 14S7					7D7 12K8 12K8GT 14J7 14S7	6J8G 6K8 6K8G 6K8GT 7J7 7S7
CONVERTERS	GENERAL PURPOSE	MIXERS					6AS6 6L7 6L7G							6L7 6L7G
CONVERTERS	TELEVISION	DOUBLE TRIODE MIXERS					6J6 12AT7	12AT7					12AT7	12AT7
CONVERTERS	TELEVISION	PENTODE MIXERS					6AG5 6AK5 6BC5 6CB6							6AG5 6BC5 6CB6
RECTIFIERS GENERAL PURPOSE — HIGH VACUUM	HALF-WAVE	DIODES			2W3 2W3GT 2Y2 2Z2		1-V 81†	12Z3	25W4GT	35W4 35Y4 35Z4GT 35Z5GT	45Z3•• 45Z5GT••	117Z3 117Z4GT	35Y4 35Z3 35Z4GT 35Z5GT 45Z5GT	1-V 1Z2 12Z3 25W4GT
RECTIFIERS GENERAL PURPOSE — HIGH VACUUM	FULL-WAVE	DOUBLE DIODES				5AZ4 5X4G 5R4GY 5Y3G 5T4 5Y3GT 5U4G 5Y4G 5V4G 5Y4GT 5W4G 5Z3 5W4GT 5Z4 5X3 80 83V	6AX5GT 7X6 6W5G 7Y4 6X4 7Z4 6X5 84/6Z4 6X5GT 6Y5 6Z5/12Z5 6ZY5G	6Z5/12Z5	25Z5 25Z6 25Z6GT	35Z6G	50X6GT 50Y6GT 50Y7GT 50Z7G	117Z6GT	50Y6GT 50Y7GT 50Z7G	6ZY5G 25Z5 25Z6 25Z6GT 35Z6G
RECTIFIERS GENERAL PURPOSE — HIGH VACUUM	DETECTORS	DIODES	1A3 1R4/ 1294 2B25		9005*		6H4GT 7C4/1203A 9004 9006						1A3 9004 1R4 9006 6H4GT 7C4/1203A	
RECTIFIERS GENERAL PURPOSE — HIGH VACUUM	DETECTORS	DOUBLE DIODES					6AL5 7A6 6H6 6H6GT	12AL5 12H6					7A6 12AL5 12H6	6AL5 6H6 6H6GT
RECTIFIERS GENERAL PURPOSE — HIGH VACUUM		QUADRUPLE DIODES					6AN6							
RECTIFIERS GENERAL PURPOSE — HIGH VACUUM	VOLTAGE DOUBLER	DOUBLE DIODE							25Z5 25Z6 25Z6GT	35Z6G	50X6 50Y6GT 50Y7GT 50Z7G	117Z6GT	50X6 50Y6GT 50Y7GT 50Z7G	25Z5 25Z6 25Z6GT 35Z6G

* 3.6 V.   † 7.5 V.   •• 45 V.

Courtesy TUNG-SOL Lamp Works, Inc.

FUNCTIONAL CLASSIFICATION OF TUBES

APPLICATION				HEATER VOLTAGES							150 MILLIAMPERE HEATER CURRENT	300 MILLIAMPERE HEATER CURRENT
				COLD CATHODE	1.4	2.5	5.0	6.3	12.6	25		
RECTIFIERS	TELEVISION — HIGH VACUUM	HIGH VOLTAGE	DIODES		1B3GT 1X2 1V2 1Y2 1Z2	2V3G 2X2 2X2/879 879						
RECTIFIERS	TELEVISION — HIGH VACUUM	VIDEO DETECTOR	DOUBLE DIODES					6AL5	12AL5		12AL5	6AL5
RECTIFIERS	TELEVISION — HIGH VACUUM	DAMPER SERVICE	DIODES				5V4G	6U4GT 6W4GT		25W4GT		25W4GT
RECTIFIERS	TELEVISION — HIGH VACUUM	DAMPER SERVICE	DIODE CONNECTED					6AS7G			6AS7G	
RECTIFIERS	TELEVISION — HIGH VACUUM	DC RESTORER	DOUBLE DIODE					6AL5	12AL5		12AL5	6AL5
RECTIFIERS	GENERAL PURPOSE—GAS	HALF WAVE	DIODES	0Y4 0Y4G								
RECTIFIERS	GENERAL PURPOSE—GAS	FULL WAVE	DOUBLE DIODE	0Z4 0Z4G		82 83						
VOLTAGE REGULATOR			GLOW DISCHARGE DIODE	0A2 0A3/VR-75 0B2 0B3/VR-90 0C3/VR-105 0D3/VR-150								
CONTROL SERVICE			GAS TRIODE	1C21		2A4G 2B4 2C4 885		6D4 6Q5G 884				
CONTROL SERVICE			GAS TETRODES					2D21 2050 2051				
CONTROL SERVICE			RELAY TUBE	0A5								

Courtesy TUNG-SOL Lamp Works, Inc.

SECTION 2

RECEIVING TUBE SUBSTITUTION GUIDE

This section includes the actual information on the tube substitutions. Four columns are included. The first column lists the tube type for which a substitute is desired. This listing is in numerical and alphabetical order. For example 6CB6 precedes 6CD6 and 6ZY5 precedes 7A4. We have not indicated any difference between metal and glass tubes of the octal type. The tube listed can thus be considered either as metal or a glass type. The letters *G, GT, GT/G, GA,* or *GP* indicates that the tube has a glass envelope, the *GT* and *GT/G* are smaller and newer versions of the *G* type. The glass tubes, in practically all cases, have the same characteristics as the metal types.

One of the primary differences between the glass and metal tubes is that the metal type usually have an internal shield. A pin at the base of these tubes is connected to this shield. In most cases this pin is wired to the common ground or B minus of the set. In a few cases substituting a glass type for a metal type causes the circuit to become unbalanced or feedback occurs due to a lack of proper shielding. Most often this can be overcome by shielding the tube or realigning the set.

The second column lists the various possible substitutes. Quite often more than one substitute is listed for a single tube. In such cases the tube in the first column is not repeated for each substitute but is listed only once.

The third column lists the performance of each tube. Three performance ratings are shown in this list. These are *E* for EXCELLENT, *G* for GOOD, and *P* for POOR. They define the suitability of a substitute predicated upon its electrical characteristics as compared to those of the original and upon the relationship between the characteristics of the substitute to the constants of the circuit, which was designed to function best with the original. The comparison between the characteristics of the tubes excludes the filament or heater voltage and current ratings. It is assumed that whatever may be the performance characteristics of the substitute — the filament or heater voltages and current are correct, even if it requires certain minor circuit modifications to accomplish this condition.

Concerning the *E, G,* and *P* ratings, it stands to reason that those tubes which bear *E* (excellent) ratings are either the exact equivalents differing perhaps in basing and maybe in filament or heater voltage and current ratings — or so closely approximate the electrical characteristics of the original as to require no significant major modifications. All applicable tube substitutions which might bear an *E* rating in performance are not shown in the main listing. Some appear on the addendum pages. These represent last-minute additions as the result of information received from television receiver manufacturers and appear at the end of this section.

Concerning the *G* (good) rating, it reflects more than just moderate differences in tube characteristics between the substitute and the original that is being replaced. It still means a triode substitute for a triode original, or a pentode substitute for a pentode original, and sometimes the conversion of a pentode into a triode, but the plate (and screen) voltage demands of the substitute may be higher than that of the original — or the transconductance or amplification constant of the substitute may be less than the original — all of which means that the circuit demands incorporated in the equipment design are not being met by the substitute tube. Possibly the plate impedance of the substitute is higher or lower, reducing the originally intended over-all amplification; perhaps a slight amount of distortion is added to the signal by the substitute. Yet the substitute may be used even if it is not as good in performance as the original, for again it is a matter of continuing the operation of a device.

Those substitutions which bear *P* (poor) ratings are used only as a last resort. They represent the extremes in tube substitution when it is a matter of accomplishing a repair job of sorts, rather than none at all because more appropriate substitutes are not available. Of course, modifications can be made in the circuit design and circuit constants so as to accommodate the tube rated poor, in which case, considerable improvement may be accomplished. It must be remembered, of course, that the *P* rating — or for that matter, the *G* rating — is not a reflection upon the capabilities of the tube or the brand. It simply means that the tube, so designated in the list, was not intended for use in the type of system for which it is suggested as a substitute. With proper circuit changes, it might, as we said before, become a better performing substitute. But whether or not such design changes are warranted is a matter of individual consideration. As far as circuit modification is concerned, it can be a tedious task. Much depends upon comparative reference data and background knowledge of circuits. Finally such changes are possible only if the cost is acceptable to the owner of the equipment.

The fourth or last column lists the circuit changes that are necessary to make the substitute operate properly. In many cases no change whatsoever is required, the original tube is pulled out and the substitute plugged in. Where the reference "parallel circuits only" or "series circuits only" is found, it refers only to the type of filament circuit arrangement in which the substitute tube can be used.

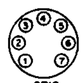
Original and Substitute Sockets

The tube substitution lists contain illustrations of the original and the substitute tube sockets when the tube interchange involves a change in sockets. These are offered as a convenience in wiring. The views are the bottoms of the sockets and these correspond to the pin locations on the bottom of the respective tube bases. The bottom socket view of the original tube will always be found to the left of the change writeup and will bear the designation "ORIG." The bottom socket view of the substitute tube will always be found to the right of the change writeup and will bear the designation "SUB."

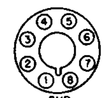
The instructions given between the two illustrations state the respective socket terminals involved in the rewiring operation. In view of the necessity for removing one socket before mounting the other, it is suggested that as each wire is disconnected from the original socket, it be labeled with a tiny tag showing the appropriate socket connection number. These correspond to the pin numbers on the tube base. Then when being rewired to the new socket, all that is required is to solder the numbered lead to the terminal on the socket as stated in the instructions.

Care must be exercised to see that the socket connections are read in accordance with the location of the key as shown on the pages. In order to attain correspondence between the socket mounted on the chassis and the instructions, one or the other should be changed in physical position so that the keys or identifying terminals are in the same relative position. Another precautionary note relates to the grid caps. In many cases capped tubes are replaced by single ended tubes, and vice-versa. The leads must be properly connected. Finally in some substitutions the pin numbers on the original and the substitute are the same, that is, 1 to 1, 2 to 2, 3 to 3 and so on. This is not standard for all the tubes, nor is it standard for all the pins even if it is true for some of them in any one substitution. In other words, the instructions should be read completely. Nothing should be taken for granted.

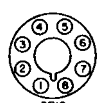
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
00A	01A	E	No changes.
	40	G	
01A	00A	E	No changes.
	00AA	E	
	01B	E	
0A2	0B2	P	Where application is not too critical.
0A3	VR75	E	No changes.
0A4	1267	E	No changes.
0B2	0C3	E	Where space permits. Change socke to octal and rewire as follows:


ORIG.

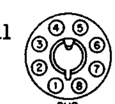
No. 1 on miniature	to No. 5 on octal
2	to 2
5	to 5


SUB

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
0B3	VR90	E	No changes.
0C3	VR105	E	No changes.
	0B2	E	Reverse 0B2 to 0C3 procedure.
0D3	VR150	E	No changes.
0Y4	0Y4G	E	No changes.
0Y4G	0Y4	E	Ground pin No. 1
0Z4	0Y4	G	No changes.
	0Z4A/1003	E	
	1005/CK1005	E	
	6X5	E	Solder socket terminal No. 2 to chassis. Connect 6V hot lead to No. 7. Motorolas and some other car radios have filament wired and the 6X5 may be used without making any changes.
	7Y4	E	Change socket to loctal and rewire as follows:


ORIG

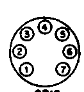
No. 3 on octal	to No. 3 on loctal
5	to 6
8	to 7

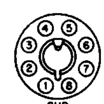

SUB.

Connect No. 8 on loctal to chassis and No. 1 on loctal to 6V hot lead.

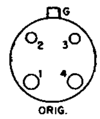
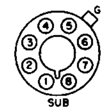
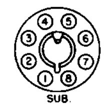
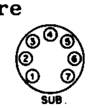
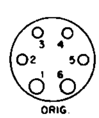
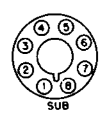
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	84	E	Reverse 84 to 6X5 procedure.
0Z4A	0Y4	G	No changes.
	1005/CK1005	G	
1A3	1B4/1294	E	Where space permits. Change socket to loctal and rewire as follows:

No. 1 on miniature	to No. 1 on loctal
2	to 4
3	to 7
6	to 4
7	to 8


ORIG.

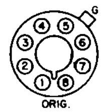

SUB.

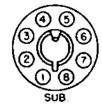
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
1A4	1B4	E	No changes.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
1A4	1D5 1E5	E E	Change socket to octal and rewire as follows:  No. 1 on four prong to No. 2 on octal 2 to 3 3 to 4 4 to 7 cap to cap 
	32 34	E E	No changes.
1A5	1C5	G	Parallel circuits only. No changes.
	1G4	P	No changes. Emergency but works well in most cases.
	1LA4 1LB4	E E	Change socket to loctal and rewire as follows:  No. 2 on octal to No. 1 on loctal 3 to 2 4 to 3 5 to 6 7 to 8 
	1N6	P	Remove and tape up any wires anchored on No. 6.
	1Q5	G	Parallel circuits only. No changes.
	1S4	P	Same as 3Q5 to 3S4, except do not connect No. 8 on octal to No. 5 on miniature. Parallel circuits only.
	1T4	P	Emergency substitution. Tone OK at low volume. Change socket to miniature and rewire as follows:  No. 2 on octal to No. 1 on miniature 3 to 2 4 to 3 5 to 6 7 to 7 
	1T5	G	No changes. Filament current 10 mils higher but gives satisfactory results.
	3Q4 3S4	P	Electric operation only. Same as 3Q5 to 3S4, except connect nothing to No. 5 on miniature.
	3Q5	P	No changes necessary. For electric operation only as the A battery will be too low with 1.4 more filament in the circuit.
1A6	1C6	E	No changes. For parallel operation only as the 1C6 draws 120 mils instead of 60.
	1C7	E	Parallel circuits only. Change socket to octal and rewire as follows:  No. 1 on six prong to No. 2 on octal 2 to 3 3 to 6 4 to 5 5 to 4 6 to 7 
	1D7	E	Same as 1A6 to 1C7. Either series or parallel circuits.
1A7	1B7	E	Parallel circuits only. No changes.
	1C7	P	Parallel circuits only.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
1A7	1D7	P	No changes, unless there is a resistor across 1A7 filament, which must be removed. 1D7 is rated 2V 60 mils and draws slightly less than 50 on 1.4.
	1L6	G	Same as 1A7 to 1U6.
	1LA6 1LC6	E E	Change socket to loctal and rewire as follows:

No. 2 on octal	to No. 1 on loctal
3	to 2
6	to 3
5	to 4
4	to 5
7	to 8
cap	to 6





TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	1R5	G	Make adaptor as follows: Solder rather heavy wires three inches long to all lugs except No. 5 of miniature socket. Break the 1A7, clean out the base and save the cap. Push the wires from miniature socket thru the base pins as follows:

No. 1 on miniature	thru No. 2 of base
2	thru 3
3	thru 6
4	thru 5
7	thru 7
6 bring out and solder grid cap on.	

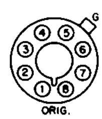
The octal socket could be replaced by a miniature using the above connections but it is usually hard to find a place to mount it.

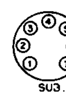
If 1R5 squeals, reduce value of oscillator grid resistor to 75000 ohms or less if necessary. This resistor is connected between terminal No. 5 on the the 1A7 socket and ground or filament.

An idea we have been using successfully is to dig a trough from pin No. 5 to pin No. 7 on the adaptor, filling this with the graphite preparation made for volume controls, measuring the resistance, and filling the trough until the desired resistance is acquired.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	1U6	G	Parallel circuits only. Change socket to miniature and rewire as follows:

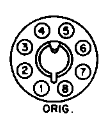
No. 2 on octal	to No. 1 on miniature
3	to 2
4	to 5
5	to 4
6	to 3
7	to 7
cap	to 6

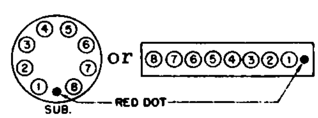




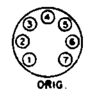
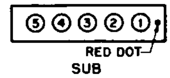
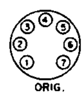
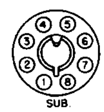
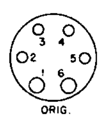
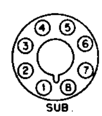
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
1AB5	1AD5	G	Parallel circuits only. Change socket to subminiature and rewire as follows:

No. 1 on loctal	to No. 4 on subminiature
2	to 7
3	to 8
6	to 2
7	to 5
8	to 5

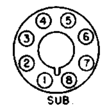
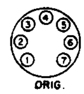
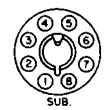
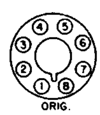
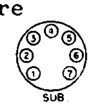


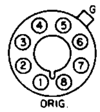
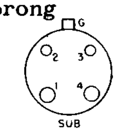
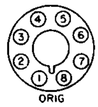
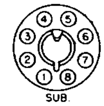
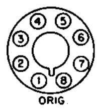
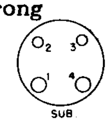
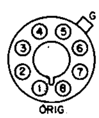
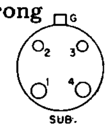
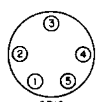
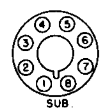
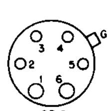
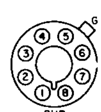


TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
1AC5	1V5	E	No changes.
1AD4	1AD5	G	Parallel circuits only.
	1AE4	G	Reverse 1AE4 to 1AD4 procedure.
1AD5	1AB5	G	Parallel circuits only. Reverse 1AB5 to 1AD5 procedure.

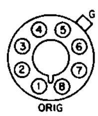
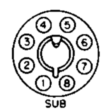
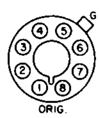
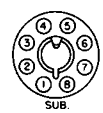
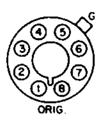
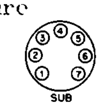
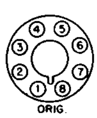
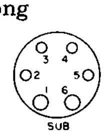
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
1AD5	1AD4	G	Parallel circuits only.
	1W5	E	No changes.
1AE4	1AD4	G	Change socket to subminiature and rewire as follows: No. 1 on miniature to No. 5 on 1AD4 2 to 1 3 to 2 5 to 5 6 to 4 7 to 3 Pin numbers on 1AD4 number from right to left from red mark on base, as shown. 
1AF4	1AF5	P	Rewire as follows: No. 5 to No. 1 2 to 5 3 to 4 Do not use terminal No. 3 for anchor
	1L4 1T4 1U4	G G G	No changes. Parallel circuits only.
1AF5	1LD5	P	Parallel circuits only. Where space permits. Change socket to loctal and rewire as follows: No. 1 on miniature to No. 1 on loctal 3 to 4 4 to 3 5 to 2 6 to 6 7 to 8 
	1S5	G	Parallel circuits only. No changes.
1B3	1X2	E	Reverse 1X2 to 1B3 procedure.
1B4*	1A4	E	No changes.
	1D5 1E5	E E	Same as 1A4 to 1D5.
	32 34	E E	No changes.
1B5	1H6	E	Change socket to octal and rewire as follows: No. 1 on six prong to No. 2 on octal 2 to 3 3 to 4 4 to 5 5 to 6 6 to 7 
	25S	E	No changes.
1B7	1A7	E	Parallel circuits only. No changes.
	1L6	G	Parallel circuits only. Same as 1A7 to 1U6
	1LA6 1LC6	E E	Parallel circuits only. Same as 1A7 to 1LA6.

* See Addendum at back of this section.

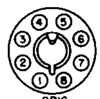
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
1B7	1R5	G	Parallel circuits only. Same as 1A7 to 1R5.
	1U6	G	Parallel circuits only. Same as 1A7 to 1U6.
1B8	1D8	E	No changes.
1C3	1G4	G	Where space permits. Change socket to octal and rewire as follows:
			 No. 1 on miniature to No. 2 on octal
			2 to 3
			4 to 5
			6 to 3
			7 to 7 
	1LE3	G	Where space permits. Change socket to loctal and rewire as follows:
			 No. 1 on miniature to No. 1 on loctal
			2 to 2
			4 to 6
			6 to 2
			7 to 8 
1C5	1A5	G	Parallel circuits only. No changes.
	1D8	P	Remove and tape up any wires connected to 6 and 8. No connection to top cap.
	1LA4	G	Same as 1A5 to 1LA4. Parallel circuits only.
	1LB4	G	
	1Q5	G	No changes. Bias different but tone is reasonably good.
	1S4	G	Same as 3Q5 to 3S4, but connect nothing to No. 5 on miniature.
	1T5	G	Parallel circuits no changes. Series circuits shunt 35 ohm resistor across filament.
	3Q4	P	Change socket to miniature and rewire as follows:
	3S4	P	 No. 2 on octal to No. 5 on miniature
			3 to 2
			4 to 4
			5 to 3
			7 to 1 and 7 
	3Q5	P	Same as 1Q5 to 3Q5.
1C6	1A6	G	Parallel circuits only. No changes.
	1C7	G	Same as 1A6 to 1C7. Either series or parallel circuits.
	1D7	G	Same as 1A6 to 1C7. Parallel circuits only.
1C7	1A6	G	Reverse 1A6 to 1C7 procedure. Parallel circuits only.
	1C6	E	Reverse 1A6 to 1C7 procedure.
	1D7	E	Parallel circuits only. No changes.
1C8	1AE5	G	Parallel circuits only.
	1E8	E	No changes.
1C21			No practical substitute.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
1D5	1A4 1B4 32 34 951	E E E E E	Change socket to four prong and rewire as follows: No. 2 on octal to No. 1 on four prong 3 to 2 4 to 3 7 to 4 cap to cap  
	1E5	G	No changes.
1D7	1A6	G	Reverse 1A6 to 1C7 procedure.
	1C6	E	Reverse 1A6 to 1C7 procedure. Parallel circuits only.
	1C7	E	Parallel circuits only. No changes.
1D8	1B8	E	No changes.
1E4	1G4 1H4	G P	No changes.
	1LE3	G	Change socket to loctal and rewire as follows: No. 2 on octal to No. 1 on loctal 3 to 2 5 to 6 7 to 8  
	30	P	Change socket to four prong and rewire as follows: No. 2 on octal to No. 1 on four prong 3 to 2 5 to 3 7 to 4  
1E5 *	1D5	G	No changes.
	1A4 1B4 32 34 951	P P P P P	Change socket to four prong and rewire as follows: No. 2 on octal to No. 1 on four prong 3 to 2 4 to 3 cap to cap  
1E7			No practical substitute.
1E8	1C8	E	No changes.
1F4	1F5	E	Change socket to octal and rewire as follows: No. 1 on five prong to No. 2 on octal 2 to 3 4 to 4 3 to 5 5 to 7  
1F5	1F4	E	Reverse 1F4 to 1F5 procedure.
1F6	1F7	E	Change socket to octal and rewire as follows: No. 1 on six prong to No. 2 on octal 2 to 3 3 to 6 4 to 4 5 to 5 6 to 7 cap to cap  

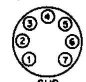
* See Addendum at back of this section.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
1F7	1F6	E	Reverse 1F6 to 1F7 procedure.
1G4	1C3	G	Reverse 1C3 to 1G4 procedure.
	1E4 1H4	G P	No changes.
	1LE3	G	Same as 1E4 to 1LE3.
	30	P	Same as 1E4 to 30.
1G5	1J5	G	No changes.
1G6	1J6	P	Parallel circuits only. No changes.
1H4	1E4	P	No changes.
	1LE3	P	Same as 1E4 to 1LE3.
	30	P	Same as 1E4 to 30.
1H5	1H6	P	Connect grid cap to socket terminal No. 6. Connect Nos. 4 and 5 together.
	1LD5	G	Change socket to loctal and rewire as follows:  No. 2 on octal to No. 1 on loctal 3 to 2 and 3 5 to 4 7 to 8 cap to 6 
	1LH4	E	Change socket to loctal and rewire as follows:  No. 2 on octal to No. 1 on loctal 3 to 2 5 to 4 7 to 8 cap to 6 
	1S5	G	Change socket to miniature or make adaptor wiring as follows:  No. 2 on octal to No. 1 on miniature 3 to 4 and 5 5 to 3 7 to 7 cap to 6 
1H6	1B5	E	Change socket to six prong and rewire as follows:  No. 2 on octal to No. 1 on six prong 3 to 2 4 to 3 5 to 4 6 to 5 7 to 6 
1J5	1G5	G	No changes.
1J6	19	E	Reverse 19 to 1J6 procedure.
1L4	1AF4	G	Parallel circuits only. No changes.
	1SA6	G	Same as 1T4 to 1SA6.
	1T4 1U4	G G	No changes.

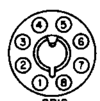
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
1L6	1U6	E	Parallel circuits only. No changes.
1LA4	1A5	G	Same as 1LB4 to 1A5.
	1C5	G	Same as 1LB4 to 1A5. Parallel circuits only.
	1LB4	G	No changes.
	1Q5	G	Same as 1LB4 to 1A5. Parallel circuits only.
	1S4	G	Same as 1LA4 to 3Q4. Parallel circuits only.
	1T5	G	Same as 1LB4 to 1A5.
	1W4	G	Same as 1LB4 to 1W4.
	3Q4 3S4	P P	Electric operation only. Change socket to miniature and rewire as follows:


ORIG.

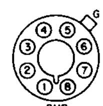
No. 1 on loctal	to No. 1 on miniature.
2	to 2
3	to 4
6	to 3
8	to 7


SUB.

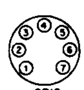
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	3Q5	P	Same as 1LB4 to 1A5. Series circuits only.
1LA6	1A7	E	Change socket to octal and rewire as follows:


ORIG.

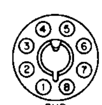
No. 1 on loctal	to No. 2 on octal
2	to 3
3	to 6
4	to 5
5	to 4
6	to cap
8	to 7


SUB

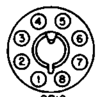
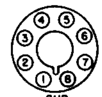
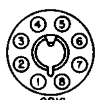
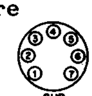
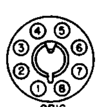
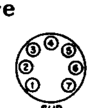
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	1B7	E	Same as 1LA6 to 1A7. Parallel circuits only.
	1L6	E	Same as 1LA6 to 1U6.
	1LB6	P	Rewire as follows: No. 5 to No. 7 Connect pins No. 5 and No. 8 together.
	1LC6	E	No changes.
	1R5	G	Make adaptor as follows: Break the glass envelope on a burned out loctal tube leaving the extension of the pins intact. Bend the extension of the pins so that they connect to a miniature socket according to the following:


ORIG.

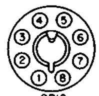
No. 1 on miniature	to No. 1 on loctal
2	to 2
3	to 3
4	to 4
6	to 6
7	to 8


SUB.

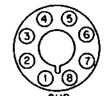
In case this substitution squeals on the high frequency end of the dial, change the oscillator grid resistor to 100M ohms or less if necessary.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
1LA6	1U6	G	Parallel circuits only. Change socket to miniature and rewire as follows: No. 1 on loctal to No. 1 on miniature 2 to 2 3 to 3 4 to 4 5 to 5 6 to 6 8 to 7  ORIG.  SUB.
1LB4	1A5 1T5	G G	Change socket to octal and rewire as follows: No. 1 on loctal to No. 2 on octal 2 to 3 3 to 4 6 to 5 8 to 7  ORIG.  SUB
	1C5	G	Same as 1LB4 to 1A5. Parallel circuits only.
	1LA4	G	No changes.
	1Q5	G	Same as 1LB4 to 1A5. Parallel circuits only.
	1S4	G	Same as 1LA4 to 3Q4. Parallel circuits only.
	1W4	G	Change socket to miniature and rewire as follows: No. 1 on loctal to No. 1 on miniature 2 to 2 3 to 3 6 to 6 8 to 7  ORIG.  SUB.
	3Q4	P	Same as 1LA4 to 3Q4.
	3Q5	P	Same as 1LB4 to 1A5. Series circuits only.
	3S4	P	Same as 1LA4 to 3Q4.
1LB6	1LA6 1LC6	P P	Rewire as follows: No. 5 to No. 8 7 to 5
1LC5	1L4	G	Same as 1LG5 to 1L4.
	1LG5	G	No changes.
	1LN5	G	No changes.
	1N5 1P5	G G	Same as 1LN5 to 1N5.
	1S4	G	Parallel circuits only. Change socket to miniature and rewire as follows: No. 1 on loctal to No. 1 on miniature 2 to 2 3 to 4 4 to 1 6 to 3 8 to 7  ORIG.  SUB.

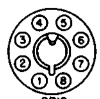
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
1LC5	1SA6	G	Change socket to octal and rewire as follows:


ORIG.

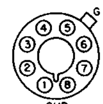
No. 1 on loctal	to No. 2 on octal
2	to 8
3	to 6
4	to 3
6	to 4
8	to 7


SUB.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	1T4	G	Same as 1LG5 to 1L4.
	1U4	G	Same as 1LG5 to 1L4.
1LC6	1A7	G	Change socket to octal and rewire as follows:

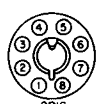

ORIG.

No. 1 on loctal	to No. 2 on octal
2	to 3
3	to 6
4	to 5
5	to 4
8	to 7
6	to cap

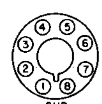


SUB.

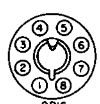
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	1B7	G	Reverse 1A7 to 1LA6 procedure. Parallel circuits only.
	1L6	G	Same as 1LA6 to 1U6.
	1LA6	E	No changes.
	1LB6	P	Same as 1LA6 to 1LB6.
	1R5	G	Same as 1LA6 to 1R5.
	1U6	G	Same as 1LA6 to 1U6. Parallel circuits only.
1LD5	1AF5	P	Parallel circuits only. Reverse 1AF5 to 1LD5 procedure.
	1N6	G	Change socket to octal and rewire as follows:


ORIG.

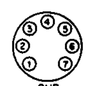
No. 1 on loctal	to No. 2 on octal
2	to 3
3	to 4
4	to 6
6	to 5
8	to 7


SUB.

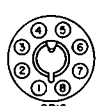
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	1S5	G	Change socket to miniature and rewire as follows:


ORIG.

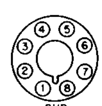
No. 1 on loctal	to No. 1 on miniature
2	to 5
3	to 4
4	to 3
6	to 6
8	to 7


SUB.

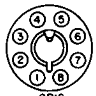
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	1SB6	G	Change socket to octal and rewire as follows:


ORIG.

No. 1 on loctal	to No. 2 on octal
2	to 3
3	to 4
4	to 5
6	to 8
8	to 7


SUB.

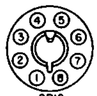
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
1LD5	1U5	G	Change socket to miniature and rewire as follows:


ORIG.

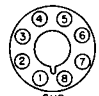
No. 1 on loctal	to No. 1 on miniature
2	to 2
3	to 3
4	to 4
6	to 6
8	to 7


SUB.

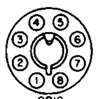
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
1LE3	1C3	G	Reverse 1C3 to 1LE3 procedure.
	1E4	G	Reverse 1E4 to 1LE3 procedure. Not a good oscillator.
	1G4	G	Change socket to octal and rewire as follows:


ORIG.

No. 1 on loctal	to No. 2 on octal
2	to 3
6	to 5
8	to 7


SUB.

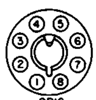
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	1H4	P	Reverse 1E4 to 1LE3 procedure. Not a good oscillator.
	1293	G	Parallel circuits only. No changes.
1LG5	1L4 1T4 1U4	G G G	Change socket to miniature and rewire as follows:


ORIG.

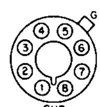
No. 1 on loctal	to No. 1 on miniature
2	to 2
3	to 3
4	to 5
6	to 6
8	to 7


SUB.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	1LC5	G	No changes.
1LH4	1H5	E	Change socket to octal and rewire as follows:


ORIG.

No. 1 on loctal	to No. 2 on octal
2	to 3
4	to 5
8	to 7
6	to cap

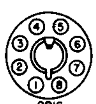


SUB

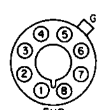
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	1S5	G	Make adaptor as follows:

No. 1 on base	to No. 1 on top
2	to 5 and 4
4	to 3
6	to 6
8	to 7

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
1LN5	1LC5	E	No changes.
	1N5 1P5	E G	Change socket to octal and rewire as follows:


ORIG.

No. 1 on loctal	to No. 2 on octal
2	to 3
3	to 4
8	to 7
6	to cap



SUB.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	1S4	G	Same as 1LC5 to 1S4. Parallel circuits only.

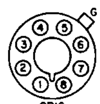
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
1LN5	1S5	P	Change socket to miniature and rewire as follows:


ORIG

Nos. 1 and 4 on loctal	to No. 1 on miniature
2	to 5
3	to 4
4	to 1
6	to 6
8 and 5	to 7

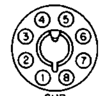

SUB.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	1SA6	G	Same as 1LC5 to 1SA6.
	3A8	P	Electric operation only. Same as 1LN5 to 1N5. Connect nothing to pins not used.
1N5	1D5	P	No changes. 1D5 rated 60 mils on 2 volts and pulls less than 50 on 1.4 volt.
	1LC5	G	Same as 1N5 to 1LN5.
	1LN5	E	Change socket to loctal and rewire as follows:

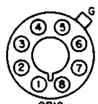

ORIG.

No. 2 on octal	to No. 1 on loctal
3	to 2
4	to 3
7	to 8
cap	to 6

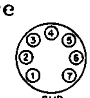
Short loctal terminals 4 and 5


SUB.

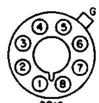
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	1P5	G	No changes.
	1S4	P	Parallel circuits only. Change socket to miniature and rewire as follows:


ORIG.

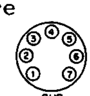
No. 2 on octal	to No. 1 on miniature
3	to 2
4	to 4
7	to 7
cap	to 3


SUB.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	1S5	G	Change socket to miniature and rewire as follows:


ORIG.

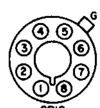
No. 2 on octal	to No. 1 on miniature
3	to 5
4	to 4
7	to 7
cap	to 6


SUB.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	1SA6	G	Make adaptor as follows:

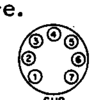
No. 2 on base	to No. 2 on top
3	to 8
4	to 6
7	to 7 and 3
cap	to 4

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	1T4	G	Change socket to miniature or make adaptor as follows:


ORIG.

No. 2 on octal	to No. 7 on miniature.
3	to 2
4	to 3
7	to 1
cap	to 6

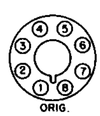
This substitution squeals in some cases, works best as r-f tube.

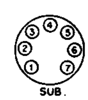

SUB.

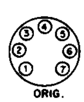
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	3A8	P	Electric operation only. Remove and tape up wire if any anchored on Nos. 5, 6 and 8.
1N6	1LD5	G	Reverse 1LD5 to 1N6 procedure.

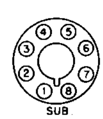
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
1N6	1SB6	G	Rewire as follows: No. 5 to No. 8 6 to 5
1P5	1N5	G	No changes.
	1S4	P	Parallel circuits only. Same as 1N5 to 1S4.
	1SA6	G	Same as 1N5 to 1SA6.
	1T4	G	Same as 1N5 to 1T4.
1Q5	1A5	G	Parallel circuits only. No changes.
	1C5	P	No changes. Bias different but tone reasonably good.
	3B5 3C5	P P	Move No. 7 to No. 8 and short No. 2 and 7 together.
	3Q4	P	Same as 1C5 to 3Q4.
	3Q5	P	Move No. 7 to No. 8 and short No. 2 and 7 together.
	3S4	P	Same as 1C5 to 3Q4.
1Q6	1S6 1T6	E E	Rewire as follows: No. 1 to No. 4 7 to 1 2 to 3
1R4/1294	1A3	P	Reverse 1A3 to 1R4/1294 procedure.
1R5	1A7	G	Where extra space permits. Reverse 1A7 to 1R5 procedure.
	1LA6 1LC6	G G	Where space permits. Reverse 1LA6 to 1R5 procedure.
1S4	1LC5 1LN5	G G	Where space permits. Parallel circuits only. Reverse 1LC5 to 1S4 procedure.
	1N5 1P5	G G	Where space permits. Parallel circuits only. Reverse 1N5 to 1S4 procedure.
	1S5	P	Parallel circuits only. Rewire as follows: Nos.2 and 6 to No. 5 3 to 6 5 to 1
	1L4 1T4 1U4	P P P	Parallel circuits only. Rewire as follows: No. 6 to No. 2 3 to 6 4 to 3

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
1S4	3E5	G	Parallel circuits only. Rewire as follows: No. 6 to No. 2 3 to 6 4 to 3 5 to 1 7 to 5 Connect 1 and 7 together.
1S5	1AF5	E	Parallel circuits only. No changes.
	1LD5	G	Where space permits. Reverse 1LD5 to 1S5 procedure.
	1SB6	G	Where space permits. Reverse 1SB6 to 1S5 procedure.
	1U5	E	Rewire as follows: No. 5 to No. 2 Reverse 3 and 4
1S6	1Q6	E	Rewire as follows: No. 3 to No. 2 1 to 7
	1T6	E	No changes.
1SA6	1L4	G	Reverse 1T4 to 1SA6 procedure
	1LC5 1LN5	G G	Reverse 1LC5 to 1SA6 procedure.
	1N5	G	Reverse 1N5 to 1SA6 procedure.
	1T4 1U4	G	Reverse 1T4 to 1SA6 procedure.
1SB6	1H5	G	Extend wire from No. 8 to cap.
	1LD5	G	Reverse 1LD5 to 1SB6 procedure.
	1S5	G	Change socket to miniature and rewire as follows: No. 2 on octal to No. 1 on miniature 3 to 5 4 to 4 5 to 3 7 to 7 8 to 6
1T4	1AF4	G	Parallel circuits only. No changes.
	1L4	G	No changes.
	1SA6	E	Where space permits. Change socket to octal and rewire as follows: No. 1 on miniature to No. 2 on octal 2 to 8 3 to 6 6 to 4 7 to 7 Connect Nos. 2 and 3 together.









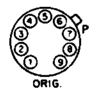
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
1T4	1U4	G	No changes.
1T5	1A5	G	No changes. 1T5 pulls 10 mils more but it works OK.
	1C5	G	Parallel circuits only. No changes.
	1D8	P	Remove and tape up wires if any anchored on No. 6 and 8. Parallel circuits only.
	1G4	P	No changes. Emergency works good in most cases.
	1LA4 1LB4	P P	Same as 1A5 to 1LA4
	1Q5	G	Parallel circuits only. No changes.
	1S4	G	Same as 3Q4 to 3S4 parallel circuits only except omit connection No. 8 on octal to No. 5 on miniature.
	3Q4 3S4	P P	Electric operation only. Same as 3Q5 to 3S4 but connect nothing to No. 5 on miniature.
1T6	1Q6	E	Rewire as follows: No. 3 to No. 2 1 to 7
	1S6	E	No changes.
1U4	1AF4	G	Parallel circuits only. No changes.
	1L4	G	No changes.
	1S5	G	Rewire as follows: No. 5 to No. 1 2 to 5 3 to 4
	1SA6	G	Where space permits. Same as 1T4 to 1SA6.
	1T4	G	No changes.
1U5	1S5	E	Rewire as follows: No. 2 to No. 5 Reverse 3 and 4
1U6	1L6	E	Parallel circuits only. No changes.
1V	6Z3	E	No changes.
	12Z3	G	No changes necessary. Series circuits only. Six volts added to the filament string makes no difference.
1V2			No practical substitute.
1V5	1AC5	E	No changes.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
1W4	1LA4	G	Where space permits. Reverse 1LB4 to 1W4 procedure.
	1LB4	G	
	3E5	G	Rewire as follows:

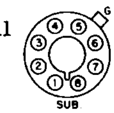
No. 7	to No. 5

Connect 1 and 7 together

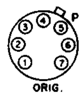
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
1W5	1V5	P	No changes.
1X2	1B3	G	Where space permits. Change socket to octal and rewire as follows:



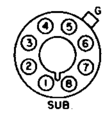
Nos. 1,3,4,6 on miniature	to	No. 2 on octal
2,5,7	to	7
cap	to	cap



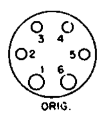
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
1Z2	1B3	G	Where space permits. Change socket to octal and rewire as follows:



Nos. 1,3,4,6 on miniature	to	No. 2 on octal
2,7,5	to	7
cap	to	cap



TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
2A3	45	G	No changes.
2A4G			No practical substitute.
2A5	47	G	Reverse 47 to 2A5 procedure.
	59	G	Change socket to seven prong and rewire as follows:



No. 1 on six prong	to No.	1 on seven prong
2	to	2
3	to	3
4	to	4
5	to	6
6	to	7

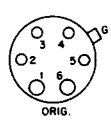
Short Nos. 5 and 6 together.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	1619	G	Parallel circuits only. Make adaptor as follows:

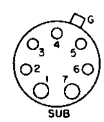
No. 1 on base	to No.	2 on top
2	to	3
3	to	4
4	to	5
5	to	8
6	to	7

There are or will be many used 1619 tubes available.

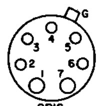
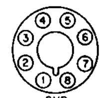
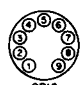
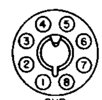
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
2A6	2B7	P	Change socket to seven prong and rewire as follows:



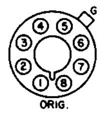
No. 1 on six prong	to No.	1 on seven prong
2	to	2 and 3
3	to	4
4	to	5
5	to	6
6	to	7
cap	to	cap



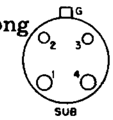
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	55	E	Parallel circuits only. No changes.
2A7	2A7S	E	No changes.
2B7	6B7	E	Heater voltage — current ratings differ.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
2B7S			No practical substitute.
2B25			No practical substitute.
2C4			No practical substitute.
2C21	6SN7	G	Change socket to octal and rewire as follows: No. 1 on seven prong to No. 8 on octal 2 to 3 3 to 2 4 to 4 5 to 5 6 to 6 7 to 7 cap to 1  ORIG.  SUB.
2C22	6AD5 6AF5 6C5 6J5 6P5	P P P P P	Rewire as follows: Connect grid cap to No. 5 Connect plate cap to No. 3
2C51	7F8	G	Where space permits. Change socket to loctal and rewire as follows: No. 1 on noval to No. 2 on loctal 2 to 4 3 to 1 4 to 3 6 to 6 7 to 8 8 to 5 9 to 7  ORIG.  SUB.
	5670	G	Parallel circuits only. No changes.
2C52	12SN7 12SX7	P P	No changes.
2D21			No practical substitute.
2E5	6E5	E	Heater voltage-current ratings differ.
	6T5	E	Same as above.
	6U5	E	Same as above.
2E26			No practical substitute.
2E30	5812	G	No changes.
2E31	2E32	E	No changes.
2E32	2E31	E	No changes.
2E35	2E36	E	No changes.
2E36	2E35	E	No changes.
2E41	2E42	E	No changes.
2E42	2E41	E	No changes.
2G5	6U5/6G5	E	Heater voltage-current ratings differ.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
2G21	2G22	E	No changes.
2G22	2G21	E	No changes.
2S/4S			No practical substitute.
2V3	2X2/879	P	Parallel circuits only. Change socket to four prong and rewire as follows:

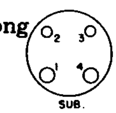


No. 2 on octal	to No. 1 on four prong
cap	to cap
7	to 4

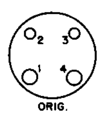


TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
2W3	2Z2/G84	E	Reverse 2Z2/G84 to 2W3 procedure.
	82	P	For half wave operation only. Change socket to four prong and rewire as follows:

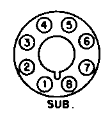
No. 2 on octal	to No. 1 on four prong
4	to 2 and 3
8	to 4



TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
2X2/879	2V3	P	Reverse 2V3 to 2X2/879 procedure. Examine power transformer and determine whether it will handle additional filament current.
2Y2			No practical substitute.
2Z2/G84	2W3	E	Change socket to octal and rewire as follows:



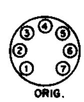
No. 1 on four prong	to No. 2 on octal
2	to 4
4	to 8



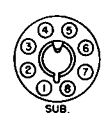
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
3A4	3Q4 3S4	P P	Parallel circuits only. Rewire as follows: Reverse connections on terminals 3 and 4.
	3V4	P	Parallel circuits only. Rewire as follows:

No. 6	to No. 2
4	to 6

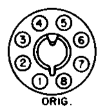
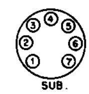
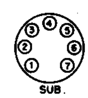
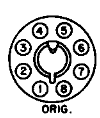
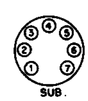
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
3A5	3C6	P	Parallel circuits only. Change socket to loctal and rewire as follows:



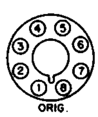
No. 1 on miniature	to No. 1 on loctal
2	to 3
3	to 4
4	to 7
5	to 5
6	to 6
7	to 8

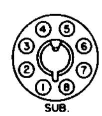


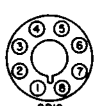
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
3A8GT			No practical substitute.
3B4			No practical substitute.
3B5	3C5	E	No changes.
	3LE4 3LF4	E E	Same as 3Q5 to 3LF4.

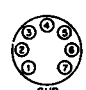
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
3B5	3Q5	E	No changes.
	3S4	G	Same as 3Q5 to 3S4 except omit connection of No. 8 on octal to No. 5 on miniature.
3B7	1291	E	No changes.
3B7/1291	3A5	P	Change socket to miniature and rewire as follows: No. 1 on loctal to No. 1 on miniature 2 to 2 3 to 3 4 to 4 6 to 5 7 to 6 8 to 7  
	3C6	P	Parallel circuits only. Rewire as follows: No. 6 to No. 5 7 to 6 4 to 7 3 to 4 2 to 3
3C5	3B5 3Q5	E E	No changes.
	3LE4 3LF4	E E	Same as 3Q5 to 3LF4
3C6	3A5	P	Parallel circuits only. Reverse 3A5 to 3C6 procedure.
	3B7/1291	G	Parallel circuits only. Reverse 3B7/1291 to 3C6 procedure.
3D6/1299	3LF4	G	Parallel circuits only. No changes.
	3S4	G	Parallel circuits only. Change socket to miniature and rewire as follows: No. 1 on loctal to No. 1 on miniature 2 to 2 3 to 4 6 to 3 7 to 5 8 to 7  
	3Q5	E	Parallel circuits only. Reverse 3C5 to 3LE4 procedure.
	3V4	G	Parallel circuits only. Change socket to miniature and rewire as follows: No. 1 on loctal to No. 1 on miniature 2 to 2 3 to 3 6 to 6 7 to 5 8 to 7  
3E5	3S4	G	Parallel circuits only. Rewire as follows: No. 3 to No. 4 6 to 3
	3V4	G	Parallel circuits only. No changes.
3E6			No practical substitute.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
3LE4	3LF4	E	No changes.
	3V4	G	Same as 3D6/1299 to 3V4.
3LF4	3D6/1299	G	Parallel circuits only. No changes.
	3V4	G	Same as 3D6/1299 to 3V4.
3Q4	3A4	P	Parallel circuits only. Rewire as follows: Reverse No. 3 and No. 4
	3D6/1299	G	Parallel circuits only. Reverse 3D6/1299 to 3Q4 procedure.
	3E5	G	Parallel circuits only. Rewire as follows: No. 6 to No. 2 3 to 6 4 to 3
	3LE4 3LF4	G G	Reverse 3D6/1299 to 3Q4 procedure.
	3S4	G	No changes.
	3V4	G	Rewire as follows: No. 6 to No. 2 3 to 6 4 to 3
3Q5	1A5 1G4	P P	No changes. For electric operation only. Battery operation requires resistor 25 to 30 ohms in one of the A leads.
	1LA4 1LB4	P P	Electric operation only. Same as 1A5 to 1LB4.
	1T4	P	Same as 1A5 to 1T4. Electric operation only. Emergency substitution.
	1T5	P	No changes. Electric operation only.
	3B5	E	No changes.
	3C5	E	No changes.
	3LF4 3LE4	E E	Change socket to loctal and rewire as follows: No. 2 on octal to No. 1 on loctal 3 to 2 4 to 3 5 to 6 7 to 8 8 to 7
	3Q4 3S4	G G	Change socket to miniature and rewire as follows: No. 2 on octal to No. 1 on miniature 3 to 2 4 to 4 5 to 3 7 to 7 8 to 5

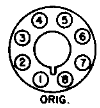




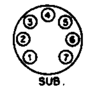




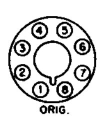
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
3Q5	3V4	G	Change socket to miniature and rewire as follows:



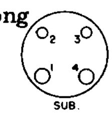
No. 2 on octal	to No. 1 on miniature
3	to 2
4	to 3
5	to 6
7	to 7
8	to 5



TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
3S4	3E5	G	Parallel circuits only. Same as 3Q4 to 3E5.
	3Q4	G	No changes.
	3V4	G	Same as 3Q4 to 3V4.
3V4	3A4	P	Parallel circuits only. Reverse 3A4 to 3V4 procedure.
	3E5	G	Parallel circuits only. No changes.
	3Q4	G	Reverse 3Q4 to 3V4 procedure.
	3S4	G	
4A6			No practical substitute.
5A6			No practical substitute.
5AX4	5AZ4	G	No changes.
	5U4	G	
	5V4	G	
	5W4	G	
	5Y3	G	
	5Z4	G	
5AZ4	5AX4	G	No changes.
	5U4	G	
	5V4	G	
	5W4	G	
	5Y3	G	
	5Z4	G	
5R4GY	5T4	G	No changes. Use only where inverse peak voltage does not exceed 450 volts per plate.
	5U4	G	
	5V4	P	
	5Y3	P	
	5Z4	P	
	5X4	G	Same as 5T4 to 5Y4
	5Y4	P	
	5Z3	G	Where inverse peak voltage per plate does not exceed 450 volts. Change socket to four prong and rewire as follows:
	80	P	
	83	G	
	83V	G	

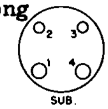
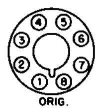
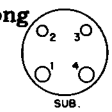
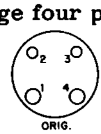
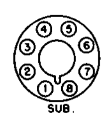


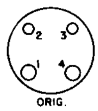
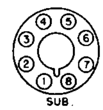
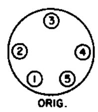
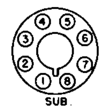
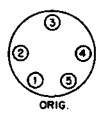
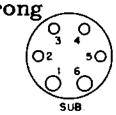
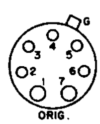
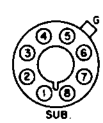
No. 2 on octal	to No. 1 on four prong
4	to 2
6	to 3
8	to 4



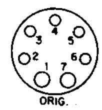
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
5T4	5AX4	G	No changes.
	5AZ4	G	
	5U4	G	
	5V4	G	
	5W4	G	
	5Y3	G	
	5Z4	G	

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
5T4	5Y4	G	Make adaptor as follows: No. 1 on base to No. 1 on top 2 to 8 4 to 3 6 to 5 8 to 7
5U4	5AX4	G	No changes.
	5AZ4	G	
	5T4	G	
	5V4	G	
	5W4	G	
	5Y3	G	
	5Z4	G	
	5Y4	G	Same as 5T4 to 5Y4.
	5Z3	E	Same as 5R4GY to 5Z3.
	80	G	
	83	G	
	83V	G	
5V4	5AX4	G	No changes.
	5AZ4	G	
	5T4	G	
	5U4	G	
	5W4	G	
	5Y3	G	
	5Z4	G	
	5Y4	G	Same as 5T4 to 5Y4.
	5Z3	G	Same as 5R4GY to 5Z3.
	80	G	
	83	G	
	83V	G	
5W4	5AX4	G	No changes.
	5AZ4	G	
	5T4	G	
	5U4	G	
	5V4	G	
	5Y3	G	
	5Z4	G	
	5Y4	G	Same as 5T4 to 5Y4.
	5Z3	G	Same as 5R4GY to 5Z3.
	80	G	
	83	G	
	83V	G	
5X3	5Z3	G	No changes.
	80	G	
	83	G	
	83V	G	
	1275	G	
5X4	5T4	G	Rewire as follows:
	5U4	G	
	5V4	G	No. 7 to No. 2
	5Y3	G	3 to 4
	5Z4	G	5 to 6

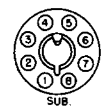
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
5X4	5Y4	G	No changes.
	5Z3	G	Change octal to four prong socket and rewire as follows:
	80	P	 No. 3 on octal to No. 2 on four prong 
	83	G	5 to 3
	83V	G	7 to 1
			8 to 4
5Y3	5AX4	G	No changes.
	5AZ4	G	
	5T4	G	
	5U4	G	
	5V4	G	
	5W4	G	
	5Z4	G	
	5Y4	E	Same as 5T4 to 5Y4.
	5Z3	G	Change socket to four prong and rewire as follows:
	80	E	 No. 2 on octal to No. 1 on four prong 
	83	G	4 to 2
	83V	G	6 to 3
			8 to 4
5Y4	5T4	G	Same as 5X4 to 5T4.
	5U4	G	
	5V4	G	
	5W4	E	
	5Y3	E	
	5X4	G	No changes.
	5Z3	G	Same as 5X4 to 5Z3.
	80	E	
	83	G	
	83V	G	
5Z3	5AX4	G	Same as 80 to 5U4.
	5AZ4	G	
	5T4	G	
	5U4	E	
	5V4	G	
	5W4	G	
	5Z4	G	
	5X3	E	No changes.
	80	G	
	83	G	
	83V	G	
	1275	G	
	5X4	E	Change four prong to octal socket and rewire as follows:
			 No. 1 on four prong to No. 7 on octal 
			2 to 3
			3 to 5
			4 to 8

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
5Z4	5AX4	G	No changes.
	5AZ4	G	
	5T4	G	
	5U4	G	
	5V4	G	
	5W4	G	
	5Y3	G	
	5Y4	G	Same as 5T4 to 5Y4.
6A3	6A5	E	Same as 6A3 to 6B4. No. 8 is cathode and filament tap.
	6B4	E	Change socket to octal and rewire as follows:  No. 1 on four prong to No. 2 on octal 2 to 3 3 to 5 4 to 7 
6A4	52	G	No changes.
6A4/LA	6F6	G	Parallel circuits only. Change socket to octal and rewire as follows:  No. 1 on five prong to No. 2 on octal 2 to 3 3 to 5 4 to 4 5 to 7 and 8 
	6G6	G	
	6K6	G	
	6U6	G	
	6V6	G	
	41	G	Parallel circuits only. Change socket to six prong and rewire as follows:  No. 1 on five prong to No. 1 on six prong 2 to 2 3 to 4 4 to 3 5 to 5 and 6 
	42	G	
6A5	6A3	E	Reverse 6A3 to 6B4 procedure.
	6B4	E	Connect a 20 ohm resistor from No. 2 to No. 8. Connect a 20 ohm resistor from No. 7 to No. 8.
6A6	6E6	G	Parallel circuits only. No changes.
	6N7	G	Reverse 6N7 to 6A6 procedure.
	79	G	Reverse 79 to 6A6 procedure.
6A7	6A8	E	Change socket to octal and rewire as follows:  No. 1 on seven prong to No. 2 on octal 2 to 3 3 to 4 4 to 6 5 to 5 6 to 8 7 to 7 cap to cap 
	6J8	E	
	6K8	E	
	6D8	E	Same as 6A7 to 6A8. Parallel circuits only.

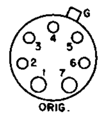
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6A7	7A8	E	Change socket to loctal and rewire as follows:
	7B8	E	
	7J8	E	
	7S7	E	



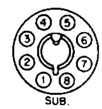
No. 1 on seven prong	to No. 1 on loctal
2	to 2
3	to 5
4	to 3
5	to 4
6	to 7
7	to 8



TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	7Q7	G	Change socket to loctal and rewire as follows:

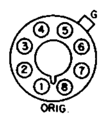


No. 1 on seven prong	to No. 1 on loctal
2	to 2
4	to 3
5	to 4
6	to 7 and 5
7	to 8
cap	to 6

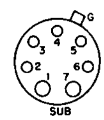


Must be well shielded.

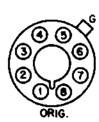
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6A8	6A7	E	Change socket to seven prong and rewire as follows:



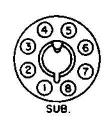
No. 2 on octal	to No. 1 on seven prong
3	to 2
4	to 3
5	to 5
6	to 4
7	to 7
8	to 6
cap	to cap



TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	6D8	E	Parallel circuits only. No changes.
	6J8	E	No changes.
	6K8	E	
	7A8	G	Same as 6D8 to 7A8 but in parallel circuit only.
	7B8	G	Same as 6D8 to 7A8
	7J7	G	Same as 6J8 to 7J7
	7Q7	G	Change socket to loctal and rewire as follows:



No. 2 on octal	to No. 1 on loctal
3	to 2
5	to 4
6	to 3
7	to 8
8	to 7 and 5
cap	to 6

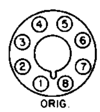
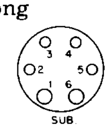
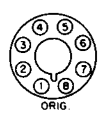
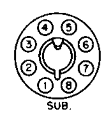
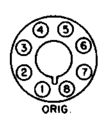
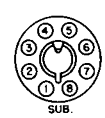


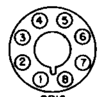
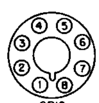
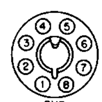
Must be well shielded. Realign if necessary.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6AB4	6C4	G	Remove and tape up any wires anchored on No. 5.
	6J4	P	Parallel circuits only. Rewire as follows:

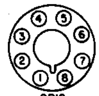
No. 7	to No. 2
1	to 7

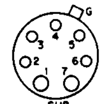
Do not use blank connections on socket.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6AB4	6N4	P	Parallel circuits only. Rewire as follows:
			Reverse No. 6 and No. 7
			Connect No. 1 to No. 5
			Remove and tape any wires connected to unused pins.
	9002	P	Rewire as follows:
			Remove and tape up any wires anchored on pins No. 2 and No. 5
6AB5/6N5	6E5	P	Parallel circuits only. No changes.
	6U5/6G5	P	Parallel circuits only. No changes.
6AB6	6AC6	G	Parallel circuits only. No changes.
	6B5	G	Change socket to six prong and rewire as follows:
			 No. 2 on octal to No. 1 on six prong 
			3 to 2
			4 to 3
			5 to 4
			7 to 6
			8 to 5
	6N6	G	No changes.
6AB7/1853	6AC7/1852	G	No changes.
	6AJ7	G	No changes.
	6SD7	G	Parallel circuits only. No changes.
	6SE7	G	
	6SJ7	G	
	6SK7	G	
	6SS7	G	
	5693	G	
	7V7	G	Change socket to loctal and rewire as follows:
			 No. 2 on octal to No. 1 on loctal 
			3 to 4
			4 to 6
			5 to 7
			6 to 3
			7 to 8
			8 to 2
	7W7	G	Change socket to loctal and rewire as follows:
			 No. 2 on octal to No. 1 on loctal 
			3 to 5
			4 to 6
			5 to 4 or 7
			6 to 3
			7 to 8
			8 to 2
6AC5G	6AC5GT	E	No changes.
	6AC5GT/G	E	

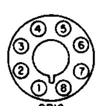
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6AC5GT	6AC5G	E	No changes.
	6AC5GT/G	E	
6AC6	6AB6	G	Parallel circuits only. No changes.
6AC7	7W7	G	Same as 6AB7/1853 to 7W7.
6AC7/1852	6AB7/1853	G	No changes.
	6AH6	G	Change socket to miniature and rewire as follows:  ORIG. No. 2 on octal to No. 3 on miniature 3 to 2 4 to 1 5 to 7 6 to 6 7 to 4 8 to 5  SUB.
	6AJ7	G	No changes.
	6SD7	G	Parallel circuits only. No changes.
	6SE7	G	
	6SJ7	G	
	6SK7	G	
	6SS7	G	
	5693	G	
	7V7	G	Same as 6AB7/1853 to 7V7.
6AD4	6K4	G	No changes.
6AD5	6AE5	G	No changes.
	6AF5	G	
	6C5	G	
	6J5	G	
	6P5	G	
	6F5	E	Rewire as follows: Remove wires from No. 3 and connect to No. 4. Connect grid lead to No. 5. This pin may be used for anchor. Extend to grid cap.
	6K5	G	Rewire as follows: Connect terminal No. 5 to grid cap. This terminal may be used as an anchor.
	7B4	G	Change socket to loctal and rewire as follows:  ORIG No. 2 on octal to No. 1 on loctal 3 to 2 5 to 6 7 to 8 8 to 7  SUB.
6AD6	6AF6	G	No changes.

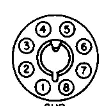
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6AD7	6F7	G	Parallel circuits only. Change socket to seven prong and rewire as follows: No. 1 on octal to No. 5 on seven prong 2 to 1 3 to 2 4 to 3 5 to cap 6 to 4 7 to 7 8 to 6
	6P7	G	Parallel circuits only. Remove wires from No. 5 and extend to grid cap. Rewire as follows: No. 4 to No. 5 3 to 4 7 to 3 1 to 7
6AE5	6AD5 6AF5 6C5 6J5 6P5		No changes.
6AE6	6AH7	G	Parallel circuits only. Rewire as follows: Remove and tape up any wires on No. 1 No. 8 to No. 4 2 to 8 4 to 6 Connect No. 4 and No. 2 together Connect No. 1 and No. 5 together
	6N7	P	Parallel circuits only. Rewire as follows: No. 4 to No. 6 Connect No. 4 and No. 5 together.
6AF5	6AD5 6AE5 6C5 6J5 6P5	G G G G G	No changes.
6AF6	6AD6	G	No changes.
6AF7			No practical substitute.
6AG5	6AJ5	P	Parallel circuits only. No changes.
	6AK5	G	Parallel circuits only. No changes.
	6AU6	G	No changes.
	6BC5	G	No changes.
	5590 5591 9001 9003	G G G G	Parallel circuits only. No changes.
6AG6G			No practical substitute.


ORIG.

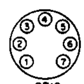
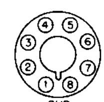

SUB

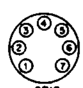
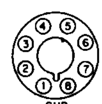
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6AG7	6AK7	E	No changes.
6AH5	6AL6	G	Rewire as follows: No. 4 to cap 1 to 4 6 to 5
	6L6	G	Rewire as follows: No. 4 to No. 3 1 to 4 6 to 5
6AH6 *	6AJ5	P	Parallel circuits only. No changes.
	6AK5	P	
	6AS6	P	Parallel circuits only. Rewire as follows: Reverse No. 2 and No. 7
	6AU6	P	Parallel circuits only. No changes.
	6BC5	G	Parallel circuits only. No changes.
	6BD6	P	Parallel circuits only. No changes.
	EF50	P	Parallel circuits only. Reverse EF50 to 6BA6 procedure.
6AH7	6AE6	G	Parallel circuits only. Reverse 6AE6 to 6AH7 procedure.
	6C8	G	Rewire as follows: Connect wire from No. 1 to grid cap. Remove wires from No. 2 No. 8 to No. 2 4 to 8 Connect wires removed from No. 2 to No. 4.
	6SN7	P	Parallel circuits only. Rewire as follows: Reverse No. 2 and No. 3 Remove wires from No. 4 No. 5 to No. 4 6 to 5 Connect wires removed from No. 4 to No. 6.
	7N7	P	Parallel circuits only. Change socket to loctal and rewire as follows: No. 1 on octal to No. 4 on loctal 2 to 2 3 to 3 4 to 7 5 to 5 6 to 6 7 to 8 8 to 1
6AJ5	6AG5	P	Parallel circuits only. No changes.
	6AK5	P	No changes.
	6AU6	P	Parallel circuits only. No changes.


ORIG.


SUB.

* See Addendum at back of this section.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6AJ7	6AB7/1853 6AC7/1852	G G	No changes.
	6SD7 6SE7 6SJ7 6SK7 6SS7 5693	G G G G G G	Parallel circuits only. No changes.
6AK5	6AG5	G	Parallel circuits only. No changes.
	6AH6	G	Parallel circuits only. Connect No. 2 and No. 7 together.
	6AJ5	P	No changes.
	6AU6	P	Parallel circuits only. No changes.
6AK6	6AR5	G	Parallel circuits only. Rewire as follows: Connect No. 2 and No. 7 together
6AK7	6AG7	E	No changes.
6AL5	6H6	G	Where space permits. Change socket to octal and rewire as follows: No. 1 on miniature to No. 8 on octal 2 to 3 3 to 2 4 to 7 5 to 4 7 to 5  ORIG.  SUB.
6AL6	6AH5	G	Reverse 6AH5 to 6AL6 procedure.
	6L6	E	Rewire as follows: cap to No. 3
6AL7			No practical substitute.
6AM5	6AQ5	P	Parallel circuits only. No. 7 to No. 6
	6AR5	P	Parallel circuits only. Rewire as follows: No. 7 to No. 6
6AM6	6AH6 6AK6	G G	Parallel circuits only. Same as 6AM6 to 6AU6.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6AM6	6AU6 6BA6 6BD6	G G G	Rewire as follows: Remove wires from No. 2 No. 6 to No. 2 7 to 6 Connect wires removed from No. 2 to No. 7.
6AN5	6AQ5	G	Rewire as follows; No. 7 to No. 2
6AN6			No practical substitute.
6AN7			No practical substitute.
6AQ5	6AM5	P	Parallel circuits only. Rewire as follows: No. 7 to No. 1 6 to 7
	6AN5	G	Parallel circuits only. Rewire as follows: No. 7 to No. 1
	6AR5	G	Rewire as follows: No. 7 to No. 1
	6AS5	G	Parallel circuits only. Reverse 6AS5 to 6AQ5 procedure.
	6BF5	P	Parallel circuits only. No changes.
	6V6	G	Where space permits. Change socket to octal and rewire as follows: No. 1 on miniature to No. 5 on octal 2 to 8 3 to 2 4 to 7 5 to 3 6 to 4 7 to 5  ORIG.  SUB
6AQ6	6BD7	G	Parallel circuits only. Reverse 6BD7 to 6AQ6 procedure.
	6AT6 6AV6 6BF6 6BK6 6BT6 6BU6	G G G G G G	Parallel circuits only. No changes.
6AQ7	6AW7	G	Rewire as follows: Remove wires from No. 1 No. 2 to No. 1 4 to 2 Connect wires removed from No. 1 to No. 4. Remove wires from No. 3 No. 5 to No. 3 6 to 5 Connect wires removed from No. 3 to No. 6.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6AR5	6AK6	G	Parallel circuits only. Rewire as follows: Connect No. 2 to No. 7 together.
	6AM5	P	Parallel circuits only. Rewire as follows: No. 6 to No. 7
	6AQ5	G	Parallel circuits only. No changes. Any wires connected to terminal No. 7 must be removed and taped up.
	6AS5	G	Parallel circuits only. Reverse 6AS5 to 6AR5 procedure.
6AR6	6F6	G	Parallel circuits only. Rewire as follows: No. 8 to No. 2 1 to 8 5 to 4 7 to 5 6 to 7
	6G6	G	
	6K6	G	
	6L6	G	
	6U6	G	
	6V6	G	
	6W6	G	
	6Y6	G	
	5824	G	
6AR7			No practical substitute.
6AS5	6AN5	G	Parallel circuits only. Rewire as follows: Reverse No. 1 and No. 2 5 to 1 7 to 5
	6AQ5	G	Parallel circuits only. Rewire as follows: Reverse No. 1 and No. 2 5 and 7
	6AR5	G	Parallel circuits only. Rewire as follows: Reverse No. 1 and No. 2 5 to 1 7 to 5
6AS6	6AH6	P	Parallel circuits only. Rewire as follows: Reverse No. 2 and No. 7
	6BH6	G	Parallel circuits only. No changes.
	6BJ6	G	
	6CB6	G	
6AS7G			No practical substitute.
6AT6	6AQ6	G	Parallel circuits only. No changes.

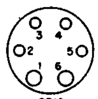
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6AT6	6AV6	G	No changes.
	6BF6	G	
	6BK6	G	
	6BT6	G	
	6BU6	G	
	6BD7	G	Parallel circuits only. Reverse 6BD7 to 6AQ6 procedure.
6AU5	6AV5	G	Parallel circuits only. No changes.
	6BD5	G	
6AU6 *	6AG5	P	No changes.
	6AJ5	P	Parallel circuits only. No changes.
	6AK5	P	
	6BA6	G	No changes.
	6BH6	G	Parallel circuits only. Rewire as follows: Reverse No. 2 and No. 7
	EF50	G	Reverse EF50 to 6BA6 procedure.
6AV5	6AU5	G	No changes.
	6BD5	G	
	6BQ6	G	Parallel circuits only. Reverse 6BQ6 to 6BD5 procedure.
6AV6	6AQ6	G	Parallel circuits only. No changes.
	6AT6	G	No changes.
6AW7	6AQ7	G	Reverse 6AQ7 to 6AW7 procedure.
6AX5	6AX6	E	Parallel circuits only. Tie Nos. 4 and 8 together.
	6BY5	E	Parallel circuits only. Rewire as follows: Connect Nos. 1 and 8 together; also Nos. 3 and 4.
	6W5	G	Parallel circuits only. No changes.
	6X5	G	
	6ZY5	G	
	1274	G	
6AX6	6AX5	G	Can be used only where No. 4 and No. 8 in 6AX6 are connected together without change.
	6W5	G	
	6X5	G	
	6ZY5	G	
	1274	G	

* See Addendum at back of this section.

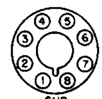
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6AX6	6BY5	E	Parallel circuits only. Rewire as follows:

No. 4 to No. 1
3 to 4

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6B4	6A3	G	Reverse 6A3 to 6B4 procedure.
	6A5	E	No changes but remove any wires anchored on No. 8.
6B5	6AB6	E	Same as 6B5 to 6N6. Parallel circuits only.
	6N6	E	Change socket to octal and rewire as follows:


ORIG.

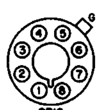
No. 1 on six prong to No. 2 on octal
2 to 3
3 to 4
4 to 5
5 to 8
6 to 7


SUB.

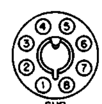
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	42	P	No changes.
6B6	6Q7	E	No changes.
	6SQ7	E	Make adaptor as follows:

No. 1 on base to No. 1 on top
2 to 8
3 to 6
4 to 4
5 to 5
7 to 7
8 to 3
Extend No. 2 on top to grid connection.

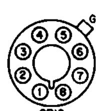
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	6T7	E	Parallel circuits only. No changes.
	7B6	G	Change socket to loctal and rewire as follows:


ORIG.

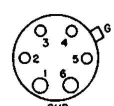
No. 2 on octal to No. 1 on loctal
3 to 2
4 to 5
5 to 6
7 to 8
8 to 4 or 7
cap to 3


SUB.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	7C6	E	Same as 6B6 to 7B6. Parallel circuits only.
	75	E	Change socket to six prong and rewire as follows:

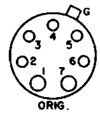

ORIG.

No. 2 on octal to No. 1 on six prong
3 to 2
4 to 3
5 to 4
7 to 6
8 to 5
cap to cap

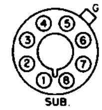

SUB.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6B7	2B7	E	Heater voltage-current ratings differ.

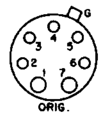
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6B7	6B8	E	Change socket to octal and rewire as follows:



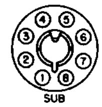
No. 1 on seven prong	to No.	2 on octal
2	to	3
3	to	6
4	to	4
5	to	5
6	to	8
7	to	7
cap	to	cap



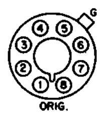
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	7E7	G	Change socket to loctal and rewire as follows:



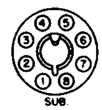
No. 1 on seven prong	to No.	1 on loctal
2	to	2
3	to	5
4	to	3
5	to	4
6	to	7
7	to	8
cap	to	6



TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6B8	6B7	E	Reverse 6B7 to 6B8 procedure.
	7E7	G	Change socket to loctal and rewire as follows:

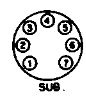


No. 2 on octal	to No.	1 on loctal
3	to	2
4	to	3
5	to	4
6	to	5
7	to	8
8	to	7
cap	to	6

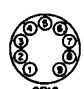


TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6BA5	6BH6	P	Change to miniature and connect as follows:
	6BJ6	P	

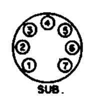
	No. 1 on 6BA5 base	to No.	5 on miniature
The 6BA5 base	2	to	2
numbers 1 to 6	3	to	1
clockwise; an	4	to	3 and 7
arrow indicates	5	to	6
plate lead No. 1.	6	to	4



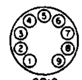
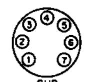
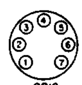
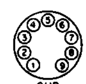
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6BA6	6AU6	G	No changes.
	6BD6	G	
	EF50	G	Reverse EF50 to 6BA6 procedure.
6BA7	6BE6	G	Change socket to miniature and rewire as follows:



No. 1 on noval	to No.	6 on miniature
2	to	1
3	to	2
4	to	3
5	to	4
6	to	2
7	to	7
9	to	5



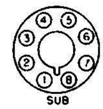
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6BC5	6AG5	P	No changes.
	6AJ5	P	Parallel circuits only. No changes.
	6AK5	P	
	9001	P	
	9003	P	

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6BC7			No practical substitute.
6BD5	6AU5 6AV5	P P	Parallel circuits only. No changes.
	6BQ6	G	Parallel circuits only. Reverse 6BQ6 to 6BD5 procedure.
6BD6	6AH6	P	Parallel circuits only. No changes.
	EF50	G	Reverse EF50 to 6BA6 procedure.
6BD7	6AQ6 6AT6 6BF6 6BT6 6BU6	G G G G G	Parallel circuits only. Change socket to miniature and rewire as follows: No. 1 on noval to No. 7 on miniature 2 to 1 3 to 2 4 to 3 5 to 4 6 to 5 8 to 6  ORIG.  SUB.
6BE6	6BA7	G	Change socket to nine pin noval and rewire as follows: No. 1 on miniature to No. 2 on noval 2 to 3 3 to 4 4 to 5 5 to 9 6 to 1 7 to 7  ORIG.  SUB.
	5915	G	No changes.
6BF5	6AQ5	P	Parallel circuits only. No changes.
	6AR5	P	Parallel circuits only. Short No. 7 to No. 1.
6BF6	6BD7	G	Parallel circuits only. Reverse 6BD7 to 6AQ6 procedure.
	6BU6	G	No changes.
6BF7	6BG7	E	
6BG6	6BQ6	P	Parallel circuits only. Rewire as follows: No. 8 to No. 4 3 to 8
	6CD6	P	Parallel circuits only. No changes. Sometimes it is necessary to increase wattage rating of screen resistor.
6BG7	6BF7	E	No changes.
6BH6	6BJ6	G	No changes.
	6AS6 6BC5 6CB6	G P G	Parallel circuits only. No changes.
6BJ6	6AS6 6BC5 6CB6	G P G	Parallel circuits only. No changes.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6BJ6	6BH6	G	No changes.
6BK6	6AT6	G	No changes.
	6AV6	G	
	6BF6	G	
	6BT6	G	
	6BU6	G	
6BN6			No practical substitute.
6BQ6	6AV5	G	Parallel circuits only. Rewire as follows: No. 5 to No. 1 8 to 3 cap to 5 4 to 8
	6BD5	G	
	6BG6	P	Parallel circuits only. Rewire as follows: No. 8 to No. 3 4 to 8
	6CD6	P	Where extra filament current is available. Parallel circuits only. Rewire as follows: No. 8 to No. 3 4 to 8
6BT6	6AQ6	G	Parallel circuits only. No changes.
	6BD7	G	Parallel circuits only. Reverse 6BD7 to 6AQ6 procedure.
	6BK6	G	No changes.
6BU6	6BD7	G	Parallel circuits only. Reverse 6BD7 to 6AQ6 procedure.
	6BF6	G	No changes.
6BY5	6AX5	G	Parallel circuits only. Where No. 1 and No. 8 are connected together, change connections as follows: No. 4 to No. 3
	6W5	G	
	6X5	G	
	6ZY5	G	
	1274	G	
6C4	6AB4	G	Rewire as follows: Connect No. 5 to No. 1
	6J4	P	Parallel circuits only. Rewire as follows: No. 7 to No. 2 1 to 7 5 to 7

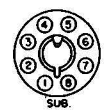
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6C4	6AD5	P	Parallel circuits only. Where space permits, change socket to octal and rewire as follows:
	6AE5	P	
	6AF5	P	
	6C5	P	
	6J5	P	
	6P5	P	

No. 1 on miniature	to No. 3 on octal
3	to 2
4	to 7
5	to 3
6	to 5
7	to 8



TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	6L5	P	Where space permits. Same as 6C4 to 6AD5.
	6N4	P	Parallel circuits only. Rewire as follows: No. 1 to No. 5. Reverse No. 6 and No. 7.
	7A4	G	Parallel circuits only. Where space permits. Change socket to loctal and rewire as follows:
	7B4	P	

No. 1 on miniature	to No. 2 on loctal
3	to 1
4	to 8
5	to 2
6	to 6
7	to 7

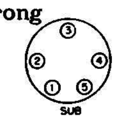


TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	9002	P	No changes.
6C5	6AD5	G	No changes.
	6AE5	G	
	6AF5	G	
	6C4	G	Reverse 6C4 to 6AD5 procedure.
	6F5	G	Make adaptor as follows:

No. 1 on base	to No. 1 on top
2	to 2
3	to 4
5	to cap
7	to 7
8	to 8

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	6J5	G	No changes.
	6P5	G	
	7A4	G	Same as 6J5 to 7A4.
	7B4	G	Same as 6J5 to 7A4
	37	G	Change socket to five prong and rewire as follows:
	76	G	

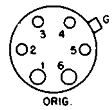
No. 2 on octal	to No. 1 on five prong
3	to 2
5	to 3
7	to 5
8	to 4



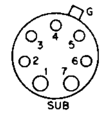
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6C6*	6D6	G	No changes.

* See Addendum at back of this section.

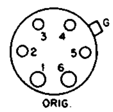
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6C6	6D7	G	Change socket to seven prong and rewire as follows:
	6E7	G	



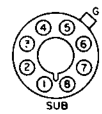
No. 1 on six prong	to No.	1 on seven prong
2	to	2
3	to	3
4	to	4
5	to	6
6	to	7
cap	to	cap



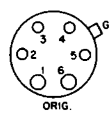
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	6J7	E	Change socket to octal and rewire as follows:
	6K7	G	
	6U7	G	



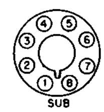
No. 1 on six prong	to No.	2 on octal
2	to	3
3	to	4
4	to	5
5	to	8
6	to	7
cap	to	cap



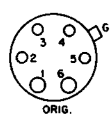
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	6S7	G	Same as 6C6 to 6J7. Parallel circuits only.
	6SJ7	E	Change socket to octal and rewire as follows:
	6SK7	G	



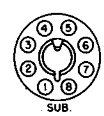
No. 1 on six prong	to No.	2 on octal
2	to	8
3	to	6
4	to	3
5	to	5
6	to	7
cap	to	4



TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	6W7	G	Same as 6C6 to 6J7. Parallel circuits only.
	7A7	G	Change socket to loctal and rewire as follows:



No. 1 on six prong	to No.	1 on loctal
2	to	2
3	to	3
4	to	4
5	to	7
6	to	8
cap	to	6

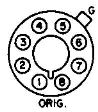


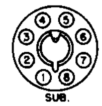
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	7B7	G	Same as 6C6 to 7A7. Parallel circuits only.
	7C7	G	
	77	E	No changes.
	78	E	
	1221	E	
6C7	6Q7	G	Make adaptor as follows:
	6R7	G	

No. 1 on base	to No.	2 on top
2	to	3
4	to	4
5	to	5
6	to	8
7	to	7

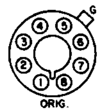
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	6T7	G	Same as 6C7 to 6Q7. Parallel circuits only.
6C8	6F8	G	Parallel circuits only. No changes.

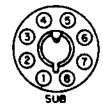
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6C8	7F7	G	Change socket to loctal and rewire as follows:
			No. 2 on octal to No. 1 on loctal
			3 to 3
			4 to 2
			5 to 5
			6 to 6
			7 to 8
			8 to 7
			cap to 4
6CB6	6AS6	P	Parallel circuits only. No changes.
	6BH6	P	
	6BJ6	P	
6CD6	6BG6	G	Parallel circuits only. No changes.
	6BQ6	P	Parallel circuits only. Rewire as follows:
			No. 8 to No. 4
			3 to 8
6D4			No practical substitute.
6D6	6C6	G	No changes.
	6D7	G	Same as 6C6 to 6D7.
	6E7	G	Same as 6C6 to 6D7.
	6J7	G	Same as 6C6 to 6J7.
	6K7	E	
	6S7	G	Same as 6C6 to 6J7. Parallel circuits only.
	6SJ7	G	Same as 6C6 to 6SJ7.
	6SK7	E	
	6U7	G	Same as 6C6 to 6J7.
	6W7	G	Same as 6C6 to 6J7. Parallel circuits only.
	7A7	E	Same as 6C6 to 7A7.
	7B7	G	Same as 6C6 to 7A7. Parallel circuits only.
	7C7	G	
	39/44	G	Same as 78 to 39/44.
	77	G	No changes.
	78	E	
6D7	6E7	G	No changes.
6D8	6A7	G	Parallel circuits only. Reverse 6A7 to 6A8 procedure.
	6A8	G	Parallel circuits only. No changes.
	6J8	G	
	6K8	G	



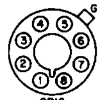


TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6D8	7A8	G	Change socket to loctal and rewire as follows: No. 2 on octal to No. 1 on loctal 3 to 2 4 to 5 5 to 4 6 to 3 7 to 8 8 to 7 cap to 6
	7B8	G	Same as 6D8 to 7A8. Parallel circuits only.
	7J7	G	
	7S7	G	
	7Q7	G	Same as 6A8 to 7Q7. Parallel circuits only.
	12A8	P	Series circuits only. No changes.
	12K8	P	
6E5	2E5	E	Heater voltage - current ratings differ.
	6AB5/6N5	P	Parallel circuits only. No changes.
	6T5	E	No changes.
	6U5/6G5	E	
6E6	6A6	G	Parallel circuits only. No changes.
6E7	6D7	G	No changes.
6E8			No practical substitute.
6F4	6L4	P	No changes.
6F5	6AD5	G	Make adaptor as follows: No. 1 on base to No. 1 on socket 2 to 2 4 to 3 7 to 7 8 to 8 Connect grid cap to 5 on base.
	6C5	G	Reverse 6C5 to 6F5 procedure.
	6J5	G	
	6K5	E	Change connections as follows: No. 4 to No. 3
	6SF5	E	Make adaptor as follows: No. 1 on base to No. 1 on top 2 to 8 4 to 5 7 to 7 8 to 2 cap to 3





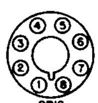
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6F5	7A4 7B4	G G	Change socket to loctal and rewire as follows:


ORIG.

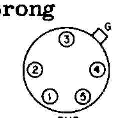
No. 2 on octal	to No. 1 on loctal
4	to 2
7	to 8
8	to 7
cap	to 6


SUB.

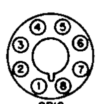
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6F6 *	6A4/LA	P	Parallel circuits only. Reverse 6A4/LA to 6F6 procedure.
	6AD7	G	Parallel circuits only. Remove and tape up any wires on Nos. 1 and 6.
	6AR6	G	Where additional filament current is available. Reverse 6AR6 to 6F6 procedure.
	6G6 6K6 6L6 6U6 6V6	P G G G G	Parallel circuits only. No changes.
	7B5 7C5	G G	Same as 6K6 to 7B5.
	38	G	Parallel circuits only. Change socket to five prong and rewire as follows:


ORIG.

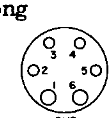
No. 2 on octal	to No. 1 on five prong
3	to 2
4	to 3
5	to cap
7	to 5
8	to 4


SUB.

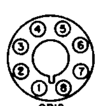
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	41	G	Same as 6F6 to 42. Parallel circuits only.
	42	E	Change socket to six prong and rewire as follows:


ORIG.

No. 2 on octal	to No. 1 on six prong
3	to 2
4	to 3
5	to 4
7	to 6
8	to 5

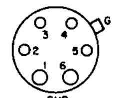

SUB.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	89	G	Parallel circuits only. Change socket to six prong and rewire as follows:

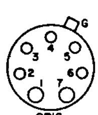

ORIG.

No. 2 on octal	to No. 1 on six prong
3	to 2
4	to 3
5	to cap
7	to 6
8	to 5

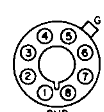
short 4 and 5 together.


SUB

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6F7	6P7	E	Change socket to octal and rewire as follows:

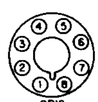
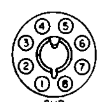
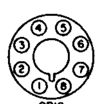
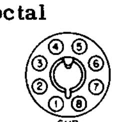

ORIG.

No. 1 on seven prong	to No. 2 on octal
2	to 4
3	to 5
4	to 6
5	to 7
6	to 8
7	to 3
cap	to cap

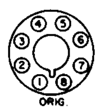

SUB.

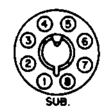
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6F8	6C8	G	Parallel circuits only. No changes.

* See Addendum at back of this section.

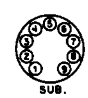
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6G5	6AB5	G	Parallel circuits only. No changes.
	6E5	G	No changes.
	6T5	G	
	6U5	G	
6G6	6A4/LA	G	Parallel circuits only. Reverse 6A4/LA to 6F6 procedure.
	6F6	G	Parallel circuits only. No changes.
	6K6	G	
	6V6	G	
	12A6	P	Series circuits only. No changes.
	41	G	Same as 6F6 to 42. Parallel circuits only.
	42	G	
	89	G	Same as 6F6 to 89. Parallel circuits only.
6H4	6H6	G	Parallel circuits only. Rewire as follows: No. 4 to No. 3 Connect No. 3 and No. 5 together. Connect No. 4 and No. 8 together.
6H5	6U5/6G5	E	No changes.
6H6	6AL5	G	Same as 12H6 to 12AL5.
	6W5	P	Parallel circuits only. Tie Nos. 4 and 8 together.
	6X5	P	
	6ZY5	P	Tie Nos. 4 and 8 together.
	7A6	E	Parallel circuits only. Change socket to loctal and rewire as follows: No. 1 on octal to No. 5 on loctal 2 to 1 3 to 3 4 to 2 5 to 6 7 to 8 8 to 7  ORIG.  SUB
	7Y4	P	Parallel circuits only. Change socket to loctal and rewire as follows: No. 2 on octal to No. 1 on loctal 3 to 3 4 and 8 to 7 5 to 6 7 to 8 8 to 7  ORIG.  SUB.
	7Z4	P	
6H8			No practical substitute.
6J4	6AB4	P	Parallel circuits only. Rewire as follows: Nos.1 and 5 to 6 7 to 1 2 to 7

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6J4	6C4	G	Parallel circuits only. Reverse 6C4 to 6J4 procedure.
	6N4	G	Parallel circuits only. Rewire as follows:
			Reverse Nos. 5 and 7
			No. 6 to No. 7
	9002	G	Parallel circuits only. Rewire as follows:
			Nos. 1 and 5 to No. 6
			7 to 1
6J5	6AD5	G	No changes.
	6AE5	G	
	6AF5	G	
	6C5	G	
	6F5	G	Same as 6C5 to 6F5.
	6K5	G	Change connections as follows: No. 5 to cap.
	6L5	G	Parallel circuits only. No changes.
	6P5	G	No changes.
	7A4	E	Change socket to loctal and rewire as follows:
	XXL	E	No. 2 on octal to No. 1 on loctal
			3 to 2
			5 to 6
			7 to 8
			8 to 7

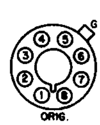


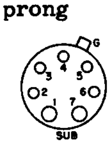


TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	37	G	Same as 6C5 to 37.
	76	G	
6J6	5687	P	Parallel circuits only. Change socket to noval and rewire as follows:
			No. 1 on miniature to No. 9 on noval
			2 to 1
			3 to 4
			4 to 5
			5 to 2
			6 to 7
			7 to 3 and 6



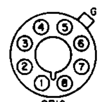
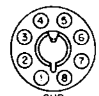
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6J7 *	6C6	E	Reverse 6C6 to 6J7 procedure.
	6D6	E	
	6D7	G	Change socket to seven prong and rewire as follows:
	6E7	G	No. 2 on octal to No. 1 on seven prong
			3 to 2
			4 to 3
			5 to 4
			7 to 7
			8 to 6
			cap to cap



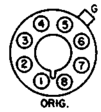


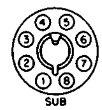
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	6K7	G	No changes.
	6S7	G	Parallel circuits only. No changes.

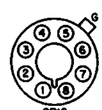
* See Addendum at back of this section.

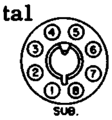
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY		
6J7	6SH7	G	Make adaptor as follows:		
	6SJ7	E		No. 1 on base	to No. 1 on top
	6SK7	G		2	to 2
				3	to 8
				4	to 6
				5	to 3
				7	to 7
				8	to 5
				cap	to 4
	6U7	G	No changes.		
	6W7	G	Parallel circuits only. No changes.		
	7A7	G	Change socket to loctal and rewire as follows:		
	7H7	G		No. 1 on octal	to No. 5 on loctal
	7L7	G		2	to 1
			 ORIG.	3	to 2
				4	to 3
				5	to 4
				7	to 8  SUB
				8	to 7
				cap	to 6
	7B7	G	Same as 6J7 to 7L7. Parallel circuits only.		
	7C7	G			
	7G7	G	Same as 6J7 to 6L7.		
	39/44	G	Same as 6K7 to 39/44.		
	36	G			
	77	E	Reverse 6C6 to 6J7 procedure.		
	78	G			
	1221	E	Reverse 6C6 to 6J7 procedure.		
	1223	E	No changes.		
	1232	E	Same as 6J7 to 6L7.		
	1620	E	No changes.		
6J8	6A7	G	Same as 6A8 to 6A7.		
	6A8	G	No changes.		
	6D8	G	Parallel circuits only. No changes.		
	6K8	G	No changes.		
	7A8	G	Same as 6D8 to 7A8. Parallel circuits only.		
	7B8	G			

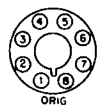
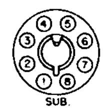
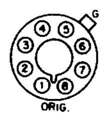
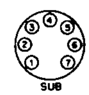
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6J8	7J7 7S7	G G	Change socket to loctal and rewire as follows: No. 2 on octal to No. 1 on loctal 3 to 2 4 to 5 5 to 4 6 to 3 7 to 8 8 to 7 cap to 6
	7Q7	G	Same as 6A8 to 7Q7.
6K4	6AD4	E	No changes.
6K5	6AD5	G	Make adaptor as follows: No. 2 on base to No. 2 on cap 3 to 3 7 to 7 8 to 8 Connect grid cap to No. 5 on base. This substitution can also be made by merely connecting the grid cap to No. 5 on the socket.
	6AE5 6C5 6J5	G G G	Change connection as follows: cap to No. 5.
	6F5	G	Change connections as follows: No. 3 to No. 4
	6Q7	G	Cut off pins Nos. 4 and 5.
	6SF5	G	Make adaptor as follows: No. 1 on base to No. 1 on top 2 to 8 3 to 5 7 to 7 8 to 2 cap to 3
	7A4 7B4	G G	Change socket to loctal and rewire as follows: No. 2 on octal to No. 1 on loctal 3 to 2 7 to 8 8 to 7 cap to 6
6K6	6A4/LA	P	Parallel circuits only. Reverse 6A4/LA to 6F6 procedure.
	6AD7	G	Parallel circuits only. Remove and tape up any wires anchored on pins Nos. 1 and 6.
	6AR6	P	Where additional filament current is available. Reverse 6AR6 to 6F6 procedure.

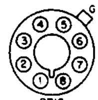
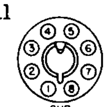
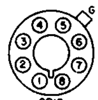
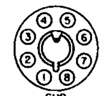
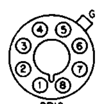
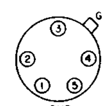




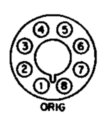


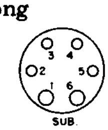


TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6K6	6F6	G	Parallel circuits only. No changes.
	6G6	P	
	6L6	G	
	6U6	G	
	6V6	G	
	7A5	G	Same as 6K6 to 7B5. Parallel circuits only.
	7B5	E	Change socket to loctal and rewire as follows: No. 2 on octal to No. 1 on loctal 3 to 2 4 to 3 5 to 6 7 to 8 8 to 7  
	7C5	G	Same as 6K6 to 7B5. Parallel circuits only.
	38	G	Same as 6F6 to 38. Parallel circuits only.
	41	E	Same as 6F6 to 42. Parallel or series circuits.
	42	G	Same as 6F6 to 42. Parallel circuits only.
	89	G	Same as 6F6 to 89. Parallel or series circuits.
6K7	6AU6	G	Change socket to miniature and rewire as follows: No. 2 on octal to No. 3 on miniature 3 to 5 4 to 6 5 to 2 7 to 4 8 to 7 cap to 1  
	6BA6	G	
	6BD6	G	
	6C6	G	Reverse 6C6 to 6J7 procedure.
	6D6	E	
	6D7	G	Same as 6J7 to 6D7.
	6E7	G	
	6J7	G	No changes.
	6Q7	P	Cut off pins No. 4 and No. 5. Emergency substitution.
	6S7	G	Parallel circuits only. No changes.
	6SH7	G	Same as 6J7 to 6SJ7.
	6SJ7	G	
	6SK7	E	
	6SS7	G	Same as 12K7 to 12SK7. Parallel circuits only.
	6U7	G	No changes.
	6W7	G	Parallel circuits only. No changes.

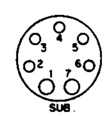
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6K7	XXL 7A4	P P	Change socket to loctal and rewire as follows: Remove No. 4 and tape up No. 2 on octal to No. 1 on loctal 3 to 2 8 to 7 7 to 8 cap to 6  ORIG  SUB
	7A7 7H7 7L7	E G G	Change socket to loctal and rewire as follows: No. 1 on octal to No. 5 on loctal 2 to 1 3 to 2 4 to 3 5 to 4 7 to 8 8 to 7 cap to 6  ORIG  SUB
	7B7 7C7 7G7	G G G	Same as 6K7 to 7A7. Parallel circuits only.
	39/44	E	Change socket to five prong type and rewire as follows: No. 2 on octal to No. 1 on five prong 3 to 2 4 to 3 5 to 4 7 to 5 8 to 4 cap to cap  ORIG  SUB
	77 78	G E	Reverse 6C6 to 6J7 procedure.
	1232	G	Same as 6K7 to 7A7. Parallel circuits only.
6K8	6A8 6J8	G G	No changes.
	7J7 7S7	G G	Same as 6J8 to 7J7.
	7Q7	G	Same as 12A8 to 14B8.
6L4	6F4	P	No changes.
	955	G	Parallel circuits only. Refer to base diagram for changes.
6L5	6AD5 6AE5	G G	Parallel circuits only. No changes.
	6C5	G	Parallel circuits only. No changes.
	7A4 XXL	G G	Same as 6J5 to 7A4. Parallel circuits only.
	37 76	G G	Same as 6C5 to 37. Parallel circuits only.
6L6	6AD7	G	Remove and tape up any wires anchored on pins Nos. 1 and 6.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6L6	6AL6	G	Rewire as follows: Connect No. 3 to cap.
	6AR6	G	Reverse 6AR6 to 6F6 procedure.
	6F6	G	Parallel circuits only. No changes.
	6K6	G	
	6U6	G	
	6V6	G	
	1614	E	No changes.
6L7	1612	E	No changes.
6M5			No practical substitute.
6M6G			No practical substitute.
6M7G			No practical substitute.
6M8GT			No practical substitute.
6N4	6AB4	G	Parallel circuits only. Reverse 6AB4 to 6N4 procedure.
	6J4	G	Parallel circuits only. Reverse 6J4 to 6N4 procedure.
6N5	6AB5	E	See 6AB5 substitutes.
6N6	6AB6	G	Parallel circuits only. No changes.
	6B5	E	Change socket to six prong and rewire as follows: No. 2 on octal to No. 1 on six prong 3 to 2 4 to 3 5 to 4 7 to 6 8 to 5



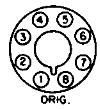


TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6N7	6A6	G	Change socket to seven prong and rewire as follows: No. 2 on octal to No. 1 on seven prong 3 to 2 4 to 3 5 to 5 6 to 6 7 to 7 8 to 4

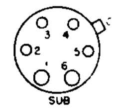


TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	6AE6	P	Parallel circuits only. Reverse 6AE6 to 6N7 procedure.
	6Y7	G	Parallel circuits only. No changes.
	6Z7	G	

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6N7	79	G	Change socket to six prong and rewire as follows:

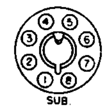


No. 2 on octal	to No.	1 on six prong
3	to	2
4	to	3
5	to	cap
6	to	5
7	to	6
8	to	4

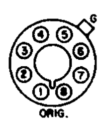


TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6N8	7R7	P	Change socket to loctal and rewire as follows:

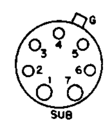
No. 1 on noval	to No.	5 on loctal
2	to	6
3	to	7
4	to	1
5	to	8
6	to	2
7	to	3
8	to	4
9	to	7



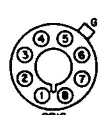
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6P5	6AD5	G	No changes.
	6AE5	G	
	6AF5	G	
	6C5	G	
	6J5	G	
	6L5	G	Parallel circuits only. No changes.
	7A4	G	Same as 6J5 to 7A4.
	37	G	Same as 6C5 to 37.
	76	G	
6P7	6F7	E	Change socket to seven prong and rewire as follows:



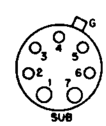
No. 2 on octal	to No.	1 on seven prong
3	to	7
4	to	2
5	to	3
6	to	4
7	to	5
8	to	6
cap	to	cap

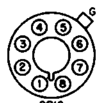
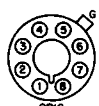
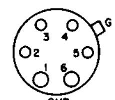


TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6P8G			No practical substitute.
6Q5G			No practical substitute.
6Q6			No practical substitute.
6Q7	6B6	E	No changes.
	6C7	G	Change socket to seven prong type and rewire as follows:



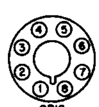
No. 2 on octal	to No.	1 on seven prong
3	to	2
4	to	4
5	to	5
7	to	7
8	to	6
cap	to	cap

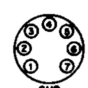


TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6Q7	6SQ7 6SR7	E G	Same as 12Q7 to 12SQ7.
	6R7	G	No changes.
	6T7	G	Parallel circuits. No changes.
	6V7	G	No changes.
	7B6 7E6	E G	Change socket to loctal and rewire as follows:  ORIG. No. 2 on octal to No. 1 on loctal 3 to 2 4 to 5 5 to 6 7 to 8 8 to 7 or 4 cap to 3  SUB.
	7C6	G	Same as above. Parallel circuits only.
	75 85	E G	Change socket to six prong type and rewire as follows:  ORIG. No. 2 on octal to No. 1 on six prong 3 to 2 4 to 3 5 to 4 7 to 6 8 to 5 cap to cap  SUB.
6R4			No practical substitute.
6R6	6K7 6U7	G G	Rewire as follows: No. 3 to No. 4 5 to 3 Short Nos. 5 and 8 on socket together.
6R7	6C7	G	Same as 6Q7 to 6C7.
	6Q7	G	No changes.
	6SQ7 6SR7	G E	Same as 12Q7 to 12SQ7.
	6T7	G	Parallel circuits only. No changes.
	6V7	G	No changes.
	7B6	G	Same as 6Q7 to 7B6.
	7C6	E	Parallel circuits only. Same as 6Q7 to 7B6.
	7E6	G	Same as 6Q7 to 7B6.
	75 85	G E	Same as 6Q7 to 75.
6R8	6T8	G	No changes.
6S4			No practical substitute.

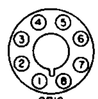
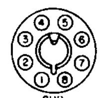
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6S6			No practical substitute.
6SA7	7Q7	G	Same as 12SA7 to 14Q7.
	6SB7Y	G	No changes.
	6SD7 6SH7 6SK7	P P P	Same as 12SA7 to 12SK7.
6S8GT			No practical substitute.
6S7	6D6	G	Parallel circuits only. Reverse 6C6 to 6J7 procedure.
	6D7 6E7	G G	Same as 6J7 to 6D7. Parallel circuits only.
	6J7 6K7	G G	Parallel circuits only. No changes.
	6SJ7 6SK7	G G	Parallel circuits only. Same as 12K7 to 12SK7.
	6SS7	E	Same as 12K7 to 12SK7.
	6U7	G	Parallel circuits only. No changes.
	6W7	G	No changes.
	7A7	G	Parallel circuits only. Same as 12K7 to 7B7.
	7B7 7C7	G G	Same as 12K7 to 7B7.
	12K7	P	Series circuits only. No changes.
	12SK7	P	Series circuits only. Same as 12K7 to 12SK7.
	14A7/12B7	P	Series circuits only. Same as 12K7 to 7B7.
	39/44	G	Parallel circuits only. Same as 6K7 to 39/44.
	77 78 666	G G G	Parallel circuits only. Reverse 6C6 to 6J7 procedure.
6SB7Y	6BE6	G	Change socket to miniature and rewire as follows:

No. 1 on octal	to No. 2 on miniature
2	to 3
3	to 5
4	to 6
5	to 1
6	to 2
7	to 4
8	to 7


ORIG.

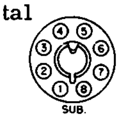

SUB.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6SC7	6C8	G	Same as 6SC7 to 6F8.

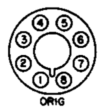
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6SC7	6F8	G	Make adaptor as follows:
			No. 1 on base to No. 1 on top
			2 to 3
			3 to cap
			4 to 5
			5 to 6
			6 to 4 and 8
			7 to 7
			8 to 2
			Parallel circuits only.
	6SL7	G	Make adaptor as follows:
			No. 2 on base to No. 2 on top
			3 to 1
			4 to 4
			5 to 5
			6 to 3 and 6
			7 to 7
			8 to 8
	6SN7	G	Same as 6SC7 to 6SL7. Parallel circuits only.
	7F7	G	Change socket to loctal and rewire as follows:
			No. 2 on octal to No. 3 on loctal
			3 to 4
			 ORIG. 4 to 5  SUB.
			5 to 6
			6 to 2 and 7
			7 to 1
			8 to 8
6SD7	6AB7/1853	G	Parallel circuits only. No changes.
	6AC7/1852	G	
	6SS7	G	
	6SE7	G	No changes.
	6SJ7	G	No changes.
	6SK7	G	
	5693	G	
6SE7	6AB7/1853	G	Parallel circuits only. No changes.
	6AC7/1852	G	
	6SS7	G	
	6SD7	G	No changes.
	6SJ7	G	No changes.
	6SK7	G	
	5693	G	
6SF5	6F5	E	Reverse 6F5 to 6SF5 procedure.
	6K5	G	Make adaptor as follows:
			No. 1 on base to No. 1 on top
			2 to 8
			3 to cap
			5 to 3
			7 to 7
			8 to 2

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6SF5	7B4	G	Change socket to loctal and rewire as follows. Parallel circuits only:

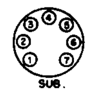
No. 2 on octal	to No. 7 on loctal
3	to 6
5	to 2
7	to 1
8	to 8



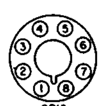
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6SF7	6SV7	G	No changes.
6SG7	6AB7	G	Parallel circuits only. No changes.
	6AC7	G	
	6AG5	G	Change socket to miniature and rewire as follows:
	6BC5	G	



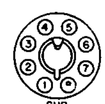
No. 2 on octal	to No. 3 on miniature
3 and 5	to 2
4	to 1
6	to 6
7	to 4
8	to 5



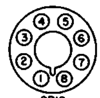
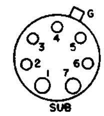
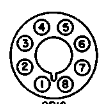
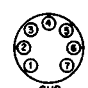
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	6AJ5	G	Same as 6SG7 to 6AG5. Parallel circuits only.
	6AK5	G	
	6AN5	G	
	5591	G	
	9001	G	
	9003	G	
	6SH7	G	No changes. Cathode and suppressor grid are internally connected in the 6SG7. In a limited number of circuits this substitution does operate. In these cases short pins 3 and 5 together.
	6SJ7	G	
	6SK7	G	
6SH7	6AB7	G	Parallel circuits only. No changes.
	6AC7	G	
	6AG5	G	Same as 6SG7 to 6AG5.
	6BC5	G	
	6AJ5	G	Same as 6SG7 to 6AG5. Parallel circuits only.
	6AK5	G	
	6AN5	G	
	5591	G	
	9001	G	
	9003	G	
	6SG7	G	No changes.
	6SJ7	G	
	6SK7	G	
	7G7/1232	G	Parallel circuits only. Change socket to loctal and rewire as follows:



No. 1 on octal	to No. 5 on loctal
2	to 1
3	to 4
4	to 6
5	to 7
6	to 3
7	to 8
8	to 2

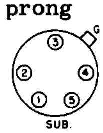


TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6SJ7	6C6	E	Reverse 6C6 to 6SJ7 procedure.
	6D6	G	
	77	E	
	78	G	

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6SJ7	6D7	G	Change socket to seven prong type and rewire as follows: No. 2 on octal to No. 1 on seven prong 3 to 4 4 to cap 5 to 6 6 to 3 7 to 7 8 to 2  ORIG.  SUB
	6E7	G	
	6J7	E	Same as 12SK7 to 12K7.
	6K7	G	
	6U7	G	
	6S7	G	Same as 12SK7 to 12K7. Parallel circuits only.
	6W7	G	
	6SK7	G	No changes.
	5693	E	
	6SS7	G	Parallel circuits only. No changes.
	7A7	G	Same as 12SJ7 to 7B7.
	7B7	G	Same as 12SJ7 to 7B7. Parallel circuits only.
	7C7	G	
6SK7	6AB7	G	Parallel circuits only. No changes.
	6AC7	G	
	6AH6	G	Same as 6SK7 to 6AU6. Parallel circuits only.
	6AK6	G	
	6AU6	G	Change socket to miniature and rewire as follows: No. 2 on octal to No. 3 on miniature 3 to 2 4 to 1 5 to 7 6 to 6 7 to 4 8 to 5  ORIG.  SUB.
	6BA6	G	
	6BD6	G	
	6C6	G	Reverse 6C6 to 6SJ7 procedure.
	6D6	E	
	77	G	
	78	E	
	6D7	G	Same as 6SJ7 to 6D7.
	6E7	G	
	6J7	G	Same as 12SK7 to 12K7.
	6K7	E	
	6U7	G	
	6S7	G	Same as 12SK7 to 12K7. Parallel circuits only.
	6W7	G	
	6SG7	G	No changes.
	6SH7	G	
	6SJ7	G	No changes.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6SK7	6SS7	G	Parallel circuits only. No changes.
	36	G	Change socket to five prong and rewire as follows:
	39/44	E	

No. 2 on octal	to No.	1 on five prong
3 and 5	to	4
4	to	cap
6	to	3
7	to	5
8	to	2

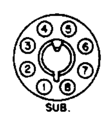


TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	7A7	E	Same as 12SJ7 to 7B7.
	7B7	E	Same as 12SJ7 to 7B7. Parallel circuits only.
	7C7	G	
6SL7	2C21	P	Reverse 2C21 to 6SN7 procedure.
	6C8	G	Same as 6SL7 to 6F8.
	6F8	G	Make adaptor as follows:

No. 1 on base	to	cap on top
2	to	3
3	to	4
4	to	5
5	to	6
6	to	8
7	to	7
8	to	2

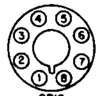
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	6SC7	G	If the 6SL7 employs the two cathodes separately this substitution may be impractical. Reverse 6SC7 to 6SL7 procedure.
	6SN7	G	Parallel circuits only. No changes.
	6SU7	G	No changes.
	7F7	G	Change socket to loctal and rewire as follows:

No. 1 on octal	to No.	4 on loctal
2	to	3
3	to	2
4	to	5
5	to	6
6	to	7
7	to	1
8	to	8

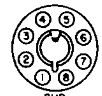


TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	7N7	G	Same as 6SL7 to 7F7. Parallel circuits only.
	5691	E	No changes.
	5692	P	
6SN7	2C21	G	Reverse 2C21 to 6SN7 procedure.
	6F8	G	Same as 6SL7 to 6F8. Parallel circuits only.
	6SC7	G	Reverse 6SC7 to 6SL7 procedure. Parallel circuits only.
	6SL7	G	Parallel circuits only. No changes.
	7F7	G	Same as 6SL7 to 7F7. Parallel circuits only.

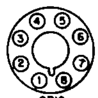
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6SN7	7F8	G	Parallel circuits only. Change socket to loctal and rewire as follows:


ORIG.

No. 1 on octal	to No. 1 on loctal
2	to 3
3	to 4
4	to 8
5	to 6
6	to 5
7	to 7
8	to 2


SUB.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	5691	P	No changes.
	5692	G	
6SQ7	6AQ6	G	Same as 6SQ7 to 6AT6. Parallel circuits only.
	6AT6	G	Change socket to miniature and rewire as follows:
	6AV6	G	
	6BF6	G	
	6BK6	G	
	6BT6	G	
	6BU6	G	


ORIG.

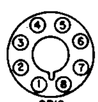
No. 2 on octal	to No. 1 on miniature
3	to 2
4	to 5
5	to 6
6	to 7
7	to 4
8	to 3


SUB.

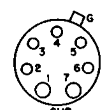
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	6B6	G	Make adaptor as follows:

No. 1 on base	to No. 1 on top
2	to cap
3	to 8
4	to 4
5	to 5
7	to 7
8	to 2

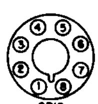
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	6C7	G	Change socket to seven prong and rewire as follows:


ORIG.

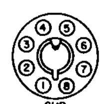
No. 2 on octal	to cap on seven prong
3	to 6
4	to 4
5	to 5
6	to 2
7	to 1
8	to 7


SUB

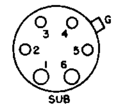
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	6Q7	E	Same as 6SQ7 to 6B6.
	6R7	G	Same as 6SQ7 to 6B6.
	6SR7	G	No changes.
	6ST7	G	Parallel circuits only. No changes.
	6T7	G	Same as 6SQ7 to 6B6. Parallel circuits only.
	6V7	G	
	7B6	E	Change socket to loctal and rewire as follows:
	7E6	G	


ORIG.

No. 2 on octal	to No. 3 on loctal
3	to 4 or 7
4	to 5
5	to 6
6	to 2
7	to 1
8	to 8


SUB.

RECEIVING TUBE SUBSTITUTION GUIDE

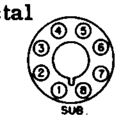
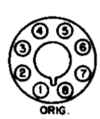
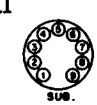
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6SQ7	7C6	G	Same as above. Parallel circuits only.
	75	E	Change socket to six prong and rewire as follows:
	85	G	No. 2 on octal to cap on six prong
			3 to 5
			 4 to 3 
			5 to 4
			6 to 2
			7 to 1
			8 to 6
6SR7	6AQ6	G	Same as 6SQ7 to 6AT6. Parallel circuits only.
	6AT6	G	Same as 6SQ7 to 6AT6.
	6AV6	G	
	6BF6	G	
	6BK6	G	
	6BT6	G	
	6BU6	G	
	6B6	G	Same as 6SQ7 to 6B6.
	6Q7	G	
	6C7	G	Same as 6SQ7 to 6C7.
	6R7	E	Same as 6SQ7 to 6B6.
	6V7	G	
	6SQ7	G	No changes.
	6ST7	G	Parallel circuits only. No changes.
	6SZ7	G	Parallel circuits only. No changes.
	6T7	G	Same as 6SQ7 to 6B6. Parallel circuits only.
	75	G	Same as 6SQ7 to 75.
	85	E	
6SS7	6AK6	G	Same as 6SK7 to 6AU6.
	6AH6	G	Same as 6SK7 to 6AU6. Parallel circuits only.
	6AU6	G	
	6BA6	G	
	6BD6	G	
	6S7	G	Same as 12SK7 to 12K7.
	6SG7	E	
	6W7	E	
	6SJ7	G	Parallel circuits only. No changes.
	6SK7	G	
	7B7	G	Same as 12SJ7 to 7B7.
	7C7	G	
	12K7	P	Same as 12SK7 to 12K7. Series circuits only.
	12SK7	P	Series circuits only. No changes.
	14A7/12B7	P	Same as 12SJ7 to 7B7. Series circuits only.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6ST7	6SQ7	G	Parallel circuits only. No changes.
	6SR7	G	
	6T7	E	Same as 6SQ7 to 6B6.
6SU7	6SL7	E	No changes.
	6SN7	P	
6SV7	6SF7	G	No changes.
6SZ7	6SQ7	G	Parallel circuits only. No changes.
	6SR7	G	
	6ST7	G	No changes.
6T5	2E5	E	Heater voltage-current ratings differ.
	6AB5	G	Parallel circuits only. No changes.
	6E5	G	No changes.
	6G5	G	
	6U5	G	
6T6			No practical substitute.
6T7	6B6	G	Parallel circuits only. No changes.
	6Q7	G	Parallel circuits only. No changes.
	6R7	G	
	6SQ7	G	Same as 12Q7 to 12SQ7. Parallel circuits only.
	6ST7	E	Same as 12Q7 to 12SQ7.
	6V7	G	Parallel circuits only. No changes.
	7B6	G	Same as 6Q7 to 7B6. Parallel circuits only.
	7C6	G	Same as 6Q7 to 7B6.
	12Q7	P	Series circuits only. No changes.
	12SQ7	P	Same as 12Q7 to 12SQ7. Series circuits only.
	75	G	Same as 6Q7 to 75. Parallel circuits only.
	85	G	
6T8 *	6R8	G	No changes.
6U4	6W4	E	No changes.
6U5/6C5	6N5	E	Parallel circuits only. No changes.
6U5/6G5	2E5	E	Heater voltage-current ratings differ.
	6E5	E	No changes.
6U6	6A4/LA	P	Parallel circuits only. Reverse 6A4/LA to 6F6 procedure.
	6AR6	P	Where additional filament current is available. Reverse 6AR6 to 6F6 procedure.

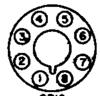
* See Addendum at back of this section.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6U6	6F6	G	Parallel circuits. No changes.
	6G6	P	
	6K6	G	
	6L6	P	
	6V6	G	
	6W6	P	
6U7	6AU6	G	Same as 6K7 to 6AU6.
	6BA6	G	
	6BD6	G	
	6C6-77	G	Reverse 6C6 to 6J7 procedure.
	6D6-78	G	
	6D7	G	Same as 6J7 to 6D7.
	6E7	G	
	6K7	G	No changes.
	6S7	G	Same as 6J7 to 6SJ7.
	6SH7	G	
	6SJ7	G	
	6SK7	G	
	6SS7	G	
	6W7	G	
	7A7	G	Same as 6K7 to 7A7.
	7B7	G	Same as 6K7 to 7A7. Parallel circuits only.
	7C7	G	
	7G7	G	
	36	G	Same as 6K7 to 39/44.
	39/44	G	
6V4	6X4	E	Reverse 6X4 to 6V4 procedure.
	6X5	G	Where space permits, reverse 6X5 to 6V4 procedure.
6V6	6A4/LA	P	Parallel circuits only. Reverse 6A4/LA to 6F6 procedure.
	6AD7	G	Parallel circuits only. Remove and tape up any wires anchored on pins Nos. 1 and 6.
	6AQ5	G	Reverse 6AQ5 to 6V6 procedure.
	6AR6	P	Where additional filament current is available. Reverse 6AR6 to 6F6 procedure.
	6F6	G	Parallel circuits only. No changes.
	6G6	P	
	6K6	G	
	6L6	G	Parallel circuits only. No changes.
	6U6	G	
	6Y6	G	
	7A5	G	Parallel circuits only. Remove and tape up any wires anchored on pins Nos. 1 and 6.

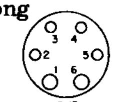
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6V6	7B5	G	Same as 6K6 to 7B5.
	7C5	G	
	38	G	Same as 6F6 to 38. Parallel circuits only.
	41	G	Same as 6F6 to 41. Parallel circuits only.
	42	G	
	89	G	Same as 6F6 to 89. Parallel circuits only.
6V7	6C7	G	Same as 6Q7 to 6C7.
	6R7	G	No changes.
	6SQ7	G	Same as 12Q7 to 12SQ7.
	6SR7	G	
	6T7	G	Parallel circuits only. No changes.
	7B6	G	Same as 6Q7 to 7B6.
	7C6	G	Same as 6Q7 to 7B6. Parallel circuits only.
	7E6	G	Same as 6Q7 to 7B6.
	75	G	Same as 6Q7 to 75.
	85	G	
6W4	6U4	E	No changes.
6W5	0Z4	G	No changes. Do not use where AC plate voltage exceeds 250 volts per plate.
	6AX5	G	Parallel circuits only. No changes.
	6AX6	E	Parallel circuits only. Tie No. 4 and No. 8 together.
	6BY5	G	Parallel circuits only. Rewire as follows: Connect Nos. 1 and 8 together No. 3 to No. 4
	6X5	G	Parallel circuits only. No changes.
	6ZY5	G	
	6Z6	G	Parallel circuits only. Short Nos. 4 and 8.
	7Y4	G	Same as 6X5 to 7Y4.
	7Z4	G	
	1274	G	No changes. Parallel circuits only.
6W6	6AR6	G	Reverse 6AR6 to 6F6 procedure.
	6L6	G	Parallel circuits only. No changes.
6W7	6C6-77	G	Parallel circuits only. Reverse 6C6 to 6J7 procedure.
	6D6-78	G	
	6D7	G	Same as 6J7 to 6D7. Parallel circuits only.
	6E7	G	

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6W7	6J7 6K7	G G	Parallel circuits only. No changes.
	6S7	G	No changes.
	6SH7 6SJ7 6SK7	G G G	Same as 6J7 to 6SJ7. Parallel circuits only.
	6U7	G	Parallel circuits only. No changes.
	7A7	G	Same as 6K7 to 7A7. Parallel circuits only.
	7B7 7C7	G G	Same as 6K7 to 7A7.
	7H7	G	Same as 6K7 to 7A7. Parallel circuits only.
	7L7	G	Same as 6K7 to 7A7. Parallel circuits only.
	12J7 12K7	P P	No change. Series circuits only.
	77-6C6 78-6D6	G G	Reverse 6C6 to 6J7 procedure. Parallel circuits only.
6X4	6V4	E	Change socket to noval and rewire as follows: No. 1 on miniature to No. 1 on noval 3 to 4 4 to 5 6 to 7 7 to 3 
	6X5	E	Where space permits. Change socket to octal and rewire as follows: No. 1 on miniature to No. 3 on octal 3 to 2 4 to 7 6 to 5 7 to 8 
	84/6Z4	G	Parallel circuits only. Where space permits, reverse 84/6Z4 to 6X4 procedure.
	5726	G	Parallel circuits only. Reverse 5726 to 6X4 procedure.
6X5	6AX5	G	Parallel circuits only. No changes.
	6AX6	G	Parallel circuits only. Tie no. 4 and no. 8 together.
	6BY5	G	Parallel circuits only. Rewire as follows: Connect Nos. 1 and 8 together No. 3 to No. 4
	6V4	G	Change socket to noval and rewire as follows: No. 2 on octal to No. 4 on noval 3 to 1 5 to 7 7 to 5 8 to 3 

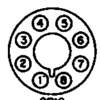
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6X5	6W5	G	Parallel circuits only. No changes.
	6X4	G	Reverse 6X4 to 6X5 procedure.
	6Y5	E	Parallel circuits only. Change socket to six prong and rewire as follows:


ORIG.

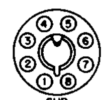
No. 2 on octal	to No. 1 on six prong
3	to 3
5	to 5
7	to 6
8	to 4


SUB.

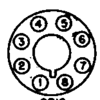
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	0Z4	E	No changes. Do not use where AC plate voltage exceeds 250 volts per plate.
	6Z5	G	Same as 6X5 to 6Y5. Parallel circuits only.
	6Z6	G	Same as 6W5 to 6Z6.
	6ZY5	G	Parallel circuits only. No changes.
	7Y4	E	Parallel circuits only. Change socket to loctal and rewire as follows:


ORIG.

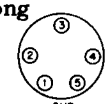
No. 2 on octal	to No. 1 on loctal
3	to 3
5	to 6
7	to 8
8	to 7


SUB.

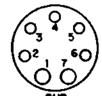
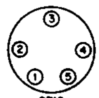
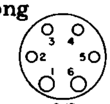
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	7Z4	G	Same as 6X5 to 7Y4.
	84	E	Change socket to five prong and rewire as follows:


ORIG.

No. 2 on octal	to No. 1 on five prong
3	to 2
5	to 3
7	to 5
8	to 4


SUB.

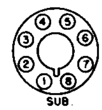
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	1274	G	Parallel circuits only. No changes.
6X6G			No practical substitute.
6Y3G			No practical substitute.
6Y5	6X5	G	Parallel circuits only. Reverse 6X5 to 6Y5 procedure.
	6Z5	G	Rewire as follows: Connect Nos. 2 and 6 together.
6Y6	6AR6	G	Reverse 6AR6 to 6F6 procedure.
	6G6	P	Parallel circuits only. No changes.
	6K6	G	
	6L6	G	
	6U6	G	
	6V6	G	
	7A5	G	Same as 6K6 to 7B5. Parallel circuits only.
	7B5	G	Same as 6K6 to 7B5. Parallel circuits only.
	7C5	G	

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6Y7*	6A6	G	Change socket to seven prong and rewire as follows:  ORIG. No. 2 on octal to No. 1 on seven prong 3 to 2 4 to 3 5 to 5 6 to 6 7 to 7 8 to 4  SUB.
	6N7	G	Parallel circuits only. No changes.
	6Z7	G	
6Z3	1V	E	No changes.
6Z4	6Y5	G	Parallel circuits only. Change socket to six prong and rewire as follows:  ORIG. No. 1 on five prong to No. 1 on six prong 2 to 3 3 to 5 4 to 4 5 to 6  SUB
6Z5	6Y5	E	No changes for six volt operation.
6Z7	6A6	G	Same as 6Y7 to 6A6. Parallel circuits only.
	6N7	G	Parallel circuits only. No changes.
	6Y7	G	
6ZY5	0Z4	G	No changes. Do not use where AC plate voltage exceeds 250 volts per plate.
	6AX5	G	Paralled circuits only. No changes.
	6AX6	G	Parallel circuits only. Tie Nos. 4 and 8 together.
	6BY5	G	Parallel circuits only. Rewire as follows: Connect Nos. 1 and 8 together No. 3 to No. 4
	6W5	G	Parallel circuits only. No changes.
	6X5	G	Parallel circuits only. No changes.
	6Y5	G	Same as 6X5 to 6Y5. Parallel circuits only.
	6Z5	G	
	7Y4	G	Same as 6X5 to 7Y4. Parallel circuits only.
	7Z4	G	
	84	G	Same as 6X5 to 84. Parallel circuits only.
	1274	G	Parallel circuits only. No changes.

* See Addendum at back of this section.

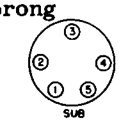
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
7A4	6AE5	G	Change socket to octal and rewire as follows:

No. 2 on loctal	to No. 3 on octal
1	to 2
6	to 5
7	to 8
8	to 7



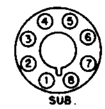
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	6C5	G	Reverse 6J5 to 7A4 procedure.
	6J5	G	Reverse 6J5 to 7A4 procedure.
	6L5	G	Same as 7A4 to 6AE5. Parallel circuits only.
	7B4	G	No changes.
	XXL	E	
	37	G	Change socket to five prong and rewire as follows
	76	G	

No. 1 on loctal	to No. 1 on five prong
2	to 2
6	to 3
7	to 4
8	to 5



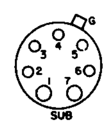
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
7A5	6F6	E	Parallel circuits only. Change socket to octal and rewire as follows.
	6K6	G	
	6L6	G	
	6U6	G	
	6V6	G	
	6Y6	G	

No. 1 on loctal	to No. 2 on octal
2	to 3
3	to 4
6	to 5
7	to 8
8	to 7

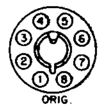
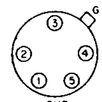


TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	7B5	G	Parallel circuits only. No changes.
	7C5	G	
7A6	6H6	E	Reverse 6H6 to 7A6 procedure.
	5679	E	No changes. Do not use unused terminals for anchor.
7A7	6C6	G	Reverse 6C6 to 7A7 procedure.
	6D6	E	
	77	G	
	78	E	
	6D7	G	Change socket to seven prong and rewire as follows:
	6E7	G	

No. 1 on loctal	to No. 1 on seven prong
2	to 2
3	to 3
4	to 4
6	to cap
7	to 6
8	to 7



TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	6J7	G	Reverse 6K7 to 7A7 procedure
	6K7	E	
	6S7	G	Parallel circuits only. Reverse 6K7 to 7A7 procedure.
	6SH7	G	Reverse 12SJ7 to 7B7 procedure.
	6SJ7	G	
	6SK7	E	

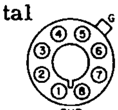
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
7A7	6SS7	G	Parallel circuits only. Reverse 12SJ7 to 7B7 procedure.
	6U7	G	Reverse to 6K7 to 7A7 procedure.
	6W7	G	Parallel circuits only. Reverse to 6K7 to 7A7 procedure.
	7B7 7C7	G G	Parallel circuits only. No changes.
	7H7 7L7	G G	No changes.
	39/44	E	Change socket to five prong and rewire as follows: No. 1 on loctal to No. 1 on five prong 2 to 2 3 to 3 4 to 4 6 to cap 7 to 4 8 to 5  ORIG.  SUB.
7A8	6A7	E	Parallel circuits only. Reverse 6A7 to 7B8 procedure.
	6A8	E	Parallel circuits only. Reverse 6D8 to 7A8 procedure.
	6D8	G	Reverse 6D8 to 7A8 procedure.
	7B8 7J8 7S7	E G G	Parallel circuits only. No changes.
	7Q7	G	Parallel circuits only. Remove and tape up wires on No. 5. Connect Nos. 5 and 8 together.
	12A8	P	Series circuits only. Reverse 12A8 to 14B8 procedure.
	14B8 14J7 14S7	P P P	Series circuits only. No changes.
7AB7	7AD7 7AJ7 7AK7 7G7 7H7 7L7 7T7 7V7	P P P P P P P P	Same as 7AB7 to 7AG7. Parallel circuits only.
	7AG7 7AH7 7B7 7C7	G G G G	Rewire as follows: Remove wires from No. 1 No. 2 to No. 1 3 to 2 Connect wires removed from No. 1 to No. 3 Remove wires from No. 8 No. 7 to No. 8 6 to 7 5 to 6 Connect wires removed from No. 8 to No. 7 Connect No. 4 and No. 7 together.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
7AB7	1204	E	No changes.
7AD7	7AG7	P	Parallel circuits only. No changes.
	7AH7	P	
	7AJ7	P	
	7AK7	P	
	7B7	P	
	7C7	P	
	7G7	P	
	7H7	P	
	7L7	P	
	7T7	P	
	7V7	P	
7AF7	7F7	G	No changes.
	7N7	G	Parallel circuits only. No changes.
7AG7	7AH7	G	No changes.
	7B7	P	
	7C7	P	
	7AJ7	P	Parallel circuits only. No changes.
	7AK7	P	
	7G7	G	
	7H7	G	
	7L7	G	
	7T7	G	
	7V7	G	
7AH7	7AG7	G	No changes.
	7B7	P	
	7C7	P	
	7AJ7	G	Parallel circuits only. No changes.
	7AK7	P	
	7G7	P	
	7H7	P	
	7L7	P	
	7T7	P	
	7V7	P	
7AJ7	7AH7	G	Parallel circuits only. No changes.
	7AK7	P	
	7B7	P	
	7C7	P	
	7G7	P	
	7V7	P	
	7H7	P	No changes.
	7L7	P	
	7T7	P	
7AK7	7AH7	P	Parallel circuits only. No changes.
	7AJ7	P	
	7B7	P	
	7C7	P	
	7G7	P	
	7H7	P	
	7L7	P	
	7T7	P	
	7V7	P	

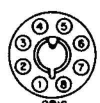
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
7B4	6AD5	G	Reverse 6J5 to 7A4 procedure.
	6AE5	G	
	6F5	G	Change socket to octal and rewire as follows.


ORIG.

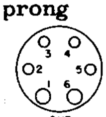
No. 1 on loctal	to No. 2 on octal
2	to 4
6	to cap
7	to 8
8	to 7


SUB

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	6J5	G	Reverse 6J5 to 7A4 procedure.
	6K5	G	Reverse 6K5 to 7B4 procedure.
	6P5	G	Reverse 6J5 to 7A4 procedure.
	7A4	G	No changes.
	XXL	G	
7B5	6AD7	G	Parallel circuits only. Reverse 6K6 to 7B5 procedure. Remove and tape up any wires anchored on unused pins.
	6F6	G	Parallel circuits only. Reverse 6K6 to 7B5 procedure.
	6K6	E	Reverse 6K6 to 7C5 procedure.
	6L6	G	Parallel circuits only. Reverse 6K6 to 7B5 procedure.
	6U6	G	
	6V6	G	
	6Y6	G	
	7A5	G	Parallel circuits only. No changes.
	7C5	G	
	41	G	Change socket to six prong and rewire as follows:
	42	E	

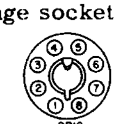

ORIG.

No. 1 on loctal	to No. 1 on six prong
2	to 2
3	to 3
6	to 4
7	to 5
8	to 6

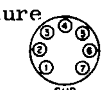

SUB

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
7B6	6B6	E	Reverse 6B6 to 7B6 procedure.
	6Q7	E	Reverse 6Q7 to 7B6 procedure.
	6R7	G	
	6SQ7	E	Reverse 6SQ7 to 7B6 procedure.
	6T7	G	Parallel circuits only. Reverse 6Q7 to 7B6 procedure.
	7C6	G	Parallel circuits only. No changes.
	7E6	G	No changes.
	75	E	Reverse 75 to 7E6 procedure.
	85	G	Reverse 75 to 7E6 procedure.
7B7	6C6	G	Parallel circuits only. Reverse 6C6 to 7A7 procedure.
	6D6	G	

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
7B7	6D7	G	Same as 7A7 to 6D7. Parallel circuits only.
	6E7	G	
	6J7	G	Parallel circuits only. Reverse 6J7 to 7L7 procedure.
	6K7	G	Parallel circuits only. Reverse 6K7 to 7A7 procedure.
	6S7	G	Reverse 6K7 to 7A7 procedure.
	6SH7	G	Parallel circuits only. Reverse 12SJ7 to 7B7 procedure.
	6SJ7	G	
	6SK7	G	
	6SS7	G	Reverse 12SJ7 to 7B7 procedure.
	6U7	G	Parallel circuits only. Reverse 6K7 to 7A7 procedure.
	6W7	G	Reverse 6K7 to 7A7 procedure.
	7A7	G	Parallel circuits only. No changes.
	7C7	G	No changes.
	7H7	G	Parallel circuits only. No changes.
	12J7	P	Series circuits only. Reverse 6K7 to 7A7 procedure.
	12K7	P	
	12SG7	P	Series circuits only. Reverse 12SJ7 to 7B7 procedure.
	12SH7	P	
	12SJ7	P	
	12SK7	P	
	14A7/12B7	P	Series circuits only. No changes.
	39/44	G	Same as 7A7 to 39/44. Parallel circuits only.
	77	G	Parallel circuits only. Reverse 6C6 to 7A7 procedure.
	78	G	
7B8	6A7	G	Reverse 6A7 to 7B8 procedure.
	6A8	G	Reverse as 12A8 to 14B8 procedure.
	6D8	G	Parallel circuits only. Reverse 12A8 to 14B8 procedure.
	6J8	E	Reverse 12A8 to 14B8 procedure.
	6K8	E	
	7A8	G	Parallel circuits only. No changes.
	7J7	G	No changes.
	7S7	G	No changes.
7C4	1203A	E	No changes.
	9006	G	Change socket to miniature and rewire as follows:


ORIG.

No. 1 on loctal	to No.	3 on miniature
4	to	1
7	to	7
8	to	4


SUB.

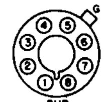
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
7C5	6AD7	G	Parallel circuits only. Reverse 6K6 to 7B5 procedure. Do not anchor on unused pins.
	6F6	G	Parallel circuits only. Reverse 6K6 to 7B5 procedure.
	6G6	G	
	6K6	G	
	6L6	G	
	6U6	G	
	6V6	E	
	6Y6	G	
	7A5	G	Parallel circuits only. No changes.
	7B5	G	Parallel circuits only. No changes.
	41	G	Same as 7B5 to 41. Parallel circuits only.
	42	G	
7C6	6B6	G	Parallel circuits only. Reverse 6Q7 to 7B6 procedure.
	6Q7	G	
	6R7	G	
	6SQ7	G	Parallel circuits only. Reverse 6SQ7 to 7B6 procedure.
	6ST7	G	Reverse 6SQ7 to 7B6 procedure.
	6T7	G	
	7B6	G	Parallel circuits only. No changes.
	12Q7	P	Series circuits only. Reverse 6Q7 to 7B6 procedure.
	12SQ7	P	Series circuits only. Reverse 6SQ7 to 7B6 procedure.
	12SR7	P	
	14B6	P	Series circuits only. No changes.
	14E6	P	
	75	G	Parallel circuits only. Reverse 75 to 7E6 procedure.
	85	G	
7C7	6C6	G	Parallel circuits only. Reverse 6C6 to 7A7 procedure.
	6D6	G	
	77	G	
	78	G	
	6D7	G	Same as 7A7 to 6D7. Parallel circuits only.
	6E7	G	
	6S7	G	Reverse 6K7 to 7A7 procedure.
	6SS7	G	Reverse 12SJ7 to 7B7 procedure.
	6W7	G	Reverse 6K7 to 7A7 procedure.
	7A7	G	Parallel circuits only. No changes.
	7B7	G	No changes.
	7H7	G	Parallel circuits only. No changes.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
7C7	12J7	P	Series circuits only. Reverse 6K7 to 7A7 procedure.
	12K7	P	
	12SG7	P	Series circuits only. Reverse 12SJ7 to 7B7 procedure.
	12SH7	P	
	12SJ7	P	
	12SK7	P	
	14A7/12B7	P	Series circuits only. No changes.
	36	G	Same as 7A7 to 39/44. Parallel circuits only.
	39/44	G	
7D7			No practical substitute.
7E5	7A4	P	Parallel circuits only. Rewire as follows: Remove wires from No. 1 No. 2 to No. 1 3 and 7 to 2 4 and 6 to 7 5 to 6 Connect wires removed from No. 1 to No. 6
	7B4	P	
	1201	E	No changes.
7E6	6B6	G	Reverse 6Q7 to 7B6 procedure.
	6Q7	G	
	6R7	G	Reverse 6Q7 to 7B6 procedure.
	6SQ7	G	Reverse 6SQ7 to 7B6 procedure.
	6SR7	G	Reverse 6SQ7 to 7B6 procedure.
	6T7	G	Parallel circuits only. Reverse 6Q7 to 7B6 procedure.
	75	G	Reverse 75 to 7E6 procedure.
	85	G	Reverse 75 to 7E6 procedure.
	7B6	G	No changes.
	7C6	G	Parallel circuits only. No changes.
7E7	6B8	G	Reverse 6B8 to 7E7 procedure.
	7R7	G	No changes.
7F7	6C8	G	Reverse 6C8 to 7F7 procedure.
	6F8	G	Parallel circuits only. Reverse 6C8 to 7F7 procedure.
	6SC7	G	Reverse 6SC7 to 7F7 procedure.
	6SL7	G	Reverse 6SL7 to 7F7 procedure.
	7AF7	G	No changes.
	7F8	G	Reverse 7F8 to 7F7 procedure.
	7N7	G	Parallel circuits only. No changes.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
7F8	2C51	P	Reverse 2C51 to 7F8 procedure.
	6F8	P	Parallel circuits only. Change socket to octal and rewire as follows:

No. 1 on loctal to cap on octal
2 to 2
3 to 3
4 to 4
5 to 8
6 to 6
7 to 7
8 to 5


ORIG.


SUB

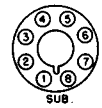
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	7AF7	P	Same as 7F8 to 7F7.
	7F7	P	Rewire as follows: Remove wires from No. 1 No. 2 to No. 1 4 to 2 Connect wires removed from No. 1 to No. 4 Remove wires from No. 8 No. 7 to No. 8 5 to 7 Connect wires removed from No. 8 to No. 5
	7N7	P	Same as 7F8 to 7F7. Parallel circuits only.
	5670	E	Parallel circuits only. Reverse 2C51 to 7F8 procedure.
7G7	7A7	G	Parallel circuits only. No changes.
	7B7	G	
	7C7	G	
	7H7	G	
	7L7	G	
	7V7	G	No changes.
	1232	G	Parallel circuits only. No changes.
7G7/1232	6J7	G	Parallel circuits only. Reverse 6J7 procedure.
	6K7	G	
	6U7	G	
7H7	7A7	G	No changes.
	7B7	G	Parallel circuits only. No changes.
	7C7	G	
	7L7	G	No changes.
	7T7	G	
	7V7	G	Parallel circuits only. No changes.
	1231	G	
	1273	G	No changes.
7J7	6A8	E	Reverse 6J8 to 7J7 procedure.
	6J8	E	
	6K8	E	
	7B8	G	No changes.
	7S7	G	

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
7K7	7B6 7E6	G G	Rewire as follows: No. 2 to No. 7 3 to 2 4 to 3
	7X7	G	Rewire as follows: Remove wires from No. 2 No. 3 to No. 2 4 to 3 Connect wires removed from No. 2 to No. 4
7L7	6J7	G	Reverse 6J7 to 7L7 procedure.
	6K7	G	Reverse 6K7 to 7A7 procedure.
	7A7	G	No changes.
	7G7	G	Parallel circuits only. No changes.
	7H7	G	No changes.
	7T7	G	No changes.
	7V7	G	Parallel circuits only. No changes.
7N7	6C8	G	Parallel circuits only. Reverse 6C8 to 7F7 procedure.
	6F8	G	Reverse 6C8 to 7F7 procedure.
	7AF7	G	Parallel circuits only. No changes.
	7F7	G	Parallel circuits only. No changes.
7Q7	6SA7	G	Reverse 12SA7 to 14Q7 procedure.
7R7	7E7	G	No changes.
7S7	6A7 6A8	G G	Reverse 6A7 to 7B8 procedure.
	6J8 6K8	G G	Reverse 6J8 to 7J7 procedure.
	7B8 7J7	G G	No changes.
7T7	7A7	G	No changes.
	7B7	G	Parallel circuits only. No changes.
	7C7	G	Parallel circuits only. No changes.
	7G7	G	Parallel circuits only. No changes.
	7H7	G	No changes.
	7L7	G	No changes.
	7V7	G	No changes.
	1231	G	Parallel circuits only. No changes.

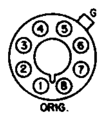
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
7T7	1273	G	No changes.
7V7	7B7	G	Parallel circuits only. No changes.
	7C7	G	
	7G7	G	No changes.
	1232	G	
	7W7	E	Rewire as follows: No. 4 to No. 5 Do not use No. 4 for anchor
7W7	7V7	E	Rewire as follows: No. 4 to No. 7 5 to 4
7X6	7Y4	G	Parallel circuits only. Rewire as follows:
	7Z4	G	Connect Nos. 2 and 7 together. Cannot be used where 7X6 is employed as a doubler.
7X7	7K7	G	Rewire as follows: Remove wires from No. 2 No. 4 to No. 2 3 to 4 Connect wires removed from No. 2 to No. 3
	XXFM	E	No changes.
7Y4	6X5	E	Reverse 6X5 to 7Y4 procedure.
	7X6	G	Parallel circuits only. No changes. If it is convenient, connect No. 2 and 7 together.
	7Z4	G	Parallel circuits only. No changes.
7Z4	6W5	G	Parallel circuits only. Reverse 6X5 to 7Y4 procedure.
	6X5	E	
	6ZY5	G	
	7X6	G	No changes. If it is convenient, connect Nos. 2 and 7 together.
	7Y4	G	Parallel circuits only. No changes.
10	10Y	E	No changes.
	RK10	E	
	50	G	
	210	E	
	310	E	
10Y	10	E	No changes.
	RK10	E	
	50	G	
	210	E	
	310	E	
12A	71A	G	No changes.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
12A5	12A6	G	12 volt operation only. Parallel circuits only. Change socket to octal and rewire as follows:

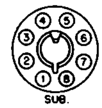
No. 1 on seven prong	to No. 2 on octal
2	to 3
3	to 4
4	to 5
5	to 8
7	to 7



TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
12A6	6G6	P	No changes. Series circuits.
	14A5	G	Same as 35L6 to 35A5.
12A8	12K8	G	No changes.
	14A7/12B7	P	Change socket to loctal and rewire as follows:

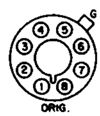


No. 2 on octal	to No. 1 on loctal
3	to 2
5	to 6
6	to 3
7	to 8
8	to 7
cap	to 4

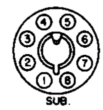


Must be well shielded. Realign if necessary

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	14B8 14J7 14S7	G G G	Change socket to loctal and rewire as follows:

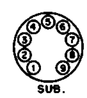


No. 2 on octal	to No. 1 on loctal
3	to 2
4	to 5
5	to 4
6	to 3
7	to 8
8	to 7
cap	to 6



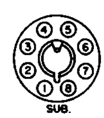
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
12AH7	12AT7	G	Change socket to noval and rewire as follows:

No. 1 on octal	to No. 2 on noval
2	to 3
3	to 1
4	to 8
5	to 7
6	to 6
7	to 5
8	to 4



TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	14AF7/XXD 14F7	G G	Change socket to loctal and rewire as follows:

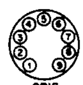
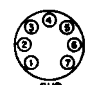
No. 1 on octal	to No. 4 on loctal
2	to 2
3	to 3
4	to 7
5	to 5
6	to 6
7	to 8
8	to 1

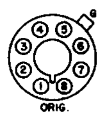
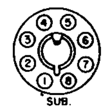
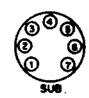


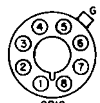
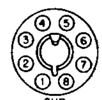
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
12AL5	12H6	G	Where space permits. Same as 6AL5 to 6H6.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
12AT6	12AV6	G	No changes.
	12BF6	P	
	12BK6	G	
	12BT6	P	
	12BU6	P	
	12SQ7	G	Where space permits. Reverse 12SQ7 to 12AT6 procedure.
	12SR7	P	
	12SW7	P	
12AT7 *	12AH7	G	Where space permits. Reverse 12AH7 to 12AT7 procedure.
	12AU7	G	No changes.
	12AV7	G	Parallel circuits only. No changes.
	12AX7	G	No changes.
	12AY7	G	
	12BH7	G	Parallel circuits only. No changes.
12AU6	12AW6	G	Reverse Nos. 2 and 7.
	12BA6	G	No changes.
	12BD6	G	
12AU7 *	12AT7	G	No changes.
	12AV7	G	Parallel circuits only. No changes.
	12AX7	G	No changes.
	12AY7	G	
12AV6	12AT6	G	No changes.
	12BF6	P	
	12BK6	G	
	12BT6	G	
	12BU6	G	
12AV7	12AT7	G	Parallel circuits only. No changes.
	12AU7	G	
	12AX7	G	
	12AY7	G	
	12BH7	G	
12AW6	12AU6	G	Rewire as follows:
	12BA6	G	Reverse No. 2 and No. 7
12AX7	12AT7	G	No changes.
	12AU7	G	
	12AV7	G	Parallel circuits only. No changes.
	12AY7	G	No changes.
	12BH7	G	Parallel circuits only. No changes.
12AY7	12AT7	G	No changes.
	12AU7	G	
	12AV7	G	Parallel circuits only. No changes.

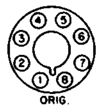
* See Addendum at back of this section.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
12AY7	12AX7	G	No changes.
	12BH7	G	Parallel circuits only. No changes.
12B6M			No practical substitute.
12B7	14A7	E	No changes.
12B8GT			No practical substitute.
12BA6	12AU6	G	No changes.
	12AV6	G	Reverse 12AW6 to 12AU6 procedure.
	12AW6	G	
12BA7	12BE6	G	Change socket to miniature and rewire as follows: No. 1 on noval to No. 6 on miniature 2 to 1 3 to 2 4 to 3 5 to 4 6 to 2 7 to 7 9 to 5  ORIG.  SUB.
12BD6	12AU6	G	No changes.
	12AW6	G	Rewire as follows: Reverse No. 7 and No. 2
	12BA6	G	No changes.
12BE6	12BA7	G	Same as 6BE6 to 6BA7.
	12SA7	G	Where space permits. Reverse 12SA7 to 12BE6 procedure.
12BF6	12AT6	P	No changes.
	12AV6	P	
	12BK6	P	
	12BT6	P	
	12BU6	G	
12BH7	12AT7	G	Parallel circuits only. No changes.
	12AU7	G	
	12AV7	G	
	12AX7	G	
	12AY7	G	
12BK6	12AT6	G	No changes.
	12AV6	G	
	12BF6	P	
	12BT6	G	
	12BU6	G	
12BT6	12AT6	G	No changes.
	12AV6	G	
	12BF6	P	
	12BK6	G	
	12BU6	G	

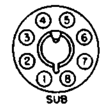
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
12BU6	12AT6	P	No changes.
	12AV6	P	
	12BF6	G	
	12BK6	P	
	12BT6	P	
12C8	14E7	G	Change socket to loctal and rewire as follows: No. 2 on octal to No. 1 on loctal 3 to 2 4 to 3 5 to 4 6 to 5 7 to 8 8 to 7 cap to 6  
	14R7	G	
12E5	1626	G	Parallel circuits only. No changes.
12F5	12J5	G	Rewire as follows: No. 4 to No. 3. Connect grid wire to No. 5.
	12SF5	E	Same as 6F5 to 6SF5.
12G7G			No practical substitute.
12H6	12AL5	E	Change socket to miniature and rewire as follows: No. 2 on octal to No. 3 on miniature 3 to 2 4 to 5 5 to 7 7 to 4 8 to 1  
12J5	12F5	G	Rewire as follows: No. 3 to No. 4 Connect wire from No. 5 to grid cap.
	12SF5	G	Same as 12SF5 to 12J5.
	14A4	G	Same as 6J5 to 7A4.
	1626	G	Parallel circuits only. No changes.
12J7	6S7	P	Series circuits only. No changes.
	6W7	P	
	7B7	P	Same as 12K7 to 7B7 but in series circuits only.
	7C7	P	
	12B7	E	
	12K7	G	No changes.
	12SG7	G	Same as 12K7 to 12SK7.
	12SH7	G	
	12SJ7	E	
	12SK7	G	
	14A7	E	Same as 12K7 to 7B7 but in series circuits only.
12K7	6S7	P	Series circuits only. No changes.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
12K7	6SS7	G	Same as 12K7 to 12SK7. Series circuits only.
	6W7	E	Series circuits only. No changes.
	7B7	P	Change socket to loctal and rewire as follows, series circuits only:
	7C7	P	No. 1 on octal to No. 5 on loctal
	12B7	E	2 to 1
	14A7	E	3 to 2
	14C7	E	4 to 3
			 ORIG.  SUB.
			5 to 4
			7 to 8
			8 to 7
			cap to 6
	12J7	G	No changes.
	12SK7	E	Make adaptor as follows:
			No. 1 on base to No. 1 on top
			2 to 2
			3 to 8
			4 to 6
			5 to 3
			7 to 7
			8 to 5
			cap to 4
12K8	12A8	G	No changes.
	14B8	G	Same as 12A8 to 14B8.
	14J7	G	
	14S7	G	
12L8	1644	G	No changes.
12Q7	6ST7	P	Same as 12Q7 to 12SQ7. Series circuits only.
	6T7	P	Series circuits only. No changes.
	7C6	P	Series circuits only. Same as 6Q7 to 7B6.
	14B6	E	
	14E6	G	
	12SQ7	E	Make adaptor as follows:
			No. 1 on base to No. 1 on top
			2 to 8
			3 to 6
			4 to 4
			5 to 5
			7 to 7
			8 to 3
12SA7	6SS7	P	Same as 12SA7 to 12SK7 series circuits.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
12SA7	7A8	P	Series circuits only. Change socket to loctal and rewire as follows:

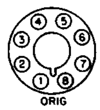


No. 1 on octal to shield connection on loctal socket
2 to No. 1
3 to 2
4 to 5
5 to 4
6 to 7
7 to 8
8 to 6

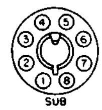


The 7A8 heats faster than the other tubes and a 200 ohm 1/2 watt resistor must be connected across the filament terminals 2 and 7 or its life will be very short.

SUB.	PERF.	CIRCUIT CHANGES NECESSARY
7B7	P	Series circuits only. Change socket to loctal and rewire as follows:
7C7	P	
12B7/14A7	P	

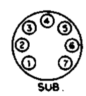


No. 2 on octal to No. 1 on loctal
3 to 2
4 to 3
5 to 6
6 to 7
7 to 8
8 to 4



SUB.	PERF.	CIRCUIT CHANGES NECESSARY
12BE6	G	Change socket to miniature and rewire as follows:

No. 2 on octal to No. 3 on miniature
3 to 5
4 to 6
5 to 1
6 to 2
7 to 4
8 to 7



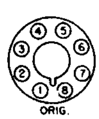
SUB.	PERF.	CIRCUIT CHANGES NECESSARY
12J7	P	Make adaptor as follows:
12K7	P	

No. 1 on base to No. 1 on top
2 to 2
3 to 3
4 to 4
5 to cap
6 to 8
8 to 5

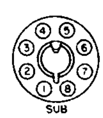
SUB.	PERF.	CIRCUIT CHANGES NECESSARY
12SJ7	P	Change connections as follows:
12SK7	P	

Reverse Nos. 8 and 3
Remove wire from No. 6
Move wire from No. 4 to 6
from 5 to 4
from 6 to 5
This uses suppresor grid as control grid and control as oscillator grid.

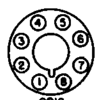
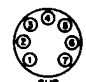
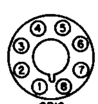
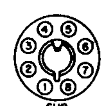
SUB.	PERF.	CIRCUIT CHANGES NECESSARY
14Q7	G	Change socket to loctal and rewire as follows:



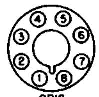
No. 2 on octal to No. 1 on loctal
3 to 2
4 to 3
5 to 4
6 to 7 and 5
7 to 8
8 to 6



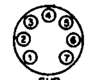
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
12SC7	12SL7	G	Same as 6SC7 to 6SL7.
	1634	G	No changes.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
12SF5	12F5	G	Reverse 6F5 to 6SF5 procedure.
	12J5	G	Rewire as follows: Reverse No. 2 and No. 8 Reverse No. 3 and No. 5
12SF7	12SK7 and Germanium Diode	P	Rewire as follows: Move wire from No. 2 to No. 4 6 to 8 8 to 2 4 to 6 Remove wires from No. 5 Connect No. 3 and No. 5 together Diode crystal from No. 3 or 5 to wires removed from No. 3
12SG7	12AU6 12BA6 12BD6	G G G	Change socket to miniature and rewire as follows: No. 2 on octal to No. 3 on miniature 3 to 7 4 to 1 5 to 7 6 to 6 7 to 4 8 to 5  ORIG.  SUB.
	12SH7 12SJ7 12SK7	G G G	No changes.
12SH7	12AU6 12BA6 12BD6	G G G	Same as 12SG7 to 12BA6.
	12SG7 12SJ7 12SK7	G G G	No changes.
12SJ7	6S7 6W7	P P	Same as 12SK7 to 12K7. Series circuits only.
	12B7 14A7 14C7	G G G	Change socket to loctal and rewire as follows: No. 2 on octal to No. 1 on loctal 3 to 4 4 to 6 5 to 7 6 to 3 7 to 8 8 to 2  ORIG.  SUB.
	12J7 12K7	G G	Same as 12SK7 to 12K7.
12SK7	6S7 6W7	P P	Same as 12SK7 to 12K7. Series circuits only.
	6SS7	P	No changes. Series circuits only.

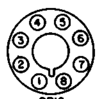
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
12SK7	12AV6	G	Change socket to miniature and rewire as follows:
	12BA6	G	
	12BD6	G	


ORIG.

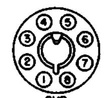
No. 2 on octal	to No. 3 on miniature
3	to 2
4	to 1
5	to 7
6	to 6
7	to 4
8	to 5


SUB.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	12B7	E	Change socket to loctal and rewire as follows:
	14A7	E	
	14C7	G	


ORIG.

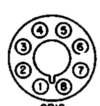
No. 1 on octal	to No. 5 on loctal
2	to 1
3	to 4
4	to 6
5	to 7
6	to 3
7	to 8
8	to 2


SUB.

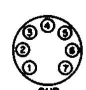
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	12J7	G	Make adaptor as follows:
	12K7	E	

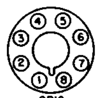
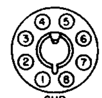
No. 1 on base	to No. 1 on top
2	to 2
3	to 5
4	to cap
5	to 8
6	to 4
7	to 7
8	to 3

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	12SG7	G	No changes.
	12SH7	G	
	12SJ7	G	
12SL7	12SC7	G	Reverse 6SC7 to 6SL7 procedure. If the 12SL7 employs the two cathodes separately this substitution may be impractical.
12SN7	12SL7	P	Parallel circuits only. No changes.
	12SX7	G	No changes.
12SQ7	6ST7	P	Series circuits. No changes.
	6T7	P	Same as 12SQ7 to 12Q7. Series circuits only.
	7C6	P	Same as 12SQ7 to 14B6. Series circuits only.
	12AT6	G	Change socket to miniature and rewire as follows:
	12AV6	G	
	12BK6	G	
	12BT6	G	
	12BU6	P	


ORIG.

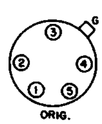
No. 2 on octal	to No. 1 on miniature
3	to 2
4	to 5
5	to 6
6	to 7
7	to 3
8	to 4


SUB.

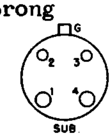
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
12SQ7	12Q7	E	Make adaptor as follows:
			No. 1 on base to No. 1 on top
			2 to cap
			3 to 8
			4 to 4
			5 to 5
			6 to 3
			7 to 7
			8 to 2
	12SR7	G	No changes.
	12SW7	P	No changes.
	14B6	E	Change socket to loctal and rewire as follows:
	14E6	G	No. 2 on octal to No. 3 on loctal
			3 to 7
			 ORIG. 4 to 5
			5 to 6
			6 to 2  SUB.
			7 to 8
			8 to 1
12SR7	12AT6	P	Same as 12SQ7 to 12AT6.
	12AV6	P	
	12BK6	P	
	12BT6	P	
	12BU6	G	
	12Q7	G	Same as 12SQ7 to 12Q7.
	12SQ7	G	No changes.
	12SW7	G	No changes.
	14B6	G	Same as 12SQ7 to 14B6.
	14E6	G	
12SW7	12AT6	P	Same as 12SQ7 to 12AT6.
	12AV6	P	
	12BK6	P	
	12BT6	P	
	12BU6	G	
	12SQ7	P	No changes.
	12SR7	G	
12SX7	12SL7	P	Parallel circuits only. No changes.
	12SN7	G	No changes.
12SY7	12SA7	G	No changes.
	14Q7	G	Same as 12SA7 to 14Q7.
12Z3	1V	G	Series circuits only. No changes.
	14Z3	G	No changes.
12Z5			No practical substitute.
14A4	12J5	E	Reverse 6J5 to 7A4 procedure.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
14A5	12A6	E	Reverse 35L6 to 35A5 procedure.
	1284	P	No changes. Connect No. 4 to No. 7 for best results.
14A7/12B7	6S7	P	Reverse 12K7 to 7B7 procedure. Series circuits only.
	6W7	P	
	6SS7	P	Reverse 12SJ7 to 7B7 procedure. Series circuits only.
	7B7	P	Series circuits only. No changes.
	7C7	P	
	12B7	E	No changes.
	14C7	G	
	14H7	G	
	1280	G	
	1284	E	
	12J7	G	Reverse 12K7 to 7B7 procedure.
	12K7	E	
	12SH7	G	Reverse 12SJ7 to 7B7 procedure.
	12SJ7	G	
	12SK7	E	
14AF7/XXD	12AH7	G	Reverse 12AH7 to 14AF7/XXD procedure.
	14F7	G	No changes.
	14N7	G	Parallel circuits only. No changes.
14B6	7C6	P	Series circuits only. No changes.
	12Q7	E	Reverse 6Q7 to 7B6 procedure.
	14E6	G	No changes.
14B8	7A8	P	Series circuits only. No changes.
	12A8	G	Reverse 12A8 to 14B8 procedure.
	14J7	G	No changes.
	14S7	G	
14C5	14A5	G	Parallel circuits only. No changes.
14C7	7B7	P	Series circuits only. No changes.
	7C7	P	
	12B7	E	No changes.
	14A7	G	
	14H7	G	
	1280	G	
	1284	E	
14E6	12Q7	G	Reverse 6Q7 to 7B6 procedure.
	14B6	G	No changes.
14E7	12C8	G	Reverse 12C8 to 14E7 procedure.

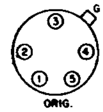
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
14E7	14R7	G	No changes.
14F7	12AH7	G	Reverse 12AH7 to 14AF7/XXD procedure.
	14AF7/XXD	G	No changes.
	14F8	G	Reverse 7F8 to 7F7 procedure.
14F8	14F7	G	Same as 7F8 to 7F7.
14H7	12B7	G	No changes.
	14A7	G	
	14C7	G	
	1280	G	
	1284	G	
14J7	7A8	P	Series circuits. No changes.
	14B8	G	No changes.
	14S7	G	
14N7	14AF7/XXD	G	Parallel circuits only. No changes.
14Q7	12SA7	G	Reverse 12SA7 to 14Q7 procedure.
14R7	12C8	G	Reverse 12C8 to 14E7 procedure.
	14E7	G	No changes.
14S7	7A8	P	Series circuits only. No changes. Put 200 or 250 ohm 1/2 watt resistor across filament terminals when substituting 7 volt for 12 volt types to compensate for faster heating.
	14B8	G	No changes.
	14J7	G	No changes.
14V7			No practical substitute.
14W7	12B7	G	No changes.
	14A7	G	
	14C7	G	
	14H7	G	
	1280	G	
	1284	G	
14Y4			No practical substitute.
15	1A4	G	Same as 15 to 1B4. Battery operation only. Parallel circuits.
	1B4	G	For battery operation only. Parallel circuits. Change socket to four prong type and rewire as follows:



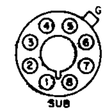
No. 1 on five prong	to	No. 1 on four prong	
2	to	2	
3	to	3	
4	to	4	
5	to	4	
cap	to	cap	



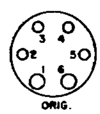
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
15	1E5	G	For battery operation only. Parallel circuits. Change socket to octal and rewire as follows:



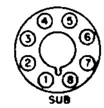
No. 1 on five prong	to No. 2 on octal
2	to 3
3	to 4
4	to 7
5	to 7
cap	to cap



TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	32	G	Same as 15 to 1B4. Battery operation only. Parallel circuits.
	34	G	
	951	G	
17			No practical substitute.
18			No practical substitute.
19	1J6	E	Change socket to octal and rewire as follows:



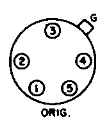
No. 1 on six prong	to No. 2 on octal
2	to 3
3	to 4
4	to 5
5	to 6
6	to 7



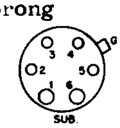
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
19BG6	25BQ6	P	Rewire as follows:

No. 8	to No. 4
3	to 8

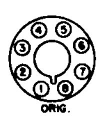
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
19C8	19T8	G	No changes.
19T8	19C8	G	No changes.
20	X99	G	Parallel circuits only. No changes.
20J8			No practical substitute.
21A7			No practical substitute.
22			No practical substitute.
24A	35/51	G	Use as IF or RF amplifier. Does not make good detector.
	57	G	Change socket to six prong and rewire as follows:
	58	E	



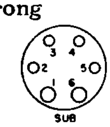
No. 1 on five prong	to No. 1 on six prong
2	to 2
3	to 3
4	to 4 and 5
5	to 6
cap	to cap

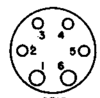
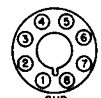


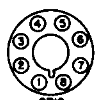
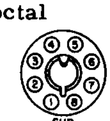
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
25A6	25B6	G	No changes.
	25C6	G	
	25L6	G	
	43	G	Change socket to six prong and rewire as follows:



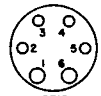
No. 2 on octal	to No. 1 on six prong
3	to 2
4	to 3
5	to 4
7	to 6
8	to 5



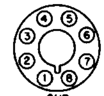
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
25A6	5824	G	No changes.
25A7	32L7	E	No changes.
25AC5			This is a positive bias triode output tube. Operation can be accomplished by rewiring circuit and installing standard power amplifier tube.
25AV5	25BQ6	G	Rewire as follows: No. 8 to No. 4 3 to 8 5 to cap 1 to 5
25B5	25N6 25B6 25C6 25L6	G G G G	Change socket to octal and rewire as follows: No. 1 on six prong to No. 2 on octal 2 to 3 3 to 4 4 to 5 5 to 8 6 to 7  ORIG.  SUB.
	43	G	No changes.
25B6	25A6	G	No changes.
	25B5	E	Reverse 25B5 to 25N6 procedure.
	25G6 25L6 25N6	G G G	No changes.
	43	G	Reverse 43 to 25L6 procedure.
	5824	E	No changes.
25B8GT			No practical substitute.
25BQ6	19BG6	G	Rewire as follows: No. 8 to No. 3 4 to 8 Insert 20 ohm 10 watt resistor in series with filament circuit.
	25AV5	G	Rewire as follows: No. 5 to No. 1 cap to 5 8 to 3 4 to 8
25C6	25A6	G	No changes.
	25B5	G	Reverse 25B5 to 25N6 procedure.
	25B6 25LG	G G	No changes.
	25N6	G	No changes.
	43	G	Reverse 43 to 25L6 procedure.
	5824	G	No changes.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
25D8GT			No practical substitute.
25L6	25A6	G	No changes.
	25B5	G	Reverse 25B5 to 25N6 procedure.
	25B6 25C6	G G	No changes.
	25N6	G	No changes.
	43	G	Reverse 43 to 25L6 procedure.
	5824	E	No changes.
25N6	25B5	G	Reverse 25B5 to 25N6 procedure.
25S	1B5	E	No changes.
25W4	25Z6	E	Rewire as follows: No. 8 to No. 2 3 to 4 Connect No. 4 and No. 8 together 3 and 5 together
25X6	25Z6	G	Where 25X6 is used by itself only. Replace line cord with 310 ohms. No changes.
	50X6	G	When 25X6 is used by itself, replace line cord or filament dropping resistor with 445 ohms. Change socket to loctal and rewire as follows: No. 2 on octal to No. 1 on loctal 3 to 3 4 to 2 5 to 6 7 to 8 8 to 7  ORIG.  SUB.
	50Y6	G	Where 25X6 is used by itself, replace line cord or filament dropping resistor with 445 ohms.
	50Y7 50Z7	G G	When 25X6 is used by itself, replace line cord or filament dropping resistor with 445 ohms. Do not use No. 6 for anchor.
25Y4			No practical substitute.
25Y5	25Z5	E	No changes.
	25Z6	E	Same as 25Z5 to 25Z6.
25Z3			No practical substitute.
25Z4	25Z6	E	No changes. Remove and tape up wires on unused terminals.
25Z5	6J5	P	Connect 60 ohm 5 watt resistor in series with filament circuit, will not work in voltage doubler circuit. If one cathode is used by itself for field excitation connect 4 and 8 together.
	25Y5	E	No changes.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
25Z5	25Z6	E	Change socket to octal and rewire as follows:


ORIG.

No. 1 on six prong	to No. 2 on octal
2	to 3
3	to 4
4	to 8
5	to 5
6	to 7


SUB.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
25Z6	6J5	P	Connect 60 ohm 5 watt resistor in series with filament circuit, will not work in voltage doubler circuit. If one cathode is used by itself for field excitation connect 4 and 3 together. Make adaptor as follows:

No. 1 on base	to No. 2 on top
2 and 5	to 3 and 5
3 and 4	to 8
6	to 7

Can be used only in half wave circuits. If the cathodes are separate supplies in a half wave circuit connect 4 and 8 together. Insert 10 watt 75 or 100 ohm resistor in series with the filament string.

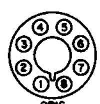
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	6SL7	P	Insert 75 or 100 ohm 10 watt resistor in series with the filament string.
	6SN7	P	
	25AC5	P	No changes. Use only where 4 and 8 are connected together. Will not work in voltage doubler circuit. If one cathode is used by itself for field excitation tie 4 and 8 together.
	25W4	G	When 25Z6 is used as straight half wave rectifier. Rewire as follows:

No. 3	to No. 5
4 and 8	to 3
2	to 8

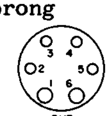
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	25Z4	G	Where 25Z6 is used as straight half wave rectifier only. Rewire as follows:

No. 3	to No. 5
4	to 8

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	25Z5	E	Change octal to six prong socket and rewire as follows:

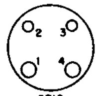

ORIG.

No. 2 on octal	to No. 1 on six prong
3	to 2
4	to 3
5	to 5
7	to 6
8	to 4

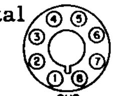

SUB.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	35Z6	G	No changes.
26			No practical substitute.
26A6			No practical substitute.
26A7			No practical substitute.
26BK6	26C6	P	No changes.
26C6	26BK6	P	No changes.
26D6			No practical substitute.
27	56	G	No changes.
	485	P	

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
28D7	28D7W	E	No changes.
28D7W	28D7	E	No changes.
28Z5			No practical substitute.
30	1E4	P	Change socket to octal and rewire as follows:
	1G4	P	No. 1 on four prong to No. 2 on octal
	1H4	E	2 to 3
			3 to 5
			4 to 7
	31	G	Parallel circuits only. No changes.
31	30	G	Parallel circuits only. No changes.
32	1A4	G	No changes. 34 does not make good detector.
	1B4	G	
	34	G	
	951	G	
32L7	25A7	E	No changes.
	70A7	G	No changes. Difference in filament current makes necessary line resistance the same. Use only where 32L7 does not have other tubes in series with it.
	70L7	G	Reverse 6 and 8. Cord is correct. Use only where 32L7 does not have other tubes in series with it.
	117L7	G	Remove or short out the filament resistor and reverse connections 4 and 5
	117M7	G	to socket.
	117N7	G	Remove or short out filament resistor. Change connections as follows:
	117P7	G	No. 6 to 7
			8 to 6
			1 to 8
			4 to 5
			5 to 4
			Use only in conventional circuits where rectifier is first in the string and A.C. is connected to No. 7.
33	1F4	G	Parallel circuits only. No changes.
	950	E	
34	1A4	G	No changes.
	1B4	G	
	32	G	
	951	G	
35A5	6G6	P	Same as 35A5 to 35L6 but put a 250 ohm 10 watt resistor in series with the filament circuit.
	12A6	P	Same as above but put a 250 ohm 10 watt resistor in series with filament circuit.
	14A5	P	Put 125 ohm 10 W resistor in series with filament.



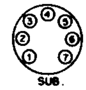
ORIG.



SUB.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
35A5	35B5 50B5	E G	Change socket to miniature and rewire as follows:

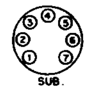
No. 1 on loctal	to No. 3 on miniature
2	to 5
3	to 6
6	to 1
7	to 2
8	to 4



Do not use No. 7 on miniature.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	35C5 50C5	E G	Change socket to minature and rewire as follows:

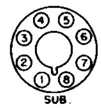
No. 1 on loctal	to No. 3 on miniature
2	to 7
3	to 6
6	to 2
7	to 1
8	to 4



Do not use No. 5 on miniature.

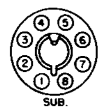
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	35L6 50L6	E G	Change socket to octal and rewire as follows:

No. 1 on loctal	to No. 2 on octal
2	to 3
3	to 4
6	to 5
7	to 8
8	to 7

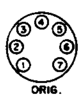


TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	50A5	G	No changes.
35B5	35A5 50A5	E G	Where space permits. Change socket to loctal and rewire as follows.

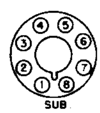
No. 1 on miniature	to No. 6 on loctal
2	to 7
3	to 1
4	to 8
5	to 2
6	to 3
7	to 6



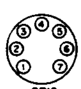
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	35C5 50C5	E G	Rewire as follows: Reverse No. 1 and No. 2 5 and 7
	35L6 50L6	E G	Where space permits. Change socket to octal and rewire as follows:



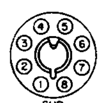
No. 1 on miniature	to No. 5 on octal
2	to 8
3	to 2
4	to 7
5	to 3
6	to 4
7	to 5

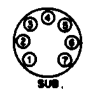
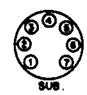
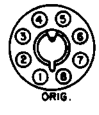
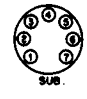


TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	50B5	G	No changes.
35C5	35A5 50A5	E G	Where space permits, change socket to loctal and rewire as follows:



No. 1 on miniature	to No. 7 on loctal
2	to 6
3	to 1
4	to 8
5	to 6
6	to 3
7	to 2



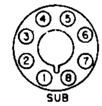
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
35L6	6G6	P	Put 250 ohm 10 watt resistor in series with filament circuit.
	12A6	P	Insert 150 ohms resistance in series with the filament circuit.
	12J5	P	Insert 150 ohms resistance in series with the filament circuit.
	35A5 50A5	E G	Change socket to loctal and rewire as follows:  No. 2 on octal to No. 1 on loctal 5 to 2 4 to 3 5 to 6 8 to 7 7 to 8 
	35B5 50B5	E G	Change socket to miniature and rewire as follows:  No. 2 on octal to No. 3 on miniature 3 to 5 4 to 6 5 to 1 7 to 4 8 to 2 Do not use No. 7 on miniature. 
	35C5 50C5	E G	Change socket to miniature and rewire as follows:  No. 2 on octal to No. 3 on miniature 3 to 7 4 to 6 5 to 2 7 to 4 8 to 1 Do not use terminal No. 5 on miniature. 
	50C6 50L6	G G	No changes.
35W4	35Y4 35Z3 35Z5	E E E	Where space permits. Reverse 35Y4 to 35W4 procedure.
	117Z3	G	Where 35W4 is used by itself only. Remove line cord resistor or filament dropping resistor and replace with ordinary line cord. Rewire as follows: Remove and tape up any wires on No. 6 No. 7 to No. 6 Pilot light will not burn. In order to light pilot light, connect 40 ohm 1 watt resistor in series with filament and connect pilot light across it.
35Y4	35W4	E	Change socket to miniature and rewire as follows:  No. 1 on loctal to No. 3 on miniature 2 to 5 4 to 6 7 to 7 8 to 4 
	35Z3	E	No change is necessary but pilot light will not light. Pilot light can be lit by same method as used from 35Z5 to 35Z4.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY

35Y4 — 35Z5 — E

Change socket to octal and rewire as follows:

No. 1 on loctal	to No. 2 on octal
2	to 5
4	to 3
7	to 8
8	to 7



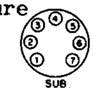
35Z3 — 7A6 — P

Move wire from No. 2 to No. 3. Short 3 and 6 together and 2 and 7 together. Connect 200 ohm 10W resistor in series with filament circuit.

35W4 — E

Change socket to miniature and rewire as follows :

No. 1 on loctal	to No. 3 on miniature
2	to 5
7	to 7
8	to 4



Do not anchor on unused terminals.

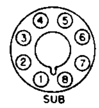
35Y4 — E

No changes. Remove wires, if any, from pin No. 4 and tape them up.

35Z4 — E
35Z5 — E

Change socket to octal and rewire as follows:

No. 1 on loctal	to No. 2 on octal
2	to 5
7	to 8
8	to 7



45Z5 — G

Same as 35Z3 to 35Z4.

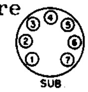
35Z4 — 12J5 — P

Add 150 ohm 5W resistor in series with filaments. Short Nos. 3 and 5.

35W4 — E

Change socket to miniature and rewire as follows:

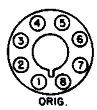
No. 2 on octal	to No. 3 on miniature
5	to 5
7	to 4
8	to 7



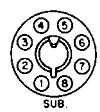
Do not connect to unused terminals.

35Y4 — E
35Z3 — E

Change socket to loctal and rewire as follows:



No. 2 on octal	to No. 1 on loctal
5	to 2
7	to 8
8	to 7



35Z5 — E

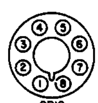
No change is necessary but remove wires, if any, from pin No. 3 and tape them up.

35Z5 — 12J5 — P

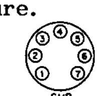
Add 150 ohm 5W resistor in series with filaments. Remove wires from No. and connect to No. 2 through 25 or 30 ohm 1W resistor. Short Nos. 3 and 5.

35W4 — E

Change socket to miniature and rewire as follows:



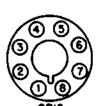
No. 2 on octal	to No. 3 on miniature.
3	to 6
5	to 5
7	to 4
8	to 7



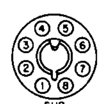
Do not connect to unused terminals.

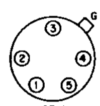
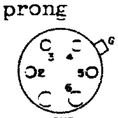
35Y4 — E

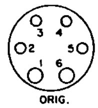
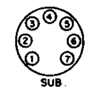
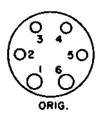
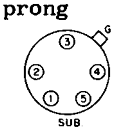
Change socket to loctal and rewire as follows:

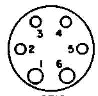
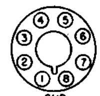
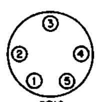
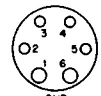
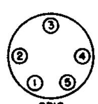
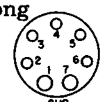


No. 2 on octal	to No. 1 on loctal
3	to 4
5	to 2
7	to 8
8	to 7

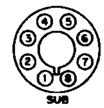
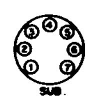


TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
35Z5	35Z4	E	No change is necessary but pilot light will not light. In order to light the pilot light,put a 40 ohm resistor in series with the filaments and connect the pilot light across it. This resistor must have a 1 watt rating.
	45Z5	G	No changes.
35Z6	25Z6	G	No change, unless 35Z6 is used singly in which case put 35 ohm 10 watt resistor in filament string.
	50Z6	G	No changes. Where a full set of five or six tubes are used, little change in operation will be noted. If 35Z6 is used by itself, this substitution may not be satisfactory.
35/51	24A	G	No changes.
36	6C6 6D6	E G	Same as 37/44 to 6D6.
	39/44	G	No changes.
	77 78	E G	Same as 37/44 to 6D6.
37	76	E	No changes.
38	41 42	G G	Parallel circuits only. Reverse 41 to 38 procedure.
39/44	6C6 6D6 77 78	G E G E	Change socket to six prong and rewire as follows: No. 1 on five prong to No. 1 on six prong 2 to 2 3 to 3 4 to 4 and 5 5 to 6 cap to cap  ORIG.  SUB.
	6J7 6K7	G E	Reverse 6K7 to 39/44 procedure.
	6S7	G	Reverse 6K7 to 39/44 procedure. Parallel circuits only.
	6SH7 6SJ7 6SK7	G G E	Reverse 6SK7 to 39/44 procedure.
	6SS7	G	Reverse 6SK7 to 39/44 procedure. Parallel circuits only.
	6U7 6W7	G G	Reverse 6K7 to 39/44 procedure.
	7A7 7H7 7L7	E G G	Reverse 7A7 to 39/44 procedure.
	7B7 7C7	G G	Reverse 7A7 to 39/44 procedure. Parallel circuits only.
	36	G	No changes.
40	00A 01A 12A	G G G	No changes.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
41	6A4/LA	G	Parallel circuits only. Reverse 6A4/LA to 42 procedure.
	6AD7	G	Reverse 6F6 to 41 procedure. Parallel circuits only. Connect nothing to unused pins.
	6AR5	G	Change socket to miniature and rewire as follows: No. 1 on six prong to No. 3 on miniature 2 to 5 3 to 6 4 to 1 5 to 2 6 to 4 
	6F6	G	Parallel circuits only. Reverse 6F6 to 41 procedure.
	6G6	P	
	6L6	G	
	6U6	G	
	6V6	G	
	6K6	E	Reverse 6F6 to 41 procedure.
	7A5	G	Parallel circuits only. Reverse 7B5 to 41 procedure.
	7B5	E	Reverse 7B5 to 41 procedure.
	7C5	G	Parallel circuits only. Reverse 7B5 to 41 procedure.
	38	G	Parallel circuits only. Change socket to five prong and rewire as follows: No. 1 on six prong to No. 1 on five prong 2 to 2 3 to 3 4 to cap 5 to 4 6 to 5 
	42	G	No changes.
	89	G	Change socket connections as follows: Move wire from No. 4 to cap. Short Nos. 4 and 5 together.
42	6A4/LA	G	Parallel circuits only. Reverse 6A4/LA to 42 procedure.
	6AD7	G	Parallel circuits only. Reverse 6F6 to 41 procedure. Remove and tape up any wires connected to unused pins.
	6AR5	G	Same as 41 to 6AR5. Parallel circuits only.
	6B5	G	No changes.
	6F6	E	Reverse 6F6 to 41 procedure.
	6G6	P	Parallel circuits only. Reverse 6F6 to 41 procedure.
	6K6	G	
	6L6	G	
	6U6	G	
	6V6	G	
	7A5	G	Reverse 7B5 to 41 procedure.
	7B5	G	Parallel circuits only. Reverse 7B5 to 41 procedure.
	7C5	G	

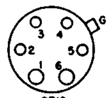
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
42	38	G	Same as 41 to 38. Parallel circuits only.
	41	G	No changes.
	89	G	Same as 41 to 89. Parallel circuits only.
43	25A6	G	Reverse 25A6 to 43 procedure.
	25L6	E	Change socket to octal and rewire as follows:  ORIG. No. 1 on six prong to No. 2 on octal 2 to 3 3 to 4 4 to 5 5 to 8 6 to 7  SUB
45	2A3	G	No changes.
45Z3	35W4	G	Where 45Z3 is used by itself only, remove 960-ohm line cord resistor or filament dropping resistor and replace with 550-ohm. Rewire as follows: No. 1 to No. 3 2 to 5 6 to 5 Reverse Nos. 4 and 7 Do not anchor to unused terminals.
	117Z3	G	Where 45Z3 is used by itself only, remove line cord resistor or filament dropping resistor and replace with ordinary line cord. Rewire as follows: No. 7 to No. 3 2 and 6 to 5 4 to 6 1 to 4
45Z5	35Z5	G	No changes.
46	47	G	Only when 46 is operated as class A with plate and screen tied together.
47	2A5	G	Change socket to six prong type and rewire as follows:  ORIG. No. 1 on five prong to No. 1 on six prong 2 to 2 3 to 4 4 to 3 5 to 6  SUB Connect 5 and 6 together.
	46	P	Remove wire from No. 4 and short Nos. 2 and 4 together.
	59	G	Change socket to seven prong and rewire as follows:  ORIG. No. 1 on five prong to No. 1 on seven prong 2 to 2 3 to 4 4 to 3 5 to 5,6 and 7  SUB.
	1619	G	Parallel circuits only. Make adaptor as follows: No. 1 on base to No. 2 on top 2 to 3 3 to 5 4 to 4 5 to 7 and 8 There are or will be many used 1619 tubes available.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
48			No practical substitute.
49			No practical substitute.
50	10	G	No changes.
50A5	35A5	E	No changes. Place 100-ohm resistor in filament circuit.
	35B5	E	Same as 35A5 to 35B5. Place 100-ohm 10-W resistor in series with filaments.
	35C5	E	Same as 35A5 to 35C5. Place 100-ohm 10-W resistor in series with filament.
	35L6	E	Same as 35A5 to 35L6. Place 100-ohm resistor in filament circuit.
	50B5	E	Same as 35A5 to 35B5.
	50C5	E	Same as 35A5 to 35C5.
	50C6 50L6	G E	Same as 35A5 to 35L6.
50AX6	50Z6	G	No changes.
50B5	35B5	E	Place 100 ohms 5 watts in series with filament.
	50A5	G	Where space permits. Same as 35B5 to 35A5.
	50C5	E	Same as 35B5 to 35C5.
	50L6	G	Where space permits. Same as 35B5 to 35L6.
50C5	50A5	G	Where space permits. Same as 35C5 to 35A5.
	50L6	E	Where space permits. Reverse 35L6 to 35C5 procedure.
50C6	35L6	G	Place 100-ohm 10-W resistor in series with filament.
	50A5	G	Same as 35L6 to 35A5.
	50L6	G	No changes.
50L6	12A6	P	No changes. Connect a 250-ohm 10-W resistor in series with the filament circuit.
	12J5	P	Emergency substitution. Works well at low volume. Put 250-ohm 10-w resistor in series with filaments.
	35A5	E	Same as 35L6 to 35A5. Place 100-ohm 5-w resistor in series with filaments.
	35B5	E	Same as 35L6 to 35B5. Place 100-ohm 10-w resistor in series with filament.
	35C5	E	Same as 35L6 to 35C5. Place 100-ohm 10-w resistor in series with filament.
	35L6	E	Place 100-ohm 5-w resistance in series with filaments.
	50B5	E	Same as 35L6 to 35B5.
	50C5	E	Same as 35L6 to 35C5.
	70A7	P	Remove and tape up wires connected to No. 6 or cut off No. 6 pin on 70A7.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
50X6	25X6	G	Insert 160-ohm 10-w resistor in series with filament. Reverse 25X6 to 50X6 procedure.
	50Y6	G	Reverse 25X6 to 50X6 procedure.
	50Y7 50Z7	E E	Change socket to octal and rewire as follows: No. 1 on loctal to No. 2 on octal 2 to 4 3 to 3 6 to 5 7 to 8 8 to 7 Do not use No. 6 for anchor.  
50Y6	50Z7	E	No changes. Disconnect wires from pin No. 6, if any.
50Y7	25X6	G	Insert 160-ohm 10-w resistor in series with filament. Reverse 25X6 to 50Y7 procedure.
	50X6	G	Only when No. 7 filament tap on 50Y7 is not used. Reverse 50X6 to 50Y7 procedure.
	50Y6	G	Only when No. 7 filament tap on 50Y7 is not used. Reverse 25X6 to 50Y7 procedure.
	50Z7	G	No changes.
50Z6	25Z6	E	No changes. Place 83-ohm 20-w resistor in series with filament.
	35Z6	E	Place 50-ohm resistor in series with filament.
	50AX6	E	No changes.
50Z7	50Y6	E	No changes are necessary but pilot light will not light. You may light pilot light by inserting 40 ohms resistance in series with the filament circuit and connecting the pilot light across it.
	50Y7	G	No changes.
EF50	6AH6 6AK6	G G	Same as EF50 to 6AU6. Parallel circuits only.
	6AU6 6BA6 6BD6	G G G	Change socket to miniature and rewire as follows: No. 1 on noval to No. 3 on miniature 2 to 6 3 to 5 4 to 2 6 to 7 7 to 1 9 to 4  
52			No practical substitution.
VT52	10 50	P P	Parallel circuits only. No changes.
53	5608-A	E	No changes.
55	2A6	E	No changes.
55S	2A6 55	E E	No changes.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
56	27	G	No changes.
	485	G	No changes.
56AS	37	E	Parallel circuits only. No changes.
	76	E	
56S	27	E	No changes.
	56	E	
57	58	G	No changes.
57AS	6C6	E	Parallel circuits only. No changes.
	77	E	
57S	57	E	No changes.
	58	E	
58	57	G	No changes. 58 is not a good second detector.
58AS	6D6	E	Parallel circuits only. No changes.
	78	E	
58S	57	E	No changes.
	58	E	
59	47	G	Reverse 47 to 59 procedure.
	1619	G	Parallel circuits only. Make adaptor as follows: No. 1 on base to No. 2 on top 2 to 3 3 to 4 4 to 5 5 and 6 to 8 7 to 7 There are or will be many used 1619 tubes available.
70A7	32L7	G	No changes. Where no other tubes in series with the 70A7 which has 150 mil filament instead of 0.3 amp.
	70L7	E	Change connection as follows: No. 8 to No. 6 6 to 8 Connect Nos. 7 and 8 together. Pilot light will not light but may be lit by same procedure as 50Z7 to 50Y6.
	117L7	E	Remove the line cord resistor and replace with straight AC cord. Reverse connections to 4 and 5.
	117M7	E	
	117N7	E	Remove line resistor cord and replace with straight AC cord. Remove wire from No. 8 Move No. 1 to No. 8 Reverse Nos. 4 and 5 Move No. 6 to No. 7 Place No. 8 on No. 6
	117P7	E	
70L7	32L7	G	Cord is correct. If 32L7 is alone in circuit. Reverse Nos. 6 and 8.
	70A7	E	Change connections as follows: No. 6 to No. 8 8 to 6

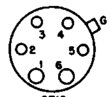
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
70L7	117L7	E	Remove line resistor cord and replace with straight AC cord.
	117M7	E	Reverse Nos. 4 and 5 Reverse 6 and 8
	117N7	E	Remove line cord resistor and replace with straight AC cord.
	117P7	E	Reverse Nos 4 and 5 No. 8 on No. 7 1 on 8
71A	482	G	No changes. If push-pull circuit, both tubes must be changed to avoid hum.
	483	G	
75	6AQ6	G	Same as 75 to 6AT6. Parallel circuits only.
	6AT6	G	Change socket to miniature and rewire as follows:
	6AV6	G	
	6BF6	G	
	6BK6	G	
	6BT6	G	
	6BU6	G	


ORIG.

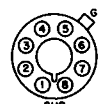
No. 1 on six prong	to No. 3 on miniature
2	to 7
3	to 5
4	to 6
5	to 2
6	to 4
cap	to 1


SUB.

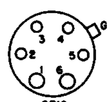
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	6B6	E	Change socket to octal and rewire as follows:
	6Q7	E	
	6R7	G	


ORIG.

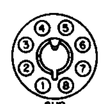
No. 1 on six prong	to No. 2 on octal
2	to 3
3	to 4
4	to 5
5	to 8
6	to 7
cap	to cap


SUB.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	6C6	P	Emergency substitution. No changes but considerable loss of volume.
	6SQ7	E	Reverse 6SQ7 to 75 procedure.
	6SR7	G	
	6T7	G	Same as 75 to 6Q7. Parallel circuits only.
	6V7	G	Same as 75 to 6Q7.
	7B6	E	Change socket to loctal and rewire as follows:
	7E6	G	


ORIG.

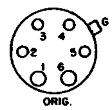
No. 1 on six prong	to No. 1 on loctal
2	to 2
3	to 5
4	to 6
5	to 4 or 7
6	to 8
cap	to 3


SUB.

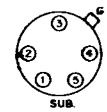
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	7C6	G	Same as above. Parallel circuits only.
	85	G	No changes. Sometimes works excellent, other times not so well.
76	6AE5	G	Reverse 6C5 to 37 procedure.
	6C5	E	Reverse 6C5 to 37 procedure.
	6J5	G	Reverse 6C5 to 37 procedure.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
76	6L5	G	Reverse 6C5 to 37 procedure.
	6P5	G	Reverse 6C5 to 37 procedure.
	7A4	E	Reverse 7A4 to 37 procedure.
	7B4	G	
	XXL	E	
	37	E	No changes.
77	6C6	E	No changes.
	6D7	G	Same as 6C6 to 6D7.
	6E7	G	
	6J7	E	
	6K7	G	Same as 6C6 to 6J7.
	6S7	G	Same as 6C6 to 6J7. Parallel circuits only.
	6SH7	G	Same as 6C6 to 6SJ7.
	6SJ7	E	Same as 6C6 to 6SJ7.
	6SK7	G	Same as 6C6 to 6SJ7.
	6U7	G	Same as 6C6 to 6J7.
	6W7	G	Same as 6C6 to 6J7. Parallel circuits only.
	7A7	G	Same as 6C6 to 7A7.
	7B7	G	Same as 6C6 to 7A7. Parallel circuits only.
	7C7	G	
	7H7	G	Same as 6C6 to 7A7.
	7L7	G	Same as 6C6 to 7A7.
	1221	E	No changes.
78	6D6	E	No changes.
	6D7	G	Same as 6C6 to 6D7.
	6E7	G	
	6J5	G	Same as 6C6 to 6J7.
	6K7	E	
	6S7	G	Same as 6C6 to 6J7. Parallel circuits only.
	6SH7	G	Same as 6C6 to 6SJ7.
	6SJ7	G	Same as 6C6 to 6SJ7.
	6SK7	E	Same as 6C6 to 6SJ7.
	6U7	G	Same as 6C6 to 6J7.
	6W7	G	Same as 6C6 to 6J7. Parallel circuits only.
	7A7	E	Same as 6C6 to 7A7.

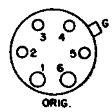
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
78	7B7	G	Same as 6C6 to 7A7. Parallel circuits only.
	7C7	G	Same as 6C6 to 7A7. Parallel circuits only.
	7H7	G	Same as 6C6 to 7A7.
	7L7	G	Same as 6C6 to 7A7.
	39/44	E	Change socket to five prong type and rewire as follows:



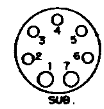
No. 1 on six prong	to No. 1 on five prong
2	to 2
3	to 3
4, remove and tape up	
5	to 4
6	to 5
cap	cap



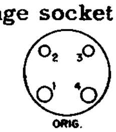
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
79*	6A6	G	Parallel circuits only. Change socket to seven prong and rewire as follows:



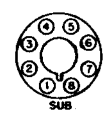
No. 1 on six prong	to No. 1 on seven prong
2	to 2
3	to 3
4	to 4
5	to 6
6	to 7
cap	to 5



TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	6N7	G	Parallel circuits only. Reverse 6N7 to 79 procedure.
	6Y7G	G	Reverse 6N7 to 79 procedure.
	6Z7	G	Parallel circuits only. Reverse 6N7 to 79 procedure.
80	5T4 5U4 5V4 5W4 5Y3 5Z4	G G G G E G	Change socket to octal and rewire as follows:

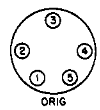
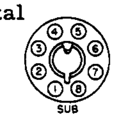
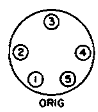
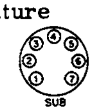
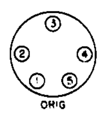
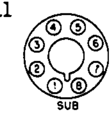


No. 1 on four prong	to No. 2 on octal
2	to 4
3	to 6
4	to 8

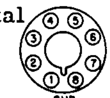


TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	5X4 5Y4	G E	Reverse 5X4 to 5Z3 procedure.
	83V 83	G G	No changes.
	5Z3	G	No changes.
81	10 50	P P	No changes.
82	2A3 45	P P	No changes.
83	5T4 5U4	G G	Same as 80 to 5U4.
	5X4	G	Reverse 5X4 to 5Z3 procedure.
	5Z3	G	No changes.

* See Addendum at back of this section.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
83V	5T4	G	Same as 80 to 5U4.
	5U4	G	
	5V4	G	
	5W4	G	
	5Y3	G	
	5Z3	G	No changes.
	5Z4	G	Same as 80 to 5U4.
	80	G	No changes.
	83	G	
84	7Y4	E	Change socket to loctal and rewire as follows:  No. 1 on five prong to No. 1 on loctal 2 to 3 3 to 6 4 to 7 5 to 8 
84/6Z4	6X4	G	Parallel circuits only. Change socket to miniature and rewire as follows:  No. 1 on five prong to No. 3 on miniature 2 to 1 3 to 6 4 to 7 5 to 4 
	6X5	E	Change socket to octal and rewire as follows:  No. 1 on five prong to No. 2 on octal 2 to 3 3 to 5 4 to 8 5 to 7 
85	6AQ6	G	Same as 75 to 6AT6. Parallel circuits only.
	6AT6	G	Same as 75 to 6AT6.
	6AV6	G	
	6B6	G	Same as 75 to 6Q7.
	6BF6	G	Same as 75 to 6AT6.
	6BK6	G	
	6BT6	G	
	6BU6	G	
	6Q7	G	Same as 75 to 6Q7.
	6R7	E	
	6SQ7	G	Reverse 6SQ7 to 75 procedure.
	6SR7	E	
	6T7	G	Same as 75 to 6Q7. Parallel circuits only.
	6V7	G	Same as 75 to 6Q7.
	7B6	G	Same as 75 to 7E6.
	7C6	G	Same as 75 to 7E6. Parallel circuits only.
	7E6	G	Same as 75 to 7E6.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
85	75	G	No changes.
85AS	85	E	No changes.
89	6K6	G	Same as 6F6 to 89. Parallel or series circuits.
	41	G	Reverse 41 to 89 procedure.
	42	G	Parallel circuits only. Reverse 41 to 89 procedure.
99V			No practical substitution.
X99	20	G	Parallel circuits only. No changes.
117L7	32L7	G	Place 280-ohm cord or 50-w resistor in series with filaments. Reverse socket connections Nos. 4 and 5.
	70A7	G	Place 300-ohm cord or 10-w resistor in series with filaments. Reverse socket connections Nos. 4 and 5.
	70L7	G	Place 300-ohm 10-w resistor in series with filaments. Reverse socket connections Nos. 4 and 5, also 6 and 8.
	117M7	E	No changes.
117L7 or 117M7	117N7 or 117P7	E E	Make adaptor as follows: No. 1 on base to No. 8 on top 2 to 2 3 to 3 4 to 4 5 to 5 7 to 7 8 to 6 AC line must connect to No. 7
117L7/M7	25A7	G	Connect 300-ohm line cord in place of AC cord and change connections as follows: Reverse Nos. 4 and 5.
117M7	32L7	G	Same as 117L7 to 32L7.
	70A7	G	Same as 117L7 to 70A7.
	70L7	G	Same as 117L7 to 70L7.
117N7	25A7	G	Connect 300-ohm line cord in place of AC cord and change connections as follows: No. 6 to No. 7 8 to 6 1 to 8 Reverse Nos. 4 and 5.
	32L7	G	Remove and tape up any wire anchored on No. 1. Place 280-ohm cord or 50-w resistor in series with filaments. Reverse socket connections Nos. 4 and 5. Move No. 8 to No. 1.
	70A7	G	Place 300-ohm cord or 10-w resistor in series with filaments. Reverse socket connections Nos.4 and 5. Move No. 8 to No.1 and No. 6 to No. 8.
	70L7	G	Remove and tape up any wires connected to No. 1. Place 300-ohm cord or 10-w resistor in series with filaments. Reverse Nos. 4 and 5, move No. 8 to No. 1 and short Nos. 7 and 8 together. For use in circuits where AC line is connected to No.7.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
117N7	117P7	E	No changes.
117P7	25A7	G	Same as 117N7 to 25A7. Cord or resistor must dissipate 90 w.
117Z3	35W4	G	Replace line cord with 533-ohm resistor cord. Rewire as follows: No. 6 to No. 7 Do not use No. 6 for anchor.
	45Z3	G	Replace line cord with 960-ohm resistor cord. Rewire as follows. No. 3 to No. 1 4 to 7 5 to 2 6 to 4 Do not use unused terminals for anchors.
	117Z4	G	Where space permits. Change socket to octal and rewire as follows: No. 3 on miniature to No. 2 on octal 4 to 7 5 to 5 6 to 8  ORIG.  SUB
117Z4	117Z3	G	Reverse 117Z3 to 117Z4 procedure.
	117Z6	E	No change except to remove and tape up any wires which may be anchored to Nos. 3 and 4.
117Z6	6X5	P	Connect 200-ohm 100-w resistor in series with filament. Use only where Nos. 4 and 8 are tied together.
	25Z6	G	Connect 300-ohm line cord or 50-w resistor in series with filament.
	50Y6	E	No change except that a 450-ohm 20-w resistor or line cord must be used in series with the filament.
	50Z6	E	Connect 220-ohm line cord in place of AC cord.
	50Z7	E	Connect 440-ohm line cord in place of AC cord.
182B/482B	71A 183/483	E E	No changes.
183/483	71A 182B/482B	E E	No changes.
210T	VT52 10 50	P E G	No changes.
485	27	G	No changes in connections but put one inch piece of screen wire doubled in series with one side of filament winding.
	56	G	Same as 485 to 27.
864			No practical substitute.
950	1F4	G	No changes.
	33	G	Parallel circuits only. No changes.
954	956	E	No changes.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
955	5731	P	No changes.
956	954	E	No changes.
957	958A	G	Parallel circuits only. No changes.
958A	957	G	Parallel circuits only. No changes.
959			No practical substitute.
FM1000			No practical substitute.
1005/CK1005	0Y4	G	No changes.
	0Z4A	G	
CK1013	5517	E	No changes.
1201	7E5	E	No changes.
1203	7C4	E	No changes.
1204	7AB7	E	No changes.
1206	7G8	E	No changes.
1221	6C6	E	No changes.
	77	E	
1223	6J7	E	No changes.
1229	1A4	E	No changes.
	1B4	E	
	32	E	
	951	E	
1230	30	E	No changes.
1231	7G7	G	No changes.
	7V7	G	
1232	7G7	E	No changes.
1247			No practical substitute.
1265			No practical substitute.
1266			No practical substitute.
1267	0A4	G	No changes.
1273	7A7	G	No changes.
	7AJ7	G	
	7H7	G	
	7L7	G	
	7T7	G	
1274	6AX5	G	Parallel circuits only. No changes.
	6W5	G	
	6ZY5	G	
	6AX6	G	No change necessary but tie Nos. 4 and 8 together if convenient.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
1274	6BY5	G	Parallel circuits only. Rewire as follows: Connect Nos. 1 and 8 together No. 3 to No. 4
	6X5	E	No changes.
	7Y4	E	Same as 6X5 to 7Y4. Parallel circuits only.
	7Z4	E	
1275	5X3	G	No changes.
	5Z3	E	
	80	G	
	83	G	
	83V	G	
1276			No practical substitute.
1280	12B7	G	No changes.
	14A7	G	No changes.
	14C7	G	
	14H7	E	
	1284	G	
1284	12B7	G	No changes.
	14A7	G	
	14C7	G	
	14H7	G	
	1280	G	
1291	3B7	E	No changes.
1293	1LE3	G	Parallel circuits only. No changes.
1294	1R4	E	No changes.
1299	3D6	E	No changes.
1612	6L7	E	No changes.
1614	6L6	E	No changes.
1619	2A5	G	Reverse 2A5 to 1619 procedure.
1620	6J7	E	No changes.
1626	12E5	G	Parallel circuits only. No changes.
	12J5	G	
1629			No practical substitute.
1634	12SC7	G	No changes.
1644	12L8	G	No changes.
1654			No practical substitute.
2050	2051	E	No changes.
2051	2050	E	No changes.
5517	CK1013	E	No changes.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
5517/CK1013			No practical substitute.
5590	6AG5	P	Parallel circuits only. No changes.
	6BC5	G	
	5591	G	No changes.
	9001	G	
	9003	G	
5591	6BC5	P	Parallel circuits only. No changes.
	6AG5	G	
	5590	G	No changes.
	9001	G	
	9003	G	
5608-A	53	E	No changes.
5618	2E30	G	Parallel circuits only. Rewire as follows:
	5812	G	Remove wires from No. 4
			No. 1 to No. 4
			6 to 1
			3 to 6
			7 to 3
			5 to 7
			2 to 5
			Connect wires removed from No. 4 to No. 2.
5635			No practical substitute.
5636			No practical substitute.
5643			No practical substitute.
5646			No practical substitute.
5647			No practical substitute.
5654	6AJ5	G	No changes.
	6AK5	G	
5670	7F8	G	Where space permits. Same as 2C51 to 7F8. Parallel circuits only.
5672	5678	G	No changes.
5676	5677	P	Parallel circuits only. No changes.
5677	5676	G	Parallel circuits only. No changes.
5678	5672	G	No changes.
5679	7A6	E	Where No. 4 is not used on 5679. No changes.
5686			No practical substitute.
5687	6J6	G	Parallel circuits only. Reverse 6J6 to 5687 procedure.
5691	6SL7	E	Parallel circuits only. No changes.
	6SN7	P	No changes.
	5692	P	

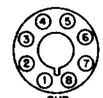
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
5692	6SN7	G	No changes.
	5691	P	
5693	6SJ7	E	No changes.
	6SK7	P	
5694			No practical substitute.
5697			No practical substitute.
5702	5784	G	No changes.
5703	5744	P	No changes.
5704			No practical substitute.
5718	5719	P	No changes.
5719	5718	P	No changes.
5722			No practical substitute.
5725	6AJ5	P	No changes.
	6AK5	P	
5726	6X4	G	Parallel circuits only. Rewire as follows: No. 7 to No. 6 1 and 5 to 7 2 to 1
5731	955	P	No changes.
5744	5703	P	No changes.
5783			No practical substitute.
5784	5702	G	No changes.
5785			No practical substitute.
5787			No practical substitute.
5812	2E30	G	No changes.
5823			No practical substitute.
5824	25A6	P	No changes.
	25B6	E	
	25C6	P	
	25L6	E	
5840	5899	G	No changes.
	5900	G	
	5901	G	
5847			No practical substitute.
5879			No practical substitute.
5896			No practical substitute.
5897	5898	P	No changes.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
5898	5897	P	No changes.
5899	5840	G	No changes.
	5900	G	
	5901	G	
5900	5840	G	No changes.
	5899	G	
	5901	G	
5901	5840	G	No changes.
	5899	G	
	5900	G	
5910			No practical substitute.
5915	6BE6	E	No changes.
5931			No practical substitute.
5932			No practical substitute.
9001	5590	P	No changes.
	5591	G	
	9003	G	
9002	6AB4	P	Rewire as follows: No. 2 to No. 7 5 to 1
9003	5590	G	No changes.
	9001	G	
9004			No practical substitute.
9005			No practical substitute.
9006			No practical substitute.
X6030			No practical substitute.
XXFM	7X7	E	No changes.
XXL	6C5	E	Reverse 6J5 to XXL procedure.
	6J5	E	Reverse 6J5 to XXL procedure.
	6K7	E	Reverse 6K7 to XXL procedure.
	7A4	E	No changes.

TUBE.	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6AH6	6AC7	G	Change socket to octal and rewire as follows:

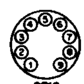

ORIG.

No. 1 on miniature	to No. 4 on octal
2	to 3
3	to 2
4	to 7
5	to 8
6	to 6
7	to 5

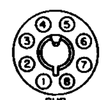

SUB

Connect pin 1 on octal to common ground on chassis.

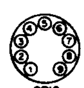
TUBE.	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6AU6	6BJ6	G	Parallel circuits only. Rewire as follows: Interchange leads between pins 2 and 7.
6T8	6AL5 } 6AQ6 }	G	The 6T8 is a triple-diode triode tube. If a 6R8 is not available as a substitute, two tubes can be used if space permits. Of the tube combinations listed here one tube is a double diode (the 6AL5) while the other tubes are double-diode triode types. Of the substitute tubes only those elements necessary to perform the required functions are used.
	6AL5 } 6AT6 }	G	
	6AL5 } 6AV6 }	G	
	6AL5 } 12AV6 }	G	
12AT7	7F8	G	Change socket to loctal and rewire as follows:


ORIG.

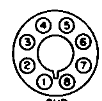
No. 1 on noval	to No. 3 on loctal
2	to 1
3	to 4
4	to 2
5	to 2
6	to 6
7	to 8
8	to 5
9	to 7


SUB.

TUBE.	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
12AU7	6SN7	G	Change socket to octal and rewire as follows:


ORIG.

No. 1 on noval	to No. 2 on octal
2	to 1
3	to 3
4	to 7
5	to 7
6	to 5
7	to 4
8	to 6
9	to 8


SUB

The above filament rewiring applies only if the leads from pins 4 and 5 on the noval are tied together or to the same point.

TUBE.	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	12BH7	G	Parallel circuits only. No changes.
1B4	1E5GP	E	No changes.
1E5GP	1B4	E	No changes.
6C6	1603	E	No changes.
	7700	E	
6F6	1611	E	No changes.
6J7	7000	E	No changes.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6Y7G	79	G	Reverse 6N7 to 79 procedure.
79	6Y7G	G	Reverse 6N7 to 79 procedure.
1603	6C6	E	No changes.
	7700	E	
1611	6F6	E	No changes.
7000	6J7	E	No changes.
7700	6C6	E	No changes.
	1603	E	

IDENTICAL TUBES WITH UNLIKE HEATER VOLTAGE AND CURRENT RATINGS

Substitute high voltage tubes for low voltage tubes in series circuits only with suitable shunt resistor when required. Substitute low voltage tubes for high voltage tubes in parallel circuits with voltage dropping resistor in series with filament -- in series circuits with suitable shunt resistor. For all cases see instructions in Section 1. The performance for each substitution is excellent.

TUBE	SUB.	TUBE	SUB.	TUBE	SUB.
2A3	6A3	7B6	14B6	14B8	7B8
2A5	42	7B8	14B8	14E6	7E6
2A6	75	7E6	14E6	14E7	7E7
2A7	6A7	7E7	14E7	14F7	7F7
2B7	6B7	7F7	14F7	14F8	7F8
6A3	2A3	7F8	14F8	14J7	7J7
	1276	7J7	14J7	14N7	7N7
6A6	53	7N7	14N7	14N7	7N7
6A7	2A7	7Q7	14Q7	14Q7	7Q7
6A8	12A8GT	7R7	14R7	14R7	7R7
6B7	2B7	12A8GT	6A8	25B8GT	12B8G
6B8	12C8	12B8G	25B8GT	25L6	1632
6F5	12F5GT	12C8	6B8	30	RK42
6H6	12H6	12F5GT	6F5	42	2A5
6J5	12J5GT	12H6	6H6	53	6A6
6J7	12J7GT	12J5GT	6J5	55	85
6K7	12K7GT	12J7GT	6J7	56	56AS
6K8	12K8	12K7GT	6K7		76
6L6	1631	12K8	6K8	56AS	56
6Q7	12Q7GT	12Q7GT	6Q7		76
6SA7	12SA7	12SA7	6SA7	57	57AS
6SC7	12SC7	12SC7	6SC7	57AS	57
	1634	12SF5	6SF5	58	58AS
6SF5	12SF5	12SF7	6SF7	58AS	58
6SF7	12SF7	12SG7	6SG7	75	2A6
6SG7	12SG7	12SH7	6SH7	76	56
6SH7	12SH7	12SJ7	6SJ7	85	55
6SJ7	12SJ7	12SK7	6SK7	1276	2A3
6SK7	12SK7	12SL7GT	6SL7GT		6A3
6SL7GT	12SL7GT	12SN7GT	6SN7GT	1631	6L6
6SN7GT	12SN7GT		1633	1632	25L6
	1633	12SQ7	6SQ7	1633	6SN7GT
6SQ7	12SQ7	12SR7	6SR7		12SN7GT
6SR7	12SR7	14A4	7A4	1634	6SC7
7A4	14A4	14B6	7B6	RK42	30

SECTION 3

TELEVISION RECEIVER FILAMENT CIRCUIT ARRANGEMENT

The filaments of the tubes in most television receivers are either arranged in parallel, series and parallel, or series-parallel circuits. It is necessary to know the filament arrangement of a particular television receiver before some of the tubes in the circuit may be substituted because in many cases, a substitution will involve the addition of a resistor (or other circuit component), or the rearrangement of some part of the filament circuit to make for proper tube operating conditions. For example, the substitution of a tube with a 6.3 volt filament for one with a 12.6 volt filament requires the addition of a series resistor or a shunting resistor depending upon whether the filament is in a parallel or a series circuit respectively. (see Section 1).

In the following section all of the information about filament circuits needed to effect successful substitutions is given for most television receivers. The receivers are listed by model number (or chassis number for those sets having no model number) under the name of the manufacturer. In the second column is found the first page number of the section in the Rider Television Manuals in which all of the servicing information as well as schematics for the set are given. Under "Type Circuit", a "P" indicates that all of the filaments are in parallel chains across the secondaries of the power and/or filament transformers, an "S,P" indicates that some of the filaments are in parallel chains and some are in series circuits across the line or power transformer, and "S-P" indicates that the filaments are in a series-parallel circuit across the line. Where the filament arrangement is either "S,P" or "S-P", the filament circuit is reproduced at the end of this section, and appears with the number shown in the "Schematic" column. The schematics numbered 1-6 are typical of the majority of parallel filament circuits except for the addition of one or two chains similar to those shown. The schematics 7-35 are reproductions of the "S,P", and "S-P" circuits previously referred to.

The number of circuits or chains into which the filaments of any set are divided appears under the "Number of Chains" column. NOTE: The 1B3 high voltage rectifier circuit has not been included in the number of chains since this rectifier in practically all cases comes off the secondary of the horizontal output transformer.

Model	Rider Man. Page	Type Cir.	No. of Chains	Sch.
ADMIRAL CORP.				
4H15A, 4H15B, Ch. 20A1; 4J1, Radio Ch.	4-1	P	2	1
4H15S, 4H15SN, Ch. 30A1, 30B1, 30C1, 30D1; 4H1, Radio Ch.	3-17	P	5	3
4H16A, 4H16B, Ch. 20A1; 4J1, Radio Ch.	4-1	P	2	1
4H16S, 4H16SN, Ch. 30A1, 30B1, 30C1, 30D1; 4H1, Radio Ch.	3-17	P	5	3
4H17A, 4H17B, Ch. 20A1; 4J1, Radio Ch.	4-1	P	2	1
4H18C, 4H18CN, Ch. 20B1; 4K1, Radio Ch.	4-1	P	2	1
4H18S, 4H18SN, Ch. 30A1, 30B1, 30C1, 30D1; 4H1, Radio Ch.	3-17	P	5	3
4H19C, 4H19CN, Ch. 20B1; 4K1, Radio Ch.	4-1	P	2	1
4H19S, 4H19SN, Ch. 30A1, 30B1, 30C1, 30D1; 4H1, Radio Ch.	3-17	P	5	3
4H115S, 4H115SN, 4H116S, 4H116SN, 4H117S, 4H117SN, Ch. 30A1, 30B1, 30C1, 30D1; 4H1, Radio Ch.	3-17	P	5	3
4H126A, 4H126B, Ch. 21A1; 4J1, Radio Ch.	4-1	P	2	1
4H126C, 4H126CN, Ch. 21A1; 4K1, Radio Ch.	4-1	P	2	1
4H126S, 4H126SN, Ch. 30A1, 30B1, 30C1, 30D1; 4H1, Radio Ch.	3-17	P	5	3
4H137A, 4H137B, Ch. 21A1; 4J1, Radio Ch.	4-1	P	2	1
4H137S, 4H137SN, Ch. 30A1, 30B1, 30C1, 30D1; 4H1, Radio Ch.	3-17	P	5	3
4H145A, 4H145B, Ch. 20B1; 4J1, Radio Ch.	4-1	P	2	1
4H145C, 4H145CN, Ch. 20B1; 4K1, Radio Ch.	4-1	P	2	1
4H145S, 4H145SN, Ch. 30A1, 30B1, 30C1, 30D1; 4H1, Radio Ch.	3-17	P	5	3
ADMIRAL CORP. (Cont'd)				
4H146A, 4H146B, Ch. 20B1; 4J1, Radio Ch.	4-1	P	2	1
4H146C, Ch. 20B1; 4K1, Radio Ch.	4-1	P	2	1
4H146S, 4H146SN, Ch. 30A1, 30B1, 30C1, 30D1; 4H1, Radio Ch.	3-17	P	5	3
4H147A, 4H147B, Ch. 20B1; 4J1, Radio Ch.	4-1	P	2	1
4H147S, 4H147SN, 4H155S, 4H155SN, Ch. 30A1, 30B1, 30C1, 30D1, 4H1, Radio Ch.	3-17	P	5	3
4H156C, 4H156CN, Ch. 20B1; 4K1, Radio Ch.	4-1	P	2	1
4H156S, 4H156SN, Ch. 30A1, 30B1, 30C1, 30D1; 4H1, Radio Ch.	3-17	P	5	3
4H157A, 4H157B, Ch. 20B1; 4J1, Radio Ch.	4-1	P	2	1
4H157S, 4H157SN, Ch. 30A1, 30B1, 30C1, 30D1; 4H1, Radio Ch.	3-17	P	5	3
4H165A, 4H165B, Ch. 20B1; 4J1, Radio Ch.	4-1	P	2	1
4H165S, 4H165SN, Ch, 30A1, 30B1, 30C1, 30D1; 4H1, Radio Ch.	3-17	P	5	3
4H166A, 4H166B, Ch. 20B1; 4J1, Radio Ch.	4-1	P	2	1
4H166C, 4H166CN, Ch. 20B1; 4K1, Radio Ch.	4-1	P	2	1
4H166S, 4H166SN, Ch. 30A1, 30B1, 30C1, 30D1; 4H1, Radio Ch.	3-17	P	5	3
4H167A, 4H167B, Ch. 20B1; 4J1, Radio Ch.	4-1	P	2	1
4H167C, 4H167CN, Ch. 20B1; 4K1, Radio Ch.	4-1	P	2	1

Model	Rider Man. Page	Type Cir.	No. of Chains	Sch.
ADMIRAL CORP. (Cont'd)				
4H167S, 4H167SN, Ch. 30A1, 30B1, 30C1, 30D1; 4H1, Radio Ch.	3-17	P	5	3
8C11, Ch. 30A1; 8C1, Radio Ch.	2-1	P	5	3
8C11, 8C11N, 8C11S, 8C11SN, 8C11T, 8C11TN, 8C11UL, Ch. 30A1, 30B1, 30C1, 30D1; 4H1, Radio Ch.	3-17	P	5	3
8C12, Ch. 30A1; 8C1, Radio Ch.	2-1	P	5	3
8C12, 8C12N, 8C12S, 8C12SN, 8C12T, 8C12TN, 8C12UL, Ch. 30A1, 30B1, 30C1, 30D1; 4H1, Radio Ch.	3-17	P	5	3
8C13, Ch. 30A1; 8C1, Radio Ch.	2-1	P	5	3
8C13, 8C13N, 8C13S, 8C13SN, 8C13T, 8C13TN, 8C13UL, Ch. 30A1, 30B1, 30C1, 30D1; 4H1, Radio Ch.	3-17	P	5	3
19A11S, 19A11SN, 19A12S, 19A12SN, 19A15S, 19A15SN, Ch. 19A1	3-1	P	2	1
20X11, 20X12, 20X122, Ch. 20X1; 4L1, Radio Ch.	4-38	P	2	1
20X136, 20X145, 20X146, 20X147, Ch. 20Y1; 4L1, Radio Ch.	4-38	P	2	1
24A12, 24A125, Ch. 20A1	4-1	P	2	1
24A125AN, Ch. 20X1; 4L1, Radio Ch.	4-38	P	2	1
24C15, 24C16, Ch. 20B1	4-1	P	2	1
24X15, 24X15S, 24X16, 24X16S, 24X17S, Ch. 20X1; 4L1, Radio Ch.	4-38	P	2	1
25A15, 25A16, 25A17, Ch. 21A1	4-1	P	2	1
26X35, 26X36, 26X37, Ch. 24D1; 29X16, 29X17, Ch. 24F1	4-1	P	3	2
30A12, 30A12N, 30A12S, 30A12SN, 30A12T, 30A12TN, 30A12UL, 30A13, 30A13N, 30A13S, 30A13SN, 30A13T, 30A13TN, 30A13UL, 30A14, 30A14N, 30A14S, 30A14SA, 30A14SN, 30A14T, 30A14TN, 30A14UL, Ch. 30A1, 30B1, 30C1, 30D1; 4H1, Radio Ch.	3-17	P	5	3
30A15	1-1	P	5	3
30A15, 30A15N, 30A15S, 30A15SA, 30A15SN, 30A15T, 30A15TN, 30A15UL, Ch. 30A1, 30B1, 30C1, 30D1; 4H1, Radio Ch.	3-17	P	5	3
30A16	1-1	P	5	3
30A16, 30A16N, 30A16S, 30A16SN, 30A16T, 30A16TN, 30A16UL, Ch. 30A1, 30B1, 30C1, 30D1; 4H1, Radio Ch.	3-17	P	5	3
30B15S, 30B15SN, 30B16S, 30B16SN, 30B17S, 30B17SN, Ch. 30A1, 30B1, 30C1, 30D1; 4H1, Radio Ch.	3-17	P	5	3
30C15S, 30C15SN, 30C16S, 30C16SN, 30C17S, 30C17SN, Ch. 30A1, 30B1, 30C1, 30D1; 4H1, Radio Ch.	3-17	P	5	3
30F15, Ch. 20B1; 4J1, Radio Ch.	4-1	P	2	1
30F15A, Ch. 20B1; 4K1, Radio Ch.	4-1	P	2	1
30F16, Ch. 20B1; 4J1, Radio Ch.	4-1	P	2	1

Model	Rider Man. Page	Type Cir.	No. of Chains	Sch.
ADMIRAL CORP. (Cont'd)				
30F16A, Ch. 20B1; 4K1, Radio Ch.	4-1	P	2	1
30F17, Ch. 20B1; 4J1, Radio Ch.	4-1	P	2	1
30F17A, Ch. 20B1; 4K1, Radio Ch.	4-1	P	2	1
36X36, 36X37, Ch. 24E1; 39X16, 39X17, Ch. 24G1	4-1	P	3	2
AFFILIATED RETAILERS, INC.				
AR-TV-10C, AR-TV-12X, AR-TV-12X	3-1	P	3	4
AR-23-TV-1	3-8	P	3	2
16CX, 816, 816CR	5-1	P	3	4
AIR KING PRODUCTS CO., INC.				
A-1000	2-1	P	3	5
A-1001-A, A-2000, A-2001, A-2002	3-1	P	2	1
12C1, 12T1, 12T2, Ch. 700	5-1	P	2	1
16C1, Ch. 700-1	5-3	P	3	2
16C2, Ch. 700-1	5-3	P	3	2
16K1, Ch. 700-2; 507, Radio Ch.	5-3	P	3	2
16T1, Ch. 700-1	5-3	P	3	2
712, Ch. 700	5-1	P	2	1
718R, Ch. 700-1	5-3	P	3	2
ALLIED PURCHASING CORP. DIV. OF ALLIED STORES				
G-16, V16, 616, 816, Same as Tele-King 616	5-1	P	3	4
910, Same as Tele-King 510	4-1	P	3	4
912, Same as Tele-King 512	3-1	P	3	4
1012, Same as Tele-King 612	3-1	P	3	4
ALTEC LANSING CORP.				
ALC201	3-1	P	4	6
202A	4-1	P	3	2
205	4-2	P	3	2
ANDREA RADIO CORP.				
BCO-VJ12-2, Ch. VJ12-2	2-3	P	5	3
BCO-VJ15, Ch. VJ15	2-3	P	5	3
BT-VK12, Ch. VK12	2-8	P	5	3
C-VJ12, CO-VJ12, Ch. VJ12, CO-VJ12-2, Ch. VJ12-2	2-3	P	5	3
CO-VJ15, Ch. VJ15	2-3	P	5	3
CO-VK15, Corinthian; CO-VK16, Caronia; Ch. VK15-16	2-8	P	5	3
CO-VK16 Late, Caronia, Ch. VK-19	2-8	P	5	3
CO-VK16"C", Dynasty, Ch. VK15-16	2-8	P	5	3

Model	Rider Man. Page	Type Cir.	No. of Chains	Sch.
ANDREA RADIO CORP. (Cont'd)				
CO-VK124, Edgemont, Ch. VK124	2-8	P	5	3
CO-VK125, Ridgeway, Ch. VK12	2-8	P	5	3
CVK19, Normandy, Ch. VK-19	2-8	P	5	3
CVK-126, Gramercy, Ch. VK12	2-8	P	5	3
T-VJ12, Ch. VJ12	1-1	P	5	3
TVK12, Saratoga; TVK-127, Sharron; Ch. VK12	2-8	P	5	3
ANSLEY RADIO & TELEV., INC.				
701	2-1	P	3	5
702, 113 AM-FM, Radio	2-2	P	3	5
717, 718, 725, Ch. P-101	4-1	P	3	5
ASSOCIATED MERCHANTS CORP.				
AM510, Same as Tele-King 510	4-1	P	3	4
AM712, Same as Tele-King 712	4-1	P	3	4
THE ASTATIC CORP.				
AT-1, Booster	4-1	P	1	
ATWATER TELEVISION CO.				
135, 513	5-1	P	3	2
AUTOMATIC RADIO MFG. CO., INC.				
AR-TV-709	2-1	S-P	2	7
TV-12-49, TV-12-50	4-1	S-P	3	8
TV-16-49, TV-16-50, TV-16-51	3-1	P	3	2
TV-1205	5-5	S-P	3	8
TV-1205, Series B	5-1	P	1	
TV-1294	5-5	S-P	3	8
TV-1294, Series B	5-1	P	1	
TV-1605, TV-1615	5-5	S-P	3	8
TV-1649, TV-1650, TV-1651, Series B	5-6	P	3	2
TV-1694	5-5	S-P	3	8
TV-5001	5-2	P	1	
TV-5006	5-2	P	1	
TV-5012	5-2	P	1	
TV-5061, TV-5077	5-2	P	1	
TV-5111	5-2	P	1	
BACE TELEVISION CORP.				
16 RCC, 16 RCH, 19 RCC, 19 RCH	4-1	P	5	3
150-D	2-1	P	5	1&5
160C	2-1	P	3	5
160-K	2-1	P	3	5
BACE TELEVISION CORP. (Cont'd)				
160TM	2-1	P	3	5
190-K, 190-KFD, 190KHD	2-1	P	3	5
BAGDAD TELEVISION CO., INC.				
19 Tube Set	2-1	P	2	1
BELL TELEVISION, INC.				
16DD, 16T, 16TD, 19DD, 19T, 19TD, 1502, 1503, 2002, 2003	4-1	P	3	5
BELMONT RADIO CORP. (RAYTHEON)				
Coronet	3-1	S-P	9	10
Observer	3-1	S-P	3	9
A-7DX22-P, Series A	4-1	S-P	3	9
A-10DX22, Observer; A-10DX24, Ch. A, B, C, D; Radio Ch.	3-1	S-P	6	10
B-10DX22, Ch. A, B, C, D; Radio Ch.	3-1	S-P	6	10
C-1102, Ch. 12AX22	4-6	P	2	1
C-1104B, Ch. 12AX27	5-1	P	3	2
C-1401, Ch. 14AX21	5-9	P	3	2
C-1602, Ch. 16AX23, 16AX25, 16AX26	5-21	P	2	1
7DX21	2-6	S-P	3	9
7DX21, Series B	2-6	S-P	3	9
10AXF43, Ch. A, B, C, D; Radio Ch.	3-1	S-P	3	9
10DX21, Ch. A, B, C, D; Radio Ch.	2-1	S-P	6	10
10DX22, 10DX24, Coronet, Ch. A, B, C, D; Radio Ch.	31-1	S-P	6	10
18DX21	2-6	S-P	3	9
18DX21A	2-6	S-P	3	9
21A21	1-1	P	2	1
22A21, 22AX21, 22AX22	1-25	P	2	1
BENDIX RADIO DIV.				
235B1	2-1	P	2	1
235B1, Codes A, B, C, D, E, F, G, H, I, J, K, L, M, MA, MB, MC, MD	3-1	P	2	1
23M1	2-1	P	2	1
325M8, Codes A, B, C, D, E, F, G, H, I, J, K, L, M, MA, MB, MC, MD	3-1	P	2	1
2001, 2002, 2020, 2021; 2000 Series	3-21	P	3	2
2025	4-1	P	3	2
2051	5-1	P	3	2
3001, 3002, 3030, 3031; 3000 Series	3-21	P	3	2
3033	4-1	P	3	2

Model	Rider Man. Page	Type Cir.	No. of Chains	Sch.
BENDIX RADIO DIV. (Cont'd)				
3051, 6001	5-1	P	3	2
6002	4-1	P	3	2
6003	5-1	P	3	2
6100	5-1	P	3	2
BRUNSWICK See RADIO & TELEVISION INC.				
BUD RADIO CO.				
TAB-98, Booster	2-1	P	1	
TAB-99, PreAmp	2-1	P	1	
CALBEST ENGINEERING & ELECTRONICS CO.				
5082, 5086, 5086R, 5089, 5089R	5-1	P	3	2
CAPEHART-FARNSWORTH CORP. Also See FARNSWORTH TELEV. & RADIO CORP				
3001-B, 3001-M, 3002-B, 3002-M, Ch. C-272; Ch. CX-30	4-1	S,P	3	15
3004-M, Ch. C-268; 3006-M, Ch. C-274; CX-31	4-17	P	3	2
3007-M, Ch. C-276; Ch. CX-30	4-1	S,P	3	15
3011-B, 3011-M, 3012-B, 3012-M, Ch. C-281; Ch. CX-33	5-1	P	2	1
4001-M, Ch. C-268; 4002-M, Ch. C-274; Ch. CX-31	4-17	P	3	2
CERTIFIED RADIO LABORATORIES				
47-71	1-1	P	3	2
48-10	1-1	P	3	2
49-10	2-1	P	3	2
49-710	2-1	P	3	2
4920	4-1	P	4	6
CERTIFIED TELEVISION LABORATORIES See CERTIFIED RADIO LABORATORIES				
CLEERVUE TELEVISION CORP.				
Hollywood, Regency	1-1	P	3	5
CONSOLIDATED TELEVISION CORP. Also See TELE-KING CORP.				
2315	1-1	P	1	
CORNELL TELEVISION, INC. See VIDEO CORP. OF AMERICA				
CROSLEY DIV. AVCO MFG. CORP.				
9-403M, 9-403MA, 9-403M-2	3-1	P	4	6
9-404M	4-1	P	4	6
9-407, 9-407M, 9-407-1, 9-407M-2, 9-407M-3	2-1	P	2	2
9-409M3-LD	4-13	P	3	2

Model	Rider Man. Page	Type Cir.	No. of Chains	Sch.
CROSLEY DIV. AVCO MFG. CORP. (Cont'd)				
9-413B, 9-413B-2	3-1	P	4	6
9-414B	4-1	P	4	6
9-419M1-LD, 9-419M3-LD	4-26	P	3	2
9-420M	4-38	P	4	6
9-422M, 9-422MA	4-47	P	3	2
9-422M-LD	5-1	P	3	2
9-423M	4-59	P	4	6
9-423M-LD	5-14	P	4	6
9-424B	4-38	P	4	6
9-425	3-9	P	3	4
10-401	5-25	P	3	4
10-414MU, 10-416MU, 10-416M1U	5-37	P	4	6
10-419MU	5-42	P	3	4
307TA, 307TA-50	1-1	P	3	5
348CP, Ch. TR1, TR2, TR3	2-15	P	3	6
THE DENMAR TELEVISION CO.				
630-HV	3-1	P	3	6
DE WALD RADIO MFG. CORP.				
BT-100, BT-101	2-1	P	3	5
CT-101	3-1	P	3	5
CT-102, CT-103, CT-104	3-2	P	5	3
DT-120	4-1	P	5	3
DT-161	4-1	P	5	3
DT-1020, DT-1030, DT-X-160	4-1	P	5	3
ALLEN B. DUMONT LABORATORIES, INC.				
Inputuner	1-1	P	1	
RA-101, Devonshire, Hampshire, Plymouth, Revere, Sherwood, Westminster	1-7	P	6	4&5
RA-101-B	2-1	P	6	2&5
RA-102, RA-102-B1, RA-102-B2, RA-102-B3, Clifton, Club	1-34	P	3	5
RA-103, Chatham, Savoy	1-58	P	3	2
RA-103-D, Canterbury, Rumson, Sheffield; RA-104-A, Hastings, Wellington	3-1	P	4	6
RA-105, Colony, Stratford, Westbury, Whitehall	2-5	P	4	5
RA-105-B, Sussex	4-5	P	4	5
RA-106, Club 20	2-34	P	4	5
RA-108-A, Bradford, Mansfield	4-5	P	5	5&1

Model	Rider Man. Page	Type Cir.	No. of Chains	Sch.
ALLEN B. DUMONT LABORATORIES, INC. (Cont'd)				
RA-110-A, Fairfield, Westwood	3-1	P	4	6
DYNAMIC TELEV. ASSOCIATES, INC.				
TU-10C	2-1	P	3	2
ELECTROMATIC MFG. CORP.				
101, 120-A	5-1	S-P	3	11
ELECTRO-TECHNICAL INDUSTRIES (TELEKIT)				
7 Telekit	1-1	P	3	2
7-A	2-1	P	4	6
7B	3-1	P	4	6
10 Telekit	1-23	P	6	3
10-A	2-11	P	4	5
10B	4-8	P	4	6
13B-KT Tuner; 16CK, Conversion Kit	4-14	P	1	
EMERSON RADIO & PHONO. CORP.				
527, Ch. 120019	1-1	P	3	4
545, Ch. 120047	1-8	P	3	2
571, Ch. 66B	2-1	S-P	3	12
571, Ch. 86B	2-1	S,P	3	12
585, Ch. 120025B, 120088B;	3-1	S,P	3	12
120024B, 120081B, Radio Ch.	3-11	S	1	
600, Ch. 120103B	4-1	S-P	3	13
606, Ch. 66B	2-1	S-P	3	12
606, Ch. 86B	2-1	S,P	3	12
608, Ch. 120089B	3-19	P	3	4
611, Ch. 87B	2-1	P	2	1
614, Ch. 120110B, 120110C	4-9	P	3	4
618, Ch. 120090B, 120090D;	3-1	P	2	1
120081B, Radio Ch.	3-11	S	1	
621, Ch. 120098B; 622, Ch. 120098P	4-21	P	3	4
626, Ch. 120104B, 120104BJ	3-19	P	2	1
628, Ch. 120098B	4-21	P	3	4
629D, Ch. 120124B	5-27	P	3	4
630, Ch. 120099B	4-21	P	3	4
631, Ch. 120109B; 632, Ch.120096B; 633, Ch. 120114B	5-6	P	3	4
637, Ch. 120110B, 120110C	4-9	P	3	4
639, Ch. 120103B	4-1	S-P	3	13
644, 647, Ch. 120113B, 120113C	4-9	P	3	4
648B, Ch. 120110-E	4-9	P	3	4
650, Ch. 120113B, 120113C	4-9	S,P	4	14

Model	Rider Man. Page	Type Cir.	No. of Chains	Sch.
EMERSON RADIO & PHONO. CORP. (Cont'd)				
651D, 658B, Ch. 120124B	5-27	P	3	4
470606, Tuner	5-1	P	1	
ESPEY MFG. CO., INC.				
3-Inch Kit	1-1	P	3	2
FADA RADIO & ELECTRIC CO., INC.				
R-1025, R-1050	5-1	P	3	5
TV-30	2-1	P	3	5
799	2-1	P	3	5
880	3-1	P	3	5
895; 891, Radio Ch.	4-7	P	3	5
899	2-1	P	3	5
925	4-1	P	3	5
930, 940	3-20	P	3	5
965	4-1	P	3	5
FARNSWORTH TELEV. & RADIO CORP. Also See CAPEHART-FARNSWORTH CORP.				
GV-260	1-1	P	4	3
U-12-A, Capehart	2-9	P	3	2
504P16, Ch. U-12	2-9	P	3	2
651-P	2-1	P	4	3
661-P	2-1	P	4	3
FEDERAL TELEVISION CORP.				
1501TV	4-1	P	3	2
FEDERAL VIDEO CORP.				
209, 309, 409, Ch. 31	3-1	P	3	5
FERGUSON RADIO, INC.				
749PTV, 749TV	3-1	S-P	3	16
1049TVT	3-2	P	3	2
THE FIRESTONE TIRE & RUBBER CO.				
13-G-3	3-1	S-P	2	17
13-G-4	4-1	P	4	6
13-G-5	3-5	P	4	3
13-G-33	4-6	S-P	2	17
FREED-EISEMANN See FREED RADIO CORP.				
FREED RADIO CORP. (FREED-EISEMANN)				
55, Ch. 1620C	5-1	P	4	5
56, Ch. 1620	3-1	P	4	5
77, Ch. 1610	3-1	P	4	5

RECEIVING TUBE SUBSTITUTION GUIDE

GAMBLE- SKOGMO, INC.

Model	Rider Man. Page	Type Cir.	No. of Chains	Sch.
FA43-8965A, FA43-8965B	3-1	S-P	3	9
FA43-8966	4-1	S-P	6	10
TV43-8908	4-15	P	3	2
TV43-8960	3-10	P	3	2
94TV1-43-8940A	4-21	P	2	1
94TV2-43-8970A, 94TV2-43-8971A	3-17	P	4	6
94TV6-43-8953A	5-9	P	3	2

GAROD RADIO CORP.

Model	Rider Man. Page	Type Cir.	No. of Chains	Sch.
10TZ20, Ambassador; 10TZ21, Malibu; 10TZ22, Monticello; 10TZ23, Catalina	4-5	P	4	6
12TZ20, Belvedere; 12TZ21, Claridge; 12TZ22, Caronet; 12TZ23, Carlton	4-5	P	4	6
15TZ24, 15TZ25, 15TZ26, 15TZ27	4-5	P	4	6
19C6,	5-18	P	3	4
900 Series	2-1	P	4	6
1000	2-1	P	4	6
1042G	3-7	P	3	4
1042T	4-10	P	3	4
1043G	3-7	P	3	4
1043T	4-10	P	3	4
1100	2-1	P	4	6
1142	4-1	P	3	4
1143	4-1	P	3	4
1200	2-1	P	4	6
1244T	4-12	P	3	4
1245T	4-10	P	3	4
1344	4-1	P	3	4
1345	4-1	P	3	4
1346T	4-11	P	3	4
1547T	4-10	P	3	4
1548T	4-10	P	3	4
1549T	4-10	P	3	4
	4-1	P	3	4
	4-1	P	3	4
	4-1	P	3	4
	4-1	P	3	4
	5-15	P	3	4
	5-18	P	3	4
	4-15	P	3	4

GAROD RADIO CORP. (Cont'd)

Model	Rider Man. Page	Type Cir.	No. of Chains	Sch.
2043T	4-10	P	3	4
2546T	4-10	P	3	4
2547T	4-10	P	3	4
2548T	4-10	P	3	4
2549T	4-10	P	3	4
3912TVFMP; 11FMT, Radio	1-1	P	4	6
3915TVFMP; 9FMT, Radio	2-12	P	4	6

GENERAL ELECTRIC CO.

Model	Rider Man. Page	Type Cir.	No. of Chains	Sch.
HM-171	1-1	P	3	2
HM-185	1-3	P	3	2
HM-225, HM-225B	1-14	P	2	1
HM-226B, HM-226-7A	1-14	P	2	1
10C101, 10C102, 10T1, 10T4, 10T5, 10T6	5-1	S-P	2	19
12C101, 12C102, 12C105	5-25	S-P	2	19
12C107, 12C108, 12C109	5-35	S-P	2	20
12C107, 12C108, 12C109, B Version	5-35	S-P	2	20
12K1	5-12	S-P	2	19
12T1	5-25	S-P	2	19
12T3, 12T4	5-35	S-P	2	20
12T3, 12T4; B Version	5-35	S-P	2	20
800A, 800B, 800C, 800D	4-1	S-P	2	18
801, Early, Late	1-28	P	3	2
802	1-52	P	4	6
803	2-1	P	4	6
805, Early, S, T, U, W, Versions	3-1	S-P	2	18
806, 807, Early, S, T, U, W, Versions	3-1	S-P	2	18
809, Early, S, T, U, W, Versions	3-1	S-P	2	18
810	2-11	P	5	5
811	2-11	P	5	5
814	2-22	P	5	5
817, S, T, U, W, Versions	4-9	S-P	2	18
818	4-24	S-P	2	18
820	3-16	P	5	5
821, S, T, U, W, Versions	4-9	S-P	2	18
830, Early, R, T, Versions	3-31	P	5	5
835, Early, R, Versions	3-45	P	4	5
840	4-34	P	5	5
901, Preliminary	1-73	P	5	3

Model	Rider Man. Page	Type Cir.	No. of Chains	Sch.
GENERAL ELECTRIC CO. (Cont'd)				
901, Final	2-32	P	5	3
910, Preliminary	1-73	P	5	3
910, Final	2-32	P	5	3
GENERAL INSTRUMENT CORP.				
TVA	3-1	P	1	
TVB	2-1	P	1	
TVB Revised, TVC	3-1	P	1	
44, Revised	5-1	P	1	
44TV Tuner	4-1	P	1	
GILFILLAN BROS., INC.				
	1-1	P	3	2
GUTHMAN INTERNATIONAL CORP.				
34-1024, Tuner	3-1	P	1	
THE HALLICRAFTERS CO.				
T-54	1-1	S-P	2	2
T-60	4-1	P	3	2
T-68	4-1	P	3	2
505	1-1	S-P	2	2
	3-8	P	3	2
	4-18	P	3	2
	5-1	P	3	2
HOFFMAN RADIO CORP.				
	2-1	P	3	5
	3-1	P	3	2
	3-1	P	3	2
	3-1	P	3	2
	3-1	P	3	2
HOWARD RADIO CO.				
	2-1	P	3	5
I.D.E.A. See INDUSTRIAL DEVELOPMENT ENG. ASSOCIATES, INC.				
INDUSTRIAL DEVELOPMENT ENG. ASSOCIATES, INC. (I.D.E.A.)				
Regency	4-1	P	1	
Regency	4-1	P	1	
INDUSTRIAL TELEV., INC.				
	1-1	P	6	2&5
	1-11	P		4
	2-1	P	4	6

Model	Rider Man. Page	Type Cir.	No. of Chains	Sch.
INDUSTRIAL TELEV., INC. (Cont'd)				
IT-13R	2-1	P	4	6
IT-15R, Guest Television	2-4	P	2	1
IT-21R, IT-21R-1, IT-21R-2, Ch.	4-1	P	3	4
IT-22R	2-6	P	3	2
IT-26R	3-1	P	7	2&6
IT-35R	3-1	P	7	2&6
IT-39R, IT-40R, IT-42R, IT-46R	3-1	P	7	2&6
IT-48R-1-2-3-4	5-1	P	3	2
326	3-1	P	7	2&6
721, 821, 921, 1021	4-1	P	3	4
INTERNATIONAL TELEV. CORP.				
D16	3-1	P	3	5
E-16	4-1	P	2	1
INTERSTATE STORES BUYING CORP. (PLYMOUTH)				
IS510, Same as Tele-King 510	4-1	P	3	4
IS812, Same as Tele-King 512	3-1	P	3	4
250, 350, 750		P	2	2
JACKSON INDUSTRIES				
5000TV, 5050CTV, 520CTV 5250CTV, 5600TV, 5650CTV		P	2	1
JAMAICA RADIO TELE MFG. CO.				
RTP	3-1	P	2	1
WBS, DeLuxe	3-2	P	2	1
JERROLD ELECTRONICS CORP.				
TV-FM, Booster	2-1	P	1	
TV-FM, Series 5, Booster	3-1	P	1	
KAYE-HALBERT See TELINDUSTRIES, INC.				
MACY'S				
	5-1	P	2	5
	5-1	P	3	5
THE MAGNAVOX CO.				
	2-1	P	3	2
	2-1	P	3	2
	2-1	P	3	2
	3-1	P	3	2

Model	Rider Man. Page	Type Cir.	No. of Chains	Sch.
THE MAGNAVOX CO. (Cont'd)				
CT-221	2-1	P	3	2
CT-222	3-1	P	3	2
CT-224, CT-235	4-1	P	2	1
CT-237, CT-238	3-1	P	3	2
MCT 228	4-14	P	3	2
MAJESTIC RADIO & TELEV. CORP.				
7TV850, Ch. 18C90	3-1	P	2	1
MAJESTIC RADIO AND TELEVISION, INC.				
19C6, 19C7, 1672, 1673, 1674, 1675, 1974, 1975	5-12	P	3	4
MARS TELEVISION INC.				
1200	2-1	P	3	5
MASCO See MARK SIMPSON MFG. CO., INC.				
JOHN MECK INDUSTRIES, INC.				
XA-701, XB-702, XC-703	3-1	S-P	3	16
XL-750	3-1	P	3	2
XM-751, XN-752, XO-774, XQ-776, XR-778, XS-786, XT-785	4-1	P	3	4
MEISSNER MFG. DIV. MAGUIRE INDUSTRIES, INC.				
24TV	2-1	P	3	2
25TV	4-1	P	3	2
MERRICK TELEVISION CO.				
Visionmaster	2-1	P	4	6
MIDWEST RADIO & TELEV. CORP.				
JR-32, Ch. CJ-32, CR-30	4-11	P	2	1
JX-26, JXA-24, Ch. CX-26, CXA-24	4-5	P	2	1
MX-22, MXA-20, Ch. CM-22, CMA-20	4-1	P	2	1
TRC-12, Ch. TR12	4-16	P	4	6
XA-12, Ch. CA-12; XT-12, Ch. CT-12	3-1	P	4	5
932, Ch. CA-12; 936, Ch. CT-12	3-1	P	3	2
945, Ch. TR12	4-16	P	3	2
MITUS, INC.				
Master No. 2 System	1-1	P	5	3
MONTGOMERY WARD				
84GSE-3011A	4-1	P	3	4
84HA-3002A	3-1	S-P	3	25
84HA-3002B	3-6	S-P	3	25
84HA-3007A, 84HA-3007B, 84HA-3007C	4-7	P	3	2

Model	Rider Man. Page	Type Cir.	No. of Chains	Sch.
MONTGOMERY WARD (Cont'd)				
84HA-3010A, 84HA-3010B, 84HA-3010C	5-1	P	3	2
94BR-3004, 94BR-3004C, 94BR-3004D, 94BR-3005, 94BR-3005C	5-10	S-P	3	9
94BR-3004E	5-10	S-P	3	10
94BR-3017A	3-11	S-P	3	9
94BR-3021A, 94BR-3024A, Code 1	4-17	P	2	1
94GSE-3015A	4-22	P	3	4
94GSE-3018A	5-29	P	3	4
94GSE-3025A, 94GSE-3033A	5-38	P	4	3
94WG-3022A, 94WG-3026A, 94WG-3026B, 94WG-3026B, 94WG-3029A, 94WG-3029B	4-38	P	4	6
MOTOROLA INC.				
VF102, VF102-A, VF102-C, Ch. TS-7; HS-108, Radio Ch.	2-1	P	5	3
VF103, VF103M, Ch. TS-8	4-1	P	5	6
VK101, Early, Late, Ch. TS-3	1-53	P	5	3
VK106, Ch. TS-9, TS-9B, Revised	2-27	S, P	3	12
VK106, Ch. TS-9A, TS-9B, TS-9D	3-1	P	4	6
VK106B, VK106M, Ch. TS-9, TS-9B	3-1	S, P	3	12
VK106B, VK106M, Ch. TS-9B, TS-9C, TS-9D	3-1	P	4	6
VT71, Ch. TS-4	1-1	S-P	3	22
VT71, Ch. TS-4B, TS-4C, TS-4D, TS-4E, TS-4F, TS-4G, TS-4H, TS-4J	2-34	S-P	3	24
VT105, Ch. TS-9A, TS-9C, TS-9D	3-1	P	4	6
VT105M, Ch. TS-9, TS-9B; Revised	2-27	S, P	3	12
VT105M, Ch. TS-9A, TS-9C; TS-9D	3-1	P	4	6
VT107, Ch. TS-9, TS-9B; Revised	2-27	S, P	3	12
VT107, Ch. TS-9A, TS-9C; TS-9D	3-1	P	4	6
VT107M, Ch. TS-9, TS-9B; Revised	2-27	S, P	3	12
VT107M, Ch. TS-9A, TS-9C; TS-9D	3-1	P	4	6
VT121, Ch. TS-15, TS-15A, TS-15B, TS-15C, TS-15C1	3-26	P	5	6
7VT1, 7VT2, 7VT5, Ch. TS-18, TS-18A	4-11	S-P	3	26
10T2, Ch. TS-14B	4-19	P	3	4
10VK9, 10VT3, Ch. TS-9E, TS-9D1	3-18	P	4	6
10VK12, 10VK12R, 10VK22R, 10VT10, 10VT10B, 10VT10R, 10VT24R, Ch. TS-14, TS-14A, TS-14B	4-19	P	3	4
12K1, 12K1B, 12K2, 12K2B, 12T1, 12T1B, Ch. TS-23B	4-19	P	3	4
12VF4B, 12VF4R, 12VF4R-C, Ch. TS-23, TS-23A	4-19	P	3	4

Model	Rider Man. Page	Type Cir.	No. of Chains	Sch.
MOTOROLA INC.				
12VF26B, 12VF26B-C, 12VF26R, 12VF26R-C, Ch. TS-23A, TS-23B		P	3	4
12VK11, 12VK11B, 12VK11R, Ch. TS-23, TS-23A, TS-23B	4-19	P	3	4
12VK15B, 12VK15R, Ch. TS-30, TS-30A	5-8	P	3	4
12VT13, 12VT13B, 12VT13R, Ch. TS-23, TS-23A, TS-23B	4-19	P	3	4
16K2L, 16K2LB, Ch. TS-52	4-19	P	3	4
16VK1B, 16VK1R, Ch. TS-52	4-19	P	3	4
16VK7B, 16VK7R, Ch. TS-16, TS-16A	4-30	P	3	4
19F1, 19F1B, 19K1, Ch. TS-67, TS-67A	5-22	P	3	4
MULTIPLE TELEV. MFG. CO.				
M-1500, M-2000	2-1	P	4	5
MR-1500, MR-2000	2-2	P	4	5
MT-1250	2-1	P	4	5
MUNTZ T-V, INC.				
M-12, Ch. M-158	3-1	P	3	4
M-20, M-21, M-22, Ch. M-159-A	3-2	P	3	4
M30, Ch. TV16A1; M31, Ch. TV16A2; M31R, M32, Ch. TV16A3	5-1	P	3	4
M-159, Ch.	4-1	P	3	4
M-159-B, Ch.	3-3	P	3	4
M-169, Ch.	3-4	P	3	4
M-169, Ch., Revised	4-2	P	3	4
NATIONAL CO., INC.				
NC-TV-7, NC-TV-7M, NC-TV-7W;	2-1	S-P	2	23
1st Revision	3-1	S-P	2	23
2nd Revision	3-3	P	4	6
NC-TV-10C	4-1	P	4	6
NC-TV-10T	4-1	P	4	6
TV-1001, TV-1025	4-1	P	4	6
TV-1201	5-3	P	4	6
TV-1226, TV-1601, TV-1625	5-3	P	4	6
NEW ENGLAND TELEV. CO.				
Custom Console	2-1	P	4	6
THE NIELSEN TELEV. CORP.				
1018	2-1	P	3	5
1618	4-1	P	3	5
NORELCO See NORTH AMERICAN PHILLIPS CO., INC.				
NORTH AMERICAN PHILLIPS CO., INC. (NORELCO)				
160, Protelgram	3-1	P		
OLYMPIC RADIO & TELEV. INC.				
DX-214, DX-215, DX-216, Serial No. H-200,001 to H-205,000	4-1	P		
DX-619, DX-620, DX-621, DX-622, DX-931, DX-932, DX-950	5-1	P		
TV-104, Cruzair; TV-105, TV-106, Challenger; TV-107, Pacemaker; TV-108, DeLuxe Ten	3-1	P		
TV-922	2-1	P		
TV-922L, DeLuxe Ten	3-1	P	3	2
TV-928	2-1	P	4	6
TV-944, Beverly; TV-945, Plaza; TV-946, Champion	3-1	P	3	
TV-947, Baronet; TV-949, TV-950	3-11	P	3	2
XL-210, XL-211, XL-612, XL-613	5-8	P	3	4
PACKARD-BELL CO.				
1091, Ch. 3091; 1080, Radio Ch.	4-1	P	3	5
2001-TV, 2002-TV	5-1	P	3	4
2091-TV, 2092-TV	5-3	P	3	4
2291TV, 2292TV, 2293TV, 2294TV, 2295TV, 2296TV	4-10	P	3	4
2297-TV, DeLuxe, Standard; 2298-TV	4-16	P	3	4
2601-TV, 2692-TV	5-9	P	3	5
2981, Ch.	4-5	P	3	5
2991-TV	4-20	P	3	5
3191TV, 3192TV	4-27	P	3	5
3193TV, 3194TV; 10520, R-F Tuner	3-1	P	3	5
3381TV	3-4	P	3	5
4580TV	3-12	P	5	1 & 5
4691-TV	4-23	P	5	1 & 5
10527, R-F Tuner	3-23	P	1	
PATHE TELEVISION CORP.				
12-2, Ch. 700	5-4	P	2	1
16-21, 16-22, 16-23, 16-24, 16-25 Ch. 700-1	5-9	P	3	2
PHILCO CORP.				
48-700	2-1	P	3	2
48-1000, 48-1000-5, Code 125;	1-1	P	3	4
Code 122	2-20	P	3	4
Code 121	2-37	P	3	4

Model	Rider Man. Page	Type Cir.	No. of Chains	Sch.
PHILCO CORP. (Cont'd)				
48-1001, Code 121	1-17	P	3	4
48-1001, Code 122	1-17	P	3	4
48-2500, Code 122; 48-2500, 48-2500-5	1-23	P	3	4
49-1002	2-70	P	3	2
49-1040, Code 121	3-1	P	3	2
49-1040, Code 123	4-3	P	3	2
49-1075	2-70	S, P	4	12
49-1075, 49-1076, Code 122	4-25	S, P	4	12
49-1076, Code 123; 49-1077, Code 122	4-3	S, P	4	12
49-1150, Codes 121A, 121B, 122A, 122B	3-4	P	3	2
49-1150, Codes 123A, 123B, 124A, 124B	3-19	P	3	2
49-1175, Codes 121A, 121B, 122A, 122B	3-4	S, P	4	12
49-1175, Codes 123A, 123B, 124A, 124B	3-19	S, P	4	12
49-1240	2-70	P	3	2
49-1240, Code 123	4-25	P	3	2
49-1240, Code 124	4-3	P	3	2
49-1275	2-70	S, P	4	12
49-1278, Code 122	4-25	S, P	4	12
49-1278, Code 123, 49-1279, Code 122; 49-1280, Code 121	4-3	S, P	4	12
49-1450, Codes 121A, 121B	3-4	P	2	1
49-1450, Codes 123A, 123B	3-19	P	2	1
49-1450, Codes 123TA, 123TB	3-23	P	2	1
49-1475, Codes 121A, 121B	3-4	S, P	4	12
49-1475, Codes 123A, 123B	3-19	S, P	4	12
49-1475, Codes 123TA, 123TB	3-23	S, P	4	12
49-1480, Codes 121A, 121B	3-4	S, P	4	12
49-1480, Codes 123A, 123B	3-19	S, P	4	12
49-1480, Codes 123TA, 123TB	3-23	S, P	4	12
50-T1104, Code 123	4-27	P	3	4
50-T1105, 50-T1106	5-1	P	3	4
50-T1400, 50-T1402, 50-T1404	4-27	P	3	4
50-T1600, 50-T1632, 50-T1633, Code 121	5-17	P	3	4
PHILHARMONIC RADIO CORP.				
TV-1049, TV-1249	2-1	P	4	6
PHILMORE MFG. CO., INC.				
P30	2-1	P	3	5
PILOT RADIO CORP.				
TV-37	2-1	S-P	2	27

Model	Rider Man. Page	Type Cir.	No. of Chains	Sch.
PILOT RADIO CORP. (Cont'd)				
TV-37U	2-1	S-P	2	27
TV-40, TV-42	2-8	P	5	5
TV-44 Series, TV-46, TV-47	3-1	P	3	5
TV-120 Series, TV-121	3-10	P	3	2
TV-125	5-1	P	3	2
TV-161	5-1	P	4	6
TV-950, TV-952	2-8	P	5	5
PLYMOUTH See INTERSTATE STORES BUYING CORP.				
RADIO CORP. OF AMERICA (RCA)				
S1000, Ch. KCS31-1; RC617B, Radio Ch.	5-48	P	3	2
T100, Ch. KCS38	5-65	P	3	2
T120, Ch. KCS34C	5-80	P	3	2
T121, Ch. KCS34C	5-95	P	3	2
TRK-5, Ch. KC-3A; RC-429, Radio Ch.	1-1	P	4	5
TRK-9, Ch. KC-4A, KC-4C; RC-427A, Radio Ch.	1-14	P	5	5
TRK-12, Ch. KC-4, KC-4B; RC-427, Radio Ch.	1-14	P	5	5
TRK-90, Ch. KC-4H; RC-427G, Radio Ch.	1-14	P	5	5
TRK-120, Ch. KC-4F, KC-4J; RC-427F, Radio Ch.	1-14	P	5	5
TT-5, Ch. KC-3	1-1	P	4	5
8PCS41, 8PCS41-B, 8PCS41-C, Ch. KCS-24B-1, KCS-24C-1	2-1	P	7	2 & 6
8T241, 8T243, 8T244, Ch. KCS-28	3-1	P	3	2
8T270, Ch. KCS-29; 8TC270, 8TG271, Ch. KCS-29A	3-15	P	3	2
8TK29, Ch. KCS-32A, KCS-32C; RK-135, RK-135A, Radio Ch.	3-29	P	4	3
8TK320, Ch. KCS33A-1; RK135A-1, Radio Ch.	4-1	P	4	3
8TR29, Ch. KCS-32, KCS-32B; RK-135, RK-135A, Radio Ch.	3-29	P	4	3
8TS30, Ch. KCS-20J-1, KCS-20K-2	2-11	P	3	5
8TV41, Ch. KCS-25D-1, KCS-25E-2; RK-117A, Radio Ch.	2-26	P	3	5
8TV321, 8TV323, Ch. KCS-30-1; RC-616B, RC-616C, RC-616J, RC-616K, Radio Ch.	3-43	P	3	2
9PC41, Ch. KCS24C-1, KCS24D •	4-16	P	7	2 & 6
9T240, Ch. KCS28; 9T240K, Ch. KCS28A	4-26	P	3	2
9T246, Ch. KCS28C, KCS38	4-41	P	3	2
9T256, Ch. KCS38C	5-1	P	3	2

Model	Rider Man. Page	Type Cir.	No. of Chains	Sch.
RADIO CORP. OF AMERICA (Cont'd)				
9T270, Ch. KCS-29, KCS-29C	3-61	P	3	2
9TC240, Ch. KCS28B	4-26	P	3	2
9TC245, Ch. KCS34B; 9TC247, 9TC249, Ch. KCS34, KCS34B	4-58	P	3	2
9TC272, 9TC275, Ch. KCS-29, KCS-29C	3-61	P	3	2
9TW309, Ch. KCS41-1; RK135C, Radio Ch.	5-16	P	4	6
9TW333, Ch. KCS30-1; RC-616N, Radio Ch.	4-73	P	3	2
9TW390, Ch. KCS31-1; RC617A, Radio Ch.	5-32	P	3	2
621TS, Ch. KCS-21-1	1-44	P	4	6
630TS, Ch. KCS-20A, KCS-20C-2	1-76	P	3	5
641TV, Ch. KCS-25A-1, KCS-25C-2; RK-117A, Radio Ch.	1-117	P	3	5
648PTK, Ch. KCS-24-1; RK-121A, Radio Ch.	1-174	P	5	3
648PV, Ch. KCS-24A-1; RK-121A, Radio Ch.	1-174	P	5	3
721TCS, Ch. KCS-26A-1, KCS-26A-2	1-232	P	3	2
721TS, Ch. KCS-26-1, KCS-26-2	1-232	P	3	2
730TV1, Ch. KCS-27-1; RC-610A, Radio Ch.	1-255	P	4	6
730TV2, Ch. KCS-27-1; RC-610B, Radio Ch.	1-255	P	4	6
741PCS, Ch. KCS-24B-1	2-47	P	7	2 & 6
RADIO CRAFTSMEN, INC.				
RC100	4-1	P	2	1
RADIO MERCHANDISE SALES, INC.				
SP-2, Antenna Booster	3-1	P	1	
SP-4, Preamplifier	4-1	P	1	
RADIO & TELEVISION INC. (BRUNSWICK)				
C-8125, C-8165	4-1	P	3	4
55B, 55M, 55R, 55W, Ch. 66Z, Canton	2-1	S, P	4	28
506-B, Ch. 66Z, Tibet; L-14, Radio	2-1	S, P	4	28
512, 513	4-1	P	3	4
702L; 711, Club; Ch. 66Z	2-1	S, P	4	28
812, 816	4-1	P	3	4
911, 922B, 922M	3-1	P	3	5
5125, 6165	4-1	P	3	4

RAYTHEON
See BELMONT RADIO CORP.

Model	Rider Man. Page	Type Cir.	No. of Chains	Sch.
REEVES-SOUNDCRAFT CORP. (VIDEON)				
AR-100	3-1	P	10	4,5 & 6
REGAL ELECTRONICS CORP.				
CD31, CD36	3-1	P	3	5
TV-1030	2-1	P	3	5
TV-1031	2-1	P	3	5
16T31	3-1	P	3	5
16T36	3-2	P	3	5
1007, 1207, 1208	3-4	P	4	3
1230	3-6	P	3	5
1607	3-7	P	4	3

REMBRANDT
See REMINGTON RADIO CORP.

Model	Rider Man. Page	Type Cir.	No. of Chains	Sch.
REMINGTON RADIO CORP. (REMBRANDT)				
Night Watch, Remington	4-1	P	2	1
80, 130	1-1	P	5	3
721, 1606, 1606-15	4-1	P	2	1
1950	2-1	P	2	1
1950, Revised	4-1	P	2	1
REPUBLIC TELEVISION INC.				
TL-10	1-1	P	3	2
SARKES TARZIAN				
TT2	4-1	P	1	
TT3	4-3	P	1	
SCOTT RADIO LABS., INC.				
6-T-11	2-1	P	4	6
13-A	1-1	P	4	5
300	3-1	P	4	6
SEARS, ROEBUCK & CO.				
101, Ch. 549.100	5-1	P	3	2
112, Ch. 478.289	5-9	P	4	5
125, Ch. 478.257	4-1	P	4	6
8132, Ch. 101.854	3-12	P	3	2
8133, Ch. 101.846; 101.829-1, Radio Ch.	2-1	P	3	2
9119, 9120, Ch. 101.865	3-23	P	3	2
9120A, Ch. 101.865-1; 9120B, Ch. 101.865-2	4-37	P	2	1
9121, Ch. 101.867	4-10	P	2	1
9122, Ch. 101.864	3-12	P	3	2

Model	Rider Man. Page	Type Cir.	No. of Chains	Sch.
SEARS, ROEBUCK & CO. (Cont'd)				
9122A, Ch. 101.868	4-19	P	2	1
9123, Ch. 110.499, 110.499A, 110.499B, 110.499-10, 110.499010A, 110.499-10B, 110.499-20, 110.499-10A, 110.499-20B	3-1	P	2	1
9124, Ch. 110.499-1, 110.499-1A, 110.499-1B, 110.499-11, 110.499-11A, 110.499-11B, 110.499-21, 110.499-21A, 110.499-21B	3-1	P	2	1
9125, Ch. 478.252; 9125A, Ch. 478.253	4-1	P	4	6
9125B, Ch. 478.253-1	5-18	P	4	6
9126, Ch. 110.499-2, 110.499-2A, 110.499-2B, 110.499-12, 110.499-12A 110.499-12B, 110.499-22, 110.499-22A, 110.499-22B	3-1	P	2	1
9128A, Ch. 101.868	4-19,	P	2	1
9133, 9134, Ch. 101.866; 101.859, Radio Ch.	4-26	P	2	1
SENTINEL RADIO CORP.				
1U416	5-1	P	4	6
1U419, 1U420	5-9	P	4	6
400TV	2-1	P	3	2
400TV, Revised	3-1	P	3	2
401, 402, Series	3-8	P	3	4
405TVM	2-1	P	3	2
405TVM, Revised	3-1	P	3	2
406 Series	3-8	P	3	4
407, 409	4-1	P	4	3
412, 413, 414, 415	4-10	P	4	6
416	5-1	P	4	6
419, 420	5-9	P	4	6
SHEVERS, INC.				
Bryant, Classic, Regency, Trafalgar, Ch. 032-16, 032-19	5-1	P	3	5
SIGHTMASTER CORP.				
E, Series	2-3	P	3	2
K-50	5-1	P	2	1
M, Series	2-3	P	3	2
10-S1, 12-S1, 15-S1	1-1	P	3	2
10-S1, 12-S1, 15-S1, Late	2-1	P	3	2
MARK SIMPSON MFG. CO., INC. (MASCO)				
MTB-13X, 1MB-13	2-1	P	1	

Model	Rider Man. Page	Type Cir.	No. of Chains	Sch.
SKYRIDER				
520E	4-1	P	3	2
521E	4-8	P	3	2
SONIC INDUSTRIES, INC.				
IT4	4-1	P	1	
SONORA RADIO & TELEV. CORP.				
302, 303, 320	5-1	P	3	2
700	2-1	P	4	6
700A	2-5	P	4	6
SOVEREIGN TELEVISION CO.				
4920	3-1	P	4	6
SPARTON RADIO-TELEVISION DIV. OF THE SPARKS-WITHINGTON CO.				
4900TV, Ch. 24TV9C; 9L8, Radio Ch.	3-1	P	3	4
4901TV, Ch. 24TV9C	4-1	P	3	4
4916, 4917, 4918, Ch. 24TL10; 6S10, Radio Ch.	4-5	P	3	4
4920, 4921, 4922, Ch. 24TM10	4-11	P	3	4
4935, Ch. 23TC10	5-1	P	3	2
4939TV, Ch. 24TV9; 9L8, Radio Ch.	3-1	P	3	4
4940TV, 4941TV, Ch. 24TV9; 9L8, Radio Ch.	3-1	P	3	4
4942, Ch. 23TC10	5-1	P	3	2
4944, 4945, Ch. 24TB10	4-12	P	3	4
4951, 4952, Ch. 24TA10	4-1	P	3	4
4954, 4960, Ch. 23TC10	5-1	P	3	2
4964, 4965, Ch. 23TB10	5-15	P	3	4
4970, 4971, 4972, Ch. 24TF10	5-23	P	3	4
5002, 5003, 5006, 5007, Ch. 23TD10	5-1	P	3	2
STANDARD COIL PRODUCTS CO., INC.				
TV-100 Series	2-1	P	1	
STARRETT TELEVISION CORP.				
M412 Series, Nathan Hale	4-1	P	3	4
3R2-37-9, Lowell, Jackson, Cleveland, King Arthur, John Hancock	4-2	P	3	5
3R3-36-9, Adams	4-3	P	3	5
3R3-37-9, Lowell, Jackson, Cleveland, King Arthur, John Hancock	4-2	P	3	5
3V3-429, Lincoln, Gotham, Washington, Cosmopolitan	4-4	P	3	5
6S1-199, Sam Houston, Nathan Hale	5-1	P	4	6
501-22-9, Henry Hudson, Henry Parks	4-6	P	3	2

Model	Rider Man. Page	Type Cir.	No. of Chains	Sch.
STEWART-WARNER ELECTRIC DIV. OF STEWART-WARNER CORP.				
AVC1, Code 9054B; AVC2, Code 9054-C AVC3, Code 9054-B; AVT1, Code 9054-A	3-15	S-P	6	30
T-711, Code 9031-A; T-711M, Code 9031-AM; T-712, Code 9031-B; TRC-721, Code 9037-A	2-1	P	3	2
9100-A, 9100-B, 9100-C, 9100-D, 9100-E, 9100-F, 9100-G, 9100-H	3-1	S-P	5	29
9103-B, 9103-C, 9103-E	4-1	P	2	1
9104-A, 9104-B, 9104-C	4-22	P	2	1
9106-A, 9106-B	5-1	P	2	1
9108-A, 9108-B	5-15	P	2	1
STOLLE ENGINEERING & MFG. CO.				
Magic Lantern	3-1	P	3	4
4830-12	3-2	P	3	5
STROMBERG-CARLSON CO.				
TC-10, Manhattan	4-1	P	2	1
TC-19, TC-19 Rev., TC-19-M5M	5-1	P	4	5
TC-125	4-5	P	2	1
TS-15, TS-16, TS-125, Series	3-1	P	4	5
TV-10L, Ch. 112020, Series 10	1-1	P	7	4 & 6
TV-10L, Ch. 112020, Series 11	1-1	P	7	4 & 6
TV-10LW, Ch. 112020, Series 10	1-1	P	7	4 & 6
TV-10LW, Ch. 112020, Series 11	1-1	P	7	4 & 6
TV-10PM, Ch. 112025, Series 11; 1220, Ch. 112022, Radio	1-1	P	7	4 & 6
TV-10PY, Ch. 112025, Series 11; 1220, Ch. 112022, Radio	1-1	P	7	4 & 6
TV-12H1M, TV-12H2A, TV-12H2M, Ch. 112040; TV-12LM, Ch. 112035; TV-12M5M, TV-12PGM, Ch. 112034; 1220T, Ch. 112031, Radio	1-17	P	3	2
16-CA, 16-CM, 16-RPM, 16-TA, 16-TM	5-8	P	3	2
SYLVANIA ELECTRIC PRODUCTS INC.				
1-075, Ch. 1-139	4-1	P	2	1
1-076, Ch. 1-108	5-1	P	2	1
1-090, Ch. 1-168	4-16	P	2	1
1-113, 1-114, 1-124, 1-125, Ch. 1-139	4-1	P	2	1
1-128, Ch. 1-108	5-1	P	2	1
1-177, Ch. 1-186	4-14	P	2	1
1-210, Ch. 1-139	4-1	P	2	1
TECH-MASTER PRODUCTS CO. (VIDEOLA)				

Model	Rider Man. Page	Type Cir.	No. of Chains	Sch.
TECH-MASTER PRODUCTS CO. (Cont'd) (VIDEOLA)				
AGC Kit	4-1	P	1	
BC 1223, Blue Ribbon	4-2	P	3	2
TVB, Booster Kit	4-6	P	1	
16CK, Conversion Kit	4-8	P	1	
630TK, Same as RCA 630TS	1-76	P	1	
930, 1230	3-1	P	3	5
1530, 1630, 1631, 2031	3-2	P	3	5
TELECOIN CORP. (TELE-VIDEO)				
AR-100, Same as Reeves-Soundcraft AR-100	3-1	P	10	4,5&6
TELECRAFT CORP.				
15-Inch Set, See RCA 8TS30	2-11	P	3	5
TELE-KING CORP.				
210, 310	2-1	P	5	3
410	3-1	P	3	4
416	5-1	P	3	4
510	4-1	P	3	4
512	3-1	P	3	4
612	3-1	P	3	4
612, Revised	4-1	P	3	4
616	5-1	P	3	4
710	3-1	P	3	4
712	4-1	P	3	4
716	5-1	P	3	4
816	5-1	P	3	4
TELEKIT See ELECTRO-TECHNICAL INDUSTRIES				
TELE-TONE RADIO CORP.				
7-Inch AC-DC	2-1	S-P	3	31
TV-149	2-2	S-P	3	32
TV-208TR	3-1	S-P	3	17
TV-249	2-7	P	4	6
TV-254TR, Ch. TK	4-1	P	2	1
TV-255, TV-256, Ch. TS	4-6	P	3	2
TV-284, Ch. TJ	4-12	P	4	5
TV-284 up to Serial #C12-127, Ch. TH, TJ	5-2	P	4	5
TV-286, Ch. TJ	4-12	P	4	5

Model	Rider Man. Page	Type Cir.	No. of Chains	Sch.
TELE-TONE RADIO CORP. (Cont'd)				
TV-286 up to Serial #C16-263, Ch. TH, TJ	5-2	P	4	5
TV-287, Ch. TJ	4-12	P	4	5
TV-287 after Serial #12-100, Ch. TH, TJ	5-2	P	4	5
TV-288, Ch. TJ	4-12	P	4	5
220, Ch. TR, Rev.	5-1	S-P	3	17
TELE-VIDEO See TELECOIN CORP.				
TELEVISION ASSEMBLY CO. SUBSIDIARY OF SNAIDER TELEVISION CORP.				
Champion, Standard	3-1	P	3	5
F1-101	1-1	P	3	5
P-520	2-1	P	6	3
TELEVISION DEVELOPMENT LABS., INC.				
820A, Televue	1-1	P	3	2
TELEVISION EQUIPMENT CORP.				
S-501, Antenna Multicoupler	3-1	P	1	
TELEVISTA CORP. OF AMERICA				
Arista, Electra, Empress	4-1	P	4	6
Monte Carlo	2-1	P	3	5
Trafton	4-1	P	4	6
100, Monte Carlo	2-1	P	3	5
104, Arista, Electra, Empress, Trafton	4-1	P	4	6
TELINDUSTRIES, INC. (KAYE-HALBERT)				
821, 921, 1621	4-1	P	3	2
TEL VISION				
TR7-1, Ch. TR10C-1	1-1	P	2	1
TR10-1, Ch. TR10C-1	1-1	P	2	1
TEMPLE See TEMPLETONE RADIO MFG. CORP.				
TEMPLETONE RADIO MFG. CORP. (TEMPLE)				
TV-1776	2-1	P	2	1
TRAD TELEVISION CORP.				
13, 14	3-1	P	5	3
TT-63-SH	5-1	P	3	5
TRADIO, INC. (TRADIOVISION)				
	1-1	P	5	1&4
TRADIOVISION See TRADIO, INC. Also See TRAD TELEVISION CORP.				
TRANSVISION, INC.				
Booster	2-6	P	1	
A-1	2-1	P	2	1
A-2	2-4	P	2	1
A-3	2-1	P	2	1
7-Inch Kit, Early	1-1	P	3	2
7-Inch Kit, Late	1-1	P	3	2
12-Inch Kit	1-31	P	3	2
TRANS-VUE CORP.				
90X, 90XFM, 90XFMB	4-1	P	4	6
145, 145B	3-1	P	4	6
160-L, Entertainer	3-3	S-P	6	33
400	5-1	P	2	1
601, 610, Ch. 16AX23, 16AX25, 16AX26	5-11	P	2	1
TRAV-LER RADIO CORP.				
10T	3-1	P	3	4
12L50	5-1	P	4	6
12T	3-1	P	3	4
16G50, 16R50	5-1	P	4	6
16-T	4-1	P	3	4
16T, Rev.	5-11	P	3	4
16T50	5-1	P	4	6
UNITED MOTORS SERVICE DIV. OF GENERAL MOTORS CORP.				
TV-71	2-1	S-P	3	25
TV-71A	2-6	S-P	3	25
TV-101	3-1	P	3	2
TV-102	4-1	P	3	2
TV-121, TV-122	5-1	P	3	2
TV-160	4-9	P	3	2
TV-201	3-8	P	3	2
U.S. TELEVISION MFG. CORP.				
R-F Tuner, Type A	1-1	P	1	
10-Inch Direct View	1-37	P	3	2
10-Inch Direct View; 15-Inch Direct View	1-39	P	3	2
C1630, C19031	4-1	P	3	5
CFM12823-1, CFM15925	3-1	P	3	2
CFM16031, CFM19032	4-1	P	3	5

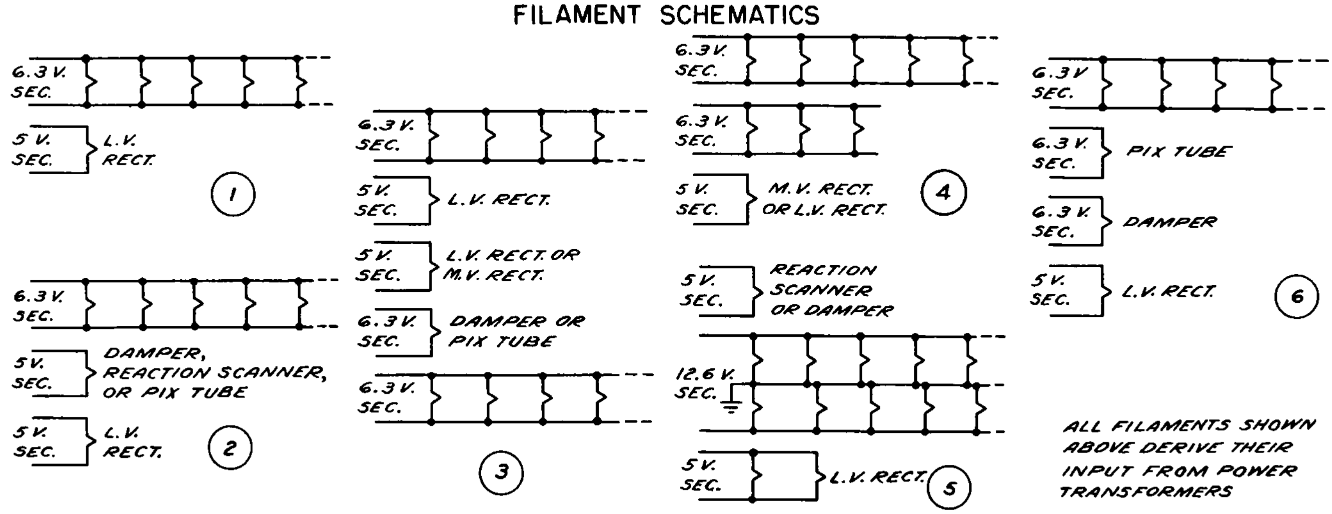
Model	Rider Man. Page	Type Cir.	No. of Chains	Sch.
U.S. TELEVISION MFG. CORP. (Cont'd)				
KRV12823-1, KRV15831-3	3-1	P	3	2
T502, T507, T508, T521, T525, T530, T621	1-13	P	4	3
T10823	2-1	P	3	2
T16030, T19031, TFM16031, TFM19032	4-1	P	3	5
VIDAIRE TELEVISION CO.				
SC-1 Tuner	4-2	P	1	
100	3-1	P	3	5
100A	3-1	P	3	5
VIDCRAFT TELEVISION CORP.				
A-101, Add-A-Vision	2-1	P	4	6
017, 017B, 017C, 017D	5-1	P	3	4
024 Series	5-2	P	3	2
5700R	2-3	P	5	1&5
VIDEO CORP. OF AMERICA				
VS-120	2-1	P	4	6
VS-160	4-1	P	4	6
1510	2-2	P	3	5
VIDEODYNE, INC.				
10FM, 10TV, 12FM, 12TV	2-1	P	4	6
VIDEOLA See TECH-MASTER PRODUCTS CO.				
VIDEON See REEVES-SOUNDCRAFT CORP.				
VIEWTONE TELEVISION & RADIO CORP.				
VP100, VP100A, VP101A, Adventurer, Futura	1-1	P	3	2
VISION RESEARCH LABS., INC.				
F-M Teletuner	2-1	P	1	
TVA	2-1	P	1	
TVX	2-2	P	1	
TVZ	2-2	P	1	
WARWICK MFG. CORP.				
167	5-1	P	3	4
WESTERN AUTO SUPPLY CO.				
D1090	5-1	P	3	2
D1092	5-7	P	3	4
D1990	3-1	S-P	6	10
D1991A, D1991B	3-15	P	4	6
D1992	3-1	S-P	6	10
WESTERN AUTO SUPPLY CO. (Cont'd)				
D1993A, D1993B	3-15	P	4	6
D1994	4-1	P	4	6
D1996	4-11	P	3	2
D1997A, D1998A	5-12	P	4	6
D1998B	5-12	P	3	2
D2044	5-28	P	2	1
D2047	5-22	P	2	1
D2050A	5-12	P	4	6
D2982	4-18	P	3	4
D2983	4-11	P	3	2
D2985A, D2985B	3-24	S-P	3	9
D2987	3-1	S-P	6	10
10AX21, Ch.	5-32	P	2	1
10AXF44, Ch. 10AX21	5-32	P	2	1
WESTINGHOUSE ELECTRIC CORP.				
H-181	1-30	P	3	2
H-196, Ch. V-2130	3-1	P	4	5
H-216, Ch. V-2146-05DX; H-216A, Ch. V-2146-45DX	5-1	P	4	5
H-217, H-217A, Ch. V-2146-1	5-11	P	6	5
H-217, H-217A, Ch. V-2146-11DX; H-217B, Ch. V-2146-35DX	5-11	P	4	5
H-223, Ch. V-2150-01	3-19	P	3	5
H-226, Ch. V-2146-21DX, V-2146-25DX	5-26	P	4	5
H-231, Ch. V-2150-51; V-2137-3, V-2137-3S, Radio Ch.	5-35	P	3	5
H-242, Ch. V-2150-31	4-1	P	3	5
H-251, Ch. V-2150-81, V-2150-82, V-2150-84	4-9	P	3	5
H-600T16, Ch. V-2150-61	4-17	P	3	5
H-601K12, H-602K12, Ch. V-2150-41	4-25	P	3	5
H-603C12, Ch. V-2152-01	5-46	P	5	5
H-604T10, H-604T10A, Ch. V-2150-91A, V-2150-94, V-2150-94A	4-33	P	3	5
H-605T12, Ch. V-2150-101	5-55	P	3	5
H-608C12, Ch. V-2152-01	5-46	P	5	5
WRT-700, WRT-701	1-1	P	4	5
WRT-702, WRT-703	1-7	P	5	5
WILCOX-GAY CORP.				
OD Series, Serial Nos. below 26,000	5-1	P	4	6
OF Series	5-11	P	4	6

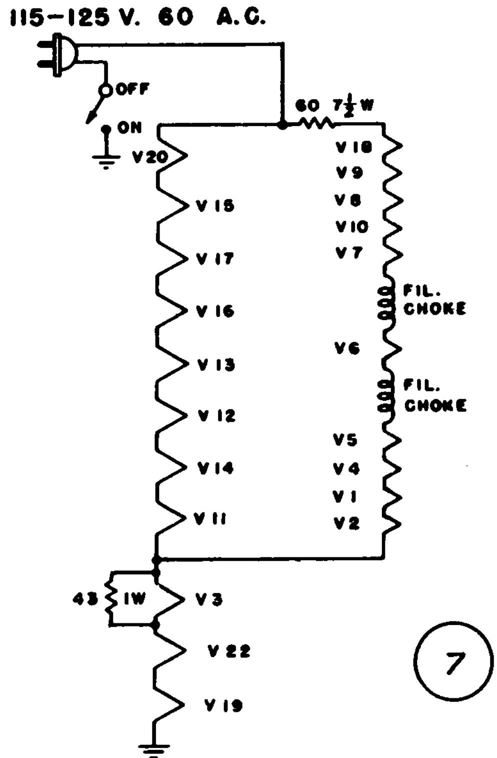
RECEIVING TUBE SUBSTITUTION GUIDE

Model	Rider Man. Page	Type Cir.	No. of Chains	Sch.
WILCOX-GAY CORP. (Cont'd)				
OL Series, Serial Nos. Below 26,000	5-22	P	3	2
9V Series	4-1	P	2	1
9W Series	4-12	S,P	2	34
ZENITH RADIO CORP.				
G2322, Ch. 23G22, Claridge	4-17	S-P	5	35
G2322Z, G2327Z, Ch. 23G24, Garfield	4-38	P	3	5
G2340, Ch. 23G22, Endear; G2340R, Ch. 23G22, Saratoga	4-17	S-P	5	35
G2340RZ, Ch. 23G24, Adams; G2340, Ch. 23G24, Ensign	4-38	P	3	5
G2346R, Ch. 23G22, Graemere	4-17	S-P	5	35
G2350RZ, Ch. 23G24, Adams; G2350Z, Ch. 23G24, Ensign	4-38	P	3	5
G2353E, Ch. 23G22, Biltmore	4-17	S-P	5	35
G2353EZ, G2356EZ, Ch. 23G24, Tyler	4-38	P	3	5
G2420E, Ch. 24G20, Wilshire; G2420-EOX, Ch. 24G20-OX, Wilshire, G2420R, Ch. 24G20, Newport; G2420-ROX, Ch. 24G20-OX, Newport	4-1	P	4	6
G2437RZ, Jackson; G2438RZ, Lincoln; G2438Z, Entice; G2439RZ, Monroe; Ch. 24G26	4-38	P	3	5
G2441, Ch. 24G24, Endow; G2441R, Ch. 24G22, 24G24, Lexington	4-17	S-P	5	35
G2441RZ, Lincoln; G2441Z, Entice; Ch. 24G26	4-38	P	3	5
G2442E, Waldorf; G2442R, Mayfair; Ch. 24G22, 24G24	4-17	S-P	5	35
G2442RZ, Jackson; G2448RZ, Monroe; Ch. 24G26	4-38	P	3	5
G2454R, Ch. 24G21; G2454-RCX, Ch. 24G21-OX	4-1	P	4	6

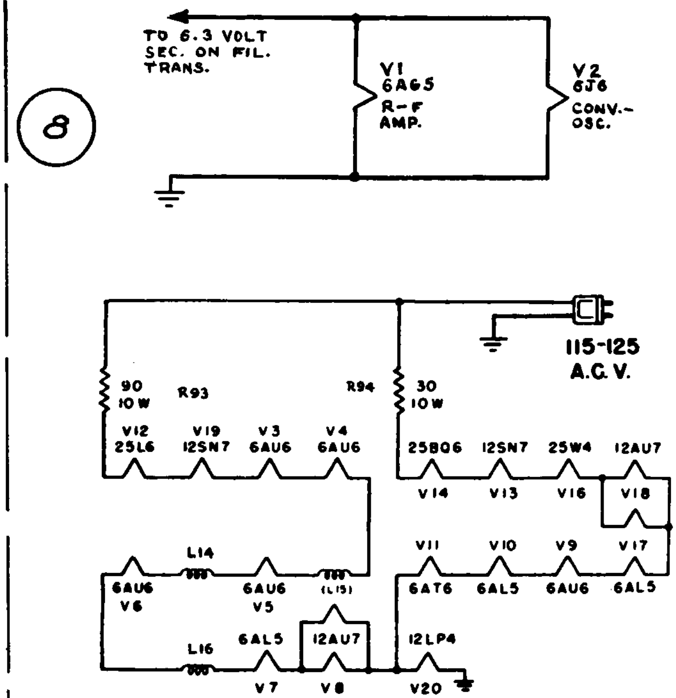
Model	Rider Man. Page	Type Cir.	No. of Chains	Sch.
ZENITH RADIO CORP. (Cont'd)				
G2951, G2951R, Stratosphere; G2952R, St. Regis; Ch. 29G20	3-1	P	5	5
G2957, Ch. 23G23, Endue; G2957R, Ch. 23G23, Regent; G3059R, Ch. 24G23, 24G25, Sheraton; G3062, Ch. 24G23, 24G25, Classic; 6G20, Radio Ch.	4-17	S-P	5	35
G3157RZ, Madison; G3157Z, Entwine; G3158RZ, Van Buren; G3173RZ, Madison; G3173Z, Entwine; G3174RZ, Van Buren; Ch. 23G24	4-38	P	3	5
G3259RZ, Washington; G3262Z, Jefferson; G3275RZ, Washington; G3276Z, Jefferson; Ch. 24G26	4-38	P	3	5
27T965R, Ch. 27F20, 27F20Z, Broadmoor	3-1	P	5	5
28T295, Ch. 28F22	2-1	P	5	5
28T925E, 28T925EU, Ch. 28F22, Revised, Biltmore; 28T295R, 28T92RU, Ch. 28F22 Revised, Mayflower; 28T926E, Ch. 28F25, Saratoga; 28T926R, Ch. 28F25, Claridge	3-1	P	5	5
28T960, Ch. 28F20	2-1	P	5	5
28T960E, Ch. 28F20 Revised, 28F20Z, Waldorf; 28T960K, Ch. 28F20 Revised, Derby	3-1	P	5	5
28T961, Ch. 28F21	2-1	P	5	5
28T961E, Ch. 28F21 Revised, Wilshire	3-1	P	5	5
28T962, Ch. 28F20	2-1	P	5	5
28T962R, Ch. 28F20, Revised, Warwick	3-1	P	5	5
28T963, Ch. 28F21	2-1	P	5	5
28T963R, Ch. 28F21 Revised, Newport; 28T964R, Ch. 28F23, Stratosphere	3-1	P	5	5
29G20, Ch.	3-1	P	5	5
37T996RLP, Ch. 28F23, Sovereign; 37T998RLP, Ch. 9E21Z, 28F20 Revised, Gotham; 42T999RLP, Ch. 28F23 Marlborough	3-1	P	5	5

FILAMENT SCHEMATICS

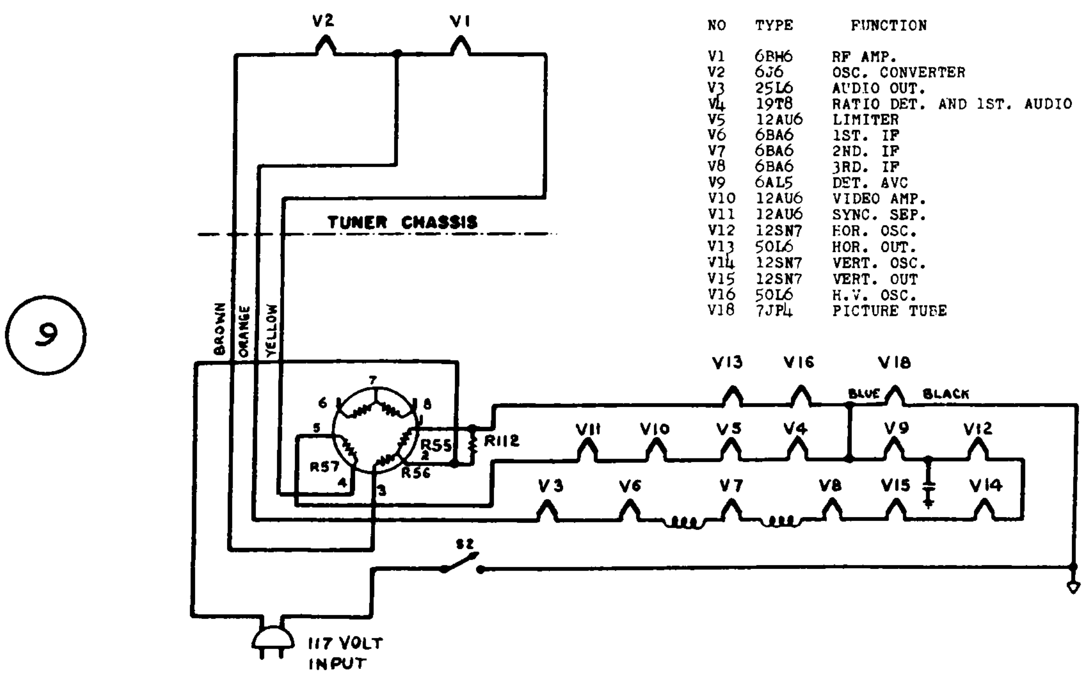




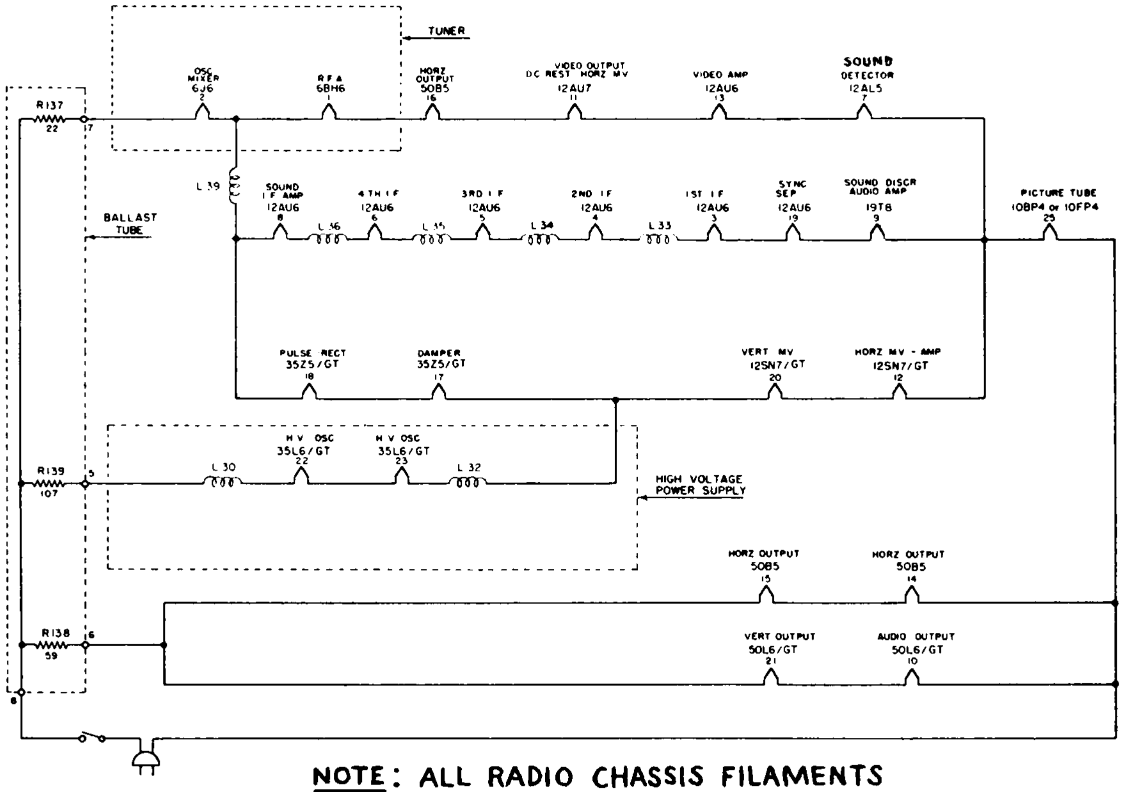
NO	TYPE	FUNCTION
V1	6AU6	RF AMP.
V2	6AG5	MIXER
V3	6J6	RF OSC.
V4	6AU6	1ST. IF AMP.
V5	6AU6	2ND. IF AMP.
V6	6AU6	3RD. IF AMP.
V7	6AL5	VIDEO 2ND. DETECTOR
V8	6AU6	VIDEO AMP.
V9	6AU6	VIDEO OUTPUT
V10	6AU6	RATIO DETECTOR DRIVER
V11	6AL5	RATIO DETECTOR
V12	6AT6	AUDIO AMP.
V13	25L6	AUDIO OUTPUT
V14	12SN7	HORIZ. OSC.
V15	12SN7	HORIZ. OUTPUT
V16	12SN7	VERT. OSC.
V17	12SN7	VERT. OUTPUT
V18	25Z6	L.V.RECTIFIER
V19	6X5	L.V.RECTIFIER
V20	12SN7	H.V. OSC.
V22	7JP4	PICTURE TUBE



NO	TYPE	FUNCTION
V1	6AG5	RF AMP.
V2	6J6	CONVERTER OSC.
V3	6AU6	1ST. IF AMP.
V4	6AU6	2ND. IF AMP.
V5	6AU6	3RD. IF AMP.
V6	6AU6	4TH. IF AMP.
V7	6AL5	PIX 2ND DET.
V8	12AU7	1ST. AND 2ND. VIDEO AMP.
V9	6AU6	1ST. SOUND IF
V10	6AL5	AUDIO DISCR.
V11	6AT6	AUDIO AMP.
V12	25L6	AUDIO OUT.
V13	12SU7	HOR. OSC. AND DISCH.
V14	25B4	HOR. OUT.
V16	25W4	HOR. DAMP.
V17	6AL5	HOR. SYNC. DISCR.
V18	12AU7	SYNC. SEP. AND AMP.
V19	12SN7	VERT. OSC. AND OUT.
V20	12LP4	PICTURE TUBE



NO	TYPE	FUNCTION
V1	6BH6	RF AMP.
V2	6J6	OSC. CONVERTER
V3	25L6	AUDIO OUT.
V4	19T8	RATIO DET. AND 1ST. AUDIO
V5	12AU6	LIMITER
V6	6BA6	1ST. IF
V7	6BA6	2ND. IF
V8	6BA6	3RD. IF
V9	6AL5	DET. AVC
V10	12AU6	VIDEO AMP.
V11	12AU6	SYNC. SEP.
V12	12SN7	HOR. OSC.
V13	50L6	HOR. OUT.
V14	12SN7	VERT. OSC.
V15	12SN7	VERT. OUT
V16	50L6	H.V. OSC.
V18	7JP4	PICTURE TUBE



NOTE: ALL RADIO CHASSIS FILAMENTS ARE IN SERIES ACROSS THE LINE.

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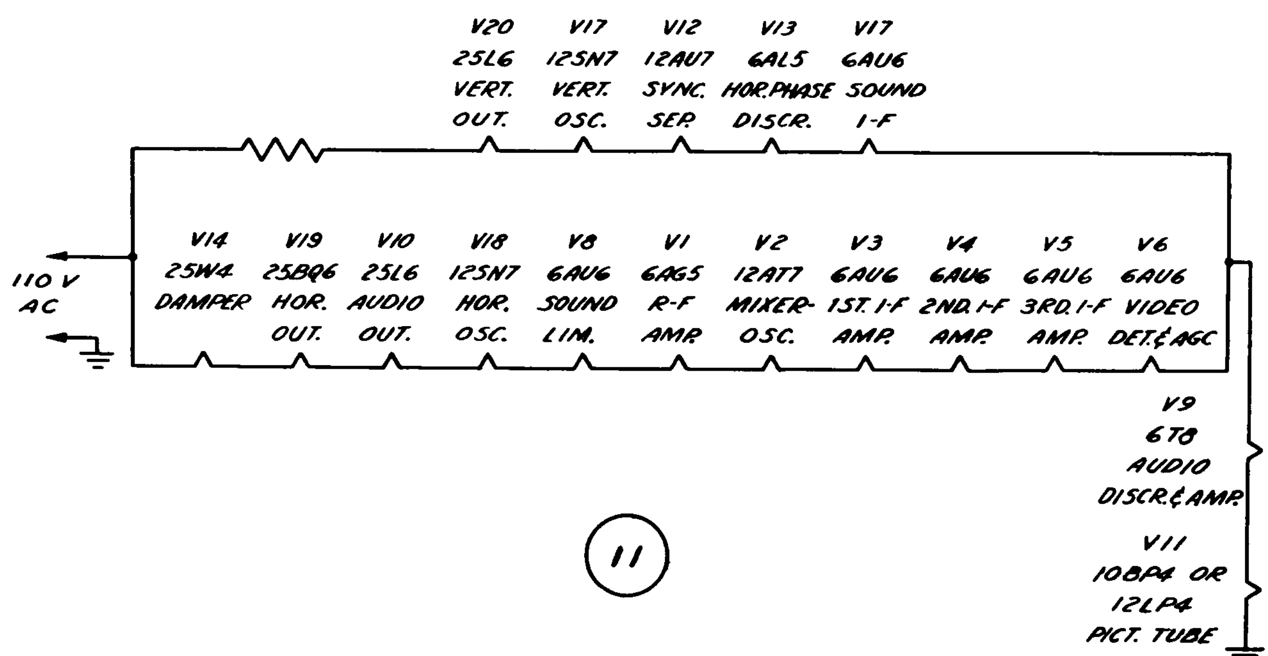

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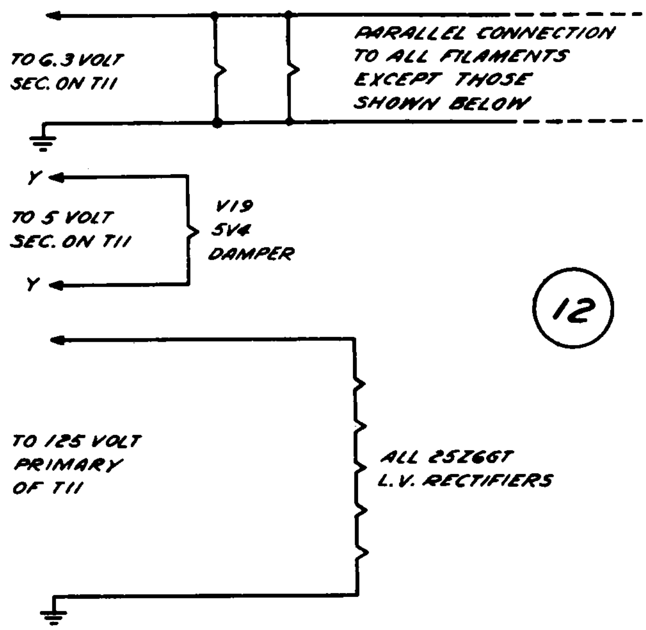

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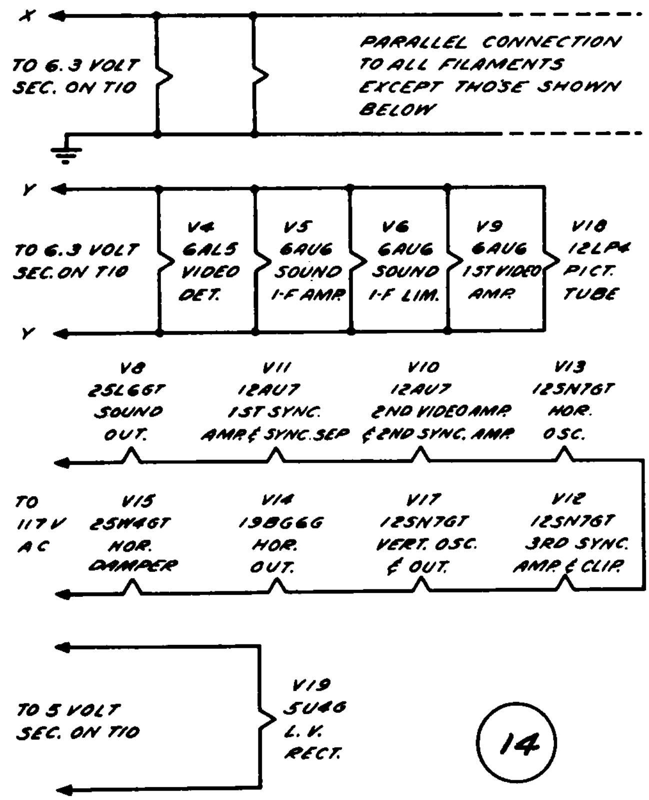

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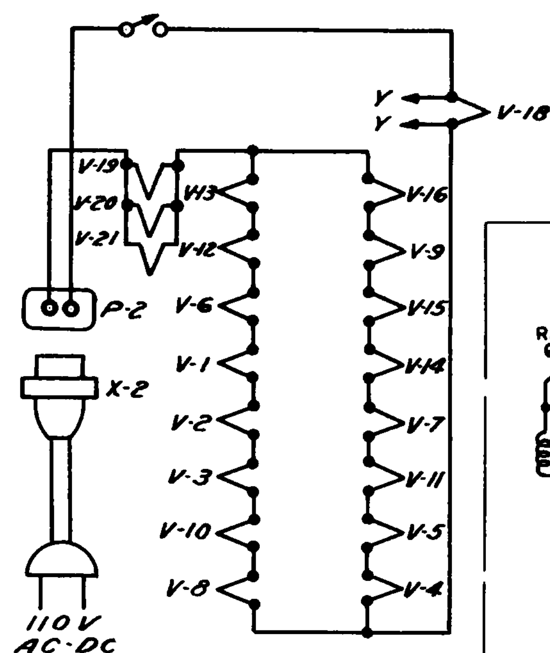
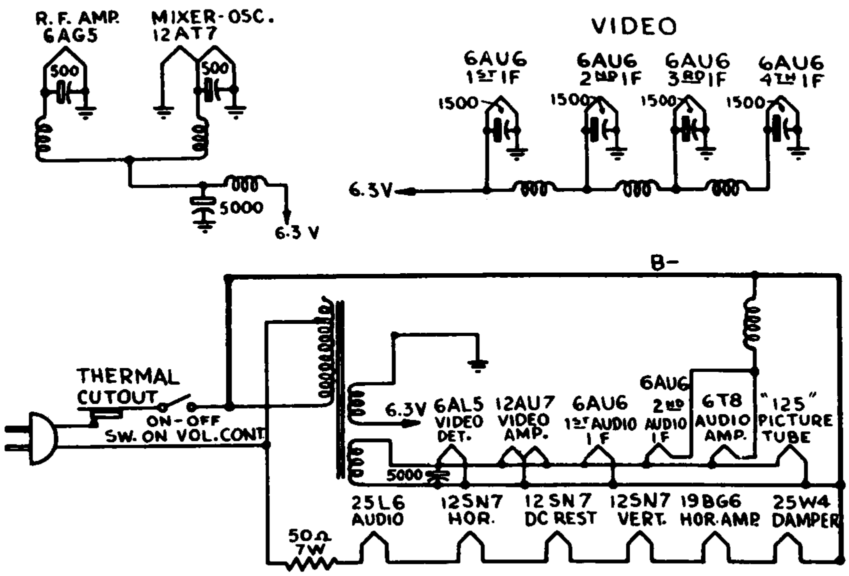


NO	TYPE	FUNCTION
V1	6AU6	1st VIDEO IF
V2	6AU6	2nd VIDEO IF
V3	6AU6	3rd VIDEO IF
V4	6AL5	DET., AGC
V5	12AU7	SYNC SEP, 1st VIDEO
V6	25L6	2nd VIDEO AMP.
V7	6SH7	LIM., SOUND IF
V8	6S8	DET., AUDIO AMP.
V9	25L6	AUDIO OUT.
V10	6AL5	AFC PHASE DET.
V11	12AU7	PHASE INV., DC AMP.
V12	12SN7	HOR. OSC.
V13	25L6	HOR. AMP.
V14	12SN7	VERT. OSC.
V15	6SL7	VERT. AMP.
V16	25L6	H.V. OSC.
V18	7JP4	PICT. TUBE
V19	6J6	OSC.
V20	6J6	CONV.
V21	6J6	RF AMP.

13



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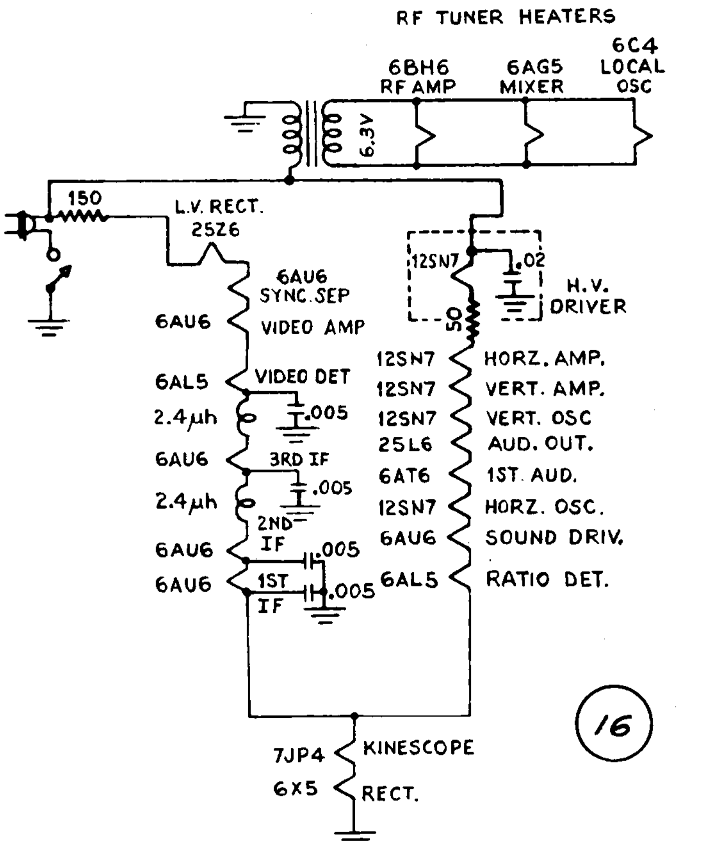

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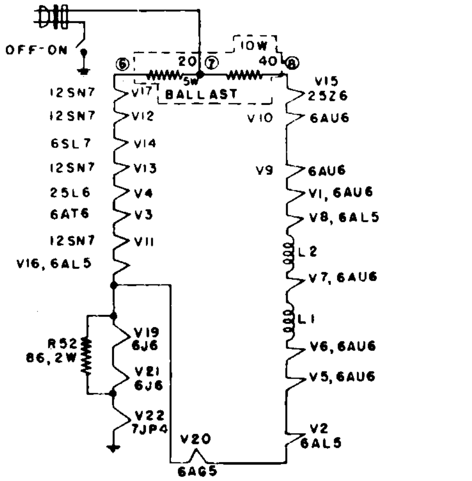

NO	FUNCTION	NO	FUNCTION
V1	4.5 MC AMPLIFIER	V12	HORIZ DEFLECTION AMPLIFIER
V2	RATIO DETECTOR	V13	VERTICAL OSCILLATOR
V3	AUDIO AMPLIFIER	V14	VERT DEFLECTION AMPLIFIER
V4	AUDIO OUTPUT	V15	LOW VOLTAGE RECTIFIER
V5	1st I F AMPLIFIER	V16	A F C DISCRIMINATOR
V6	2d I.F AMPLIFIER	V17	HIGH VOLTAGE R F OSC
V7	3d I F AMPLIFIER	V18	HIGH VOLTAGE RECTIFIER
V8	VIDEO DETECTOR & A G C	V19	OSCILLATOR
V9	VIDEO AMPLIFIER	V20	CONVERTER
V10	SYNC SEPARATOR & DC RESTORER	V21	R F AMPLIFIER
V11	HORIZ OSC & A F C AMPLIFIER	V22	PICTURE TUBE

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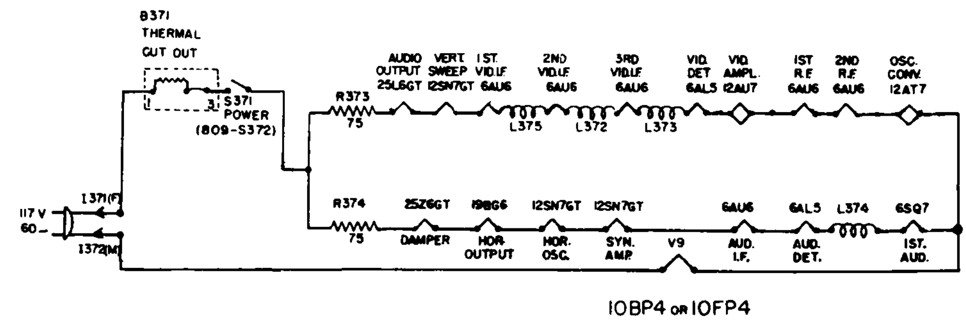

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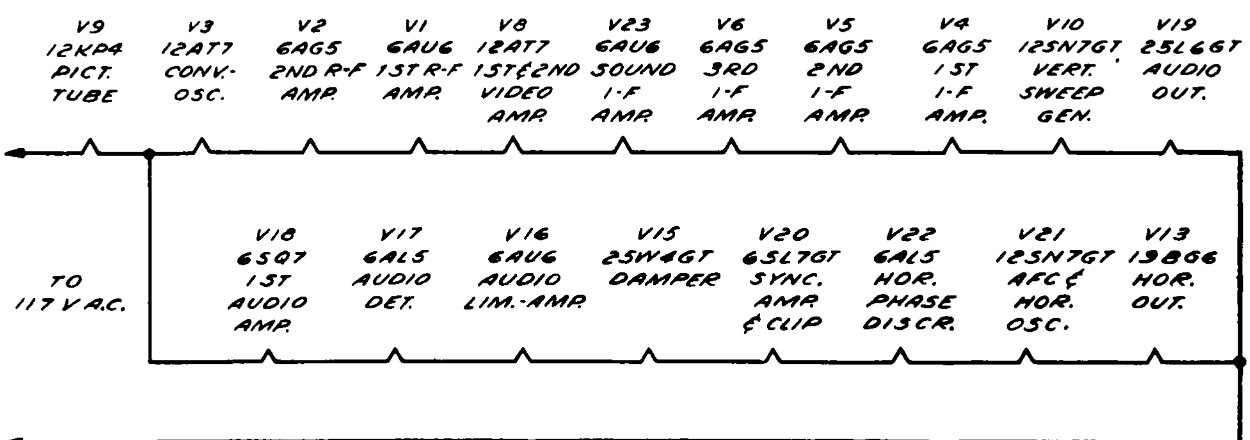

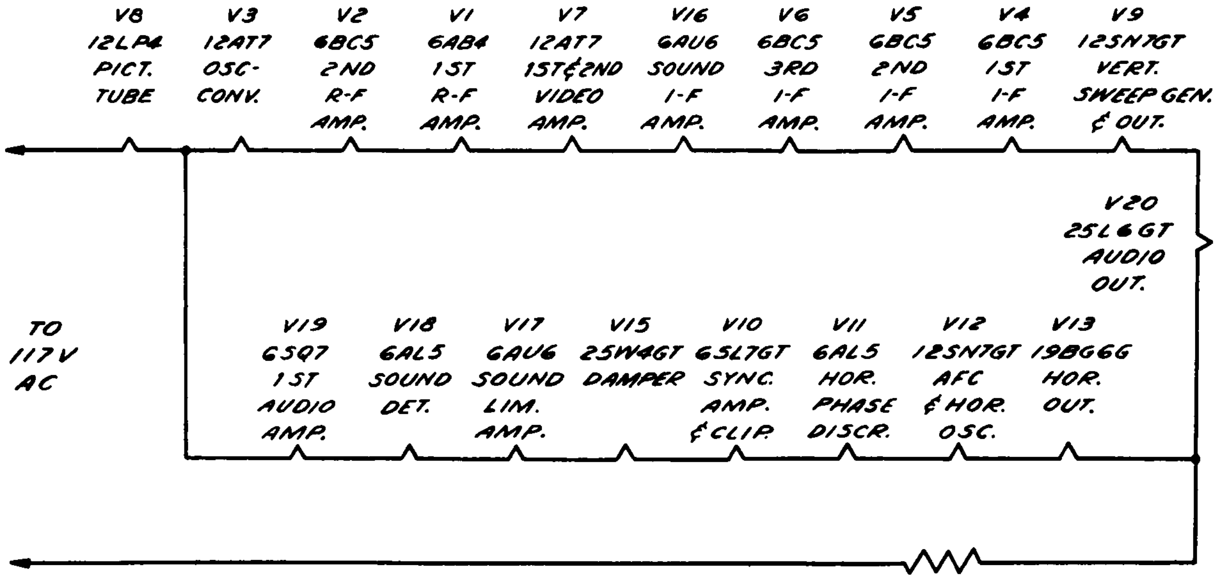

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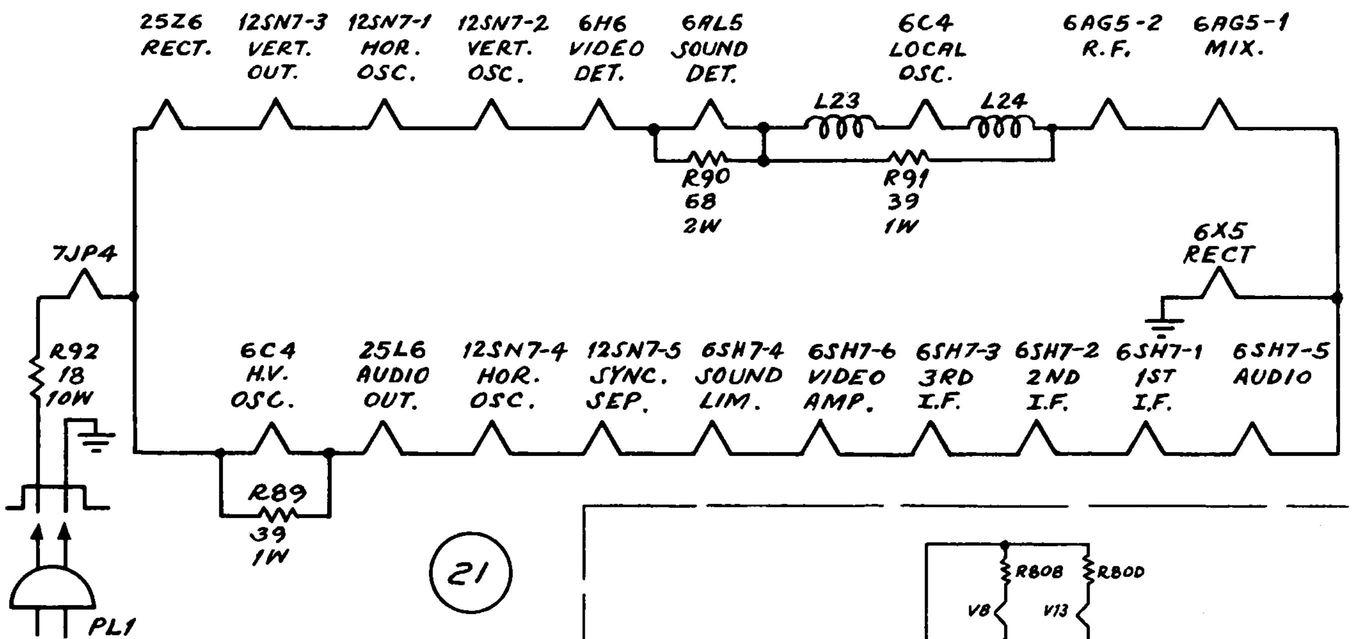

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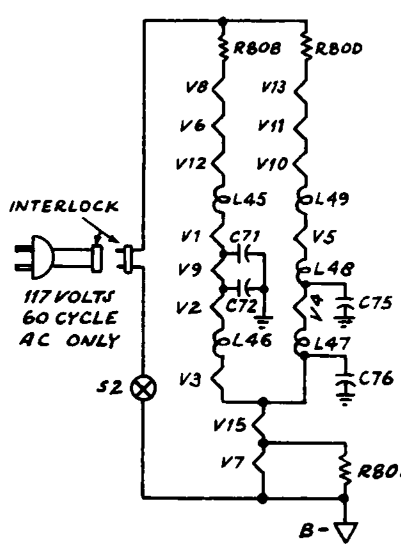
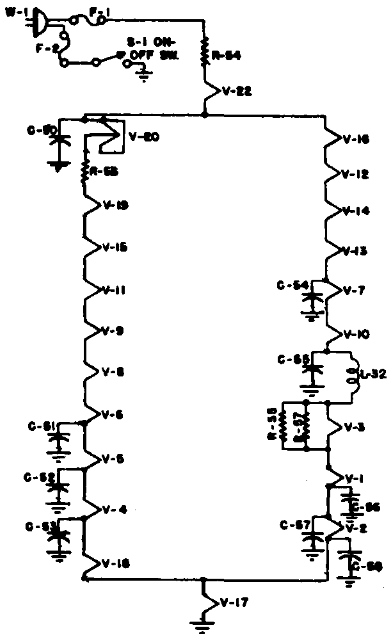
NO	TYPE	FUNCTION
V1	6AG5	RF AMP.
V2	6AG5	1ST. IF AMP.
V3	6AG5	2ND. IF AMP.
V4	6AG5	3RD. IF AMP.
V5	6AU6	VIDEO AMP.
V6	6AU6	LIMITER
V7	6S8 GT	RATIO DETECTOR AND AUDIO AMP.
V8	6SL7 GT	VERT. SWEEP OUT.
V9	7F8	RF OSC. AND CONVERTER
V10	12SN7	1ST. CLIPPER AND VERT. SWEEP OSC.
V11	12SN7	2ND. CLIPPER AND HORIZ. SWEEP OSC.
V12	25L6 GT	AUDIO OUT.
V13	25L6 GT	H.V. OSC.
V15	7JP4	PICTURE TUBE





	Tube	Function
V1	6AU6	R.F. Amplifier
V2	6AG5	Mixer
V3	6C4	Local Oscillator
V4	6AU6	First Video I.F. Amplifier
V5	6AU6	Second Video I.F. Amplifier
V6	6AU6	Third Video I.F. Amplifier
V7	6AL5	Video Detector—Automatic Gain Control
V8	6AU6	Video Amplifier
V11	5AU6	Sync Clipper—D.C. Restorer
V9	6AU6	4.5 Mc. Ratio Detector Driver
V10	6AL5	Ratio Detector
V18	6AT6	Audio Amplifier
V19	25L6GT/G	Audio Output
V13	12SN7GT	Vertical Sweep Generator
V12	12SN7GT	Vertical Sweep Output
V15	12SN7GT	Horizontal Sweep Generator
V14	12SN7GT	Horizontal Sweep Output
V20	12AU7	R.F. High Voltage Oscillator
V21	1B3GT/8016	High Voltage Rectifier
V16	25Z6GT/G	Low Voltage Doubler—B Minus Voltage Rectifier
V17	6X5GT/G	Voltage Multiplier
V22	7JP4	Picture Tube

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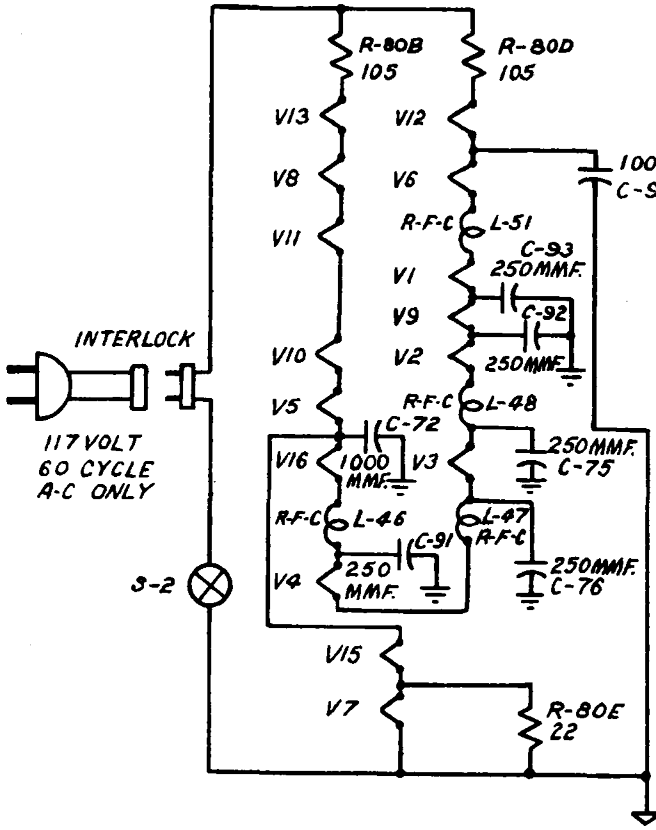

NO	TYPE	FUNCTION
V1	6AG5	RF AMP.
V2	6AG5	1ST. VIDEO IF AMP.
V3	6AG5	2ND. VIDEO IF AMP.
V4	6AG5	3RD. VIDEO IF AMP.
V5	6AU6	VIDEO AMP.
V6	6AU6	LIMITER
V7	6SQ7	AUDIO AMP.
V8	6SL7GT	VERT. SWEEP OUT.
V9	7F8	RF OSC. AND CONVERTER
V10	12SN7GT	1ST. CLIPPER AND VERT. SWEEP OSC.
V11	12SN7GT	2ND. CLIPPER AND HOR. SWEEP OSC.
V12	25L6GT	AUDIO OUT.
V13	25L6GT	H.V. SUP. OSC.
V15	7JP4	PICTURE TUBE
V16	6AL5	RATIO DET.

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NO	TYPE	FUNCTION
V1	6SH7	AUDIO IF
V2	6AL5	FM-DET.
V3	6SH7	AUDIO AMP.
V4	25L6GT	AUDIO OUTPUT
V5	6AG5	RF AMP.
V6	6AG5	MIXER
V7	6SH7	1ST. IF
V8	6SH7	2ND. IF
V9	6SH7	3RD. IF
V10	6H6	VIDEO DET.
V11	6SH7	VIDEO AMP.
V12	12SN7GT	VIDEO OUT.,SYNC.SEP.,DC REST.
V13	7JP4	KINESCOPE
V14	6C4	OSCILLATOR
V15	25Z6GT	RECTIFIER
V16	6X5	RECTIFIER
V17	12SN7GT	HORIZONTAL OSCILLATOR
V18	12SN7GT	VERTICAL OSCILLATOR
V19	12SN7GT	HORIZONTAL AMPLIFIER
V20	12SN7GT	VERTICAL AMPLIFIER
V21	6C4	H.V. OSC.

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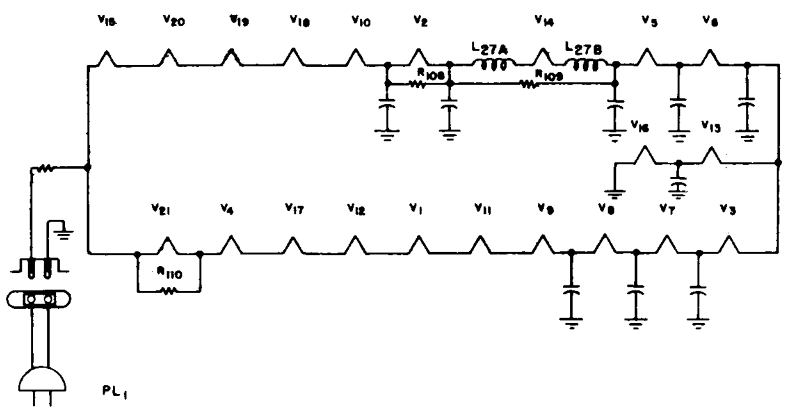

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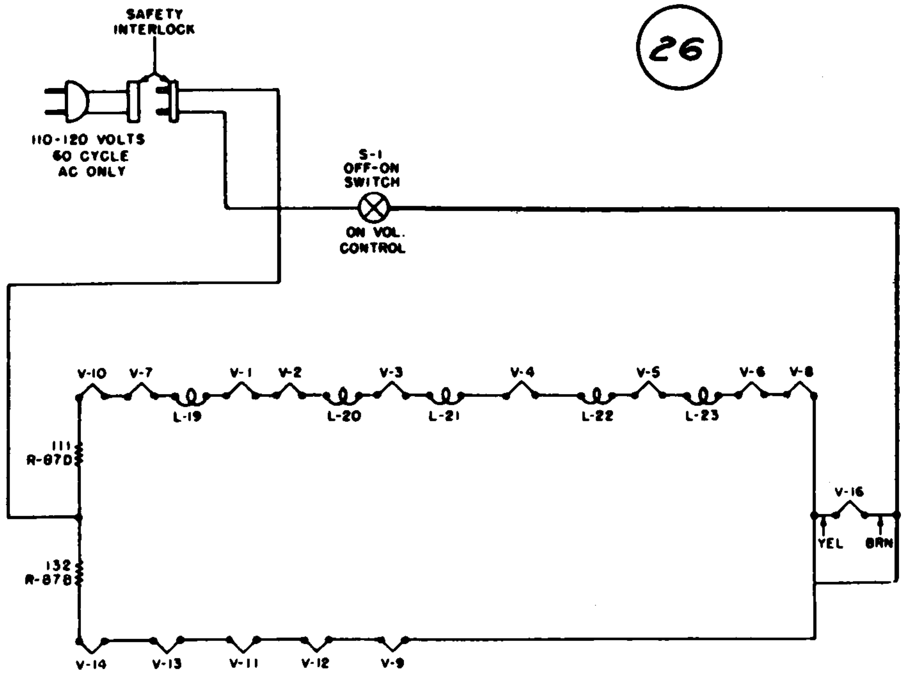
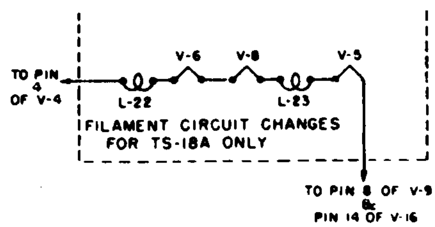


NO	TYPE	FUNCTION
V1	6AG5	RF AMP.
V2	12AT7	MIXER OSC.
V3	6AU6	1ST IF AMP.
V4	6AU6	2ND IF AMP.
V5	6AU6	3RD IF AMP.
V6	6AU6	VIDEO AMP.
V7	6AU6	AUDIO DRIVER-LIMITER
V8	6AL5	RATIO DETECTOR
V9	12SN7	1ST AUDIO AMP., VERT. SWEEP OSC.
V10	25L6	AUDIO OUTPUT
V11	12SN7	1ST & 2ND CLIPPER
V12	12SN7	HORIZ. OSC. & AFC DIODE
V13	6SL7	VERT. SWEEP OUTPUT
V14	25L6	H.V. OSC.
V16	7JP4 8BP4	PICTURE TUBE



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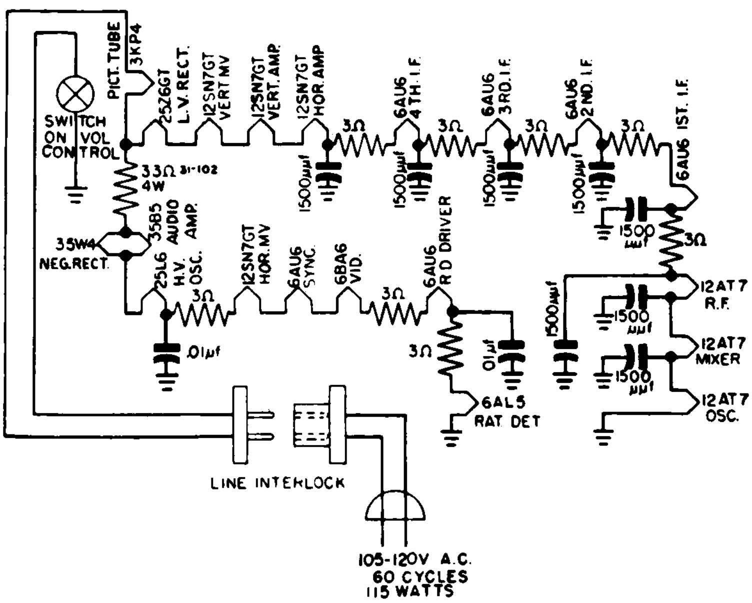

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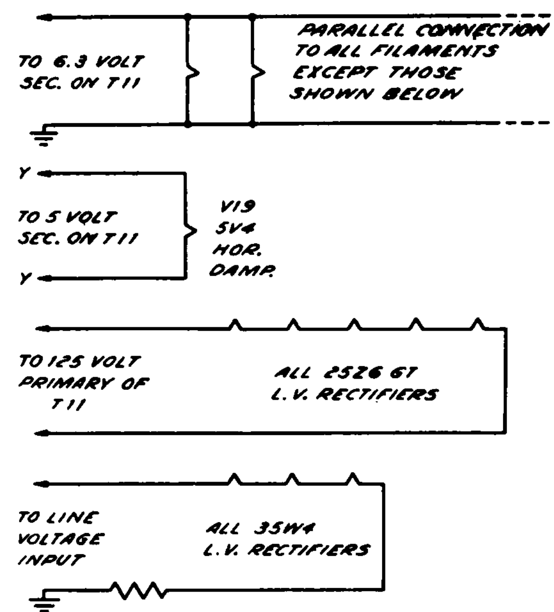
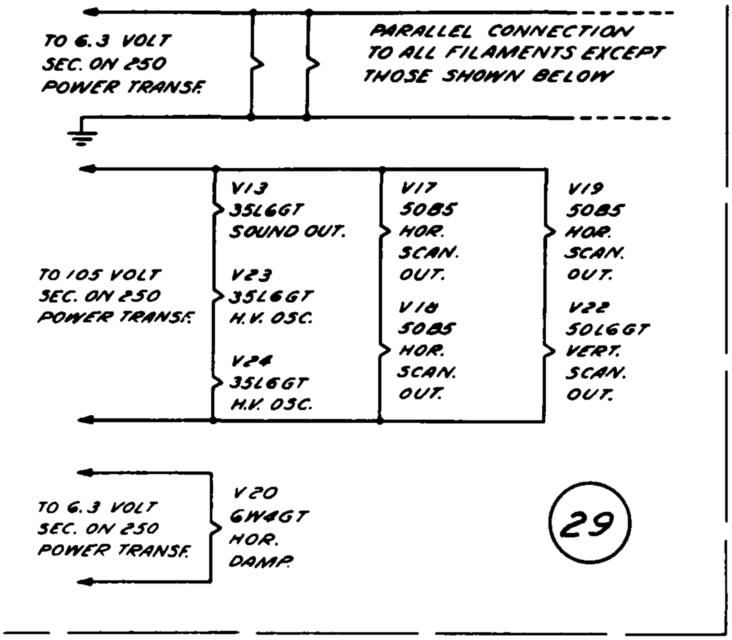


NOTE:
MODEL 506-B (TIBET) RADIO CHASSIS FILAMENTS ARE IN PARALLEL ARRANGEMENT.



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NO	TYPE	FUNCTION
V1	6BH6	RF AMP.
V2	6J6	MIXER-OSC.
V3	12AU6	1ST. IF AMP.
V4	12AU6	2ND. IF AMP.
V5	12AU6	3RD. IF AMP.
V6	12AU6	4TH. IF AMP.
V7	12AL5	DET. AGC
V8	12AU6	VIDEO AMP.
V9	12AU7	DC REST., HOR. SCAN. MVBTR.
V10	10BP4	PICTURE TUBE
V11	12AU6	SOUND IF AMP. AND LIM.
V12	19T8	DYN. LIM., SOUND DISCR., SOUND AMP.
V13	50L6GT	SOUND OUT.
V14	12AU6	SYNC. CLIP.
V15	12SN7GT	HOR. SCAN. MVBTR. AND AMP.
V16	50B5	HOR. SCAN. OUT.
V17	50B5	HOR. SCAN. OUT.
V18	50B5	HOR. SCAN. OUT.
V19	35Z5GT	HOR. DAMP.
V20	12SN7GT	VERT. SCAN. MVBTR.
V21	50L6GT	VERT. SCAN. OUT.
V22	35L6GT	H.V. OSC.
V23	35L6GT	H.V. OSC.
V25	35Z5GT	L.V. RECT.

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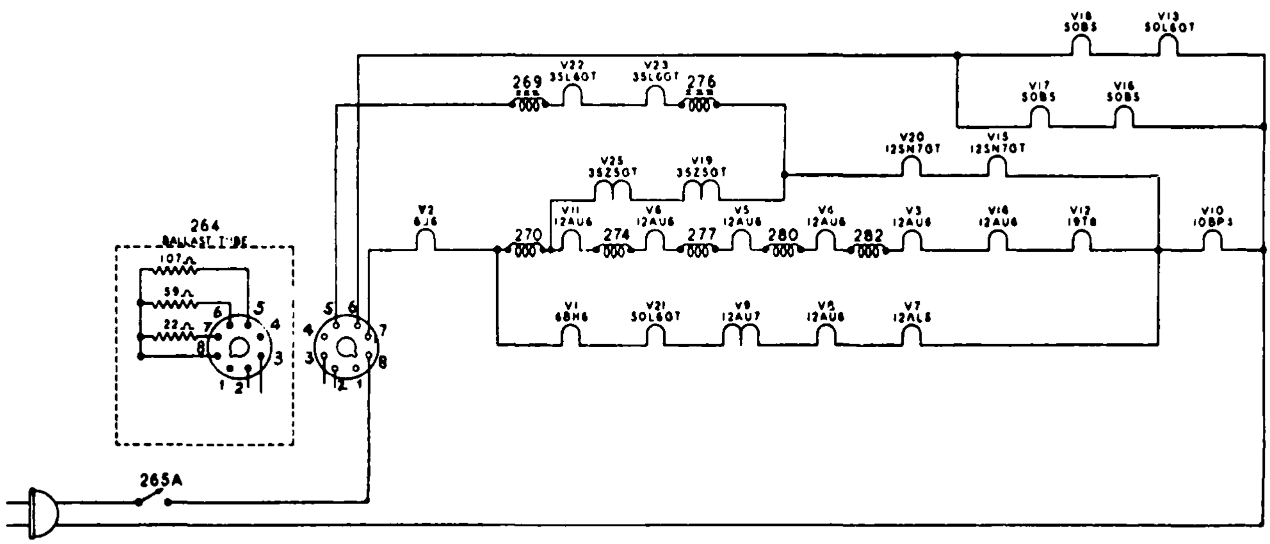
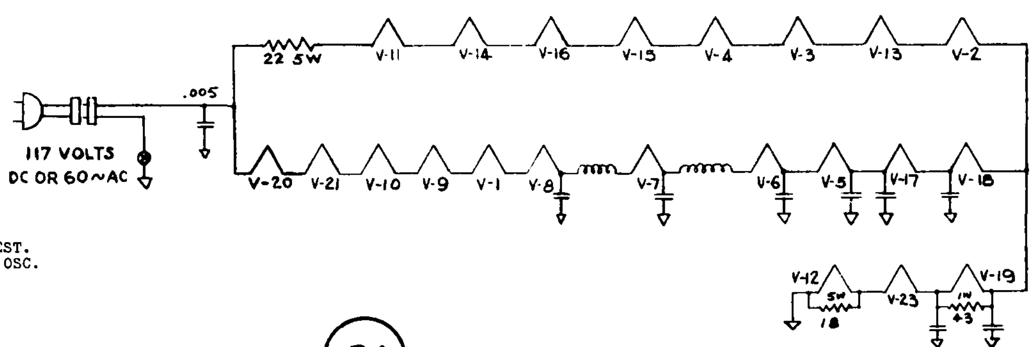


NO	TYPE	FUNCTION
V1	6AU6	AUDIO IF
V2	6AL5	RATIO DET.
V3	6AT6	AUDIO AMP.
V4	25L6	AUDIO OUT.
V5	6AU6	1ST. VIDEO IF
V6	6AU6	2ND. VIDEO IF
V7	6AU6	3RD. VIDEO IF
V8	6AL5	VIDEO DET.
V9	6AU6	VIDEO AMP.
V10	6AU6	SYNC. SEP. AND DC REST.
V11	12SN7	SYNC. AMP. AND HOR. OSC.
V12	6H6	HOR. SYNC. DISCR.
V13	12SN7	HOR. OSC. AND DISCH.
V14	12SN7	HOR. OUT.
V15	12SN7	VERT. OSC.
V16	6SL7	VERT. AMP.
V17	6AU6	RF AMP.
V18	6AG5	CONVERTER
V19	6J6	RF OSC.
V20	25L6	H.V. OSC.
V21	25L6	H.V. OSC.
V23	7JP4	PICTURE TUBE



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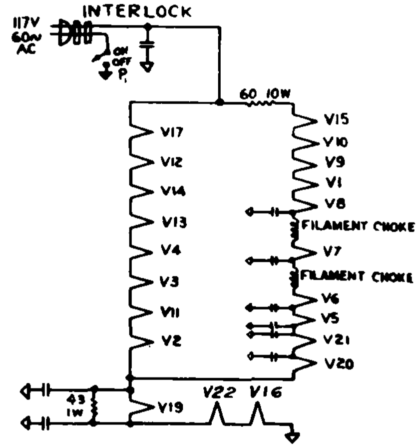

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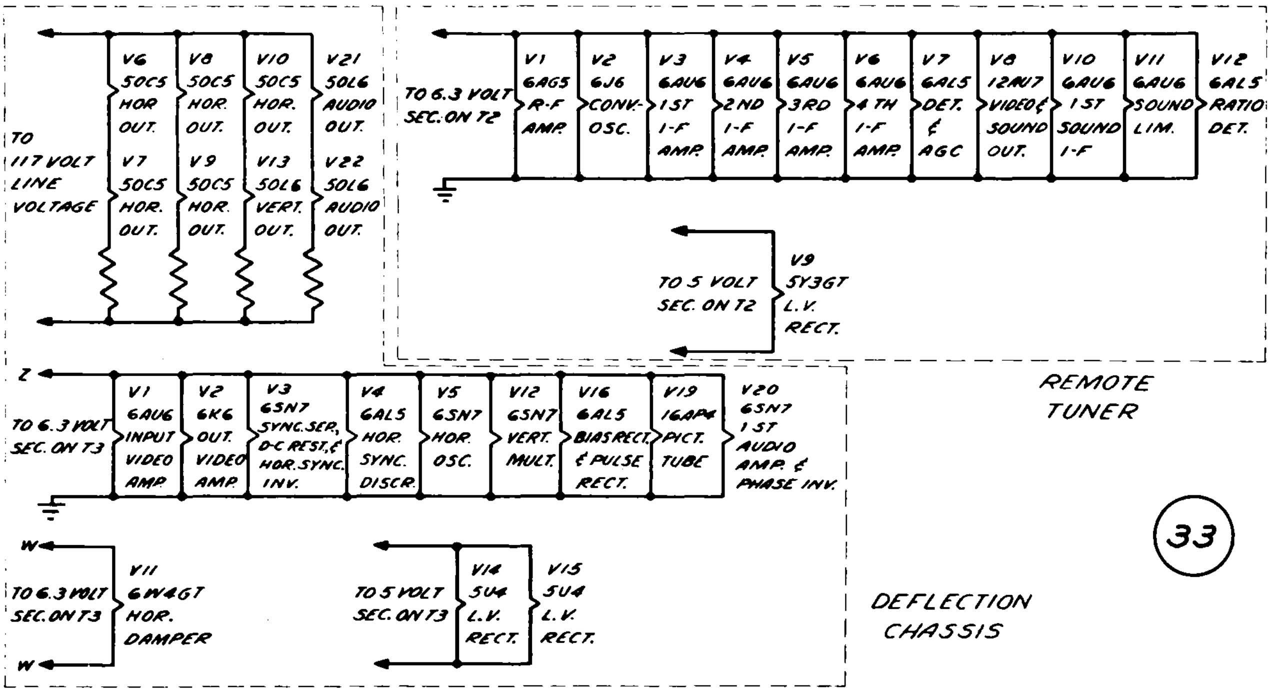
NO	TYPE	FUNCTION
V1	6AU6	AUDIO IF
V2	6AL5	RATIO DET.
V3	6AT6	AUDIO AMP.
V4	25L6	AUDIO OUT.
V5	6AU6	1ST. VIDEO IF
V6	6AU6	2ND. VIDEO IF
V7	6AU6	3RD. VIDEO IF
V8	6AL5	VIDEO DET. AND AGC DIODE
V9	6AU6	VIDEO AMP.
V10	6AU6	SYNC. SEP. AND DC REST.
V11	12SN7	HOR. OSC.
V12	12SN7	HOR. AMP.
V13	12SN7	VERT. OSC.
V14	12SN7	VERT. AMP.
V15	25Z6	L.V. RECT.
V16	6X5	VOLTAGE DOUBLER
V17	12SN7	H.V. OSC.
V19	6J6	RF OSC.
V20	6AG5	CONVERTER
V21	6AU6	RF AMP.
V22	7JP4	PICTURE TUBE



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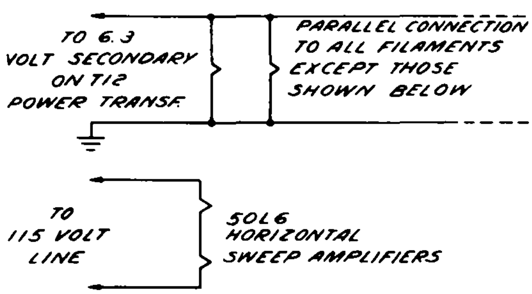

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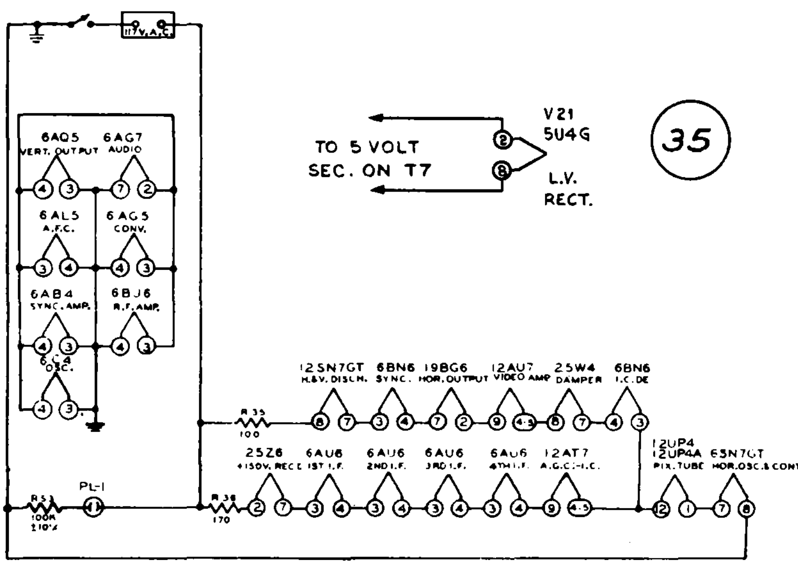

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SECTION 4

SERVICING SUGGESTIONS

Suggestions For Making Adapters

When they are available, the manufacturer's bases and sockets are the thing to use in making adapters but,when this material is not to be had,we have found the following methods very practical.

There is a molded octal socket sold everywhere, which, with the tinned metal mounting removed, fits into the top of a bakelite octal tube base as if made for the purpose. No. 24 or 26 wires are soldered to the socket and pulled down through the tube base pins, soldered and cut off. Bits of spaghetti should be used to avoid shorts. In the case of 12K7 and other tubes with top caps,a hole is drilled in the side of the base opposite the grid pin. A flexible wire with grid clip is brought out through this hole to connect the top cap. In case of substituting a loctal for an octal such as the 1LA6 for 1A7 the grid lead from tube socket is brought out through this hole to connect the top cap.

In case of substituting a loctal for an octal such as the 1LA6 for 1A7,the grid lead from the tube socket is brought out through the side of the base and an old tube cap soldered on. Always select bakelite bases with eight pins. Most octal tubes have only 7 pins or less, but pin 6 is needed in most adapters.

Another, and we believe, better way to make adapters is to remove the 8 pin wafers from the bases of metal tubes. Use No. 18 tinned wire soldering them in the pins first, preferably by dipping, then bend each one so that it will meet the terminal lug on whatever kind of socket is necessary. All of the socket terminal lugs sit down on the bakelite ridge around the wafer and the wires hold them firmly in place.

If 1R5 tubes are comparatively plentiful and 1A7's are impossible to secure, an adapter can be made easily and quickly as follows:

Select an 8 pin octal base with metal band. With the pliers remove the metal, leaving the bottom wafer and pins. Cut 5 pieces of No. 18 tinned wire 1 1/4 inches long, dropping them down into pins 2, 3, 5, 6, and 7, bending them over enough to avoid their falling through and then solder the ends. Put a piece of spaghetti 3/8 inch long on the wire from pin 6 and bend it flat down on the wafer and across to the pin 3, then straight up. Push the wires through holes in miniature socket lugs as shown in substitution data, bend wires outward and down, then cut off close, clinch with pliers and solder. This makes a rugged adapter with very little danger of shorts. The same procedure is followed in making an adapter to use a 1T4 in place of a 1N5. An 8 pin wafer from the base of a metal tube also makes a good adapter.

Adapters are best soldered by dipping. Melt enough solder in a very small pan or tin can lid over an electric or gas hot plate to just touch the ends of the pins on an octal base when the guide pin is on the bottom. Use a quarter-inch dowel pin or piece of shaft,pushing it down inside the guide pin so that it can be used as a handle. Dip the pins for 3 or 4 seconds then lift it out and dip the ends of the pins in water to cool them quickly. This is very much faster and better than doing it one pin at a time with a soldering iron.

To Repair the Filaments in 150 Ma Tubes (For Emergency Use Only)

Many 150-ma heater tubes can be made to give additional service after they have been burned out, that is,after the filament is open. The necessary parts are: a power transformer with a 50-ma secondary that will deliver 750 volts across the high-voltage winding, seven octal sockets, two loctal sockets, and a chassis pan with room enough to mount them. The connections are very simple, as illustrated in the diagram of Fig. 4-1, and require less than two hours to assemble.

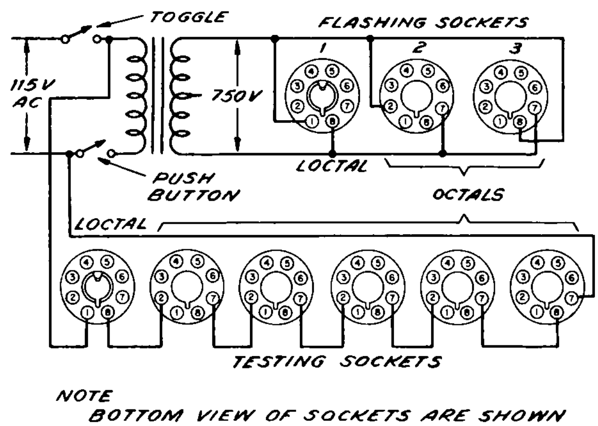


FIG. 4-1. Illustrating the setup for filament repair.

We have found by experience that putting the push button in the primary side of the transformer, in addition to protecting the operator from shocks, causes a hotter starting arc to weld the broken filament. The six sockets connected in series are for testing the repaired tubes. Put enough tubes in series to make as close as possible to 115 volts and short the filament connections on the remaining sockets that are left empty. Number 3 octal socket is for a 12SQ7, 6SQ7, and a few other types which have their heater connections on pins 7 and 8.

The operation is as follows. Insert the line plug, turn on the switch, and place the tube to be repaired in the proper socket. A low-wattage lamp drawing current from the same electric circuit should be in front of the operator. Press the button quickly, making as short a contact as possible. If the lamp dims, you have welded the ends of the heater together. If they are not welded, press the button several more times, while snapping at the tube with the fingers of the other hand. If this does not weld the filaments, allow three seconds to elapse when working with metal tubes and then push the button again. Repeat this, then wait ten seconds and press for the last time. The switch contact should be as short as possible each time.

For 6- and 12-volt glass tubes, the same procedure is employed except that you must observe the tube and continue to press the button at intervals until the filament shows light. For higher voltage tubes such as 50L6, 35L6, 35A5, etc. the button must be held down slightly longer. Success has been obtained in repairing about forty percent of burned out 150-ma heater tubes which include 12SA7, 12SK7, 12SQ7, 50L6, 35Z5, and almost all other 12-, 14-, 35-, and 50-volt heater tubes. The filaments of tubes having current ratings of less than 150 ma will be completely destroyed when burned in this apparatus, and tubes with high current ratings will overload the transformer severely, although in some cases a repair can be made. If the results are not satisfactory, try using a different transformer. Our experience shows, however, that a 750-volt secondary is the most satisfactory.

We have had many inquiries about the low-wattage lamp mentioned above. This lamp should be not larger than 40 watts and does not have to be connected to the apparatus. It may be the light in the shop where you are working and serves only to show you when the current has welded the ends of the broken filament in a metal tube. When the high voltage passes through the filament, there is a surge of current lasting only a very small fraction of a second. The transformer draws a rather large amount of current from the electric light line, pulling the voltage down and causing the light to blink or flicker. It is not needed in the case of glass tubes since you are able to see when the filament lights.

The average life of repaired tubes is short. We describe this process for use only in case of emergency and in no case recommend the use of a repaired tube when a new one is available. Even when the tube is not available, a repaired tube should be burned for at least one hour before putting it in a customer's radio.

35Z5 Tubes

Possibly most service men know this, but it will bear repeating for the benefit of those who do not. The 35Z5 filament is between pins 2 and 7 with a tap brought out to pin 3. This tap is about 5 volts, from pins 2 to 3 and provides current for the pilot light. Operating the radio with burned out pilot light causes this section to burn out and breaks the filament circuit. Pins 2 and 3 may be shorted together so as to use the remaining 30-volt filament and the tube may still give long service. Check every burned out 35Z5, and if there is continuity between pins 3 and 7, the tube is still usable.

If it is necessary to use the pilot light, connect a 25- to 30-ohm resistor from pins 3 to 2, either on the tube base (be careful that it does not short to metal chassis) or on the socket terminals, and the pilot light will light as usual.

Substitution of Complete Sets of Tubes

Most of the popular 12-, 35-, and 50-volt tubes now in use are nearing the end of their lives. Often a customer comes in and pays for a substitute tube and the necessary rewiring job, only to be back again within a week or ten days with another "impossible to get" tube burned out. He may again go to considerable expense to replace that one and have the same thing happen again.

Since most of the 6- and 25-volt, 0.3-ampere tubes are comparatively plentiful, a complete changeover job is more practical and satisfactory. Replace 12SA7 with 6SA7, 12SK7 with 6SK7, 12SQ7 with 6SQ7, 50L6 or 35L6 or any of the other 25-volt, 0.3-ampere output tubes, and 25Z5 with 25Z6. The only necessary changes are in connection with the rectifier tube and replacement of the a-c line cord with a line resistor cord of 130 ohms. Red goes to the switch and black to pins 3 and 5 of the 35Z5 socket after removing the pilot light wire from pin 3. Any wire on pin 4 is removed and taped up, 4 is connected to 8, the line cord resistor and a 25-ohm resistor are connected to the wire from pin 3 and the other end of resistor to pin 2.

Changing Battery-Operated Radios For Electric Operation

This is not a job for the novice, but any experienced radio serviceman can make the change with very satisfactory results if there is room on the chassis for an additional tube.

First find a location for the rectifier tube, drill a hole and mount the socket. Remove all battery wires. Connect one side of the line cord to pins 2, 3, and 5 of a 117Z6 socket; connect the other side of the cord to the A battery switch, ground the other side of the switch and also pin 7 of the 117Z6.

From pins 4 and 8, the cathodes of the rectifier, connect a 1-w, 1,500-ohm resistor, R1, to the screen grid of the 3Q5 tube or whatever output tube is used. This is the filter resistor and must have a 20-mf, 150-volt capacitor, C1, from each end of the resistor to ground for 60-cycle operation, or 40 mf for 25-cycle operation.

It is quite likely that you will find one end of each tube filament connected to ground. All of these grounds must be removed and the filaments connected in series as shown in Fig. 4-2. The tubes indicated are for a typical battery-operated receiver. The capacitors and resistors connected to pins 2 and 7 may be left where they are, at least for the present. (We are using pin numbers of octal tubes. If the loctal series is used, the filament pins are usually 1 and 8 instead of 2 and 7. The loctal 1LA6 or 1LC6 is the equivalent of the octal 1A7, the loctal 1LN5 or 1LH4 for the octal 1H5, and the loctal 1LA4 or 1LB4 for the octal 1A5 or 1T5.) If there are more tubes than are shown in the diagram, connect their filaments between the 1N5 and the 1H5.

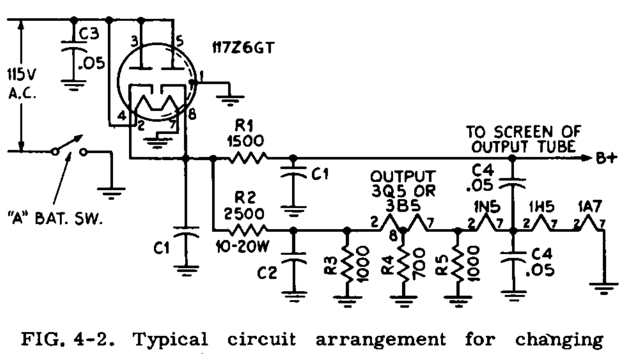


FIG. 4-2. Typical circuit arrangement for changing battery-operated radio to electric operation using a 117Z6GT rectifier tube.

Connect a 2,500-ohm resistor between the rectifier cathodes and one side of the filament of the output tube. This is the filament dropping resistor and has a filter capacitor of from 40 to 200 mf connected between its low end and ground. This capacitor should be rated at 25 volts because if a tube burns out the voltage rises and might break down a 6- or 12-volt rated capacitor. The filament dropping resistor should be 10 watts if mounted above the chassis and at least 20 watts if mounted underneath where it cannot radiate the heat so readily. There is a 2,200-ohm, 16-w flexible resistor, that seems to be quite plentiful, rather low priced, and is very easy to mount since it is insulated.

Wire in the resistors R4 and R5 permanently, and R3 temporarily as it may have to be changed. If a 1A5 or 1T5 is used instead of the 3Q5 or 3B5, resistor R4 is omitted. The purpose of R4 and R5 is to bypass the current passed from plate to filament in the output tube and to avoid overloading the other filaments.

Now check the grid resistors. The resistor from the grid of the output tube should go directly to ground and each of the others to its own negative filament, pin 7. The lower end of the volume control is connected either directly or through a resistor to ground, or to a filament (which has been disconnected from ground). Leave it where it is for trial; however, if there is distortion, try returning it to the filament circuit between the 1A7 and 1H5 for 1.4-volt bias, or between the 1H5 and 1N5 for 2.8-volt bias, leaving it wherever the tone is best.

Now make up a resistor to take the place of a set of tubes. The resistance of each 1.4-volt filament is approximately 28 ohms, and for the set shown in Fig. 4-2 should be a total of 140 ohms. If it had a 1A5 or 1T5 in the output, the resistance would be 28 ohms less, or 112 ohms. If there should be an additional 1.4-volt tube, it would be 28 ohms more, or 168 ohms. Connect this resistor from pin 2 of the output tube to ground. Put in the rectifier tube, connect the line cord of the set and then turn it on. The voltage across the resistor should be slightly less than 7 volts. If over 7 volts, replace resistor R3 with a lower value. If under 6.2 volts, replace R3 with a higher value. If you have difficulty in getting the correct filament voltage, remember that increasing the capacitance of C1 at the rectifier increases the voltage, and if this capacitor does not have sufficient capacitance you cannot get the correct voltage.

When the voltage has been adjusted, remove resistor R3 and then insert the tubes. The bypass capacitor C4 may already be in the set. If the capacitors are not in and there is a tendency to distort or oscillate, put them in, and make sure that all No. 1 pins of the tubes are grounded to chassis. If the radio does not have a series capacitor in the antenna, it is necessary to put in a 0.01 mf between the antenna and coil to avoid burning out the coil if the antenna should be grounded.

Many other types of rectifiers may be used instead of the 117Z6 which was chosen as the example because it does not require a resistor line cord. For 25Z6, use a line-cord resistor of 300 ohms, connecting red to switch, black to pins 3 and 5, and resistor to pin 2; for 35Z5 and 35Z4 tubes, use a 540-ohm resistor cord, connecting black to pin 5, red to switch, and resistor to pin 2; for a 25Z5 tube, use a 300-ohm cord, connecting red to switch, black to pins 2 and 5, resistor to pin 1, pin 6 to ground, and the filter resistor to pins 3 and 4. These are the most popular rectifiers, but several others may be used with the proper line-cord resistor.

The grounding system and physical factors of the receiver to be worked on should be examined before attempting the changeover. Some bugs may be expected on the first job so do not be discouraged if it does not work perfectly right at first; a little patience in trying to get rid of the bugs will be well rewarded. Remember that the filaments of tubes in most battery-operated radios are only d-c operated. Always check the filament conditions of the tubes with which you are working.

SECTION 5

CHARTS AND TABLES

In this section a number of charts and tables are shown that we believe will be very helpful to users of this book. Included in this grouping is a complete listing of receiving tube characteristics and bases and also a separate listing of cathode-ray-tube characteristics and bases. In addition such tabulated matter as RTMA capacitor, resistor, and transformer color codes, ballast tube and resistor numbering codes, pilot lamps, and a cross index of Army VT numbers and commercial vacuum-tube numbers are included. The last named chart will not only help Armed Forces personnel but will be of valuable aid to anyone who has surplus Army tubes and desires to identify the equivalent commercial number for possible use or substitution in commercial equipment.

RTMA RECEIVING TUBE RATINGS

It shall be standard to interpret the ratings on receiving types of tubes according to the following conditions:

1. CATHODE

The heater or filament voltage is given as a normal value unless otherwise stated. This means that transformers or resistances in the heater or filament circuit should be designed to operate the heater or filament at rated value for full-load operating conditions under average supply-voltage conditions. A reasonable amount of leeway is incorporated in the cathode design so that moderate fluctuations of heater or filament voltage downward will not cause marked falling off in response; also, moderate voltage fluctuations upward will not reduce the life of the cathode to an unsatisfactory degree.

A. 1.4-VOLT BATTERY TUBE TYPES

The filament power supply may be obtained from dry-cell batteries, from storage batteries, or from a power line. With dry-cell battery supply, the filament may be connected either directly across a battery rated at a terminal potential of 1.5 volts, or in series with the filaments of similar tubes across a power supply consisting of dry cells in series. In either case, the voltage across each 1.4-volt section of filament should not exceed 1.6 volts. With power-line or storage-battery supply, the filament may be operated in series with the filaments of similar tubes.

For such operation, design adjustments should be made so that with tubes of rated characteristics, operating with all electrode voltages applied and on a normal line voltage of 117 volts or on a normal storage-battery voltage of 2.0 volts per cell (without a charger) or 2.2 volts per cell (with a charger), the voltage drop across each 1.4-volt section of filament will be maintained within a range of 1.25 to 1.4 volts with a nominal center of 1.3 volts. In order to meet the recommended conditions for operating filaments in series from dry-battery, storage-battery, or power-line sources it may be necessary to use shunting resistors across the individual 1.4-volt sections of filament.

B. 2.0-VOLT BATTERY TUBE TYPES

The 2.0-volt line of tubes is designed to be operated with 2.0 volts across the filament. In all cases the operating voltage range should be maintained within the limits of 1.8 volts to 2.2 volts.

2. POSITIVE POTENTIAL ELECTRODES

The power sources for the operation of radio equipment are subject to variations in their terminal potential. Consequently, the maximum rating shown on the RTMA Vacuum Tube Data Sheets have been established for certain design center voltages which experience has shown to be representative. The design center voltages to be used for the various power supplies together with other rating considerations are as given below:

A. A-C OR D-C POWER-LINE SERVICE IN U.S.A.

The design center voltage for this type of power supply is 117 volts. The maximum ratings of plate voltages, screen-supply voltages, dissipations, and rectifier output currents are design maximums and should not be exceeded in equipment operated at a line voltage of 117 volts.

B. STORAGE-BATTERY SERVICE

When storage-battery equipment is operated without a charger, it should be designed so that the published RTMA maximum values of plate voltages, screen-supply voltages, dissipations, and rectifier output currents are never exceeded for a terminal potential at the battery source of 2.0 volts per cell. When storage-battery equipment is operated with a charger, it should be designed so that 90% of the same RTMA values are never exceeded for a terminal potential at the battery source of 2.2 volts.

C. "B"-BATTERY SERVICE

The design center voltage "B" batteries is the normal voltage rating of the battery block, such as 45 volts, 90 volts, etc. Equipment should be designed so that under no condition of battery voltage will the plate voltages or dissipations ever exceed the recommended respected maximum values shown in the data for each tube type by more than 10%.

D. OTHER CONSIDERATIONS

1) Class A Amplifiers

The maximum plate dissipation occurs at the "zero-signal" condition. The maximum screen dissipation usually occurs at the condition where the peak-input signal voltage is equal to the bias voltage.

2) Class B Amplifiers

The maximum plate dissipation theoretically occurs at approximately 63% of the "maximum-signal" condition, but may occur practically at any signal voltage value.

3) Converters

The maximum plate dissipation occurs at the "zero-signal" condition and the frequency at which the oscillator-developed bias is a minimum. The screen dissipation for any reasonable variation in signal voltage must never exceed the rated value by more than 10%.

4) Screen Ratings

When the screen voltage is supplied through a series voltage-dropping resistor, the maximum screen voltage rating may be exceeded, provided the maximum screen dissipation rating is not exceeded at any signal condition, and the maximum screen voltage rating is not exceeded, at the maximum-signal condition. Provided these conditions are fulfilled, the screen-supply voltage may be as high as, but not above, the maximum plate voltage rating.

3. TYPICAL OPERATION

For many receiving tubes, the data show typical operating conditions in particular services. These typical operating values are given to show concisely some guiding information for the use of each type. They are not to be considered as ratings, because the tube can be used under any suitable conditions within its rating limitations.

RECEIVING TUBE BASES

The diagrams on the following pages show standard socket connections corresponding to the base designations given in the column headed "Socket Connections" in the classified tube-data tables. Bottom views are shown throughout. Terminal designations are as follows:

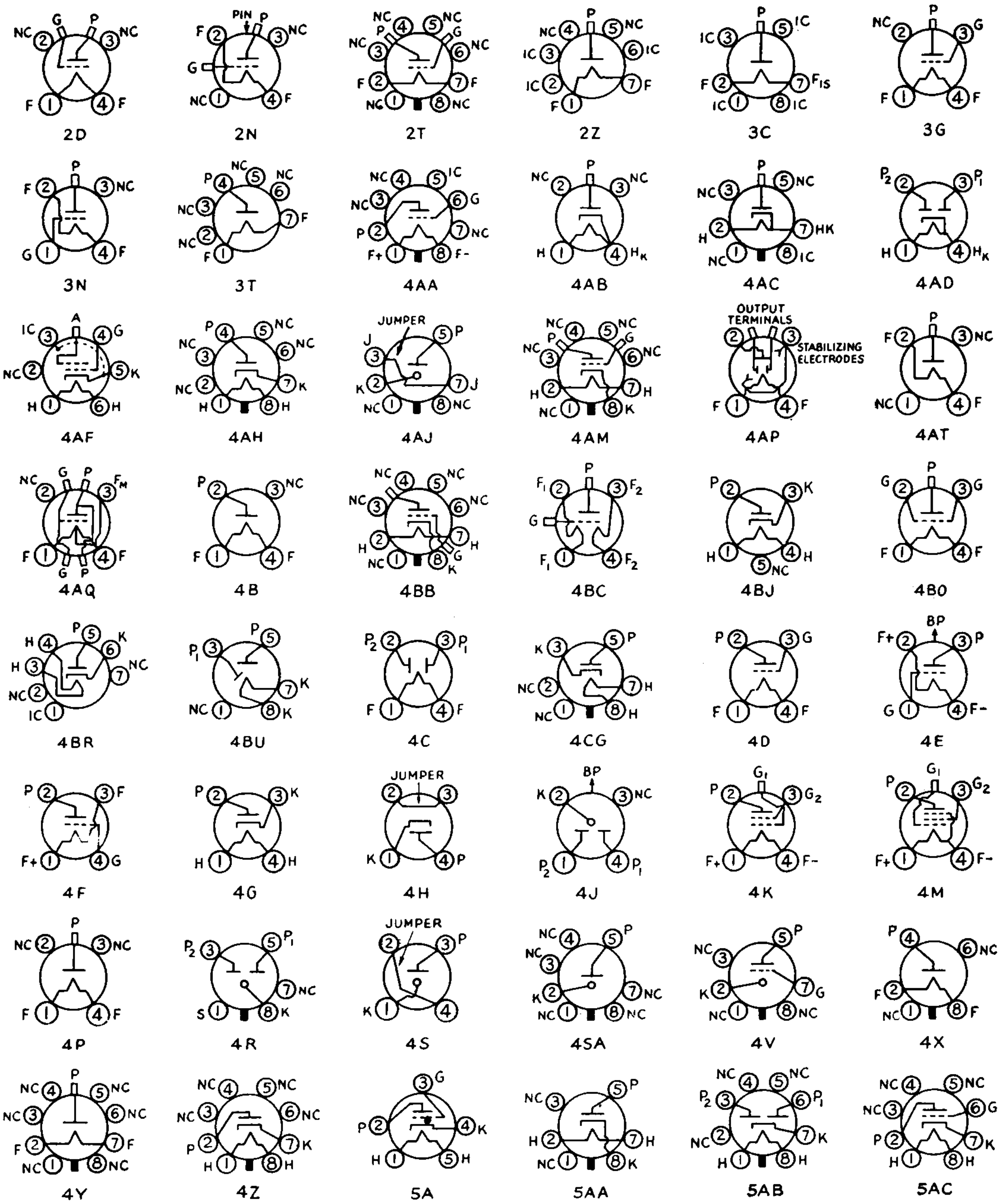
- A = Anode
- B = Beam
- BP = Bayonet Pin
- BS = Base sleeve
- D = Deflecting Plate
- F = Filament
- G = Grid
- H = Heater
- IC = Internal Connection
- IS = Internal Shield
- K = Cathode
- NC = No Connection
- P = Plate (Anode)
- P_1 = Starter-Anode
- P_{BF} = Beam-Forming Plates
- RC = Ray-Control Electrode
- Ref = Reflector or repeller
- S = Shell
- TA = Target
- ● = Gas-Type Tube
- U = Unit

Alphabetical subscripts D, P, T and HX indicate, respectively, diode unit, pentode unit, triode unit or hexode unit in multi unit types. Subscript M, T or CT indicates filament or heater tap.

Generally when the No. 1 pin of a metal-type tube in Table I, with the exception of all triodes, is shown connected to the shell, the No. 1 pin in the glass (G or GT) equivalent is connected to an internal shield.

R.M.A. TUBE BASE DIAGRAMS

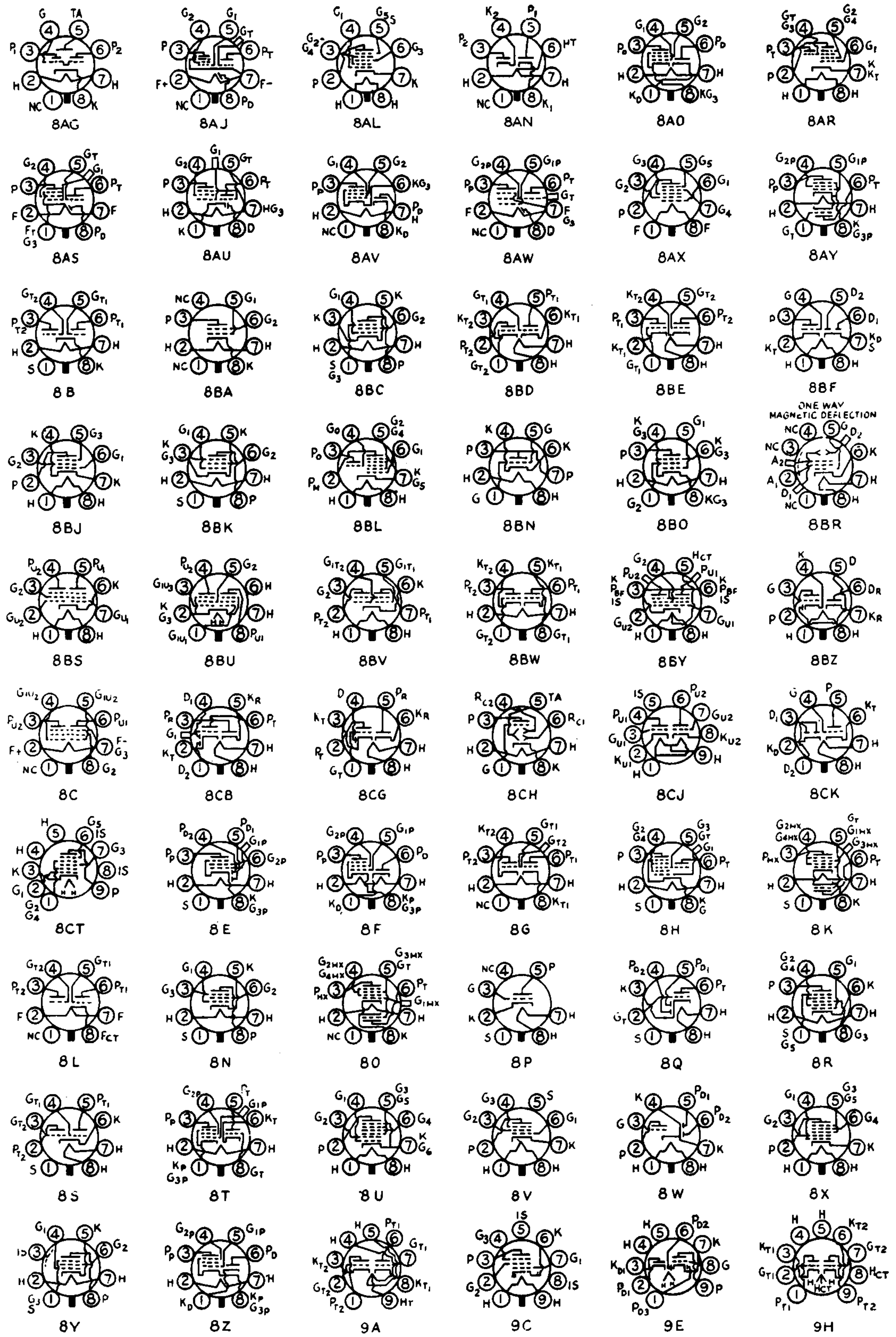
Bottom views are shown. Terminal designations on sockets are shown above.



Courtesy ARRL Handbook

R.M.A. TUBE BASE DIAGRAMS

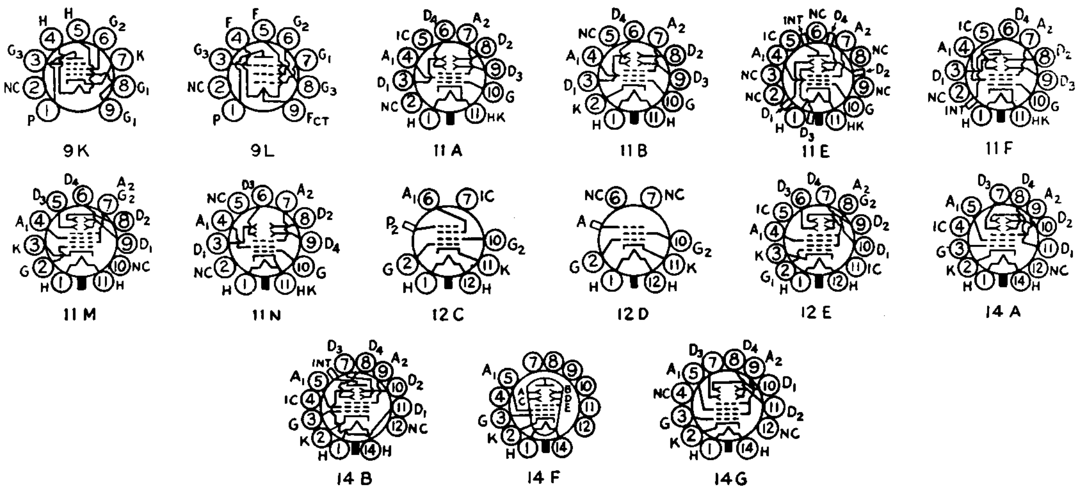
Bottom views are shown.



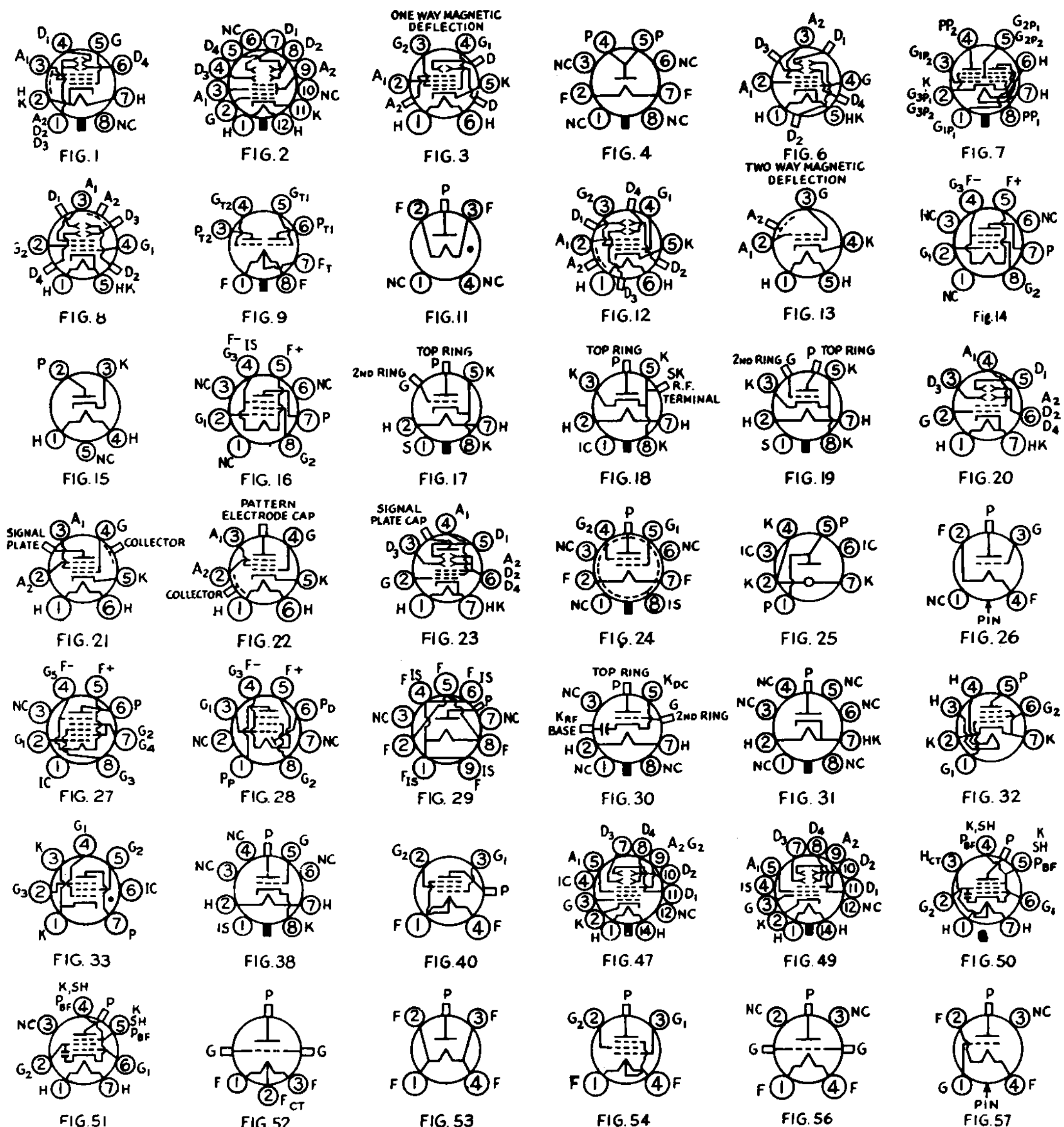
Courtesy ARRL Handbook

R.M.A. TUBE BASE DIAGRAMS

Bottom views are shown.



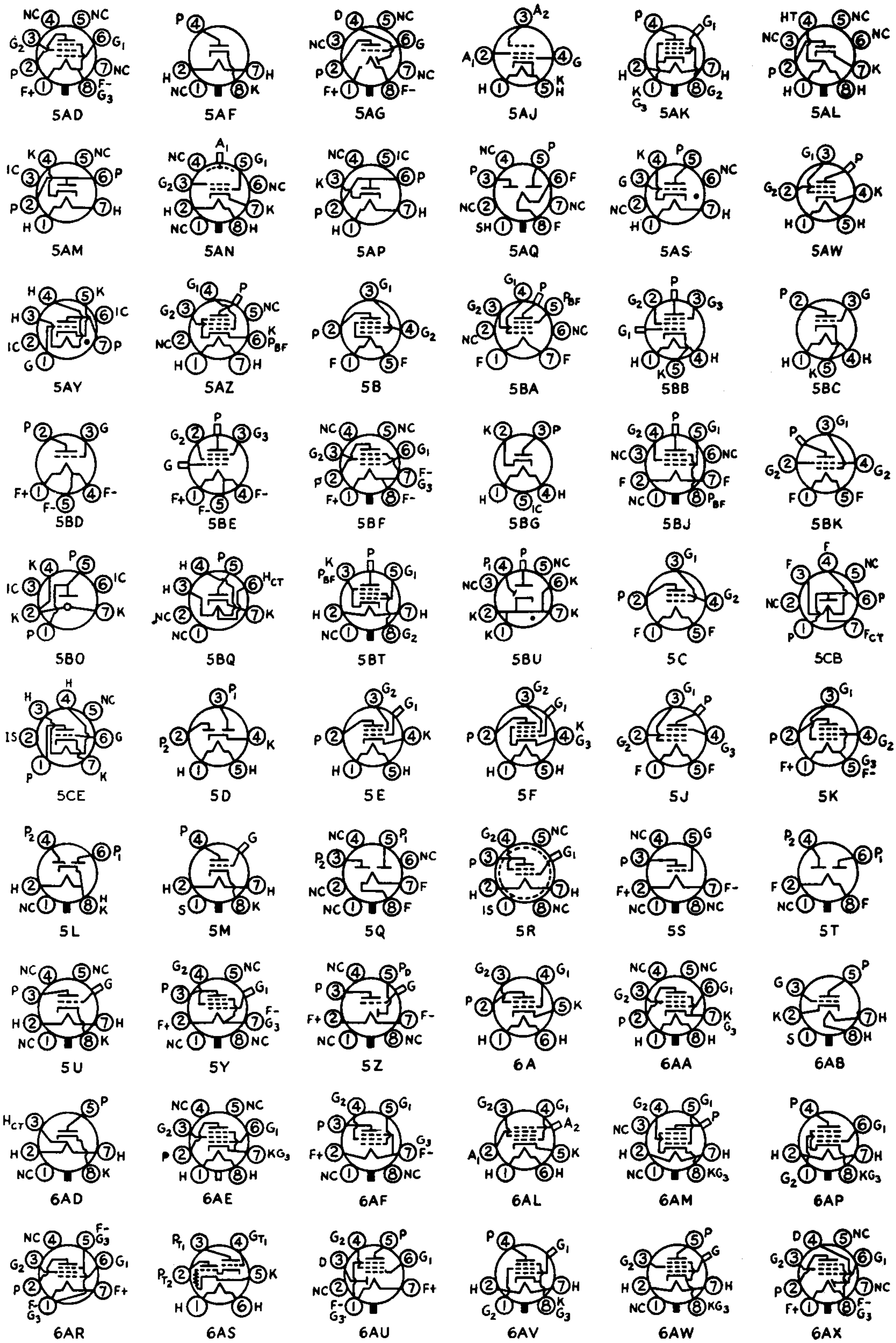
SUPPLEMENTARY BASE DIAGRAMS



Courtesy ARRL Handbook

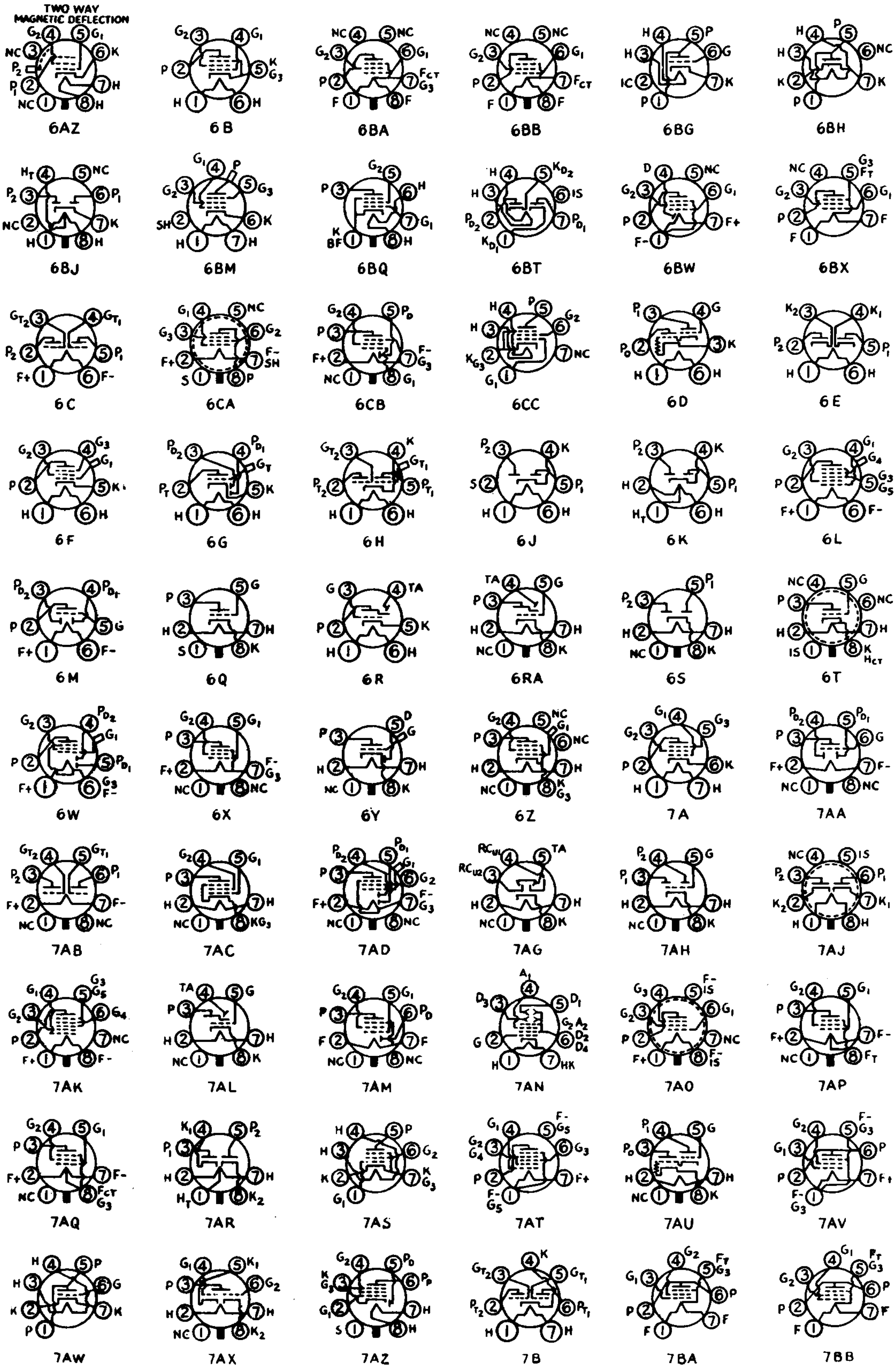
R.M.A. TUBE BASE DIAGRAMS

Bottom views are shown.



R.M.A. TUBE BASE DIAGRAMS

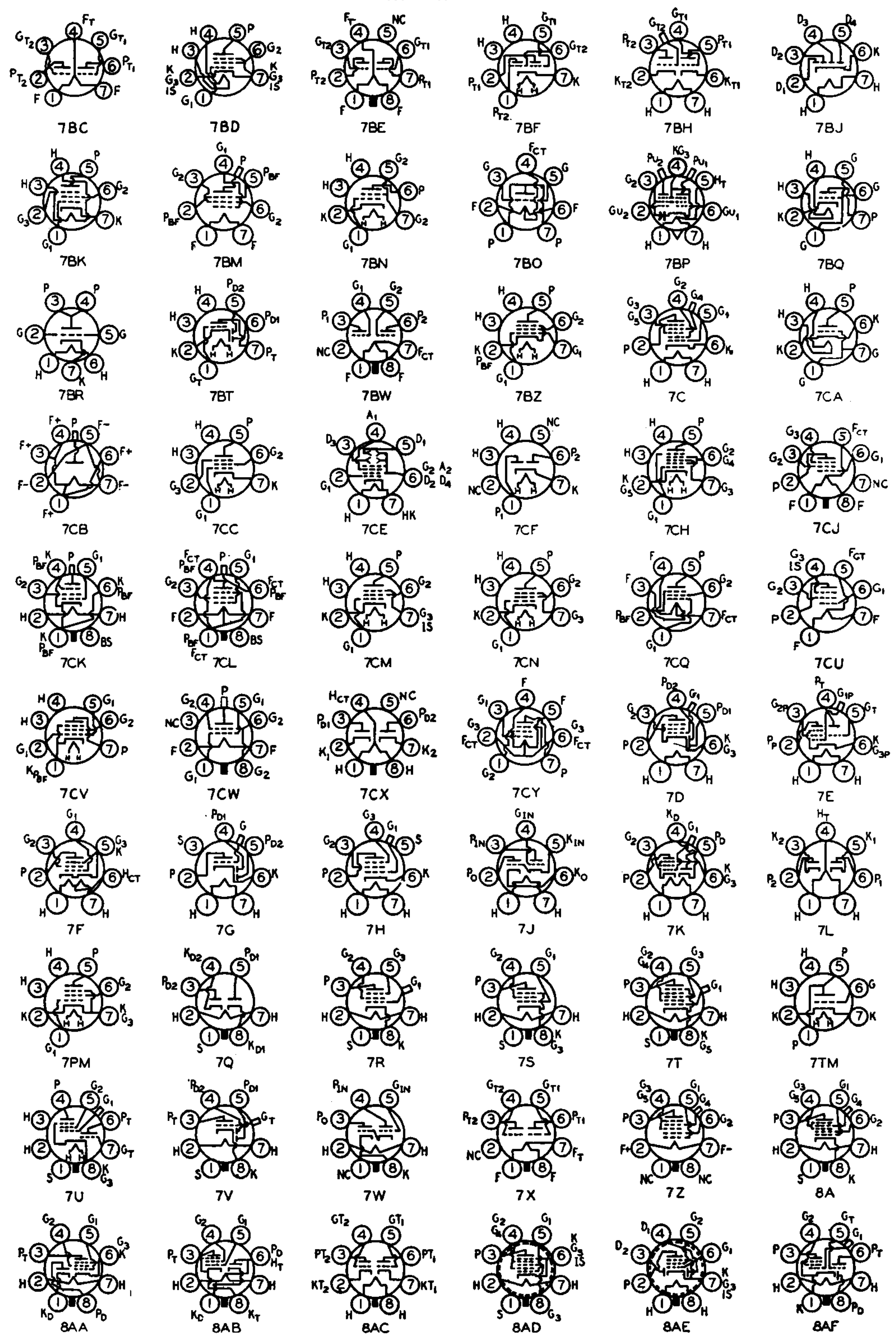
Bottom views are shown.



Courtesy ARRL Handbook

R.M.A. TUBE BASE DIAGRAMS

Bottom views are shown.



RECEIVING TUBE CHARACTERISTICS

TABLE I—METAL RECEIVING TUBES

Characteristics given in this table apply to all tubes having type numbers shown, including metal tubes, glass tubes with "G" suffix, and bantam tubes with "GT" suffix. For "G" and "GT" tubes not listed (not having metal counterparts), see Tables II, VII, VIII and IX.

Type	Name	Socket Connections	Fil. or Heater		Capacitance μμfd.			Use	Plate Supply Volts	Grid Bias	Screen Volts	Screen Current Ma.	Plate Current Ma.	Plate Resistance Ohms	Transconductance Micromhos	Amp. Factor	Load Resistance Ohms	Power Output Watts	Type
			Volts	Amp.	In	Out	Plate-Grid												
6A8	Pentagrid Converter	8A	6.3	0.3	—	—	—	Osc.-Mixer	250	−3.0	100	3.2	3.3	Anode-grid (No. 2) 250 volts max. thru 20,000 ohms					6A8
6AB7 1853	Television Amp. Pentode	8N	6.3	0.45	8	5	0.015	Class-A Amp.	300	−3.0	200	3.2	12.5	700000	5000	3500	—	—	6AB7 1853
6AC7 1852	Television Amp. Pentode	8N	6.3	0.45	11	5	0.015	Class-A Amp.	300	160*	150	2.5	10	1000000	9000	6750	—	—	6AC7 1852
6AG7	Sharp Cut-off Pentode	8Y	6.3	0.65	13	7.5	0.06	Class-A_1 Amp.	300	−3.0	150	7/9	30/30.5	130000	11000	—	10000	3.0	6AG7
6AJ7	Sharp Cut-off Pentode	8N	6.3	0.45	—	—	—	Class-A Amp.	300	160*	300	2.5	10	1000000	9000	—	—	—	6AJ7
6AK7	Pentode Power Amp.	8Y	6.3	0.65	13	7.5	0.06	Class-A Amp.	300	−3	150	7	30	130000	11000	—	10000	3.0	6AK7
6B8	Duplex-Diode Pentode	8E	6.3	0.3	6	9	0.005	Class-A Amp.	250	−3.0	125	2.3	9.0	650000	1125	730	—	—	6B8
6C5	Triode	6Q	6.3	0.3	3	11	2	Class-A Amp.	250	−8.0	—	—	8.0	10000	2000	20	—	—	6C5
								Bias Detector	250	−17.0	—	—	Plate current adjusted to 0.2 ma. with no signal						
6F5	High-μ Triode	5M	6.3	0.3	5.5	4	2.3	Class-A Amp.	250	−1.3	—	—	0.2	66000	1500	100	—	—	6F5
6F6	Pentode Power Amplifier	7S	6.3	0.7	6.5	13	0.2	Class-A_1 Pent.[5]	250 315	−16.5 −22.0	250 315	6.5 8.0	36[7] 42	80000 75000	2500 2650	200 200	7000 7000	3.2 5.0	6F6
								Class-A_1 Triode[1]	250	−20.0	—	—	34[7]	2600	2500	6.8	4000	0.85	
								Class-AB_2 Amp.[6] Class-AB_2 Amp.[4]	375 375	340* −26.0	250 250	8/18 5/19.5	54/77 34/82	Power output for 2 tubes at stated load, plate-to-plate			10000[5] 10000[8]	19.0 18.5	
								Class-AB_2 Amp.[1][6]	350 350	730* −38	— —	— —	50/61 48/92	— —	— —	— —	10000[6] 6000[8]	9 13	
6H6	Twin Diode	7Q	6.3	0.3	—	—	—	Rectifier		Max. a.c. voltage per plate = 150 r.m.s. Max. output current 8.0 ma. d.c.									6H6
6J5	Triode	6Q	6.3	0.3	3.4	3.6	3.4	Class-A Amp.	250	−8.0	—	—	9	7700	2600	20	—	—	6J5
6J7	Sharp Cut-off Pentode	7R	6.3	0.3	7	12	0.005	R.F. Amp.	250	−3.0	100	0.5	2.0	1.5 meg.	1225	1500	—	—	6J7
								Bias Detector	250	−4.3	100	Cathode current 0.43 ma.			—	—	0.5 meg.	—	
6K7	Variable-μ Pentode	7R	6.3	0.3	7	12	0.005	R.F. Amp.	250	−3.0	125	2.6	10.5	600000	1650	990	—	—	6K7
								Mixer	250	−10.0	100	—	—	—	Oscillator peak volts = 7.0				
6K8	Triode-Hexode	8K	6.3	0.3	—	—	—	Converter	250	−3.0	100	6	2.5	Triode Plate (No. 2) 100 volts, 3.8 ma.					6K8
6L6	Beam Power Amplifier	7AC	6.3	0.9	10	12	0.4	Single Tube Class A_1	250 300	170* 220*	250 200	5.4/7.2 3.0/4.6	75/78 51/54.5	— —	— —	— —	2500 4500	6.5 6.5	6L6
								Single Tube Class A_1	250 350	−14.0 −18.0	250 250	5.0/7.3 2.5/7.0	72/79 54/66	22500 33000	6000 5200	— —	2500 4200	6.5 10.8	
								P.P. Class A_1[6]	270	125*	270	11/17	134/145	—	—	—	5000[5]	18.5	
								P.P. Class A_1[6]	250 270	−16.0 −17.5	250 270	10/16 11/17	120/140 134/155	24500 23500	5500 5700	— —	5000[8] 5000[8]	14.5 17.5	
								P.P. Class AB_1[5]	360	250*	270	5/17	88/100	Power output for 2 tubes. Load plate-to-plate			9000[5]	24.5	
								P.P. Class AB_1[6]	360	−22.5	270	5/15	88/132				6600[4]	26.5	
								P.P. Class AB_2[6]	360 360	−18.0 −22.5	225 270	3.5/11 5/16	78/142 88/205				6000[5] 3800[8]	31.0 47.0	
6L7	Pentagrid Mixer Amplifier	7T	6.3	0.3	—	—	—	R.F. Amp.	250	−3.0	100	5.5	5.3	800000	1100	—	—	—	6L7
								Mixer	250	−6.0	150	8.3	3.3	Over 1 meg.	Oscillator-grid (No. 3) voltage = −15				
6N7	Twin Triode	8B	6.3	0.8	—	—	—	Class-B Amp.	300	0	—	—	35/70	—	—	—	8000	10.0	6N7
6Q7	Duplex-Diode Triode	7V	6.3	0.3	5	3.8	1.4	Triode Amp.	250	−3.0	—	—	1.1	58000	1200	70	—	—	6Q7
6R7	Duplex-Diode Triode	7V	6.3	0.3	4.8	3.8	2.4	Triode Amp.	250	−9.0	—	—	9.5	8500	1900	16	10000	0.28	6R7
6S7	Remote Cut-off Pentode	7R	6.3	0.15	6.5	10.5	0.005	Class-A Amp.	250	−3.0	100	2.0	8.5	1000000	1750	—	—	—	6S7
6SA7	Pentagrid Converter	8R[2]	6.3	0.3	—	—	—	Converter	250	0[3]	100	8.0	3.4	800000	Grid No. 1 resistor 20000 ohms				6SA7
6SB7Y	Pentagrid Converter	8R	6.3	0.3	9.6	9.2	—	Converter	100	−1	100	10.2	3.6	500000	900	—	—	—	6SB7Y
								Converter	250	−1	100	10	3.8	1000000	950	—	—	—	
					Osc. Section in 88–108 Mc. Serv.				250	22000[9]	12000[9]	12.6/12.5	6.8/5.5	—	—	—	—	—	
6SC7	Twin-Triode	8S	6.3	0.3	—	—	—	Class-A Amp.	250	−2.0	—	—	2.0	53000	1325	70	—	—	6SC7
6SF5	High-μ Triode	6AB	6.3	0.3	4	3.6	2.4	Class-A Amp.	250	−2.0	—	—	0.9	66000	1500	100	—	—	6SF5

Courtesy ARRL Handbook

TABLE I—METAL RECEIVING TUBES—*Continued*

Type	Name	Socket Connections	Fil. or Heater Volts	Fil. or Heater Amp.	Capacitance μμfd. In	Capacitance μμfd. Out	Capacitance μμfd. Plate-Grid	Use	Plate Supply Volts	Grid Bias	Screen Volts	Screen Current Ma.	Plate Current Ma.	Plate Resistance Ohms	Transconductance Micromhos	Amp. Factor	Load Resistance Ohms	Power Output Watts	Type
6SF7	Diode Variable-μ Pentode	7AZ	6.3	0.3	5.5	6	0.004	Class-A Amp.	250	− 1.0	100	3.3	12.4	700000	2050	—	—	—	6SF7
6SG7	Semivariable-μ Pentode	8BK	6.3	0.3	8.5	7	0.003	H.F. Amp.	250	− 2.5	150	3.4	9.2	Over 1 meg.	4000	—	—	—	6SG7
6SH7	Sharp Cut-off Pentode	8BK	6.3	0.3	8.5	7	0.003	Class-A Amp.	250	− 1.0	150	4.1	10.8	900000	4900	—	—	—	6SH7
6SJ7 [4]	Sharp Cut-off Pentode	8N	6.3	0.3	6	7	0.005	Class-A Amp.	250	− 3.0	100	0.8	3	1500000	1650	2500	—	—	6SJ7
6SK7	Variable-μ Pentode	8N	6.3	0.3	6	7	0.003	Class-A Amp.	250	− 3.0	100	2.4	9.2	800000	2000	1600	—	—	6SK7
6SQ7	Duplex-Diode Triode	8Q	6.3	0.3	3.2	3.0	1.6	Class-A Amp.	250	− 2.0	—	—	0.8	91000	1100	100	—	—	6SQ7
6SR7	Duplex-Diode Triode	8Q	6.3	0.3	3.6	2.8	2.40	Class-A Amp.	250	− 9.0	—	—	9.5	8500	1900	16	—	—	6SR7
6SS7	Variable-μ Pentode	8N	6.3	0.15	5.5	7.0	0.004	Class-A Amp.	250	− 3.0	100	2.0	9.0	1000000	1850	—	—	—	6SS7
6ST7	Duplex-Diode Triode	8Q	6.3	0.15	2.8	3	1.50	Class-A Amp.	250	− 9.0	—	—	9.5	8500	1900	16	—	—	6ST7
6SV7	Diode R.F. Pentode	7AZ	6.3	0.3	6.5	6	0.004	Class-A Amp.	250	− 1	150	2.8	7.5	800000	3400	—	—	—	6SV7
6SZ7	Duplex-Diode Triode	8Q	6.3	0.15	2.6	2.8	1.10	Class-A Amp.	250	− 3	—	—	1.0	58000	1200	70	—	—	6SZ7
6T7	Duplex-Diode Triode	7V	6.3	0.15	1.8	3.1	1.70	Class-A Amp.	250	− 3.0	—	—	1.2	62000	1050	65	—	—	6T7
6V6	Beam Power Amplifier	7AC	6.3	0.45	2.0	7.5	0.7	Class-A$_1$ Amp. [5]	250	−12.5	250	4.5/7.0	45/47	52000	4100	218	5000	4.5	6V6
								Class-AB$_1$ Amp. [6]	250	−15.0	250	5/13	70/79	60000	3750	—	10000 [8]	10.0	
									285	−19.0	285	4/13.5	70/92	65000	3600	—	8000 [8]	14.0	
1611	Pentode Power Amplifier	7S	6.3	0.7	—	—	—	Audio Amp.	Characteristics same as 6F6										1611
1612	Pentagrid Amplifier	7T	6.3	0.3	7.5	11	0.001	Class-A Amp.	250	− 3.0	100	6.5	5.3	600000	1100	880	—	—	1612
1620	Sharp Cut-off Pentode	7R	6.3	0.3	—	—	—	Class-A Amp.	Characteristics same as 6J7										1620
1621	Power Amplifier Pentode	7S	6.3	0.7	—	—	—	Class-AB$_2$ Amp. [6]	300	−30.0	300	6.5/13	38/69	—	—	—	4000 [8]	5.0	1621
								Class-A$_1$ Amp. [1]	330	500*	—	—	55/59	—	—	—	5000 [8]	2.0	
1622	Beam Power Amplifier	7AC	6.3	0.9	—	—	—	Class-A$_1$ Amp.	300	−20.0	250	4/10.5	86/125	—	—	—	4000	10.0	1622
1851	Television Amp. Pentode	7R	6.3	0.45	11.5	5.2	0.02	Class-A Amp.	300	− 2.0	150	2.5	10	750000	9000	6750	—	—	1851
5693	Sharp Cut-off Pentode	8N	6.3	0.3	5.3	6.2	0.005	Class-A Amp.	250	− 3	100	0.85	3.0	1000000	1650	—	—	—	5693

* Cathode resistor—ohms.
[1] Screen tied to plate.
[2] For 6SA7GT use base diagram 8AD.
[3] Grid bias—2 volts if separate oscillator excitation is used.
[4] Also Type "6SJ7Y."
[5] Values are for single tube.
[6] Values are for two tubes in push-pull.
[7] Max.-signal value.
[8] Plate-to-plate value.
[9] Osc. grid leak—Scrn res.

TABLE II—6.3-VOLT GLASS TUBES WITH OCTAL BASES

(For "G" and "GT"-Type Tubes Not Listed Here, See Equivalent Type in Table I; Characteristics and Connections Will Be Identical)

Type	Name	Socket Connections	Fil. or Heater Volts	Fil. or Heater Amp.	Capacitance μμfd. In	Capacitance μμfd. Out	Capacitance μμfd. Plate-Grid	Use	Plate Supply Volts	Grid Bias	Screen Volts	Screen Current Ma.	Plate Current Ma.	Plate Resistance Ohms	Transconductance Micromhos	Amp. Factor	Load Resistance Ohms	Power Output Watts	Type
2C22	Triode	4AM	6.3	0.3	2.2	0.7	3.60	Class-A Amp.	300	−10.5	—	—	11	6600	3000	20	—	—	2C22
6A5G	Triode Power Amplifier	6T	6.3	1.0	—	—	—	Class-A Amp. [4]	250	−45.0	—	—	60	800		4.2	2500	3.75	6A5G
								P.P. Class AB [5]	325	−68.0	—	—	80	—	5250	—	3000 [6]	15.0	
								P.P. Class AB [5]	325	850*			80	—		—	5000 [6]	10.0	
6AB6G	Direct-Coupled Amplifier	7AU	6.3	0.5	—	—	—	Class-A Amp.	250	0	Input		5.0	40000	1800	72	8000	3.5	6AB6G
									250	0	Output		34						
6AC5G	High-μ Power-Amplifier Triode	6Q	6.3	0.4	—	—	—	P.P. Class B [5]	250	0	—	—	5.0	36700	3400	125	10000 [8]	8.0	6AC5G
								Dyn.-Coupled	250	—	—	—	32				7000	3.7	
6AC6G	Direct-Coupled Amplifier	7AU	6.3	1.1	—	—	—	Class-A Amp.	180	0	Input		7.0	—	3000	54	4000	3.8	6AC6G
									180	0	Output		45						
6AD5G	High-μ Triode	6Q	6.3	0.3	4.1	3.9	3.3	Class-A Amp.	250	− 2.0	—	—	0.9	—	1500	100	—	—	6AD5G
6AD6G [10]	Electron-Ray Tube	7AG	6.3	0.15	—	—	—	Indicator	100		0 for 90°; −23 for 135°; 45 for 0°. Target current 1.5 ma.								6AD6G
6AD7G	Triode-Pentode	8AY	6.3	0.85	—	—	—	Triode Amp.	250	−25.0	—	—	4.0	19000	325	6.0	—	—	6AD7G
								Pentode Amp.	250	−16.5	250	6.5	34	80000	2500	—	7000	3.2	
6AE5G [10]	Triode Amplifier	6Q	6.3	0.3	—	—	—	Class-A Amp.	95	−15.0	—	—	7.0	3500	1200	4.2	—	—	6AE5G
6AE6GT [10]	Twin-Plate Triode with Single Grid	7AH	6.3	0.15	Remote cut-off			Class-A Amp.	250	− 1.5	—	—	6.5	25000	1000	25	—	—	6AE6GT
					Sharp cut-off			Class-A Amp.	250	− 1.5			4.5	35000	950	33			

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TABLE II—6.3-VOLT GLASS TUBES WITH OCTAL BASES—*Continued*

Type	Name	Socket Connec-tions	Fil. or Heater		Capacitance μμfd.			Use	Plate Supply Volts	Grid Bias	Screen Volts	Screen Current Ma.	Plate Current Ma.	Plate Resistance Ohms	Transcon-ductance Micromhos	Amp. Factor	Load Resistance Ohms	Power Output Watts	Type
			Volts	Amp.	In	Out	Plate-Grid												
6AE7GT[10]	Twin-Input Triode	7AX	6.3	0.5	—	—	—	Driver Amplifier	250	−13.5	—	—	5.0	9300	1500	14	—	—	6AE7GT
6AF5G	Triode	6Q	6.3	0.3	—	—	—	Class-A Amplifier	180	−18.0	—	—	7.0	—	1500	7.4	—	—	6AF5G
6AF7G	Twin Electron Ray	8AG	6.3	0.3	—	—	—	Indicator Tube											6AF7G
6AG6G	Power-Amplifier Pentode	7S	6.3	1.25	—	—	—	Class-A Amplifier	250	− 6.0	250	6.0	32	—	10000	—	8500	3.75	6AG6G
6AH5G	Beam Power Amplifier	6AP	6.3	0.9	—	—	—	Class-A Amplifier	350	−18	250	—	—	33000	5200	—	4200	10.8	6AH5G
6AH7GT	Twin Triode	8BE	6.3	0.3	—	—	—	Converter & Amp.	250	− 9.0	—	—	12[1]	6600	2400	16	—	—	6AH7GT
6AL6G	Beam Power Amplifier	6AM	6.3	0.9	—	—	—	Class-A Amplifier	250	−14.0	250	5.0	72	22500	6000	—	2500	6.5	6AL6G
6AL7GT	Electron-Ray Tube	8CH	6.3	0.15	—	—	—	Indicator	Outer edge of any of the three illuminated areas displaced 1/16 in. min. outward with +5 volts to its electrode. Similar inward disp. with —5 volts. No pattern with —6 volts grid.										6AL7GT
6AQ7GT	Duplex Diode Triode	8CK	6.3	0.3	2.3	1.5	2.8	Class-A Amplifier	250	− 2.0	—	—	2.3	44000	1600	70	—	—	6AQ7GT
6AR6	Beam Power Amp.	6BQ	6.3	1.2	11	7	0.55	Class-A Amplifier	250	−22.5	250	5	77	21000	5400	95	—	—	6AR6
6AR7GT	Diode Triode	8CG	6.3	0.3	1.4	1	2	Class-A Amplifier	250	− 2	—	—	1.3	66500	1050	70	—	—	6AR7GT
6AS7G	Low-Mu Twin Triode	8BD	6.3	2.5	—	—	—	D.C. Amplifier	135	250*	—	—	125	280	7500	2.1	—	—	6AS7G
								Class-A_1 Amp. P.P.	250	2500*	—	—	100/106	280	225[9]	—	6000[8]	13	
6B4G	Triode Power Amplifier	5S	6.3	1.0	—	—	—	Power Amplifier		Characteristics same as Type 6A3—Table IV						—	—	—	6B4G
6B6G	Duplex-Diode High-μ Triode	7V	6.3	0.3	1.7	3.8	1.7	Detector-Amplifier		Characteristics same as Type 75—Table IV						—	—	—	6B6G
6BQ6GT	Beam Pentode	6AM	6.3	1.2	—	—	—	Deflection Amp.	250	47*	150	2.1	45		5500	—	—	—	6BQ6GT
6BG6	Beam Power Amplifier	5BT	6.3	0.9	11	6.5	0.5	Deflection Amp.	400	−50	350	6.0	70	—	6000	—	—	—	6BG6
6C8G	Twin Triode	8G	6.3	0.3	—	—	—	Amp. 1 Section	250	− 4.5	—	—	3.1	26000	1450	38	—	—	6C8G
6D8G	Pentagrid Converter	8A	6.3	0.15	—	—	—	Converter	250	− 3.0	100	Cathode current 13.0 Ma.			Anode grid (No. 2) Volts = 250[3]				6D8G
6E8G[10]	Triode-Hexode Converter	8O	6.3	0.3	—	—	—	Converter	250	− 2.0			Triode Plate 150 volts						6E8G
6F8G	Twin Triode	8G	6.3	0.6	—	—	—	Amplifier	250	− 8.0	—	—	9[1]	7700	2600	20	—	—	6F8G
6G6G	Pentode Power Amplifier	7S	6.3	0.15	—	—	—	Class-A Amplifier	180	− 9.0	180	2.5	15	175000	2300	400	10000	1.1	6G6G
								Class-A Amplifier	180	−12.0	—	—	—	4750	2000	9.5	12000	0.25	
6H4GT	Diode Rectifier	5AF	6.3	0.15	—	—	—	Detector	100	—	—	—	4.0	—	—	—	—	—	6H4GT
6H8G	Duo-Diode High-μ Pentode	8E	6.3	0.3	—	—	—	Class-A Amplifier	250	− 2.0	100	—	8.5	650000	2400	—	—	—	6H8G
6J8G[10]	Triode Heptode	8H	6.3	0.3	—	—	—	Converter	250	− 3.0	100	2.8	1.2	Anode-grid (No. 2) 250 volts max.[3] 5 ma.					6J8G
6K5GT[10]	High-μ Triode	5U	6.3	0.3	2.4	3.6	2.0	Class-A Amplifier	250	− 3.0	—	—	1.1	50000	1400	70	—	—	6K5GT
6K6GT	Pentode Power Amplifier	7S	6.3	0.4	—	—	—	Class-A Amplifier		Characteristics same as Type 41—Table IV									6K6GT
6L5G	Triode Amplifier	6Q	6.3	0.15	2.8	5.0	2.8	Class-A Amplifier	250	− 9.0	—	—	8.0	—	1900	17	—	—	6L5G
6M6G	Power Amplifier Pentode	7S	6.3	1.2	—	—	—	Class-A Amplifier	250	− 6.0	250	4.0	36	—	9500	—	7000	4.4	6M6G
6M7G	Pentode Amplifier	7R	6.3	0.3	—	—	—	R.F. Amplifier	250	− 2.5	125	2.8	10.5	900000	3400	—	—	—	6M7G
6M8GT	Diode Triode Pentode	8AU	6.3	0.6	—	—	—	Triode Amplifier	100	—	—	—	0.5	91000	1100	—	—	—	6M8GT
								Pentode Amplifier	100	− 3.0	100	—	8.5	200000	1900	—	—	—	
6N6G[10]	Direct-Coupled Amplifier	7AU	6.3	0.8	—	—	—	Power Amplifier		Characteristics same as Type 6B5—Table IV						—	—	—	6N6G
6P5GT[10]	Triode Amplifier	6Q	6.3	0.3	3.4	5.5	2.6	Class-A Amplifier	250	−13.5	—	—	5.0	9500	1450	13.8	—	—	6P5GT
6P7G[10]	Triode-Pentode	7U	6.3	0.3	—	—	—	Class-A Amplifier	Characteristics same as 6F7—Table IV										6P7G
6P8G	Triode-Hexode Converter	8K	6.3	0.8	—	—	—	Converter	250	− 2.0	75	1.4	1.5	Triode Plate 100 v. 2.2 ma.					6P8G
6Q6G	Diode-Triode	6Y	6.3	0.15	—	—	—	Class-A Amplifier	250	− 3.0	—	—	1.2	—	1050	65	—	—	6Q6G
6R6G	Pentode Amplifier	6AW	6.3	0.3	4.5	11	0.007	Class-A Amplifier	250	− 3.0	100	1.7	7.0	—	1450	1160	—	—	6R6G
6S6GT	Remote Cut-off Pentode	5AK	6.3	0.45	—	—	—	R.F. Amplifier	250	− 2.0	100	3.0	13	350000	4000	—	—	—	6S6GT
6S8GT	Triple Diode Triode	8CB	6.3	0.3	1.2	5	2	Class-A Amplifier	250	− 2.0	—	—	0.9	91000	1100	100	—	—	6S8GT
6SD7GT	Medium Cut-off Pentode	8M	6.3	0.3	9	7.5	.0035	R.F. Amplifier	250	− 2.0	100	1.9	6.0	1000000	3600	—	—	—	6SD7GT
6SE7GT	Sharp Cut-off Pentode	8N	6.3	0.3	8	7.5	.005	R.F. Amplifier	250	− 1.5	100	1.5	4.5	1100000	3400	3750	—	—	6SE7GT
6SH7L	Pentode R.F. Amp.	8BK	6.3	0.3	—	—	—	Class-A Amplifier	100	− 1.0	100	2.1	5.3	350000	4000	—	—	—	6SH7L
									250	− 1.0	150	4.1	10.8	900000	4900	—	—	—	
6SL7GT	Twin Triode	8BD	6.3	0.3	—	—	—	Class-A Amplifier	250	− 2.0	—	—	2.3[1]	44000	1600	70	—	—	6SL7GT
6SN7GT	Twin Triode	8BD	6.3	0.6	—	—	—	Class-A Amplifier	250	− 8.0	—	—	9.0[1]	7700	2600	20	—	—	6SN7GT

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TABLE II—6.3-VOLT GLASS TUBES WITH OCTAL BASES—*Continued*

Type	Name	Socket Connec-tions	Fil. or Heater		Capacitance $\mu\mu$fd.			Use	Plate Supply Volts	Grid Bias	Screen Volts	Screen Current Ma.	Plate Current Ma.	Plate Resistance Ohms	Transcon-ductance Micromhos	Amp. Factor	Load Resistance Ohms	Power Output Watts	Type
			Volts	Amp.	In	Out	Plate-Grid												
6SU7GTY	Twin Triode	8BD	6.3	0.3	—	—	—	Class-A Amplifier	250	− 2.0	—	—	2.3	44000	1600	70	—	—	6SU7GTY
6T6GM[10]	Amplifier	6Z	6.3	0.45	—	—	—	Class-A Amplifier	250	− 1.0	100	2.0	10	1000000	5500	—	—	—	6T6GM
6U6GT	Beam Power Amplifier	7AC	6.3	0.75	—	—	—	Class-A Amplifier	200	−14.0	135	3.0	56	20000	6200	—	3000	5.5	6U6GT
6U7G	Variable-μ Pentode	7R	6.3	0.3	5	9	.007	Class-A Amplifier		Characteristics same as Type 6D6—Table III									6U7G
6V7G[10]	Duplex Diode-Triode	7V	6.3	0.3	2	3.5	1.7	Detector-Amplifier		Characteristics same as Type 85—Table III									6V7G
6W6GT	Beam Power Amplifier	7AC	6.3	1.25	—	—	—	Class-A Amplifier	135	− 9.5	135	12.0	61.0	—	9000	215	2000	3.3	6W6GT
6W7G	Pentode Det. Amplifier	7R	6.3	0.15	5	8.5	.007	Class-A Amplifier	250	− 3.0	100	2.0	0.5	1500000	1225	1850	—	—	6W7G
6X6G	Electron-Ray Tube	7AL	6.3	0.3	—	—	—	Indicator Tube	250		0 v. for 300°, 2 ma. —8 v. for 0°, 0 ma. Vane grid 125 v.								6X6G
6Y6G	Beam Power Amplifier	7AC	6.3	1.25	15	8	0.7	Class-A Amplifier	135	−13.5	135	3.0	60.0	9300	7000	—	2000	3.6	6Y6G
6Y7G[10]	Twin Triode Amplifier	8B	6.3	0.3	—	—	—	Class-B Amplifier		Characteristics same as Type 79—Table IV									6Y7G
6Z7G	Twin Triode Amplifier	8B	6.3	0.3	—	—	—	Class-B Amplifier	180	0	—	—	8.4	—	—	—	12000	4.2	6Z7G
									135	0	—	—	6.0	—	—	—	9000	2.5	
717A	Sharp Cut-off Pentode	8BK	6.3	0.175	—	—	—	Class-A Amplifier	120	− 2.0	120	2.5	7.5	390000	4000	—	—	—	717A
1223	Sharp Cut-off Pentode	7R	6.3	0.3	—	—	—	Class-A Amplifier		Characteristics same as 6C6—Table IV									1223
1635	Twin Triode Amplifier	8B	6.3	0.6	—	—	—	Class-B Amplifier	400	0	—	—	10/63	—	—	—	14000	17	1635
5691	Hi-Mu Twin Triode	8BD	6.3	0.6	2.4[7] 2.7[8]	2.3[7] 2.7[8]	3.6[7] 3.6[8]	Class-A Amp.	250	− 2	—	—	2.3[1]	44000	1600	70	—	—	5691
5692	Medium-Mu Twin Triode	8BD	6.3	0.6	2.3[7] 2.6[8]	2.5[7] 2.7[8]	3.5[7] 3.3[8]	Class-A Amp.	250	− 9	—	—	6.5[1]	9100	2200	18	—	—	5692
7000	Low-Noise Amplifier	7R	6.3	0.3	—	—	—	Class-A Amplifier	Characteristics same as Type 6J7—Table										7000

* Cathode resistor-ohms.
[1] Per plate.
[2] Screen tied to plate.
[3] Through 20,000-ohm dropping resistor.
[4] Values are for single tube.
[5] Values are for two tubes in push-pull.
[6] Plate-to-plate value.
[7] No. 1 triode.
[8] No. 2 triode.
[9] Peak a.f. volts G-G.
[10] Discontinued.

TABLE III—7-VOLT LOCK-IN-BASE TUBES

For other lock-in-base types see Tables VIII, IX, and X

Type	Name	Socket Connec-tions	Heater		Capacitance $\mu\mu$fd.			Use	Plate Supply Volts	Grid Bias	Screen Volts	Screen Current Ma.	Plate Current Ma.	Plate Resistance Ohms	Transcon-ductance Micromhos	Amp. Factor	Load Resistance Ohms	Power Output Watts	Type
			Volts	Amp.	In	Out	Plate-Grid												
7A4	Triode Amplifier	5AC	7.0	0.32	3.4	3	4	Class-A Amplifier	250	− 8.0	—	—	9.0	7700	2600	20	—	—	7A4
7A5	Beam Power Amplifier	6AA	7.0	0.75	13	7.2	0.44	Class-A_1 Amplifier	125	− 9.0	125	3.2/8	37.5/40	17000	6100	—	2700	1.9	7A5
7A6	Twin Diode	7AJ	7.0	0.16	—	—	—	Rectifier			Max. A.C. volts per plate—150. Max. Output current—10 ma.								7A6
7A7	Remote Cut-off Pentode	8V	7.0	0.32	6	7	.005	Class-A Amplifier	250	− 3.0	100	2.0	8.6	800000	2000	1600	—	—	7A7
7A8	Multigrid Converter	8U	7.0	0.16	7.5	9.0	0.15	Converter	250	− 3.0	100	3.1	3.0	50000	Anode-grid 250 volts max.[1]				7A8
7AD7	Pentode	8V	6.3	0.6	11.5	7.5	0.03	Class-A_1 Amp.	300	68*	150	7.0	28.0	300000	9500	—	—	—	7AD7
7AF7	Twin Triode	8AC	6.3	0.3	2.2	1.6	2.3	Class-A Amp.	250	−10	—	—	9.0	7600	2100	16	—	—	7AF7
7AG7	Sharp Cut-off Pentode	8V	7.0	0.16	7.0	6.0	0.005	Class-A_1 Amp.	250	250*	250	2.0	6.0	750000	4200	—	—	—	7AG7
7AH7	Pentode Amplitier	8V	6.3	0.15	7.0	6.5	0.005	Class-A_1 Amplifier	250	250*	250	1.9	6.8	1000000	3300	—	—	—	7AH7
7B4	High-μ Triode	5AC	7.0	0.32	3.6	3.4	1.6	Class-A Amplifier	250	− 2.0	—	—	0.9	66000	1500	100	—	—	7B4
7B5	Pentode Power Amplifier	6A[illegible]	7.0	0.43	3.2	3.2	1.6	Class-A_1 Amplifier	250	−18.0	250	5.5/10	32/33	68000	2300	—	7600	3.4	7B5
7B6	Duo-Diode Triode	8W	7.0	0.32	3.0	2.4	1.6	Class-A Amplifier	250	− 2.0	—	—	1.0	91000	1100	100	—	—	7B6
7B7	Remote Cut-off Pentode	8V	7.0	0.16	5	7	.005	Class-A Amplifier	250	− 3.0	100	2.0	8.5	700000	1700	1200	—	—	7B7
7B8	Pentagrid Converter	8X	7.0	0.32	10.0	9.0	0.2	Converter	250	− 3.0	100	2.7	3.5	360000	Anode-grid 250 volts max.[1]				7B8
7C5	Tetrode Power Amplifier	6AA	7.0	0.48	9.5	9.0	0.4	Class-A_1 Amplifier	250	−12.5	250	4.5/7	45/47	52000	4100	—	5000	4.5	7C5
7C6	Duo-Diode Triode	8W	7.0	0.16	2.4	3	1.4	Class-A Amplifier	250	− 1.0	—	—	1.3	100000	1000	100	—	—	7C6
7C7	Pentode Amplifier	8V	7.0	0.16	5.5	6.5	.007	Class-A Amplifier	250	− 3.0	100	0.5	2.0	2 meg.	1300	—	—	—	7C7
7D7	Triode-Hexode Converter	8AR	7.0	0.48	—	—	—	Converter	250	− 3.0	Triode Plate (No. 3) 150 v. 3.5 ma.								7D7

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TABLE III—7-VOLT LOCK-IN-BASE TUBES—*Continued*

Type	Name	Socket Connections	Heater		Capacitance μμfd.			Use	Plate Supply Volts	Grid Bias	Screen Volts	Screen Current Ma.	Plate Current Ma.	Plate Resistance Ohms	Transconductance Micromhos	Amp. Factor	Load Resistance Ohms	Power Output Watts	Type
			Volts	Amp.	In	Out	Plate-Grid												
7E6	Duo-Diode Triode	8W	7.0	0.32	—	—	—	Class-A Amplifier	250	− 9.0	—	—	9.5	8500	1900	16	—	—	7E6
7E7	Duo-Diode Pentode	8AE	7.0	0.32	4.6	4.6	.005	Class-A Amplifier	250	− 3.0	100	1.6	7.5	700000	1300	—	—	—	7E7
7F7	Twin Triode	8AC	7.0	0.32	—	—	—	Class-A Amplifier[2]	250	− 2.0	—	—	2.3	44000	1600	70	—	—	7F7
7F8	Twin Triode	8BW	6.3	0.30	2.8	1.4	1.2	R.F. Amplifier	250	− 2.5	—	—	10.0	10400	5000	—	—	—	7F8
									180	− 1.0			12.0	8500	7000				
7G7/ 1232	Sharp Cut-off Pentode	8V	7.0	0.48	9	7	.007	Class-A Amplifier	250	− 2.0	100	2.0	6.0	800000	4500	—	—	—	7G7/ 1232
7G8/ 1206	Dual Tetrode	8BV	6.3	0.30	3.4	2.6	0.15	R.F. Amplifier[2]	250	− 2.5	100	0.8	4.5	225000	2100	—	—	—	7G8/ 1206
7H7	Semi-Variable-μ Pentode	8V	7.0	0.32	8	7	.007	R.F. Amplifier	250	− 2.5	150	2.5	9.0	1000000	3500	—	—	—	7H7
7J7	Triode-Heptode Converter	8AR	7.0	0.32	—	—	—	Converter	250	− 3.0	100	2.9	1.3	Triode Plate 250 v. Max.[1]					7J7
7K7	Duo-Diode High-μ Triode	8BF	7.0	0.32	—	—	—	Class-A Amplifier	250	− 2.0	—	—	2.3	44000	1600	70	—	—	7K7
7L7	Sharp Cut-off Pentode	8V	7.0	0.32	8	6.5	.01	Class-A Amplifier	250	− 1.5	100	1.5	4.5	100000	3100	Cathode Resistor 250 ohms			7L7
7N7	Twin Triode	8AC	7.0	0.6	3.4[3] 2.9[4]	2.0[3] 2.4[4]	3.0[3] 3.0[4]	Class-A Amplifier[2]	250	− 8.0	—	—	9.0	7700	2600	20	—	—	7N7
7Q7	Pentagrid Converter	8AL	7.0	0.32	—	—	—	Converter	250	0	100	8.0	3.4	800000	Grid No. 1 resistor 20000 ohms				7Q7
7R7	Duo-Diode Pentode	8AE	7.0	0.32	5.6	5.3	.004	Class-A Amplifier	250	− 1.0	100	1.7	5.7	1000000	3200	—	—	—	7R7
7S7	Triode Hexode Converter	8BL	7.0	0.32	—	—	—	Converter	250	− 2.0	100	2.2	1.7	2000000	Triode Plate 250 v. Max.[1]				7S7
7T7	Pentode Amplifier	8V	7.0	0.32	8	7	.005	Class-A Amplifier	250	− 1.0	150	4.1	10.8	900000	4900	—	—	—	7T7
7V7	Sharp Cut-off Pentode	8V	7.0	0.48	9.5	6.5	.004	Class-A Amplifier	300	160*	150	3.9	10	300000	5800	—	—	—	7V7
7W7	Sharp Cut-off Pentode	8BJ	7.0	0.48	9.5	7.0	.0025	Class-A Amplifier	300	− 2.2	150	3.9	10	300000	5800	—	—	—	7W7
7X7	Duo-Diode Triode	8BZ	6.3	0.3	—	—	—	Class-A Amplifier	250	− 1.0	—	—	1.9	67000	1500	100	—	—	7X7
1231	Pentode Amplifier	8V	6.3	0.45	8.5	6.5	.015	Class-A Amplifier	300	200*	150	2.5	10	700000	5500	3850	—	—	1231
1273	Nonmicrophonic Pentode	8V	7.0	0.32	6.0	6.5	.007	Class-A_1 Amplifier	250	− 3.0	100	0.7	2.2	1000000	1575	—	—	—	1273
									100	− 1.0	100	1.8	5.7	400000	2275	—	—	—	
5679	Twin Diode	7CX	6.3	0.15	—	—	—	V.T.V.M. Rectifier	Same as 7A6										5679
XXL	Triode Oscillator	5AC	7.0	0.32	—	—	—	Oscillator	250	− 8.0	—	—	8.0	—	2300	20	—	—	XXL

* Cathode resistor—ohms. [1] Applied through 20000-ohm dropping resistor. Each section. [3] Triode No. 1. [4] Triode No. 2.

TABLE IV—6.3-VOLT GLASS RECEIVING TUBES

Type	Name	Base	Socket Connections	Fil. or Heater		Capacitance μμfd.			Use	Plate Supply Volts	Grid Bias	Screen Volts	Screen Current Ma.	Plate Current Ma.	Plate Resistance Ohms	Transconductance Micromhos	Amp. Factor	Load Resistance Ohms	Power Output Watts	Type
				Volts	Amp.	In	Out	Plate-Grid												
2C21/ 1642	Twin-Triode Amplifier	M.	7BH	6.3	0.6	—	—	—	Class-A Amp.	250	−16.5	—	—	8.3	7600	1375	10.4	—	—	2C21/ 1642
6A3	Triode Power Amplifier	M.	4D	6.3	1.0	7.0	5.0	16.0	Class-A Amp.	250	−45	—	—	60	800	5250	4.2	2500	3.5	6A3
									Class AB_1 Amp.[10]	300 300	−62 850*	Fixed Bias Self Bias		80 80	—	—	—	3000[11] 5000[11]	15 10	
6A4#	Pentode Power Amplifier	M.	5B	6.3	0.3	—	—	—	Class-A Amp.	180	−12.0	180	3.9	22	60000	2500	150	8000	1.5	6A4
6A6	Twin Triode Amplifier	M.	7B	6.3	0.8	—	—	—	Class-B Amp. P.P.	250 300	0 0	—	—	Power output is for one tube at stated load, plate-to-plate				8000 10000	8.0 10.0	6A6
6A7	Pentagrid Converter	S.	7C	6.3	0.3	8.5	9.0	0.3	Converter	250	− 3.0	100	2.2	3.5	360000	Anode grid (No. 2) 200 volts max.				6A7
6AB5/6N5	Electron-Ray Tube	S.	6R	6.3	0.15	—	—	—	Indicator Tube	180	Cut-off Grid Bias = −12 v.			0.5	Target Current 2 ma.				—	6AB5/6N5
6AF6G	Electron-Ray Tube Twin Indicator Type	S.	7AG	6.3	0.15	—	—	—	Indicator Tube	135 100	Ray Control Voltage = 81 for 0° Shadow Angle. Target current 1.5 ma. Ray Control Voltage = 60 for 0° Shadow Angle. Target current 0.9 ma.									6AF6G
6B5	Direct-Coupled Power Amplifier	M.	6AS	6.3	0.8	—	—	—	Class-A Amp.[9] Push-Pull Amp.[10]	300 400	0 −13.0	— —	6[1] 4.5[1]	45 40	241000 —	2400 —	58 —	7000 10000[11]	4.0 20	6B5

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TABLE IV—6.3-VOLT GLASS RECEIVING TUBES—*Continued*

Type	Name	Base	Socket Connec-tions	Fil. or Heater		Capacitance μμfd.			Use	Plate Supply Volts	Grid Bias	Screen Volts	Screen Current Ma.	Plate Current Ma.	Plate Resistance Ohms	Transcon-ductance Micromhos	Amp. Factor	Load Resistance Ohms	Power Output Watts	Type
				Volts	Amp.	In	Out	Plate-Grid												
6B7	Duplex-Diode Pentode	S.	7D	6.3	0.3	3.5	9.5	.007	Pentode R.F. Amp.	250	− 3.0	125	2.3	9.0	650000	1125	730	—	—	6B7
6C6	Sharp Cut-off Pentode	S.	6F	6.3	0.3	5	6.5	.007	R.F. Amplifier	250	− 3.0	100	0.5	2.0	1500000	1225	1500	—	—	6C6
6C7 *	Duplex Diode Triode	S.	7G	6.3	0.3	—	—	—	Class-A Amp.	250	− 9.0	—	—	4.5	—	20	1250	—	—	6C7
6D6	Variable-μ Pentode	S.	6F	6.3	0.3	4.7	6.5	.007	R.F. Amplifier	250	− 3.0	100	2.0	8.2	800000	1600	1280	—	—	6D6
6D7 #	Sharp Cut-off Pentode	S.	7H	6.3	0.3	5.2	6.8	.01	Class-A Amp.	250	− 3.0	100	0.5	2.0	—	1600	1280	—	—	6D7
6E5	Electron-Ray Tube	S.	6R	6.3	0.3	—	—	—	Indicator Tube	250	0	—	—	0.25	Target Current 4 ma.				—	6E5
6E6 #	Twin Triode Amplifier	M.	7B	6.3	0.6	—	—	—	Class-A Amp.	250	−27.5	Per plate—18.0			3500	1700	6.0	14000	1.6	6E6
6E7 #	Variable-μ Pentode	S.	7H	6.3	0.3	—	—	—	R.F. Amplifier				Characteristics same as 6U7G—Table II							6E7
6F7	Triode Pentode	S.	7E	6.3	0.3	—	—	—	Triode Unit Amp.	100	− 3.0	—	—	3.5	16000	500	8	—	—	6F7
									Pentode Unit Amplifier	250	− 3.0	100	1.5	6.5	850000	1100	900	—	—	
6U5/6G5	Electron-Ray Tube	S.	6R	6.3	0.3	—	—	—	Indicator Tube	250 100	Cut-off Grid Bias = −22 v. Cut-off Grid Bias = −8 v.			0.24 0.19	Target Current 4 ma. Target Current 1 ma.				—	6U5/6G5
6H5	Electron-Ray Tube	S.	6R	6.3	0.3	—	—	—	Indicator Tube			Same characteristics as Type 6G5—Circular Pattern								6H5
6T5	Electron-Ray Tube	S.	6R	6.3	0.3	—	—	—	Indicator Tube	250	Cut-off Grid Bias −12 v.			0.24	Target Current 4 ma.				—	6T5
36	Tetrode R.F. Amplifier	S.	5E	6.3	0.3	3.8	9	.007	R.F. Amplifier	250	− 3.0	90	1.7	3.2	550000	1080	595	—	—	36
37	Triode Detector Amplifier	S.	5A	6.3	0.3	3.5	2.9	2	Class-A Amp.	250	− 18.0	—	—	7.5	8400	1100	9.2	—	—	37
38	Pentode Power Amplifier	S.	5F	6.3	0.3	3.5	7.5	0.3	Class-A Amp.	250	−25.0	250	3.8	22.0	100000	1200	120	10000	2.5	38
39/44	Remote Cut-off Pentode	S.	5F	6.3	0.3	3.8	10	.007	R.F. Amplifier	250	− 3.0	90·	1.4	5.8	1000000	1050	1050	—	—	39/44
41	Pentode Power Amplifier	S.	6B	6.3	0.4	—	—	—	Class-A Amp.	250	−18.0	250	5.5	32.0	68000	2200	150	7600	3.4	41
42	Pentode Power Amplifier	M.	6B	6.3	0.7	—	—	—	Class-A Amp.	250	−16.5	250	6.5	34.0	100000	2200	220	7000	3.0	42
52	Dual Grid Triode	M.	5C	6.3	0.3	—	—	—	Class-A Amp.[4]	110	0	—	—	43.0	1750	3000	5.2	2000	1.5	52
									Class-B, 2 tubes[5]	180	0	—	—	3.0[11]				10000	5.0	
56AS	Triode Amplifier	S.	5A	6.3	0.4	—	—	—	Class-A Amp.	Characteristics same as 56										56AS
57AS	Sharp Cut-off Pentode	S.	6F	6.3	0.4	—	—	—	R.F. Amplifier	Characteristics same as 57										57AS
58AS	Remote Cut-off Pentode	S.	6F	6.3	0.4	—	—	—	R.F. Amplifier	Characteristics same as 58										58AS
75	Duplex-Diode Triode	S.	6G	6.3	0.3	1.7	3.8	1.	Triode Amplifier	250	− 1.35	—	—	0.4	91000	1100	100	—	—	75
76	Triode Detector Amplifier	S.	5A	6.3	0.3	3.5	2.5	2.8	Class-A Amp.	250	−13.5	—	—	5.0	9500	1450	13.8	—	—	76
77	Sharp Cut-off Pentode	S.	6F	6.3	0.3	4.7	11	.007	R.F. Amplifier	250	− 3.0	100	0.5	2.3	1500000	1250	1500	—	—	77
78	Variable-μ Pentode	S.	6F	6.3	0.3	4.5	11	.007	R.F. Amplifier	250	− 3.0	100	1.7	7.0	800000	1450	1160	—	—	78
79	Twin Triode Amplifier	S.	6H	6.3	0.6	—	—	—	Class-B Amp.	250	0	—	—	10.6[12]	Power output is for one tube			14000	8.0	79
85	Duplex-Diode Triode	S.	6G	6.3	0.3	1.5	4.3	1.5	Class-A Amp.	250	−20.0	—	—	8.0	7500	1100	8.3	20000	0.35	85
85AS	Duplex-Diode Triode	S.	6G	6.3	0.3	—	—	—	Class-A Amp.	250	− 9.0	—	—	5.5	—	1250	20	—	—	85AS
89	Power Amplifier Pentode	S.	6F	6.3	0.4	—	—	—	Triode Amp.[2]	250	−31.0	—	—	32.0	2600	1800	4.7	5500	0.9	89
									Pentode Amp.[8]	250	−25.0	250	5.5	32.0	70000	1800	125	6750	3.4	
1221	Pentode R.F. Amplifier	S.	6F	6.3	0.3	—	—	—	Class-A Amp.	Special non-microphonic. Characteristics same as 6C6										1221
1603[3]	Sharp Cut-off Pentode	M.	6F	6.3	0.3	—	—	—	Class-A Amp.	Characteristics same as 6C6										1603
7700[3]	Sharp Cut-off Pentode	S.	6F	6.3	0.3	—	—	—	Class-A Amp.	Characteristics same as 6C6										7700

* Cathode bias resistor—ohms.
\# Discontinued.

[1] Current to input plate (P_1).
[2] Grids Nos. 2 and 3 connected to plate.
[3] Low noise, nonmicrophonic tubes.
[4] G_2 tied to plate.
[5] G_1 tied to G_2.
[6] Osc. grid leak ohms.
[7] Screen dropping resistor ohms.
[8] Grid No. 2, screen; grid No. 3, suppressor.
[9] Values for single tube.
[10] Values for two tubes in push-pull.
[11] Plate-to-plate value.
[12] No signal value.

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TABLE V—2.5-VOLT RECEIVING TUBES

Type	Name	Base	Socket Connections	Fil. or Heater Volts	Fil. or Heater Amp.	Capacitance μμfd. In	Capacitance μμfd. Out	Capacitance μμfd. Plate-Grid	Use	Plate Supply Volts	Grid Bias	Screen Volts	Screen Current Ma.	Plate Current Ma.	Plate Resistance Ohms	Transconductance Micromhos	Amp. Factor	Load Resistance Ohms	Power Output Watts	Type
2S/4S	Duodiode	M.	5D	2.5	1.35	—	—	—	Detector	At 50 d.c. Volts per plate, cathode ma. = 80										2S/4S
2A3	Triode Power Amplifier	M.	4D	2.5	2.5	7.5	5.5	16.5	Class-A Amp.	Characteristics same as Type 6A3, Table IV										2A3
2A5	Pentode Power Amplifier	M.	6B	2.5	1.75	—	—	—	Class-A Amp.	Characteristics same as Type 42, Table IV										2A5
2A6	Duplex-Diode Triode	S.	6G	2.5	0.8	1.7	3.8	1.7	Class-A Amp.	Characteristics same as Type 75, Table IV										2A6
2A7	Pentagrid Converter	S.	7C	2.5	0.8	—	—	—	Converter	Characteristics same as Type 6A7, Table IV										2A7
2B6	Direct-Coupled Amplifier	M.	7J	2.5	2.25	—	—	—	Amplifier	250	−24.0	—	—	40.0	5150	3500	18.0	5000	4.0	2B6
2B7	Duplex-Diode Pentode	S.	7D	2.5	0.8	3.5	9.5	.007	Pentode Amp.	Characteristics same as Type 6B7—Table IV										2B7
2E5	Electron-Ray Tube	S.	6R	2.5	0.8	—	—	—	Indicator Tube	Characteristics same as Type 6E5—Table IV										2E5
2G5	Electron-Ray Tube	S.	6R	2.5	0.8	—	—	—	Indicator Tube	Characteristics same as 6U5/6G5—Table IV										2G5
24-A	Tetrode R.F. Amplifier	M.	5E	2.5	1.75	5.3	10.5	.007	Screen-Grid R.F. Amplifier	250	− 3.0	90	1.7	4.0	600000	1050	630	—	—	24-A
									Bias Detector	250	− 5.0	20/45	Plate current adjusted to 0.1 ma. with no signal							
27	Triode Detector-Amplifier	M.	5A	2.5	1.75	3.1	2.3	3.3	Class-A Amp.	250	−21.0	—	—	5.2	9250	975	9.0	—	—	27
									Bias Detector	250	−30.0	—	Plate current adjusted to 0.2 ma. with no signal							
35/51	Remote Cut-off Pentode	M.	5E	2.5	1.75	5.3	10.5	.007	Screen-Grid R.F. Amplifier	250	− 3.0	90	2.5	6.5	400000	1050	420	—	—	35/51
45	Triode Power Amplifier	M.	4D	2.5	1.5	4	3	7	Class-A Amp.	275	−56.0	—	—	36.0	1700	2050	3.5	4600	2.00	45
46	Dual-Grid Power Amp.	M.	5C	2.5	1.75	—	—	—	Class-A Amp.[2]	250	−33.0	—	—	22.0	2380	2350	5.6	6400	1.25	46
									Class-B Amp.[3]	400	0	—	—	12	Power output for 2 tubes			5800	20.0	
47	Pentode Power Amplifier	M.	5B	2.5	1.75	8.6	13	1.2	Class-A Amp.	250	−16.5	250	6.0	31.0	60000	2500	150	7000	2.7	47
53	Twin Triode Amplifier	M.	7B	2.5	2.0	—	—	—	Class-B Amp.	Characteristics same as Type 6A6, Table IV										53
55	Duplex-Diode Triode	S.	6G	2.5	1.0	1.5	4.3	1.5	Class-A Amp.	Characteristics same as Type 85, Table IV										55
56	Triode Amplifier, Detector	S.	5A	2.5	1.0	3.2	2.4	3.2	Class-A Amp.	Characteristics same as Type 76, Table IV										56
57	Sharp Cut-off Pentode	S.	6F	2.5	1.0	—	—	—	R.F. Amplifier	250	− 3.0	100	0.5	2.0	1500000	1225	1500	—	—	57
58	Remote Cut-off Pentode	S.	6F	2.5	1.0	4.7	6.3	.007	Screen-Grid R.F. Amplifier	250	− 3.0	100	2.0	8.2	800000	1600	1280	—	—	58
59	Pentode Power Amplifier	M.	7A	2.5	2.0	—	—	—	Class-A Triode[4]	250	−28.0	—	—	26.0	2300	2600	6.0	5000	1.25	59
									Class-A Pentode[5]	250	−18.0	250	9.0	35.0	40000	2500	100	6000	3.0	
RK15	Triode Power Amplifier	M.	4D[1]	2.5	1.75	—	—	—		Characteristics same as Type 46 with Class-B connections										RK15
RK16	Triode Power Amplifier	M.	5A	2.5	2.0	—	—	—		Characteristics same as Type 59 with Class-A triode connections										RK16
RK17	Pentode Power Amplifier	M.	5F	2.5	2.0	—	—	—		Characteristics same as Type 2A5										RK17

[1] Grid connection to cap; no connection to No. 3 pin. [2] Grid No. 2 tied to plate. [3] Grids Nos. 1 and 2 tied together. [4] Grids Nos. 2 and 3 connected to plate. [5] Grid No. 2, screen; grid No. 3, suppressor.

TABLE VI—2.0-VOLT BATTERY RECEIVING TUBES

Type	Name	Base	Socket Connections	Filament Volts	Filament Amp.	Capacitance μμfd. In	Capacitance μμfd. Out	Capacitance μμfd. Plate-Grid	Use	Plate Supply Volts	Grid Bias	Screen Volts	Screen Current Ma.	Plate Current Ma.	Plate Resistance Ohms	Transconductance Micromhos	Amp. Factor	Load Resistance Ohms	Power Output Watts	Type
1A4P	Variable-μ Pentode	S.	4M	2.0	0.06	5	11	.007	R.F. Amplifier	180	− 3.0	67.5	0.8	2.3	1000000	750	750	—	—	1A4P
1A4T	Variable-μ Tetrode	S.	4K	2.0	0.06	5	11	.007	R.F. Amplifier	180	− 3.0	67.5	0.7	2.3	960000	750	720	—	—	1A4T
1A6	Pentagrid Converter	S.	6L	2.0	0.06	—	—	—	Converter	180	− 3.0	67.5	2.4	1.3	500000	Anode grid (No. 2) 180 max. volts				1A6
1B4P/951	Pentode R.F. Amplifier	S.	4M	2.0	0.06	5	11	.007	R.F. Amplifier	180 90	− 3.0 − 3.0	67.5 67.5	0.6 0.7	1.7 1.6	1500000 1000000	650 600	1000 550	—	—	1B4P/951
1B5/25S	Duplex-Diode Triode	S.	6M	2.0	0.06	1.6	1.9	3.6	Triode Class-A	135	− 3.0	—	—	0.8	35000	575	20	—	—	1B5/25S

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TABLE VI—2.0-VOLT BATTERY RECEIVING TUBES—*Continued*

Type	Name	Base	Socket Connections	Filament Volts	Filament Amp.	Capacitance μμfd. In	Capacitance μμfd. Out	Capacitance μμfd. Plate-Grid	Use	Plate Supply Volts	Grid Bias	Screen Volts	Screen Current Ma.	Plate Current Ma.	Plate Resistance Ohms	Transconductance Micromhos	Amp. Factor	Load Resistance Ohms	Power Output Watts	Type
1C6	Pentagrid Converter	S.	6L	2.0	0.12	10	10	—	Converter	180	− 3.0	67.5	2.0	1.5	750000	Anode grid (No. 2) 135 max. volts				1C6
1F4	Pentode Power Amplifier	M.	5K	2.0	0.12	—	—	—	Class-A Amp.	135	− 4.5	135	2.6	8.0	200000	1700	340	16000	0.34	1F4
1F6	Duplex-Diode Pentode	S.	6W	2.0	0.06	4	9	.007	R.F. Amplifier	180	− 1.5	67.5	0.6	2.0	1000000	650	650	—	—	1F6
									A.F. Amplifier	135	− 1.0	135	Plate, 0.25 megohm; screen, 1.0 megohm					Amp. = 48		
15 #	Sharp Cut-off Pentode	S.	5F	2.0	0.22	2.3	7.8	0.01	R.F. Amplifier	135	− 1.5	67.5	0.3	1.85	800000	750	600	—	—	15
19	Twin-Triode Amplifier	S.	6C	2.0	0.26	—	—	—	Class-B Amp.	135	0	—	—	—	Load plate-to-plate			10000	2.1	19
30	Triode Detector Amplifier	S.	4D	2.0	0.06	—	—	—	Class-A Amp.	180	−13.5	—	—	3.1	10300	900	9.3	—	—	30
31	Triode Power Amplifier	S.	4D	2.0	0.13	3.5	2.7	5.7	Class-A Amp.	180	−30.0	—	—	12.3	3600	1050	3.8	5700	0.375	31
32	Sharp Cut-off Pentode	M.	4K	2.0	0.06	5.3	10.5	.015	R.F. Amplifier	180	− 3.0	67.5	0.4	1.7	1200000	650	780	—	—	32
33	Pentode Power Amplifier	M	5K	2.0	0.26	8	12	1	Class-A Amp.	180	−18.0	180	5.0	22.0	55000	1700	90	6000	1.4	33
34	Variable-μ Pentode	M.	4M	2.0	0.06	6	11	.015	R.F. Amplifier	180	− 3.0	67.5	1.0	2.8	1000000	620	620	—	—	34
49	Dual-Grid Power Amp.	M.	5C	2.0	0.12	—	—	—	Class-A Amp.[1]	135	−20.0	—	—	6.0	4175	1125	4.7	11000	0.17	49
									Class-B Amp.[2]	180	0	—	—	Power output for 2 tubes				12000	3.5	
840	Pentode	S.	5J	2.0	0.13	—	—	—	Class-A Amp.	180	− 3.0	67.5	0.7	1.0	1000000	400	400	—	—	840
950	Pentode Power Amplifier	M.	5K	2.0	0.12	—	—	—	Class-A Amp.	135	−16.5	135	2.0	7.0	100000	1000	125	13500	0.575	950
RK24	Triode	M.	4D	2.0	0.12	—	—	—	Class-A Amp.	180	−13.5	—	—	8.0	5000	1600	8.0	12000	0.25	RK24
1229	Tetrode	M.	4K	2.0	0.06	—	—	—		Special Type 32 for low grid-current applications										1229
1230	Triode	M.	4D	2.0	0.06	3.0	2.1	6.0		Special Type 30 for low grid-current applications										1230

Discontinued. [1] Grid No. 2 tied to plate. [2] Grids Nos. 1 and 2 tied together.

TABLE VII—2.0-VOLT BATTERY TUBES WITH OCTAL BASES

Type	Name	Socket Connections	Filament Volts	Filament Amp.	Capacitance μμfd. In	Capacitance μμfd. Out	Capacitance μμfd. Plate-Grid	Use	Plate Supply Volts	Grid Bias	Screen Volts	Screen Current Ma.	Plate Current Ma.	Plate Resistance Ohms	Transconductance Micromhos	Amp. Factor	Load Resistance Ohms	Power Output Watts	Type
1C7G	Heptode	7Z	2.0	0.06	10	14	0.26	Converter	Characteristics same as Type 1C6—Table VI										1C7G
1D5GP	Variable-μ Pentode	5Y	2.0	0.06	5	11	.007	R.F. Amplifier	Characteristics same as Type 1A4P—Table VI										1D5GP
1D5GT #	Variable-μ Tetrode	5R	2.0	0.06	—	—	—	R.F. Amplifier	180	− 3.0	67.5	0.7	2.2	600000	650				1D5GT
1D7G	Pentagrid Converter	7Z	2.0	0.06	10.5	9.0	0.25	Converter	Characteristics same as Type 1A6—Table VI										1D7G
1E5GP	Pentode Amplifier	5Y	2.0	0.06	5	11	.007	R.F. Amplifier	Characteristics same as Type 1B4—Table VI										1E5GP
1E7G	Double Pentode Power Amp.	8C	2.0	0.24	—	—	—	Class-A Amplifier	135	− 7.5	135	2.0[1]	6.5[1]	220000	1600	350	24000	0.65	1E7G
1F5G	Pentode Power Amplifier	6X	2.0	0.12	—	—	—	Class-A Amplifier	Characteristics same as Type 1F4—Table VI										1F5G
1F7G[2]	Duplex-Diode Pentode	7AD	2.0	0.06	3.8	9.5	0.01	Detector-Amplifier	Characteristics same as Type 1F6—Table VI										1F7G
1G5G	Pentode Power Amplifier	6X	2.0	0.12	—	—	—	Class-A Amplifier	135	−13.5	135	2.5	8.7	160000	1550	250	9000	0.55	1G5G
1H4G	Triode Amplifier	5S	2.0	0.06	—	—	—	Detector-Amplifier	Characteristics same as Type 30—Table VI										1H4G
1H6G	Duplex-Diode Triode	7AA	2.0	0.06	1.6	1.9	3.6	Detector-Amplifier	Characteristics same as Type 1B5—Table VI										1H6G
1J5G #	Pentode Power Amplifier	6X	2.0	0.12	—	—	—	Class-A Amplifier	135	−16.5	135	2.0	7.0	—	950	100	13500	0.45	1J5G
1J6G	Twin Triode	7AB	2.0	0.24	—	—	—	Class-B Amplifier	Characteristics same as Type 19—Table VI										1J6G
4A6G	Twin Triode	8L	2.0	0.12	—	—	—	Class-A, 1 section	90	− 1.5	—	—	1.1	26600	750	20			4A6G
			4.0	0.06				Class-B, 2 sections	90	− 1.5	—	—	10.8[3]				8000	1.0	

Discontinued. [1] Total current for both sections; no signal. [2] Type GV has 7AF base. [3] Max. signal.

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TABLE VIII—1.5-VOLT FILAMENT BATTERY TUBES

See also Table X for Special 1.4-volt Tubes

Type	Name	Base	Socket Connections	Filament		Capacitance μμfd.			Use	Plate Supply Volts	Grid Bias	Screen Volts	Screen Current Ma.	Plate Current Ma.	Plate Resistance Ohms	Transconductance Micromhos	Amp. Factor	Load Resistance Ohms	Power Output M-watts	Type
				Volts	Amp.	In	Out	Plate-Grid												
1A5GT	Pentode Power Amplifier	O.	6X	1.4	0.05	—	—	—	Class-A_1 Amp.	90	−4.5	90	0.8	4.0	300000	850	240	25000	115	1A5GT
1A7GT	Pentagrid Converter	O.	7Z	1.4	0.05	—	—	—	Converter	90	0	45	0.6	0.55	600000	Anode-grid volts 90				1A7GT
1AB5	Pentode R.F. Amplifier	L.	5BF	1.2	0.05	2.8	4.2	0.25	R.F. Amplifier	90 150	0 −1.5	90 150	0.8 2.0	3.5 6.8	275000 125000	1100 1350	—	—	—	1AB5
1B7GT ♯	Heptode	O.	7Z	1.4	0.1	—	—	—	Converter	90	0	45	1.3	1.5	350000	Grid No. 1 resistor 200,000 ohms				1B7GT
1B8GT	Diode Triode Pentode	O.	8AW	1.4	0.1	—	—	—	Triode Amplifier Pentode Amp.	90 90	0 −6.0	— 90	— 1.4	0.15 6.3	240000 —	275 1150	— —	— 14000	— 210	1B8GT
1C5GT	Pentode Power Amplifier	O.	6X	1.4	0.1	—	—	—	Class-A_1 Amp.	90	−7.5	90	1.6	7.5	115000	1550	165	8000	240	1C5GT
1D8GT	Diode Triode Pentode	O.	8AJ	1.4	0.1	—	—	—	Triode Amp. Pentode Amp.	90 90	0 −9.0	— 90	— 1.0	1.1 5.0	43500 200000	575 925	25 —	— —	— —	1D8GT
1E4G	Triode Amplifier	O.	5S	1.4	0.05	2.4	6	2.40	Class-A Amp.	90 90	0 −3.0	—	—	4.5 1.5	11000 17000	1325 825	14.5 14	—	—	1E4G
1G4GT	Triode Amplifier	O.	5S	1.4	0.05	2.2	3.4	2.80	Class-A Amp.	90	−6.0	—	—	2.3	10700	825	8.8	—	—	1G4GT
1G6GT	Twin Triode	O.	7AB	1.4	0.1	—	—	—	Class-A Amp.	90	0	—	—	1.0	45000	675	30	—	—	1G6GT
									Class-B Amp.	90	0	—	—	1/7	34 volts input per grid			12000	675	
1H5GT	Diode High-μ Triode	O.	5Z	1.4	0.05	1.1	6	1.00	Class-A Amp.	90	0	—	—	0.14	240000	275	65	—	—	1H5GT
1LA4	Pentode Power Amplifier	L.	5AD	1.4	0.05	—	—	—	Class-A Amp.	90	Characteristics same as 1A5GT									1LA4
1LA6	Pentagrid Converter	L.	7AK	1.4	0.05	—	—	—	Converter	90	0	45	0.6	0.55	Anode Grid Volts 90					1LA6
1LB4	Pentode Power Amplifier	L.	5AD	1.4	0.05	—	—	—	Class-A Amp.	90	−9	90	1.0	5.0	200000	925	—	12000	200	1LB4
1LB6	Heptode Converter	L.	8AX	1.4	0.05	—	—	—	Converter	90	0	67.5	2.2	0.4	Grid No. 4—67.5 v., No. 5—0 v.					1LB6
1LC5	Remote Cut-off Pentode	L.	7AO	1.4	0.05	3.2	7	.007	R.F. Amplifier	90	0	45	0.2	1.15	1500000	775	—	—	—	1LC5
1LC6	Pentagrid Converter	L.	7AK	1.4	0.05	—	—	—	Converter	90	0	35[1]	0.7	0.75		Anode Grid Volts 45				1LC6
1LD5	Diode Pentode	L.	6AX	1.4	0.05	3.2	6	0.18	Class-A Amp.	90	0	45	0.1	0.6	950000	600	—	—	—	1LD5
1LE3	Triode Amplifier	L.	4AA	1.4	0.05	1.7	3	1.70	Class-A Amp.	90 90	0 −3	—	—	4.5 1.3	11200 19000	1300 760	14.5	—	—	1LE3
1LG5	Pentode R.F. Amp.	L.	7AO	1.4	0.05	—	—	—	Class-A Amp.	90	0	45	0.4	1.7	1000000	800	—	—	—	1LG5
1LH4	Diode High-μ Triode	L.	5AG	1.4	0.05	1.1	6	1.00	Class-A Amp.	90	0	—	—	0.15	240000	275	65	—	—	1LH4
1LN5	Remote Cut-off Pentode	L.	7AO	1.4	0.05	3.4	8	.007	Class-A Amp.	90	0	90	0.3	1.2	1500000	750	—	—	—	1LN5
1N5GT	Remote Cut-off Pentode	O.	5Y	1.4	0.05	3	10	.007	Class-A Amp.	90	0	90	0.3	1.2	1500000	750	1160	—	—	1N5GT
1N6G ♦	Diode-Power-Pentode	O.	7AM	1.4	0.05	—	—	—	Class-A Amp.	90	−4.5	90	0.6	3.1	300000	800	—	25000	100	1N6G
1P5GT	Pentode	O.	5Y	1.4	0.05	3	10	.007	R.F. Amplifier	90	0	90	0.7	2.3	800000	800	640	—	—	1P5GT
1Q5GT	Tetrode Power Amplifier	O.	6AF	1.4	0.1	—	—	—	Class-A Amp.	85 90	−5.0 −4.5	85 90	1.2 1.6	7.2 9.5	70000 75000	1950 2100	—	9000 8000	250 270	1Q5GT
1R4/1294	U.h.f. Diode	L.	4AH	1.4	0.15	—	—	—	Rectifier		Max. r.m.s. voltage per plate—30				Max. d.c. output current—340 μa.					1R4/1294
1SA6GT	Medium Cut-off Pentode	O.	6CA	1.4	0.05	5.2	8.6	0.01	R.F. Amplifier	90	0	67.5	0.68	2.45	800000	970	—	—	—	1SA6GT
1SB6GT	Diode Pentode	O.	6CB	1.4	0.05	3.2	3	0.25	Class-A Amp.	90	0	67.5	0.38	1.45	700000	665	—	—	—	1SB6GT
									R.C. Amplifier	90	0	90	Screen resistor 5 meg., grid 10 meg.					1 meg.	110[2]	
1T5GT	Beam Power Amplifier	O.	6AF	1.4	0.05	4.8	8	0.50	Class-A Amp.	90	−6.0	90	1.4	6.5	—	1150	—	14000	170	1T5GT
3B7/1291	U.h.f. Twin Triode	L.	7BE	2.8[3]	0.11	1.4	2.6	2.6	Class-A Amp.	90	0	—	—	5.2	11350	1850	20	—	—	3B7/1291
1293	U.h.f. Triode	L.	4AA	1.4	0.11	1.7	3.0	1.7	Class-A Amp.	90	0	—	—	4.7	10750	1300	14	—	—	1293
3D6/1299	U.h.f. Tetrode	L.	6BB	2.8[3]	0.11	7.5	6.5	0.30	Class-A Amp.	135	−6	90	0.7	5.7	—	2200	—	13000	500	3D6/1299
3E6	R.F. Pentode	L.	7CJ	1.4 2.8	0.10 0.05	5.5	7.5	0.007	Class-A Amp.	90	0	90	1.3	3.8	300000	2100	—	—	—	3E6
RK42	Triode Amplifier	S.	4D	1.5	0.6	—	—	—	Class-A Amp.		Characteristics same as Type 30—Table VI									RK42
RK43	Twin Triode Amplifier	S.	6C	1.5	0.12	—	—	—	Class-A Amp.	135	−3	—	—	4.5	14500	900	13	—	—	RK43

♯ Discontinued. [1] Through series resistor. Screen voltage must be at least 10 volts lower than oscillator anode. [2] Voltage gain. [3] Center-top filament permits 1.4-volt operation.

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TABLE IX—HIGH-VOLTAGE HEATER TUBES

Type	Name	Base	Socket Connec-tions	Heater		Capacitance μμfd.			Use	Plate Supply Volts	Grid Bias	Screen Volts	Screen Current Ma.	Plate Current Ma.	Plate Resistance Ohms	Transcon-ductance Micromhos	Amp. Factor	Load Resistance Ohms	Power Output Watts	Type
				Volts	Amp.	In	Out	Plate-Grid												
12A5[8]	Pentode Power Amplifier	M.	7F	12.6 6.3	0.3 0.6	9.0	9.0	0.3	Class-A_1 Amp.[6]	100 180	−15 −25	100 180	3/6.5 8/14	17/19 45/48	50000 35000	1700 2400	— —	4500 3300	0.8 3.4	12A5
12A6	Beam Power Amplifier	O.	7AC	12.6	0.15	—	—	—	Class-A Amp.	250	−12.5	250	3.5	30	70000	3000	—	7500	3.4	12A6
12A7	Rectifier-Amplifier	M.	7K	12.6	0.3	—	—	—	Class-A Amp.	135	−13.5	135	2.5	9.0	102000	975	100	13500	0.55	12A7
12A8GT	Heptode	O.	8A	12.6	0.15	9.5	12	0.26	Converter	Characteristics same as 6A8—Table I										12A8GT
12AH7GT	Twin Triode	O.	8BE	12.6	0.15	Each Triode Sect.			Class-A Amp.	180	− 6.5	—	—	7.6	8400	1900	16	—	—	12AH7GT
12B6M	Diode Triode	O.	6Y	12.6	0.15	—	—	—	Class-A Amp.	250	− 2.0	—	—	0.9	91000	1100	100	—	—	12B6M
12B7ML	Pentode Amplifier	O.	8V	12.6	0.15	—	—	—	Class-A Amp.	250	− 3.0	100	2.6	9.2	800000	2000	—	—	—	12B7ML
12B8GT[8]	Triode-Pentode	O.	8T	12.6	0.3	Triode Section Pentode Section			Class-A Amp. Class-A Amp.	100 100	− 1 − 3	— 100	— 2	0.6 8	73000 170000	1500 2100	110 360	— —	— —	12B8GT
12C8	Duplex-Diode Pentode	O.	8E	12.6	0.15	6	9	.005	Class-A Amp.	Characteristics same as 6B8—Table I										12C8
12E5GT	Triode Amplifier	O.	6Q	12.6	0.15	3.4	5.5	2.60	Class-A Amp.	250	−13.5	—	—	50	—	1450	13.8	—	—	12E5GT
12F5GT	Triode Amplifier	O.	5M	12.6	0.15	1.9	3.4	2.40	Class-A Amp.	Characteristics same as 6SF5—Table I										12F5GT
12G7G	Duplex-Diode Triode	O.	7V	12.6	0.15	—	—	—	Class-A Amp.	250	− 3.0	—	—	—	58000	1200	70	—	—	12G7G
12H6	Twin Diode	O.	7Q	12.6	0.15	—	—	—	Rectifier	Characteristics same as 6H6—Table I										12H6
12J5GT	Triode Amplifier	O.	6Q	12.6	0.15	3.4	3.6	3.40	Class-A Amp.	Characteristics same as 6J5—Table I										12J5GT
12J7GT	Sharp Cut-off Pentode	O.	7R	12.6	0.15	4.2	5.0	3.8	Class-A Amp.	Characteristics same as 6J7—Table I										12J7GT
12K7GT	Remote Cut-off Pentode	O.	7R	12.6	0.15	4.6	12	.005	R.F. Amplifier	Characteristics same as 6K7—Table I										12K7GT
12K8	Triode Hexode Converter	O.	8K	12.6	0.15	—	—	—	Converter	Characteristics same as 6K8—Table I										12K8
12L8GT	Twin Pentode	O.	8BU	12.6	0.15	5	6	0.70	Class-A_1 Amp.	180	− 9.0	180	2.8	13.0	160000	2150	—	10000	1.0	12L8GT
12Q7GT	Duplex-Diode Triode	O.	7V	12.6	0.15	2.2	5	1.60	Class-A Amp.	Characteristics same as 6Q7—Table I										12Q7GT
12S8GT	Triple-Diode Triode	O.	8CB	12.6	0.15	2.0	3.8	1.2	Class-A Amp.	250	− 2.0	—	—	0.9	91000	1100	100	—	—	12S8GT
12SA7	Heptode	O.	8R	12.6	0.15	9.5	12	0.13	Converter	Characteristics same as 6SA7—Table I										12SA7
12SC7	Twin Triode	O.	8S	12.6	0.15	2.2	3.0	2.0	Class-A Amp.	Characteristics same as 6SC7—Table I										12SC7
12SF5	High-μ Triode	O.	6AB	12.6	0.15	4	3.6	2.40	Class-A Amp.	Characteristics same as 6SF5—Table I										12SF5
12SF7	Diode Variable-μ Pentode	O.	7AZ	12.6	0.15	5.5	6.0	.004	Class-A Amp.	Characteristics same as 6SF7—Table I										12SF7
12SG7	Medium Cut-off Pentode	O.	8BK	12.6	0.15	8.5	7.0	.003	Class-A Amp.	Characteristics same as 6SG7—Table I										12SG7
12SH7	Sharp Cut-off Pentode	O.	8BK	12.6	0.15	8.5	7.0	.003	H-F Amplifier	Characteristics same as 6SH7—Table I										12SH7
12SJ7	Sharp Cut-off Pentode	O.	8N	12.6	0.15	—	—	—	Class-A Amp.	Characteristics same as 6SJ7—Table I										12SJ7
12SK7	Remote Cut-off Pentode	O.	8N	12.6	0.15	6.0	7.0	.003	R.F. Amplifier	Characteristics same as 6SK7—Table I										12SK7
12SL7GT	Twin Triode	O.	8BD	12.6	0.15	—	—	—	Class-A Amp.	Characteristics same as 6SL7GT—Table II										12SL7GT
12SN7GT	Twin Triode	O.	8BD	12.6	0.3	—	—	—	Class-A Amp.	Characteristics same as 6SN7GT—Table II										12SN7GT
12SQ7	Duplex-Diode Triode	O.	8Q	12.6	0.15	3.2	3.0	1.60	Class-A Amp.	Characteristics same as 6SQ7—Table I										12SQ7
12SR7	Duplex-Diode Triode	O.	8Q	12.6	0.15	3.6	2.8	2.40	Class-A Amp.	Characteristics same as 6R7—Table I										12SR7
12SW7	Duplex-Diode Triode	O.	8Q	12.6	0.15	3.0	2.8	2.4	Class-A_1 Amp.	250	− 9	—	—	9.5	8500	1900	16	—	—	12SW7
12SX7	Twin Triode	O.	8BD	12.6	0.3	3.0	0.8	3.6	Class-A_1 Amp.[5]	250	− 8	—	—	9	7700	2600	20	—	—	12SX7
12SY7	Heptode Converter	O.	8R	12.6	0.15	Osc.-Grid leak 20000 ohms			Converter	250	− 2	100	8.5	3.5	1000000	450	—	—	—	12SY7
14A4	Triode Amplifier	L.	5AC	14	0.16	3.4	3.0	4.00	Class-A Amp.	Characteristics same as 7A4—Table III										14A4
14A5	Beam Power Amplifier	L.	6AA	14	0.16	—	—	—	Class-A_1 Amp.	250	−12.5	250	3.5/5.5	30/32	70000	3000	—	7500	2.8	14A5
14A7/12B7	Remote Cut-off Pentode	L.	8V	14	0.16	6.0	7.0	.005	Class-A Amp.	250	− 3.0	100	2.6	9.2	800000	2000	—	—	—	14A7/12B7
14AF7	Twin Triode	L.	8AC	14	0.16	2.2	1.6	2.30	Class-A Amp.	250	−10	—	—	9	7600	2100	16	—	—	14AF7
14B6	Duplex-Diode Triode	L.	8W	14	0.16	—	—	—	Class-A Amp.	Characteristics same as 7B6—Table III										14B6
14B8	Pentagrid Converter	L.	8X	14	0.16	Ic2 = 4 Ma.			Converter	Characteristics same as 7B8—Table III										14B8
14C5	Beam Power Amplifier	L.	6AA	14	0.24	—	—	—	Class-A Amp.	Characteristics same as 6V6—Table I										14C5

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TABLE IX—HIGH-VOLTAGE HEATER TUBES—*Continued*

Type	Name	Base	Socket Connections	Heater Volts	Heater Amp.	Capacitance μμfd. In	Capacitance μμfd. Out	Capacitance μμfd. Plate-Grid	Use	Plate Supply Volts	Grid Bias	Screen Volts	Screen Current Ma.	Plate Current Ma.	Plate Resistance Ohms	Transconductance Micromhos	Amp. Factor	Load Resistance Ohms	Power Output Watts	Type
14C7	R.F. Pentode	L.	8V	14	0.16	6.0	6.5	.007	Class-A Amp.	250	−3.0	100	0.7	2.2	1000000	1575	—	—	—	14C7
14E6	Duplex-Diode Triode	L.	8W	14	0.16	—	—	—	Class-A Amp.	Characteristics same as 7E6—Table III										14E6
14E7	Duplex-Diode Pentode	L.	8AE	14	0.16	4.6	5.3	.005	Class-A Amp.	Characteristics same as 7E7—Table III										14E7
14F7	Twin Triode	L.	8AC	14	0.16	—	—	—	Class-A Amp.	Characteristics same as 7F7—Table III										14F7
14F8	Twin Triode	L.	8BW	12.6	0.15	2.8	1.4	1.2	Class-A$_1$ Amp.	Characteristics same as 7F8										14F8
14H7	Semi-Variable-μ Pentode	L.	8V	14	0.16	8.0	7.0	.007	Class-A Amp.	250	−2.5	150	3.5	9.5	800000	3800	—	—	—	14H7
14J7	Triode-Hexode Converter	L.	8BL	14	0.16	Ipt=5 Ma.			Converter	Characteristics same as 7J7—Table III										14J7
14N7	Twin Triode	L.	8AC	14	0.32	—	—	—	Class-A Amp.	Characteristics same as 7N7—Table III										14N7
14Q7	Heptode Pentagrid Converter	L.	8AL	14	0.16	—	—	—	Converter	Characteristics same as 7Q7—Table III										14Q7
14R7	Duplex-Diode Pentode	L.	8AE	14	0.16	5.6	5.3	.004	Class-A Amp.	Characteristics same as 7R7—Table III										14R7
14S7	Triode Heptode	L.	8BL	14	0.16	Ipt=5 Ma.			Converter	250	−2.0	100	3	1.8	1250000	525	—	—	—	14S7
14V7	H.f. Pentode	L.	8V	14	0.24	—	—	—	Class-A Amp.	300	−2.0	150	3.9	9.6	300000	5800	—	—	—	14V7
14W7	Pentode	L.	8BJ	14	0.24	Rk=160 ohms			Class-A Amp.	300	−2.2	150	3.9	10	300000	5800	—	—	—	14W7
18	Pentode	M.	6B	14	0.30	—	—	—	Class-A Amp.	Characteristics same as 6F6G										18
19BG6G	Beam Power Amp.	O.	5BT	18.9	0.3	11	6.5	0.65	Deflection Amp.	400	Peak surge E_P=4000 V. Peak surge E_G=−100 V. I_{G2}=6 ma. I_P=70 ma.									19BG6G
20J8GM	Triode Heptode Converter	O.	8H	20	0.15	—	—	—	Converter	250	−3.0	100	3.4	1.5	Triode Plate (No. 6) 100 v. 1.5 ma.					20J8GM
21A7	Triode Hexode Converter	L.	8AR	21	0.16	—	—	—	Converter	250 150	−3.0 −3.0	100 Triode	2.8	1.3 3.5	— —	275 1900	— 32	— —	— —	21A7
25A6[8]	Pentode Power Amplifier	O.	7S	25	0.3	8.5	12.5	0.20	Class-A Amp.	135	−20.0	135	8	37	35000	2450	85	4000	2.0	25A6
25A7GT[8]	Rectifier Power Pentode	O.	8F	25	0.3	—	—	—	Class-A Amp.	100	−15.0	100	4	20.5	50000	1800	90	4500	0.77	25A7GT
25AC5GT[8]	Triode Power Amplifier	O.	6Q	25	0.3	—	—	—	Class-A Amp.	110 165	+15.0 Used in dynamic-coupled circuit with 6AF5G driver	—	—	45	—	3800	58	2000 3500	2.0 3.3	25AC5GT
25B5[8]	Direct-Coupled Triodes	S.	6D	25	0.3	—	—	—	Class-A Amp.	110	0	110	7	45	11400	2200	25	2000	2.0	25B5
25B6G[8]	Pentode Power Amplifier	O.	7S	25	0.3	—	—	—	Class-A Amp.	95	−15.0	95	4	45	—	4000	—	2000	1.75	25B6G
25B8GT[8]	Triode Pentode	O.	8T	25	0.15	—	—	—	Class-A Amp.		Characteristics same as 12B8GT									25B8GT
25BQ6GT	Beam Pentode	O.	6AM	25	0.3	—	—	—	Deflection Amp.	250	47*	150	2.1	45	—	5500	—	—	—	25BQ6GT
25C6G[8]	Beam Power Amplifier	O.	7AC	25	0.3	—	—	—	Class-A$_1$ Amp.	135	−13.5	135	3.5/11.5	58/60	9300	7000	—	2000	3.6	25C6G
25D8GT	Diode Triode Pentode	O.	8AF	25	0.15	—	—	—	Triode Amp. Pentode Amp.	100 100	−1.0 −3.0	— 100	— 2.7	0.5 8.5	91000 200000	1100 1900	100 —	— —	— —	25D8GT
25L6	Beam Power Amplifier	O.	7AC	25	0.3	16	13.5	0.30	Class-A$_1$ Amp.	110	−8.0	110	3.5/10.5	45/48	10000	8000	80	2000	2.2	25L6
25N6G[8]	Direct-Coupled Triodes	O.	7W	25	0.3	—	—	—	Class-A Amp.	110	0	110	7	45	11400	2200	25	2000	2.0	25N6G
26A7GT	Twin Beam-Power Audio Amplifier	O.	8BU	26.5	0.6	Each Unit Push-Pull			Class-A Amp. Class-AB Amp.[3]	26.5 26.5	−4.5 −7.0	26.5 26.5	2/5.5 2/8.5	20/20.5 19/30	2500 —	5500 —	— —	1500 2500[4]	0.2 0.5	26A7GT
32L7GT	Diode-Beam Tetrode	O.	8Z	32.5	0.3	—	—	—	Class-A Amp.	110	−7.5	110	3	40	15000	6000	—	2500	1.5	32L7GT
35A5	Beam Power Amplifier	L.	6AA	35	0.15	—	—	—	Class-A$_1$ Amp.	110	−7.5	110	3/7	40/41	14000	5800	—	2500	1.5	35A5
35L6G	Beam Power Amplifier	O.	7AC	35	0.15	13	9.5	0.80	Class-A$_1$ Amp.	110	−7.5	110	3/7	40/41	13800	5800	—	2500	1.5	35L6G
43	Pentode Power Amplifier	M.	6B	25	0.3	8.5	12.5	0.20	Class-A Amp.	95	−15.0	95	4.0	20.0	45000	2000	90	4500	0.90	43
48[8]	Tetrode Power Amplifier	M.	6A	30	0.4	—	—	—	Class-A Amp.	96	−19.0	96	9.0	52.0	—	3800	—	1500	2.0	48
50A5	Beam Power Amplifier	L.	6AA	50	0.15	—	—	—	Class-A$_1$ Amp.	110	−7.5	110	4/11	49/50	10000	8200	—	2000	2.2	50A5
50C6GT	Beam Power Amplifier	O.	7AC	50	0.15	—	—	—	Class-A$_1$ Amp.	135	−13.5	135	3.5/11.5	58/60	9300	7000	—	2000	3.6	50C6GT
50L6GT	Beam Power Amplifier	O.	7AC	50	0.15	—	—	—	Class-A Amp.	110	−7.5	110	4/11	49/50	—	8200	82	2000	2.2	50L6GT
70A7GT	Diode-Beam Tetrode	O.	8AB[1]	70	0.15	—	—	—	Class-A Amp.	110	−7.5	110	3.0	40	—	5800	80	2500	1.5	70A7GT
70L7GT	Diode-Beam Tetrode	O.	8AA	70	0.15	—	—	—	Class-A$_1$ Amp.	110	−7.5	110	3/6	40/43	15000	7500	—	2000	1.8	70L7GT
117L7GT/ 117M7GT	Rectifier-Amplifier	O.	8AO	117	0.09	—	—	—	Class-A Amp.	105	−5.2	105	4/5.5	43	17000	5300	—	4000	0.85	117L7GT/ 117M7GT
117N7GT	Rectifier-Amplifier	O.	8AV	117	0.09	—	—	—	Class-A Amp.	100	−6.0	100	5.0	51	16000	7000	—	3000	1.2	117N7GT
117P7GT	Rectifier-Amplifier	O.	8AV	117	0.09	—	—	—	Class-A Amp.	105	−5.2	105	4/5.5	43	17000	5300	—	4000	0.85	117P7GT

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TABLE IX—HIGH-VOLTAGE HEATER TUBES—*Continued*

Type	Name	Base	Socket Connections	Heater		Capacitance μμfd.			Use	Plate Supply Volts	Grid Bias	Screen Volts	Screen Current Ma.	Plate Current Ma.	Plate Resistance Ohms	Transconductance Micromhos	Amp. Factor	Load Resistance Ohms	Power Output Watts	Type
				Volts	Amp.	In	Out	Plate-Grid												
1280	Pentode	L.	8V	12.6	0.15	6.0	6.5	0.007	Class-A₁ Amp.	Same as 14C7 (Special Non-microphonic)										1280
1284	U.h.f. Pentode	L.	8V	12.6	0.15	5.0	6.0	0.01	Class-A Amp.	250	−3.0	100	2.5	9.0	800000	2000	—	—	—	1284
1629	Electron-Ray Tube	O.	6RA	12.6	0.15	—	—	—	Indicator Tube	Characteristics same as 6E5—Table IV										1629
1631	Beam Power Amplifier	O.	7AC	12.6	0.45	—	—	—	Class-A Amp.	Characteristics same as 6L6—Table I										1631
1632	Beam Power Amplifier	O.	7AC	12.6	0.6	—	—	—	Class-A Amp.	Characteristics same as 25L6										1632
1633	Twin Triode	O.	8BD	25	0.15	—	—	—	Class-A Amp.	Characteristics same as 6SN7GT—Table I										1633
1634	Twin Triode	O.	8S	12.6	0.15	—	—	—	Class-A Amp.	Characteristics same as 6SC7—Table I										1634
1644	Twin Pentode	O.	Fig. 7	12.6	0.15	—	—	—	Class-A Amp.	180	−9.0	180	2.8/4.6	13	160000	2150	—	10000	1.0	1644
XXD/ 14AF7	Twin Triode	L.	8AC	12.6	0.15	—	—	—	Class-A Amp.	250	−10	—	—	9.0	—	2100	16	—	—	XXD/ 14AF7
28D7	Double Beam Power Amplifier	L.	8BS	28.0	0.4	—	—	—	Class-A Amp.	28	390* 180*	28[2] 28[3]	0.7[2] 1.2[3]	9.0[2] 18.5[3]	— —	— —	— —	4000[4] 6000[4]	0.08[5] 0.175[6]	28D7

* Cathode resistor—ohms.
[1] 6.3-volt pilot lamp must be connected between Pins 6 and 7.
[2] Per section—resistance-coupled.
[3] P.p. operation—values for both sections.
[4] Plate to plate.
[5] Values are for each unit.
[6] Values are for single tube.
[7] Grids 2 and 3 connected to plate.
[8] Discontinued.

TABLE X—SPECIAL RECEIVING TUBES

Type	Name	Base	Socket Connections	Fil. or Heater		Capacitance μμfd.			Use	Plate Supply Volts	Grid Bias	Screen Volts	Screen Current Ma.	Plate Current Ma.	Plate Resistance Ohms	Transconductance Micromhos	Amp. Factor	Load Resistance Ohms	Power Output Watts	Type
				Volts	Amp.	In	Out	Plate-Grid												
00-A [7]	Triode Detector	M.	4D	5.0	0.25	3.2	2.0	8.50	Grid-Leak Det.	45	—	—	—	1.5	30000	666	20	—	—	00-A
01-A [7]	Triode Detector Amplifier	M.	4D	5.0	0.25	—	—	—	Class-A Amp.	135	−9.0	—	—	3.0	10000	800	8.0	—	—	01-A
3A8GT	Diode Triode Pentode	O.	8AS	1.4	0.1	2.6	4.2	2.0	Class-A Triode	90	0	—	—	0.15	240000	275	65	—	—	3A8GT
				2.8	0.05	3.0	10.0	0.012	Class-A Pentode	90	0	90	0.3	1.2	600000	750	—	—	—	
3B5GT	Beam Power Amplifier	O.	7AP	1.4 2.8	0.1 0.05	—	—	—	Class-A Amp.	67.5	−7.0	67.5	0.6 0.5	3.0 6.7	100000	1650 1500	—	5000	0.2 0.18	3B5GT
3C5GT	Power Output Pentode	O.	7AQ	1.4 2.8	0.1 0.05	—	—	—	Class-A Amp.	90	−9.0	90	1.4	6.0	—	1550 1450	—	8000 10000	0.24 0.26	3C5GT
3C6	Twin Triode	L.	7BW	1.4 2.8	0.1 0.05	—	—	—	Class-A Amp.	90	0	—	—	4.5	11200	1300	14.5	—	—	3C6
3LE4	Power Amplifier Pentode	L.	6BA	2.8	0.05	—	—	—	Class-A Amp.	90	−9.0	90	1.8	9.0	110000	1600	—	6000	0.30	3LE4
3LF4	Power Amplifier Tetrode	L.	6BB	1.4 2.8	0.1 0.05	—	—	—	Class-A Amp.	90	−4.5	90	1.3 1.0	9.5 8.0	75000 80000	2200 2000	—	8000 7000	0.27 0.23	3LF4
3Q5GT	Beam Power Amplifier	O.	7AQ	1.4 2.8	0.1 0.05	Parallel Filaments Series Filaments			Class-A Amp.	90	−4.5	90	1.3 1.0	9.5 7.5	—	2100 1900	—	8000	0.27 0.25	3Q5GT
4A6G	Twin Triode Amplifier	O.	8L	4	0.06	Triodes Parallel			Class-A Amp.	90	−1.5	—	—	2.2	13300	1500	20	—	—	4A6G
				2	0.12	Both Sections			Class-B Amp.	90	0	—	—	4.6	—	—	—	3000	1.0	
6F4	Acorn Triode	A.	7BR	6.3	0.225	2.0	0.6	1.90	Class-A Amp.	80	150*	—	—	13.0	2900	5800	17	—	—	6F4
6L4	U.H.F. Triode	A.	7BR	6.3	0.225	1.3	0.5	1.6	Class-A₁ Amp.	80	150*	—	—	9.5	4400	6400	28	—	—	6L4
10	Triode Power Amplifier	M.	4D	7.5	1.25	4.0	3.0	7.00	Class-A Amp.	425	−39.0	—	—	18.0	5000	1600	8.0	10200	1.6	10
11/12 [7]	Triode Detector Amplifier	M.	4F/4D	1.1	0.25	—	—	—	Class-A Amp.	135	−10.5	—	—	3.0	15000	440	6.6	—	—	11/12
20 [7]	Triode Power Amplifier	S.	4D	3.3	0.132	2.0	2.3	4.10	Class-A Amp.	135	−22.5	—	—	6.5	6300	525	3.3	6500	0.11	20
22 [7]	Tetrode R.F. Amplifier	M.	4K	3.3	0.132	3.5	10	0.02	Class-A Amp.	135	−1.5	67.5	1.3	3.7	325000	500	160	—	—	22
26	Triode Amplifier	M.	4D	1.5	1.05	2.8	2.5	8.10	Class-A Amp.	180	−14.5	—	—	6.2	7300	1150	8.3	—	—	26
40 [7]	Triode Voltage Amplifier	M.	4D	5.0	0.25	2.8	2.2	2.00	Class-A Amp.	180	−3.0	—	—	0.2	150000	200	30	—	—	40
50	Triode Power Amplifier	M.	4D	7.5	1.25	4.2	3.4	7.10	Class-A Amp.	450	−84.0	—	—	55.0	1800	2100	3.8	4350	4.6	50

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TABLE X—SPECIAL RECEIVING TUBES—*Continued*

Type	Name	Base	Socket Connections	Fil. or Heater		Capacitance $\mu\mu$fd.			Use	Plate Supply Volts	Grid Bias	Screen Volts	Screen Current Ma.	Plate Current Ma.	Plate Resistance Ohms	Transconductance Micromhos	Amp. Factor	Load Resistance Ohms	Power Output Watts	Type
				Volts	Amp.	In	Out	Plate-Grid												
71-A	Triode Power Amplifier	M.	4D	5.0	0.25	3.2	2.9	7.50	Class-A Amp.	180	−43.0	—	—	20.0	1750	1700	3.0	4800	0.79	71-A
99[6]	Triode Detector Amplifier	S.	4D	3.3	0.063	2.5	2.5	3.30	Class-A Amp.	90	− 4.5	—	—	2.5	15500	425	6.6	—	—	99
112A[7]	Triode Detector Amplifier	M.	4D	5.0	0.25	—	—	—	Class-A Amp.	180	−13.5	—	—	7.7	4700	1800	8.5	—	—	112A
182B/ 482B	Triode Amplifier	M.	4D	5.0	1.25	—	—	—	Class-A Amp.	250	−35.0	—	—	18.0	—	1500	5.0	—	—	182B/ 482B
183/483[7]	Power Triode	M.	4D	5.0	1.25	—	—	—	Class-A Amp.	250	−60.0	—	—	25.0	18000	1800	3.2	4500	2.0	183/483
485[7]	Triode	S.	5A	3.0	1.3	—	—	—	Class-A Amp.	180	− 9.0	—	—	6.0	9300	1350	12.5	—	—	485
864	Triode Amplifier	S.	4D	1.1	0.25	—	—	—	Class-A Amp.	90	− 4.5	—	—	2.9	13500	610	8.2	—	—	864
954	Pentode Detector, Amplifier	A.	5BB	6.3	0.15	3.4	3.0	0.007	Class-A Amp.	250	− 3.0	100	0.7	2.0	1.5 meg.	1400	2000	—	—	954
									Bias Detector	250	− 6.0	100	—	Plate current to be adjusted to 0.1 ma. with no signal					—	
955	Triode Detector, Amplifier, Oscillator	A.	5BC	6.3	0.15	1.0	0.6	1.40	Class-A Amp.	250	− 7.0	—	—	6.3	11400	2200	25	—	—	955
										90	− 2.5	—	—	2.5	14700	1700	25	—	—	
956	Variable-μ Pentode R.F. Amplifier	A.	5BB	6.3	0.15	3.4	3.0	0.007	Class-A Amp.	250	− 3.0	100	2.7	6.7	700000	1800	1440	—	—	956
									Mixer	250	−10.0	100	—	—	Oscillator peak volts—7 min.					
957	Triode Detector, Amplifier, Oscillator	A.	5BD	1.25	0.05	0.3	0.7	1.20	Class-A Amp.	135	− 5.0	—	—	2.0	20800	650	13.5	—	—	957
958 958-A	Triode A.F. Amplifier, Oscillator	A.	5BD	1.25	0.1	0.6	0.8	2.60	Class-A Amp.	135	− 7.5	—	—	3.0	10000	1200	12	—	—	958 958-A
959	Pentode Detector, Amplifier	A.	5BE	1.25	0.05	1.8	2.5	0.015	Class-A Amp.	145	− 3.0	67.5	0.4	1.7	800000	600	480	—	—	959
7E5/1201	U.h.f. Triode	L.	8BN	6.3	0.15	3.6	2.8	1.50	Class-A Amp.	180	− 3	—	—	5.5	12000	—	36	—	—	7E5/1201
7C4/1203	U.h.f. Diode	L.	4AH	6.3	0.15	—	—	—	Rectifier		Max. r.m.s. voltage—150				Max. d.c. output current—8 ma.					7C4/1203
7AB7/ 1204	Sharp Cut-off Pentode	L.	8BO	6.3	0.15	3.5	4.0	0.06	Class-A Amp.	250	− 2	100	0.6	1.75	800000	1200	—	—	—	7AB7/ 1204
1276	Triode Power Amplifier	M.	4D	4.5	1.14	—	—	—	Class-A Amp.				Characteristics similar to 6A3							1276
1609	Pentode Amplifier	S.	5B	1.1	0.25	—	—	—	Class-A Amp.	135	− 1.5	67.5	0.65	2.5	400000	725	300	—	—	1609
9004	U.h.f. Diode	A.	4BJ	6.3	0.15	—	—	—	Detector			Max. a.c. voltage—117. Max. d.c. output current—5 ma.								9004
9005	U.h.f. Diode	A.	5BG	3.6	0.165	—	—	—	Detector			Max. a.c. voltage—117. Max. d.c. output current—1 ma.								9005
EF-50	Sharp Cut-off Pentode	L.	9C	6.3	0.3	8	5	0.007	I.F.-R.F. Amp.	250	150*	250	3.1	10	600000	6300	—	—	—	EF-50
GL-2C44 GL-464A	U.h.f. Triode	O.	Fig. 17	6.3	0.75	—	—	—	Class-A Amp. and Modulator	250	100*	—	—	25.0	—	7000	—	—	—	GL-2C44 GL-464A
GL-446A GL-446B	U.h.f. Triode	O.	Fig. 19	6.3	0.75	—	—	—	Oscillator, Amp. or Converter	250	200*	—	—	15.0	—	4500	45	—	—	GL-446A GL-446B
559 GL-559	U.h.f. Diode	O.	Fig. 18	6.3	0.75	—	—	—	Detector or trans. line switch	5.0	—	—	—	24.0	—	—	—	—	—	559 GL-559
NU-2C35	Special Hi-Mu Triode	O.	Fig. 38	6.3	0.3	5.2	2.3	0.62	Shunt Voltage Regulator	8000	−200	—	—	5.0	525000	950	500	—	—	NU-2C35
VT52	Triode	M.	4D	7.0	1.18	5.0	3.0	7.7	Class-A$_1$ Amp.	220	−43.5	—	—	29.0	1650	2300	3.8	3800	1.0	VT52
X6030	Diode	L.	Fig. 4	3.0	0.6	—	—	—	Noise Diode	90	—	—	—	4.0	—	—	—	—	—	X6030

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TABLE X—SPECIAL RECEIVING TUBES—*Continued*

Type	Name	Base	Socket Connections	Fil. or Heater Volts	Fil. or Heater Amp.	Capacitance μμfd. In	Capacitance μμfd. Out	Capacitance μμfd. Plate-Grid	Use	Plate Supply Volts	Grid Bias	Screen Volts	Screen Current Ma.	Plate Current Ma.	Plate Resistance Ohms	Transconductance Micromhos	Amp. Factor	Load Resistance Ohms	Power Output Watts	Type
XXB	Twin-Triode Frequency Converter	L.	Fig. 9	2.8/ 1.4 3.2[3]/ 1.6	0.05/ 0.10 — —	—	—	—	Converter[2]	90[1]	0	—	—	4.5[4] 4.5[5]	11200[4] 11200[5]	1300[4] 1300[5]	14.5[1]	—	—	XXB
											− 3	—	—	1.4[4] 1.4[5]	1900[4] 1900[5]	760[4] 760[5]	14.5[1]	—	—	
XXFM	Twin-Diode Triode	L.	8BZ	6.3	0.3	—	—	—	Class-A Amp.	250	− 1	—	—	1.9	6700	1500	100	—	—	XXFM
										100	0	—	—	1.2	85000	1000	85	—	—	

* Cathode resistor—ohms.
[1] Both sections.
[2] Section No. 2 recommended for h.f.o.
[3] Dry battery operation.
[4] Section No. 1.
[5] Section No. 2.
[6] Same as X99. Type V99 is same, but socket connections are 4E.
[7] Discontinued.

TABLE XI—MINIATURE RECEIVING TUBES

Other miniature types in Tables XIII and XV

Type	Name	Base	Socket Connections	Fil. or Heater Volts	Fil. or Heater Amp.	Capacitance μμfd. In	Capacitance μμfd. Out	Capacitance μμfd. Plate-Grid	Use	Plate Supply Volts	Grid Bias	Screen Volts	Screen Current Ma.	Plate Current Ma.	Plate Resistance Ohms	Transconductance Micromhos	Amp. Factor [4]	Load Resistance Ohms	Power Output Watts	Prototype
1A3	H. F. Diode	B.	5AP	1.4	0.15	—	—	—	Detector F.M. Discrim.		Max. a.c. voltage per plate—117. Max. output current—0.5 ma.									—
1L4	Sharp Cut-off Pentode	B.	6AR	1.4	0.05	3.6	7.5	.008	Class-A Amp.	90	0	90	2.0	4.5	350000	1025	—	—	—	1N5GT
1R5	Pentagrid Converter	B.	7AT	1.4	0.05	—	—	—	Converter	90	0	67.5	3.0	1.7	500000	300	Grid No. 1 100000 ohms			1A7GT
1S4	Pentagrid Power Amp.	B.	7AV	1.4	0.1	—	—	—	Class-A Amp.	90	− 7.0	67.5	1.4	7.4	100000	1575	—	8000	0.270	1Q5GT
1S5	Diode Pentode	B.	6AU	1.4	0.05	—	—	—	Class-A Amp.	67.5	0	67.5	0.4	1.6	600000	625	—	—	—	—
									R-Coupled Amp.	90	0	90	Screen resistor 3 meg., grid 10 meg.					1 meg.	0.050	
1T4	Variable-μ Pentode	B.	6AR	1.4	0.05	3.6	7.5	0.01	Class-A Amp.	90	0	67.5	1.4	3.5	500000	900	—	—	—	1P5GT
1U4	Sharp Cut-off Pentode	B.	6AR	1.4	0.05	3.6	7.5	0.01	Class-A Amp.	90	0	90	0.5	1.6	1500000	900	—	—	—	1N5GT
1U5	Diode Pentode	B.	6BW	1.4	0.05	—	—	—	Class-A Amp.	67.5	0	67.5	0.4	1.6	600000	625	—	—	—	—
2C51	Twin Triode	B.	8CJ	6.3	0.3	2.2	1.0	1.3	Class-A_1 Amp.	150	− 2	—	—	8.2[1]	—	5500	35	—	—	7F8
2E30	Beam Power Pentode	B.	7CQ	6.0	0.7	10	4.5	0.5	Class-A_1 Single	250	450*	250	7.4[2]	44[2]	63000	3700	40[5]	4500	4.5	—
									Class-A_1 Amp.[3]	250	225*	250	14.8[2]	88[2]	—	—	80[5]	9000[6]	9	
									Class-AB_1 Amp.[3]	250	−25	250	13.5[2]	80[2]	—	—	48[5]	8000[6]	12.5	
									Class-AB_2 Amp.[3]	250	−30	250	20[2]	120[2]	—	—	40[5]	3800[6]	17	
3A4	Power Amplifier Pentode	B.	7BB	1.4 2.8	0.2 0.1	4.8	4.2	0.34	Class-A_1 Amp.	135 150	− 7.5 − 8.4	90 90	2.6 2.2	14.9[2] 14.1[2]	90000 100000	1900	—	8000	0.6 0.7	—
3A5	H.F. Twin Triode	B.	7BC	1.4 2.8	0.22 0.11	0.9	1.0	3.20	Class-A Amp.	90	− 2.5	—	—	3.7	8300	1800	15	—	—	—
3Q4	Power Amplifier Pentode	B.	7BA	1.4 2.8	0.1 0.05	Parallel Filaments Series Filaments			Class-A Amp.	90	− 4.5	90	2.1 1.7	9.5 7.7	100000 120000	2150 2000	—	10000	0.27 0.24	3Q5GT
3S4	Power Amplifier Pentode	B.	7BA	1.4 2.8	0.1 0.05	Parallel Filaments Series Filaments			Class-A Amp.	90	− 7.0	67.5	1.4 1.1	7.4 6.1	100000	1575 1425	—	8000	0.27 0.235	3Q5GT
3V4	Power Amplifier Pentode	B.	6BX	1.4	0.1	Parallel Filaments			Class-A Amp.	90	− 4.5	90	2.1	9.5	100000	2150	—	10000	0.27	3Q5GT
				2.8	0.05	Series Filaments			Class-A Amp.	90	− 4.5	90	1.7	7.7	120000	2000	—	10000	0.24	
6AB4	Triode R.F. Amp.	B.	5CE	6.3	0.15	2.2	0.5	1.5	Class-A Amp.	250	− 2	—	—	10	—	5500	55	—	—	Single unit 12AT7
6AG5	Sharp Cut-off Pentode	B.	7BD	6.3	0.3	—	—	—	Class-A Amp.	250 100	200* 100*	150 100	2.0 1.6	7.0 5.5	800000 300000	5000 4750	— —	— —	—	6SH7GT
6AH6	Sharp Cut-off Pentode	B.	7CC	6.3	0.45	10	2	0.03	Pentode Amp.	300	160*	150	2.5	10	500000	9000	—	—	—	6AC7
									Triode Amp.[7]	150	160*	—	—	12.5	3600	11000	40	—	—	
6AJ5	Sharp Cut-off Pentode	B.	7PM	6.3	0.175	—	—	—	R.F. Amplifier	28	200*	28	1.2	3.0	90000	2750	250	—	—	—
									Class-AB Amp.[3]	180	− 7.5	75	—	—	—	—	—	28000[6]	1.0	
6AK5	Sharp Cut-off Pentode	B.	7BD	6.3	0.175	4.3	2.1	0.03	R.F. Amplifier	180	200*	120	2.4	7.7	690000	5100	3500	—	—	—
										150	330*	140	2.2	7.0	420000	4300	1800	—	—	
										120	200*	120	2.5	7.5	340000	5000	1700	—	—	

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TABLE XI—MINIATURE RECEIVING TUBES—*Continued*

Type	Name	Base	Socket Connections[1]	Fil. or Heater Volts	Fil. or Heater Amp.	Capacitance μμfd. In	Capacitance μμfd. Out	Capacitance μμfd. Plate-Grid	Use	Plate Supply Volts	Grid Bias	Screen Volts	Screen Current Ma.	Plate Current Ma.	Plate Resistance Ohms	Transconductance Micromhos	Amp. Factor[4]	Load Resistance Ohms	Power Output Watts	Prototype
6AK6	Power Amplifier Pentode	B.	7BK	6.3	0.15	3.6	4.2	0.12	Class-A Amp.	180	− 9.0	180	2.5	15.0	200000	2300	—	10000	1.1	—
6AL5	U.h.f. Twin Diode	B.	6BT	6.3	0.3	—	—	—	Detector		Max. r.m.s. voltage—150. Max. d.c. output current—10 ma.[1]									6H6GT
6AN5	Power Amp. Pentode	B.	7BD	6.3	0.5	9.0	4.8	0.05	Class-A_1 Amp.	120	− 6	120	12	35	12500	8000	—	—	—	6AG7
6AN6	Twin Diode	B.	7BJ	6.3	0.2	—	—	—	Detector	R.m.s. voltage per plate = 75 volts; d.c. output = 3.5 ma. with 25000 ohms and 8 μμfd. load; peak current per plate = 10 ma.; peak inverse voltage = 210.										—
6AQ5	Beam Power Tetrode	B.	7BZ	6.3	0.45	7.6	6.0	0.35	Class-A_1 Amp.	180	− 8.5	180	4.0[2]	30[2]	58000	3700	29[5]	5500	2.0	6V6GT
										250	−12.5	250	7.0[2]	47[2]	52000	4100	45[5]	5000	4.5	
6AQ6	Duodiode Hi-mu Triode	B.	7BT	6.3	0.15	1.7	1.5	1.80	Class-A Triode	250	− 3.0	—	—	1.0	58000	1200	70	—	—	6T7G
										100	− 1.0	—	—	0.8	61000	1150	70	—	—	
6AR5	Pentode Power Amp.	B.	6CC	6.3	0.4	—	—	—	Class-A_1 Amp.	250	−18	250	5.5[2]	33[2]	68000	2300	—	7600	3.4	6K6GT
										250	−16.5	250	5.5[2]	35[2]	65000	2400	—	7000	3.2	
6AS5	Beam Pentode	B.	7CV	6.3	0.8	12	6.2	0.6	Class-A_1 Amp.	150	− 8.5	110	2/6.5	35/36	—	5600		4500	2.2	—
6AS6	Sharp Cut-off Pentode	B.	7CM	6.3	0.175	4.0	3.0	0.02	Class-A Amp.	120	− 2	120	3.5	5.5	—	3500	—	—	—	—
6AT6	Duplex Diode Triode	B.	7BT	6.3	0.3	2.3	1.1	2.10	Class-A Amp.	250	− 3	—	—	1.0	58000	1200	70	—	—	6Q7GT
6AU6	Sharp Cut-off Pentode	B.	7BK	6.3	0.3	5.5	5.0	.0035	Class-A Amp.	250	− 1	150	4.3	10.8	2000000	5200	—	—	—	6SH7GT
6AV6	Duodiode Hi-mu Triode	B.	7BT	6.3	0.3	—	—	—	Class-A_1 Amp.	250	− 2	—	—	1.2	62500	1600	100	—	—	6SQ7GT
6BA6	Remote Cut-off Pentode	B.	7CC	6.3	0.3	5.5	5.0	.0035	Class-A Amp.	250	68*	100	4.2	11	1500000	4400	—	—	—	6SG7GT
6BA7	Pentagrid Converter	B.	8CT	6.3	0.3	9.5	8.3	—	Converter	250	− 1	100	10	3.8	1000000	3.5	—	—	—	6SB7Y
6BD6	Remote Cut-off Pentode	B.	7CC	6.3	0.3	—	—	—	Class-A Amp.	100	− 1	100	5	13	120000	2350	—	—	—	6SK7GT
										250	− 3	100	3.5	9	700000	2000	—	—	—	
6BE6	Pentagrid Converter	B.	7CH	6.3	0.3	Osc. Grid 50000 Ω			Converter	250	− 1.5	100	7.8	3.0	1000000	475	—	—	—	6SA7GT
6BF6	Duplex-Diode Triode	B.	7BT	6.3	0.3	1.8	1.1	2.0	Class-A_1 Amp.	250	− 9	—	—	9.5	8500	1900	16	10000	—	6SR7GT
6BH6	Sharp Cut-off Pentode	B.	7CM	6.3	0.15	5.4	4.4	0.0035	Class-A_1 Amp.	250	− 1	150	2.9	7.4	1400000	4600	—	—	—	—
6BJ6	Remote Cut-off Pentode	B.	7CM	6.3	0.15	4.5	5.0	.0035	Class-A_1 Amp.	250	− 1	100	3.3	9.2	1300000	3800	—	—	—	6SS7GT
6C4	Triode Amplifier	B.	6BG	6.3	0.15	1.8	1.3	1.60	Class-A_1 Amp.	250	− 8.5	—	—	10.5	7700	2200	17	—	—	6J5GT
6J4	U.h.f. Grounded-Grid R.F. Amplifier	B.	7BQ	6.3	0.4	5.5	0.24	4.0	Grounded-Grid	150	200*	—	—	15.0	4500	12000	55	—	—	—
									Class-A_1 Amp.	100	100*	—	—	10.0	5000	11000	55	—	—	
6J6	Twin Triode	B.	7BF	6.3	0.45	2.2	0.4	1.6	Class-A_1 Amp. Mixer, Oscillator	100	50*	—	—	8.5	7100	5300	38	—	—	—
6N4	U.h.f. Triode Amplifier	B.	7CA	6.3	0.2	3.0	1.6	1.10	Class-A Amp.	180	− 3.5	—	—	12.0	—	6000	32	—	—	—
6T8	Triple-Diode Triode	B.	9E	6.3	0.45	1.5	1.1	2.4	Class-A_1 Amp.	250	− 3	—	—	1.0	5800	1200	70	—	—	—
										100	− 1	—	—	0.8	5400	1300	70	—	—	
12AL5	Twin Diode	B.	6BT	12.6	0.15	2.5	—	—	Detector		R.m.s. voltage per plate = 117; d.c. output = 9 ma. per plate; peak ma. per plate = 54; peak inverse voltage = 330.									12H6GT
12AT6	Duplex Diode Triode	B.	7BT	12.6	0.15	2.3	1.1	2.10	Class-A Amp.	250	− 3.0	—	—	1.0	58000	1200	70	—	—	12Q7GT
12AT7	Double Triode	B.	9A	6.3	0.3	2.5[7]	0.45[7]	1.45[7]	Class-A_1 Amp.	250	− 2	—	—	10	10000	5500	55	—	—	—
				12.6	0.15	2.5[8]	0.35[8]	1.45[8]	Each Unit	180	− 1	—	—	11	9400	6600	62	—	—	
12AU6	Sharp Cut-off Pentode	B.	7CC	12.6	0.15	5.5	5.0	.0035	Class-A_1 Amp.	250	− 1.0	150	4.3	10.8	1 meg.	5200	—	—	—	12SH7GT
12AU7	Twin-Triode Amplifier	B.	9A	6.3	0.3	1.6[7]	0.5[7]	1.5[7]	Class-A_1 Amp.	250	− 8.5	—	—	10.5	7700	2200	17	—	—	12SN7GT
				12.6	0.15	1.6[8]	0.35[8]	1.5[8]												
12AV6	Duodiode Hi-mu Triode	B.	7BT	12.6	0.15	—	—	—	Class-A_1 Amp.	250	− 2	—	—	1.2	62500	1600	100	—	—	—
12AW6	Sharp Cut-off Pentode	B.	7CM	12.6	0.15	6.5	1.5	0.025	Pentode Amp.	250	200*	150	2.0	7.0	800000	5000	—	—	—	—
									Triode Amp.[9]	250	825*	—	—	5.5	11000	3800	42	—	—	
12AW7	Sharp Cut-off Pentode	B.	7CM	12.6	0.15	6.5	1.5	0.025	Class-A_1 Amp.	250	200*	150	2.0	7.0	0.8 meg.	5000	—	—	—	—
12AX7	Double Triode	B.	9A	12.6	0.15	1.6[7]	0.46[7]	1.7[7]	Class-A_1 Amp.	250	− 2	—	—	1.2[7]	62500	1600	100	—	—	—
				6.3	0.3	1.6[8]	0.34[8]	1.7[8]		100	− 1	—	—	0.5[8]	8000	1250	100	—	—	
12AY7	Dual Triode	B.	9A	12.6 6.3	0.15 0.3	1.3	0.6	1.3	Class-A Amp.	250	− 4	—	—	3	—	1750	40	—	—	—
									Lo-Level Amp.	150	2700*	Plate resistor = 20000 Ω. Grid resistor = 0.1 Meg. V.G. = 12.5								
12BA6	Remote Cut-off Pentode	B.	7CC	12.6	0.15	5.5	5.0	.0035	Class-A Amp.	250	68*	100	4.2	11.0	1500000	4400	—	—	—	12SG7G

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TABLE XI — MINIATURE RECEIVING TUBES — *Continued*

Type	Name	Base	Socket Connections[1]	Fil. or Heater Volts	Fil. or Heater Amp.	Capacitance $\mu\mu$fd. In	Capacitance $\mu\mu$fd. Out	Capacitance $\mu\mu$fd. Plate-Grid	Use	Plate Supply Volts	Grid Bias	Screen Volts	Screen Current Ma.	Plate Current Ma.	Plate Resistance Ohms	Transconductance Micromhos	Amp. Factor	Load Resistance Ohms	Power Output Watts	Prototype
12BA7	Pentagrid Converter	B.	8CT	12.6	0.15	9.5	8.3	—	Converter	250	−1	100	10	3.8	1000000	3.5	—	—	—	—
12BD6	Remote Cut-off Pentode	B.	7CC	12.6	0.15	4.3	5.0	.004	Class-A Amp.	250	−3	100	3.5	9.0	700000	2000	—	—	—	12SK7GT
12BE6	Pentagrid Converter	B.	7CH	12.6	0.15	Osc. Grid 50000 Ω			Converter	250	−1.5	100	7.8	3.0	1000000	475	—	—	—	12SA7GT
12BF6	Duodiode Triode	B.	7BT	12.6	0.15	1.8	1.1	2.00	Class-A Amp.	250	−9	—	—	9.5	8500	1900	16	—	—	12SR7GT
19J6	Twin Triode	B.	7BF	18.9	0.15	2.0	0.4	1.5	Class-A$_1$ Amp.	100	50*	—	—	8.5[1]	7100	5300	38	—	—	—
19T8	Triple-Diode Triode	B.	9E	18.9	0.15	1.5	1.1	2.4	Class-A$_1$ Amp.	250	−3	—	—	1.0	5800	1200	70	—	—	—
26A6	Remote Cut-off Pentode	B.	7BK	26.5	0.07	6.0	5.0	.0035	Class-A$_1$ Amp.	250	125*	100	4	10.5	1000000	4000	—	—	—	—
26C6	Duplex-Diode Triode	B.	7BT	26.5	0.07	1.8	1.4	2	Class-A$_1$ Amp.	250	−9	—	—	9.5	8500	1900	16	—	—	—
26D6	Pentagrid Converter	B.	7CH	26.5	0.07	Osc. Grid 20000 Ω			Converter	250	−1.5	100	7.8	3.0	1000000	475	—	—	—	—
35B5	Beam Power Amplifier	B.	7BZ	35	0.15	11	6.5	0.4	Class-A$_1$ Amp.	110	−7.5	110	7[2]	41[2]	—	5800	40[4]	2500	1.5	35L6GT
35C5	Beam Power Amplifier	B.	7CV	35	0.15	12	6.2	0.57	Class-A$_1$ Amp.	110	−7.5	110	3/7	40/41	—	5800		2500	1.5	—
50B5	Beam Power Amplifier	B.	7BZ	50	0.15	13	6.5	0.50	Class-A Amp.	110	−7.5	110	4.0	49.0	14000	7500	—	3000	1.9	50L6GT
50C5	Beam Power Amplifier	B.	7CV	50	0.15	—	—	—	Class-A$_1$ Amp.	110	−7.5	110	4/8.5	49/50	10000	7500	—	2500	1.9	—
5590	Pentode	B.	7BD	6.3	0.15	3.4	2.9	0.01	Class-A$_1$ Amp.	90	820*	90	1.4	3.9	300000	2000	—	—	—	—
5591	R.F. Pentode	B.	7BD	6.3	0.15	3.9	2.85	0.01	Class-A$_1$ Amp.	180	200*	120	2.4	1.7	690000	5100	3500	—	—	—
5654	Sharp Cut-off Pentode	B.	7BD	6.3	0.175	4	2.9	0.02	Class-A$_1$ Amp.	120	200*	120	2.5	7.5	340000	5000	—	—	—	—
5687	Dual Triode	B.	9H	12.6	0.45	4	0.45	3.1	Class-A Amp.	250	12.5	—	—	16	4000	4100	16.5	—	—	—
				6.3	0.9					120	2	—	—	34	2000	10000	20	—	—	
5722	Noise Generating Diode	B.	5CB	2/5.5	1.6	—	1.5	—	Noise Generator	200	—	—	—	35	—	—	—	—	—	—
9001	Sharp Cut-off Pentode	B.	7PM	6.3	0.15	3.6	3.0	0.01	Class-A Amp.	250	−3.0	100	0.7	2.0	1 meg.	1400	—	—	—	—
									Mixer	250	−5.0	100	Osc. peak voltage 4 volts			550	—	—	—	
9002	Triode Detector, Amplifier, Oscillator	B.	7TM	6.3	0.15	1.2	1.1	1.40	Class-A Amp.	250	7.0	—	—	6.3	11400	2200	25	—	—	—
										90	2.5	—	—	2.5	14700	1700	25	—	—	
9003	Remote Cut-off Pentode	B.	7PM	6.3	0.15	3.6	3.0	0.01	Class-A Amp.	250	−3.0	100	2.7	6.7	700000	1800	—	—	—	—
									Mixer	250	10.0	100	Osc. peak voltage 9 volts			600	—	—	—	
9006	U.h.f. Diode	B.	6BH	6.3	0.15	—	—	—	Detector	Max. a.c. voltage—270. Max. d.c. output current—5 ma.										—

* Cathode resistor—ohms.

[1] Per Plate.
[2] Maximum-signal current for full-power output.
[3] Values are for two tubes in push-pull.
[4] Also no-signal plate ma. when so indicated.
[5] No signal plate ma.
[6] Effective plate-to-plate.
[7] Triode No. 1.
[8] Triode No. 2.
[9] Grid No. 2 tied to plate and No. 3 to cathode.

TABLE XII — SUB-MINIATURE TUBES

Type	Name	Base	Socket Connections	Fil. or Heater Volts	Fil. or Heater Amp.	Capacitance $\mu\mu$fd. In	Capacitance $\mu\mu$fd. Out	Capacitance $\mu\mu$fd. Plate-Grid	Use	Plate Supply Volts	Grid Bias	Screen Volts	Screen Current Ma.	Plate Current Ma.	Plate Resistance Ohms	Transconductance Micromhos	Amp. Factor	Load Resistance Ohms	Power Output Watts	Type
1AC5	Power Pentode	Bs.	Fig. 14	1.25	0.04	—	—	—	Class-A$_1$ Amp.	67.5	−4.5	67.5	0.4	2.0	150000	750	—	25000	0.05	1AC5
1AD5	Sharp Cut-off Pentode	Bs.	Fig. 16	1.25	0.04	1.8	2.8	0.01	Class-A$_1$ Amp.	67.5	0	67.5	0.75	1.85	700000	735	—	—	—	1AD5
1C8	Heptode	—	—	1.25	0.04	6.5	4.0	0.25	Converter	30	0	30	0.75	0.32	300000	100	—	—	—	1C8
1E8	Pentagrid Converter	Bs.	Fig. 27	1.25	0.04	6	—	—	Converter	67.5	0	67.5	1.5	1.0	—	150	—	—	—	1E8
1T6	Diode-Pentode	Bs.	Fig. 28	1.25	0.04	—	—	—	Class-A$_1$ Amp.	67.5	0	67.5	0.4	1.6	400000	600	—	—	—	1T6
1V5	Audio Pentode	[1]	[2]	1.25	0.04	—	—	—	Class-A$_1$ Amp.	67.5	−4.5	67.5	0.4	2.0	150000	750	—	25000	0.05	1V5
1W5	Sharp Cut-off Pentode	[1]	[2]	1.25	0.04	2.3	3.5	0.01	Class-A$_1$ Amp.	67.5	0	67.5	0.75	1.85	700000	735	—	—	—	1W5
2E31	R.F. Pentode	[1]	[2]	1.25	0.05				Class-A$_1$ Amp.	22.5	0	22.5	0.3	0.4	—	500	—	—	—	2E31
2E32	R.F. Pentode	[1]	[2]	1.25	0.05				Class-A Amp.	22.5	0	22.5	0.3	0.4	350000	500	—	—	—	2E32
2E35	Audio Pentode	[1]	[2]	1.25	0.03				Class-A$_1$ Amp.	22.5	0	22.5	0.07	0.27	—	385	—	—	0.0012	2E35
2E36	Audio Pentode	[1]	[2]	1.25	0.03				Class-A$_1$ Amp.	22.5	0	22.5	0.07	0.27	220000	385	—	150000	0.0012	2E36
										45	−1.25	45	0.11	0.45	250000	500	—	100000	0.006	
2E41	Diode Pentode	[1]	[2]	1.25	0.03	—	—	—	Detector Amp.	22.5	0	22.5	0.12	0.35	—	—	—	—	—	2E41
2E42	Diode Pentode	[1]	[2]	1.25	0.03				Detector Amp.	22.5	0	22.5	0.12	0.35	250000	375	—	1 meg.	—	2E42

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TABLE XII — SUB-MINIATURE TUBES — *Continued*

Type	Name	Base	Socket Connections	Fil. or Heater		Capacitance μμfd.			Use	Plate Supply Volts	Grid Bias	Screen Volts	Screen Current Ma.	Plate Current Ma.	Plate Resistance Ohms	Transconductance Micromhos	Amp. Factor	Load Resistance Ohms	Power Output Watts	Type
				Volts	Amp.	In	Out	Plate-Grid												
2G21	Triode Heptode	[1]	[2]	1.25	0.05	—	—	—	Converter	22.5	—	22.5	0.2	0.3	—	75	—	—		2G21
2G22	Converter	[1]	[2]	1.25	0.05				Converter	22.5	0	22.5	0.3	0.2	500000	60	—	—	—	2G22
6K4	Triode	[1]	[2]	6.3	0.15	2.4	0.8	2.4	Class A_1 Amp.	200	680*	—	—	11.5	4650	3450	16	—	—	6K4
1247	Diode	[1]	[2]	0.7	0.065	—	—	—	R.F. Probe			Max. a.c. volts—300 r.m.s.				D.C. plate current—0.4 Ma.				1247
CK501	Pentode Voltage Amplifier	—[1]	[2]	1.25	0.033	—	—	—	Class-A Amp.	30	0	30	0.06	0.3	1000000	325	—	—	—	CK501
										45	−1.25	45	0.055	0.28	1500000	300				
CK502	Pentode Output Amplifier	—[1]	[2]	1.25	0.033	—	—	—	Class-A Amp.	30	0	30	0.13	0.55	500000	400	—	60000	0.003	CK502
CK503	Pentode Output Amplifier	—[1]	[2]	1.25	0.033	—	—	—	Class-A Amp.	30	0	30	0.33	1.5	150000	600	—	20000	0.006	CK503
CK504	Pentode Output Amplifier	—[1]	[2]	1.25	0.033	—	—	—	Class-A Amp.	30	−1.25	30	0.09	0.4	500000	350	—	60000	0.003	CK504
CK505	Pentode Voltage Amplifier	—[1]	[2]	0.625	0.03	—	—	—	Class-A Amp.	30	0	30	0.07	0.17	1100000	140	—	—	—	CK505
										45	−1.25	45	0.08	0.2	2000000	150				
CK506	Pentode Output Amplifier	—[1]	[2]	1.25	0.05	—	—	—	Class-A_1 Amp.	45	−4.5	45	0.4	1.25	120000	500	—	30000	0.025	CK506
CK507	Pentode Output Amplifier	—[1]	[2]	1.25	0.05	—	—	—	Class-A_1 Amp.	45	−2.5	45	0.21	0.6	360000	500	—	50000	0.010	CK507
CK509	Triode Voltage Amplifier	—[1]	[2]	0.625	0.03	—	—	—	Class-A Amp.	45	0	—	—	0.15	150000	160	16	1000000	—	CK509
CK510	Dual Space-Charge Tetrode	—[1]	[2]	0.625	0.05	—	—	—	Class-A Amp.	45	0	0.2	200 μa	60 μa	500000	65	32.5	—	—	CK510
CK512	Low Microphonic Pentode	[1]	[2]	0.625	0.02	—	—	—	Voltage Amp.	22.5	0	22.5	0.04	0.125	—	160	—	—	—	CK412
CK515BX	Triode Voltage Amplifier	—[1]	[2]	0.625	0.03	—	—	—	Class-A Amp.	45	0	—	—	0.15	—	160	24	1000000	—	CK515BX
CK520AX	Audio Pentode	[1]	[2]	0.625	0.05	—	—	—	Class-A_1 Amp.	45	−2.5	45	0.07	0.24	—	180	—	—	0.0045	CK520AX
CK521AX	Audio Pentode	[1]	[2]	1.25	0.05	—	—	—	Class-A_1 Amp.	22.5	−3	22.5	0.22	0.8	—	400	—	—	0.006	CK521AX
CK522AX	Audio Pentode	[1]	[2]	1.25	0.02	—	—	—	Class-A_1 Amp.	22.5	0	22.5	0.08	0.3	—	450	—	—	0.0012	CK522AX
CK523AX	Pentode Output Amp.	[1]	—	1.25	0.03	—	—	—	Class-A Amp.	22.5	−1.2	22.5	0.075	0.3	—	360	—	—	0.0025	CK523AX
CK524AX	Pentode Output Amp.	[1]	—	1.25	0.03	—	—	—	Class-A Amp.	15	−1.75	15	0.125	0.45	—	300	—	—	0.0022	CK524AX
CK525AX	Pentode Output Amp.	[1]	—	1.25	0.2	—	—	—	Class-A Amp.	22.5	−1.2	22.5	0.06	0.25	—	325	—	—	0.0022	CK525AX
CK526AX	Pentode Output Amp.	[1]	—	1.25	0.2	—	—	—	Class-A Amp.	22.5	−1.5	22.5	0.12	0.45	—	400	—	—	0.004	CK526AX
CK527AX	Pentode Output Amp.	[1]	—	1.25	0.015	—	—	—	Class-A Amp.	22.5	0	22.5	0.025	0.1	—	75	—	—	0.0007	CK527AX
CK529AX	Shielded Output Pentode	[1]	—	1.25	0.02	—	—	—	Class-A Amp.	15	−1.5	15	0.05	0.2	—	275	—	—	0.0012	CK529AX
CK551AXA	Diode Pentode	[1]	[2]	1.25	0.03	—	—	—	Detector-Amp.	22.5	0	22.5	0.04	0.17	—	235	—	—	—	CK551AXA
CK553AXA	R.F. Pentode	[1]	[2]	1.25	0.05	—	—	—	Class-A_1 Amp.	22.5	0	22.5	0.13	0.42	—	550	—	—	—	CK553AXA
CK556AX	U.h.f. Triode	[1]	[2]	1.25	0.125	—	—	—	R.F. Oscillator	135	−5	—	—	4.0	—	1600	—	—	—	CK556AX
CK568AX	U.h.f. Triode	[1]	[2]	1.25	0.07	—	—	—	R.F. Oscillator	135	−6	—	—	1.9	—	650	—	—	—	CK568AX
CK569AX	R.F. Pentode	[1]	[2]	1.25	0.05	—	—	—	Class-A_1 Amp.	67.5	0	67.5	0.48	1.8	—	1100	—	—	—	CK569AX
CK605CX	Sharp Cut-off Pentode	[1]	—	6.3	0.2	—	—	—	Class-A Amp.	120	−2	120	2.5	7.5	—	5000	—	—	—	CK605CX
CK606BX	Single Diode	[1]	[2]	6.3	0.15	—	—	—	Detector	150 a.c.	—	—	—	9.0 d.c.	—	—	—	—	—	CK606BX
CK608CX	U.h.f. Triode	[1]	[2]	6.3	0.2	—	—	—	500-Mc. Osc.	120	−2	—	—	9.0	—	5000	—	—	0.75	CK608CX
CK619CX	Hi-Mu Triode	[1]	[2]	6.3	0.2	—	—	—	Class-A_1 Amp.	250	−2	—	—	4.0	—	4000	—	—	—	CK619CX
CK624CX	Sharp Cut-off Pentode	[1]	—	6.3	0.2	—	—	—	Class-A Amp.	120	−2	120	3.5	5.2	—	3000	—	—	—	CK624CX
CK650AX	Sharp Cut-off Pentode	[1]	[2]	6.3	0.2	—	—	—	Class-A_1 Amp.	120	−2	120	2.5	7.5	—	5000	—	—	—	CK650AX
CK5672	Pentode Output Amp.	[1]	—	1.25	0.05	—	—	—	Class-A Amp.	67.5	−6.25	67.5	1.0	2.75	—	625	—	—	0.06	CK5672
HY113 HY123	Triode Amplifier	—[1]	5K	1.4	0.07	—	—	—	Class-A Amp.	45	−4.5	—	—	0.4	25000	250	6.3	40000	0.0065	HY113 HY123
HY115 HY145	Pentode Voltage Amplifier	—[1]	5K	1.4	0.07	—	—	—	Class-A Amp.	45 90	−1.5 −1.5	22.5 45	0.008 0.1	0.03 0.48	5200000 1300000	58 270	300 370	—	—	HY115 HY145
HY125 HY155	Pentode Power Amplifier	—[1]	5K	1.4	0.07	—	—	—	Class-A Amp.	45 90	−3.0 −7.5	45 90	0.2 0.5	0.9 2.6	825000 420000	310 450	255 190	50000 28000	0.0115 0.09	HY125 HY155
M54	Tetrode Power Amplifier	[1]	[2]	0.625	0.04	—	—	—	Class-A Amp.	30	0	30	0.06	0.5	130000	200	26	35000	0.005	M54
M64	Tetrode Voltage Amplifier	[1]	[2]	0.625	0.02	—	—	—	Class-A Amp.	30	0	—	—	0.03	200000	110	25	—	—	M64
M74	Tetrode Voltage Amplifier	[1]	[2]	0.625	0.02	—	—	—	Class-A Amp.	30	0	7.0	0.01	0.02	500000	125	70	—	—	M74
RK61	Gas Triode	[1]	[2]	1.4	0.05	—	—	—	Radio Control	45	—	—	—	1.5	—	—	—	—	—	RK61
SD917A 5637	Triode	[1]	[2]	6.3	0.15	2.6	0.7	1.4	Class-A_1 Amp.	100	820*	—	—	1.4	26000	2700	70	—	—	SD917A 5637

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TABLE XII — SUB-MINIATURE TUBES — *Continued*

Type	Name	Base	Socket Connec-tions	Fil. or Heater Volts	Fil. or Heater Amp.	Capacitance μμfd. In	Capacitance μμfd. Out	Capacitance μμfd. Plate-Grid	Use	Plate Supply Volts	Grid Bias	Screen Volts	Screen Current Ma.	Plate Current Ma.	Plate Resistance Ohms	Transcon-ductance Micromhos	Amp. Factor	Load Resistance Ohms	Power Output Watts	Type
SD828A 5638	Audio Pentode	1	2	6.3	0.15	4.0	3.0	0.22	Class-A_1 Amp.	100	270*	100	1.25	4.8	150000	3300	—	—	—	SD828A 5638
SD828E 5634	Sharp Cut-off Pentode	4	—	6.3	0.15	4.4	2.8	0.01	Class-A_1 Amp.	100	150*	100	2.5	6.5	240000	3500	—	—	—	SD828E 5634
SN944 5633	Remote Cut-off Pentode	4	—	6.3	0.15	4.0	2.8	0.01	Class-A_1 Amp.	100	150*	100	2.8	7.0	200000	3400	—	—	—	SN944 5633
SN946	Diode	1	2	6.3	0.15	1.8	—	—	Rectifier	150	—	—	—	9.0	—	—	—	—	—	SN946
SN947D 5640	Audio Beam Pentode	1	2	6.3	0.45	—	—	—	Class-A_1 Amp.	100	−9	100	2.2	31.0	15000	5000	—	3000	1.25	SN947C 5640
SN948C	Voltage Regulator	1	—	—	—	—	—	—	Regulator	Operating voltage = 95; Max. current = 25 Ma.										SN948C
SN953D	Power Pentode	1	—	6.3	0.15	9.5	3.8	0.2	Class-A Amp.	150	100*	100	4/7.5	21/20	50000	9000	—	9000	1.0	SN953D
SN954 5641	Half-Wave Rectifier	1	2	6.3	0.45	—	—	—	Rectifier	300	—	—	—	45.0	—	—	—	—	—	SN954 5641
SN955B	Dual Triode	1	2	6.3	0.45	2.8	1.0	1.3	Class-A_1 Amp.[5]	100	100*	—	—	5.5	8000	4250	34	—	—	SN955B
SN956B 5642	H.V. Half-Wave Rectifier	4	—	1.25	0.14	—	—	—	H.V. Rectifier	Peak inverse V. = 10000 Max. Average Ip = 2 Ma. Peak Ip = 23 Ma.										SN956B 5642
SN957A 5645	Triode	1	2	6.3	0.15	2.0	1.0	1.8	Class-A_1 Amp.	100	560*	—	—	5.0	7400	2700	20	—	—	SN957A 5645
SN1006	Triode	1	2	6.3	0.15				Class-A_1 Amp.	100	820*	—	—	1.4	29000	2400	70	—	—	SN1006
SN1007B	Mixer	4	—	6.3	0.15	5.0	2.8	0.003	Mixer	100	150*	100	5.0	4.0	230000	900	—	—	—	SN1007B

* Cathode resistor ohms. [1] No base; tinned wire leads. [2] Leads identified on tube. [3] No screen connection. [4] Double-ended type. [5] Values per triode.

TABLE XIII—CONTROL AND REGULATOR TUBES

Type	Name	Base	Socket Connec-tions	Cathode	Fil. or Heater Volts	Fil. or Heater Amp.	Use	Peak Anode Voltage	Max. Anode Ma.	Minimum Supply Voltage	Operating Voltage	Operating Ma.	Grid Resistor	Tube Voltage Drop	Type
0A2	Voltage Regulator	7-pin B.	5BO	Cold	—	—	Voltage Regulator	—	—	185	150	5–30	—	—	0A2
OA5	Gas Pentode	7-pin B.	Fig. 33	Cold	—	—	Relay or Trigger	Plate — 750 V., Screen — 90 V., Grid — 3 V., Pulse — 85 V.							OA5
0B2	Voltage Regulator	7-pin B.	5BO	Cold	—	—	Voltage Regulator	—	—	133	108	5–30	—	—	0B2
0A4G 1267	Gas Triode Starter-Anode Type	6-pin O.	4V 4V	Cold	—	—	Cold-Cathode Starter-Anode Relay Tube	With 105–120-volt a.c. anode supply, peak starter-anode a.c. voltage is 70, peak r.f. voltage 55. Peak d.c. ma = 100. Average d.c. ma = 25.							0A4G 1267
1B47	Voltage Regulator	7-pin B.	—	—	—	—	Voltage Regulator	—	—	225	82	1–2	—	—	1B47
1C21	Gas Triode Glow-Discharge Type	6-pin O.	4V	Cold	—	—	Relay Tube Voltage Regulator	125–145	25 0.1 [6]	66 [6] 180 [4]	—	—	—	73 55	1C21
2A4G	Gas Triode Grid Type	7-pin O.	5S	Fil.	2.5	2.5	Control Tube	200	100	—	—	—	—	15	2A4G
6Q5G 2B4	Gas Triode Grid Type	8-pin O. 5-pin M.	6Q 5A	Htr. Htr.	6.3 2.5	0.6 1.4	Sweep Circuit Oscillator	300	300	—	—	1.0	0.1–10 [7]	19	6Q5G 2B4
2C4	Gas Triode	7-pin B.	5AS	Fil.	2.5	0.65	Control Tube	Plate volts = 350; Grid volts = −50; Avg. Ma. = 5; Peak Ma. = 20; Voltage drop = 16.							2C4
2D21	Gas Tetrode	7-pin B.	7BN	Htr.	6.3	0.6	Grid-Controlled Rectifier Relay Tube	650 400	500 —	— —	650 —	100 —	0.1–10 [7] 1.0 [7]	8 —	2D21
3C23	Gas and Mercury Vapor Grid Type	4-pin M.	3G	Fil.	2.5	7.0	Grid-Controlled Rectifier	1000	6000	— —	500 100	1500 1500	−4.5 [8] −2.5 [8]	15 15	3C23
6D4	Gas Triode	7-pin B.	5AY	Htr.	6.3	0.25	Control Tube	Plate volts = 350; Grid volts = −50; Avg. Ma. = 25; Peak Ma. = 100; Voltage drop = 16.							6D4
17	Mercury Vapor Triode	4-pin M.	3G	Fil.	2.5	5.0	Grid-Controlled Rectifier	7500 [5] 2500	2000	— −5 [3]	— 1000	500 250	200–3000 —	— 10–24	17
874	Voltage Regulator	4-pin M.	4S	—	—	—	Voltage Regulator	—	—	125	90	10–50	—	—	874
876	Current Regulator	Mogul	—	—	—	—	Current Regulator	—	—	—	40–60	1.7	—	—	876
884	Gas Triode Grid Type	6-pin O.	6Q	Htr.	6.3	0.6	Sweep Circuit Oscillator Grid-Controlled Rectifier	300 350	300 300	— —	— —	2 75	25000 25000	— —	884
885	Gas Triode Grid Type	5-pin S.	5A	Htr.	2.5	1.4	Same as Type 884	Characteristics same as Type 884							885

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TABLE XIII—CONTROL AND REGULATOR TUBES

Type	Name	Base	Socket Connections	Cathode	Fil. or Heater		Use	Peak Anode Voltage	Max. Anode Ma.	Minimum Supply Voltage	Operating Voltage	Operating Ma.	Grid Resistor	Tube Voltage Drop	Type
					Volts	Amp.									
886	Current Regulator	Mogul	—	—	—	—	Current Regulator	—	—	—	40–60	2.05	—	—	886
967	Mercury Vapor Triode	4-pin M.	3G	Fil.	2.5	5.0	Grid-Controlled Rectifier	2500	500	−5 [8]	—	—	—	10–24	967
991	Voltage Regulator	Bayonet	—	—	—	—	Voltage Regulator	—	—	87	55–60	2.0	—	—	991
1265	Voltage Regulator	6-pin O.	4AJ	Cold	—	—	Voltage Regulator	—	—	130	90	5–30	—	—	1265
1266	Voltage Regulator	6-pin O.	4AJ	Cold	—	—	Voltage Regulator	—	—	—	70	5–40	—	—	1266
1267	Gas Triode	6-pin O.	4V	Cold	—	—	Relay Tube			Characteristics same as OA4G					1267
2050	Gas Tetrode	8-pin O.	8BA	Htr.	6.3	0.6	Grid-Controlled Rectifier	650	500	—	—	100	0.1–10 [7]	8	2050
2051	Gas Tetrode	8-pin O	8BA	Htr.	6.3	0.6	Grid-Controlled Rectifier	350	375	—	—	75	0.1–10 [7]	14	2051
2523N1/ 128AS	Gas Triode Grid Type	5-pin M.	5A	Htr.	2.5	1.75	Relay Tube	400	300	—	—	1.0	300 [7]	13	2523N1/ 128AS
5651	Voltage Regulator	7-pin B.	5BO	Cold	—	—	Voltage Regulator	115	—	115	87	1.5–3.5	—	—	5651
KY21	Gas Triode Grid Type	4-pin M.	—	Fil.	2.5	10.0	Grid-Controlled Rectifier	—	—	—	3000	500	—	—	KY21
RK61	Thyratron	— [9]	—	Fil.	1.4	0.05	Radio-Controlled Relay	45	1.5	30	—	0.5–1.5	3 [7]	30	RK61
RK62	Gas Triode Grid Type	4-pin S.	4D	Fil.	1.4	0.05	Relay Tube	45	1.5	—	30–45	0.1–1.5	—	15	RK62
RM208	Permatron	4-pin M.	—	Fil.	2.5	5.0	Controlled Rectifier [1]	7500 [2]	1000	—	—	—	—	15	RM208
RM209	Permatron	4-pin M.	—	Fil.	5.0	10.0	Controlled Rectifier [1]	7500 [2]	5000	—	—	—	—	15	RM209
OA3/VR75	Voltage Regulator	6-pin O.	4AJ	Cold	—	—	Voltage Regulator	—	—	105	75	5–40	—	—	OA3/VR75
OB3/VR90	Voltage Regulator	6-pin O.	4AJ	Cold	—	—	Voltage Regulator	—	—	125	90	5–40	—	—	OB3/VR90
OC3/VR105	Voltage Regulator	6-pin O.	4AJ	Cold	—	—	Voltage Regulator	—	—	135	105	5–40	—	—	OC3/VR105
OD3/VR150	Voltage Regulator	6-pin O.	4AJ	Cold	—	—	Voltage Regulator	—	—	185	150	5–40	—	—	OD3/VR150
KY866	Mercury Vapor Triodr	4-pin M.	Fig. 8	Fil.	2.5	5.0	Grid-Controlled Rectifier	10000	1000	0–150	—	—	—	—	KY866

[1] For use as grid-controlled rectifier or with external magnetic control. RM-208 has characteristics of 866, RM-209 of 872.
[2] When under control peak inverse rating is reduced to 2500.
[3] At 1000 anode volts.
[4] Grid tied to plate.
[5] Peak inverse voltage.
[6] Grid.
[7] Megohms.
[8] Grid voltage.
[9] No base. Tinned wire leads.

Courtesy ARRL Handbook

RECEIVING TUBE SUBSTITUTION GUIDE

TABLE XV—RECTIFIERS—RECEIVING AND TRANSMITTING

See also Table XIII—Control and Regulator Tubes

Type No.	Name	Base	Socket Connec-tions	Cathode	Fil. or Heater Volts	Fil. or Heater Amp.	Max. A.C. Voltage Per Plate	D.C. Output Current Ma.	Max. Inverse Peak Voltage	Peak Plate Current Ma.	Type
BA	Full-Wave Rectifier	4-pin M.	4J	Cold	—	—	350	350	Tube drop 80 v.		G
BH	Full-Wave Rectifier	4-pin M.	4J	Cold	—	—	350	125	Tube drop 90 v.		G
BR	Half-Wave Rectifier	4-pin M.	4H	Cold	—	—	300	50	Tube drop 60 v.		G
CE-220	Half-Wave Rectifier	4-pin M.	4P	Fil.	2.5	3.0	—	20	20000	100	HV
OY4	Half-Wave Rectifier	5-pin O.	4BU	Cold	Connect Pins 7 and 8		95	75	300	500	G
OZ4	Full-Wave Rectifier	5-pin O.	4R	Cold	—	—	350	30–75	1250	200	G
1	Half-Wave Rectifier	4-pin S.	4G	Htr.	6.3	0.3	350	50	1000	400	MV
1-V	Half-Wave Rectifier	4-pin S.	4G	Htr.	6.3	0.3	350	50	—	—	HV
1B3GT/8016	Half-Wave Rectifier	6-pin O.	3C	Fil.	1.25	0.2	—	2.0	4000	17	HV
1B48	Half-Wave Rectifier	7-pin B.	—	Cold	—	—	800	6	2700	50	G
1X2	Half-Wave Rectifier	9-pin B.	Fig. 29	Fil.	1.25	0.2	—	1	15000	10	HV
1Z2	Half-Wave Rectifier	7-pin B.	7CB	Fil.	1.5	0.3	7800	2	20000	10	HV
2B25	Half-Wave Rectifier	7-pin B.	3T	Fil.	1.4	0.11	1000	1.5	—	9	HV
2V3G	Half-Wave Rectifier	6-pin O.	4Y	Fil.	2.5	5.0	—	2.0	16500	12	HV
2W3	Half-Wave Rectifier	5-pin O.	4X	Fil.	2.5	1.5	350	55	—	—	HV
2X2/879[10]	Half-Wave Rectifier	4-pin S.	4AB	Htr.	2.5	1.75	4500	7.5	—	—	HV
2X2-A	Half-Wave Rectifier	4-pin S.	4AB	Same as 2X2/879 but will withstand severe shock & vibration							HV
2Y2	Half-Wave Rectifier	4-pin M.	4AB	Fil.	2.5	1.75	4400	5.0	—	—	HV
2Z2/G84	Half-Wave Rectifier	4-pin M.	4B	Fil.	2.5	1.5	350	50	—	—	HV
3B24	Half-Wave Rectifier	4-pin M.	T-4A	Fil.	5.0 2.5[9]	3.0 3.0	— —	60 30	20000 20000	300 150	HV
3B25	Half-Wave Rectifier	4-pin M.	4P	Fil.	2.5	5.0	—	500	4500	2000	G
3B26	Half-Wave Rectifier	8-pin O.	Fig. 31	Htr.	2.5	4.75	—	20	15000	8000	HV
DR-3B27	Half-Wave Rectifier	4-pin M.	4B	Fil.	2.5	5.0	3000	250	8500	1000	HV
5AZ4	Full-Wave Rectifier	5-pin O.	5T	Fil.	5.0	2.0	Same as Type 80				HV
5R4GY	Full-Wave Rectifier	5-pin O.	5T	Fil.	5.0	2.0	900[4] 950[7]	150[4] 175[7]	2800	650	HV
5T4	Full-Wave Rectifier	5-pin O.	5T	Fil.	5.0	3.0	450	250	1250	800	HV
5U4G	Full-Wave Rectifier	8-pin O.	5T	Fil.	5.0	3.0	Same as Type 5Z3				HV
5V4G	Full-Wave Rectifier	8-pin O.	5L	Htr.	5.0	2.0	Same as Type 83V				HV
5W4	Full-Wave Rectifier	5-pin O.	5T	Fil.	5.0	1.5	350	110	1000	—	HV
5X3	Full-Wave Rectifier	4-pin M.	4C	Fil.	5.0	2.0	1275	30	—	—	HV
5X4G	Full-Wave Rectifier	8-pin O.	5Q	Fil.	5.0	3.0	Same as 5Z3				HV
5Y3G	Full-Wave Rectifier	5-pin O.	5T	Fil.	5.0	2.0	Same as Type 80				HV
5Y4G	Full-Wave Rectifier	8-pin O	5Q	Fil.	5.0	2.0	Same as Type 80				HV
5Z3	Full-Wave Rectifier	4-pin M.	4C	Fil.	5.0	3.0	500	250	1400	—	HV
5Z4	Full-Wave Rectifier	5-pin O.	5L	Htr.	5.0	2.0	400	125	1100	—	HV
6W4GT	Damper Service Half-Wave Rectifier	6-pin O.	4CG	Htr.	6.3	1.2	— 350	125 125	2000 1250	600 600	HV
6W5G	Full-Wave Rectifier	6-pin O.	6S	Htr.	6.3	0.9	350	100	1250	350	HV
6X4	Full-Wave Rectifier	7-pin B.	7CF	Htr.	6.3	0.6	325	70	1250	210	HV
6X5	Full-Wave Rectifier	6-pin O.	6S	Htr.	6.3	0.5	350	75	—	—	HV
6Y3G	Half-Wave Rectifier	5-pin O.	4AC	Htr.	6.3	0.7	5000	7.5	—	—	HV
6Y5[10]	Full-Wave Rectifier	6-pin S.	6J	Htr.	6.3	0.8	350	50	—	—	HV
6Z3	Half-Wave Rectifier	4-pin M.	4G	Fil.	6.3	0.3	350	50	—	—	HV
6Z5[10]	Full-Wave Rectifier	6-pin S.	6K	Htr.	6.3	0.6	230	60	—	—	HV
6ZY5G	Full-Wave Rectifier	6-pin O.	6S	Htr.	6.3	0.3	350	35	1000	150	HV
7Y4	Full-Wave Rectifier	8-pin L.	5AB	Htr.	6.3	0.5	350	60	—	—	HV
7Z4	Full-Wave Rectifier	8-pin L.	5AB	Htr.	6.3	0.9	450[1] 325[4]	100	1250	300	HV
12A7	Rectifier-Pentode	7-pin S.	7K	Htr.	12.6	0.3	125	30	—	—	HV
12Z3	Half-Wave Rectifier	4-pin S.	4G	Htr.	12.6	0.3	250	60	—	—	HV
12Z5	Voltage Doubler	7-pin M.	7L	Htr.	12.6	0.3	225	60	—	—	HV
14Y4	Full-Wave Rectifier	8-pin L.	5AB	Htr.	12.6	0.3	450[1] 325[4]	70	1250	210	HV
14Z3	Half-Wave Rectifier	4-pin S.	4G	Htr.	12.6	0.3	250	60	—	—	HV
25A7G[10]	Rectifier-Pentode	8-pin O.	8F	Htr.	25	0.3	125	75	—	—	HV
25W4	Half-Wave Rectifier	6-pin O.	4CG	Htr.	25	0.3	350	125	1250	600	HV
25X6GT	Voltage Doubler	7-pin O.	7Q	Htr.	25	0.15	125	60	—	—	HV
25Y4GT	Half-Wave Rectifier	6-pin O.	5AA	Htr.	25	0.15	125	75	—	—	HV
25Y5[10]	Voltage Doubler	6-pin S.	6E	Htr.	25	0.3	250	85	—	—	HV
25Z3	Half-Wave Rectifier	4-pin S.	4G	Htr.	25	0.3	250	50	—	—	HV
25Z4	Half-Wave Rectifier	6-pin O.	5AA	Htr.	25	0.3	125	125	—	—	HV
25Z5	Rectifier-Doubler	6-pin S.	6E	Htr.	25	0.3	125	100	—	500	HV
25Z6	Rectifier-Doubler	7-pin O.	7Q	Htr.	25	0.3	125	100	—	500	HV
28Z5	Full-Wave Rectifier	8-pin L.	5AB	Htr.	28	0.24	450[7] 325[4]	100	—	300	HV
32L7GT	Rectifier-Tetrode	8-pin O.	8Z	Htr.	32.5	0.3	125	60	—	—	HV
35W4	Half-Wave Rectifier	7-pin B.	5BQ	Htr.	35[2]	0.15	125	100[8]	330	600	HV
35Y4	Half-Wave Rectifier	8-pin O.	5AL	Htr.	35[2]	0.15	235	60 100[5]	700	600	HV
35Z3	Half-Wave Rectifier	8-pin L.	4Z	Htr.	35	0.15	250	100	700	600	HV
35Z4GT	Half-Wave Rectifier	6-pin O.	5AA	Htr.	35	0.15	250	100	700	600	HV
35Z5G	Half-Wave Rectifier	6-pin O.	6AD	Htr.	35[2]	0.15	125	60 100[8]	—	—	HV

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TABLE XV—RECTIFIERS—RECEIVING AND TRANSMITTING—*Continued*

See also Table XIII—Control and Regulator Tubes

Type No.	Name	Base	Socket Connections	Cathode	Fil. or Heater		Max. A.C. Voltage Per Plate	D.C. Output Current Ma.	Max. Inverse Peak Voltage	Peak Plate Current Ma.	Type
					Volts	Amp.					
35Z6G	Voltage Doubler	6-pin O.	7Q	Htr.	35	0.3	125	110	—	500	HV
40Z5GT	Half-Wave Rectifier	6-pin O.	6AD	Htr.	40[2]	0.15	125	60 100[8]	—	—	HV
45Z3	Half-Wave Rectifier	7-pin B.	5AM	Htr.	45	0.075	117	65	350	390	HV
45Z5GT	Half-Wave Rectifier	6-pin O.	6AD	Htr.	45[2]	0.15	125	60 100[8]	—	—	HV
50X6	Voltage Doubler	8-pin L.	7AJ	Htr.	50	0.15	117	75	700	450	HV
50Y6GT	Full-Wave Rectifier	7-pin O.	7Q	Htr.	50	0.15	125	85	—	—	HV
50Y7GT	Voltage Doubler	8-pin L.	8AN	Htr.	50[2]	0.15	117	65	700		HV
50Z6G	Voltage Doubler	7-pin O.	7Q	Htr.	50	0.3	125	150	—	—	HV
50Z7G[10]	Voltage Doubler	8-pin O.	8AN	Htr.	50	0.15	117	65	—	—	HV
70A7GT	Rectifier-Tetrode	8-pin O.	8AB	Htr.	70	0.15	125[5]	60	—	—	HV
70L7GT	Rectifier-Tetrode	8-pin O.	8AA	Htr.	70	0.15	117	70	—	350	HV
72	Half-Wave Rectifier	4-pin M.	4P	Fil.	2.5	3.0	—	30	20000	150	HV
73	Half-Wave Rectifier	8-pin O.	4Y	Fil.	2.5	4.5	—	20	13000	3000	HV
80	Full-Wave Rectifier	4-pin M.	4C	Fil.	5.0	2.0	350[4] 500[7]	125 125	1400	375	HV
81	Half-Wave Rectifier	4-pin M.	4B	Fil.	7.5	1.25	700	85	—	—	HV
82	Full-Wave Rectifier	4-pin M.	4C	Fil.	2.5	3.0	500	125	1400	400	MV
83	Full-Wave Rectifier	4-pin M.	4C	Fil.	5.0	3.0	500	250	1400	800	MV
83-V	Full-Wave Rectifier	4-pin M.	4AD	Htr.	5.0	2.0	400	200	1100	—	HV
84/6Z4	Full-Wave Rectifier	5-pin S.	5D	Htr.	6.3	0.5	350	60	1000	—	HV
117L7GT/ 117M7GT	Rectifier-Tetrode	8-pin O.	8AO	Htr.	117	0.09	117	75	—	—	HV
117N7GT	Rectifier-Tetrode	8-pin O.	8AV	Htr.	117	0.09	117	75	350	450	HV
117P7GT	Rectifier-Tetrode	8-pin O.	8AV	Htr.	117	0.09	117	75	350	450	HV
117Z3	Half-Wave Rectifier	7-pin B.	4BR	Htr.	117	0.04	117	90	330	—	HV
117Z4GT	Half-Wave Rectifier	6-pin O.	5AA	Htr.	117	0.04	117	90	350	—	HV
117Z6GT	Voltage Doubler	7-pin O.	7Q	Htr.	117	0.075	235	60	700	360	HV
217-A[10]	Half-Wave Rectifier	4-pin J.	4AT	Fil.	10	3.25	—	—	3500	600	HV
217-C	Half-Wave Rectifier	4-pin J.	4AT	Fil.	10	3.25	—	—	7500	600	HV
2225	Half-Wave Rectifier	4-pin M.	4P	Fil.	2.5	5.0	—	250	10000	1000	MV
249-B	Half-Wave Rectifier	4-pin M.	Fig. 53	Fil.	2.5	7.5	3180	375	10000	1500	MV
HK253	Half-Wave Rectifier	4-pin J.	4AT	Fil.	5.0	10	—	350	10000	1500	HV
705A RK-705A	Half-Wave Rectifier	4-pin W.	T-3AA	Fil.	2.5[9] 5.0	5.0 5.0	— —	50 100	35000 35000	375 750	HV
816	Half-Wave Rectifier	4-pin S.	4P	Fil.	2.5	2.0	2200	125	7500	500	MV
836	Half-Wave Rectifier	4-pin M.	4P	Htr.	2.5	5.0	—	—	5000	1000	HV
866A/866	Half-Wave Rectifier	4-pin M.	4P	Fil.	2.5	5.0	3500	250	10000	1000	MV
866B	Half-Wave Rectifier	4-pin M.	4P	Fil.	5.0	5.0	—	—	8500	1000	MV
866 Jr.	Half-Wave Rectifier	4-pin M.	4B	Fil.	2.5	2.5	1250	250[3]	—	—	MV
HY866 Jr.	Half-Wave Rectifier	4-pin M.	4P	Fil.	2.5	2.5	1750	250[3]	5000	—	MV
RK866	Half-Wave Rectifier	4-pin M.	4P	Fil.	2.5	5.0	3500	250	10000	1000	MV
871[10]	Half-Wave Rectifier	4-pin M.	4P	Fil.	2.5	2.0	1750	250	5000	500	MV
878	Half-Wave Rectifier	4-pin M.	4P	Fil.	2.5	5.0	7100	5	20000	—	HV
879	Half-Wave Rectifier	4-pin S.	4P	Fil.	2.5	1.75	2650	7.5	7500	100	HV
872A/872	Half-Wave Rectifier	4-pin J.	4AT	Fil.	5.0	7.5	—	1250	10000	5000	MV
975A	Half-Wave Rectifier	4-pin J.	4AT	Fil.	5.0	10.0	—	1500	15000	6000	MV
OZ4A/ 1003	Full-Wave Rectifier	5-pin O.	4R	Cold	—	—	—	110	880	—	G
1005/ CK1005	Full-Wave Rectifier	8-pin O.	5AQ	Fil.	6.3	0.1	—	70	450	210	G
1006/ CK1006	Full-Wave Rectifier	4-pin M.	4C	Fil.	1.75	2.25	—	200	1600	—	G
CK1007	Full-Wave Rectifier	8-pin O.	T-9G	Fil.	1.0	1.2	—	110	980	—	G
CK1009/BA	Full-Wave Rectifier	4-pin M.	—	Cold	—	—	—	350	1000	—	G
1274	Full-Wave Rectifier	6-pin O.	6S	Htr.	6.3	0.6	Same as 7Y4				HV
1275	Full-Wave Rectifier	4-pin M.	4C	Fil.	5.0	1.75	Same as 5Z3				HV
1616	Half-Wave Rectifier	4-pin M.	4P	Fil.	2.5	5.0	—	130	6000	800	HV
1641/ RK60	Full-Wave Rectifier	4-pin M.	T-4AG	Fil.	5.0	3.0	—	50 250	4500 2500	— —	HV
1654	Half-Wave Rectifier	7-pin B.	2Z	Fil.	1.4	0.05	2500	1	7000	6	HV
5517	Half-Wave Rectifier	7-pin B.	5BU	Cold	—	—	1200	6	—	50	G
5825	Half-Wave Rectifier	4-pin M.	4P	Fil.	1.6	1.25	—	2	60000	40	HV
8008	Half-Wave Rectifier	4-pin[6]	Fig. 11	Fil.	5.0	7.5	—	1250	10000	5000	MV
8013A	Half-Wave Rectifier	4-pin M.	4P	Fil.	2.5	5.0	—	20	40000	150	HV
8016	Half-Wave Rectifier	6-pin O.	4AC	Fil.	1.25	0.2	—	2.0	10000	7.5	HV
8020	Half-Wave Rectifier	4-pin M.	4P	Fil.	5.0 5.8	5.5 6.5	10000 12500	100 100	40000 40000	750 750	HV
RK19	Full-Wave Rectifier	4-pin M.	4AT	Htr.	7.5	2.5	1250	200[4]	3500	600	HV
RK21	Half-Wave Rectifier	4-pin M.	4P	Htr.	2.5	4.0	1250	200[4]	3500	600	HV
RK22	Full-Wave Rectifier	4-pin M.	T-4AG	Htr.	2.5	8.0	1250	200[4]	3500	600	HV

[1] With input choke of at least 20 henrys.
[2] Tapped for pilot lamps.
[3] Per pair with choke input.
[4] Condenser input.
[5] With 100 ohms min. resistance in series with plate; without series resistor, maximum r.m.s. plate rating is 117 volts.
[6] Same as 872A/872 except for heavy-duty push-type base. Filament connected to pins 2 and 3, plate to top cap.
[7] Choke input.
[8] Without panel lamp.
[9] Using only one-half of filament.
[10] Discontinued.

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CATHODE-RAY TUBE BASES

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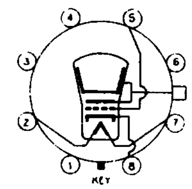
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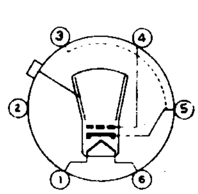
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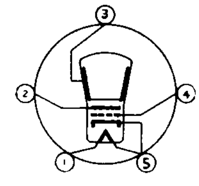
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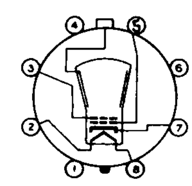
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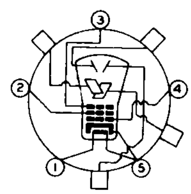

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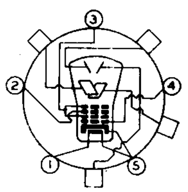
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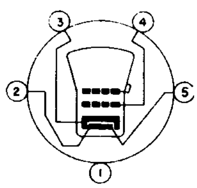
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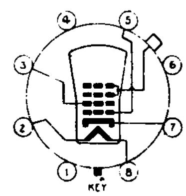
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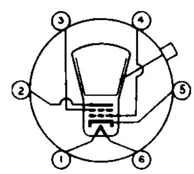
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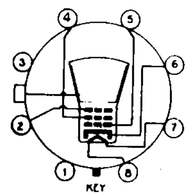

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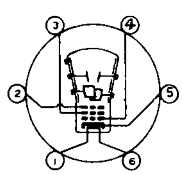
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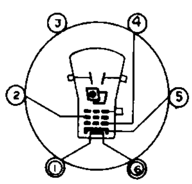
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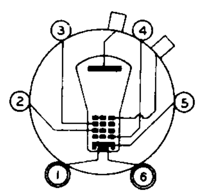
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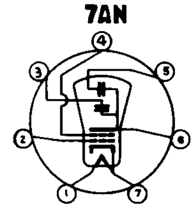
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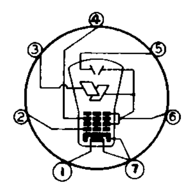

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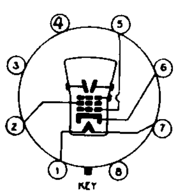
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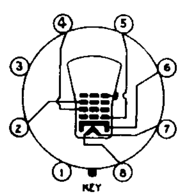
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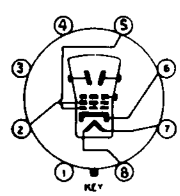
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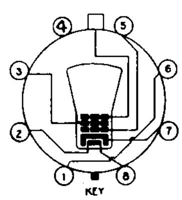
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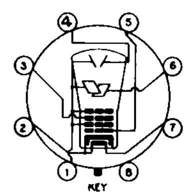

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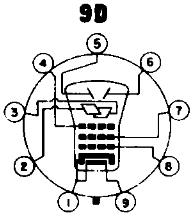
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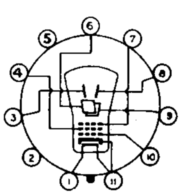
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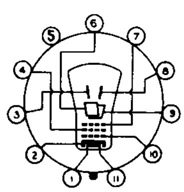
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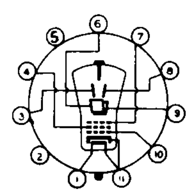
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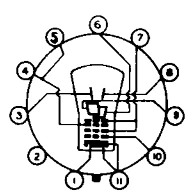
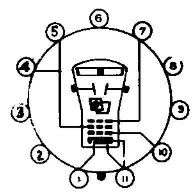
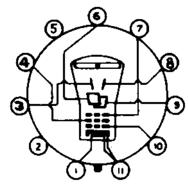


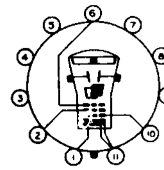
11E



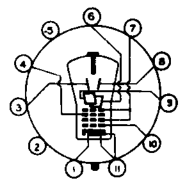
11F



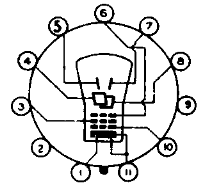
11G



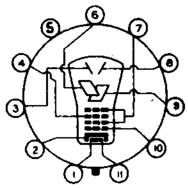
11H



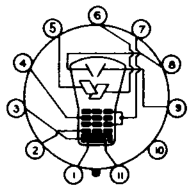
11J



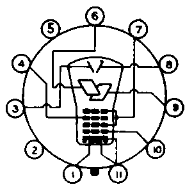
11L



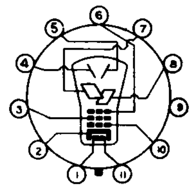
11M



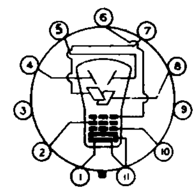
11N



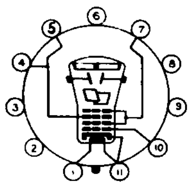
11P



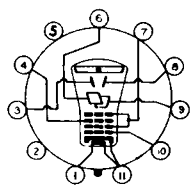
11Q



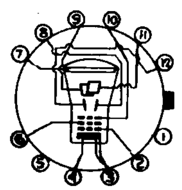
11S



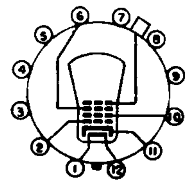
11T



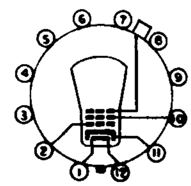
12A



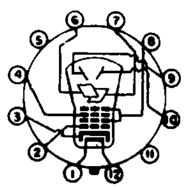
12C



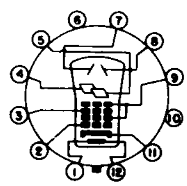
12D



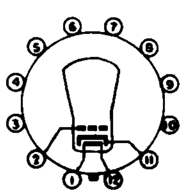
12E



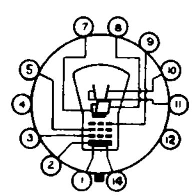
12F



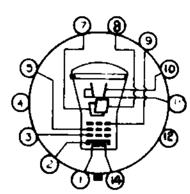
12H



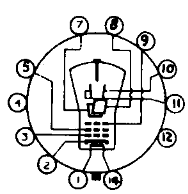
14A



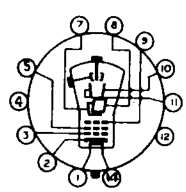
14B



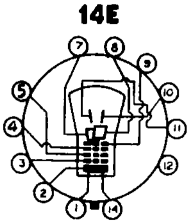
14C



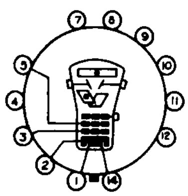
14D



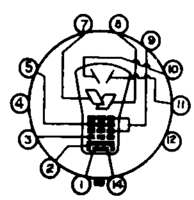
14E



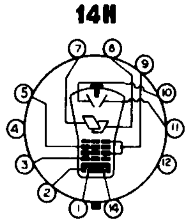
14F



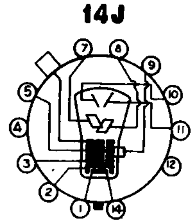
14G



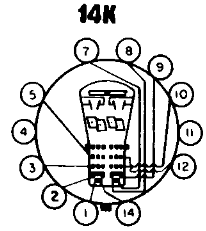
14H



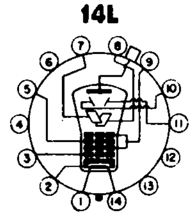
14J



14K



14L



CATHODE-RAY TUBE CHARACTERISTICS

ELECTROSTATIC TYPES—CATHODE RAY TUBES

Type	Heater		Nominal Dimensions		Base	RMA Basing	Screen		Maximum Design Center Ratings				Typical Operating Conditions					
	Volts	Amperes	Diameter Inches	Length Inches			Fluorescence	Persistence	Anode #1 Volts	Anode #2 Volts	Anode #3 Volts	Anode #2 to Deflection Plate Peak Volts	Anode #2 Volts	Anode #1 Avg. Volts**	Anode #3 Volts	Grid Range Volts*	Deflection Avg. Volts DC/Inch D 1-2	D 3-4
2AP1) 2AP1A)	6.3	0.6	2	7-7/16	Small Shell Magnal 11 Pin	11B 11L	Green	Medium	500	1000	....	600	500 1000	125 250	....	15-45 30-90	115 230	98 196
2BP1	6.3	0.6	2-1/16	7-5/8	Small Shell Duodecal 12 Pin	12E 12F	Green	Medium	1000	2500	....	500	1000 2000	150-280 300-560	....	0-67.5 0-135	115-155 230-310	74-100 148-200
3AP1) 3AP1A) 3AP4)	2.5	2.1	3	11-1/2	Medium 7 Pin	7AN 7CE 7AN	Green Green White	Medium Medium Medium	1000	1500	....	600	600 800 1000 1200 1500	170 230 285 345 475	....	14-40 14-40 17-50 20-60 22.5-67.5	47 61 76 91 114	45 58 73 87 109
3BP1) 3BP1A)	6.3	0.6	3	10	Medium Shell Diheptal 12 Pin	14A 14A	Green Green	Medium Medium	1000	2000	....	500	1500 2000	430 575	....	22.5-67.5 30-90	168 221	123 164
3CP1	6.3	0.6	3	10-3/8	Medium Magnal 11 Pin, Sleeve	11C	Green	Medium	1000	2000	....	500	1500 2000	430 575	....	22.5-67.5 30-90	165.5 124	221 165
3DP1) 3DP1A)	6.3	0.6	3	10-7/16	Medium Shell Diheptal 12 Pin	14C 14H	Green	Medium	1000	2000	....	500	1500 2000	430 575	....	22.5-67.5 30-90	166 221	123 164
3EP1	6.3	0.6	3	9-15/16	Large Wafer Magnal 11 Pin, Sleeve	11A	Green	Medium	1000	2000	....	500	1500 2000	430 575	....	22.5-67.5 30-90	165.5 221	124 165
3FP7 3FP7A	6.3	0.6	3	10	Medium Shell Diheptal 12 Pin	14B 14J	Characteristics of Phosphor No.7		1000	2000	4000	500	2000 1500 2000	575 430 575	2000 3000 4000	30-90 22.5-67.5 30-90	221 221 295	164 163 217
3GP1 3GP4	6.3	0.6	3	11-1/2	Medium Shell Magnal 11 Pin	11A 11A	Green White	Medium Medium	1000	1500	....	500	1000 1500	234 350	....	16.5-49.5 25-75	80 120	70 105
3GP1A 3GP4A	6.3	0.6	3	11-1/2	Medium Shell Magnal 11 Pin	11N 11N	Green White	Medium Medium	1000	1500	....	550	1000 500	163-291 245-437	....	16.5-49.5 25-75	64-96 96-144	56-84 84-126
3JP1	6.3	0.6	3	10	Medium Shell Diheptal 12 Pin	14J 14J	Green	Medium	1000	2000	4000	500	500 2000 500 2000	430 575 430 575	1500 2000 3000 4000	22.5-67.5 30-90 22.5-67.5 30-90	120 160 150 200	89 119 111 148
3KP1 3KP4	6.3	0.6	3	11-1/2	Medium Shell Magnal 11 Pin	11M 11M	Green White	Medium Medium	1000	2500	....	500	1000 2000	160-300 320-600	....	0-45 0-90	50-68 100-136	38-52 76-104
3MP1	6.3	0.6	3	8	Small Shell Duodecal 12 Pin	12F	Green	Medium	1000	2500	....	500	1000 2000	200-350 400-700	....	0-63 0-126	140-190 280-380	130-180 260-360
3QP1	6.3	0.3	2-3/4	6-1/8	European 9 Pin	9D	Green	Medium	700	1500	....	550	800 1200	200-320 240-480	....	21-50 31-74	143-193 214-290	89-121 133-181
3RP1 3RP1A	6.3	0.6	3	9-1/8	Small Shell Duodecal 12 Pin	12E	Green	Medium	1000	2500	....	500	1000 2000	165-310 330-620	....	67.5 13.5	85 61	172 122
3SP1 3SP4	6.3	0.6	3x1-1/2	9-1/8	Small Shell Duodecal 12 Pin	12E	Green White	Medium Medium	1100	2750	....	...	1000 2000	165-310 330-620	....	28.5-67.5 58-135	73-99 146-198	52-70 104-140
5AP1	6.3	0.6	5-1/4	13	Large Wafer Magnal 11 Pin, Sleeve	11A	Green	Medium	1200	2000	....	500	1500 2000	430 575	....	31-57 40-74	93	90
5AP4	6.3	0.6	5-1/4	13	Large Wafer Magnal 11 Pin, Sleeve	11A	White	Medium	1200	2000	....	500	1500 2000	430 575	....	17.6-57 22.8-74	93	90
5BP1 5BP4	6.3	0.6	5-1/4	16-3/4	Large Wafer Magnal 11 Pin	11A 11A	Green White	Medium Medium	1000	2000	....	500	1500 2000	310 425	....	20-60	63 84	57 76
5BP1A	6.3	0.6	5-1/4	16-3/4	Medium Shell Magnal 11 Pin	11N	Green	Medium	1000	2000	....	500	1500 2000	337-450	....	15-45 20-60	63 84	57 76
5BP7A	6.3	0.6	5-1/4	16-3/4	Medium Shell Magnal 11 Pin	11N	Characteristics of P7 Screen		1000	2000	....	500	1500 2000	235-420 315-560	....	15-45 20-60	52-74 70-98	47-67 63-89

*Cut-off voltage. Supply should be adjustable from 0 to value shown.

**Bogey value for focus. Voltage should be adjustable about value shown.

Commonly used Phosphors only listed.

Courtesy Sylvania Electric Products Inc.

ELECTROSTATIC TYPES—CATHODE RAY TUBES

Type	Heater		Nominal Dimensions		Base	RMA Basing	Screen		Maximum Design Center Ratings				Typical Operating Conditions					
	Volts	Amperes	Diameter Inches	Length Inches			Fluorescence	Persistence	Anode #1 Volts	Anode #2 Volts	Anode #3 Volts	Anode #2 to Deflection Plate Peak Volts	Anode #2 Volts	Anode #1 Avg. Volts**	Anode #3 Volts	Grid Range Volts*	Deflection Avg. Volts DC/Inch D 1-2	D 3-4
5CP1 5CP4	6.3	0.6	5-1/4	16-3/4	Medium Shell Diheptal 12 Pin	14B 14B	Green White	Medium Medium	1000	2000	4000	500	2000 1500 2000	575 430 575	2000 3000 4000	30-90 22.5-67.5 30-90	73 69 92	64 56 74
5CP1A	6.3	0.6	5-1/4	16-3/4	Medium Shell Diheptal 12 Pin	14J 14J	Green	Medium	1000	2000	4000	500	2000 1500 2000	575 430 575	2000 3000 4000	30-90 22.5-67.5 30-90	73 69 92	64 56 74
5GP1	6.3	0.6	5-1/4	16-3/4	Large Wafer Magnal 11 Pin, Sleeve	11A	Green	Medium	1000	2000	....	500	2000	425	....	24-56	36	72
5HP1 5HP4	6.3	0.6	5-1/4	16-3/4	Large Wafer Magnal 11 Pin, Sleeve	11A 11A	Green White	Medium Medium	1000	2000	....	500	1500 2000	310 425	....	15-45 20-60	63.5 84.8	57.8 77.0
5HP1A	6.3	0.6	5-1/4	16-3/4	Large Wafer Magnal 11 Pin, Micanol	11N	Green	Medium	1000	2000	....	500	1500 2000	337 450	....	15-45 20-60	63 84	57 76
5JP1 5JP4	6.3	0.6	5-5/16	16-3/4	Medium Magnal 11 Pin	11E 11E	Green White	Medium Medium	1000	2000	4000	500	1000 2000	260 520	2000 4000	22.2-51.8 45-105	96	96
5JP1A 5JP4A	6.3	0.6	5-5/16	16-3/4	Medium Magnal 11 Pin	11S 11S	Green White	Medium Medium	1000	2000	4000	500	1500 2000	250-472 333-630	3000 4000	34-79 45-105	58-86 77-115	58-86 77-115
5LP1 5LP4	6.3	0.6	5-5/16	16-3/4	Medium Magnal 11 Pin, Sleeve	11F 11F	Green White	Medium Medium	1000	2000	4000	500	1000 1500 2000	250 375 500	2000 3000 4000	15-45 22.5-67.5 30-90	52 77 103	45 68 90
5LP1A 5LP4A	6.3	0.6	5-5/16	16-3/4	Medium Magnal 11 Pin, Sleeve	11T 11T	Green White	Medium Medium	1000	2000	4000	550	1500 2000	282-475 376-633	3000 4000	22.5-67.5 30-90	62-93 83-124	54-81 72-108
5MP1 5MP4	2.5	2.1	5-5/16	15-7/8	Large 7 Pin	7AN 7AN	Green White	Medium Medium	1000	1500	....	600	1000 1500	250 375	....	16.5-49.5 15-45	66	60
5NP1 5NP4	6.3	0.6	5-5/16	16-3/4	Large Wafer Magnal 11 Pin, Sleeve	11A 11A	Green White	Medium Medium	1000	2000	....	500	1500 2000	337 450	....	15-45 20-60	84	76
5RP1 5RP4	6.3	0.6	5-1/4	16-3/4	Medium Shell Diheptal 12 Pin	14F 14F	Green White	Medium Medium	15550	3500	25500	1200	2000 2000	518 528	10000 20000	30-90 30-90	30-45 36-54	30-45 36-54
5RP1A 5RP4A	6.3	0.6	5-1/4	16-3/4	Medium Shell Diheptal 12 Pin	14F	Green White	Medium Medium	15550	3500	25500	1200	2000 2000	518 528	10000 20000	30-90 30-90	30-45 36-54	30-45 36-54
5SP1 5SP4	6.3	0.6	5-1/4	18-1/2	Medium Shell Diheptal 12 Pin	14K 14K	Green White	Medium Medium	1000	2000	4000	500	1500 1500 2000	431 431 575	1500 3000 4000	22.5-67.5 22.5-67.5 30-90	55 69 92	48 59 79
5UP1	6.3	0.6	5-1/4	14-3/4	Small Shell Duodecal 12 Pin	12E	Green	Medium	1000	2500	....	500	1000 2000	170-320 340-640	....	22.5-67.5 30-90	28-38.5 56-77	28-31 46-62
5VP7	6.3	0.6	5-1/4	16-3/4	Medium Shell Magnal 11 Pin	11N	Characteristics of Phosphor No. 7		1000	2500	....	500	1500 2000	236-422 315-562	....	15-45 20-60	52-74 70-98	47-67 63-89
5XP1	6.3	0.6	5-1/4	17-5/8	Medium Shell Diheptal 12 Pin	14F	Green	Medium	1550	3500	25500	1200	2000 2000 2000	362-695 362-695 362-695	4000 10000 20000	30-90 30-90 30-90	72-108 102-695 362-695	24-36 34-52 46-68
7EP4	6.3	0.6	7	15-1/2	Medium Shell Magnal 11 Pin	11N	White	Medium	1500	3300	....	700	2500	650	....	36-84	110	95
7GP4	6.3	0.6	7	14-1/2	Medium Shell Diheptal 12 Pin	14G	White	Medium	1500	4000	....	500	3000	810-1200	....	36-84	93-123	75-102
7JP1 7JP4	6.3	0.6	7	14-1/2	Medium Shell Diheptal 12 Pin	14G	Green White	Medium Medium	2800	6000	....	750	6000	1620-2400	....	72-168	186-246	150-204
8BP4	6.3	0.6	8-3/4	16-1/2	Medium Shell Diheptal 12 Pin	14G	White	Medium	3100	6600	....	750	6000	2000	....	72-168	146-198	124-198
9NP1	2.5	2.1	9	21	Medium 6 Pin	6BN	Green	Medium	1500	5500	....	1500	5000	1150	....	45-135	190	175

* Cut-off voltage. Supply should be adjustable from 0 to value shown.

** Bogey value for focus. Voltage should be adjustable about value shown.

Courtesy Sylvania Electric Products Inc.

ELECTROSTATIC TYPES—CATHODE RAY TUBES

Type	Heater		Nominal Dimensions		Base	RMA Basing	Screen		Maximum Design Center Ratings				Typical Operating Conditions				Deflection Avg. Volts DC/Inch	
	Volts	Amperes	Diameter Inches	Length Inches			Fluorescence	Persistence	Anode #1 Volts	Anode #2 Volts	Anode #3 Volts	Anode #2 to Deflection Plate, Peak Volts	Anode #2 Volts	Anode #1 Avg. Volts**	Anode #3 Volts	Grid Range Volts*	D 1-2	D 3-4
10GP4	6.3	0.6	10	18-1/2	Medium Shell Diheptal 12 Pin	14G	White	Medium	2000	5000	....	500	4500 5000	1130-1660 1250-1850	....	54-126 60-140	112-149 125-165	90-127 100-135
10HP4	6.3	0.6	10	19-1/4	Medium Shell Diheptal 12 Pin	14G	White	Medium	2000	5000	....	600	4000 5000	960-1440 1200-1800	....	48-112 60-140	88-120 110-150	68-92 85-115
12FP7	6.3	0.6	12	24	Medium Shell Diheptal 12 Pin	14E	Characteristics of Phosphor No. 7		2000	4000	8000	1000	2000 4000 3000 4000	625 1250 937 1250	4000 4000 6000 8000	30-90 30-90 30-90 30-90	55 83 110	63 94 125
12GP7	6.3	0.6	12	22	Medium Shell Diheptal 12 Pin	14B	Characteristics of Phosphor No. 7		2000	4000	6000	1000	3000 3000 4000 4000	857 857 1143 1143	3000 6000 4000 6000	49-147 49-147 65-195 65-195	73 89 97 108	68 83 91 101
12HP1	6.3	0.6	12	23-1/2	Medium Magnal 11 Pin, Sleeve	11J	Green	Medium	1500	5500	....	1000	5000	1150 +25% -30%	....	45-135	19	25
14AP1 14AP4	2.5	2.1	13-3/8	24-1/4	12 Pin Peripheral Contact	12A 12A	Green White	Medium Medium	1800	4000	8000	....	2000 4000	500 1000	4000 8000	20-60 40-120	65 130	65 130
20AP1 20AP4	2.5 2.5	2.1 2.1	20 20	27-7/8 27-7/8	12 Pin Peripheral Contact	12A 12A	Green White	Medium Medium	1800 1800	4000 4000	8000 8000	....	2000 4000 2000 4000	500 1000 500 1000	4000 8000 4000 8000	20-60 40-120 20-60 40-120	55 110 65 130	55 110 65 130
902	6.3	0.6	2	7-1/2	Medium Shell Octal 8 Pin	8CD	Green	Medium	300	600	....	347	400 600	100 150	....	20-60 30-90	93 139	78 117
902-A	6.3	0.6	2	7-7/16	Medium Shell Octal 8 Pin	8CD	Green	Medium	300	600	....	347	400 600	100 150	....	20-60 30-90	93 139	78 117
905 907 909	2.5	2.1	5-1/4	16-1/2	Long Shell Medium 5 Pin Micanol	5BP 5BP 5BP	Green Blue Bluish-White	Medium Very Short Long	600	2000	....	1000	1500 2000	338 450	....	13-39 17.5-52.5	86 115	73 97
905-A	2.5	2.1	5-1/4	16-1/2	Long Shell Medium 5 Pin Micanol	5BR	Green	Medium	600	2000	....	1000	1500 2000	338 450	....	13-39 17.5-52.5	86 115	73 97
908 910	2.5	2.1	3	11-1/2	Medium 7 Pin	7AN 7AN	Bluish Bluish-White	Very Short Long	1000	1500	....	600	600 800 1000 1200 1500	170 230 285 345 475	....	 13-46 30-70	46.3 62 77 94 115.2	44 57.8 72.5 88 110
908-A	2.5	2.1	3	11-1/2	Medium 7 Pin	7CE	Blue	Very Short	1000	1500	....	500	1000 1500	287 430	....	16.5-49.5 25-75	76 114	73 109
912	2.5	2.1	5-1/4	16-1/2	Medium 5 Pin Micanol	912	Green	Medium	4500	1500	....	7000	5000 10,000 15,000	1000 2000 3000	....	27-81 31-93 35-105	306 620 910	248 498 746
913	6.3	0.6	1-5/8	4-3/4	Small Wafer Octal 8 Pin	913	Green	Medium	200	500	....	250	250 500	50 100	....	10-30 32-98	169 363	121 254
914	2.5	2.1	9-1/4	21-1/2	Medium 6 Pin	6BF	Green	Medium	1900	7000	....	3000	1500 2500 5000 7000	300 515 1030 1450	....	25-75 25-75 25-75 25-75	75 124.5 248 348	58.7 97.8 195 274
914A	2.5	2.1	9-1/4	20-1/16	Medium 6 Pin	914A	Green	Medium	1900	7000	....	3000	1500 2500 5000 7000	320 550 1100 1550	....	25-75 25-75 25-75 25-75	69.5 115 231 323	54.6 91 182 254
VCR 139A	4.0	1.1	2-3/4	7-7/8	European	VCR 139A	Green	Medium	1000	1000	....		800	120-150	....	7-16	104	140

* Cut-off voltage. Supply should be adjustable from 0 to value shown.

** Bogey value for focus. Voltage should be adjustable about value shown.

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MAGNETIC TYPE CATHODE RAY TUBES

Type No.	Heater		Bulb						Ion Trap Required	Base	RMA Basing	$\mu\mu f$ Filter Capacitance Provided by Bulb Coating	Deflection and Focusing Method	Maximum Design Center Ratings		Typical Operation			Type No.
	Volts	Amperes	Nominal Face Dimensions in Inches	Length in Inches	Con-struction	Terminal	Face Plate Color	Deflection Angle in Degrees (Note 1)						Anode Volts	Acceler-ator Grid Volts	Anode Volts	Acceler-ator Grid Volts	Control Grid Negative Volts	
3HP7	6.3	0.6	3 Diam.	9-13/16	Glass	Snap	Clear	55	None	Medium Shell Octal 8 Pin	5AN	None	Magnetic	5000	200	4000 5000	150 150	15-45 15-45	3HP7
3NP4	6.3	0.6	2-9/16 Diam.	10	Glass	Recessed Small Ball	Clear	42	None	Special 5 Pin	3NP4	275 Min, 375 Max.	Magnetic	25000	...	24000	...	60	3NP4
5FP4A	6.3	0.6	5 Diam.	11-1/8	Glass	Recessed Small Ball	Clear	53	None	Medium Shell Octal 8 Pin	8BX	None	Magnetic	8000	300	6000	250	45	5FP4A
5FP7A	6.3	0.6	5 Diam.	11-1/2	Glass	Recessed Small Ball	Clear	53	None	Medium Shell Octal 8 Pin	8BX	None	Magnetic	8000	700	4000 7000	250 250	25-70 25-70	5FP7A
5FP7	6.3	0.6	5 Diam.	11-1/8	Glass	Snap	Clear	55	None	Small Wafer Octal 8 Pin with Sleeve	5AN	None	Magnetic	7000	300	4000 7000	250 250	25-75 25-75	5FP7
5FP14	6.3	0.6	5 Diam.	11-1/8	Glass	Snap	Clear	55	None	Small Wafer Octal 8 Pin with Sleeve	5AN	None	Magnetic	7000	700	4000 7000	250 250	25-75 25-75	5FP14
5TP4	6.3	0.6	5 Diam.	11-3/4	Glass	Recessed Small Cavity	Clear	50	None	Medium Shell Diheptal 12 Pin	12C1	100 Min, 500 Max.	Note 2	27000	350	27000	200	70	5TP4
5WP15	6.3	0.6	5 Diam.	11-7/16	Glass	Recessed Small Cavity	Clear	50	None	Small Shell Duodecal 7 Pin	12C1	100 Min, 500 Max.	Note 2	27000	350	20000	200	70	5WP15
7AP4	2.5	2.1	7-1/8 Diam.	13-1/2	Glass	None	Clear	55	None	Medium 5 Pin	5AJ	None	Note 2	35000	No Grid	35000	No Grid	67.5	7AP4
7BP1	6.3	0.6	7 Diam.	13-1/4	Glass	Snap	Clear	55	None	Octal 8 Pin with Sleeve	5AN	None	Magnetic	7000	675	4000 7000	250 250	50 50	7BP1
7BP7	6.3	0.6	7 Diam.	13-1/4	Glass	Snap	Clear	55	None	Octal 8 Pin with Sleeve	5AN	None	Magnetic	7000	300	4000 7000	250 250	50 50	7BP7
7BP7A	6.3	0.6	7 Diam.	13-1/4	Glass	Recessed Small Ball	Clear	53	None	Medium Shell Octal 8 Pin	8BX	None	Magnetic	8000	700	4000 7000	250 250	25-70 25-70	7BP7A
7CP1	6.3	0.6	7 Diam.	13-7/16	Glass	Snap	Clear	57	None	Medium Shell Octal 8 Pin	6AZ	None	Note 2	8000	300	4000 7000	250 250	45 45	7CP1
7CP4	6.3	0.6	7 Diam.	13-7/16	Glass	Recessed Small Ball	Clear	57	None	Medium Shell Octal 8 Pin	6AZ	None	Note 2	8000	300	6000	250	45	7CP4
7DP4	6.3	0.6	7-3/16 Diam.	14-1/16	Glass	Recessed Small Cavity	Clear	50	Double	Small Shell Duodecal 7 Pin	12C2	400 Min, 1500 Max.	Note 2	8000	410	6000	250	45	7DP4
7HP4	6.3	0.6	7-3/16 Diam.	13	Glass	Recessed Small Ball	Clear	50	None	Small Shell Duodecal 7 Pin	12D2	500 Max.	Magnetic	8000	410	6000	250	33-77	7HP4
8AP4	6.3	0.6	8-1/2 Diam.	14-1/4	Metal	Cone Lip	Clear	54	Single	Small Shell Duodecal 7 Pin	12H	None	Magnetic	10000	No Grid	9000	No Grid	27-63	8AP4
8AP4A	6.3	0.6	8-1/2 Diam.	14-1/4	Metal	Cone Lip	Gray	54	Single	Small Shell Duodecal 5 Pin	12H	None	Magnetic	9000	No Grid	7000	No Grid	27-63	8AP4A
9AP4	2.5	2.1	9-1/8 Diam.	21	Glass	Cap	Clear	40	None	Medium 6 Pin	6AL	None	Note 2	7000	250	6000 7000	250 250	25 25	9AP4
9CP4	2.5	2.1	9 Diam.	15-7/8	Glass	Cap	Clear	...	None	6 Pin Base	4AF	None	Magnetic	7000	No Grid	6000 7000	No Grid	90 100	9CP4
9GP7	6.3	0.6	9 Diam.	17	Glass	Cap	Clear	55	None	Octal 8 Pin with Sleeve	5AN	None	Magnetic	7000	300	4000 7000	250 250	45 45	9GP7
9JP1	2.5	2.1	9 Diam.	15-11/16	Glass	Snap	Clear	55	None	Small Wafer Octal 8 Pin with Sleeve	8BH	None	Note 3	5000	No Grid	2500 5000	No Grid	45 90	9JP1
9LP7	6.3	0.6	9 Diam.	14-31/32	Glass	Cap	Clear	55	None	Octal 8 Pin with Sleeve	5AN	None	Magnetic	7000	300	4000 4000 7000 7000	250 125 250 125	55-105 30-50 60-100 30-50	9LP7
9MP7	6.3	0.6	9 Diam.	17-1/2	Glass	Cap	Clear	55	None	Octal 8 Pin with Sleeve	5AN	None	Magnetic	7000	300	4000 6000	250	25-75	9MP7
10BP4	6.3	0.6	10-1/2 Diam.	17-5/8	Glass	Recessed Small Cavity	Clear	50	Double	Small Shell Duodecal 7 Pin	12D2	500 Min, 2500 Max.	Magnetic	10000	410	9000	250	20-60	10BP4
10BP4A							Gray												10BP4A
10CP4	6.3	0.6	10-1/2 Diam.	16-5/8	Glass	Recessed Small Ball	Clear	50	None	Small Shell Duodecal 7 Pin	12D2	500 Max.	Magnetic	11000	410	8000	250	30-66	10CP4

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MAGNETIC TYPE CATHODE RAY TUBES

Type No.	Heater		Bulb						Ion Trap Required	Base	RMA Basing	μμf Filter Capacitance Provided by Bulb Coating	Deflection and Focusing Method	Maximum Design Center Ratings		Typical Operation			Type No.
	Volts	Amperes	Nominal Face Dimensions in Inches	Length in Inches	Construction	Terminal	Face Plate Color	Deflection Angle in Degrees (Note 1)						Anode Volts	Accelerator Grid Volts	Anode Volts	Accelerator Grid Volts	Control Grid Negative Volts	
10DP4	6.3	0.6	10-1/2 Diam.	17-5/8	Glass	Recessed Small Cavity	Clear	50	None	Small Shell Duodecal 7 Pin	12C3	None	Note 2	10000	410	9000	250	36-84	10DP4
10EP4	6.3	0.6	10-1/2 Diam.	17-5/8	Glass	Snap	Clear	50	Double	Small Shell Duodecal 7 Pin	12D2	....	Magnetic	11000	330	8000	250	20-65	10EP4
10FP4	6.3	0.6	10-1/2 Diam.	17-5/8	Glass	Recessed Small Cavity	Clear	50	None	Small Shell Duodecal 7 Pin	12C1	500 Min, 2500 Max.	Magnetic	10000	410	9000	250	27-63	10FP4
10KP7	6.3	0.6	10-1/2 Diam.	17-5/8	Glass	Recessed Small Cavity	Clear	50	None	Small Shell Duodecal 7 Pin	12D1	None	Magnetic	10000	700	7000 9000	250 250	27-63 27-63	10KP7
10MP4	6.3	0.6	10-1/2 Diam.	17	Glass	Recessed Small Cavity	Clear	52	Double	Small Shell Duodecal 5 Pin	12G	500 Min, 2500 Max.	Magnetic	10000	No Grid	9000	No Grid	27-63	10MP4
10MP4A							Gray												10MP4A
12AP4	2.5	2.1	12-1/16 Diam.	25-3/8	Glass	Cap	Clear	40	None	Medium 6 Pin	6AL	None	Note 2	7000	250	6000 7000	250 250	75 75	12AP4
12CP4	2.5	2.1	12-1/16 Diam.	18-5/8	Glass	Cap	Clear	...	None	6 Pin Base	4AF	None	Magnetic	7000	No Grid	6000 7000	No Grid	90 110	12CP4
12DP7	6.3	0.6	12 Diam.	20-3/4	Glass	Medium Cap	Clear	55	None	Small Wafer Octal 8 Pin with Sleeve	5AN	None	Magnetic	7000	300	4000 7000	250 250	25-75 25-75	12DP7
12DP7A	6.3	0.6	12 Diam.	19-5/8	Glass	Medium Cap	Clear	50	None	Medium Shell Octal 8 Pin	8HR	None	Magnetic	10000	700	4000 7000	250 250	25-70 25-70	12DP7A
12JP4	6.3	0.6	12 Diam.	17-1/2	Glass	Snap	Clear	50	None	Small Shell Duodecal 7 Pin	12D1	None	Magnetic	12000	410	10000	250	27-63	12JP4
12KP4	6.3	0.6	12-7/16 Diam.	17-5/8	Glass	Recessed Small Cavity	Clear	54	None	Small Shell Duodecal 7 Pin	12D2	500 Min, 2500 Max.	Magnetic	12000	410	10000	250	27-63	12KP4
12KP4A	6.3	0.6	12-7/16 Diam.	17-5/8	Glass	Recessed Small Cavity	Gray	54	None	Small Shell Duodecal 5 Pin	12D2	500 Min, 2500 Max.	Magnetic	12000	410	11000	250	27-63	12KP4A
12LP4	6.3	0.6	12-7/16 Diam.	18-3/4	Glass	Recessed Small Cavity	Clear	54	Double	Small Shell Duodecal 5 Pin	12D2	750 Min, 3000 Max.	Magnetic	12000	410	11000	250	27-63	12LP4
12LP4A							Gray												12LP4A
12QP4	6.3	0.6	12-7/16 Diam.	17-1/2	Glass	Recessed Small Ball Cap	Clear	55	Single	Small Shell Duodecal 7 Pin	12D1	None	Magnetic	12000	410	10000	250	27-63	12QP4
12QP4A							Gray												12QP4A
12RP4	6.3	0.6	12 Diam.	17-1/2	Glass	Recessed Small Ball Cap	Clear	56	Single	Small Shell Duodecal 7 Pin	12D2	....	Magnetic	12000	410	10000	250	27-63	12RP4
12SP7	6.3	0.6	12-7/16 Diam.	18-3/4	Glass	Recessed Small Cavity	Clear	55	None	Small Shell Duodecal 7 Pin	12D1	None	Magnetic	10000	410	9000	250	27-63	12SP7
12TP4	6.3	0.6	12-7/16 Diam.	18-3/4	Glass	Recessed Small Cavity	Clear	54	Double	Small Shell Duodecal 7 Pin	12D1	None	Magnetic	12000	410	11000	250	27-63	12TP4
12UP4	6.3	0.6	12-7/16 Diam.	18-5/8	Metal	Cone Lip	Clear	54	Double	Small Shell Duodecal 7 Pin	12D3	None	Magnetic	12000	410	11000	250	27-63	12UP4
12UP4A							Gray												12UP4A
12UP4B							Gray												12UP4B
12VP4	6.3	0.6	12-3/8 Diam.	18	Glass	Recessed Small Cavity	Clear	55	Double	Small Shell Duodecal 5 Pin	12G	750 Min, 3000 Max.	Magnetic	12000	No Grid	11000	No Grid	33-77	12VP4
12VP4A							Gray												12VP4A
14BP4	6.3	0.6	12-1/2 x 9-11/16	16-13/16	Glass	Recessed Small Cavity	Gray	65	Double	Small Shell Duodecal 5 Pin	12D2	500 Min, 2000 Max.	Magnetic	12000	410	11000	250	27-63	14BP4
14CP4	6.3	0.6	12-1/2 x 9-11/16	16-3/4	Glass	Recessed Small Cavity	Gray	65	Double	Small Shell Duodecal 5 Pin	12D2	1500	Magnetic	14000	410	12000	300	33-77	14CP4
14DP4	6.3	0.6	12-1/2 x 9-11/16	16-3/4	Glass	Recessed Small Cavity	Gray	65	Double	Small Shell Duodecal 5 Pin	12D1	None	Magnetic	14000	410	11000	250	27-63	14DP4
15AP4	6.3	0.6	15-1/2 Diam.	20-1/2	Glass	Recessed Small Ball	Clear	52	None	Small Shell Duodecal 7 Pin	12G	None	Magnetic	15000	410	12000	250	27-63	15AP4
15CP4	6.3	0.6	15-1/2 Diam.	21-1/2	Glass	Recessed Small Cavity	Clear	57	Double	Small Shell Duodecal 7 Pin	12D1	None	Magnetic	15000	410	9000 15000	250 +	45	15CP4

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MAGNETIC TYPE CATHODE RAY TUBES

Type No.	Heater		Bulb						Ion Trap Required	Base	RMA Basing	$\mu\mu f$ Filter Capacitance Provided by Bulb Coating	Deflection and Focusing Method	Maximum Design Center Ratings		Typical Operation			Type No.
	Volts	Amperes	Nominal Face Dimensions in Inches	Length in Inches	Con-struction	Terminal	Face Plate Color	Deflection Angle in Degrees (Note 1)						Anode Volts	Acceler-ator Grid Volts	Anode Volts	Acceler-ator Grid Volts	Control Grid Negative Volts	
15DP4	6.3	0.6	15-1/2 Diam.	20-1/2	Glass	Recessed Small Ball Cap	Clear	57	Double	Small Shell Duodecal 5 Pin	12D1	None	Magnetic	15000	410	13000	250	27-63	15DP4
16AP4	6.3	0.6	15-7/8 Diam.	22-5/16	Metal	Cone Lip	Clear	53	Double	Small Shell Duodecal 5 Pin	12D3	None	Magnetic	14000	410	9000 12000	300 300	33-77 33-77	16AP4
16AP4A							Gray												16AP4A
16CP4	6.3	0.6	15-7/8 Diam.	21-1/2	Glass	Recessed Small Cavity	Clear	52	Double	Small Shell Duodecal 7 Pin	12D1	None	Magnetic	15000	410	12000	250	27-63	16CP4
16DP4	6.3	0.6	15-7/8 Diam.	20-3/4	Glass	Recessed Small Cavity	Clear	60	Double	Small Shell Duodecal 7 Pin	12D1	None	Magnetic	15000	410	9000 12000	250	45	16DP4
16DP4A							Gray												16DP4A
16FP4	6.3	0.6	15-7/8 Diam.	19-5/8	Metal	Cone Lip	Clear	60	Double	Small Shell Duodecal 5 Pin	12D3	None	Magnetic	14000	410	12000	300	33-77	16EP4
16FP4A							Gray												16EP4A
16FP4	6.3	0.6	16-1/8 Diam.	20-1/4	Glass	Recessed Small Ball Cap	Clear	62	Single	Small Shell Duodecal 7 Pin	12D1	None	Magnetic	16000	410	13000	250	27-63	16FP4
16GP4	6.3	0.6	15-7/8 Diam.	17-11/16	Metal	Cone Lip	Clear	70	Single	Small Shell Duodecal 5 Pin	12D3	None	Magnetic	14000	410	12000	300	33-77	16GP4
16HP4	6.3	0.6	15-7/8 Diam.	21-1/4	Glass	Recessed Small Cavity	Clear	60	Double	Small Shell Duodecal 5 Pin	12D2	1500 Min, 3500 Max.	Magnetic	14000	410	12000	300	33-77	16HP4
16HP4A							Gray												16HP4A
16JP4	6.3	0.6	16-1/8 Diam.	20-3/4	Glass	Recessed Small Cavity	Clear	60	Double	Small Shell Duodecal 5 Pin	12D2	750 Min, 2000 Max.	Magnetic	14000	410	11000	250	27-63	16JP4
16JP4A							Gray												16JP4A
16KP4	6.3	0.6	14-3/4 x 11-1/2	18-3/4	Glass	Recessed Small Cavity	Clear	65	Single	Small Shell Duodecal 5 Pin	12D2	1500	Magnetic	16000	410	14000	300	33-77	16KP4
16LP4	6.3	0.6	15-7/8 Diam.	22-1/4	Glass	Recessed Small Cavity	Clear	52	Double	Small Shell Duodecal 5 Pin	12D2	1500 Min, 3500 Max.	Magnetic	14000	410	12000	300	33-77	16LP4
16LP4A							Gray												16LP4A
16MP4	6.3	0.6	16-1/8 Diam.	21-3/4	Glass	Recessed Small Cavity	Clear	60	Double	Small Shell Duodecal 5 Pin	12D2	1500 Min, 3500 Max.	Magnetic	14000	410	12000	300	33-77	16MP4
16MP4A							Gray												16MP4A
16QP4	6.3	0.6	14-3/4 x 11-17/32	19.146	Glass	Recessed Small Cavity	Gray	65	Double	Small Shell Duodecal 7 Pin	12D1	None	Magnetic	16000	410	8000 14000	250 250	27-63	16QP4
16RP4	6.3	0.6	14-3/4 x 11-1/2	18-3/4	Glass	Recessed Small Cavity	Gray	65	Single	Small Shell Duodecal 5 Pin	12D2	1500	Magnetic	16000	410	12000	300	33-77	16RP4
16SP4	6.3	0.6	15-7/8 Diam.	17-5/16	Glass	Recessed Small Cavity	Clear	70	Double	Small Shell Duodecal 5 Pin	12D2	1500 Min, 3500 Max.	Magnetic	14000	410	12000	300	33-77	16SP4
16SP4A							Gray												16SP4A
16TP4	6.3	0.6	16-1/8 Diam.	18-1/8	Glass	Recessed Small Cavity	Gray	70	Single	Small Shell Duodecal 5 Pin	12D2	1500	Magnetic	14000	410	12000	300	33-77	16TP4
16UP4	6.3	0.6	14-3/4 x 11-1/2	18-1/8	Glass	Recessed Small Cavity	Gray	65	Single	Small Shell Duodecal 5 Pin	12D1	None	Magnetic	15000	410	12000	300	27-63	16UP4
16VP4	6.3	0.6	15-7/8 Diam.	17-3/16	Glass	Recessed Small Cavity	Gray	70	Single	Small Shell Duodecal 5 Pin	12D1	None	Magnetic	15000	410	12000	250	27-63	16VP4
16WP4	6.3	0.6	15-7/8 Diam.	17-3/4	Glass	Recessed Small Cavity	Gray	70	Double	Small Shell Duodecal 5 Pin	12D1	None	Magnetic	15000	410	12000	250	27-63	16WP4
16XP4	6.3	0.6	14-3/4 x 11-17/32	18-3/4	Glass	Recessed Small Cavity	Gray	65	Double	Small Shell Duodecal 5 Pin	12D1	None	Magnetic	15000	410	12000	250	27-63	16XP4
16YP4	6.3	0.6	15-7/8 Diam.	17-5/16	Glass	Recessed Small Cavity	Gray	70	Single	Small Shell Duodecal 5 Pin	12D2	750 Min, 2000 Max.	Magnetic	14000	410	12000	300	33-77	16YP4
19AP4	6.3	0.6	18-5/8 Diam.	21-1/2	Metal	Cone Lip	Clear	66	Single	Small Shell Duodecal 7 Pin	12D3	None	Magnetic	19000	410	13000	250	27-63	19AP4
19AP4A							Gray												19AP4A

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MAGNETIC TYPE CATHODE RAY TUBES

Type No.	Heater		Bulb						Ion Trap Required	Base	RMA Basing	$\mu\mu$f Filter Capacitance Provided by Bulb Coating	Deflection and Focusing Method	Maximum Design Center Ratings		Typical Operation			Type No.
	Volts	Amperes	Nominal Face Dimensions in Inches	Length in Inches	Con-struction	Terminal	Face Plate Color	Deflection Angle in Degrees (Note 1)						Anode Volts	Acceler-ator Grid Volts	Anode Volts	Acceler-ator Grid Volts	Control Grid Negative Volts	
19DP4	6.3	0.6	18-7/8 Diam.	21-1/2	Glass	Recessed Small Cavity	Clear	66	Double	Small Shell Duodecal 5 Pin	12D2	1000 Min, 3000 Max.	Magnetic	19000	410	13000	250	26-63	19DP4
19FP4	6.3	0.6	18-7/8 Diam.	22	Glass	Recessed Small Cavity	Gray	66	Double	Small Shell Duodecal 5 Pin	12D1	None	Magnetic	19000	410	13000	250	27-63	19FP4
19GP4	6.3	0.6	18-7/8 Diam.	21-1/4	Glass	Recessed Small Cavity	Gray	66	Single	Small Shell Duodecal 5 Pin	12D1	None	Magnetic	19000	410	13000	250	27-63	19GP4
20BP4	6.3	0.6	20 Diam.	28-3/4	Glass	Medium Cap	Clear	54	None	Small Shell Duodecal 7 Pin	12D1	None	Magnetic	16500	750	10000 15000	250 250	25-70 25-70	20BP4
22AP4	6.3	0.6	21-11/16 Diam.	22-7/8	Metal	(Cone Lip)	Clear	70	Single	Small Shell Duodecal 5 Pin	12D3	None	Magnetic	19000	410	14000	300	33-77	22AP4
22AP4A							Gray												22AP4A
904	2.5	2.1	5-1/16 Diam.	16-1/4	Glass	Cap	Clear	...	None	Medium 6 Pin	6AL	None	Note 4	4600	250	1000 3000 4600	100 100 250	34 35 39	904
5WP11	6.3	0.6	5 Diam.	11-7/16	Glass	Recessed Small Cavity	Clear	50	None	Small Shell Duodecal 7 Pin	12C2	100 Min, 500 Max.	Note 2	27000	350	27000	200	42-98	5WP11
7MP7	6.3	0.6	7-3/16 Diam.	12-1/2	Glass	Recessed Small Cavity	Clear	50	None	Small Shell Duodecal 5 Pin	12D1	None	Magnetic	8000	700	4000 7000	250 250	27-63 27-63	7MP7
19EP4	6.3	0.6	17 x 13-3/32	21-1/8	Glass	Recessed Small Cavity	Gray	65	Single	Small Shell Duodecal 5 Pin	12D2	1000 Min, 2500 Max.	Magnetic	19000	410	13000	250	26-63	19EP4
16ZP4	6.3	0.6	15-7/8 Diam.	22-1/4	Glass	Recessed Small Cavity	Gray	52	Single	Small Shell Duodecal 5 Pin	12D2	750 Min, 2000 Max.	Magnetic	16000	410	12000	300	33-77	16ZP4
16WP4A	6.3	0.6	15-7/8 Diam.	17-3/4	Glass	Recessed Small Cavity	Gray	70	Single	Small Shell Duodecal 5 Pin	12D2	750 Min, 2000 Max.	Magnetic	16000	410	12000	250	27-63	16WP4A
17AP4	6.3	0.6	15-3/8 x 12-1/4	18-5/8	Glass	Recessed Small Cavity	Gray	65	Single	Small Shell Duodecal 5 Pin	12D2	750 Min, 2000 Max.	Magnetic	16000	410	12000	300	33-77	17AP4
17BP4	6.3	0.6	15-25/64 x 12-9/64	19-5/8	Glass	Recessed Small Cavity	Clear	65	Single	Small Shell Duodecal 5 Pin	12D2	750 Min, 2000 Max.	Magnetic	16000	410	12000	300	33-77	17BP4
17BP4A							Gray												17BP4A
10FP4A	6.3	0.6	10-1/2 Diam.	17-5/8	Glass	Recessed Small Cavity	Gray	54	None	Small Shell Duodecal 5 Pin	12D2	500 Min, 2500 Max.	Magnetic	12000	410	11000	250	27-63	10FP4A

Courtesy Sylvania Electric Products Inc.

Note 1: Horizontal Deflection Angles are given for Rectangular Tubes.

Note 2: Magnetic Deflection, Electrostatic Focusing.

Note 3: Electrostatic and Magnetic Deflection, Magnetic Focusing.

Note 4: Electrostatic and Magnetic Deflection, Electrostatic Focusing.

CROSS INDEX OF ARMY VT NUMBERS AND COMMERCIAL NUMBERS

VT NUMBER	COMMERCIAL NUMBER
VT-1	WE-203A (obsolete)
VT-2	WE-205B
VT-3	Obsolete.
VT-4A	Obsolete.
VT-4B	Commercial 211.
VT-4C	JAN 211.
VT-5	WE-215A
VT-6	212A (obsolete)
VT-7	WX-12 (obsolete)
VT-8	UV-204 (obsolete)
VT-10	Obsolete.
VT-11	Obsolete.
VT-12	Obsolete.
VT-13	Obsolete.
VT-14	Obsolete.
VT-16	Obsolete.
VT-17	860.
VT-18	Obsolete.
VT-19	861.
VT-20	Obsolete.
VT-21	Obsolete.
VT-22	204A.
VT-23	Obsolete.
VT-24	864.
VT-25	10.
VT-25A	10 Special.
VT-26	22.
VT-27	30.
VT-28	24, 24A.
VT-29	27.
VT-30	01-A
VT-31	31.
VT-32	Obsolete.
VT-33	33.
VT-34	207.
VT-35	35/51.
VT-36	36.
VT-37	37.
VT-38	38.
VT-39	869.
VT-39A	869A
VT-40	40.
VT-41	851.
VT-42	872.
VT-42A	872A (Special fil.).
VT-43	845.
VT-44	32.
VT-45	45.
VT-46	866.
VT-46A	866A.
VT-47	47.
VT-48	41.
VT-49	39/44.
VT-50	50.
VT-51	841.
VT-52	45 Special.
VT-53	Canceled (superseded by VT-42A).
VT-54	34.
VT-55	865.
VT-56	56.
VT-57	57.
VT-58	58.
VT-60	850.
VT-62	801,801A.
VT-63	46.
VT-64	800.
VT-65	6C5.
VT-65A	6C5G.
VT-66	6F6.
VT-66A	6F6G.
VT-67	30 Special.
VT-68	6B7.
VT-69	6D6.
VT-70	6F7.
VT-72	842.
VT-73	843.
VT-74	5Z4.
VT-75	75.
VT-76	76.
VT-77	77.
VT-78	78.
VT-80	80.
VT-83	83.
VT-84	84/6Z4.
VT-86	6K7.
VT-86A	6K7G.
VT-86B	6K7GT.
VT-87	6L7.
VT-87A	6L7G.
VT-88	6R7.
VT-88A	6R7G.
VT-88B	6R7GT.
VT-89	89
VT-90	6H6.
VT-90A	6H6GT.
VT-91	6J7.
VT-91A	6J7GT.
VT-92	6Q7.
VT-92A*	6Q7G.
VT-93	6B8.
VT-93A	6B8G.
VT-94	6J5.
VT-94A	6J5G.
VT-94B	6J5 Special selec.
VT-94C	6J5G Special selec.
VT-94D	6J5GT.
VT-95	2A3.
VT-96	6N7.
VT-96B	6N7 Special selec.
VT-97	5W4.
VT-98	6U5/6G5.
VT-99	6F8G.
VT-100	807.
VT-100A	807 Modified.
VT-101	837.
VT-102	Canceled.
VT-103	6SQ7.
VT-104	12SQ7.
VT-105	6SC7.
VT-106	803.
VT-107	6V6.
VT-107A	6V6GT.
VT-107B	6V6G.
VT-108	450TH.
VT-109	2051.
VT-111	5BP4/1802P4.
VT-112	6AC7/1852.
VT-114	5T4.
VT-115	6L6.
VT-115A	6L6G.
VT-116	6SJ7.
VT-116A	6SJ7GT.
VT-116B	6SJ7Y.
VT-117	6SK7.
VT-117A	6SK7GT.
VT-118	832.
VT-119	2X2/879.
VT-120	954.
VT-121	955.
VT-122	530.
VT-123	RCA A-5586 (superseded by VT-128).
VT-124	1A5GT.
VT-125	1C5GT.
VT-126	6X5.
VT-126A	6X5G.
VT-126B	6X5GT.
VT-127	Special tube.
VT-127A	Special tube.
VT-128	1630 (A-5588).
VT-129	304TL.
VT-130	250TL.
VT-131	12SK7.
VT-132	12K8 Special.
VT-133	12SR7
VT-134	12A6.
VT-135	12J5GT.
VT-135A	12J5.
VT-136	1625.
VT-137	1626.
VT-138	1629.
VT-139	VR150-30.
VT-140*	1628.
VT-141	531.
VT-142	WE-39DY1.
VT-143	805.
VT-144	813.

* Indicates VT number has been canceled.

VT NUMBER	COMMERCIAL NUMBER	VT NUMBER	COMMERCIAL NUMBER	VT NUMBER	COMMERCIAL NUMBER
VT-145. . . .	5Z3.	VT-185. . . .	3D6/1299.	VT-230. . . .	350A.
VT-146. . . .	1N5GT.	VT-186. . . .	Special tube.	VT-231. . . .	6SN7GT.
VT-147. . . .	1A7GT.	VT-187. . . .	575A.	VT-232. . . .	E-1148.
VT-148. . . .	1D8GT.	VT-188. . . .	7E6.	VT-233. . . .	6SR7.
VT-149. . . .	3A8GT.	VT-189. . . .	7F7.	VT-234. . . .	HY-114B.
VT-150. . . .	6SA7.	VT-190. . . .	7H7.	VT-235. . . .	HY-615
VT-150A. . .	6SA7GT.	VT-191. . . .	316A.	VT-236. . . .	836.
VT-151. . . .	6A8G.	VT-192. . . .	7A4.	VT-237. . . .	957.
VT-151B. . .	6A8GT.	VT-193. . . .	7C7.	VT-238. . . .	956.
VT-152. . . .	6K6GT.	VT-194. . . .	7J7.	VT-239. . . .	1LE3.
VT-152A. . .	6K6G.	VT-195. . . .	1005.	VT-240. . . .	710A.
VT-153. . . .	12C8 Special.	VT-196. . . .	6W5G.	VT-241. . . .	7E5/1201.
VT-154. . . .	814.	VT-197A. . .	5Y3GT/G.	VT-243. . . .	7C4/1203A.
VT-155. . . .	Special tube.	VT-198A. . .	6G6G.	VT-244. . . .	5U4G.
VT-156. . . .	Special tube.	VT-199. . . .	6SS7.	VT-245. . . .	2050.
VT-157. . . .	Special tube.	VT-200. . . .	VR-105-30.	VT-246. . . .	918.
VT-158. . . .	Special tube.	VT-201. . . .	25L6.	VT-247. . . .	6AG7.
VT-159. . . .	Special tube.	VT-201C. . .	25L6GT.	VT-248. . . .	1808P1.
VT-160. . . .	Special tube.	VT-202. . . .	9002.	VT-249. . . .	1006.
VT-161. . . .	12SA7.	VT-203. . . .	9003.	VT-250. . . .	EF50.
VT-162. . . .	12SJ7.	VT-204. . . .	HK24G.	VT-251. . . .	441.
VT-163. . . .	6C8G.	VT-205. . . .	6ST7.	VT-252. . . .	923.
VT-164. . . .	1619.	VT-206A. . .	5V4G.	VT-254. . . .	304TH.
VT-165. . . .	1624.	VT-207. . . .	12AH7GT.	VT-255. . . .	705A.
VT-166. . . .	371A.	VT-208. . . .	7B8.	VT-256. . . .	ZP486.
VT-167. . . .	6K8.	VT-209. . . .	12SG7.	VT-257. . . .	K-7.
VT-167A. . .	6K8G.	VT-210. . . .	1S4.	VT-259. . . .	829.
VT-168A. . .	6Y6G.	VT-211. . . .	6SG7.	VT-260. . . .	VR75-30.
VT-169. . . .	12C8.	VT-212. . . .	958.	VT-264. . . .	3Q4.
VT-170. . . .	1E5-GP.	VT-213A. . .	6L5G.	VT-266. . . .	1616.
VT-171. . . .	1R5.	VT-214. . . .	12H6.	VT-267. . . .	578.
VT-171A. . .	Loctal Equiv. of 1R5.	VT-215. . . .	6E5.	VT-268. . . .	12SC7.
VT-172. . . .	1S5.	VT-216. . . .	816.	VT-269. . . .	717A.
VT-173. . . .	1T4.	VT-217. . . .	811.	VT-277. . . .	417.
VT-174. . . .	3S4.	VT-218. . . .	100TH.	VT-279. . . .	GY-2.
VT-175. . . .	1613.	VT-219. . . .	Canceled.	VT-280*. . .	C7063.
VT-176. . . .	6AB7/1853.	VT-220. . . .	250TH.	VT-281*. . .	HY-145ZT.
VT-177. . . .	1LH4.	VT-221. . . .	3Q5GT.	VT-282. . . .	ZG489.
VT-178. . . .	1LC6.	VT-222. . . .	884.	VT-283*. . .	QF-206.
VT-179. . . .	1LN5.	VT-223. . . .	1H5GT.	VT-284*. . .	QF-197.
VT-180*. . .	3LF4.	VT-224. . . .	RK-34.	VT-285*. . .	QF-200C.
VT-181. . . .	7Z4.	VT-225. . . .	307A.	VT-286. . . .	832A.
VT-182. . . .	3B7/1291.	VT-226. . . .	3EP1/1806P1.	VT-287. . . .	815.
VT-183. . . .	1R4/1294.	VT-227. . . .	7184.	VT-288. . . .	12SH7.
VT-184. . . .	VR90-30.	VT-228. . . .	8012.	VT-289. . . .	12SL7GT.
		VT-229. . . .	6SL7GT.		

* Indicates VT number has been canceled.

BALLAST TUBE AND RESISTOR NUMBERING CODES

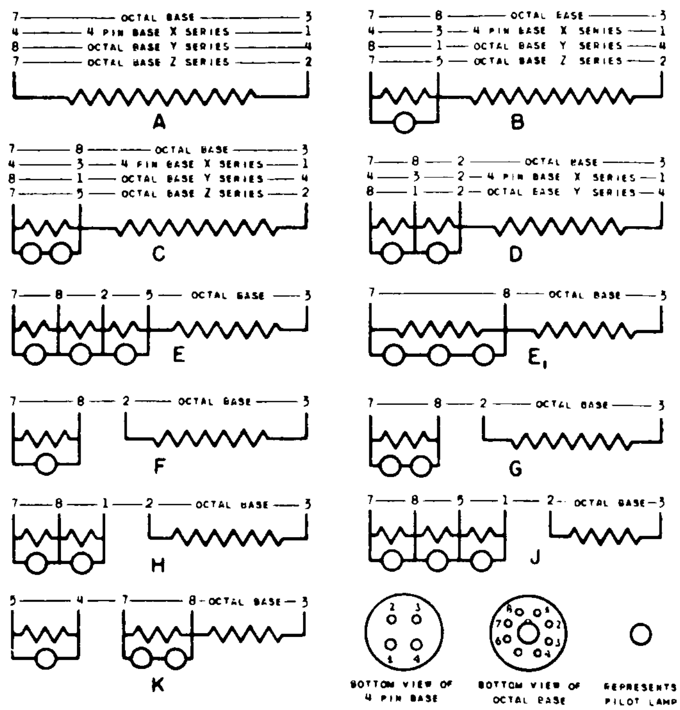
FOR AC-DC RECEIVERS USING 0.3 AMP. SERIES CONNECTED HEATERS

There are two numbering codes now in use for ballast and resistor tubes. Both codes use parts of the type designation to indicate the various divisions of the tube's service. For example, type numbers in the first system (A) might be BKX51DJ or L55B and, in the second system (B), might be 200R44 or 200R. These letter and number combinations are explained by the following examples.

SYSTEM A

BKY49CJG

- The letter G, if present, indicates that the tube has a glass bulb and octal base.
- The letter J, if present, indicates that a jumper is located between pins 3 and 4.
- Letters A to K here indicate the internal circuit connections. *(See adjacent figures.)*
- This number gives the voltage drop with 0.3 ampere. *(See Note 4.)*
- The letters X, Y, or Z, if present, indicate the style of base and the pin connections. *(See Note 3.)*
- The letters K, L, or M indicate the type of pilot lamp that must be used with this tube. *(See Note 2.)*
- The letter B, when present, indicates that the pilot-lamp shunt-resistor is a ballast type. *(See Note 1.)*



NOTE 1.

"Ballast" action indicates that the pilot lamp shunt resistor has low starting resistance when cold, protecting the lamp filament from the initial current surge, and has much higher resistance when hot, applying full operating voltage to the lamp.

NOTE 2.

Tube Letter	Lamp No.	Volts	Amperes	Bead Color
K	40 and 47	6.3	0.15	Brown
L	44 and 46	6.3	0.25	Blue
M	50 and 51	7.5	0.2	White

NOTE 3.

X denotes a 4 pin base and metal shell. Y or Z denote octal bases but with different pin connections. *(See Figures A to K.)*

NOTE 4.

This number includes the drop in the series resistor plus the drop in the pilot lamp and its shunt. The number represents the difference between the sum of the heater voltages and the line voltage of 117.5 volts. Tubes are made with the following numbers: 98, 92, 86, 80, 73, 67, 61, 55, 49, 42, 36, 30, 23, 17, 11. The number to be used is the one closest to the voltage difference mentioned above.

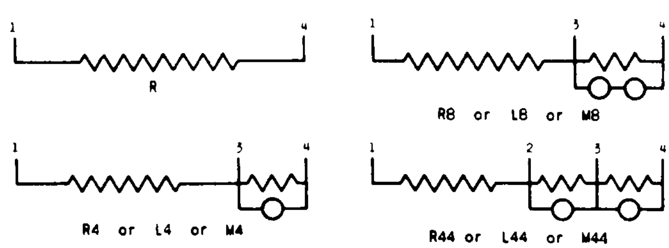
SYSTEM B

All tubes under System B have glass bulbs and 4 pin bases and their type designations start with a number.

EXAMPLE

200R44

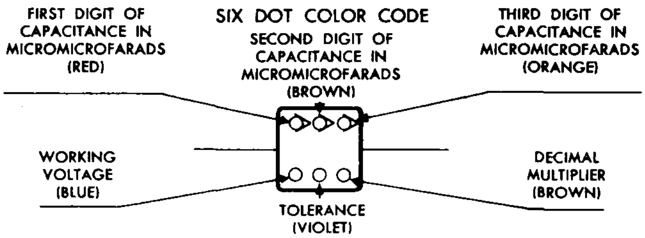
- The numbers 4, 8, or 44, in combination with the preceding letter, indicate the internal tube connections. *(See below.)*
- The letters R, L, or M, when followed by a number, indicate the type of pilot lamp which must be used with this tube. See Note 2, using the letter R in place of K. (The letter R, alone, indicates only a form of internal tube connection without pilot lamp.)
- This number indicates the equivalent resistance in ohms at 0.3 ampere. Thus, 200 × 0.3 = 60 volts drop.



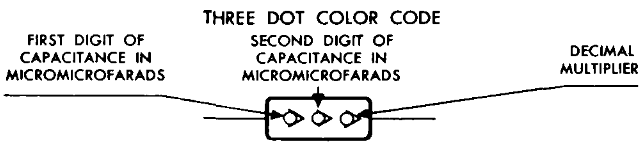
Courtesy TUNG-SOL Lamp Works, Inc.

RTMA CAPACITOR, RESISTOR, AND TRANSFORMER COLOR CODES

CAPACITOR COLOR CODE

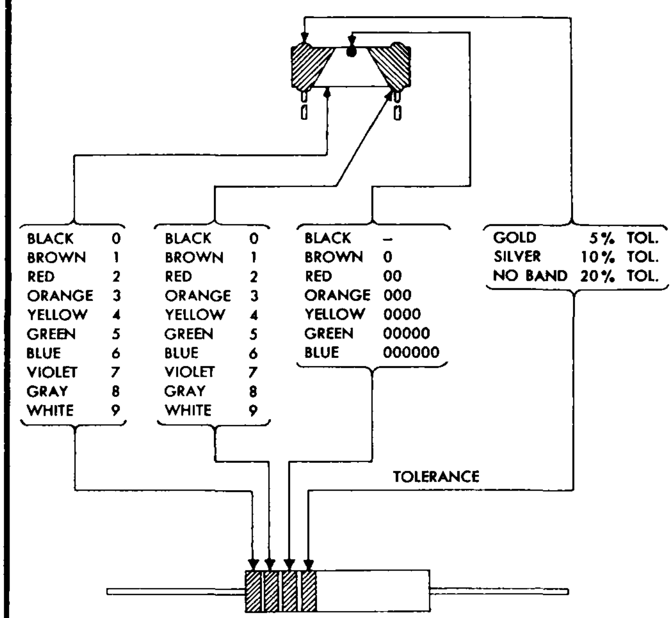


EXAMPLE: 2130 $\mu\mu f$. ±7%, 600 W.V. (Values for color shown in the above parenthesis)



COLOR	DIGIT NUMERAL	DECIMAL MULTIPLIER	TOLERANCE	WORKING VOLTAGE
BLACK	0	1	20%	—
BROWN	1	10	1%	100
RED	2	100	2%	200
ORANGE	3	1000	3%	300
YELLOW	4	10000	4%	400
GREEN	5	—	5%	500
BLUE	6	—	6%	600
VIOLET	7	—	7%	700
GRAY	8	—	8%	800
WHITE	9	—	9%	900
GOLD	–	0.1	–	1000
SILVER	–	0.01	10%	—

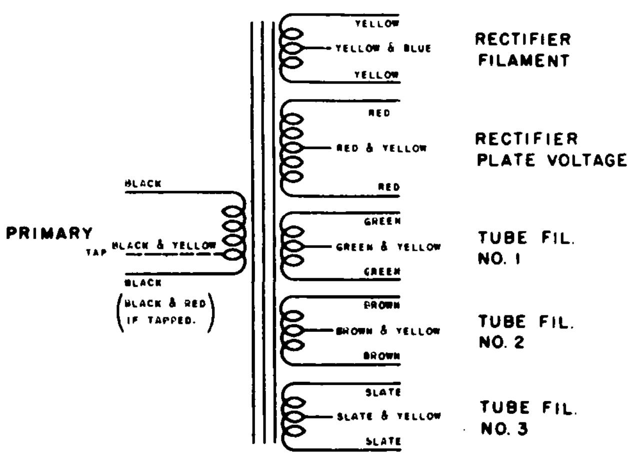
RESISTOR COLOR CODE



RESISTANCE VALUE: The nominal resistance valuu in ohms is identified by a three digit symbol. The first two digits are the first two figures of the resistance value in ohms. The third digit specifies the number of zeros which follow the first two figures.

POWER TRANSFORMER LEAD COLOR CODE

Power transformer leads in radio receivers may be identified by the following colors (or color patterns) on the lead coverings.



Courtesy TUNG-SOL Lamp Works, Inc.

I-F TRANSFORMER LEAD COLOR CODE

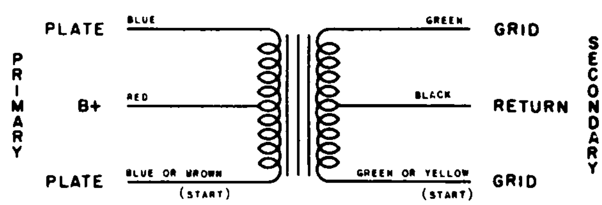
I-F transformer leads in radio receivers may be identified by the following colors on the lead coverings.

PLATE LEAD	BLUE	GRID (or diode lead)	GREEN
B+ LEAD	RED	GRID RETURN	BLACK

FOR "FULL-WAVE" TRANSFORMER SECOND DIODE LEAD WILL BE GREEN-BLACK.

AUDIO TRANSFORMER LEAD COLOR CODE

Interstage and Output Audio Transformer leads in radio receivers may be identified by the colors on the lead coverings as shown.



In cases where use is made of a single primary and/or a single secondary, the upper half of the diagram indicates the color coding. The brown and yellow leads indicate the start of the primary and secondary windings respectively and will be used in place of the blue and green (as shown) where polarity indications are required.

PILOT LAMP TABLE

Lamp No.	Volts	Amperes	Bead Color	Miniature Base	Bulb Type
40	6-8	0.15	Brown	Screw	T-3 1/4
41	2.5	0.50	White	Screw	T-3 1/4
42	3.2	0.35	Green	Screw	T-3 1/4
43	2.5	0.50	White	Bayonet	T-3 1/4
44	6-8	0.25	Blue	Bayonet	T-3 1/4
45	3.2	0.35	White	Bayonet	T-3 1/4
46	6-8	0.25	Blue	Screw	T-3 1/4
47	6-8	0.15	Brown	Bayonet	T-3 1/4
48	2.0	0.06	Pink	Screw	T-3 1/4
49	2.0	0.06	Pink	Bayonet	T-3 1/4
50	6-8	0.20	White	Screw	G-3 1/2
51	6-8	0.20	White	Bayonet	G-3 1/2
55	6-8	0.40	White	Bayonet	G-4 1/2
292	2.9	0.17	White	Screw	T-3 1/4
292A	2.9	0.17	White	Bayonet	T-3 1/4
1455	18.0	0.25	Brown	Screw	G-5
1455A	18.0	0.25	Brown	Bayonet	G-5
1490	3.2	0.16	- - -	Bayonet	T-3 1/4

GERMANIUM CRYSTAL DIODE CHARACTERISTICS

Germanium Crystal	Min. Forward Current at +1v (Ma)	Max. Reverse Current (Microamp.)	Peak Inverse Voltage (Volts)	Average Anode Rect. Current (Ma)	Peak Anode Rect. Current (Ma)
1N34, 1N34A	5.0	50 at -10v; 800 at -50v	75	40	150
1N35*	7.5	10 at -3v	75	22.5	60
1N38, 1N38A	3.0	6 at -3v; 625 at -100v	120	40	150
1N39	3.0	200 at -100v; 800 at -200v	225	40	150
1N40**	12.75 (at 1.5 volts)	50 at -10v	75	22.5	60
1N41**	12.75 (at 1.5 volts)	50 at -10v	75	22.5	60
1N42**	12.75 (at 1.5 volts)	6 at -3v; 625 at -100v	120	22.5	60
1N48	4.0	833 at -50v	85	50	150
1N51	2.5	1670 at -50v	50	25	100
1N52	4.0	150 at -50v	85	50	150
1N54, 1N54A	5.0	10 at -10v	75	40	150
1N55, 1N55A	3.0	300 at -100v; 800 at -150v	170	40	150
1N56, 1N56A	15.0	300 at -30v	50	50	200
1N57	4.0	500 at -75v	90	40	150
1N58, 1N58A	4.0	800 at -100v	115	40	150
1N60†	†	†	70	40	150
1N63	4.0	50 at -50v	125	50	150
1N64	Tested for efficiency in 44 Mc video detector circuit.				
1N65	2.5	250 at -50v	85	50	150
1N69†	5.0	850 at -50v	75	40	125
1N70†	3.0	410 at -50v	125	30	90
1N71††	15.0	300 at -30v	50	50	200

NOTE: Crystals 1N48, 1N51, 1N52, 1N63, 1N64, and 1N65 are General Electric types, all others are Sylvania types unless otherwise indicated.

* Units are matched in the forward direction at +1 volt so that the current flowing through the higher resistance unit is within 10% of that in the lower resistance unit. Ratings shown are for each diode.

**Consists of 4 specially selected and matched germanium diodes whose resistances are balanced within ± 2.5% in the forward direction at 1.5 volts. For additional balance, the forward resistance of each pair of varistor crystals are matched within 3 ohms. Ratings shown above are for each diode.

† Units are tested in a circuit employing an input of 1.8 volts rms at 40 mc. 70% modulated at 400 cycles. Demodulated output across a 4700 ohm resistor shunted by a 5 mmf capacitor is a minimum of 1.1 volts peak to peak.

† JAN types

††Consists of four matched low impedance germanium diodes each of which, with a voltage of one volt impressed in the forward direction, will pass a current within one ma of the average current of the four. Ratings shown above are for each diode.

FIRST SUPPLEMENT

RECEIVING TUBE SUBSTITUTION GUIDE BOOK

BY

H. A. MIDDLETON

JOHN F. RIDER PUBLISHER, INC.
480 CANAL STREET NEW YORK 13, N. Y.

TABLE OF CONTENTS

First Printing, November, 1951
Second Printing, May, 1952
Third Printing, December, 1952
Fourth Printing, May, 1953
Fifth Printing, September, 1953

Printed in the United States of America

FOREWORD

Continued development and improvement of radios, television receivers, and other electronic equipment is to a great extent dependent on new and better vacuum tubes. Because of constant circuit changes and improvements, keeping a current list of tube substitutions for radios and television receivers is almost a never-ending job. Therefore, as the number of new substitutions justify it, supplements such as this one will be published periodically in order to keep your information up-to-date.

There are about 750 new substitutions listed in this supplement. Among these are some of the older tube types that were left out of the original Receiving Tube Substitution Guide Book. Substitutions are also listed here for some of the types for which we then thought were no substitutes. Most of the substitutions listed are for television receivers. When substituting tubes in television receivers, refer to the information given in the article "Tube Substitutions in Television Receivers" in this supplement.

It is not the object of these instructions to tell you how to improve radios, television sets, and other electronic equipment, but rather to help you in using the tubes you have to replace those that are not available.

It is important to understand that the information here calls for substitutes only. We do not recommend the use of these tubes when the original type is available. However, when you do not have the original tube types needed to repair electronic equipment, the Receiving Tube Substitution Guide Book and this supplement will prove invaluable to you. They will save you many hours and expedite repairs. In spite of over eight years experience in making and compiling these substitutions, there are no doubt some substitutions not listed here. Although a sincere effort has been made to list all the practical substitutions, to do so is practically an impossibility. We noticed while compiling these substitutions that one substitute served as a thought starter that brought others to mind. It may work the same way for you. You may find a substitute that we do not have listed. If you do work out a good substitute, do not trust your memory, but write it up in a form similar to that used here and attach it to the proper page in your Substitution Guide Book.

In addition to assisting you during times of tube shortages, this substitution information will help you to use tubes you have had on hand for long periods of time. Also, when tubes are plentiful, the information can be used for reconverting in cases where the substitute is less efficient than the original.

November, 1951

H. A. Middleton

SECTION 1

TUBE SUBSTITUTIONS IN TELEVISION RECEIVERS

Television sets of a few years ago, with their 7- to 10-inch picture tubes, used ordinary receiving tubes throughout except for the high-voltage rectifier tubes and, of course, the cathode-ray tubes. Consumer demand called upon the ingenuity of the television receiver and tube manufacturers for larger and larger pictures. Along with larger size picture tubes, it was necessary to develop other specialized types of television tubes. Special circuits in television receivers require characteristics in receiving tubes which are different from those of most ordinary radio receiving types.

Consider the use of magnetically deflected picture tubes. The magnetic picture tube requires sweep amplifiers capable of high power output. Tube manufacturers developed special tube types for these circuits which are capable of high plate current without the use of extremely high plate voltages. It is entirely possible that efficient operation in this circuit could have been accomplished by the use of higher output tubes which were already available and by increasing the size and output of the low-voltage power supply. However, the cost of building and maintaining this larger power supply, its greater size and weight, and the added danger are only a few of the reasons why this was not done. By designing new and special tube types, improved performance was made possible, circuits were simplified, and troubleshooting was made easier and safer for the television technician.

Although there are some twenty to thirty stages commonly used in television receivers, there are only about thirteen different tube classifications denoted by manufacturers in common use. There are many variations within each of these thirteen classifications. A large portion of tubes in a given similar classification which are designed for the same circuit application are enough alike to operate in some fashion when substituted for each other without change of circuit components. Sometimes a type designed for one circuit gives excellent results in another circuit. It is sometimes necessary to make mechanical changes in order to accomplish substitutions.

Because of the similarity of characteristics of many tubes, the more familiar the technician is with the circuit use of, the similarity between, and the satisfactory or unsatisfactory operation of one tube type compared to another, the more versatile and valuable his tube stock becomes. This is true especially in an emergency.

Listed on page 2 are thirteen classifications of tubes used in television receivers along with the commonly used types. Under each classification are listed the majority of individual circuits in which these tubes are used. A careful study of this chart will familiarize you with the tubes used in the most common television receiver circuits and will serve to expedite your service problems.

These listings will serve to indicate the most common usages of the tube types in each classification. Other types that are not listed may come to mind as you look over this list, or you may find additional listings in your Receiving Tube Substitution Guide Book. Differences in circuitry as used by various manufacturers may place some of the tubes into categories other than those shown here. As stated before, the object of the chart is to list the most common types in their most common circuits.

It has been found that substitutions in the front end or in the video strip can be more satisfactorily accomplished in television receivers located in strong signal areas than those located in fringe areas. A very small loss or gain that would go unnoticed when a substitution has been made in a receiver located in a strong signal area might be sufficient to seriously impair the picture quality in a fringe area.

In some areas, fringe conditions may exist on one channel while local conditions exist on another channel. Referring to the classifications

TELEVISION RECEIVER TUBES

Classification	Common Types	Specific Circuits
1. Low-voltage Rectifier	5U4, 5V4, 5Y3, 6AX5, 6X5, 25Z6	Low-voltage rectifier
2. High-voltage Rectifier	1B3, 1V2, 1X2, 1Y2, 1Z2, 5642	High-voltage rectifier
3. Pentode Power Amplifier and Beam Power Amplifier	6AQ5, 6F6, 6K6, 6L6, 6V6, 6Y6, 7B5, 7C5, 25L6, 35L6, 50L6	Audio output Vertical sweep output Horizontal sweep oscillator High-voltage r-f oscillator Video output
4. Duo-diode Triode	6AT6, 6AV6, 6SQ6, 6BF6, 6BK6, 6BT6, 6BU6, 12AT6, 12SQ6	First audio amplifier
5. High-frequency Triode	6AB4, 6C4	Local oscillator in front end Vertical sweep oscillator
6. R-f Pentode	6AG5, 6AJ5, 6AK5, 6AU6, 6BA6, 6BC5, 6BD6, 6BH6, 6CB6, 12AU6, 12BA6	Video i-f amplifier Sound i-f amplifier Radio-frequency amplifier Video output
7. Twin Triode	6BL7, 6F6, 6F8, 6J6, 6SL7, 6SN7, 7F7, 7F8, 12AT7, 12AU7, 12AV7, 12AX7, 12AY7, 12AZ7, 12SN7	Video amplifier Sync separator Mixer oscillator Vertical sweep output
8. High-power Beam Pentodes	6AU5, 6AV5, 6BD5, 6BG6, 6BQ6, 6CD6	Horizontal sweep output
9. Damper Rectifier	6AX6, 6V4, 6W4, 12AX4, 25W4	Damper
10. Twin Diode	6AL5, 6H6, 7A6, 12AL5, 12H6	Video detector circuit Horizontal discriminator Sound ratio detector
11. Triple-diode Triode	6R8, 6S8, 6T8	Ratio detector and first audio
12. Gated Beam Pentode	6BN6, 12BN6	FM detector Vertical sweep oscillator
13. High-frequency Triode Pentode	6U8, 6X8	Oscillator mixer

as specified in the performance column of your Substitution Guide, the substitution of a "G" or "P" classified type in the front end or video strip may impair the picture quality or even cause loss of the picture entirely in the case of the fringe area station while the local stations continue to be received satisfactorily. However, in times of tube shortages, when the original or a substitute with a classification of "E" is unavailable, this would be better than no reception at all.

The lack of uniformity of design and the variability of materials used in the manufacture of the same tube types by different manufacturers may cause premature failure in a given circuit in one run of tubes while a different run will hold up well. A certain run of 6BG6 tubes installed in sets with a 17-inch picture tube may fail after a week or two because of their lack of power-handling capabilities. Tubes from this same run may give good service in other sets where the power output requirements are less. The same may be found to be true of damper rectifier types where extremely high peak inverse voltages may cause flashover in an inferior run of 6U4 types. Low-voltage rectifiers in certain runs have been known to have inefficient filaments, and their output falls off rapidly when used in large-tube sets where output current requirements are high. When your service department finds such a run of tubes on hand, use them in the smaller-tube sets for most reliable service.

Low-voltage Rectifiers

Requirements for rectifier tubes in the low-voltage power supply of a television receiver are the same as for those used in ordinary radio receiving equipment, except that higher output current is usually required.

When choosing a substitute, it is only necessary to select a type which has sufficient current-carrying capacity and a peak inverse voltage rating equal to or greater than the original type. If the substitute type meets these requirements but also has higher filament current requirements that will reach the maximum rating of the available filament transformer winding, it is recommended as a substitute over another type that falls short of output current and does not have at least an equal peak inverse voltage. This is so even though this latter type has the same filament rating as the original tube.

Selenium rectifiers can be used as substitutes for tube-type rectifiers. When substituting with selenium rectifiers in the low-voltage power supply, it is good practice to use a large safety factor. For example, if the tube rectifier has a rated output current capacity of 225 ma, use at least a 300-ma selenium rectifier or a larger one if space permits. Rectifiers in the low-voltage power supply have had a high record for failure. Thus, the practice of using at least the next size larger as a substitution will help to eliminate expensive call-backs. Refer to the Receiving Tube Substitution Guide Book for additional information on selenium rectifiers.

High-voltage Rectifiers

There are only a limited number of types of high-voltage rectifiers being currently produced. When choosing a substitute, use the type that has an equal or higher peak inverse voltage rating than the type for which you are substituting. The output current requirement from these rectifiers is so small that little consideration need be given to this characteristic of the substitute type.

Since there are only a few of this type of tube available, mechanical alterations are frequently necessary when making a substitution. You must either extend the plate lead, install sockets, or do other rewiring. It is sometimes necessary to increase the size of the high voltage shield or modify it in some other way. Make sure that all high voltage leads are properly insulated and that the shield is fastened securely for safety's sake. One of the most difficult substitutions here is for the Sylvania type 5642 because of the small size of this subminiature tube. It is necessary to find space for mounting a tube socket and a shield can.

Pentode Power Amplifiers

Pentode power amplifier tubes and the small beam power types are generally used in five different circuits in television receivers. They are the audio output stage, the vertical sweep output, the horizontal sweep oscillator, the high-voltage r-f oscillator, and video output stage.

When substituting in the vertical output or high-voltage r-f oscillator circuits, be sure to choose a type whose output is equal to or greater than the original because of the amount of power involved in these stages. The use of a lower-powered tube than the original can sometimes be made to give from fair to good results by altering the values of the circuit components. The interelectrode capacitances are not generally considered to be a critical characteristic of the tube used in this circuit.

The audio output circuits of television receivers are not different from those used in ordinary radio receivers. Only in cases where high audio power is required from the receiver are substitutions in this stage critical. Component part changes may sometimes be necessary in order to secure optimum output from the substitute tubes.

The video output stage is a wide-band amplifier and is not critical with respect to power output. This is true because it is feeding into a relatively high impedance load. It is important to choose a substitute with similar interelectrode capacitance in order to insure uniform amplification throughout the entire video band. It is better to choose a tube with lower interelectrode capacitance than the reverse. If the substitute tube has lower interelectrode capacitance than the original, over-peaking may result. This can be compensated for by the installation of small carbon resistors across the peaking coils. Their value will vary with the substitution and can be determined by experimentation.

The horizontal sweep oscillator circuit is the least critical of all stages discussed in this section. Therefore, when a receiver utilizes a similar tube in any of the other four stages just mentioned, make the substitution in the horizontal oscillator stage. For example, assume that the vertical output tube is the same type as that used in the horizontal oscillator. If the vertical output tube is to be substituted for, it is usually desirable to transfer the horizontal oscillator tube to the vertical output stage and then substitute for the horizontal sweep oscillator.

Duo-diode Triodes

Duo-diode triodes are generally used in only one stage of television receivers, namely, the first audio amplifier. This circuit is identical to those used in ordinary radio receivers. When choosing a substitute for this circuit, the main consideration is the amplification factor of the triode section. Try to choose a substitute that has approximately the same amplification factor for best results. These types are often used only as triodes and no connection is made to the diode terminals. Under these conditions, they can be substituted for with a triode tube having characteristics similar to those of the triode section.

High-frequency Triodes

These types are generally used in two television circuits, the local oscillator in the front end and the vertical sweep oscillator.

Local oscillator circuits used in television receivers are basically the same as those used in radio receivers. Television oscillators, however, operate at a much higher frequency than do oscillators in ordinary radio receivers. For this reason, they are very critical as to any substitution. Even a very small change in the inductance or capacitance of the circuit may cause the circuit to become inoperative or operate at an incorrect frequency. Leads should be kept as short as possible. This should be kept in mind when making substitutions that require wiring changes. All of the mechanical characteristics of the circuit should be made as similar as possible to the original. Some oscillator tubes have more than one of the pins connected to the same element in the tube. When a substitution is made, the same method of connection should be followed.

The interelectrode capacitance of the substitute tube has a large effect on the circuit operation. The type of oscillator and the physical construction of the circuit afford different tolerances according to the specific case. If the grid-to-plate capacitance is higher in the substitute tube, the oscillator frequency would be lower in proportion to the increase in capacitance. If the capacitance is lower, the oscillator frequency will be higher. If the oscillator slug adjustment will not resonate the circuit to the proper frequency and the interelectrode capacitance is not too far off, it is possible that adjustment of the coils in the circuit will effect satisfactory operation. This, however, is no job for the novice, and, if you are not very sure of exactly how to go about it, let the job go until a satisfactory substitute or the original type becomes available. The adding or removal of a shield in this circuit will sometimes change the effective circuit capacitance enough to make the difference between satisfactory and unsatisfactory operation.

The vertical sweep oscillator operates at 60 cps so that high-frequency triodes are not actually required for this circuit. However, they are sometimes used for this service. Under these conditions, they are not considered critical as to substitution. The ordinary radio receiving type triode will make a good substitution in this stage. If the local ordinary oscillator in the front end fails and the same type is used in the vertical oscillator stage, place the tube from the vertical oscillator stage into the local oscillator socket and make the substitution in the less critical vertical sweep oscillator stage.

R-f Pentodes

Radio-frequency pentodes are the most used classification of tubes in television receivers. Because of this, there have been many variations of this type produced. Many of these are of the miniature, seven-pin construction.

In addition to some miscellaneous applications, they are used in four different circuits of a television receiver. These are the radio-frequency amplifier in the front end, the video i-f amplifiers, the sound i-f amplifiers, and the video amplifiers.

The small size of the miniature version of this tube type makes possible higher efficiency circuits at the very high frequencies. Therefore, the substitution of a larger tube designed for operation at lower frequencies will usually not be satisfactory. For example, a 6SH7 could not be used as a substitute for a 6BC5 because of the higher interelectrode capacitance of the larger tube. This, in addition to the greater distributed capacitance in the circuit due to longer leads required when changing the tube socket, would make alignment of the circuit almost impossible.

The radio-frequency stage in the front end is used primarily as an isolation stage between the antenna and the mixer. This stage is required to have a wide pass band so that not too much amplification is possible. This tube is therefore considered to be reasonably non-critical as to substitutions. Even a large difference in the gain of the tube used has little effect on the overall operation of the receiver.

The video i-f strip utilizes three or more stages of amplification. Of these, the first and the last usually contribute the least to the amplification of the signal. These are, therefore, the least critical as to substitutions. It is suggested that, when substitution is necessary in the i-f strip and where several tubes of identical type are used, that you first attempt a substitution without changing either alignment or component parts. Refer to your Receiving Tube Substitution Guide Book for performance classifications as well as characteristics. Tubes with high transconductance are usually the most satisfactory in this circuit, where amplification requirements are high. Theoretically, when a substitution is made in any of the video i-f stages, complete realignment is mandatory. However, from a practical standpoint, this may not be necessary.

The sound i-f strip has a much narrower bandwidth than the video i-f strip, and the available amplification is ordinarily greater than is required. For this reason, a reasonable reduction in the gain of the sound i-f stage is considered unimportant, making the circuit less critical to substitutions than are the video i-f stages.

It may be found that one of the video i-f tubes in a given receiver is defective and that the tubes used in the sound i-f are of identical types. In this case, replace the defective video stage tube with one of the sound stage tubes and proceed with the substitution in the less critical sound stage.

In the circuits discussed above, it is very important that connecting leads be kept short. When changing a socket, be sure to reconnect the leads the same way as they were originally in order to avoid increasing the distributed capacitance of the circuit and to minimize the possibility of regeneration.

The video output stage is not very critical as to substitutions. If you have a variety of substitutes, it is recommended that you try them all and use the one that produces the best results. If over-peaking is evident in the picture after a substitution has been made, this can be eliminated by shunting the peaking coils with small carbon resistors, as mentioned previously.

Twin Triodes

Twin triodes have many equivalents and many uses. Some of these are the following:

mixer-oscillator, sync separator, video amplifier, vertical oscillator, horizontal oscillator, and horizontal frequency control.

In its application as mixer-oscillator in the front end, substitution is very critical. It is important to choose a substitute type tube whose interelectrode capacitance is very similar and which was designed for the same circuit. If the interelectrode capacitance is not too different from that of the original, adjustment of the oscillator tuning slug will resonate the oscillator circuit at the proper frequency. For further information on the operation of the oscillator section, refer to the paragraph discussing high-frequency triodes used as local oscillators in the front end. When twin triodes are used (with one triode as the local oscillator and the other as the mixer), so long as the oscillator circuit operates properly with the substitute, the mixer circuit can usually be relied upon to operate equally well. The mixer alignment should be checked and adjusted if necessary.

Sync separators operate at low frequencies and at low power. They are considered non-critical as to substitutions. In making your choice of a substitute for this circuit you need give little consideration to the interelectrode capacitance and to the recommended operating frequency of the type used. Try to choose a type in which the plate current, amplification factor and grid bias are approximately the same as the original.

Video amplifiers are wide-band amplifiers, and, therefore, when choosing a substitute type, select one that has similar interelectrode capacitance in order to insure uniform amplification throughout the entire band.

The vertical oscillator and the vertical output stage functions in television receivers are ordinarily performed by the same tube when a triode is employed. It is important when choosing a substitute for these stages that the substitute type have equal or higher power rating characteristics. All other characteristics are relatively unimportant, and the circuit is generally considered non-critical as to substitutions.

The horizontal oscillator and frequency control circuit functions are sometimes performed by the same tube. The circuits are also considered fairly non-critical as to substitutions. When choosing a substitute for these circuits, select one that has similar power rating characteristics. The interelectrode capacitance has little effect on the circuit.

High-power Beam Pentodes

These types, as used in television receivers, were especially designed for use with magnetically deflected picture tubes. Effectively, they are redesigned versions of the high-power audio output pentode tubes as used in low power amplifiers. They are highly insulated in order to withstand the high peak voltages in the horizontal output circuit of a television receiver. The high output power needed requires these tubes to be so designed that they draw high plate current while using low operating voltages. When substituting in this circuit, it is important that the substitute be capable of equal or higher output as compared with the original type.

Damper Rectifiers

Damper rectifiers with indirectly heated cathodes are especially designed for television service and are capable of withstanding high peak inverse voltages and of producing fairly high output currents. When choosing a substitute for the damper stage, be sure that it is capable of withstanding the high voltage without flashover and that it has at least an equal current rating as compared to the original. A high percentage of failure of this tube type is due to flashover between the heater and cathode. If no substitute tube is available that has an equal or higher peak inverse and output current rating, try an ordinary radio power rectifier that has the required output current rating. The filament must be heated by a separate transformer having a breakdown voltage rating of not less than 3,000 volts. When this substitution is made in a transformer-type television receiver, the original filament leads should be disconnected and securely taped. In transformerless receivers, where the damper tube filament is a part of a series circuit, the original filament leads must be disconnected from the socket and reconnected to a resistor of the correct value to properly complete the filament circuit. Data for computing the filament resistor necessary is contained in the Receiving Tube Substitution Guide Book.

Twin Diodes

Twin diode tubes are generally used in three different television circuits. These are the video detector, the horizontal discriminator, and the sound detector. There is a very limited choice in this classification. It may sometimes be found necessary to use the corresponding diodes in some multi-purpose tube to accomplish substitution in these stages. When this is done, connect all unused elements in the substitute tube to ground. If a substitute tube is not available, any of these circuits can be made operative by the use of a pair of germanium crystal diodes whose current ratings are comparable to the original tube. When a substitution has been made in the sound detector, the last i-f sound stage should be checked for alignment. When a substitute has been made in the video detector, the alignment of the last video i-f stage should be checked and realignment performed if necessary.

Triple-diode Triodes

Triple-diode triodes especially designed for television receivers are frequently used in the ratio detector and first audio circuits. There are a very limited number in this classification of tubes. The circuits are considered fairly non-critical as to substitutions, but the problem of finding a substitute with the necessary quantity of elements may be difficult. A good substitute, however, is a duo-diode triode having similar characteristics and the addition of a germanium crystal diode to take the place of the missing diode element. Where space is not a factor in the substitution, a combination of two tubes may be used to accomplish the same purpose. When making substitutions of this kind, select a tube with a triode section that has similar characteristics to the original type. Realignment of the last sound i-f stage is ordinarily necessary after this substitution has been made.

Gated Beam Pentodes

Designed especially for television and f-m receivers, the gated beam pentode is used in the f-m detector circuit and in the vertical oscillator circuit. No other tube type can be easily substituted in this circuit. The number of types available in this classification are very few.

When this tube is not available, it will be necessary to substitute another circuit using conventional tubes. A ratio detector should be substituted for the f-m sound detector. The reason for suggesting a ratio detector circuit is that a limiter stage is not usually required. Since the gated beam tube f-m detector does not require the limiter stage, the ratio detector circuit involves fewer circuit changes. This substitution could be accomplished with a triple-diode triode tube such as the 6T8 or with a duo-diode triode such as the 6AT6 in conjunction with a germanium diode crystal. It is necessary to change the last sound i-f transformer to a ratio detector transformer and to change any other components necessary for this new circuit.

If the gated beam pentode is used as the vertical oscillator, it will again be necessary to change the circuit when the original type or a similarly classified type tube is not available. Any conventional triode having the required characteristics may be used as the vertical oscillator if the blocking oscillator circuit is employed. Any conventional twin triode with the required characteristics may be used if the multivibrator oscillator circuit is employed.

High-frequency Triode Pentodes

These types are recent additions to special television types and are for use in the front end as the local oscillator and mixer. Like the high-frequency triode tube used as the local oscillator in the front end, they are very critical as to substitution. The type is composed of two separate sections: a high-frequency triode for use as the local oscillator and a pentode section for use as a mixer. The interelectrode capacitance of any substitution for these types must be very similar to the original. Shielding these types will change the circuit capacitance considerably. Since the variety of these types is very limited, it may be necessary to use two tubes as a substitute. The placement and the length of the connecting leads are a critical consideration when mechanical and wiring changes are required. The older type triode pentodes such as the 6F7, 6AD7, and 6P7 are not capable of operation on television frequencies and cannot be satisfactorily used as substitutes.

EXAMPLES OF PRACTICAL TELEVISION TUBE SUBSTITUTIONS

RCA 630TS. The following substitutions were made in an RCA 630TS television chassis. This chassis is not only used in RCA television receivers but also in a great many other brand sets.

Before the substitutions were made, all tubes and component parts in the set were carefully checked and found to be in good condition. The chassis was also carefully and completely realigned for peak performance. Suitable test equipment was used to show the differences in the response curves with the original and substitute tubes.

The procedure was as follows: The response curve of the stage in which the substitution was to be made was observed on an oscilloscope and the gain and bandwidth were carefully noted. The substitute tube was then installed and the difference in response and gain were tabulated. The set was then completely realigned for optimum output. The change in efficiency of operation was then noted. The original tube was then reinstalled and the set was again completely realigned and made ready for the next substitution.

Component parts were changed to adjust the bias and operating voltages of the substitute tube when required. In none of the following substitutions was there enough improvement to justify the use of the substitute rather than the original tube. A change in alignment was necessary in some cases in order to retain the correct response curve. In a few cases it was necessary to readjust the sound traps after making a substitution.

The results of making substitutions for the video i-f amplifiers follow. The original tube was a 6AG5.

RCA 630 TS Video I-f Amplifier Substitutions

Substitute	Stage	Circuit Changes and Results
6AU6	1st, 2nd, 3rd video i-f	No changes. Results equal to original after careful realignment.
6AU6	4th video i-f	This substitution is not recommended.
6BC5	1st, 2nd, 3rd video i-f	No changes. Results equal to original without realignment.
6BC5	4th video i-f	No changes. Results equal to the original after careful realignment.
6AK5	All video i-f	No changes. Different heater current but, because of parallel connection, no rewiring required.
6CB6	All video i-f	The cathode and suppressor grids are connected internally in the 6AG5 but these elements are separate on the 6CB6. Connect pins 2 and 7 together on the socket. If pin 2 is used as a tie point on the 6AG5, remove leads from pin. Solder these together and tape. Results equal to original.
9003	All video i-f	No changes. About 5 percent loss in gain after careful realignment.
6AH6	1st, 2nd, 3rd video i-f	Results equal to original after careful realignment.
6AH6	4th video i-f	This substitution is not recommended.

RCA 630 TS Video I-f Amplifier Substitutions (cont'd)

Substitute	Stage	Circuit Changes and Results
6BA6	1st, 2nd video i-f	No changes. Results equal to original without realignment.
6BA6	3rd video i-f	No changes. About 20 percent loss in gain after careful realignment.
6BA6	4th video i-f	No changes. About 30 percent loss in gain after careful realignment.
6BD6	1st, 2nd, 3rd video i-f	Connect pins 2 and 7 together on socket. Results equal to original after careful realignment.
6BD6	4th video i-f	Connect pins 2 and 7 together on socket. Results equal to original without realignment.

The results of making substitutions for the 1st video amplifier follow. The original tube was a 6AU6.

RCA 630 TS 1st Video Amplifier Substitutions

Substitute	Circuit Changes and Results
6CB6	No changes. About 10 percent increase in gain.
6AG5	No changes. About 20 percent increase in gain after careful realignment of 4th video i-f stage.
6AK5	No changes. Heater current differs, but, since parallel connection is used, no rewiring required. About 30 percent increase in gain.
6BA6	No changes. Results equal to original without realignment.
6BH6	No changes. The suppressor grid and cathode pin connections are reversed but both are connected to the same point. Results equal to original without realignment.

The results of making substitutions for the 2nd video amplifier follow. The original tube was a 6K6.

RCA 630 TS 2nd Video Amplifier Substitutions

Substitute	Circuit Changes and Results
6F6	No changes. Heater currents differ, but this is a parallel circuit. Operates well without change or adjustment.

RCA 630 TS 2nd Video Amplifier Substitutions (cont'd)

Substitute	Circuit Changes and Results
6L6	No changes. Heater currents differ, but this is a parallel circuit. About 20 percent increase in gain without adjustment.
6U6	No changes. Heater currents differ, but this is a parallel circuit. About 20 percent increase in gain without adjustment.

The results of making substitutions for the first two sound i-f amplifiers follow. The original tube used in the first two stages was a 6BA6.

RCA 630 TS Sound I-f Amplifier Substitutions

Substitute	Circuit Changes and Results
6AU6	No changes. Equal results after realignment.
6BD6	No changes. About 50 percent loss in gain resulted. This substitution is not recommended in other than strong signal areas.
9003	No changes. Heater currents differ, but this is a parallel circuit. About 20 percent loss in gain resulted.

Because of slight differences in tube characteristics and variations in television receiver circuits and operating voltages, results obtained in every case may not match exactly those results given above. However, diffierences in results should not be too great.

Belmont 18DX21A. A Number of tube substitutions were made in a Raytheon Belmont television set, model number 18DX21A. Exactly the same procedure was used as in the case of the RCA 630 TS. The results of making substitutions for the limiter stage follow. The original tube was a 12AU6.

Belmont 18DX21A Limiter Substitutions

Substitute	Circuit Changes and Results
12BA6	No changes. Operation is equal to the original. Realignment does not improve operation.
12BD6	No changes. About 30 percent loss in gain. Realignment and changes in operating voltages were attempted without satisfaction. If the set is located in a strong signal area little change will be noticed. Do not attempt this substitution for fringe area operation.

Belmont 18DX21A Limiter Substitutions (cont'd)

Substitute	Circuit Changes and Results
12AW6	The suppressor grid and cathode are connected to opposite pins. In this set these elements are connected together; therefore, no change is required. Substitution gives a 30 percent increase in gain without realignment and is recommended for fringe area operation.

The results of making substitutions for the i-f stages follow. The original tubes used were 6BA6's.

Belmont 18DX21A I-f Amplifier Substitutions

Substitute	Stage	Circuit Changes and Results
6AU6	1st i-f	No changes. Results equal to original after careful realignment.
6AU6	2nd i-f	No changes. About 30 percent increase in gain after careful realignment. Recommended for fringe area operation.
6AU6	3rd i-f	No changes. Results equal to original. No realignment required.
6BD6	1st i-f	No changes. About 10 percent loss in gain after careful realignment.
6BD6	2nd, 3rd i-f	No changes. Results equal to original after careful realignment.
6AG5	All i-f	No changes. Results equal to original after careful realignment.
6CB6	1st i-f	No changes. Results equal to original after careful realignment.
6CB6	2nd, 3rd i-f	No changes. About 30 percent loss in gain after careful realignment.
6BC5	All i-f	No changes. Results equal to original after careful realignment.

In addition to the above, a 19C8 was substituted for the 19T8 FM discriminator and first audio amplifier. No changes were required. The only apparent result was a slight loss in audio gain.

As pointed out previously, because of slight differences in tube characteristics and variations in circuits and voltages, the exact results given above may not always be obtained. However, great differences should not be found.

SECTION 2

RECEIVING TUBE SUBSTITUTION GUIDE

This section includes the actual information on the tube substitutions. The same format is followed as was used in the Receiving Tube Substitution Guide Book. Four columns are used. The first column gives the tube type for which a substitute is desired. The listing is in numerical-alphabetical order. No distinctions are indicated insofar as glass or metal tubes are concerned and the letters G, GT, GT/G, GA, or GP all have been omitted. In most cases, these letters simply indicate a glass type whose characteristics are practically the same as the metal type having the corresponding type number.

Column three lists the performance rating. Substitutions that we have found through practical experience will operate with equal or very nearly equal results compared to the original and those that have equal or nearly equal electrical characteristics are given a performance classification of E for EXCELLENT. Substitutions that we have found to operate satisfactorily, although they do show a distinct loss, or those that have the same functional classification as the tube being substituted for but whose electrical characteristics are from 20 percent to 50 percent different, are classified G for GOOD. Others that are less efficient but which did operate in a fashion and those whose functional classification is different or whose critical characteristics are unlike the original by more than 20 percent are classified P for POOR. These are recommended for emergency use only.

Column four gives the necessary circuit changes. It is impractical to include a listing of component part changes in order to alter the circuit with the substitute tube. The changes would vary widely with the type of circuit and the applied voltages; therefore, information correct for some sets would be grossly incorrect for others. Because of this, substitutions other than those classified E are not completely worked out for you. However, those substitutions classified G are satisfactory in most cases without component part changes, thus saving the equipment owner added parts and labor changes. A complete discussion covering the technique of computing substitute bias and load resistance is contained in the Receiving Tube Substitution Guide Book. When making changes in component parts, always make a complete record of the original values of the circuit altered, and securely attach it to the chassis of the equipment.

The necessary wiring changes, socket changes, and filament voltage adjustments are described in detail for each substitution listed. The instruction "No changes" indicates that the base wiring for the substitute is the same and that the filament voltage and current ratings are equal. The note "Parallel circuits only" indicates that the filament current ratings of the two tubes are unequal. This note is appended to some types that are not usually used in other than parallel circuits. This has been done to make the information more uniform and less confusing to the novice.

A few substitutions are followed by the note "Series circuits only." In these, the filament current of the substitute is equal to that of the original but the filament voltage is unequal. If the filament voltage of the substitute is higher than the original, then the voltage is reduced on all the other tubes in the circuit. If the substitute has a lower filament voltage rating, the voltage is increased on all the other tubes in the circuit. A series filament resistor is recommended where the increase in voltage amounts to more than five percent. When making substitutions requiring rewiring or socket changes, always make a note showing the original type used and the circuit in which the substitution is made. Then attach the note securely to the chassis.

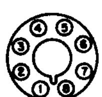
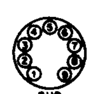
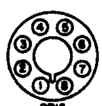
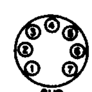
Some substitutions listed, like the nine-prong noval series, have a heater center-tap connection which permits them to be operated at either 6.3 volts or 12.6 volts. These types are almost always numbered to indicate the higher heater voltage (12AT7, 12AU7). These types are listed as substitutes for the 6 and 7 series tubes having 6.3-volt heaters. When this is done the two halves of the noval tube heater are connected in parallel, thus cutting the necessary filament voltage in half and doubling the current required. Depending on the heater current of the type being substituted for, these types may be marked "Parallel circuits only" or they may be usable in either parallel or series circuits. These same tubes may be listed elsewhere as substitutes for 12.6-volt heater types. Whether these types are used as substitutes for 6.3-volt or 12.6-volt tubes, they will be operating at the proper voltage.

Some miniature tubes with 12.6-volt heaters do not have tapped heaters. These are usually used in series circuits that are connected directly to the line. Occasionally, a 12.6-volt winding is provided on the power transformer for the heaters in a parallel circuit.

When substituting for 12.6-volt tubes in series circuits with 6.3-volt types having equal current ratings, the increase in voltage spread over all the other tubes is small and need not be considered. However, it is good practice to shunt a small resistor of about 300 ohms across the heater of the 6.3-volt tube in order to reduce the current flow through it during the time it takes for the tubes to heat. When a transformer winding is provided for the 12.6-volt tube and it is desired to use a 6.3-volt type, this can be done simply by moving one of the socket heater connections to the center-tap of the heater winding.

It should be pointed out that when "electric operation" is referred to in the substitutions which follow, the term is taken to mean non-battery operation. In other words, the receiver is to operate from the power line.

RECEIVING TUBE SUBSTITUTIONS

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
0A3	0B3	P	No changes.
0Z4	6AX5	E	Rewire as follows: Connect No. 2 to chassis Connect No. 7 to 6 volt filament.
	6AX6	E	Rewire as follows: Connect No. 4 and No. 8 together Connect No. 2 to chassis Connect No. 7 to 6 volt filament.
	6BY5	E	Rewire as follows: No. 3 to No. 4 Connect No. 1 and No. 8 together Connect No. 2 to chassis Connect No. 7 to 6 volt filament.
	6V4	E	Change socket to noval and rewire as follows: No. 3 on octal to No. 1 on noval 5 to 7 8 to 3 Connect No. 4 to chassis Connect No. 5 to 6 volt filament.  ORIG.  SUB.
	6X4	E	Change socket to miniature and rewire as follows: No. 3 on octal to No. 1 on miniature 5 to 6 8 to 7 Connect pin No. 3 to chassis Connect pin No. 4 to 6 volt filament.  ORIG.  SUB.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
0Z4	6Y5	E	Change socket to six prong and rewire as follows:

No. 3 on octal to No. 3 on six prong
5 to 5
8 to 4
Connect pin No. 1 on six prong to chassis
Connect pin No. 6 to 6 volt filament.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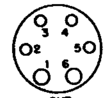
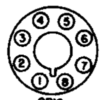

SUB.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	6Z5	E	Change socket to six prong and rewire as follows:

No. 3 on octal to No. 3 on six prong
5 to 5
8 to 4
Connect No. 2 and No. 6 to chassis
Connect No. 1 to 6 volt filament.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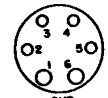
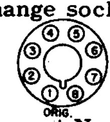

SUB.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	6ZY5	E	Same as 0Z4 to 6AX5.
	7Z4 1274	E E	Change socket to loctal and rewire as follows:

No. 3 on octal to No. 3 on loctal
5 to 6
8 to 7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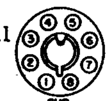

SUB.

Connect No. 8 on loctal to chassis and No. 1 on loctal to 6V hot lead.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
1A4	1A4P 1A4T	G G	No changes.
1A5	1W4	G	Change socket to miniature and rewire as follows:

No. 2 on octal to No. 7 on miniature
3 to 2
4 to 3
5 to 6
7 to 1


ORIG.


SUB.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	3LE4 3LF4	P	Electric operation only. Same as 6W6 to 7A5 except do not connect No. 8 on octal to No. 7 on loctal.
1A5	3V4	P	Electric operation only. Change socket to miniature and rewire as follows:

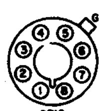
No. 2 on octal to No. 1 on miniature
3 to 2
4 to 3
5 to 6
7 to 7
Do not use pin No. 5.


ORIG.


SUB.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
1A7	1LB6	G	Change socket to loctal and rewire as follows:

No. 2 on octal to No. 1 on loctal
3 to 2
4 to 4 & 5
5 to 6
6 to 3
7 to 8
cap to 7

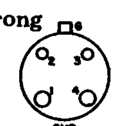

ORIG.


SUB.

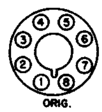
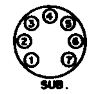
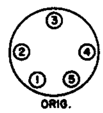
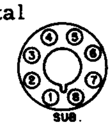
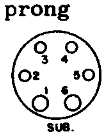
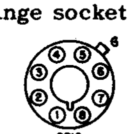
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
1AE4	1L4 1T4 1U4	P P P	Parallel circuits only. Not satisfactory for oscillator. No changes.
1AF5	1U5	G	Parallel circuits only. Change connections as follows: Remove,connect and tape up any wires connected to No. 2 Connect No. 5 to No. 2 Reverse connections between Nos. 3 and 4
1B3			
	1Y2	G	Change socket to four prong and rewire as follows:

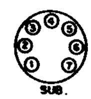
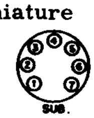
No. 2 on octal to No. 1 on four prong
7 to 4
cap to cap

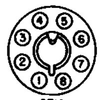
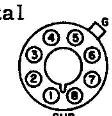
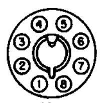
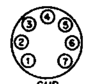
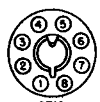
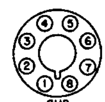
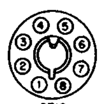
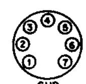
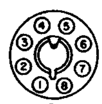
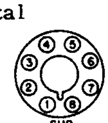
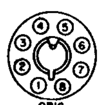
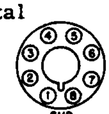
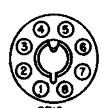
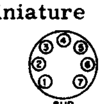
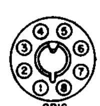
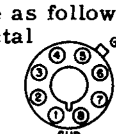

ORIG.

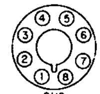
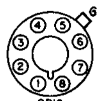
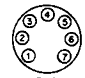
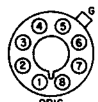
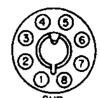
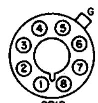
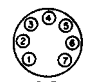
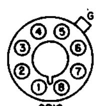
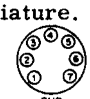
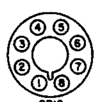
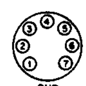

SUB.

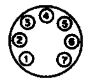
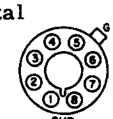
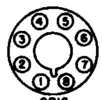
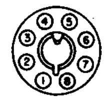
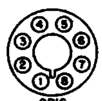
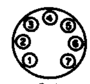
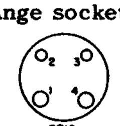
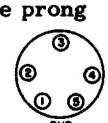
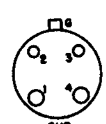
Required filament voltage for 1Y2 is 0.25 volt higher but operates satisfactorily in most cases.

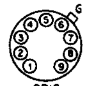
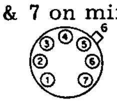
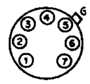
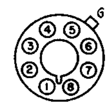
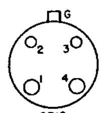
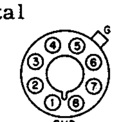
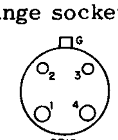
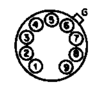
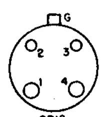
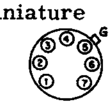
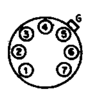
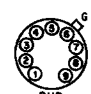
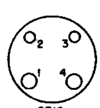
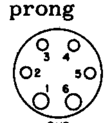
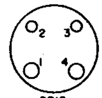
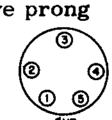
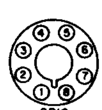
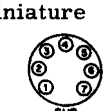
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
1B3	1Z2	G	Parallel circuits only. Same as 1B3 to 1X2A Filament voltage 0.25 volts higher. Do not use on large sets where inverse peak voltage exceeds 20,000 volts.
1C5	1W4	G	Parallel circuits only. Same as 1A5 to 1W4.
	3LE4 3LF4	G G	Change socket to loctal and rewire as follows: No. 2 on octal to No. 1 & 8 on loctal 3 to 2 4 to 3 5 to 6 7 to 7 
	3V4	G	Change socket to miniature and rewire as follows: No. 2 on octal to No. 1 & 7 on miniature 3 to 2 4 to 3 5 to 6 7 to 5 
1F4	1J5	G	Change socket to octal and rewire as follows: No. 1 on five prong to No. 2 on octal 2 to 3 4 to 4 3 to 5 5 to 7 
	33 950	G G	Parallel circuits only. No changes. No changes.
1F5	1J5 33 950	G G G	No changes. Reverse 1F4 to 1J5 procedure, parallel circuits only. Reverse 1F4 to 1J5 procedure.
1G5	1F4	E	Reverse 1F4 to 1J5 procedure.
	1F5	E	No changes.
	33	G	Reverse 1F4 to 1J5 procedure. Parallel circuits only.
	950	G	Reverse 1F4 to 1J5 procedure.
1G6	19	G	Parallel circuits only. Change socket to six prong and rewire as follows: No. 2 on octal to No. 1 on six prong 3 to 2 4 to 3 5 to 4 6 to 5 7 to 6 
1H4	1G4	E	No changes.
1H5	1N6	G	Rewire as follows: Remove, connect, and tape up any wires anchored on No. 4 and No. 6 Connect No. 3 and No. 4 together. No. 5 to No. 6 Grid lead to No. 5
	1SB6	E	Change connections as follows: Remove, connect, and tape up any wires anchored on terminals No. 4 and No. 8. No. 4 to No. 3 Grid Lead to No. 8.
	1U5	G	Change socket to miniature and rewire as follows: No. 2 on octal to No. 1 on miniature 3 to 2 & 3 5 to 4 Grid lead to 6 7 to 7 

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
1J5	1F4	G	Reverse 1F4 to 1J5 procedure.
	1F5	G	No changes.
	33	G	Reverse 1F4 to 1J5 procedure. Parallel circuits only.
	950	E	Reverse 1F4 to 1J5 procedure.
1J6	1G6	G	Parallel circuits only. No changes.
1L4	1S5	G	Same as 1T4 to 1S5
	1U5	G	Cut off pin No. 4 on 1U5. Rewire as follows: Connect No. 1 & 5 together.
1L6	1R5	G	Reverse connections between No. 5 and No. 6.
	1U6	G	Connect a 56 ohm ½ watt resistor from terminal No. 1 to No. 7 when used in series circuits. Resistor not required in parallel circuits. No other changes.
1LA4	3D6/1299	G	Parallel circuits only. Same as 1LB4 to 3D6.
	3LE4 3LF4	P P	For electric operation only. Rewire as follows: Remove, connect, and tape up any wires connected to pin No. 7 of 1LA4.
	3LE4 3LF4	G G	Parallel circuits only. Change connections as follows: Remove No. 8 lead and connect to No. 7 Connect No. 1 and No. 8 together.
	3V4	P	Electric operation only. Change socket to miniature and rewire as follows: No. 1 on loctal to No. 1 on miniature 2 to 2 3 to 3 6 to 6 8 to 7  
	3V4	G	Parallel circuits only. Change socket to miniature and rewire as follows: No. 1 on loctal to Nos. 1 & 7 on miniature 2 to 2 3 to 3 6 to 6 8 to 5  
1LB4	3LE4 3LF4 3D6/1299	G G P	Parallel circuits only. Change connections as follows: Remove No. 8 lead and connect to No. 7 Connect No. 1 and No. 8 together.
	3V4	P	Same as 1LA4 to 3V4 for electric operation only.
	3V4	G	Same as 1LA4 to 3V4 for parallel circuits only.
1LE3	1L4 1T4 1U4	G G G	Change socket to miniature and rewire as follows: No. 1 on loctal to No. 1 on miniature 2 to 2 & 3 6 to 6 8 to 7  
	1LC5 1LG5 1LN5	G G G	Rewire as follows: Remove, connect, and tape up any wires anchored on No. 3. Do the same for No. 4. Connect No. 2 and No. 3 together. Connect No. 4 and No. 5 together.

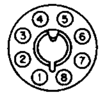
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
1LE3	1LH4	G	Cut off pin No. 4 on 1LH4. This substitution operates well as an oscillator.
1LG5	1AF4	G	Parallel circuits only. Same as 1LG5 to 5910.
	1LN5	E	No changes.
	1N5 1P5	E G	Change socket to octal and rewire as follows: No. 1 on loctal to No. 2 on octal 2 to 3 3 to 4 8 to 7 6 to cap  ORIG.  SUB.
	1S4	G	Parallel circuits only. Change socket to miniature and rewire as follows: No. 1 on loctal to No. 1 on miniature 2 to 2 3 to 4 4 to 1 6 to 3 8 to 7  ORIG.  SUB.
	1SA6	G	Change socket to octal and rewire as follows: No. 1 on loctal to No. 2 on octal 2 to 8 3 to 6 4 to 3 6 to 4 8 to 7  ORIG.  SUB.
	5910	G	Change socket to miniature and rewire as follows: No. 1 on loctal to No. 1 on miniature 2 to 2 3 to 3 4 to 5 6 to 6 8 to 7  ORIG.  SUB.
1LH4	1LD5	G	Rewire as follows: Remove and tape up any wires anchored on No. 3. Connect No. 2 and No. 3 together.
	1N6	G	Change socket to octal and rewire as follows: No. 1 on loctal to No. 2 on octal 2 to 3 & 4 4 to 6 6 to 5 8 to 7  ORIG.  SUB.
	1SB6	G	Change socket to octal and rewire as follows: No. 1 on loctal to No. 2 on octal 2 to 3 & 4 4 to 5 6 to 8 8 to 7  ORIG.  SUB.
	1U5	G	Change socket to miniature and rewire as follows: No. 1 on loctal to No. 1 on miniature 2 to 2 & 3 4 to 4 6 to 6 8 to 7  ORIG.  SUB.
	3A8	P	Parallel circuits only. Change socket to octal and rewire as follows: No. 1 on loctal to No. 1 on octal 4 to 8 6 to 5 8 to 2 & 7 Connect No. 3 and No. 4 to No. 1 Cap connection not used.  ORIG.  SUB.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
1LH4	3A8	P	Electric operation only. Change socket to octal and rewire as follows:  No. 1 on loctal to No. 2 on octal 2 to 6 4 to 8 6 to 5 8 to 7  Connect No. 2 and No. 3 to No.1.
1LN5	1L4 1T4 1U4	G G E	Same as 1LG5 to 5910.
	1LG5	G	No changes.
1N5	1U5	G	Change socket to miniature and rewire as follows:  No. 2 on octal to No. 1 on miniature 3 to 2 4 to 3 Grid lead to 6 7 to 7 
1P5	1L4	G	Same as 1P5 to 1U4.
	1LC5 1LG5 1LN5	G G E	Change socket to loctal and rewire as follows:  No. 2 on octal to No. 1 on loctal 3 to 2 4 to 3 7 to 8 cap to 6 Short loctal terminals 4 and 5 
	1S5	G	Change socket to miniature and rewire as follows:  No. 2 on octal to No. 1 on miniature 3 to 5 4 to 4 7 to 7 cap to 6 
	1U4	G	Change socket to miniature or make adaptor as follows:  No. 2 on octal to No. 7 on miniature. 3 to 2 4 to 3 7 to 1 cap to 6  This substitution squeals in some cases, works best as r-f tube.
	1U5	G	Same as 1N5 to 1U5.
1Q5	1LA4 1LB4	G G	Parallel circuits only. Same as 1A5 to 3LE4.
	1S4	G	Change socket to miniature and rewire as follows:  No. 2 on octal to No. 1 on miniature 3 to 2 4 to 4 5 to 3 7 to 7 
	1T5	G	Parallel circuits only. No changes.
	1W4	G	Parallel circuits only. Same as 1A5 to 1W4.
	3LE4 3LF4	P P	Same as 1C5 to 3LE4. Same as 1C5 to 3LE4.
	3V4	P	Same as 1C5 to 3V4.
1S4	1W4	G	Parallel circuits only. Change connections as follows: No. 6 to No. 2 3 to 6 4 to 3 5 to 1

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
1S4	3V4	G	Parallel circuits only. Change connections as follows: No. 6 to No. 2 3 to 6 4 to 3 5 to 1 7 to 5 Connect No. 1 and No. 7 together.
1S5	1AF5	G	Parallel Circuits only. Rewire as follows. Remove and tape up any wires connected to No. 5. No. 2 to No. 5
	1H5	E	Where space permits. Change socket to octal or make adaptor wiring as follows:  ORIG. No. 1 on miniature to No. 2 on octal 4 & 5 to 3 3 to 5 7 to 7 6 to cap  SUB.
1SA6	1LG5	G	Change socket to loctal and rewire as follows:  ORIG. No. 2 on octal to No. 1 on loctal 8 to 2 6 to 3 3 to 4 4 to 6 7 to 8  SUB.
	1L4 1T4 1U4	G G G	Change socket to miniature and rewire as follows:  ORIG. No. 2 on octal to No. 1 on miniature 3 to 1 4 to 6 6 to 3 7 to 7 8 to 2  SUB.
1T4	1S5	G	Change connections as follows: No. 5 to No. 1 2 to 5 3 to 4
	1U5	G	Cut off pin No. 4 on 1U5. Connect terminals No. 1 & No. 5 together.
1T5	3LE4 3LF4	G G	Parallel circuits only. Same as 1C5 to 3LF4.
	1W4	G	Same as 1A5 to 1W4.
	3V4	P	Electric operation only. Same as 1A5 to 3V4.
1U4	1S5	G	Same as 1T4 to 1S5.
	1U5	G	Cut off pin No. 4 on 1U5. Rewire as follows: Connect No. 1 and No. 5 together.
1V	14Y4	G	Series circuits only. Same as 12Z3 to 14Y4.
	37 76	G G	Change socket to five prong and rewire as follows:  ORIG. No. 1 on four prong to No. 1 on five prong 2 to 2 & 3 3 to 4 4 to 5  SUB.
1W4	1S4	G	Parallel circuits only. Rewire as follows: No. 3 to No. 4 6 to 3 Do not use pin No. 6 as anchor.
1X2	1Y2	E	Change socket to four prong and rewire as follows:  ORIG. Nos. 1, 4, 6, & 9 on noval to No. 1 on four prong. Nos. 2, 5, & 8 on noval to No. 4 on four prong. Cap on Noval to cap on four prong.  SUB.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
1X2	1Z2	E	Change socket to miniature and rewire as follows: Nos. 1,4,6 & 9 on noval to Nos. 1, 3, 4, & 6 on miniature. Nos. 2,5, & 8 on noval to Nos. 2,5, & 7 on miniature. Cap on noval to cap on miniature.  ORIG.  SUB.
1X2A	1B3	E	Where space permits. Change socket to octal and rewire as follows: Nos. 1,3,4,6 on miniature to No. 2 on octal 2,5,7 to 7 cap to cap  ORIG.  SUB.
1Y2	1B3	E	Change socket to octal and rewire as follows: No. 1 on four prong to No. 2 on octal 4 to 7 cap to cap  ORIG.  SUB.
	1B3	G	Parallel circuits only. Reverse 1B3 to 1Y2 procedure. Filament voltage will be 0.25 volts high on 1B3 and will serve to shorten its life. A small piece of resistance wire placed in series with the filament will correct this.
	1X2	E	Change socket to four prong and rewire as follows: No. 1 on four prong to No. 2 on noval 4 to 4 cap to cap  ORIG.  SUB.
	1Z2	G	Change socket to miniature and rewire as follows: No. 1 on four prong to No. 1 on miniature 4 to 7 cap to cap Connect No. 1, 3, 4, and 6 together. Connect No. 2, 5, and 7 together. Do not use where inverse peak voltage exceeds 20,000 volts.  ORIG.  SUB.
1Z2	1X2	E	Change socket to noval and rewire as follows: Nos. 1,3,4, & 6 on miniature to Nos. 1,4,6, & 9 on noval. Nos. 2,5, & 7 on miniature to Nos. 2, 5, & 8 on noval. Cap on miniature to cap on noval.  ORIG.  SUB.
	1Y2	G	Reverse 1Y2 to 1Z2 procedure.
2A3	2A5	G	Parallel circuits only. Change socket to six prong and rewire as follows: No. 1 on four prong to No. 1 on six prong 2 to 2 & 3 3 to 4 4 to 5 & 6  ORIG.  SUB.
	47	G	Parallel circuits only. Change socket to five prong and rewire as follows: No. 1 on four prong to No. 1 on five prong 2 to 2 & 4 3 to 3 4 to 5  ORIG.  SUB.
3B5	3Q4	G	Same as 1Q5 to 1S4.
	3V4	G	Change socket to miniature and rewire as follows: No. 2 on octal to No. 1 on miniature 3 to 2 4 to 3 5 to 6 7 to 7 8 to 5  ORIG.  SUB.

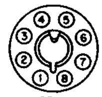
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
3LE4	3Q4 3S4	E G	Change socket to miniature and rewire as follows:


ORIG.

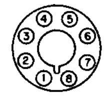
No. 1 on loctal	to No. 1 on miniature
2	to 2
3	to 4
6	to 3
7	to 5
8	to 7


SUB.

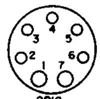
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	3Q5 3B5 3C5	G G G	Change socket to octal and rewire as follows:


ORIG.

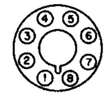
No. 1 on loctal	to No. 2 on octal
2	to 3
3	to 4
6	to 5
8	to 7
7	to 8


SUB.

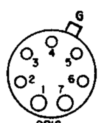
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
3LF4	3LE4	E	No changes.
	3Q4 3S4	E G	Same as 3LE4 to 3Q4.
	3Q5 3B5 3C5	E E G	Same as 3LE4 to 3Q5.
6A6	6Y7 6Z7	G G	Parallel circuits only. Change socket to octal and rewire as follows:


ORIG.

No. 1 on seven prong	to No. 2 on octal
2	to 3
3	to 4
5	to 5
6	to 6
7	to 7
4	to 8


SUB.

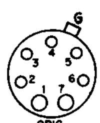
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6A7	6AN7	G	Parallel circuits only. Change socket to noval and rewire as follows:


ORIG.

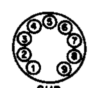
No. 1 on seven prong	to No. 4 on noval
2	to 7
3	to 1
4	to 8
grid cap	to 2
5	to 9
6	to 3
7	to 5


SUB.

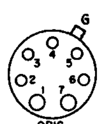
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	6BA7	G	Change socket to noval and rewire as follows:


ORIG.

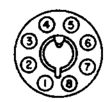
No. 1 on seven prong	to No. 4 on noval
2	to 9
3	to 1
4	to 6
cap	to 7
5	to 2
6	to 3
7	to 5


SUB.

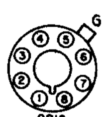
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	7A8	G	Parallel circuits only. Change socket to loctal and rewire as follows:


ORIG.

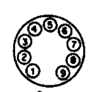
No. 1 on seven prong	to No. 1 on loctal
2	to 2
3	to 5
4	to 3
5	to 4
6	to 7
7	to 8

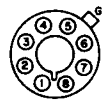
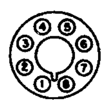
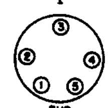

SUB.

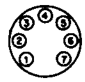
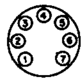
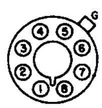
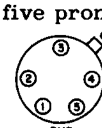
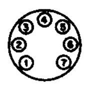
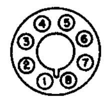
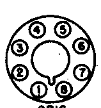
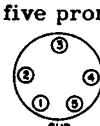
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6A8	6AN7	G	Parallel circuits only. Change socket to noval and rewire as follows:


ORIG.

No. 2 on octal	to No. 4 on noval
3	to 7
4	to 1
5	to 9
cap	to 2
6	to 8
7	to 5
8	to 3

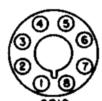

SUB.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6A8	6BA7	G	Change socket to noval and rewire as follows:
			No. 2 on octal to No. 4 on noval
			3 to 9
			4 to 1
			5 to 2
			cap to 7
			6 to 6
			7 to 5
			8 to 3
			 ORIG.  SUB.
6AD7	6U8	E	Parallel circuits only. Change socket to noval and rewire as follows:
6AE5	6F5	G	Make adaptor as follows:
			No. 1 on base to No. 1 on top
			2 to 2
			3 to 4
			5 to cap
			7 to 7
			8 to 8
	6K5	G	Change connections as follows: No. 5 to cap.
	6L5	G	No changes. Parallel circuits only.
	7A4	G	Same as 6W6 to 7A5. Series or parallel circuits.
	XXL	G	
	37	G	Change socket to five prong and rewire as follows:
	76	G	No. 2 on octal to No. 1 on five prong
			3 to 2
			5 to 3
			7 to 5
			8 to 4
			 ORIG.  SUB.
6AF5	7A4	G	Same as 6AE5 to 7A4.
	XXL	G	
	37	G	Same as 6AE5 to 37.
	76	G	
6AG5	6AH6	G	Parallel circuits only. No changes.
	6AS6	P	
	6BH6	P	
	6BJ6	P	
	6BA6	G	No changes.
	6BD6	G	
	6CB6	G	
6AK5	6AS6	P	Parallel circuits only. Change connections as follows: Connect No. 2 and No. 7 together.
	6BA6	G	
	6BD6	P	
	6BJ6	G	
	6BH6	G	
	6CB6	G	
	6BC5	P	Parallel circuits only. No changes.
	5590	G	
	5591	E	
	9001	P	
	9003	G	

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6AL5	7A6	G	Parallel circuits only. Where space permits, change socket to loctal and rewire as follows: No. 1 on miniature to No. 7 on loctal 2 to 3 4 to 8 5 to 2 3 to 1 7 to 6  ORIG.  SUB.
	12AT7 12AU7 12AX7	G G G	Change socket to noval and rewire as follows: No. 1 on miniature to No. 8 on noval 2 to 1 3 to 4 & 5 4 to 9 5 to 3 7 to 6  ORIG.  SUB.
	12AV7 12AY7	G G	Parallel circuits only. Same as 6AL5 to 12AT7.
	5726	G	No changes.
6AL6	6BG6	E	Change connections as follows: No. 8 to No. 3 4 to 8
	6CD6	E	Parallel circuits only. Same as 6AL6 to 6BG6. Use only where additional current is available in the filament supply.
	807	E	Change socket to five prong and rewire as follows: No. 2 on octal to No. 1 on five prong 4 to 2 5 to 3 7 to 5 8 to 4 cap to cap  ORIG.  SUB.
6AQ5	6F6 6G6 6K6 6U6	G G G G	Parallel circuits only. Where space permits, change socket to octal and rewire as follows: No. 1 on miniature to No. 5 on octal 2 to 8 3 to 2 4 to 7 5 to 3 6 to 4 7 to 5  ORIG.  SUB.
6AQ6	12AT6	G	Series circuits only. No changes.
6AR6	6BG6	G	Parallel circuits only. Change connections as follows: No. 3 to cap 1 to No. 3 8 to 2 5 to 8 7 to 5 6 to 7
	6CD6	G	Parallel circuits only. Same as 6AR6 to 6BG6. Use only where additional current is available from the filament power supply.
	807	G	Parallel circuits only. Change socket to five prong and rewire as follows: No. 1 on octal to No. 4 on five prong.  ORIG.  SUB.
6AU5	6BQ6	G	Change connections as follows: No. 8 to No. 4 3 to 8 5 to cap 1 to 5

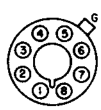
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6AU6	6CB6	P	Rewire as follows: Reverse connections between No. 2 and No. 7.
	5590	P	Parallel circuits only. No changes.
	5591	P	
	9001	P	
	9003	P	
6AX4	6U4	E	No changes.
	6W4	G	
6BA6	6AG5	G	No changes.
	6BC5	G	
	6CB6	G	
	9003	G	Parallel circuits only. No changes.
6BC5	6AN5	P	Parallel circuits only. No changes.
	6AS6	P	
	6BH6	P	
	6BJ6	P	
	5590	P	
	5591	G	
	5654	G	
	5725	P	
	6AU6	P	No changes.
	6CB6	G	
6BG6	KT66	G	Parallel circuits only. Reverse 6L6 to 6BG6 procedure.
	807	G	Reverse 807 to 6BG6 procedure.
6BH6	12AW6	G	Series circuits only. No changes.
6BL7	6SL7	P	Parallel circuits only. No changes.
	6SN7	G	
	6SU7	P	
	5591	P	
	5592	G	
6BN7	6BQ7	G	Parallel circuits only. Change connections as follows: Reverse connections between Nos. 6 and 8.
	12AT7	P	Parallel circuits only. Change connections as follows: Reverse connections between Nos. 6 and 8. Connect No. 5 to No. 9. Connect Nos. 4 and 5 together.
	12AU7	P	
	12AV7	P	
	12AX7	P	
	12AY7	P	
	12AZ7	G	
	12BH7	G	
6BQ7	6BN7	G	Parallel circuits only. Change connections as follows: Remove, connect, and tape up any wires on No. 9 No. 6 to No. 9 8 to 6
	12AT7	P	Parallel circuits only. Rewire as follows: Move wires connected to No. 5 to No. 9. Connect Nos. 4 and 5 together.
	12AU7	P	
	12AV7	P	
	12AX7	P	
	12AY7	P	
	12AZ7	G	
	12BH7	G	
6C5	6L5	G	Parallel circuits only. No changes.
	6SJ7	E	Change connections as follows: No. 5 to No. 4 8 to 5 3 to 8 & 6 Connect Nos. 3 and 5 together.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6CB6	6AG5	G	No changes.
	6BC5	G	
	6AJ5	P	Parallel circuits only. No changes.
	6AK5	G	
	5590	G	
	5591	G	
	5654	G	
	9001	P	
	9003	P	
	6AU6	G	Change connections as follows:
	6BA6	G	Reverse connections between terminals 2 and 7.
	6BD6	G	
6CD6	KT66	G	Parallel circuits only. Reverse 6L6 to 6BG6 procedure.
	807	P	Parallel circuits only. Reverse 807 to 6BG6 procedure.
6CG6	6AG5	G	No changes.
	6AU6	G	
	6BA6	G	
	6BC5	G	
	6BD6	G	
	6AH6	G	Parallel circuits only. No changes.
	6AJ5	P	
	6AK5	G	
	5590	P	
	5591	G	
	5654	G	
	9001	P	
	9003	P	
6E6	6N7	G	Parallel circuits only. Same as 3LE4 to 3Q5.
	6Z7	G	
	6Y7	G	Same as 3LE4 to 3Q5.
6F6	6AQ5	G	Parallel circuits only. Change socket to miniature and rewire as follows:
			No. 5 on octal to No. 1 on miniature
			8 to 2
			2 to 3
			7 to 4
			3 to 5
			4 to 6
			5 to 7
	5881	G	Parallel circuits only. No changes.
6F7	6F7S	E	No changes.
6F8	7AF7	G	Parallel circuits only. Same as 6F8 to 7N7.
	7N7	G	Change socket to loctal and rewire as follows:
			No. 2 on octal to No. 1 on loctal
			3 to 2
			4 to 2
			5 to 5
			6 to 6
			7 to 8
			8 to 7
			cap to 4
6J5	6SJ7	E	Same as 6C5 to 6SJ7.

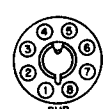


ORIG.

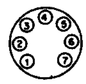
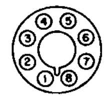
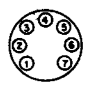
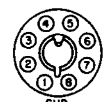
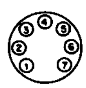
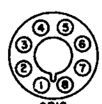
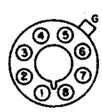
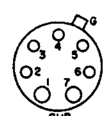
SUB.

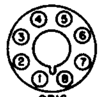
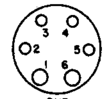
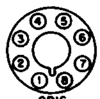
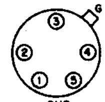
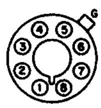
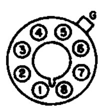
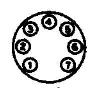


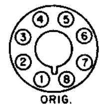
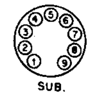
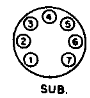
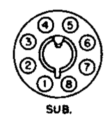
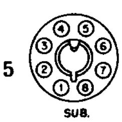
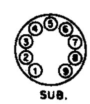
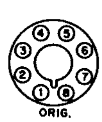
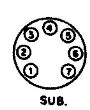
ORIG.

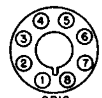
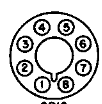
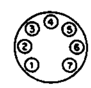
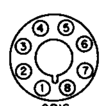
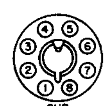
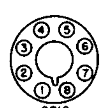
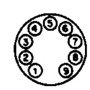


SUB.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6J6	6SL7	P	Change socket to octal and rewire as follows: No. 1 on miniature to No. 2 on octal 2 to 5 3 to 7 4 to 8 5 to 4 6 to 1 7 to 3 & 6  ORIG.  SUB.
	7F8	E	Parallel circuits only. Where space permits. Change socket to loctal and rewire as follows: No. 1 on miniature to No. 3 on loctal 2 to 6 3 to 2 4 to 7 5 to 1 6 to 8 7 to 4 & 5  ORIG.  SUB.
	12AT7 12AU7 12AY7	P P P	Parallel circuits only. Same as 6J6 to 12AV7.
	12AV7	G	Change socket to noval and rewire as follows: No. 1 on miniature to No. 1 on noval 2 to 6 3 to 4 & 5 4 to 9 5 to 7 6 to 2 7 to 3 & 8  ORIG.  SUB.
6J8	6AN7	G	Parallel circuits only. Same as 6A8 to 6AN7.
6K6	6AQ5	G	Parallel circuits only. Change socket to miniature and rewire as follows: No. 5 on octal to No. 1 on miniature 8 to 2 2 to 3 7 to 4 3 to 5 4 to 6 5 to 7  ORIG.  SUB.
	5881	G	Parallel circuits only. No changes.
6K8	6A7	E	Change socket to seven prong and rewire as follows: No. 2 on octal to No. 1 on seven prong 3 to 2 4 to 3 5 to 5 6 to 4 7 to 7 8 to 6 cap to cap  ORIG.  SUB
	6AN7	G	Parallel circuits only. Same as 6A8 to 6AN7.
	6BA7	G	Same as 6A8 to 6BA7.
6L5	6SJ7	G	Parallel circuits only. Same as 6C5 to 6SJ7.
6L6	6BG6	E	Change connections as follows: No. 3 to cap 8 to 3 4 to 8
	6CD6	E	Parallel circuits only. Same as 6L6 to 6BG6. When making this substitution be sure the filament power supply is capable of supplying an additional 1.6-ampere load.

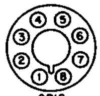
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6L6	41 42	G G	Parallel circuits only. Change socket to six prong and rewire as follows: No. 2 on octal to No. 1 on six prong 3 to 2 4 to 3 5 to 4 7 to 6 8 to 5  ORIG.  SUB.
	KT66	E	Parallel circuits only. No changes.
	807	E	Change socket to five prong and rewire as follows: No. 2 on octal to No. 1 on five prong 3 to cap 4 to 2 5 to 3 7 to 5 8 to 4  ORIG.  SUB.
	5881	E	Parallel circuits only. No changes.
6P5	6SJ7	G	Same as 6C5 to 6SJ7.
6P7	6U8 6X8	G G	Parallel circuits only. Change socket to noval and rewire as follows: No. 2 on octal to No. 4 on noval 3 to 5 4 to 6 5 to 3 cap to 2 6 to 1 7 to 9 8 to 7 & 8  ORIG.  SUB.
6Q7	6AT6 6AV6 6BK6 6BT6 6BU6	E G G E P	Change socket to miniature and rewire as follows: No. 2 on octal to No. 3 on miniature 3 to 7 4 to 5 5 to 6 7 to 4 8 to 2 cap to 1  ORIG.  SUB.
6R7	6AT6 6AV6 6BK6 6BT6 6BU6	P P P P E	Same as 6Q7 to 6AT6.
6R8	6V8	P	Same as 6T8 to 6V8.
6S4	12AT7 12AU7 12AV7 12AX7 12AY7	G G G G G	Parallel circuits only. Same as 6S4 to 12BH7.
	12BH7	G	Rewire as follows: Remove wires from No. 5. Connect No. 4 and No. 5 together. No. 6 to No. 7 9 to 6 Connect wires removed from No. 5 to No. 9. Reverse No. 2 and No. 3 connections. Connect No. 3 and No. 8 together. Connect No. 1 and No. 9 together.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6SA7	6BA7	E	Change socket to noval and rewire as follows: No. 1 on octal to No. 6 on noval 2 to 4 3 to 8 4 to 1 5 to 2 6 to 3 7 to 5 8 to 7  
	6BE6	E	Change socket to miniature and rewire as follows: No. 1 on octal to No. 2 on miniature 2 to 3 3 to 5 4 to 6 5 to 1 6 to 2 7 to 4 8 to 7  
	7A8	G	Parallel circuits only. Change socket to loctal and rewire as follows: No. 1 on octal to shield connection on loctal socket 2 to No. 1 3 to 2 4 to 5 5 to 4 6 to 7 7 to 8 8 to 6   The 7A8 heats faster than the other tubes and a 200 ohm 1/2 watt resistor must be connected across the filament terminals 2 and 7 or its life will be very short.
6SB7Y	6BA7	E	Same as 6SA7 to 6BA7.
	6SA7	G	No changes.
	7A8	G	Parallel circuits only. Same as 6SA7 to 7A8.
	7B8 7J7 7S7	P P P	Same as 6SA7 to 7A8. Series or parallel circuits.
	7Q7	E	Change socket to loctal and rewire as follows: No. 2 on octal to No. 1 on loctal 3 to 2 4 to 3 5 to 4 6 to 7 & 5 7 to 8 8 to 6  
6SC7	12AT7 12AU7 12AY7 12AZ7 12AX7	P P G P E	Change socket to noval and rewire as follows: No. 2 on octal to No. 1 on noval 3 to 2 4 to 7 5 to 6 6 to 8 & 3 7 to 4 & 5 8 to 9  
	12AV7 12BH7	P P	Parallel circuits only. Same as 6SC7 to 12AT7.
6SG7	6BA6 6AU6 6BD6	E P G	Change socket to miniature and rewire as follows: No. 2 on octal to No. 3 on miniature 3 to 7 4 to 1 6 to 6 7 to 4 8 to 5  

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6SH7	6AU6 6BA6 6BD6	G P G	Same as 6SG7 to 6BA6.
6SJ7	6AG5 6BC5	G P	Change socket to miniature and rewire as follows: No. 2 on octal to No. 3 on miniature 3 to 7 4 to 1 5 to 2 6 to 6 7 to 4 8 to 5  ORIG.  SUB.
	6AJ5 6AK5 5591 9001 9003	P P P P G	Parallel circuits only. Same as 6SJ7 to 6AG5.
6SK7	6AG5 6BC5	G G	Same as 6SJ7 to 6AG5.
	6AJ5 6AK5 6AN5 5591 9001 9003	P G P P G G	Same as 6SJ7 to 6AJ5.
	6BH6 6BJ6	G G	Parallel circuits only. Same as 6SK7 to 6CB6.
	6CB6	G	Change socket to miniature and rewire as follows: No. 2 on octal to No. 3 on miniature 3 to 7 4 to 1 5 to 2 6 to 6 7 to 4 8 to 5  ORIG.  SUB.
6SL7	7F8	P	Change socket to loctal and rewire as follows: No. 1 on octal to No. 1 on loctal 2 to 3 3 to 4 4 to 8 5 to 6 6 to 5 7 to 7 8 to 2  ORIG.  SUB.
	12AT7 12AU7 12AX7 12AY7	G P G G	Change socket to noval and rewire as follows: No. 1 on octal to No. 2 on noval 2 to 1 3 to 3 4 to 7 5 to 6 6 to 8 7 to 4 & 5 8 to 9  ORIG.  SUB.
	12AV7 12BH7	P P	Parallel circuits only. Same as 6SL7 to 12AT7.
6SN7	12AT7 12AU7 12AV7 12AX7 12AY7	P G P P P	Parallel circuits only. Same as 6SL7 to
	12BH7 12SZ7	G G	Same as 6SL7 to 12AT7.
6SQ7	6SZ7	E	Parallel circuits only. No changes.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6SR7	7B6 7E6	P G	Change socket to loctal and rewire as follows:

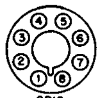
No.	2 on octal	to No.	3 on loctal
	3	to	4 or 7
	4	to	5
	5	to	6
	6	to	2
	7	to	1
	8	to	8


ORIG.


SUB.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	7C6	P	Same as 6SR7 to 7B6.
	85	G	Change socket to six prong and rewire as follows:

No.	2 on octal	to	cap on six prong
	3	to No.	5
	4	to	3
	5	to	4
	6	to	2
	7	to	6
	8	to	1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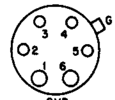
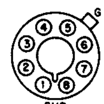

SUB.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6T8	6S8	G	Parallel circuits only. Where space permits, change socket to octal and rewire as follows:

No.	1 on noval	to No.	1 on octal
	2	to	3
	3	to	5
	4	to	7
	5	to	8
	6	to	4
	7	to	2
	8	to	cap
	9	to	6


ORIG.


SUB.

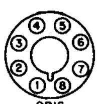
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	6V8	G	Change connections as follows: Remove wires from No. 1.

No.	9	to No.	1
	6	to	9
	8	to	6
	3	to	8
	7	to	3
	2	to	7

Connect wires removed from No. 1 to No. 2.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6U4	6AX5	G	No changes.
6U5/6G5	6AB5 6N5	G G	Parallel circuits only. No changes.
	6T5	G	No changes.
6U6	5881	G	Parallel circuits only. No changes.
6V6	6BF5	P	Parallel circuits only. Change socket to octal and rewire as follows:

No.	5 on octal	to No.	1 on miniature
	8	to	2
	2	to	3
	7	to	4
	3	to	5
	4	to	6
	5	to	7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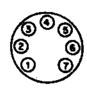
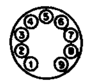
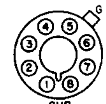
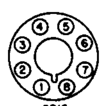
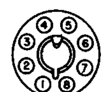
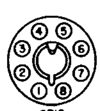
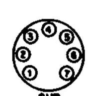
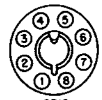
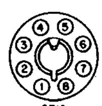
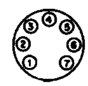
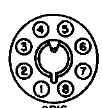
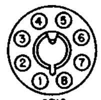

SUB.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	6BG6	G	Parallel circuits only. Same as 6L6 to 6BG6.
	6W6	G	Parallel circuits only. No changes.
6V8	6R8 6T8	P G	Reverse 6T8 to 6V8 procedure.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6V8	6S8	G	Parallel circuits only. Change socket to octal and rewire as follows: No. 1 on noval to No. 6 on octal 2 to 1 3 to 2 4 to 7 5 to 8 6 to cap 7 to 3 8 to 4 9 to 5  ORIG.  SUB.
6W4	6AX4	E	No changes.
	6AX5	G	Rewire as follows: No. 8 to No. 2 3 to 8 Connect No. 3 and No. 5 together.
	6AX6	E	Parallel circuits only. Rewire as follows: No. 8 to No. 2 3 to 8 Connect No. 3 and No. 5 together. Connect No. 4 and No. 8 gogether.
	6BY5	G	Parallel circuits only. Rewire as follows: No. 8 to No. 2 3 to 1 Connect No. 4 and No. 5 together. Connect No. 1 and No. 8 together
	6W5 6X5 6ZY5 1274	G G G G	Parallel circuits only. Same as 6W4 to 6AX5.
6W6	6AQ5	P	Parallel circuits only. Same as 6K6 to 6AQ5 procedure.
	6BF5	P	Same as 6K6 to 6AQ5 procedure. Series or parallel circuits.
	6F6 6G6 6K6 6U6 6V6 6Y6	P G G G G G	Parallel circuits only. No changes.
	7A5 7C5 7B5	G G P	Parallel circuits only. Change socket to loctal and rewire as follows: No. 2 on octal to No. 1 on loctal 3 to 2 4 to 3 5 to 6 7 to 8 8 to 7  ORIG.  SUB.
6X8	6U8	P	No changes.
7A4	7A7	G	Same as 7A4 to 7C7.
	7B7 7C7	P E	Parallel circuits only. Change connections as follows: Connect No. 2 and No. 3 together. Connect No. 4 and No. 7 together.
	7E6	G	Same as 7B4 to 7B6.
7A7	6AU6 6BA6 6BC5 6BD6	P E G P	Change socket to miniature and rewire as follows: No. 1 on loctal to No. 3 on miniature 2 to 5 3 to 6 4 to 2 6 to 1 7 to 7 8 to 4  ORIG.  SUB.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
7A7	6BH6 6BJ6	P P	Parallel circuits only. Same as 7B7 to 6BH6.
7A8	6AN7	G	Parallel circuits only. Change socket to noval and rewire as follows: No. 1 on loctal to No. 4 on noval 2 to 7 3 to 8 4 to 9 5 to 1 6 to 2 7 to 3 8 to 5  ORIG.  SUB.
7AF7	7F8	G	Rewire as follows: Remove wires from No. 4 No. 2 to No. 4 1 to 2 Connect wires removed from No. 4 to No.1. Remove wires from No. 5. No. 7 to No. 5 8 to 7 Connect wires removed from No. 5 to No. 8.
7B4	7B6	E	Rewire as follows: Remove and tape up any wires anchored on terminal No. 3. Do the same for No. 4 and No. 5. No. 6 to No. 3 Connect Nos. 4, 5, and 6 together.
	7C6	E	Parallel circuits only. Same as 7B4 to 7B6.
7B5	6AQ5	G	Parallel circuits only. Change socket to miniature and rewire as follows: No. 1 on loctal to No. 3 on miniature 2 to 5 3 to 6 6 to 7 7 to 2 8 to 4  ORIG.  ORIG.
7B6	6AT6 6AV6 6BF6 6BK6 6BT6 6BU6	G G P G G P	Same as 7C6 to 6AQ6.
7B7	6AU6 6BA6 6BC5 6BD6	G E G G	Parallel circuits only. Same as 7A7 to 6AU6.
	6BH6 6BJ6	G G	Change socket to miniature and rewire as follows: No. 1 on loctal to No. 3 on miniature 2 to 5 3 to 6 4 to 7 6 to 1 7 to 2 8 to 4  ORIG.  SUB.
	7AH7	G	No changes.
	5590 5591 9001 9003	P P P G	Same as 7A7 to 6AU6.
7B8	6AN7	G	Parallel circuits only. Same as 7A8 to 6AN7.
7C5	6AQ5	G	Same as 7B5 to 6AQ5.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
7C6	6AQ6	G	Change socket to miniature and rewire as follows:
			No. 1 on loctal to No. 3 on miniature
			2 to 7
			3 to 1
			4 & 7 to 2
			5 to 5
			6 to 6
			8 to 4
	6AT6	G	Parallel circuits only. Same as 7C6 to 6AQ6.
	6AV6	G	
	6BF6	P	
	6BK6	G	
	6BT6	G	
	6BU6	P	
7C7	6AU6	E	Parallel circuits only. Same as 7A7 to 6AU6.
	6BA6	G	
	6BC5	E	
	6BU6	E	
	6BH6	G	Same as 7B7 to 6BH6.
	6BJ6	G	
	7AB7/1204	P	Rewire as follows:
			Remove wires from terminal No. 1
			No. 3 to No. 1
			2 to 3
			Connect wires removed from No. 1 to No. 2
			Remove wires from No. 8
			No. 7 to No. 8
			Connect wires removed from No. 8 to No. 7
			No. 6 to No. 5
			Do not use terminals No. 4 or No. 6.
	7AG7	P	No changes.
	7AH7	G	
7E6	6AT6	P	Same as 7C6 to 6AQ6.
	6AV6	P	
	6BF6	G	
	6BK6	P	
	6BT6	P	
	6BU6	E	
7F8	7F8W	E	No changes.
	12AT7	G	Same as 7F8 to 12AV7.
	12AU7	G	
	12AX7	P	
	12AY7	G	
	12AV7	P	Parallel circuits only. Change socket to noval and rewire as follows:
	12BH7	G	No. 3 on loctal to No. 1 on noval
			1 to 2
			4 to 3
			2 to 4
			2 to 5
			6 to 6
			8 to 7
			5 to 8
			7 to 9
7G8	1206	E	No changes.
7J7	6AN7	G	Parallel circuits only. Same as 7A8 to 6AN7.
7N7	12AT7	E	Parallel circuits only. Same as 7N7 to 12BH7.
	12AU7	E	
	12AV7	G	
	12AX7	P	
	12AY7	P	
	12AZ7	G	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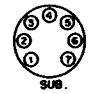
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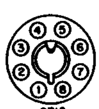
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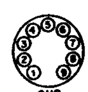
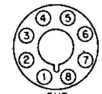

SUB.

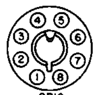
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
7N7	6SN7	E	Change socket to octal and rewire as follows:

No. 1 on loctal to No. 8 on octal
2 to 3
3 to 2
4 to 1
5 to 4
6 to 5
7 to 6
8 to 7


ORIG.

SUB

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	12BH7	E	Change socket to noval and rewire as follows:

No. 1 on loctal to Nos. 4 & 5 on noval
2 to 3
3 to 1
4 to 2
5 to 7
6 to 6
7 to 8
8 to 9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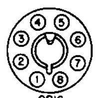
SUB.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
7Q7	7A8	G	Parallel circuits only. Same as 14Q7 to 7A8.
	7B8 7J7	G G	Same as 14Q7 to 7A8. Series or parallel circuits.
7R7	6N8	P	Change socket to noval and rewire as follows:

No. 1 on loctal to No. 4 on noval
2 to 6
3 to 7
4 to 8
5 to 1
6 to 2
7 to 3
8 to 5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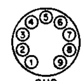
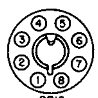

SUB.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
7S7	6AN7	G	Parallel circuits only. Same as 7A8 to 6AN7.
7Y4	0Z4	E	Same as 7Y4 to 6AX5. Filament leads need not be connected.
	6AX5	E	Parallel circuits only. Change loctal socket to octal and rewire as follows:

No. 1 on loctal to No. 2 on octal
3 to 3
6 to 5
8 to 7
7 to 8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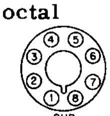
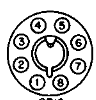

SUB.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	6X4	E	Parallel circuits only. Change socket to miniature and rewire as follows:

No. 1 on loctal to No. 3 on miniature
3 to 1
6 to 6
7 to 7
8 to 4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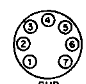
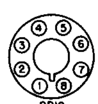

SUB.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
7Z4	0Z4	G	Same as 7Y4 to 6AX5. Filament leads need not be connected. If required output current exceeds 70 ma. this substitution is not recommended.
	6AX5	G	Parallel circuits only. Same as 7Y4 to 6AX5. 6AX5 has lower output current rating. If required current exceeds 70 ma. this substitution is not recommended.
12A6	12A5	P	Parallel circuits only. Change octal socket to seven prong and rewire as follows:

No. 2 on octal to No. 1 on seven prong
3 to 2
4 to 3
5 to 4
8 to 5
7 to 7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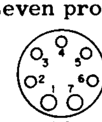
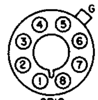

SUB.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
12A8	7A8	P	Series circuits only. Change socket to loctal and rewire as follows: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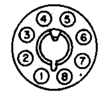
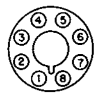
No. 2 on octal	to No. 1 on loctal
3	to 2
4	to 5
5	to 4
6	to 3
7	to 8
8	to 7
cap	to 6


SUB.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
12AH7	12AU7 12AX7 12AY7 12AZ7	P E E P	Change socket to noval and rewire as follows:

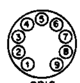

ORIG.

No. 1 on octal	to No. 2 on noval
2	to 3
3	to 1
4	to 8
5	to 7
6	to 6
7	to 5
8	to 4

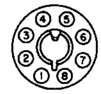

SUB.

Do not use socket terminal No. 9 as tie point.

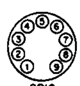
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	12BH7	P	Parallel circuits only. Same as 12AH7 to 12AU7.
12AT6	6AQ6	G	Same as 12AW6 to 6BH6.
12AT7	12AZ7	G	Parallel circuits only. No Changes.
	14F8	G	For 12 volt operation only. Change socket to loctal and rewire as follows:


ORIG.

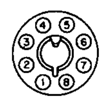
No. 1 on noval	to No. 3 on loctal
2	to 1
3	to 4
4	to 2
5	to 7
6	to 6
7	to 8
8	to 5


SUB.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
12AU7	7F8	P	Change socket to loctal and rewire as follows:


ORIG.

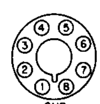
No. 1 on noval	to No. 3 on loctal
2	to 1
3	to 4
4	to 2
5	to 2
6	to 6
7	to 8
8	to 5
9	to 7


SUB.

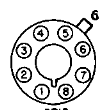
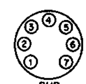
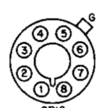
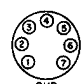
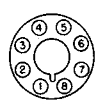
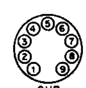
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	12AZ7	P	Parallel circuits only. No changes.
	14F8	G	For 12 volt operation only. Same as 12AT7 to 14F8.
12AV7	6SN7	P	Parallel circuits only. Change socket to octal and rewire as follows:


ORIG.

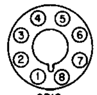
No. 1 on noval	to No. 2 on octal
2	to 1
3	to 3
4	to 7
5	to 7
6	to 5
7	to 4
8	to 6
9	to 8


SUB

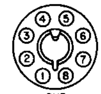
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	12AZ7	E	No changes.
	14F8	P	For 12 volt operation in parallel circuits only. Same as 12AT7 to 14F8.
12AW6	6BH6	G	No wiring changes necessary in series circuits. Install a 300 ohm, $\frac{1}{2}$ watt resistor from terminal No. 3 to terminal No. 4 on the socket. In parallel circuits disconnect and tape up filament supply lead connected to terminal No. 3. Install new wire from terminal No. 3 to center tap of 12.6 volt filament winding.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
12AX4	6AX4 6U4 6W4	E G G	Parallel circuits only. No changes. Insert a 5 ohm, 20 watt resistor in series with one side of the filament circuit.
12AX7	12AZ7	P	Parallel circuits only. No changes.
	14F8	P	For 12 volt operation only. Same as 12AT7 to 14F8.
12AY7	12AZ7	P	Parallel circuits only. No changes.
	14F8	G	For 12 volt operation only. Same as 12AT7 to 14F8.
12AZ7	12AT7 12AU7 12AX7 12AY7 12BH7	G P P P G	Parallel circuits only. No changes. Best results can sometimes be obtained by shielding the substitute tube.
	12AV7	E	No changes.
12BA6	12BD6	G	No changes.
12BH7	12AZ7	G	Parallel circuits only. No changes.
	14F8	P	For 12 volt operation in parallel circuits only. Same as 12AT7 to 14F8.
12BN6	6BN6	E	Parallel circuits only. No changes. Insert 40 ohm 10 watt resistor in series with filament circuit.
12K7	12AU6 12BD6 12BA6	P E E	Change socket to miniature and rewire as follows: No. 2 on octal to No. 3 on miniature 3 to 5 4 to 6 5 to 2 7 to 4 8 to 7 Grid lead to 1  ORIG.  SUB.
12K8	7A8	P	Series circuits only. Same as 12A8 to 7A8.
12Q7	12AT6 12AV6 12BF6 12BK6 12BT6 12BU6	P P G P P G	Change socket to miniature and rewire as follows: No. 2 on octal to No. 3 on miniature 3 to 7 4 to 5 5 to 6 cap to 1 7 to 4 8 to 2  ORIG.  SUB.
12SA7	12BA7	E	Same as 6SA7 to 6BA7.
	12SY7	E	No changes.
12SC7	12AT7 12AU7 12AX7 12AY7 12AZ7	P P E G P	Change socket to noval and rewire as follows: No. 2 on octal to No. 1 on noval 3 to 2 4 to 7 5 to 6 6 to 8 & 3 7 to 4 8 to 5  ORIG.  SUB.
	12AV7 12BH7	G G	Parallel circuits only. Same as 12SC7 to 12AT7.
12SF5	12SQ7	E	Change connections as follows: Reverse connections between Nos. 2 & 3 Move No. 5 to No. 6 Do not use Nos. 4 & 5 on socket.

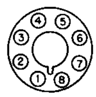
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
12SG7	14A7/12B7 14C7 14H7	G G G	Change socket to loctal and rewire as follows:


ORIG.

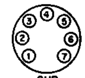
No. on octal		to No. on loctal
2	to	1
3 & 5	to	7
4	to	6
6	to	3
7	to	8
8	to	2


SUB.

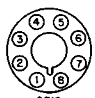
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
12SH7	14A7/12B7 14C7 14H7	G G G	Same as 12SG7 to 14A7/12B7.
12SJ7	12AU6 12BA6 12BD6	G P G	Change socket to miniature and rewire as follows:


ORIG.

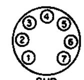
No. on octal		to No. on miniature
2	to	3
3	to	2
4	to	1
5	to	7
6	to	6
7	to	4
8	to	5


SUB.

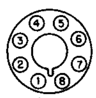
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	12AW6	P	Change socket to miniature and rewire as follows:


ORIG.

No. on octal		to No. on miniature
2	to	3
3	to	7
4	to	1
5	to	2
6	to	6
7	to	4
8	to	5

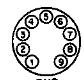

SUB.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
12SK7	12AW6	P	Same as 12SJ7 to 12AW6.
12SL7	12AT7	G	Change socket to noval and rewire as follows:

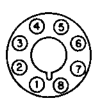

ORIG.

No. on octal		to No. on noval
1	to	2
2	to	1
3	to	3
4	to	7
5	to	6
6	to	8
7	to	4
8	to	5

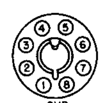
Do not use No. 9 on noval.


SUB.

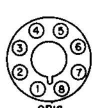
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	12AV7 12BH7	P P	Parallel circuits only. Same as 12SL7 to 12AT7.
12SN7	12AT7	P	Parallel circuits only. Same as 12SL7 to 12AT7.
	12AU7 12AV7 12AX7 12AY7 12AZ7	G P P P G	Any of these types that draw 0.3 ampere at 6.3 volts by paralleling the two halves of the filament can be used to substitute for 12SN7 in series circuits by referring to 6SL7 to 12AT7 and rewiring in the manner shown there.
	12BH7	G	Same as 12SL7 to 12AT7.
	14AF7/XXD 14F7	G P	Parallel circuits only. Change socket to loctal and rewire as follows:


ORIG.

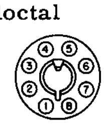
No. on octal		to No. on loctal
1	to	4
2	to	3
3	to	2
4	to	5
5	to	6
6	to	7
7	to	8
8	to	1


SUB.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	14N7	E	Same as 12SN7 to 14AF7. Series or parallel circuits.
12SQ7	14X7	G	Change socket to loctal and rewire as follows:


ORIG.

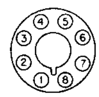
No. on octal		to No. on loctal
2	to	3
3	to	4
4	to	5
5	to	6
6	to	2
7	to	8
8	to	1


SUB.

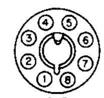
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
12SR7	6ST7	P	Series circuits only. No changes.
	6T7	P	Series circuits only. Make adaptor as follows:

No.		to No.
1 on base	to	1 on top
2	to	cap
3	to	8
4	to	4
5	to	5
6	to	3
7	to	7
8	to	2

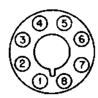
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	7C6	P	Series circuits only. Change socket to loctal and rewire as follows:


ORIG.

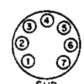
No.		to No.
2 on octal	to	3 on loctal
3	to	7
4	to	5
5	to	6
6	to	2
7	to	8
8	to	1


SUB.

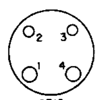
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	14X7	P	Same as 12SQ7 to 14X7.
12SW7	6ST7	P	Series circuits only. Co changes.
	6T7	P	Same as 12SR7 to 6T7. Series circuits only.
	7C6	P	Same as 12SR7 to 7C6. Series circuits only.
	14X7	P	Same as 12SQ7 to 14X7.
12SY7	12BE6	G	Change socket to miniature and rewire as follows:


ORIG.

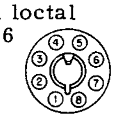
No.		to No.
2 on octal	to	3 on miniature
3	to	5
4	to	6
5	to	1
6	to	2
7	to	4
8	to	7


SUB.

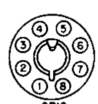
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
12Z3	14Y4	G	Change socket to loctal and rewire as follows:


ORIG.

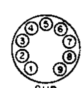
No.		to No.
1 on four prong	to	1 on loctal
2	to	3 & 6
3	to	7
4	to	8


SUB

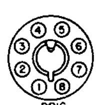
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
14A7	12AU6	P	Same as 7A7 to 6AU6.
	12BA6	G	
	12BD6	E	
14AF7	12AT7	G	Change socket to noval and rewire as follows:
	12AU7	G	
	12AX7	P	
	12AY7	P	
	12AZ7	G	


ORIG.

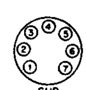
No.		to No.
1 on loctal	to	4 on noval
2	to	3
3	to	1
4	to	2
5	to	7
6	to	6
7	to	8
8	to	5

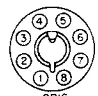
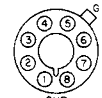
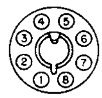
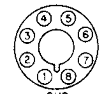
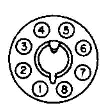
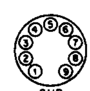

SUB.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	12AV7	P	Parallel circuits only. Same as 14AF7 to 12AT7.
	12BH7	G	
14B6	12AT6	G	Change socket to miniature and rewire as follows:
	12AV6	G	
	12BF6	P	
	12BK6	G	
	12BT6	G	
	12BU6	P	


ORIG.

No.		to No.
1 on loctal	to	3 on miniature
2	to	7
3	to	1
5	to	5
6	to	6
7	to	2
8	to	4

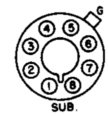

SUB.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
14C7	6S7	P	Series circuits only. Change socket to octal and rewire as follows: No. 5 on loctal to No. 1 on octal 1 to 2 2 to 3 3 to 4 4 to 5 8 to 7 7 to 8 6 to cap  ORIG.  SUB
	6SS7	P	Series circuits only. Change socket to octal and rewire as follows: No. 1 on loctal to No. 2 on octal 4 to 3 6 to 4 7 to 5 3 to 6 8 to 7 2 to 8  ORIG.  SUB
	6W7	P	Same as 14C7 to 6S7. Series circuits only.
	12AU6	E	Same as 14A7 to 12AU6
	12BA6	G	
	12BD6	G	
	12J7	G	Same as 14C7 to 6S7.
	12K7	P	
	12SG7	P	Same as 14C7 to 6SS7.
	12SH7	P	
	12SJ7	G	
	12SK7	P	
14E6	7C6	P	Series circuits only. No changes.
	12AT6	P	Same as 14B6 to 12AT6.
	12AV6	P	
	12BF6	E	
	12BK6	P	
	12BT6	P	
	12BU6	E	
14F7	12AT7	G	Same as 14AF7 to 12AT7.
	12AU7	G	
	12AX7	P	
	12AY7	P	
	12AZ7	G	
	12AV7	P	Parallel circuits only. Same as 14AF7 to 12AT7.
	12BH7	G	
14F8	12AT7	E	Change socket to noval and rewire as follows: No. 1 on loctal to No. 2 on noval 2 to 4 3 to 1 4 to 3 5 to 8 6 to 6 7 to 5 8 to 7  ORIG.  SUB. Substitutes classified "P" not recommended for oscillator-mixer service.
	12AU7	G	
	12AX7	P	
	12AY7	P	
	12AZ7	G	
	12AV7	G	Parallel circuits only. Same as 14F8 to 12AT7. 12BH7 is not recommended for oscillator-mixer service.
	12BH7	P	
14J7	12A8	P	Reverse 12A8 to 7A8 procedure.
	12K8	G	
14N7	12AT7	P	Parallel circuits only. Same as 14AF7 to 12AT7.
	12AU7	G	
	12AV7	P	
	12AX7	P	
	12AY7	P	
	12AZ7	G	

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
14N7	12BH7	G	Same as 14AF7 to 12AT7. Series or parallel circuits.
14Q7	7A8	G	Series circuits only. Rewire as follows: Remove wires from terminal No. 5 and tape up. No. 5 to No. 3
	12A8	P	Change socket to octal and rewire as follows:
	12K8	G	

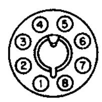

ORIG.

No.		to No.	
1 on loctal	to	2 on octal	
2	to	3	
3	to	4	
4	to	5	
5	to	8	
6	to	cap	
7	to	8	
8	to	7	

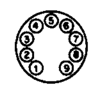


SUB.

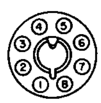
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	12BA7	G	Change socket to noval and rewire as follows:


ORIG.

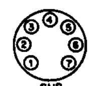
No.		to No.
1 on loctal	to	4 on noval
2	to	9
3	to	1
4	to	2
5	to	6
6	to	7
7	to	3
8	to	5


SUB.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	12BE6	G	Change socket to miniature and rewire as follows:


ORIG.

No.		to No.
1 on loctal	to	3 on miniature
2	to	5
3	to	6
4	to	1
5	to	2
6	to	7
7	to	2
8	to	4

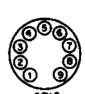

SUB.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	14B8	G	Same as 14Q7 to 7A8.
19C8	19V8	G	Reverse 19V8 to 19C8 procedure.
19T8	19V8	G	Reverse 19V8 to 19C8 procedure.
19V8	19C8	G	Rewire as follows:
	19T8	G	Remove wires from No. 9

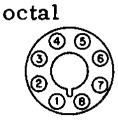
No.		to No.
1	to	9
2	to	1
7	to	2
3	to	7
8	to	3
6	to	8

Connect wires removed from No. 9 to No. 6.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
25N6	43	P	Same as 6L6 to 41. Series or parallel circuits.
26Z5W	25X6	G	Parallel circuits only. Change socket to octal and rewire as follows:
	25Z6	G	
	35Z6	P	


ORIG.

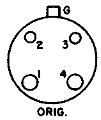
No.		to No.
1 on noval	to	3 on octal
3	to	4
4	to	2
5	to	7
6	to	5
8	to	8

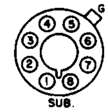

SUB.

This substitution is not practical when the 26Z5W is operated on 13 volt filament supply with the two halves of its filament in parallel.

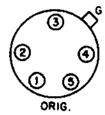
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
33	1F5	G	Parallel circuits only. Same as 1F4 to 1J5.
	1G5	G	
	1J5	G	

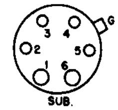
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
34	1D5 1E5	G G	Change socket to octal and rewire as follows: No. 1 on four prong to No. 2 on octal 2 to 3 3 to 4 4 to 7 cap to cap



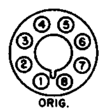


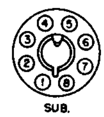
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
35/51	57 58	E E	Parallel circuits only. Change socket to six prong and rewire as follows: No. 1 on five prong to No. 1 on six prong 2 to 2 3 to 3 4 to 4 and 5 5 to 6 cap to cap



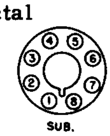


TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
35L6	14A5	P	Change socket to loctal and rewire as follows: No. 2 on octal to No. 1 on loctal 5 to 2 4 to 3 5 to 6 8 to 7 7 to 8 Add 150 ohms, 10 watt in series with filament circuit.

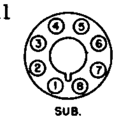




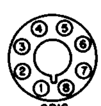
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
35Y4	50X6	P	Remove any wires anchored on No. 3, connect and tape up. Do the same for No. 6. Change connections as follows: Connect No. 2 to No. 3 and No. 6. Connect No. 2 and No. 7 together. Connect 40 ohms, 1 watt resistor from No. 1 to No. 4.
	50Y6	P	Same as 35Y4 to 50Y7. Also insert 40 ohm, 1 watt resistor between No. 2 and No. 6.
	50Y7 50Z7	P P	Change socket to octal and rewire as follows: No. 1 on loctal to No. 2 on octal 2 to 3 & 5 4 to 6 7 to 4 & 8 8 to 7

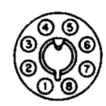


TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
35Z3	50X6	P	Rewire as follows: Remove, connect and tape up any wires anchored on No. 3. Do the same for No. 6. Connect No. 2 to No. 3. Connect No. 3 and No. 6 together. Connect No. 2 and No. 7 together.
	50Y6	P	Change socket to octal and rewire as follows: No. 1 on loctal to No. 2 on octal 2 to 3 & 5 7 to 4 & 8 8 to 7

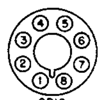


TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	50Y7 50Z7	P P	Same as 35Z3 to 50Y6. Except do not use terminal No. 6 on octal.
35Z4	50Y6	P	Rewire as follows: Remove and tape up wires on No. 3. Do the same for No. 4. Connect No. 3 and No. 5 together. Connect No. 4 and No. 8 together.
	50Y7 50Z7	P P	Rewire as follows: Remove and tape up wires on No. 3. Do the same for Nos. 4 & 6 Connect No. 3 and No. 5 together. Connect No. 4 and No. 8 together. Do not use terminal No. 6.
35Z5	35Z3	E	Change socket to loctal and rewire as follows: No. 2 on octal to No. 1 on loctal 3 to 3 5 to 2 7 to 8 8 to 7 Connect 40 ohm, 1 watt resistor from No. 1 to No. 3.

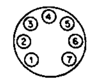




TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
35Z5	50Y6	P	Same as 35Z5 to 50Y7. Also connect a 40 ohm, 1 watt resistor from No. 2 to No. 6.
	50Y7 50Z7	P P	Rewire as follows: Remove and tape up wires on No. 4. Do the same for No. 6 Connect No. 3 to No. 6. Connect No. 3 and No. 5 together. Connect No. 4 and No. 8 together.
40Z5			Refer to type 45Z5 for substitute.
45	2A5	G	Parallel circuits only. Same as 2A3 to 2A5.
	47	G	Parallel circuits only. Same as 2A3 to 47.
45Z5	35Y4	G	Change socket to miniature and rewire as follows:

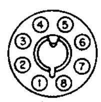

ORIG.

No. 2 on octal	to No. 3 on miniature.
3	to 6
5	to 5
7	to 4
8	to 7

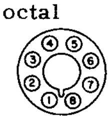

SUB.

Do not connect to unused terminals.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	50Y6	G	Same as 35Z5 to 50Y6.
	50Y7 50Z7	G G	Same as 35Z5 to 50Z7.
50A5	12A6	P	Change socket to octal and rewire as follows:

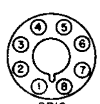

ORIG.

No. 1 on loctal	to No. 2 on octal
2	to 3
3	to 4
6	to 5
7	to 8
8	to 7

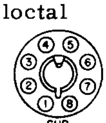

SUB.

Place a 250 ohm, 10 watt resistor in series with filament.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	14A5	G	Put a 250 ohm, 10 watt resistor in series with filament.
50B5	35C5	E	Rewire as follows: Interchange No. 1 and No. 2 connections. Interchange No. 5 and No. 7 connections. Place 100 ohm, 10 watt resistor in series with filament.
50C5	35B5 35C5 50B5	E E E	Same as complete 50B5 to 35C5 procedure. Except that for 50B5 no filament resistor is required.
50C6	35A5	E	Change socket to loctal and rewire as follows:

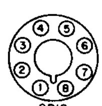

ORIG.

No. 2 on octal	to No. 1 on loctal
3	to 2
4	to 3
5	to 6
8	to 7
7	to 8

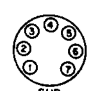

SUB.

Place 100 ohm, 10 watt resistor in series with filament.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	35B5	E	Change socket to miniature and rewire as follows:

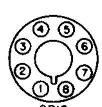

ORIG.

No. 2 on octal	to No. 3 on miniature
3	to 5
4	to 6
5	to 1
7	to 4
8	to 2

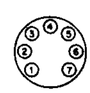

SUB.

Do not use No. 7 on miniature. Place 100 ohm, 10 watt resistor in series with filament.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	35C5	E	Change socket to miniature and rewire as follows:

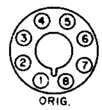

ORIG.

No. 2 on octal	to No. 3 on miniature
3	to 7
4	to 6
5	to 2
7	to 4
8	to 1

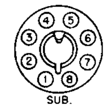

SUB.

Do not use terminal No. 5 on miniature. Place 100 ohm, 10 watt resistor in series with filament.

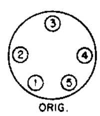
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
50C6	50B5	E	Same as 50C6 to 35B5.
50L6	14A5	G	Same as 35L6 to 14A5 except place a 250 ohm, 10 watt resistor in series with filament.
	50A5	E	Same as 35L6 to 14A5. Except do not add filament resistor.
	50C6	E	No changes.
50Y6	50X6	E	Change socket to loctal and rewire as follows:



No.	2 on octal	to No.	1 on loctal
	3	to	3
	4	to	2
	5	to	6
	7	to	8
	8	to	7

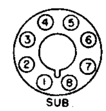


TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
57	35/51 24A	G G	Parallel circuits only. Same as 34 to 1D5.
58	24A 35/51	E G	Same as 57 to 35/51
KT66	6AL6	G	Parallel circuits only. Same as 6L6 to 6AL6.
	6BG6 6CD6	G G	Parallel circuits only. Same as 6L6 to 6BG6.
	6L6	G	Parallel circuits only. No changes.
71A	12A	P	No changes.
	182B/482B 183/483	G G	Parallel circuits only. No changes. If push-pull circuit, change both tubes.
84/6Z4	0Z4	E	Change socket to octal and rewire as follows:

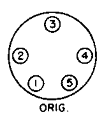


No.	1 on five prong	to No.	2 on octal
	2	to	3
	3	to	5
	4	to	8
	5	to	7

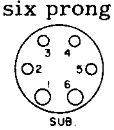
Filament leads need not be connected.



TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	6Y5	G	Parallel circuits only. Change socket to six prong and rewire as follows:



No.	1 on five prong	to No.	1 on six prong
	2	to	3
	3	to	5
	4	to	4
	5	to	6

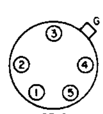


TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	6ZY5	G	Same as 84/6Z4 to 0Z4 procedure. Parallel circuits only.
89	89Y	E	No changes.
117N7	117L7 117M7	E E	Make adaptor as follows:

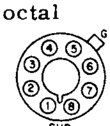
No.	1 on base	to No.	8 on top
	2	to	2
	3	to	3
	4	to	4
	5	to	5
	7	to	7
	8	to	6

AC line must connect to No. 7.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
807	6AL6	G	Reverse 6AL6 to 807 procedure.
	6AR6	G	Parallel circuits only. Reverse 6AR6 to 807 procedure.
	6BG6	E	Change socket to octal and rewire as follows:



No.	1 on five prong	to No.	2 on octal
	2	to	8
	3	to	5
	4	to	3
	5	to	7
	cap	to	cap



TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
807	6CD6	E	Parallel circuits only. Same as 807 to 6BG6. When making this substitution be sure the filament power supply is capable of an additional 1.6 ampere load.
	6L6	G	Reverse 6L6 to 807 procedure.
1614	6AL6	G	Same as 5881 to 6AL6.
	6AR6	G	Parallel circuits only. Rewire as follows: No. 2 to No. 8 8 to 1 4 to 5 5 to 7 7 to 6
	6BG6	E	Same as 6L6 to 6BG6.
	6CD6	E	Parallel circuits only. Same as 6L6 to 6BG6. Use only where addidional current is available from the filament power supply.
	5881	E	No changes.
5642			Substitution can be accomplished by using 1X2, 1X2A, 1V2, 1Y2, 1Z2, 1B3GT only if space is available for mounting sockets and shield can. Refer to section 1 of book.
	1B3	E	Install octal socket and rewire as follows: Remove wires connected to the pair of filament leads protruding from one end of the 5642 and reconnect to Nos. 2 and 7 respectively on the 1B3 socket. Remove the wires connected to the plate lead protruding from the other end of the 5642 and reconnect to the cap of the 1B3.
	1X2	E	Install noval socket and rewire as follows: Remove wires connected to the pair of filament leads protruding from one end of the 5642 and reconnect to Nos. 1, 4, 6, & 9 and 2, 5, & 8 on the 1X2 socket respectively. Remove the wires connected to the plate lead protruding from the other end of the 5642 and reconnect them to the cap of the 1X2.
	1Y2	E	Install four prong socket and rewire as follows: Remove wires connected to the pair of filament leads protruding from one end of the 5642 and reconnect to Nos. 1 and 4 respectively. Remove wires connected to the plate lead protruding from the other end of the 5642 and reconnect to the cap of the 1Y2.
	1Z2	E	Install miniature socket and rewire as follows: Remove wires connected to the pair of filament leads protruding from one end of the 5642 and reconnect to Nos. 1, 3, 4, & 6 and 2, 5, & 7 respectively on the 1Z2 socket. Remove wires connected to the plate lead protruding from the other end of the 5642 and reconnect to the cap on the 1Z2.
5881	6AD7	P	Parallel circuits only. Remove and tape up any wires anchored on pins Nos. 1 and 6. The 5881 is an industrial type 6L6 with identical characteristics.
	6AL6	P	Parallel circuits only. Rewire as follows: Connect No. 3 to cap.
	6AR6	P	Parallel circuits only. Same as 1614 to 6AR6.
	6F6 6K6 6U6 6V6	P P P P	Parallel circuits only. No changes.
	6L6	E	No changes.
	1614	E	No changes.
XXD			Same as type 14AF7 substitutes.

$.99

SECOND SUPPLEMENT

RECEIVING TUBE SUBSTITUTION GUIDEBOOK

BY

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480 CANAL STREET NEW YORK 13, N. Y.

Printed in the United States of America

FOREWORD

This Second Supplement to the Receiving Tube Substitution Guidebook, in addition to the original volume and the First Supplement to it, is an accumulation of over twelve years of experience in substituting tubes in radios, television receivers and other electronic equipment. It is a never-ending process which we shall continue in an effort to keep your information as current as possible.

Most of these additional substitutions are for use in television receivers and therefore, because of their critical application in some cases, special consideration should be given your selection when you have a choice of substitutes. A stage-by-stage discussion of the most popular circuits used in television receivers is included in the First Supplement. If there is any question as to whether or not the stage being substituted is a critical one and which characteristics of the substitute should be given special consideration, take a moment to read the article covering the stage in question.

The information herein, in the large part, calls for substitutions only. It is not the object of these instructions to tell you how to improve radios, television receivers and other electronic equipment but rather to help you use the tubes you have, in order to replace those that are not available. Exceptions to the above statement are tubes especially designed as replacements of types where improvement is needed generally or for specific use such as 5881 for 6L6, 5AW4 for 5U4G, 6CU6 for 6BQ6GT, and the same type numbers in ruggedized tubes designated by an additional ending letter, as 6SN7WGT. Types such as these are designed to improve the life of the tube, the efficiency of the circuit in which they are applied, or both. Characteristics are generally identical to the type they replace. Elements are heavier duty or especially treated in order to withstand greater overloads and construction is more rugged.

Also included in this supplement is a cumulative index indicating the volume and page where the tube you wish to substitute is located.

We have endeavored to list all the practical substitutions. Some, no doubt, have been omitted. When considering substitution, others not listed will likely come to mind. When this happens, write the tube number down immediately in the form used here and attach it in its proper place.

This supplement includes picture tube substitutions. It is recommended that before substitution of picture tube is attempted, a few moments be taken to read over the short article which precedes the picture tube section.

Phoenix, Arizona
January, 1954 H. A. Middleton

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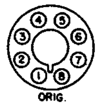
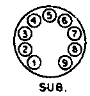
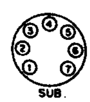
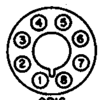
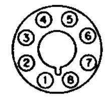
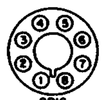
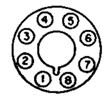
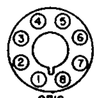
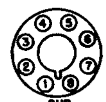
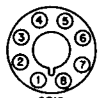
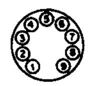
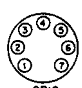
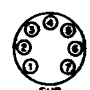
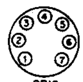
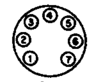
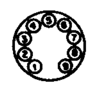
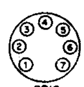
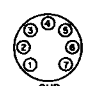
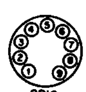
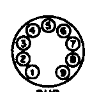
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
1B3	1AX2 1X2A	E E	Change socket to noval and rewire as follows: No. 2 on octal to No. 2 noval 7 to 8   Pins 3 and 7 may be used as tie points for filament and high voltage filter resistors.
1D5GP	1N5GT	G	Parallel circuits – add 10 ohm 1/2 watt resistor in series with filament circuit. Series circuits — in addition to above resistors, shunt a 200 ohm 1/2 watt resistor across the combination.
	1P5	G	Same as above.
1X2 1X2A	1AX2	E	It may be necessary to increase the filament current by removing the filament resistor or adding a turn to the filament loop.
5AW4	5U4 5X4 5V4	G G G	No changes.
5AZ4	5AW4		
5R4GY	5AW4		
5T4	5AW4		
5U4	5AW4		
5V4	5AW4		
5W4	5AW4		
5X4	5AW4		
5Y3	5AW4		
5Y4	5AW4		
5Z3	5AW4		
5Z4	5AW4		
6AB4	6AQ6	P	Rewire as follows: Remove wires anchored on No. 5 and tape up. Disconnect No. 2 if grounded. No. 7 to No. 2 1 to 7 6 to 1 Connect Nos. 5 and 6 to chassis.  
	6AV6 6BF6 6BK6 6BT6 6BU6	P P P P P	Same as above. Parallel circuits only.
6AF4	6AN4	G	No changes.
6AG5	6CF6	G	

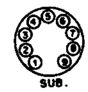
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6AH4	6BL7 6BX7	E E	Parallel circuits only. Rewire as follows. No. 8 to No. 3 2 to 8  ORIG.  SUB. Connect together Nos. 3 & 6, 2 & 5, 1 & 4.
	6F6 6K6 6L6 6U6 6V6 6W6	G G E E E E	Parallel circuits only. Rewire as follows: No. 5 to No. 3 & 4 1 to 5  ORIG.  SUB.
	6SN7	E	Parallel circuits only. Rewire as follows: No. 8 to No. 3 2 to 8  ORIG.  SUB. Connect together Nos. 3 & 6, 2 & 5, 1 & 4.
	12AU7 12BH7	E	Parallel circuits only. Change socket to noval and rewire as follows: No. 1 to No. 2 5 to 1 8 to 3 2 to 9 7 to 4  ORIG.  SUB. Connect together Nos. 1 & 6, 2 & 7, 3 & 8, 4 & 5.
6AH6	6CH6	G	Parallel circuits only. Change socket to noval and rewire as follows: No. 1 to No. 2 2 to 9 3 to 4 4 to 5 5 to 7 6 to 8 7 to 3  ORIG.  SUB. Nos. 1 and 6 are internal connections in the 6CH6 tube. Do not use these for tie points.
6AJ4	6AM4	G	No changes.
6AJ5	6CF6	P	Parallel circuits only. No changes.
6AJ8	12AH8	G	This will operate if pins 7 & 9 are connected together. Rewire as follows: Remove wires from No. 9 and put them on No. 7. Remove wires from No. 4 (or 5) and put them on No. 9. Connect No. 4 to No. 5.  ORIG.  SUB.
6AK5	6CF6	G	

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6AK6	6AM5	G	Parallel circuits only. Rewire as follows: No. 7 to No. 2 6 to 7  ORIG.  SUB.
6AK8	6T8	E	No changes.
6AM4	6AJ4	E	No changes.
	6AN4	G	Change socket to 7 pin and rewire as follows: All connections to Nos. 1, 3, & 4 must go to No. 2. All connections to Nos. 6 & 9 must go to No. 6. Then as follows: No. 2 to No. 5 5 to 1 or/& 7 7 to 3 8 to 4  ORIG.  SUB.
	6Q4	G	Parallel circuits only. Rewire as follows: No. 3 to No. 1 (Let any other connections to No. 1 stay there). 2 to 3 4 to 2 7 to 4 9 to 7 5 to 9 8 to 5 6 to 8  ORIG.  SUB.
6AM5	6AK6	E	Heater current different, make necessary changes in series circuit. Rewire as follows: Remove wires from No. 6 and tape up. No. 6 to No. 7 Connect Nos. 7 and 2 together.  ORIG.  SUB.
6AN4	6AF4	G	No changes.
	6T4	G	No changes.
	6AM4	G	Change socket to noval and rewire as follows: Connections to No. 2 may be distributed between Nos. 1, 3, & 4. Connections to No. 6 may be split up between Nos. 6 and 9. Then as follows: No. 4 to No. 8 3 to 7 1 & 7 to 5 5 to 2  ORIG.  SUB.
6AQ5	6BM5	E	No changes.
6AS5	6BM5	G	Parallel circuits only. Same as 6AS5 to 6AQ5.
6AV6	6BT6	G	No changes.
6BA6	6CG6	G	
6BC5	6CF6	G	
6BJ6	6BA6	E	Parallel circuits only. No changes.
	12BA6	E	Series circuits only. No changes.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6BK5	6BW6	G	Parallel circuits only. Rewire as follows:

Remove and tape up any wires connected to No. 2 and No. 9.

No. 1	to No.	7
3 & 7	to	1 & 2
6	to	9

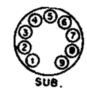


Connect Nos. 3 and 9 together.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	5686	P	Parallel circuits only. Rewire as follows:

Remove and tape up any wires on No. 2 and No. 9

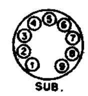
No. 3 & 7	to No.	2
1	to	7
6	to	3
8	to	6



Do not use any other pins for tie points.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6BK7	6BQ7	G	No changes.
	6BZ7	G	No changes.
	5670	G	Parallel circuits only. Rewire as follows:

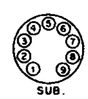
Reverse 1 & 4
2 & 3
5 & 9



TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6BL7	6BX7	E	No changes.
6BM5	6AQ5	E	No changes.
6BQ6	6CU6	E	No changes.
6BQ7	6BK7	G	No changes.
	6BZ7	E	No changes.
	5670	G	Same as 6BK7 to 5670
6BT6	6AV6	E	No changes.
6BW6	6BK5	G	Parallel circuits only. Rewire as follows:

Tape up any wires connected to No. 6.

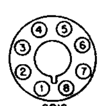
No. 1 & 2	to No.	3 or/& 7
3	to	6
7	to	1
9	to	6

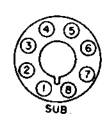


TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6BX6	6BY7	E	No changes.
6BX7	6BL7	E	No changes.
6BY5	5V4	G	This may be used if the two cathodes of the 6BY5 are connected together, and are also connected to the heater.

Connect No. 1 and No. 2 together.

No. 8	to No.	1 & 2
5	to	6

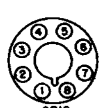


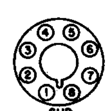


Connect a 10 watt 1/2 ohm resistor in series with one side of heater.

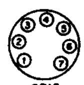
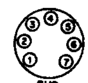
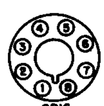
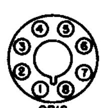
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	6AX6	E	Parallel circuits only. Rewire as follows:

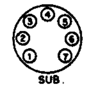
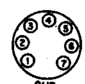
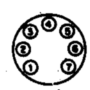
No. 4	to No.	3
1	to	4

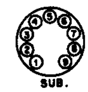
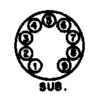
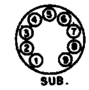




TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	6AX4	G	In damper service where both sections are paralleled.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6BY5	6U4 6W4	P G	Rewire as follows: No. 1 & 8 to No. 3 4 to 5 2 to 8  ORIG.  SUB.
6BY7	6BH5	G	Rewire socket as follows: Remove any wires from pin No. 6 and tape up. In series circuit shunt 68 ohm 1 watt resistor across 4 & 5. No. 1 to No. 3 7 to 6 8 to 1 9 to 3  ORIG.  SUB. Note — pins 7 and 8 are internal connections on the 6BH5 and must not be used for tie points. No. 9 may be used for a tie point.
	6BX6	E	No changes.
6BZ7	6BK7	G	No changes.
	6BQ7	E	No changes.
	5670	G	Same as 6BK7 to 5670
6C4	6AQ6	P	Rewire as follows: Remove and tape up wires connected to No. 2. No. 7 to No. 2 1 & 5 to 7 6 to 1 Connect Nos. 5 and 6 to chassis.  ORIG.  SUB
	6AV6 6BF6 6BK6 6BT6 6BU6	P P P P P	Same as above. Parallel circuits only.
6C5	12AT7		Same as 6C5 to 12AU7. In addition, connect together Nos. 1 and 6, 2 and 7, 3 and 8.  ORIG.  SUB.
	12AU7	E	Change socket to noval and rewire as follows: Remove and tape up any wires connected to Nos. 1, 4 and 6. No. 2 to No. 4 & 5 3 to 1 5 to 2 7 to 9 8 to 3  ORIG.  SUB.
	12AV7	G	Same as 6C5 to 12AU7. Parallel circuits only.
	12AX7	P	Same as 6C5 to 12AU7.
	12AZ7	G	Same as 6C5 to 12AU7. Parallel circuits only.
	12BH7	G	Same as 6C5 to 12AU7. Parallel circuits only.
6CB6	6CF6	E	No changes.
6CG6	6AG5	G	Remove and tape up wires on No. 2.
	6AH6	G	Parallel circuits only. No changes.
	6AJ5	G	Same as 6CG6 to 6AG5.
	6AK5	G	Same as 6CG6 to 6AG5.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6CG6	6AM6	G	Rewire as follows: Remove wires from No.2. No. 7 to No. 2 6 to 7  ORIG.  SUB. Wires removed from No. 2 connect to No. 6.
	6AU6	G	No changes.
	6BA6	G	No changes.
	6BC5	G	Same as 6CG6 to 6AG5.
	6BD6	E	No changes.
	6BH6	G	Parallel circuits only. Reverse Nos. 2 and 7.
	6BJ6	G	Parallel circuits only. Reverse Nos. 2 and 7.
	6CF6	G	
6CF6	6AG5	G	No changes.
	6AJ5	P	Parallel circuits only. No changes.
	6AK5	G	No changes.
	6AK6	G	Parallel circuits only. Change connections as follows: Reverse connections between terminals 2 and 7.
	6AU6	G	Change connections as follows: Reverse connections between terminals 2 and 7.
	6BA6	G	Same as 6CF6 to 6AU6.
	6BC5	G	No changes.
	6BD6	G	Same as 6CF6 to 6AU6.
	6CB6	E	Direct substitute.
	6CG6	G	Same as 6CF6 to 6AU6.
	5590	G	No changes.
	5591	G	
	5654	G	
	9001	P	
	9003	P	
6CH6	6AH6	P	Parallel circuits only. Change socket to 7 pin and rewire as follows: No. 2 to No. 1 3 to 7 4 to 3 5 to 4 7 to 5 8 to 6 9 to 2  ORIG.  SUB.
6CK6	6CL6	G	Rewire as follows: Reverse Nos. 1 and 3 Reverse Nos. 6 and 7 Remove and tape up wires on Nos. 8 and 9.  ORIG.  SUB.
6CL6	6AQ5	G	Change socket to 7 pin and rewire as follows: No. 2 & 9 to No. 1 & 7 1 & 7 to 2 4 to 3 5 to 4 6 to 5 3 & 8 to 6 In series circuits, shunt 20 ohm 2 watt resistor across Nos. 3 and 4.  ORIG.  SUB.
	6BK5	G	Parallel circuits only. Rewire as follows: Reverse No. 1 and No. 6. No. 7 to No. 6 3 to 8 9 to 7 2 to 3  ORIG.  SUB.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6CL6	6BV7	G	Parallel circuits only. Rewire as follows: No. 8 to No. 3 2 & 9 to 8 6 to 2   If Nos. 1 and 7 are tied together, leave as is; if No. 7 is grounded and No. 1 goes through a bias network, remove the ground from No. 7 and move leads from No. 1 to No. 7.
	6BW6	P	Parallel circuits only. Rewire as follows: No. 9 to No. 2 3 to 8 1 to 3 7 to 9 6 to 7  
	6BY7	G	Parallel circuits only. Rewire as follows: No. 9 to No. 2 7 to 9 6 to 7 3 to 8 Ground No. 6  
	6CK6	G	Rewire as follows: Reverse No. 1 and No. 3 Reverse No. 6 and No. 7 No. 8 to No. 1 Ground No. 8  
	6M5	G	Rewire as follows: No. 9 to No. 2 Remove wires from No. 3. No. 1 & 7 to No. 3 8 to 1 6 to 7   Connect wires removed from No. 3 to No. 1
6CS6	6BE6	G	No changes.
6CU6	6BQ6GT	E	No changes.
6J5	12AT7	G	This substitution utilizes both halves of the dual triode in parallel as the replacement tube. Same as 6J5 to 12AU7. In addition, connect Nos. 1 to 6, 2 to 7, and 3 to 8.  
	12AU7	E	This substitution utilizes one half of the dual triode as the replacement tube. Change socket to noval and rewire as follows: Remove and tape up any wires connected to Nos. 1, 4 and 6. No. 2 to No. 4 & 5 3 to 1 5 to 2 7 to 9 8 to 3  
	12AV7	G	Same as 6J5 to 12AU7. Parallel circuits only.
	12AX7	P	Same as 6J5 to 12AT7.
	12AZ7	G	Same as 6J5 to 12AU7. Parallel circuits only.
	12BH7	G	Same as 6J5 to 12AU7. Parallel circuits only.
6M5	6CL6	G	Reverse 6CL6 to 6M5 procedure.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY

6Q4 — 6AM4 — G

Parallel circuits only. Rewire as follows:
Remove and tape up any connections to No. 6.


ORIG.

No. 8 to No. 6
5 to 8
9 to 5
7 to 9
4 to 7
2 to 4
3 to 2
Do not use No. 3 for tie point.


SUB.

6Q4 — 6R4 — G

Parallel circuits only. Rewire as follows:
All connections to Nos. 1, 2, 7 and 8 must be moved to No. 1
No. 9 to No. 8

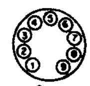

ORIG.


SUB.

6R4 — 6Q4 — G

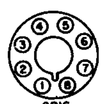
Parallel circuits only. Rewire as follows:
Remove and tape up any connections to Nos. 2, 7 and 9
No. 8 to No. 9


ORIG.


SUB.

6S8GT — 6R8 — G

Parallel circuits only. Change socket to noval and rewire as follows:

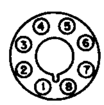

ORIG.

No. 1 on octal to No. 1 on noval
2 to 7
3 to 2
4 to 6
5 to 3
6 to 9
7 to 4
8 to 5
top cap to 8


SUB.

6S8GT — 6V8 — E

Parallel circuits only. Change socket to noval and rewire as follows:


ORIG.

No. 1 on octal to No. 2 on noval
2 to 3
3 to 7
4 to 9
5 to 8
6 to 1
7 to 4
8 to 5
top cap to 6


SUB.

6SN7 — 6BL7 — E; 6BX7 — E

Parallel circuits only. No changes.

6T4 — 6AN4 — G

No changes.

6T8 — 6AK8 — G

No changes.

6U3 — 6V3 — E

Parallel circuits only. Rewire as follows:
No. 3 to top cap

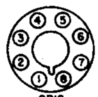
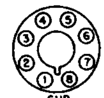
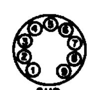
6U8 — 6X8 — G

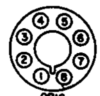
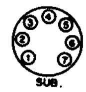
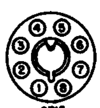
Rewire as follows (only if Nos. 7 and 8 are tied together):


ORIG.

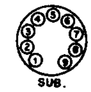
No. 1 to No. 3
2 to 7
3 to 8
6 to 9
7 & 8 to 6
9 to 2
Connect Nos. 1 and 6 together


SUB.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6V3	6U3	G	Parallel circuits only. Rewire as follows: (Be careful not to exceed the tube rating) top cap to No. 3  ORIG.  SUB.
6V5GT	6V6GT	E	Rewire as follows: Remove and tape up any wires connected to No. 2. Connect Nos. 8 and 2 together.  ORIG.  SUB
6W6	6G6 6L6 5881	P	Parallel circuits only. No changes.
6X8	6U8	G	Rewire as follows: Connect Nos. 7 and 8 together. Nos. 1 & 6 to No. 8 2 to 9 3 to 1 7 to 2 8 to 3 9 to 6  ORIG.  SUB.
12A4	12AU7	G	Rewire as follows: Remove and tape up any wires connected to Nos. 6 and 8. No. 1 to No. 3 & 8 3 to 9 9 to 1 & 6 Connect Nos. 2 and 7 together.  ORIG.  SUB.
	12B4	G	No changes.
	12BH7	G	Same as 12A4 to 12AU7.
12AH8	6AJ8	G	This will work if the 12AH8 was operating on 6 volts. Rewire as follows: Remove jumper between Nos. 4 and 5. No. 9 to Nos. 4 or 5 (whichever has no connection) Connect Nos. 7 and 9 together.  ORIG.  SUB.
12AK7	12AX7	E	No changes.
12AT6	6AQ6	E	Series circuits only. No changes.
12B4	12A4	G	No changes. For other substitutes see 12A4.
12BY7	6BY7	E	This can be used only where the 12BY7 is operating on 6.3 volts. Parallel circuits only. Rewire as follows: Remove wires from No. 4 to 5 then No. 6 to No. 4. Ground No. 6 (internal shield) If No. 3 is grounded, remove the connections from this point. If No. 9 is free, ground it or connect to No. 1.  ORIG.  SUB.
12BZ7	12AX7	E	Parallel circuits only. No changes.
12S8	19T8 19V8	E E	Same as 6S8 to 6T8. Same as 6S8 to 6V8.

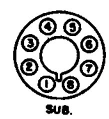
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
12SK7	12SS7	E	No changes, but in series circuits shunt 150 ohm 1 watt resistor across heater terminals, Nos. 2 and 7.
12SQ7	26BK6	G	Series circuits only. Same as 12SQ7 to 12BK6. Add 300 ohm 2 watt resistor across Nos. 3 and 4.
12SS7	12SK7	E	Make necessary circuit changes to provide additional heater current. See page 12, Section 1.
12V6	12A5	G	Change socket to small 7 pin and rewire as follows:  ORIG. No. 2 on octal to No. 1 on 7 pin 3 to 2 4 to 3 5 to 4 7 to 7 8 to 5  SUB.
12X4	6X4	E	No changes, but add a 20 ohm 5 watt resistor in series with the heater.
	6X5	E	Same as 6X4 to 6X5, except to add a 20 ohm 5 watt resistor in series with the heater.
14X7	19T8	G	Series circuits only. Change socket to noval and rewire as follows:  ORIG. No. 1 on loctal to No. 4 on noval 2 to 9 3 to 8 4 to 7 5 to 1 or/& 6 6 to 2 7 to 3 8 to 5  SUB.
	19V8	E	Series circuits only. Change socket to noval and rewire as follows:  ORIG. No. 1 on loctal to No. 4 on noval 2 to 1 3 to 6 4 to 3 5 to 9 or /& 2 6 to 7 7 to 8 8 to 5  SUB.
19AQ5	16A5	G	Change socket to noval and rewire as follows:  ORIG. No. 1 & 7 to No. 2 2 to 3 3 to 4 4 to 5 5 to 7 6 to 9 Nos. 6 and 8 are internal connections Do not use for tie points.  SUB.
	35B5	G	Series circuits only. Some circuit changes may be necessary to provide the extra 15 filament volts. No other changes.
19J6	6J6	E	Rewire as follows: Disconnect heater terminals, Nos. 3 and 4. Connect these wires to a 125 ohm 3 watt resistor, which may be mounted out of the way. Use a 6 volt filament transformer to light the 6J6.
19X3	19Y3	E	No changes.
19Y3	19X3	E	No changes.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
25BK5	12BY7	P	Rewire as follows: No. 1 to No. 7; 3 & 7 to 2; 6 to 1 & 3 or 9. No. 6 is heater tap. Do not use as tie point. Add 40 ohm 5 watt resistor in series with the filament.



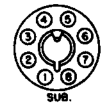
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	19AQ5	G	Change socket to 7 pin and rewire as follows: No. 1 to No. 5; 3 & 7 to 1 & 7; 4 to 3; 5 to 4; 6 to 2; 8 to 6. Remove and tape up any wires connected to Nos. 2 and 9. In parallel circuits add a 40 ohm 2 watt resistor in series with one of the filament leads. In series circuits, shunt a 120 ohm 5 watt resistor across the filament leads.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	25L6GT	E	Change socket to octal and rewire as follows: No. 1 to No. 3; 3 & 7 to 5; 4 to 2; 5 to 7; 6 to 8; 8 to 4. Connections anchored to Nos. 2 and 9 may be placed on the free terminals of the octal socket.

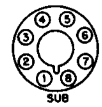
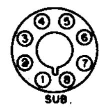
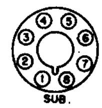


TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
25L6	25BK5	E	Change socket to noval and rewire as follows: No. 2 on octal to No. 4 on noval; 3 to 1; 4 to 8; 5 to 3 or 7; 7 to 5; 8 to 6.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
26A6	12BA6	G	No changes, except to add a 90 ohm 2 watt resistor in series with one heater lead.
26A7	12L8GT	G	No changes, except to add a 90 ohm 2 watt resistor in series with heater.
	28D7	G	Change socket to loctal and rewire as follows: No. 1 on octal to No. 7 on loctal; 2 to 6; 3 to 2; 4 to 4; 5 to 3; 6 to 1; 7 to 8; 8 to 5.



TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
26CG6	26A6	G	No changes.
	12BA6	G	Same as 26A6 to 12BA6.
26D6	12BE6	G	No changes, except to add 90 ohm 2 watt resistor in series with heater. (Parallel circuits only)

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
28D7	26A7	G	Change socket to octal and rewire as follows:  No. 1 on loctal to No. 6 on octal 2 to 3 3 to 5 4 to 4 5 to 8 6 to 2 7 to 1 8 to 7 
28Z5	OZ4A/1003	G	This will work if the requirements for proper operation of the gas rectifier are met. Change socket to octal and rewire as follows:  Remove and tapeup any wires connected to Nos. 1, 4 and 8. No. 3 on loctal to No. 3 on octal 6 to 5 7 to 8 
50AX6G	6BY5	E	Rewire as follows:  Remove wires from Nos. 2 and 7 and connect them to a 330 ohm 10 watt resistor. Remove and tape up any wires on No. 1. No. 4 to No. 1 3 to 4  The 6BY5 must be lit from a 6.3 volt 2.0 ampere filament transformer.
5590	6CF6	G	Parallel circuits only. No changes.
5591	6CF6	G	Parallel circuits only. No changes.
5670	6BK7	G	Parallel circuits only. Rewire as follows:  Reverse No. 5 and No. 9 2 3 1 4 

SUBSTITUTING PICTURE TUBES IN TV RECEIVERS

1. Connecting the External Conductive Tube Coating to Chassis

When a picture tube that does not have an external conductive coating is substituted for one that has the external coating, it is generally necessary to install a metal finger to make contact with the coating in order to connect it to the chassis. Sometimes this finger is attached to the deflection yoke support bracket. Ordinarily a tube that does not have an external coating has a 500-$\mu\mu$f capacitor connected from the anode lead to the chassis inside the high-voltage cage. It is normally not necessary to remove this capacitor when substituting a tube that has the external conductive coating.

2. Installing a Capacitor from the Anode Lead to the Chassis

When a tube that does not have the external conductive coating is substituted for one that has the external conductive coating, it is often necessary to install a capacitor from the anode lead to the chassis. In the substitutions listed here we have repeated the same value of 500 $\mu\mu$f. Ordinarily this will be satisfactory. In some cases this capacitor will not be necessary. In others best satisfaction may be had with capacitances as high as 2,000 $\mu\mu$f. This is according to individual cases and can be determined by trial. The most convenient location for this capacitor is inside the high-voltage cage.

3. Dimensions

Before attempting any of the substitutions listed here, make sure the substitute tube will fit into the available space. In the magnetic types try to choose a substitute with a neck length similar to the original. Differences in face plate curvatures may make it necessary, in some substitutions listed, to change the mask.

4. Change in Anode Connector

Either the ball-type or cavity-type anode connector is used on picture tubes. Instructions specify when a change is necessary.

5. Replacement or Deletion of Ion Trap

It is necessary to replace the ion trap with the type required by the manufacturer of the substitute tube. Some tubes do not require an ion trap and are being substituted for others requiring either a single or dual ion trap. In these cases, the instruction is "Remove ion trap." Other tubes requiring a single ion trap can be substituted for by installing a dual ion trap and vice versa. In these cases instructions are given. Some manufacturers of picture tubes are using a new type gun requiring a single ion trap in tubes that formerly used a gun requiring a dual ion trap. It is therefore important to check the individual manufacturer's specification on the substitute tube being used.

6. Electrostatic and Self-Focus Tubes

When using electrostatic or self-focus tubes as substitutions for magnetically focused tubes, it is necessary to remove the focus coil from the neck of the tube and replace it with a magnetic centering device. The focus coil may be left in the receiver circuit-wise, in which case it should be mounted in the cabinet in some position where it magnetic field has no effect on the picture. It may be replaced with a choke or resistor. The picture tube socket may have to be changed when it is necessary to bring out a lead from the focus electrode on the picture tube base except in the case of self-focus or automatic focus types. This lead should be connected to a d-c voltage point in the set which gives best focus. The voltage required normally lies between 50 and 350 volts. Self-focus or automatic focus tubes have a special gun structure within the neck of the tube designed to focus the tube automatically without the use of an external focus voltage.

7. Substituting Electrostatic or Automatic Focus Types with Magnetic Types

When replacing electrostatic focus types with magnetic focus types, discard the magnetic centering device and install a permanent magnet focusing device. This must be mounted on the yoke support with suitable metal brackets. It is practical to replace an electrostatic focus tube using high-focus voltage with a type using low-focus voltage or a self-focus type. When doing this, it is desirable to remove the focus voltage rectifier as a safety measure.

8. Differences in the Face Plate

Differences in the face plate of the tube have little effect on whether or not they may be substituted. Dark-faced tubes give better contrast than white-faced tubes. Some tubes are frosted to decrease reflections and others have an aluminized back for better contrast and brightness. Aluminized tubes in some cases have higher anode voltage applied and this voltage should be reduced in accordance with manufacturers' specifications when other than aluminized tubes are substituted. When substituting aluminized tubes for white- or gray-faced tubes, sufficient voltage is usually available for satisfactory operation.

TUBE	SUB.	CHANGES NECESSARY
7HP4	7QP4	Connect 500-$\mu\mu$f, 20-kv capacitor from anode to chassis. Change anode connector to cavity type. Change ion trap to single.
7NP4	7WP4	Connect external conductive coating to chassis.
7QP4	7HP4	Change anode connector to ball type. Connect external conductive coating to chassis. Change ion trap to double.
7WP4	7NP4	No changes.
8AP4	8AP4A	No changes. Substitute has dark face.
8AP4A	8AP4	No changes. Substitute has white face.
10BP4	10BP4A	No changes. Substitute has dark face.
10BP4 10BP4A	10CP4	Change anode connector to cavity type. Remove ion trap.
	10EP4	Change anode connector to cavity type.
	10FP4A 10FP4	Remove ion trap.
10CP4	10BP4 10BP4A	Only where 1" greater length is available. Change anode connector to ball type.
	10EP4	Only where 1" greater length is available. Change anode connector from ball to cavity type. Remove ion trap.
	10FP4 10FP4A	Change anode connector to cavity type.
10EP4	10BP4 10BP4A	Change anode connector from ball to cavity type.
	10CP4	Remove ion trap.
	10FP4 10FP4A	Change anode connector from ball to cavity type. Remove ion trap.
10FP4	10FP4A	No changes.
10FP4 10FP4A	10BP4 10BP4A	Install double ion trap.
	10CP4	Change anode connector to ball type.
	10EP4	Change anode connector from cavity to ball type. Install double ion trap.
10MP4	10MP4A	No changes.
10MP4A	10MP4	No changes.

TUBE	SUB.	CHANGES NECESSARY
12JP4	12KP4 12KP4A	Connect external conductive coating to chassis. Change anode connector to cavity type.
12JP4	12LP4 12LP4A	Only where 1 1/8" greater length is available. Change anode connector to cavity type. Install double ion trap.
	12QP4 12QP4A	Install double ion trap.
	12RP4	Install single ion trap.
	12TP4	Only where 1 1/2" greater length is available. Change anode connector to cavity type. Install double ion trap.
	12VP4 12VP4A	Change anode connector to cavity type. Install double ion trap.
	12YP4	Only where 1" greater length is available. Change anode connector to cavity. Install single ion trap. Substitute is electrostatic focus. See No. 6 in picture tube article.
12KP4	12KP4A	No changes. Substitute has dark face.
12KP4 12KP4A	12JP4	Change anode connector to cavity type.
	12QP4 12QP4A 12RP4	Connect 500-$\mu\mu$f, 20-kv capacitor from anode to chassis. Change anode connector to ball. Install single ion trap.
	12TP4	Only where 1 1/2" greater length is available. Connect 500-$\mu\mu$f, 20-kv capacitor from anode to chassis. Install double ion trap.
	12VP4 12VP4A	Install double ion trap.
	12YP4	Only where 1 1/2" greater length is available. Install single ion trap. Substitute is electrostatic focus. See No. 6 in picture tube article.
12LP4	12LP4A	No changes. Substitute has dark face.
12LP4 12LP4A	12JP4	Connect 500-$\mu\mu$f, 20-kv capacitor from anode to chassis. Change anode connector to ball type. Remove ion trap.
	12KP4 12KP4A	Remove ion trap.
	12QP4 12QP4A 12RP4	Connect 500-$\mu\mu$f, 20-kv capacitor from anode to chassis. Change anode connector to ball type. Change ion trap to single.
	12VP4 12VP4A 12TP4	No changes.
	12YP4	Change ion trap to single. Substitute is electrostatic focus. See No. 6 in picture tube article.
12QP4	12QP4A	No changes. Substitute has dark face.
12QP4 12QP4A	12JP4	Remove ion trap.
	12KP4 12KP4A	Connect external conductive coating to chassis. Change anode connector to cavity type. Remove ion trap.

TUBE	SUB.	CHANGES NECESSARY
12QP4 12QP4A	12LP4 12LP4A	Only where 1 1/2" greater length is available. Connect external conductive coating to chassis. Change anode connector to cavity type. Install ion trap.
	12RP4	No changes.
	12TP4	Only where 1 1/2" greater length is available. Change anode connector to cavity type. Change ion trap to double.
	12VP4 12VP4A	Connect external conductive tube coating to chassis. Only where 1" greater length is available. Change anode connector to cavity type. Change ion trap to double.
	12YP4	Only where 1 1/2" greater length is available. Connect external tube coating to chassis. Change anode connector to cavity type. Substitute is electrostatic focus. See No. 6 in picture tube article.
12RP4	12JP4	Remove ion trap.
	12KP4 12KP4A	Connect external conductive tube coating to chassis. Change anode connector to cavity type. Remove ion trap.
	12LP4 12LP4A	Only where 1 1/2" greater length is available. Connect external conductive tube coating to chassis. Change anode connector to cavity type. Change ion trap to double.
	12QP4 12QP4A	No changes.
	12TP4	Only where 1 1/2" greater length is available. Change anode connector to cavity type. Change ion trap to double.
	12VP4 12VP4A	Only where 1 1/2" greater length is available. Connect external conductive coating to chassis. Change anode connector to cavity type. Change ion trap to double.
	12YP4	Only where 1 1/2" greater length is available. Change anode connector to cavity type. Substitute is electrostatic focus. See No. 6 in picture tube article.
12TP4	12JP4	Change anode connector to ball type. Remove ion trap.
	12KP4 12KP4A	Connect external conductive tube coating to chassis. Remove ion trap.
	12QP4 12QP4A	Change anode connector to ball type. Change ion trap to single.
	12RP4	
	12VP4 12VP4A	Connect external conductive tube coating to chassis.
	12YP4	Connect external conductive tube coating to chassis. Change ion trap to single. Substitute is electrostatic focus. See No. 6 in picture tube article.
12UP4	12UP4A	No changes. Substitute has dark face.
12UP4 12UP4A	12UP4B	Change to single ion trap.
12UP4B	12UP4 12UP4A	Change to double ion trap.
12VP4	12VP4A	No changes. Substitute has dark face.

TUBE	SUB.	CHANGES NECESSARY
14BP4	14BP4A	No changes.
14BP4 14BP4A	14EP4 14CP4	No changes.
	14DP4	Connect 500-$\mu\mu$f, 20-kv capacitor from anode to chassis. Change ion trap to double.
	14FP4	Connect 500-$\mu\mu$f, 20-kv capacitor from anode to chassis.
14CP4	14BP4 14BP4A 14EP4	No changes.
	14DP4	Connect 500-$\mu\mu$f, 20-kv capacitor from anode to chassis. Change ion trap to double.
	14FP4	Connect 500-$\mu\mu$f, 20-kv capacitor from anode to chassis.
14DP4	14BP4 14BP4A 14CP4 14EP4	Connect external conductive coating to chassis. Change ion trap to single.
	14FP4	Change ion trap to single.
14EP4	14BP4 14BP4A 14CP4	No changes.
	14DP4	Connect 500-$\mu\mu$f, 20-kv capacitor from anode to chassis. Change ion trap to double.
	14FP4	Connect 500-$\mu\mu$f, 20-kv capacitor from anode to chassis.
14FP4	14BP4 14BP4A 14CP4 14EP4	Connect external conductive coating to chassis.
	14DP4	Change ion trap to double.
15AP4	15CP4	Only where 1" greater length is available. Change anode connector to cavity type. Install double ion trap.
	15DP4	Change ion trap to single.
	16CP4	Only where 1" greater length is available. Change anode connector to cavity type. Install double ion trap.
	16LP4 16LP4A 16ZP4	Only where 2" greater length is available. Connect external conductive coating to chassis. Install double ion trap.
15CP4	15AP4	Change ion connector to ball type. Remove ion trap.
	15DP4	Change ion connector to ball type. Change ion trap to single.
	16CP4	No changes.
	16LP4 16LP4A 16ZP4	Only where 1" greater length is available. Connect external conductive tube coating to chassis.

TUBE	SUB.	CHANGES NECESSARY
15DP4	15AP4	Install single ion trap.
	15CP4 16CP4	Only where 1" greater length is available. Change anode connector to cavity type. Change ion trap to double.
	16LP4 16LP4A 16ZP4	Only where 2" greater length is available. Connect external conductive tube coating to chassis. Change anode connector to cavity type. Change ion trap to double.
16AP4	16AP4A	No changes.
16AP4A	16AP4	No changes.
16AP4 16AP4A	16AP4B	No changes.
16CP4	15AP4	Change anode connector to ball type. Remove ion trap.
	15CP4	No changes.
	15DP4	Change anode connector to ball type. Change ion trap to single.
	16LP4 16LP4A 16ZP4	Only where 1" greater length is available. Connect external conductive tube coating to chassis.
16DP4	16DP4A	No changes.
16DP4 16DP4A	16FP4	Change anode connector to ball type. Change ion trap to single.
	16HP4 16HP4A 16JP4 16JP4A	Connect external conductive tube coating to chassis.
	16MP4 16MP4A	Connect external conductive tube coating to chassis.
16EP4	16EP4A 16EP4B	No changes.
16EP4 16EP4A 16EP4B	16AP4 16AP4A 16AP4B	Only where 2-5/8" additional length is available. Change ion trap to double.
16FP4	16HP4 16HP4A 16JP4 16JP4A	Only where 1" greater length is available. Connect external conductive tube coating to chassis. Change anode connector to cavity type. Change ion trap to double.
	16MP4 16MP4A	Only where 2" greater length is available. Connect external conductive tube coating to chassis. Change anode connector to cavity type. Change ion trap to double.
16GP4	16GP4A 16GP4B	No changes.
16HP4	16HP4A	No changes.
16HP4 16HP4A	16JP4 16JP4A	No changes.
	16MP4 16MP4A	Only where 1" greater length is available. No changes.
16JP4	16JP4A	No changes.
16JP4 16JP4A	16DP4 16DP4A	Connect 500-$\mu\mu$f, 20 kv capacitor from anode to chassis.
	16FP4 16FP4A	Change anode connector to ball type. Change ion trap to single.

TUBE	SUB.	CHANGES NECESSARY
16JP4 16JP4A	16HP4 16HP4A	No changes.
	16MP4 16MP4A	Only where 1" greater length is available. No changes.
16KP4	16KP4A	No changes.
16KP4 16KP4A	16QP4	Install 500-$\mu\mu$f, 20-kv capacitor from anode to chassis. Change ion trap to double.
	16RP4	No changes.
	16TP4	No changes.
	16UP4	Install 500-$\mu\mu$f, 20-kv capacitor from anode to chassis.
	16XP4	Install 500-$\mu\mu$f, 20-kv capacitor from anode to chassis. Change ion trap to double.
16LP4	16LP4A	No changes. Substitute has dark face.
16LP4 16LP4A	15AP4	Connect 500-$\mu\mu$f, 20-kv capacitor from anode to chassis. Change anode connector to ball type. Remove ion trap.
	15CP4	Connect 500-$\mu\mu$f, 20-kv capacitor from anode to chassis.
	15DP4	Connect 500-$\mu\mu$f, 20-kv capacitor from anode to chassis. Change anode connector to ball type. Change ion trap to single.
	16CP4	Connect 500-$\mu\mu$f, 20-kv capacitor from anode to chassis.
	16ZP4	No changes.
16MP4	16MP4A	No changes.
16MP4 16MP4A		Same as 16JP4 substitutes.
16QP4	16KP4 16KP4A	Connect external conductive tube coating to chassis. Change ion trap to single.
	16RP4	Connect external conductive tube coating to chassis. Change ion trap to single.
	16TP4	Connect external conductive tube coating to chassis. Change ion trap to single.
	16UP4	Change ion trap to single.
	16XP4	No changes.
16RP4	16KP4 16KP4A	No changes.
	16QP4	Change ion trap to double.
	16TP4	No changes.
	16UP4	Install 500-$\mu\mu$f, 20-kv capacitor from anode to chassis.
	16XP4	Install 500-$\mu\mu$f, 20-kv capacitor from anode to chassis. Change ion trap to double.

TUBE	SUB.	CHANGES NECESSARY
16SP4	16SP4A	No changes.
16SP4A	16SP4	No changes.
16SP4 16SP4A	16VP4	Install 500-$\mu\mu$f, 20-kv capacitor from anode to ground. Change ion trap to single.
	16WP4	Install 500-$\mu\mu$f, 20-kv capacitor from anode to chassis.
	16YP4	Change ion trap to single.
	16WP4A	No changes.
16TP4	16KP4 16KP4A	Only where 1" greater length is available. No changes.
	16QP4	Install 500-$\mu\mu$f, 20-kv capacitor from anode to chassis. Change ion trap to double.
	16RP4	Only where 1" greater length is available. No changes.
	16UP4	Install 500-$\mu\mu$f, 20-kv capacitor from anode to chassis.
	16XP4	Install 500-$\mu\mu$f, 20-kv capacitor from anode to chassis. Change ion trap to double.
16UP4	16KP4 16KP4A	Connect external conductive tube coating to chassis.
	16QP4	Change ion trap to double.
	16RP4	Connect external conductive tube coating to chassis.
	16TP4	Connect external conductive tube coating to chassis.
	16XP4	Change ion trap to double.
16VP4	16SP4 16SP4A	Connect external conductive tube coating to chassis. Change ion trap to double.
	16WP4	Change ion trap to double.
	16WP4A	Connect external conductive tube coating to chassis. Change ion trap to double.
	16YP4	Connect external conductive tube coating to chassis.
16WP4	16SP4 16SP4A	Connect external conductive tube coating to chassis.
	16VP4	Change ion trap to single.
	16WP4A	Connect external conductive tube coating to chassis.
	16YP4	Connect external conductive tube coating to chassis. Change ion trap to single.
16WP4A	16SP4 16SP4A	No changes.
	16VP4	Install 500-$\mu\mu$f, 20-kv capacitor from anode to chassis. Change ion trap to single.
	16WP4	Install 500-$\mu\mu$f, 20-kv capacitor from anode to chassis.
	16YP4	Change ion trap to single.

TUBE	SUB.	CHANGES NECESSARY
16XP4	16KP4 16KP4A	Connect external conductive tube coating to chassis. Change ion trap to double.
	16QP4	No changes.
	16RP4	Connect external conductive tube coating to chassis. Change ion trap to single.
	16TP4	Connect external conductive tube coating to chassis. Change ion trap to single.
	16UP4	Change ion trap to single.
	16WP4A	Change ion trap to double.
16YP4	16SP4 16SP4A	Change ion trap to double.
	16VP4	Install 500-$\mu\mu$f, 20-kv capacitor from anode to chassis.
	16WP4	Install 500-$\mu\mu$f, 20-kv capacitor from anode to chassis. Change ion trap to double.
16ZP4		Same as 16LP4 substitutes.
17AP4	17BP4	Install 500-$\mu\mu$f, 20-kv capacitor from anode to chassis.
	17BP4A 17BP4B 17BP4C	No changes.
	17JP4	No changes.
	17KP4	Substitute type is self-focus electrostatic. See No. 6 in picture tube article.
17BP4	17AP4	Connect external conductive tube coating to chassis.
	17BP4A 17BP4B 17BP4C	Connect external conductive tube coating to chassis.
	17JP4	Connect external conductive tube coating to chassis.
	17KP4	Substitute type is self-focus electrostatic. See No. 6 in picture tube article.
17BP4A	17BP4B 17BP4C	No changes.
17BP4A 17BP4B 17BP4C	17AP4	No changes.
	17BP4	Install 500-$\mu\mu$f, 20-kv capacitor from anode to chassis.
	17JP4	No changes.
	17KP4	Substitute type is self-focus electrostatic. See No. 6 in picture tube article.
17CP4	17CP4A	No changes.
17CP4A	17CP4	No changes.

TUBE	SUB.	CHANGES NECESSARY
17FP4	17FP4A	No changes.
17FP4A	17FP4	No changes.
17FP4 17FP4A	17KP4	No changes. Focus voltage rectifier may be removed as a safety measure.
17HP4	17HP4A	No changes.
17HP4A	17HP4	No changes.
17HP4 17HP4A	17KP4	No changes.
	17RP4	No changes.
17JP4	17AP4	No changes.
	17BP4	Install 500-$\mu\mu$f, 20-kv capacitor from anode to chassis.
	17BP4A 17BP4B 17BP4C	No changes.
	17KP4	Substitute is self-focus electrostatic. See No. 6 in picture tube article.
17KP4	17HP4 17HP4A	Original type is self-focus. Substitute is external control electrostatic focus. See No. 6 in picture tube article.
	17BP4 17BP4A	Original type is self-focus. Substitute is magnetic focus. See No. 7 in picture tube article.
17LP4	17LP4A	No changes.
17LP4 17LP4A	17SP4	No changes.
	17VP4	No changes.
17QP4	17SP4	Substitute is self-focus electrostatic. See No. 6 in picture tube article.
	17UP4	No changes.
17RP4	17HP4 17HP4A	No changes.
	17KP4	No changes.
17SP4	17LP4 17LP4A	Substitute is external control electrostatic. See No. 6 in picture tube article.
17UP4	17QP4	No changes.
17UP4	17SP4	Substitute is self-focus electrostatic. See No. 6 in picture tube article.
17VP4	17LP4 17LP4A	No changes.
	17SP4	No changes.

TUBE	SUB.	CHANGES NECESSARY
19AP4	19AP4A	No changes. Substitute has gray face.
	19AP4B	No changes. Substitute has gray frosted face.
	19AP4C	No changes. Substitute has gray aluminum face.
	19AP4D	No changes. Substitute has clear frosted face.
19AP4A 19AP4B 19AP4C 19AP4D		Refer to above.
19DP4	19DP4A	No changes. Substitute has gray face.
19DP4A	19DP4	No changes. Substitute has clear face.
19DP4 19DP4A	19FP4	Install 500-$\mu\mu$f, 25-kv capacitor from anode to chassis.
	19GP4	Install 500-$\mu\mu$f, 25-kv capacitor from anode to chassis. Change ion trap to single.
19EP4	19JP4	No changes.
19FP4	19DP4 19DP4A	Connect external conductive tube coating to chassis.
	19GP4	Change ion trap to single.
19GP4	19DP4 19DP4A	Connect external conductive tube coating to chassis. Change ion trap to double.
	19FP4	Change ion trap to double.
19JP4	19EP4	No changes.
20CP4	20CP4A	No changes.
	20CP4C	No changes. Substitute has treated face.
	20DP4	No changes.
	20DP4A	Connect external conductive tube coating to chassis.
	20JP4	Connect external conductive tube coating to chassis. Substitute is self-focus electrostatic. See No. 6 in picture tube article.
20CP4A	20CP4	Connect external conductive tube coating to chassis.
	20CP4C	Install 500-$\mu\mu$f, 25-kv capacitor from anode to chassis.
	20DP4	Install 500-$\mu\mu$f, 25-kv capacitor from anode to chassis.
	20DP4A	No changes.
	20JP4	Substitute is self-focus electrostatic. See No. 6 in picture tube article.
20CP4C	20CP4	No changes. Substitute has treated face.
	20CP4A	Connect external conductive tube coating to chassis
	20DP4	No changes.

TUBE	SUB.	CHANGES NECESSARY
20CP4C	20DP4A	Connect external conductive tube coating to chassis.
	20JP4	Substitute is self-focus electrostatic. See No. 6 in picture tube article.
20DP4	20CP4 20CP4C	No changes.
	20DP4A	Connect external conductive tube coating to chassis.
	20CP4A	Connect external conductive tube coating to chassis.
	20JP4	Install 500-$\mu\mu$f, 25-kv capacitor from anode to chassis.
20DP4A	20CP4 20CP4C	Install 500-$\mu\mu$f, 25-kv capacitor from anode to chassis.
	20DP4	Install 500-$\mu\mu$f, 25-kv capacitor from anode to chassis.
	20JP4	Substitute is self-focus electrostatic. See No. 6 in picture tube article.
20FP4	20GP4	Connect external conductive tube coating to chassis.
	20JP4	No changes. Focus voltage rectifier may be removed as a safety measure.
20GP4	20FP4	Install 500-$\mu\mu$f, 25-kv capacitor from anode to chassis.
	20JP4	No changes. Focus voltage rectifier may be removed as a safety measure.
20HP4	20HP4B	No changes. Substitute has treated face.
20HP4 20HP4B	20HP4A	Connect external conductive tube coating to chassis.
	20JP4	Connect external conductive tube coating to chassis.
	20LP4	Connect external conductive tube coating to chassis.
21EP4	21EP4A 21EP4B	Connect external conductive tube coating to chassis.
	21KP4	Substitute is self-focus electrostatic. See No. 6 in picture tube article.
	21KP4A	Connect external conductive tube coating to chassis. Substitute is self-focus electrostatic. See No. 6 in picture tube article.
21EP4A	21EP4B	No changes. Substitute is aluminized.
21EP4A 21EP4B	21KP4	Substitute is self-focus electrostatic. See No. 6 in picture tube article.
	21EP4	Install 500-$\mu\mu$f, 25-kv capacitor from anode to chassis.
	21KP4A	Substitute is self-focus electrostatic. See No. 6 in picture tube article.
21FP4	21FP4A	Connect external conductive tube coating to chassis.
	21KP4	No changes.
	21KP4A	Connect external conductive tube coating to chassis.

TUBE	SUB.	CHANGES NECESSARY
21FP4A	21FP4	Install 500-$\mu\mu$f, 25-kv capacitor from anode to chassis.
	21KP4	Install 500-$\mu\mu$f, 25-kv capacitor from anode to chassis.
	21KP4A	No changes.
21KP4	21KP4A	Connect external conductive tube coating to chassis.
21KP4A	21KP4	Install 500-$\mu\mu$f, 25-kv capacitor from anode to chassis.
21WP4	20CP4 20CP4C	Install 500-$\mu\mu$f, 25-kv capacitor from anode to chassis.
	20CP4A	No changes.
	20DP4	Install 500-$\mu\mu$f, 25-kv capacitor from anode to chassis.
	20DP4A	No changes.
	20JP4	Substitute is self-focus electrostatic. See No. 6 in picture tube article.
21ZP4	21ZP4A	Connect external conductive tube coating to chassis.
21ZP4A	21ZP4	Install 500-$\mu\mu$f, 25-kv capacitor from anode to chassis.
22AP4	22AP4A	No changes.
22AP4A	22AP4	No changes.
24AP4	24AP4A 24AP4B	No changes.
24AP4B	24AP4 24AP4A	No changes.
27EP4	27GP4	No changes.
	27NP4	No changes.
	27RP4	No changes.
27GP4	27EP4	No changes.
	27NP4	Connect external conductive tube coating to chassis.
	27RP4	Connect external conductive tube coating to chassis.
27NP4	27EP4	No changes.
	27GP4	No changes.
	27RP4	No changes.
27RP4	27EP4	No changes.
	27GP4	No changes.
	27NP4	No changes.

CUMULATIVE INDEX

The following index contains all the tubes listed in the RECEIVING TUBE SUBSTITUTION GUIDEBOOK, including those given in the First and Second Supplements, for which substitutions are given. Where (0) precedes the page number, the substitution information is given on the page referred to in the original RECEIVING TUBE SUBSTITUTION GUIDEBOOK; where (1) precedes the page number, the substitution information is given on the page referred to in the First Supplement; and where (2) precedes the page number, the substitution information is given on the page referred to in the Second Supplement.

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5900	(0) 142
5901	(0) 142
5910	(0) 142
5915	(0) 142
5931	(0) 142
5932	(0) 142
7000	(0) 144
7700	(0) 144
9001	(0) 142
9002	(0) 142

PICTURE TUBES

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16FP4	(2) 19	17BP4A	(2) 22	19FP4	(2) 24
16GP4	(2) 19	17BP4B	(2) 22	19GP4	(2) 24
16HP4	(2) 19	17BP4C	(2) 22	19JP4	(2) 24
16HP4A	(2) 19	17CP4	(2) 22	20CP4	(2) 24
16JP4	(2) 19, 20	17CP4A	(2) 22	20CP4A	(2) 24
16JP4A	(2) 19, 20	17FP4	(2) 23	20CP4C	(2) 24, 25
16KP4	(2) 20	17FP4A	(2) 23	20DP4	(2) 25
16KP4A	(2) 20	17HP4	(2) 23	20DP4A	(2) 25
16LP4	(2) 20	17HP4A	(2) 23	20FP4	(2) 25
16LP4A	(2) 20	17JP4	(2) 23	20GP4	(2) 25
16MP4	(2) 20	17KP4	(2) 23	20HP4	(2) 25
16MP4A	(2) 20	17LP4	(2) 23	20HP4B	(2) 25
16QP4	(2) 20	17LP4A	(2) 23	21EP4	(2) 25
16RP4	(2) 20	17QP4	(2) 23	21EP4A	(2) 25
16SP4	(2) 21	17RP4	(2) 23	21EP4B	(2) 25
16SP4A	(2) 21	17SP4	(2) 23	21FP4	(2) 25
16TP4	(2) 21	17UP4	(2) 23	21FP4A	(2) 26
16UP4	(2) 21	17VP4	(2) 23	21KP4	(2) 26
16VP4	(2) 21	19AP4	(2) 24	21KP4A	(2) 26
16WP4	(2) 21	19AP4A	(2) 24	21WP4	(2) 26
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16XP4	(2) 22	19AP4C	(2) 24	21ZP4A	(2) 26
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24AP4B	(2) 26	27GP4	(2) 26	27RP4	(2) 26

$1.35

THIRD SUPPLEMENT

RECEIVING TUBE SUBSTITUTION GUIDEBOOK

BY

H. A. MIDDLETON

JOHN F. RIDER PUBLISHER, INC.
116 WEST 14th ST., NEW YORK 11, N.Y.

Library of Congress Catalog Card Number 51-1704

Printed in the United States of America

FOREWORD

This Third Supplement to the *Receiving Tube Substitution Guidebook,* in addition to the original volume and the First and Second Supplements to it, is an accumulation of over 15 years of experience in substituting tubes in radio and television receivers and other electronic equipment. It is a never-ending process which we shall continue in an effort to keep this information as current as possible.

Most of these additional substitutions are for use in television receivers and therefore, because of their critical application in some cases, special consideration should be given your selection when you have a choice of substitutes. A stage-by-stage discussion of the most popular circuits used in television receivers is included in the First Supplement. If there is any question as to whether or not the stage being substituted is a critical one and which characteristics of the substitute should be given special consideration, take a moment to read the article covering the stage in question.

The information herein, in the large part, calls for substitutions only. It is not the object of these instructions to tell you how to improve radios, television receivers and other electronic equipment but rather to help you use the tubes you have, in order to replace those that are not available. Exceptions to the above statements are tubes especially designed as replacements of types where improvement is needed generally or for specific use such as 5881 for 6L6, 5AW4 for 5U4G, 6CU6 for 6BQ6GT, and the same type numbers in ruggedized tubes designated by an additional ending letter, as 6SN7WGT. Types such as these are designed to improve the life of the tube, the efficiency of the circuit in which they are applied, or both. Characteristics are generally identical to the type they replace. Elements are heavier duty or especially treated in order to withstand greater overloads and construction is more rugged.

Introduced in this Third Supplement is a European-American and American-European tube substitution guide. Due to the recent heavy influx of British and other European electronic equipment, the demand for a substitution guide for these tubes has been increasing steadily. This is due to the fact that in many instances European tubes are not readily available.

Also included in this supplement is a cumulative index indicating the volume and page where the tube you wish to substitute is located.

We have endeavored to list all the practical substitutions. Some, no doubt, have been omitted. When considering substitution, others not listed will likely come to mind. When this happens, write the tube number down immediately in the form used here and attach it in its proper place.

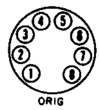
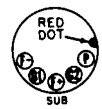
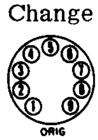
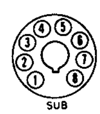
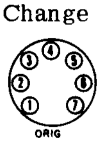
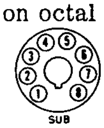
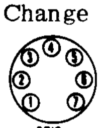
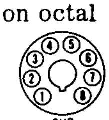
This supplement includes picture tube substitutions. It is recommended that before substitution of picture tube is attempted, a few moments be taken to read over the short article which precedes the picture tube section.

Phoenix, Arizona
June 1957

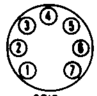
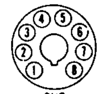
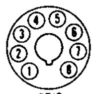
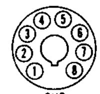
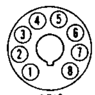
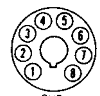
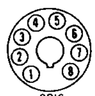
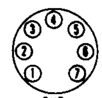
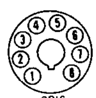
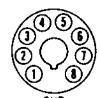
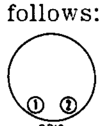
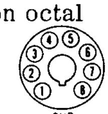
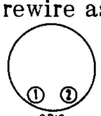
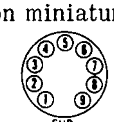
H. A. Middleton

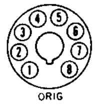
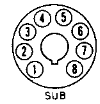
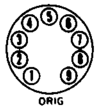
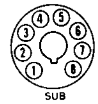
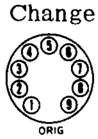
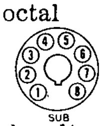
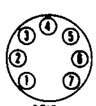
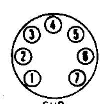
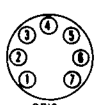
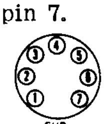
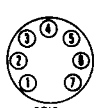
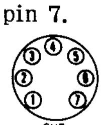
TABLE OF CONTENTS

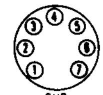
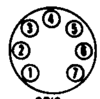
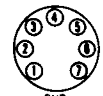
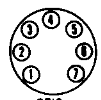
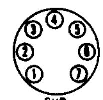
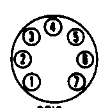
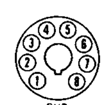
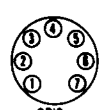
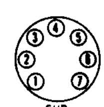
RECEIVING TUBE SUBSTITUTIONS

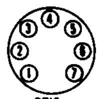
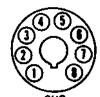
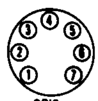
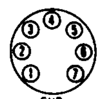
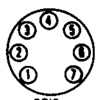
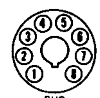
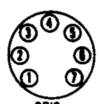
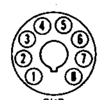
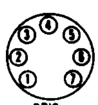
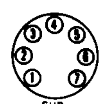
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
OB3	1266	E	No changes.
1AB6	1AC6	E	Parallel circuits only. No changes.
1AC5	1AG4	G	Change miniature socket to subminiature socket and rewire as follows: Change pin No. 4 on miniature to F-pin on subminiature. No. 2 to G1 No. 8 to G2 No. 7 to P No. 5 to F +  
1AC6	1AB6	E	No changes.
1AE5			No practical substitute.
1AF4	1AJ4	G	No changes.
1AF6			No practical substitute.
1AG4	1AC5	G	Reverse 1AC5 to 1AG4 procedure.
1AG5	1AJ5	G	No changes.
	1AK5	G	No changes.
1AH4	1AK4	E	No changes.
1AH5			No practical substitute.
1AH6			No practical substitute.
1AJ4	1AF4	G	No changes.
1AJ5	1AG5	G	No changes.
	1AK5	G	No changes.
1AK4	1AH4	E	No changes.
1AK5	1AG5	G	No changes.
	1AJ5	G	No changes.
1AX2	1B3	E	Change socket to octal and rewire as follows: No. 2 on miniature to No. 2 on octal 9 to 7  
	1X2	E	No changes.
1B3	2B3	P	No changes.
1C3	1E4	G	Change socket to octal and rewire as follows: No. 1 on miniature to No. 2 on octal 2 to 3 4 to 5 7 to 7  
	1LE3	G	Change socket to octal and rewire as follows: No. 1 on miniature to No. 1 on octal 2 to 2 4 to 6 7 to 8  

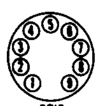
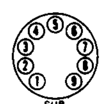
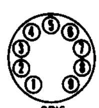
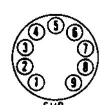
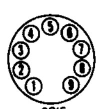
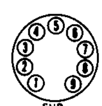
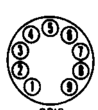
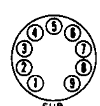
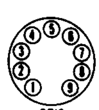
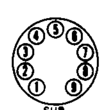
(Cont.)

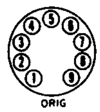
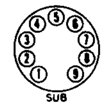
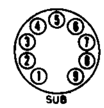
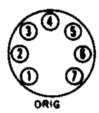
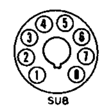
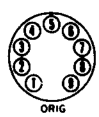
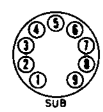
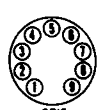
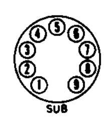
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
1C3 (Cont.)	1LF3	G	Change socket to octal and rewire as follows: No. 1 on miniature to No. 1 on octal 2 to 2 4 to 6 7 to 8  ORIG  SUB
1D3			No practical substitute.
1E3			No practical substitute.
1E4	1C3	G	Reverse 1C3 to 1E4 procedure.
	1LE3	G	Rewire as follows: No. 2 pin to No. 1 3 to 2 5 to 6 7 to 8  ORIG  SUB
	1LF3	E	Rewire as follows: No. 2 pin to No. 1 3 to 2 5 to 6 7 to 8  ORIG  SUB
1LE3	1C3	G	Change socket to miniature and rewire as follows: No. 1 on octal to pin No. 1 on miniature 2 to 2 6 to 4 8 to 7  ORIG  SUB
	1E4	E	Rewire as follows: Change No. 1 pin to pin No. 2 2 to 3 6 to 5 8 to 7  ORIG  SUB
	1LF3	E	No changes.
1LF3	1C3	G	Reverse 1C3 to 1LF3 procedure.
	1E4	G	Reverse 1E4 to 1LF3 procedure.
	1LE3	E	No changes.
1M3			No practical substitute.
1T2	1B3	G	Only where space permits, change socket to octal and rewire as follows: No. 1 on subminiature to No. 2 on octal 2 to 7  ORIG  SUB
	1X2	G	Only where space permits, change socket to nine pin miniature and rewire as follows: No. 1 on subminiature to No. 2 on miniature 2 to 9  ORIG  SUB
1U4	5910	E	No changes.
1V6			No practical substitute.
2A3	5930	E	No changes.
2AF4	2T4	G	No changes.
2B3	1B3	P	No changes.
2B5			No practical substitute.
2BN4			No practical substitute.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
2C22	6J5	G	Rewire as follows: Plate Cap to pin No. 3 Grid Cap to pin No. 5  
2C51	6SN7	G	Parallel circuits only. Rewire as follows: Change pin No. 1 to pin No. 8 on octal 2 to 3 3 to 1 4 to 2 6 to 5 7 to 4 8 to 6 9 to 7  
	5670	E	No changes.
2C52	12SL7	G	Parallel circuits only. No changes.
2CB5			No practical substitute.
2D21	2D21W	E	No changes.
	5727	E	No changes.
2D21W	2D21	G	No changes.
	5727	E	No changes.
2E22			No practical substitute.
2T4	2AF4	G	No changes.
2V2			No practical substitute.
3A2	3A3	E	Change socket to octal and rewire as follows: No. 2 on miniature to No. 2 on octal 9 to 7  
3A3	3A2	G	Reverse 3A2 to 3A3 procedure. Use only where high voltage does not exceed 20KV.
	3B2	G	No changes.
	3C2	G	No changes.
3AF4			No practical substitute.
3AL5			No practical substitute.
3AU6	3BA6	G	No changes.
	3BC5	G	Rewire as follows: Reverse connections on pin 2 and pin 7.  
	3CB6	G	Rewire as follows: Reverse connections on pin 2 and pin 7.  
	3BZ6	G	Rewire as follows: Reverse connections on pin 2 and pin 7.  
3AV6	3BT6	G	No changes.

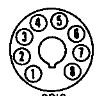
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
3B2	3A3	G	No changes.
	3C2	G	No changes.
3BA6	3AU6	G	No changes.
	3BC5	G	Rewire as follows: Reverse connections on pin No. 2 and pin No. 7.  ORIG  SUB
	3BZ6	G	Rewire as follows: Reverse connections on pin No. 2 and pin No. 7.  ORIG  SUB
	3CB6	G	Rewire as follows: Reverse connections on pin No. 2 and pin No. 7.  ORIG  SUB
3BC5	3AU6	G	Reverse 3AU6 to 3BC5 procedure.
	3BA6	G	Reverse 3BA6 to 3BC5 procedure.
	3BZ6	G	No changes. Tie pin No. 2 and No. 7 together.
	3CB6	G	No changes. Tie pin No. 2 and No. 7 together.
	3CF6	G	No changes. Tie pin No. 2 and No. 7 together.
3BE6			No practical substitute.
3BN4			No practical substitute.
3BN6			No practical substitute.
3BT6	3AV6	G	No changes.
3BU8			No practical substitute.
3BY6	3CS6	G	No changes.
3BZ6	3AU6	G	Reverse 3AU6 to 3BZ6 procedure.
	3BA6	G	Reverse 3BA6 to 3BZ6 procedure.
	3BC5	G	No changes.
	3CB6	G	No changes.
3C2	3A3	G	No changes.
	3B2	G	No changes.
3C4	3C5	G	Change socket to octal and rewire as follows: No. 1 on miniature to No. 2 on octal 2 to 3 3 to 4 5 to 8 6 to 5  ORIG  SUB
	3Q4	G	Rewire as follows: Change pin No. 3 to pin No. 4 6 to 3  ORIG  SUB
	3V4	G	No changes.
3C5	3C4	G	Parallel circuits only. Reverse 3C4 to 3C5 procedure.
3CB6	3AU6	G	Reverse 3AU6 to 3CB6 procedure.
	3BA6	G	Reverse 3BA6 to 3CB6 procedure.
	3BC5	G	No changes.
	3BZ6	G	No changes.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
3CE5	3CB6	E	No changes.
	3CF6	E	No changes.
3CF6	3BC5	G	No changes.
	3BZ6	G	No changes.
	3CB6	G	No changes.
	3CE5	E	No changes.
3CS6	3BY6	G	No changes.
3DT6			No practical substitute.
3Q4	3C4	G	Parallel circuits only. Reverse 3C4 to 3Q4 procedure.
	3Q5	G	Change socket to octal and rewire as follows: Change pin No. 1 on miniature to pin No. 2 on octal 2 to 3 4 to 4 5 to 8 6 to 3 7 to 7  ORIG  SUB
3S4	3C4	G	Parallel circuits only. Rewire as follows: Change pin No. 3 to pin No. 6 4 to 3 6 to 2  ORIG  SUB
	3Q5	G	Change socket to octal and rewire as follows: Change pin No. 1 on miniature to pin No. 2 on octal 2 to 3 3 to 5 4 to 4 5 to 8 6 to 3 7 to 7  ORIG  SUB
3V4	3C4	G	Parallel circuits only. No changes.
	3Q5	G	Change socket to octal and rewire as follows: Change pin No. 1 on miniature to pin No. 2 on octal 2 to 3 3 to 4 5 to 8 6 to 5 7 to 7  ORIG  SUB
	3S4	G	Rewire as follows: Change pin No. 3 to pin No. 4 6 to 2  ORIG  SUB
4BC5	4CB6	G	No cnanges. Tie pin No. 2 and pin No. 7 together.
4BC8	4BK7	G	No changes.
	4BQ7	G	No changes.
	4BS8	G	No changes.
	4BZ7	G	No changes.
	4BZ8	G	No changes.
	4CX7	G	No changes. Pins No. 8 and No. 9 are connected internally together.
4BK7	4BC8	G	No changes.
	4BQ7	G	No changes.
	4BS8	G	No changes.
	4BZ8	G	No changes.
	4CX7	G	No changes. Pins No. 8 and No. 9 are connected internally together.
4BN6			No practical substitute.

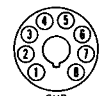
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
4BQ7	4BC8	G	No changes.
	4BK7	G	No changes.
	4BS8	G	No changes.
	4BZ7	G	No changes.
	4BZ8	G	No changes.
	4CX7	G	No changes. Pins No. 8 and No. 9 are connected together internally.
4BS8	4BC8	G	No changes.
	4BK7	G	No changes.
	4BQ7	G	No changes.
	4BZ8	G	No changes.
	4CX7	G	No changes. Pins No. 8 and No. 9 are connected together internally.
4BU8			No practical substitute.
4BX8	4BC8	G	No changes.
	4BK7	G	No changes.
	4BQ7	G	No changes.
	4BS8	G	No changes.
	4BZ8	G	No changes.
	4CX7	G	No changes. Pins No. 8 and No. 9 are connected together internally.
4BZ7	4BC8	G	No changes.
	4BK7	G	No changes.
	4BQ7	G	No changes.
	4BS8	G	No changes.
	4BZ8	G	No changes.
	4CX7	G	No changes. Remove and tape any wires anchored on pin No. 9.
4BZ8	4BC8	G	No changes.
	4BK7	G	No changes.
	4BQ7	G	No changes.
	4BS8	G	No changes.
	4CX7	G	No changes. Remove and tape any wires anchored on pin No. 9.
4CB6	4BC5	G	No changes.
4CX7	4BC8	G	Rewire as follows: Tie pins No. 8 and No. 9 together.  ORIG  SUB
	4BK7	G	Rewire as follows: Tie pins No. 8 and No. 9 together.  ORIG  SUB
	4BQ7	G	Rewire as follows: Tie pins No. 8 and No. 9 together.  ORIG  SUB
	4BS8	G	Rewire as follows: Tie pins No. 8 and No. 9 together.  ORIG  SUB
	4BZ8	G	Rewire as follows: Tie pins No. 8 and No. 9 together.  ORIG  SUB

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
4DT6			No practical substitute.
5AM8	5AS8	G	Reverse 5AS8 to 5AM8 procedure.
5AN8	5AV8	E	Rewire as follows: Reverse connections on pins No. 1 and No. 3. Change pin No. 6 to pin No. 9 7 to 8 8 to 6 9 to 7  
	5U8	G	Rewire as follows: Change pin No. 2 to pin No. 9 3 to 8 7 to 3 8 to 2 9 to 7  
5AQ5	5V6	G	Change socket to octal and rewire as follows: No. 1 on miniature to No. 5 on octal 2 to 8 3 to 2 4 to 7 5 to 3 6 to 4  
5AS4	5AU4	G	No changes. If transformer will stand 1.5 amperes more.
	5AW4	G	No changes.
	5U4GA	G	No changes.
	5U4GB	G	No changes.
	5V3	E	No changes.
	5931	E	No changes.
5AS8	5AM8	G	Rewire as follows: Change pin No. 1 to pin No. 3 3 to 1 6 to 8 7 to 9 8 to 7 9 to 6  
5AU4	5AS4	G	No changes.
	5AW4	E	No changes.
	5R4GY	G	No changes.
	5T4	G	No changes.
	5U4G	G	No changes.
	5U4GA	E	No changes.
	5U4GB	E	No changes.
	5V3	E	No changes.
	5931	E	No changes.
5AV8	5AN8	E	Reverse 5AN8 to 5AV8 procedure.
	5U8	G	Rewire as follows: Change pin No. 1 to pin No. 8 2 to 9 3 to 1 6 to 2 7 to 7 8 to 3 9 to 6  
5AW4	5AS4	G	No changes.
	5AU4	E	No changes.
	5R4GY	G	No changes.
	5T4	G	No changes.
	5U4G	G	No changes.
	5U4GA	E	No changes.
	5U4GB	E	No changes.
	5V3	E	No changes.
	5931	E	No changes.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
5AX4	5AS4	E	No changes.
	5AW4	E	No changes. If transformer will stand 1.2 amperes more.
	5T4	G	No changes.
	5U4G	G	No changes.
	5U4GA	E	No changes.
	5U4GB	E	No changes.
	5X3	E	No changes. If transformer will stand 1.3 amperes more.
	5V4	E	No changes.
	5931	E	No changes.
5AZ4	5AX4	E	No changes.
	5V4	E	No changes.
	5Y3	E	No changes.
	5Y4	G	Rewire as follows:
			Change pin No. 2 to pin No. 7
			4 to 3
			6 to 5



ORIG

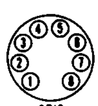


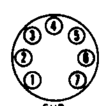
SUB

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	5Z4	E	No changes.
5B8			No practical substitute.
5BE8			No practical substitute.
5BK7	5BQ7	G	No changes.
	5BZ7	G	No changes.
5BR8			No practical substitute.
5BT8			No practical substitute.
5CG8			No practical substitute.
5CL8			No practical substitute.
5CM8			No practical substitute.
5J6			No practical substitute.
5T4	5AS4	E	No changes.
	5AW4	E	No changes.
	5R4	E	No changes.
	5U4	E	No changes.
	5U4GA	E	No changes.
	5U4GB	E	No changes.
	5V4	E	No changes.
	5931	E	No changes.
5T8			No practical substitute.
5U4G	5AS4	E	No changes.
	5AW4	E	No changes.
	5U4GA	E	No changes.
	5U4GB	E	No changes.
	5V3	E	No changes.
	5931	E	No changes.
5U4GA	5AS4	E	No changes.
	5AU4	E	No changes. If transformer will stand 1.5 amperes more.
	5AW4	E	No changes.
	5R4GY	E	No changes.
	5T4	E	No changes.
	5U4G	E	No changes.
	5U4GB	E	No changes.
	5V3	E	No changes.
	5931	E	No changes.

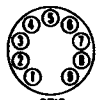
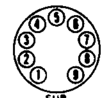
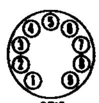
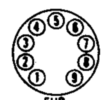
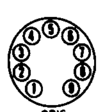
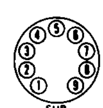
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
5U4GB	5AS4	E	No changes.
	5AU4	E	No changes.
	5AW4	E	No changes.
	5R4GT	G	No changes.
	5T4	E	No changes.
	5U4G	G	No changes.
	5U4GA	E	No changes.
	5V3	E	No changes.
	5931	E	No changes.
5U8	5AN8	G	Reverse 5AN8 to 5U8 procedure.
	5AV8	G	Reverse 5AV8 to 5U8 procedure.
5V3	5AS4	G	No changes.
	5AU4	E	No changes.
	5AW4	G	No changes.
	5U4GB	G	No changes.
5V4	5931	G	No changes.
5V6	5AQ5	E	Reverse 5AQ5 to 5V6 procedure.
5W4	5Z4	E	No changes.
	5931	G	No changes.
5X8	5AT8	E	Same as 6AT8 to 6X8 procedure.
5Y3	5AZ4	E	No changes.
	5Y3WGT	E	No changes.
	5Z4	E	No changes.
	5931	G	No changes.
5Y4	5AZ4	E	Reverse 5AZ4 to 5Y4 procedure.
	5Z4	E	No changes.
	5931	G	No changes.
5Z4	5AZ4	E	No changes.
	5V4	G	No changes.
	5W4	G	No changes.
	5Y3	E	No changes.
	5Y4	E	No changes.
	5931	G	No changes.
6AB8			No practical substitute.
6AC7	6006	G	Parallel circuits only. No changes.
	6134	E	No changes.
6AD8			No practical substitute.
6AE7			No practical substitute.
6AF4	3AF4	E	Parallel circuits only. Install 7-ohm 5-watt resistor in series with the filament.
	6T4	G	No changes.
6AG5	6186	E	No changes.
6AH6	6485	E	No changes.
6AK4	6C4	G	Where space permits:

Pin No.	to pin No.
1	to 6
3	to 3
5	to 7
6	to 4
8	to 5 & 1

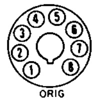
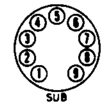
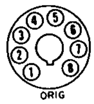
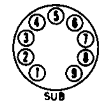
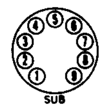
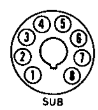




TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6AK5	6AK5W	E	No changes.
	5591	E	No changes.
	5654	E	No changes.
	6096	E	No changes.

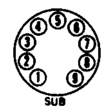
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6AL5	3AL5	E	Parallel circuits only. Install 5-ohm 5-watt resistor in series with the filament.
	6AL5W	E	No changes.
	5726	E	No changes.
	6058	E	No changes.
	6097	E	No changes.
	6663	E	No changes.
6AL6	6BJ5	G	Parallel circuits only. Reverse 6BJ5 to 6AL6 procedure.
	6BS5	G	Reverse 6BS5 to 6AL6 procedure.
6AM6	6064	E	No changes.
6AM8	5AM8	E	Parallel circuits only. Install 2.5-ohm 5-watt resistor in series with the filament.
	6AS8	G	Change pin No. 1 to pin No. 3
			3 to 1
			6 to 9
			7 to 8
			8 to 6
			9 to 7
			 ORIG  SUB
6AN8	5AN8	E	Parallel circuits only. Install 2.5-ohm 5-watt resistor in series with filament.
	6AW8	G	Rewire as follows:
			Change pin No. 1 to pin No. 3
			3 to 1
			6 to 9
			7 to 8
			8 to 7
			9 to 6
			 ORIG  SUB
6AQ4			No practical substitute.
6AQ5	6AQ5W	E	No changes.
	6CM6	E	Reverse 6CM6 to 6AQ5 procedure.
	6005	E	No changes.
	6669	G	No changes.
6AQ6	6066	E	Parallel circuits only. No changes.
6AR8			No practical substitute.
6AS6	6AS6W	E	No changes.
	5725	E	No changes.
6AS7	5998	G	Parallel circuits only. No changes.
	6080	E	No changes.
6AS8	5AM8	G	Parallel circuits only. Install 2.5-ohm 5-watt resistor in series with filament and use same procedure as 5AM8 to 6AS8.
	6AM8	G	Reverse 6AM8 to 6AS8 procedure.
6AT6	6066	E	No changes.
6AT8	5AT8	E	Parallel circuits only. Install 2.5-ohm 5-watt resistor in series with filament.
	6BR8	G	Connect pins No. 8 and No. 3 together.
	6X8	E	Rewire as follows:
			Change pin No. 1 to pin No. 2
			2 to 3
			3 to 6
			6 to 9
			7 to 8
			8 to 1
			9 to 7
			 ORIG  SUB
6AU4	6AX4	G	No changes.
	6BL4	G	No changes, where space permits.

(Cont.)

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6AU4 (Cont.)	6U3	G	Change socket to miniature and rewire as follows:
			No. 3 on octal to pin No. 3 on miniature
			5 to 9
			7 to 5
			8 to 4
			 
	6V3	G	Change socket to miniature and rewire as follows:
			No. 3 on octal to cap on miniature
			5 to pin No. 2 and 7
			7 to 4
			8 to 5
			 
	6W4	G	No changes.
6AU6	3AU6	E	Parallel circuits only. Install 5-ohm 5-watt resistor in series with filament.
	4AU6	E	Parallel circuits only. Install 5-ohm 5-watt resistor in series with filament.
	6AU6WA	E	No changes.
	5749	G	No changes.
	6136	E	No changes.
6AU8	6AW8	G	No changes.
	6BA8	G	No changes.
	6BH8	G	No changes.
	6U8	G	Parallel circuits only. Rewire as follows:
			Change pin No. 1 to pin No. 8
			2 to 9
			3 to 1
			6 to 7
			7 to 2
			8 to 3
			9 to 6
			 
6AV4	6BX4	G	No changes.
	6W5	E	Change socket to octal and rewire as follows:
			No. 1 on miniature to pin No. 3 on octal
			3 to 7
			4 to 2
			6 to 5
			7 to 8
			 
	6X4	G	No changes.
	6X5	G	Same as 6AV4 to 6W5 procedure.
6AV6	3AV6	E	Parallel circuits only. Install 5-ohm 5-watt resistor in series with filament.
	6066	G	No changes.
6AW8	6AN8	G	Parallel circuits only. Reverse 6AN8 to 6AW8 procedure.
	6AU8	G	No changes.
6AX4	6AU4	G	No changes.
	6BL4	G	No changes.
6AX5	6BW4	G	Reverse 6BW4 to 6AX5 procedure.
6AX8	6U8	G	No changes.
6AZ8			No practical substitute.
6BA6	3BA6	E	Parallel circuits only. Install 5-ohm 5-watt resistor in series with filament.
	6BA6W	E	No changes.
	6DA6	G	Reverse 6DA6 to 6BA6 procedure.
	5749	E	No changes.
	6136	G	No changes.

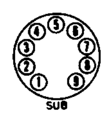
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6BA8	6AU8	G	No changes.
	6AW8	G	No changes.
	6BH8	G	No changes.
6BC4	6AJ4	G	Rewire as follows:

Change pin No.	to pin No.
1	5
2	3
4	7
5	8
6	2
7	3
8	3
9	5

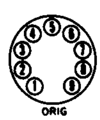


TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6BC5	3BC5	E	Parallel circuits only. Install 5-ohm 5-watt resistor in series with filament.
6BC8	4BC8	E	Parallel circuits only. Install 3.5-ohm 5-watt resistor in series with filament.
	5BC8	E	Parallel circuits only. Install 1.5-ohm 5-watt resistor in series with filament.
	6BK7	G	No changes.
	6BQ7	G	No changes.
	6BS8	G	No changes.
	6BZ7	E	No changes.
	6BZ8	G	No changes.
	X155	G	No changes.
6BD4A	6BK4	E	No changes.
6BD6	6DA6	G	Reverse 6DA6 to 6BD6 procedure.
	5749	G	No changes.
6BE6	3BE6	E	Parallel circuits only. Install 5-ohm 5-watt resistor in series with filament.
	6BY6	G	No changes.
	5750	E	No changes.
6BE7			No practical substitute.
6BE8	5BE8	E	Parallel circuits only. Install 1.5-ohm 5-watt resistor in series with filament.
	6U8	E	Rewire as follows:

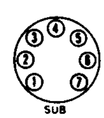
Change pin No.	to pin No.
1	9
2	1
3	8
6	7
7	7
8	7
9	2



TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6BG6	6DN6	G	No changes.
6BH5	6BD6	G	Change socket to miniature and rewire as follows:



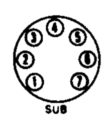
Change pin No.	to pin No.
1	6 on miniature.
2	1
3	2
4	3
5	4
6	5
3	7

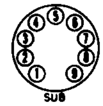
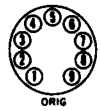
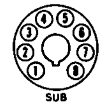
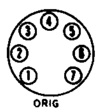
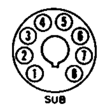
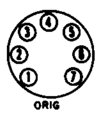
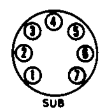


TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	6BJ6	G	Change socket to miniature and rewire as follows:

(Cont.)

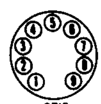
Change pin No.	to pin No.
1	6 on miniature.
2	1
3	7
4	3
5	4
6	5
3	2



TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6BH5 (Cont.)	6DA6	G	Rewire as follows: Change pin No. 1 to pin No. 8 3 to 9 6 to 7  
	6SS7	G	Parallel circuits only. Change socket to octal and rewire as follows: Change pin No. 1 to pin No. 6 on octal 2 to 4 3 to 3 4 to 2 5 to 7 6 to 8 3 to 5  
6BH6	6065	G	Parallel circuits only. Reverse 6065 to 6BH6 procedure.
	6265	E	No changes.
	6661	E	No changes.
6BH8	6AU8	G	No changes.
	6AW8	G	No changes.
	6BA8	G	No changes.
6BJ5	6AL6	G	Change socket to octal and rewire as follows: Change pin No. 1 to pin No. 5 on octal 2 to 8 3 to 2 4 to 7 5 to cap 7 to 4  
	6M5	G	Change miniature socket to noval and rewire as follows: Change pin No. 1 to pin No. 2 2 to 3 3 to 4 4 to 5 5 to 7 7 to 1  
6BJ6	6DA6	G	Reverse 6DA6 to 6BJ6 procedure.
	6662	E	No changes.
6BJ7			No practical substitute.
6BJ8	6BN8	G	No changes.
6BK4	6BD4-A	E	No changes.
6BK6	6066	G	No changes.
6BK7	5BK7	E	Parallel circuits only. Install 2.6-ohm 5-watt resistor in series with filament.
	6BC8	G	No changes.
	6BQ7	G	No changes.
	6BS8	G	No changes.
	6BZ7	G	No changes.
	6BZ8	G	No changes.
	X155	G	No changes.
6BL4	6AU4-GTA	G	No changes.
	6AX4	P	No changes.
6BN4	2BN4	E	Parallel circuits only. Install 6.8-ohm 5-watt resistor in series with filament.
	3BN4	E	Parallel circuits only. Install 7-ohm 5-watt resistor in series with filament.
6BN5			No practical substitute.
6BN6	3BN6	E	Parallel circuits only. Install 5-ohm 5-watt resistor in series with filament.
	(Cont.)		

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6BN6 (Cont.)	4BN6	E	Parallel circuits only. Install 5-ohm 5-watt resistor in series with filament.
6BN8	6BJ8	G	No changes.
6BQ6	6DQ6	E	No changes.
6BQ7	4BQ7	E	Parallel circuits only. Install 4-ohm 5-watt resistor in series with filament.
	5BQ7	E	Parallel circuits only. Install 2-ohm 5-watt resistor in series with filament.
	6BC8	G	No changes.
	6BK7	G	No changes.
	6BS8	G	No changes.
	6BZ7	G	No changes.
	6BZ8	G	No changes.
	X155	G	No changes.
6BR7	6BS7	E	Reverse 6BS7 to 6BR7 procedure.
	6C6	G	Parallel circuits only. Change socket to six pin socket and rewire as follows:

Change pin No. 2 to grid cap
3 to No. 5
4 to 1
5 to 6
7 to 2
8 to 3
9 to 4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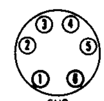
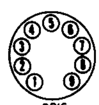

SUB

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	6J7	G	Parallel circuits only. Change socket to octal and rewire as follows:

Change pin No. 2 to grid cap on octal
3 to No. 8
4 to 2
5 to 7
7 to 3
8 to 4
9 to 5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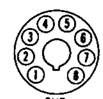
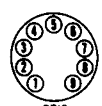
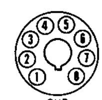

SUB

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	6W7	G	Same as 6BR7 to 6J7 procedure.
	7C7	G	Change socket to octal and rewire as follows:

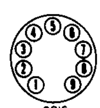
Change pin No. 2 to pin No. 6 on octal
3 to 7
4 to 1
5 to 8
7 to 2
8 to 3
9 to 4


ORIG


SUB

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6BR8	5BR8	E	Parallel circuits only. Install 3-ohm 5-watt resistor in series with filament.
6BS5	6AL6	G	Change socket to octal and rewire as follows:

Change pin No. 1 to pin No. 5 on octal
2 to 5
3 to 8
4 to 2
5 to 7
7 to cap
9 to 4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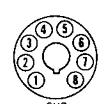
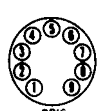

SUB

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6BS7	6BR7	E	Rewire as follows: Change grid cap on 6BS7 to pin No. 2.
	6C6 (Cont.)	G	Change socket to six pin.

Change pin No. 3 to pin No. 5
4 to 1
5 to 8
8 to 3
9 to 4
7 to 2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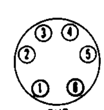
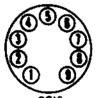
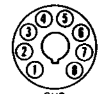
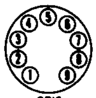
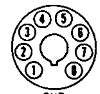
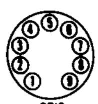
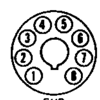
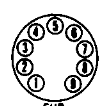
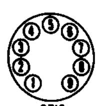
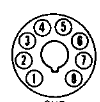
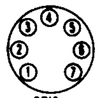
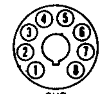
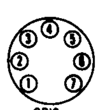
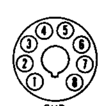
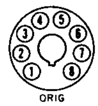
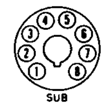

SUB

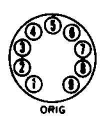
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6BS7 (Cont.)	6J7	G	Parallel circuits only. Change socket to octal and rewire as follows: Change pin No. 3 to pin No. 8 on octal 4 to 2 5 to 7 7 to 3 8 to 4 9 to 5  ORIG  SUB
	6W7	G	Same as 6BS7 to 6J7 procedure.
	7C7	G	Change socket to loctal and rewire as follows: Change pin No. 3 to pin No. 7 on octal 4 to 1 5 to 8 7 to 2 8 to 3 9 to 4  ORIG  SUB
6BS8	4BS8	E	Parallel circuits only. Install 3.5-ohm 5-watt resistor in series with filament.
	5BS8	E	Parallel circuits only. Install 1.5-ohm 5-watt resistor in series with the filament.
	6BC8	G	No changes.
	6BK7	G	No changes.
	6BQ7	E	No changes.
	6BZ7	G	No changes.
	6BZ8	G	No changes.
	X155	G	No changes.
6BT6	6066	E	No changes.
6BT8	5BT8	E	Parallel circuits only. Install 2.5-ohm 5-watt resistor in series with filament.
6BU5			No practical substitute.
6BU8	3BU8	E	Parallel circuits only. Install 5-ohm 5-watt resistor in series with filament.
	4BU8	E	Parallel circuits only. Install 5-ohm 5-watt resistor in series with filament.
6BV7			No practical substitute.
6BV8			No practical substitute.
6BW4	6AX5	E	Change socket to octal and rewire as follows: Change pin No. 1 to No. 5 on octal 4 to 2 5 to 7 7 to 3 9 to 8  ORIG  SUB
	6V4	G	Rewire as follows: Change pin No. 9 to pin No. 3  ORIG  SUB
	7Z4	E	Change socket to loctal and rewire as follows: Change pin No. 1 to pin No. 6 on octal 4 to 1 5 to 8 7 to 3 9 to 7  ORIG  SUB
6BW7	6BX6	G	No changes.

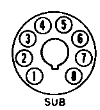
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6BX4	6AX5	E	Parallel circuits only. Change socket to octal and rewire as follows: Change pin No. 1 to pin No. 3 on octal 3 to 7 4 to 2 6 to 5 7 to 8  ORIG  SUB
	6AV4	G	Parallel circuits only. No changes.
	6X4	G	No changes.
	6X5	G	Same as 6BX4 to 6AX5.
6BX6	6BN7	G	No changes.
6BX8	4BX8	E	Parallel circuits only. Install 3.5-ohm 5-watt resistor in series with filament.
	6BC8	G	No changes.
	6BE6	G	No changes.
	6BK7	G	No changes.
	6BQ7	G	No changes.
	6BS8	G	No changes.
	6BZ7	G	No changes.
	6BZ8	G	No changes.
	X155	G	No changes.
6BY6	3BY6	E	Parallel circuits only. Install 5-ohm 5-watt resistor in series with filament.
	6CS6	G	No changes.
	5915	G	No changes.
6BY8			No practical substitute.
6BZ6	3BZ6	E	Parallel circuits only. Install 5-ohm 5-watt resistor in series with filament.
	4BZ6	E	Parallel circuits only. Install 4.7-ohm 5-watt resistor in series with filament.
	6CB6	E	No changes.
	6DE6	E	No changes.
6BZ7	4BZ7	E	Parallel circuits only. Install 2.5-ohm 5-watt resistor in series with filament.
	5BZ7	E	Parallel circuits only. Install 1.5-ohm 5-watt resistor in series with filament.
	6BC8	G	No changes.
	6BK7	G	No changes.
	6BQ8	E	No changes.
	6BS8	G	No changes.
	6BZ8	E	No changes.
	X155	E	No changes.
6BZ8	4BZ8	E	Parallel circuits only. Install 3.5-ohm 5-watt resistor in series with filament.
	6BC8	G	No changes.
	6BK7	G	No changes.
	6BS8	G	No changes.
	6BZ7	G	No changes.
	X155	E	No changes.
6C4	5610	G	No changes.
	6135	E	No changes.
6C6	6BR7	G	Parallel circuits only. Reverse 6BR7 to 6C6 procedure.
6CA5	7A5	G	Parallel circuits only. Change socket to octal and rewire as follows: Change pin No. 1 to pin No. 7 on octal 2 to 6 3 to 1 4 to 8 5 to 6 6 to 3 7 to 2  ORIG  SUB

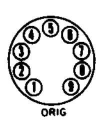
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6CA7	6L6	G	Parallel circuits only. No changes.
6CB5	6BG6	P	Rewire as follows: Change pin No. 1 to pin No. 8 4 to 5 6 to 3
	6CD6	P	Same as 6CB5 to 6BG6 procedure.
6CB6	6BZ6	G	No changes.
	6DC6	G	No changes.
	6DE6	E	No changes.
6CD6	6DN6	E	No changes.
6CD7			No practical substitute.
6CE5	3CE5	E	Parallel circuits only. Install 5-ohm 5-watt resistor in series with filament.
	4CE5	E	Parallel circuits only. Install 4.7-ohm 5-watt resistor in series with filament.
	6BZ6	G	Same as 6CE5 to 6CB6 procedure.
	6CB6	E	Rewire as follows: Connect pin No. 7 to pin No. 2
	6DE6	E	Same as 6CE5 to 6CB6 procedure.
6CG7	6BL7	E	Same as 6CG7 to 6SN7 procedure.
	6BX7	G	Parallel circuits only. Same as 6CG7 to 6SN7 procedure.
	6SN7	E	Change socket to octal and rewire as follows: Change pin No. 1 to pin No. 2 on octal 2 to 1 3 to 3 4 to 8 5 to 7 6 to 5 7 to 4 8 to 6
	12AU7	G	Parallel circuits only. Rewire as follows: Reverse wires connected to No. 5 and No. 9
6CG8	5CG8	E	Parallel circuits only. Install 2.5-ohm 5-watt resistor in series with filament.
	6AT8	G	Rewire as follows: Connect pin No. 8 to pin No. 3
	6X8	G	Rewire as follows: No. 1 to No. 2 2 to 3 3 to 6 6 to 9 7 to 8 8 to 6 9 to 7
6CH6	6132	E	No changes.
6CH7	6BC8	G	Tie pin No. 8 and No. 9 together.
	6BK7	G	Tie pin No. 8 and No. 9 together.
	6BQ7	G	Tie pin No. 8 and No. 9 together.
	6BS8	G	Tie pin No. 8 and No. 9 together.
	6BZ7	E	Tie pin No. 8 and No. 9 together.
	6BZ8	E	Tie pin No. 8 and No. 9 together.
	X155	E	Tie pin No. 8 and No. 9 together.
6CH8			No practical substitute.

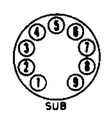






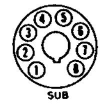






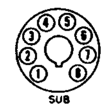
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6CJ6	6CD6	G	Where space permits. Change socket to octal and rewire as follows:

Change pin No.		to pin No. (on octal)
2	to	5
3	to	3
4	to	2
5	to	7
8	to	8
9	to	3



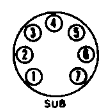
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6CL6	6677	E	No changes.
6CL8	5CL8	E	Parallel circuits only. Install 2.5-ohm 5-watt resistor in series with filament.
6CM6	5CM6	E	Parallel circuits only. Install 2.5-ohm 5-watt resistor in series with filament.
	5V6	E	Parallel circuits only. Install 2.5-ohm 5-watt resistor in series with filament. Change socket to octal. Rewire as follows:

Change pin No.		to pin No. (on octal)
1	to	4
3	to	5
4	to	2
5	to	7
6	to	5
7	to	8
9	to	3



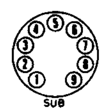
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	6AQ5	G	Change socket to miniature and rewire as follows:

Change pin No.		to pin No. (on miniature)
1	to	6
3	to	1
4	to	3
5	to	4
6	to	7
7	to	2
9	to	5

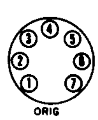


TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	6V6	G	Same as 6CM6 to 5V6 procedure.
	6W6	G	Parallel circuits only. Same as 6CM6 to 5V6 procedure.
6CM7	6CS7	G	Rewire as follows:

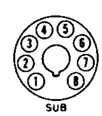
Change pin No.		to pin No.
3	to	8
8	to	3



TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6CM8	5CM8	E	Parallel circuits only. Install 2.5-ohm 5-watt resistor in series with the filament.
6CN6			No practical substitute.
6CN7			No practical substitute.
6CQ7			No practical substitute.
6CR6	6SF7	G	Change socket to octal and rewire as follows:

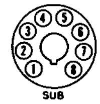
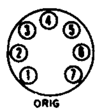
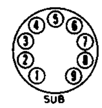
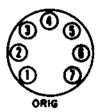
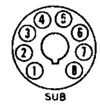
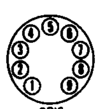
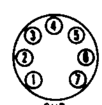
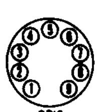
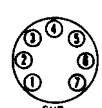


Change pin No.		to pin No. (on octal)
1	to	3
2	to	5
3	to	8
4	to	7
5	to	6
6	to	4
7	to	2



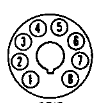
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6CS5	6CU5	G	Reverse 6CU5 to 6CS5 procedure.

(Cont.)

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6CS5 (Cont.)	6K6	G	Change socket to octal and rewire as follows:
			 ORIG  SUB
			Change pin No. 1 to pin No. 4 on octal
			2 to 8
			3 to 5
			4 to 2
			5 to 7
			6 to 5
			7 to 8
			9 to 3
	6V6	G	Same as 6CS5 to 6K6 procedure.
	6W6	E	Same as 6CS5 to 6K6 procedure.
	6Y6	G	Same as 6CS5 to 6K6 procedure.
6CS6	3CS6	E	Parallel circuits only. Install 5-ohm 5-watt resistor in series with filament.
	6BY6	G	No changes.
6CS7	6CM7	G	Reverse 6CM7 to 6CS7 procedure.
6CU5	6CS5	G	Change socket to noval and rewire as follows:
			 ORIG  SUB
			Change pin No. 1 to pin No. 2 on noval
			2 to 3
			3 to 4
			4 to 5
			5 to 6
			6 to 1
			7 to 9
	6V6	G	Same as 6CU5 to 6W6 procedure.
	6W6	G	Change socket to octal and rewire as follows:
			 ORIG  SUB
			Change pin No. 1 to pin No. 8 on octal
			2 to 5
			3 to 2
			4 to 7
			5 to 5
			6 to 4
			7 to 3
	6Y6	G	Same as 6CL5 to 6W6 procedure.
6CU6	6DQ6	E	No changes.
6CX7	4CX7	E	Parallel circuits only. Install 3.5-ohm 5-watt resistor in series with filament.
	6BC8	G	No changes. Tie pin No. 8 and No. 9 together.
	6BK7	G	Same as 6BC8 to 6CX7.
	6BQ7	E	Same as 6BC8 to 6CX7.
	6BS8	G	Same as 6BC8 to 6CX7.
	6BZ7	G	Same as 6BC8 to 6CX7.
	6BZ8	G	Same as 6BC8 to 6CX7.
	X155	G	Same as 6BC8 to 6CX7.
6DA6	6BA6	G	Change socket to miniature and rewire as follows:
			 ORIG  SUB
			Change pin No. 2 to pin No. 1 on miniature
			3 to 7
			4 to 3
			5 to 4
			7 to 5
			8 to 6
			9 to 2
	6BD6	G	Same as 6DA6 to 6BA6 procedure.
	6BJ6	G	Parallel circuits only. Change socket to miniature and rewire as follows:
			 ORIG  SUB
			Change pin No. 2 to pin No. 1 on miniature
			3 to 2
			4 to 3
			5 to 4
			7 to 5
			8 to 6
			9 to 7

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6DB6			No practical substitute.
6DC6	6BZ6	G	No changes.
	6CB6	G	No changes.
	6DC6	G	No changes.
6DE6	6BZ6	G	No changes.
	6CB6	G	No changes.
	6DE6	G	No changes.
6DG6	6K6	G	Parallel circuits only. No changes.
	6V6	G	Parallel circuits only. No changes.
	6W6	E	No changes.
6DN6	6BG6	G	No changes.
	6CD6	E	No changes.
6DQ6	6BQ6	G	No changes.
	6CU6	G	No changes.
6DT6	3DT6	E	Parallel circuits only. Install 5-ohm 5-watt resistor in series with filament.
	4DT6	E	Parallel circuits only. Install 4.7-ohm 5-watt resistor in series with filament.
6F6	1621	E	No changes.
	1622	E	Parallel circuits only. No changes.
6H6	5679	G	Reverse 5679 to 6H6 procedure.
6J4	6J4WA	E	No changes.
6J5	2C22	G	Reverse 2C22 to 6J5 procedure.
6J6	5964	E	No changes.
	6101	E	No changes.
6J7	1221	E	Reverse 1221 to 6J7 procedure.
	6059	G	Reverse 6059 to 6J7 procedure.
	7000	G	No changes.
6K6	1621	E	Parallel circuits only. No changes.
	5871	G	No changes.
6K7	5732	E	No changes.
6L6	1621	G	Parallel circuits only. No changes.
	1622	G	No changes.
	5881	E	No changes.
	5932	E	No changes.
	6550	E	No changes.
6M5	6BJ5	G	Reverse 6BJ5 to 6M5 procedure.
6N7	1635	E	Parallel circuits only. No changes.
6Q5	884	E	No changes.
6S7	5732	G	Parallel circuits only. No changes.
6SA7	5961	E	No changes.
6SB7Y	5961	G	No changes.
6SG7	6006	E	No changes.
6SH7	6006	G	No changes.
6SJ7	6SJ7WGT	E	No changes.
	6006	G	No changes.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6SK7	6006	G	No changes.
	6137	E	No changes.
6SL7	6SL7WGT	E	No changes.
	6113	E	No changes.
6SN7	6SN7WGT	E	No changes.
	6180	E	No changes.
6SU7	6113	E	No changes.
6T4	3AF4	G	Parallel circuits only. Install 7-ohm 5-watt resistor in series with filament.
	6AF4	G	No changes.
6U3	6AU4	G	Parallel circuits only. Reverse 6AU4 to 6U3 procedure.
6U7	5732	G	No changes.
6U8	6AU8	G	Parallel circuits only. Reverse 6AU8 to 6U8 procedure.
	6AX8	G	No changes.
6V3	6AU4	G	Reverse 6AU4 to 6V3 procedure.
6V4	6BW4	G	Parallel circuits only. Reverse 6BW4 to 6V4 procedure.
6V6	1621	G	Parallel circuits only. No changes.
	1622	G	Parallel circuits only. No changes.
	5871	E	No changes.
	5992	E	No changes.
	6061	E	Reverse 6061 to 6U6 procedure.
6W2	6X2	G	No changes.
6X2	6W2	E	No changes.
6X4	6AV4	E	Parallel circuits only. No changes.
	6BX4	G	No changes.
	6X4W	E	No changes.
	6063	E	No changes.
	6202	G	No changes.
6X5	6AV4	G	Parallel circuits only. Reverse 6AV4 to 6X5 procedure.
	6BX4	G	Reverse 6BX4 to 6X5 procedure.
	6X5WGT	E	No changes.
6Y7	1635	E	No changes.
7A5	6CA5	G	Reverse 6CA5 to 7A5 procedure.
7A6	6AL5	G	Parallel circuits only. Change socket to miniature and rewire as follows: Change pin No. 1 to pin No. 3 on miniature; 2 to 5; 3 to 2; 6 to 7; 7 to 1; 8 to 4
7AU7	12AT7	G	Same as 7AU7 to 12AU7 procedure.
	12AU7	E	Rewire as follows: Change pin No. 5 to pin No. 9
	12AV7	G	Same as 7AU7 to 12AU7 procedure.
7C7	6BR7	G	Reverse 6BR7 to 7C7 procedure.
	6BS7	G	Reverse 6BS7 to 7C7 procedure.
7F8	7F8W	E	No changes.
7Z4	6BW4	E	Reverse 6BW4 to 7Z4 procedure.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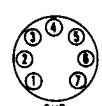
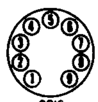
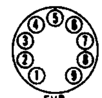
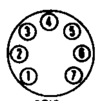
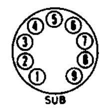
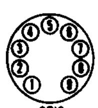
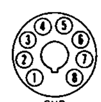
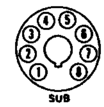
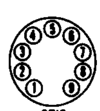
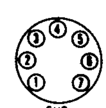

SUB

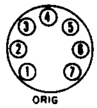
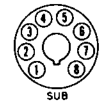
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
8AU8	8AW8	G	No changes.
	8BA8	G	No changes.
	8BH8	G	No changes.
8AW8	8AU8	G	No changes.
	6BH8	G	No changes.
8BA8	8AU8	G	No changes.
	8AW8	G	No changes.
8BH8	8AU8	G	No changes.
	8AW8	G	No changes.
8BN8			No practical substitute.
8CG7	8SN7	G	Same as 6CG7 to 6SN7 procedure.
8CM7	8CS7	G	Rewire as follows: Change pin No. 3 to pin No. 8 8 to 3  ORIG  SUB
8CN7			No practical substitute.
8CS7	8CM7	G	Same as 8CM7 to 8CS7 procedure.
8SN7	8CG7	G	Same as 6CG7 to 6CSN7 procedure.
9BM5	9BW6	G	Rewire as follows: Change pin No. 1 to pin No. 2 on noval 2 to 3 3 to 4 4 to 5 5 to 7 6 to 8 7 to 1  ORIG  SUB
9BW6	9BM5	G	Same as 9BM5 to 9BN6 procedure. Tie pin Nos. 3 and 9 together.
12A7			No practical substitute.
12AB5			No practical substitute.
12AC6	12AF6	G	No changes.
12AD6	12AG6	G	No changes.
12AD7	12AX	E	Parallel circuits only. No changes.
	12SL7	G	Parallel circuits only. Change socket to octal and rewire as follows: Change pin No. 1 to pin No. 2 on octal 2 to 1 3 to 3 4 to 8 5 to 7 6 to 5 7 to 4 8 to 6  ORIG  SUB
12AE6	12AT6	G	No changes.
	12AV6	G	No changes.
12AF6	12AC6	G	No changes.
12AG6	12AD6	G	No changes.
12AJ5			No practical substitute.
12AQ5	12CM6	E	Reverse 12CM6 to 12AQ5 procedure.

(Cont.)

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
12AQ5 (Cont.)	12V6	E	Change socket to octal and rewire as follows: Change pin No. 1 to pin No. 5 on octal 2 to 8 3 to 2 4 to 7 5 to 3 6 to 4 7 to 5  
12AS5			No practical substitute.
12AT7	12A7WA	E	No changes.
	6060	E	No changes.
	6201	E	No changes.
	6679	E	No changes.
12AU7	12AU7WA	E	No changes.
	5814	E	No changes.
	5963	G	No changes.
	6067	E	No changes.
	6189	E	No changes.
	6680	E	No changes.
12AV5	12BQ6	E	Same as 12CU6 to 12AV5 procedure.
	12CU6	E	Same as 12CU6 to 12AV5 procedure.
	12DQ6	E	Same as 12CU6 to 12AV5 procedure.
12AV7	5965	G	No changes.
12AX7	12AD7	E	No changes.
	5751	E	No changes.
	6057	E	No changes.
	6681	E	No changes.
12AY7	6072	E	No changes.
12BH7	6350	G	Reverse 6350 to 12BH7 procedure.
12BJ7			No practical substitute.
12BK5	6BK5	E	Parallel circuits only. Install 6-ohm 20-watt resistor in series with filament.
12BL6			No practical substitute.
12BQ6	6BQ6	E	Parallel circuits only. Install 6-ohm 20-watt resistor in series with filament.
	12AV5	G	Reverse 12AV5 to 12BQ6 procedure.
	12CH6	E	No changes.
	12DQ6	E	No changes.
12BR7			No practical substitute.
12BV7	12BY7	E	No changes.
12BW4	6BW4	E	Parallel circuits only. Install 7-ohm 20-watt resistor in series with filament.
	12X4	G	Parallel circuits only. Change socket to miniature and rewire as follows: Change pin No. 1 to pin No. 6 on miniature 4 to 3 5 to 4 7 to 1 9 to 7  
12BY7	12BV7	E	No changes.
12C5	12CA5 (Cont.)	G	No changes.

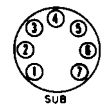
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY.
12C5 (Cont.)	12L6	G	Change socket to octal and rewire as follows:

Change pin No.	to pin No. (on octal)
1	8
2	5
3	2
4	7
5	5
6	4
7	3

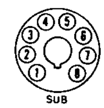
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY.
12CA5	6CA5	E	Parallel circuits only. Install 5-ohm 20-watt resistor in series with filament.
	12C5	G	No changes.
	12L6	G	Same as 12C5 to 12L6.
12CM6	5CM6	E	Parallel circuits only. Install 14-ohm 20-watt resistor in series with filament.
12CM6	6CM6	E	Parallel circuits only. Install 14-ohm 20-watt resistor in series with filament.
	12AQ5	E	Change socket to miniature and rewire as follows:

Change pin No.	to pin No. (on miniature)
1	6
3	1
4	3
5	4
6	7
7	2
9	5

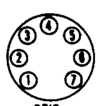
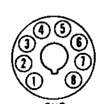
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY.
	12V6	E	Change socket to octal and rewire as follows:

Change pin No.	to pin No. (on octal)
1	4
3	5
4	2
5	7
6	5
7	8
9	3

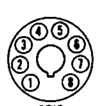
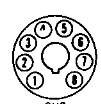
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY.
12CN5			No practical substitute.
12CR6			No practical substitute.
12CS6	3CS6	E	Parallel circuits only. Install 16-ohm 20-watt resistor in series with filament.
	6CS6	E	Parallel circuits only. Install 21-ohm 20-watt resistor in series with the filament.
	6BY6	G	Parallel circuits only. Install 21-ohm 20-watt resistor in series with filament.
12CT8			No practical substitute.
12CU5	6CU5		Parallel circuits only. Install 5-ohm 20-watt resistor in series with filament.
	12L6	G	Change socket to octal and rewire as follows:

Change pin No.	to pin No. (on octal)
1	8
2	5
3	2
4	7
5	5
6	4
7	3

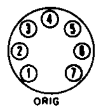
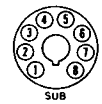
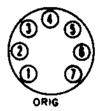
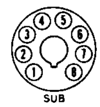
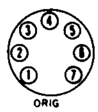
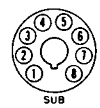
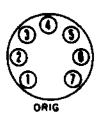
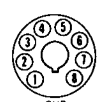



TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY.
	12W6	G	Same as 12CU5 to 12L6 procedure.
12CU6	12AV5	G	Rewire as follows:

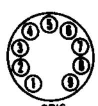
Change pin No.	to pin No.
4	8
5	1
P. Cap	5
8	3

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY.
	12BQ6	E	No changes.
	12DQ6	E	No changes.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
12D4	12AX4	G	No changes.
12DQ6	12AV5	G	Reverse 12AV5 to 12DQ6 procedure.
	12BQ6	G	No changes.
	12CU6	G	No changes.
12F8			No practical substitute.
12G4	12H4	E	Remove, connect, and tape up any wires on pin No. 2.
	12J5	E	Change socket to octal and rewire as follows:
			Change pin No. 1 to pin No. 3 on octal
			3 to 2
			 5 to 3 
			4 to 7
			6 to 5
			7 to 8
	14A4	E	Change socket to octal and rewire as follows:
			Change pin No. 1 to pin No. 2 on octal
			3 to 1
			 4 to 8 
			5 to 2
			6 to 6
			7 to 7
12G8			No practical substitute.
12H4	12G4	E	No changes.
	12J5	E	Change to octal and rewire as follows:
			Change pin No. 1 to pin No. 3 on octal
			3 to 2
			 5 to 3 
			4 to 7
			6 to 5
			7 to 8
	14A4	E	Same as 14A4 to 12G4 procedure.
12J5	12G4	E	Reverse 12G4 to 12J5 procedure.
	12H4	E	Reverse 12H4 to 12J5 procedure.
12J8			No practical substitute.
12K5			No practical substitute.
12L6	12W6	E	No changes.
	1632	E	No changes.
12R5	12W6	G	Change socket to octal and rewire as follows:
			Change pin No. 1 to pin No. 8 on octal
			2 to 5
			3 to 2
			 4 to 7 
			5 to 5
			6 to 4
			7 to 3
12SL7	2C52	E	Parallel circuits only. No changes.
12SN7	5814	G	Parallel circuits only. Reverse 5814 to 12SN7 procedure.
12U7			No practical substitute.
12V6	12CM6	E	Reverse 12CM6 to 12V6 procedure.
12W6	12L6	E	No changes.
	12R5	G	Reverse 12R5 to 12W6 procedure.
	1632	E	No changes.
12X4	12BW4	E	Reverse 12BW4 to 12Y4 procedure.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
14A4	12G4	E	Reverse 12G4 to 14A4 procedure.
	12H4	E	Reverse 12H4 to 14A4 procedure.
15A6			No practical substitute.
15A8			No practical substitute.
16A5			No practical substitute.
17AV5	6AV5	E	Parallel circuits only. Install 8.7-ohm 25-watt resistor in series with filament.
	12AV5	E	Parallel circuits only. Install 7-ohm 10-watt resistor in series with filament.
	17DQ6	E	Same as 12CU6 to 12AV5 procedure.
17AX4	6AX4	E	Parallel circuits only. Install 18-ohm 20-watt resistor in series with filament.
	12AX4	E	Parallel circuits only. Install 10-ohm 20-watt resistor in series with filament.
17C5			No practical substitute.
17CA5	6CA5	E	Parallel circuits only. Install 9-ohm 20-watt resistor in series with filament.
	12CA5	E	Parallel circuits only. Install 10-ohm 20-watt resistor in series with filament.
17DQ6	6DQ6	E	Parallel circuits only. Install 9-ohm 20-watt resistor in series with filament.
	12DQ6	E	Parallel circuits only. Install 10-ohm 20-watt resistor in series with filament.
	17AV5	E	Same as 12CU6 to 12AV5 procedure.
17H3			No practical substitute.
17Z3	17AX4	E	Where space permits change socket to octal and rewire as follows: Change pin No. 4 to pin No. 8 on octal cap to 3 5 to 7 9 to 5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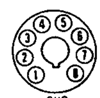
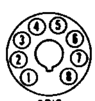

SUB

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
18A5			No practical substitute.
19AU4	6AU4	E	Parallel circuits only. Install 7-ohm 30-watt resistor in series with filament.
	19X3	G	Parallel circuits only. Change socket to miniature and rewire as follows: Change pin No. 3 to pin No. 3 on miniature 5 to 9 7 to 4 8 to 5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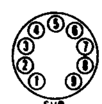
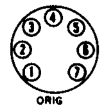
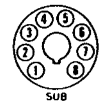

SUB

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
19X3	19AU4	G	Parallel circuits only. Reverse 19AU4 to 19X3 procedure.
19X8			No practical substitute.
21A6			No practical substitute.
25AV5	25CU6	G	Reverse 25CU6 to 25AV5 procedure.
	25DQ6	G	Reverse 25DQ6 to 25AV5 procedure.
25AX4	17AX4	E	Parallel circuits only. Install 18-ohm 10-watt resistor in series with filament.
	25U4	G	No changes.
	25W4	G	No changes.
25C5	25CA5	G	No changes.
	(Cont.)		

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
25C5 (Cont.)	25L6	G	Change socket to octal and rewire as follows:

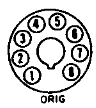
Change pin No.	to pin No. on octal
1	8
2	5
3	2
4	7
5	5
6	4
7	3

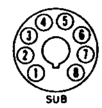




TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	25W6	G	Same as 25L6 to 25C5 procedure.
25CA5	25C5	G	No changes.
	25L6	G	Same as 25C5 to 25L6 procedure.
	25W6	G	Same as 25C5 to 25W6 procedure.
25CD6	25DN6	G	No changes.
25CU6	25AV5	G	Rewire as follows:

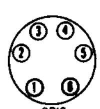
Change pin No.	to pin No.
5	1
cap	5
8	3
4	8

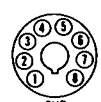




TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
	25BQ6	E	No changes.
	25DQ6	E	No changes.
25DN6	25CD6	G	No changes.
25DQ6	25AV5	G	Same as 25CU6 to 25AV5 procedure.
	25BQ6	G	No changes.
	25CU6	G	No changes.
25L6	6046	G	No changes.
25U4	25AX4	E	No changes.
	25W4	E	No changes.
25W4	25U4	G	No changes.
25W6	25L6	E	No changes.
28D7	28D7W	E	No changes.
	1238	E	No changes.
40A1	40B2	G	No changes.
40B2	40A1	G	No changes.
50A1			No practical substitute.
50BK5	25BK5	E	Parallel circuits only. Install 84-ohm 20-watt resistor in series with filament.
X155	6BC8	G	No changes.
	6BK7	G	No changes.
	6BQ7	G	No changes.
	6BS8	G	No changes.
	6BZ7	G	No changes.
	6BZ8	E	No changes.
807	5933	E	No changes.
884	6Q5	G	No changes.
1221	6J7	G	Rewire as follows: Change socket to octal.

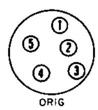
Change pin No.	to pin No. on octal
1	2
2	3
3	4
4	5
5	8
6	7

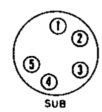




TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
1238	28D7	G	No changes.
1266	OB3	G	No changes.
1621	6F6	G	No changes.
	6K6	G	Parallel circuits only. No changes.
	6L6	G	Parallel circuits only. No changes.
	6V6	G	Parallel circuits only. No changes.
	5881	E	Parallel circuits only. No changes.
1622	6F6	G	Parallel circuits only. No changes.
	6L6	E	No changes.
	6V6	G	Parallel circuits only. No changes.
	5881	E	No changes.
1631	6L6	G	Parallel circuits only. Install 7-ohm 20-watt resistor in series with the filament.
1632	12L6	E	No changes.
	12W6	E	No changes.
1633			No practical substitute.
1635	6N7	G	Parallel circuits only. No changes.
	6Y7	G	No changes.
5591	6AK5	G	No changes.
	5654	G	No changes.
5610	6C4	G	No changes.
5633	5634	E	No changes.
5634	5633	E	No changes.
5637	5646	G	Rewire as follows:

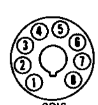
Change pin No.		to pin No.
2	to	4
3	to	3
4	to	5
5	to	2

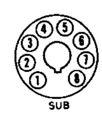




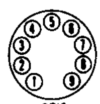
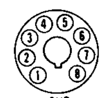
TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
5638			No practical substitute.
5654	5591	G	No changes.
	6096	E	No changes.
5670	2C51	G	No changes.
	5670WA	E	No changes.
5670WA	5670	G	No changes.
5679	6H6	G	Parallel circuits only. Rewire as follows:

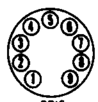
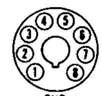
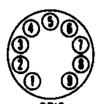
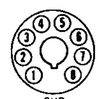
Change pin No.		to pin No.
1	to	2
2	to	4
6	to	5
7	to	8
8	to	7



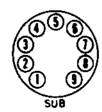


TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
5692	6180	E	No changes.
5725	6AS6	G	No changes.
	6AS6W	E	No changes.
	6187	E	No changes.
5726	6AL5	G	No changes.
	6AL5W	E	No changes.
	6058	E	No changes.
	6097	G	No changes.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
5727	2D21	G	No changes.
	2D21W	E	No changes.
5732	6K7	G	No changes.
5749	6BA6	G	No changes.
	6BA6W	E	No changes.
5750	6BE6	G	No changes.
5751	12AX7	G	No changes.
	5751WA	E	No changes.
	6057	G	No changes.
5751WA	12AX7	G	No changes.
	5751	G	No changes.
	6057	G	No changes.
5814	12AU7	G	No changes.
	12SN7	G	Parallel circuits only. Change socket to octal. Rewire as follows:
			Change pin No. 1 to pin No. 2
			2 to 1
			3 to 3
			4 to 8
			5 to 7
			6 to 5
			7 to 4
			8 to 6
			 ORIG  SUB
	5814WA	E	No changes.
	6067	E	Parallel circuits only. No changes.
5824	6046	G	No changes.
5838	5839	E	Parallel circuits only. No changes.
5839	5838	E	Parallel circuits only. No changes.
5871	6V6	G	No changes.
	5992	G	Parallel circuits only. No changes.
5881	1621	G	Parallel circuits only. No changes.
	1622	G	No changes.
	5932	G	No changes.
5899	5900	E	No changes.
5900	5899	E	No changes.
5910	1U4	G	No changes.
5915	6BY6	G	No changes.
5930	2A3	G	No changes.
5931	5U4GB	E	No changes.
5932	6L6	G	No changes.
	5881	G	No changes.
5933	807	G	No changes.
5961	6SA7	G	No changes.
5963	12AU7	G	No changes.
5964	6J6	G	No changes.
5965	12AV7	G	No changes.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
5992	6V6	G	No changes.
	5871	G	Parallel circuits only. No changes.
5998	6AS7	G	Parallel circuits only. No changes.
6005	6AQ5	G	No changes.
	6AQ5W	E	No changes.
	6095	E	No changes.
6006	6SG7	G	No changes.
6046	25L6	G	No changes.
	5824	G	No changes.
6057	12AX7	G	No changes.
	5751	G	No changes.
6058	6AL5	G	No changes.
	5726	G	No changes.
6059	6J7	G	Parallel circuits only. Change socket to octal and rewire as follows: Change pin No. 2 to cap on octal 3 to pin No. 8 4 to 2 5 to 7 7 to 3 8 to 4 9 to 5  ORIG  SUB
6060	12AT7	G	No changes.
	6201	G	No changes.
6061	6V6	G	Change socket to octal and rewire as follows: Change pin No. 1 to pin No. 5 on octal 2 to 5 3 to 8 4 to 2 5 to 7 7 to 3 8 to 4  ORIG  SUB
6063	6X4	G	No changes.
6064	6AM6	G	No changes.
6065	6BH6	G	Parallel circuits only. Rewire as follows: Change pin No. 6 to pin No. 7 7 to 6
6066	6AT6	G	No changes.
6067	12AU7	G	No changes.
	5814	E	Parallel circuits only. No changes.
6072	12AY7	G	No changes.
6080	6AS7	G	No changes.
6095	6AQ5	G	No changes.
	6AQ5W	E	No changes.
	6005	E	No changes.
6096	6AK5	E	No changes.
	5654	G	No changes.
6097	6AL5	G	No changes.
	5726	G	No changes.
6101	6J6	G	No changes.
6113	6SL7	G	No changes.

TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6132	6CH6	G	No changes.
6134	6AC7	G	No changes.
6135	6C4	G	No changes.
6136	6AU6	G	No changes.
6137	6SK7	G	No changes.
6180	6SN7	G	No changes.
	5692	E	No changes.
6186	6AG5	G	No changes.
6187	6AS6	G	No changes.
	6AS6W	E	No changes.
	5725	E	No changes.
6189	12AU7	G	No changes.
	12AU7WA	E	No changes.
6201	12AT7	G	No changes.
	6060	G	No changes.
6202	6X4	G	No changes.
6265	6BH6	G	No changes.
6350	12BH7	G	Rewire as follows: Change pin No. 2 to pin No. 3 3 to 2 7 to 8 8 to 7



TUBE	SUB.	PERF.	CIRCUIT CHANGES NECESSARY
6485	6AH6	G	No changes.
6550	6L6	G	No changes.
6661	6BH6	G	No changes.
6662	6BJ6	G	No changes.
6663	6AL5	G	No changes.
6669	6AQ5	G	No changes.
6677	6CL6	G	No changes.
6679	12AT7	G	No changes.
6680	12AU7	G	No changes.
6681	12AX7	G	No changes.
7000	6J7	G	No changes.

SUBSTITUTING PICTURE TUBES IN TV RECEIVERS

1. Connecting the External Conductive Tube Coating to Chassis

When a picture tube that does not have an external conductive coating is substituted for one that has the external coating, it is generally necessary to install a metal finger to make contact with the coating in order to connect it to the chassis. Sometimes this finger is attached to the deflection yoke support bracket. Ordinarily a tube that does not have an external coating has a 500-$\mu\mu$f capacitor connected from the anode lead to the chassis inside the high-voltage cage. It is normally not necessary to remove this capacitor when substituting a tube that has the external conductive coating.

2. Installing a Capacitor from the Anode Lead to the Chassis

When a tube that does not have the external conductive coating is substituted for one that has the external conductive coating, it is often necessary to install a capacitor from the anode lead to the chassis. In the substitutions listed here we have repeated the same value of 500 $\mu\mu$f. Ordinarily this will be satisfactory. In some cases this capacitor will not be necessary. In others best satisfaction may be had with capacitances as high as 2,000 $\mu\mu$f. This is according to individual cases and can be determined by trial. The most convenient location for this capacitor is inside the high-voltage cage.

3. Dimensions

Before attempting any of the substitutions listed here, make sure the substitute tube will fit into the available space. In the magnetic types try to choose a substitute with a neck length similar to the original. Differences in face plate curvatures may make it necessary, in some substitutions listed, to change the mask.

4. Change in Anode Connector

Either the ball-type or cavity-type anode connector is used on picture tubes. Instructions specify when a change is necessary.

5. Replacement or Deletion of Ion Trap

It is necessary to replace the ion trap with the type required by the manufacturer of the substitute tube. Some tubes do not require an ion trap and are being substituted for others requiring either a single or dual ion trap. In these cases, the instruction is "Remove ion trap." Other tubes requiring a single ion trap can be substituted for by installing a dual ion trap and vice versa. In these cases instructions are given. Some manufacturers of picture tubes are using a new type gun requiring a single ion trap in tubes that formerly used a gun requiring a dual ion trap. It is therefore important to check the individual manufacturer's specification on the substitute tube being used.

6. Electrostatic and Self-Focus Tubes

When using electrostatic or self-focus tubes as substitutions for magnetically focused tubes, it is necessary to remove the focus coil from the neck of the tube and replace it with a magnetic centering device. The focus coil may be left in the receiver circuit-wise, in which case it should be mounted in the cabinet in some position where its magnetic field has no effect on the picture. It may be replaced with a choke or resistor. The picture tube socket may have to be changed when it is necessary to bring out a lead from the focus electrode on the picture tube base except in the case of self-focus or automatic focus types. This lead should be connected to a d-c voltage point in the set which gives best focus. The voltage required normally lies between 50 and 350 volts. Self-focus or automatic focus tubes have a special gun structure within the neck of the tube designed to focus the tube automatically without the use of an external focus voltage.

7. Substituting Electrostatic or Automatic Focus Types with Magnetic Types

When replacing electrostatic focus types with magnetic focus types, discard the magnetic centering device and install a permanent magnet focusing device. This must be mounted on the yoke support with suitable metal brackets. It is practical to replace an electrostatic focus tube using high-focus voltage with a type using low-focus voltage or a self-focus type. When doing this, it is desirable to remove the focus voltage rectifier as a safety measure.

8. Differences in the Face Plate

Differences in the face plate of the tube have little effect on whether or not they may be substituted. Dark-faced tubes give better contrast than white-faced tubes. Some tubes are frosted to decrease reflections and others have an aluminized back for better contrast and brightness. Aluminized tubes in some cases have higher anode voltage applied and this voltage should be reduced in accordance with manufacturers' specifications when other than aluminized tubes are substituted. When substituting aluminized tubes for white- or gray-faced tubes, sufficient voltage is usually available for satisfactory operation.

PICTURE TUBE SUBSTITUTIONS

TUBE	SUB.	CHANGES NECESSARY
7CP4	7DP4	Change anode connector to cavity type. Connect external conductive coating to chassis. Change ion trap to double.
7DP4	7CP4	Connect a 500-$\mu\mu$f 20-kv capacitor from anode to chassis. Change anode connector to ball type. Remove ion trap.
12KP4	12ZP4	Install single ion trap.
	12ZP4A	Install single ion trap.
12LP4	12ZP4	Install single ion trap.
	12ZP4A	Install single ion trap.
12QP4	12ZP4	Change anode connector to cavity type. Connect external conductive coating to chassis.
	12ZP4A	Change anode connector to cavity type. Connect external conductive coating to chassis.
12TP4	12ZP4	Connect external conductive coating to chassis. Change ion trap to single.
12ZP4	12KP4	Remove ion trap.
	12KP4A	Remove ion trap.
	12LP4	Only where 1-1/8 inch greater length is available. Change ion trap to double.
	12LP4A	Same as for 12LP4.
	12QP4	Connect a 500-$\mu\mu$f 20-kv capacitor from anode to chassis. Change annode connector to ball type.
	12QP4A	Same as for 12QP4.
	12TP4	Only where 1-1/8 inch greater length is available. Connect a 500-$\mu\mu$f 20-kv capacitor from anode to chassis. Change ion trap to double.
	12ZP4A	No changes.
14HP4	14QP4	No changes.
14QP4	14HP4	No changes.
16AEP4	16ABP4	No changes.
17ATP4	17AVP4	No changes.
	17AVP4A	No changes.
17AVP4	17ATP4	No changes.
	17ATP4A	No changes.
17QP4	17YP4	No changes.
17YP4	17QP4	No changes.
	17QP4A	No changes.
20HP4	20HP4D	No changes.
	20LP4	No changes.
	20MP4	No changes.
20LP4	20HP4A	No changes.
	20HP4D	No changes.
	20MP4	No changes.
20MP4	20HP4A	No changes.
	20HP4D	No changes.
	20LP4	No changes.
21ACP4	21ACP4A	No changes.
	21AMP4	No changes.
	21AMP4A	No changes.
	21AQP4	Connect a 500-$\mu\mu$f 20-kv capacitor from anode to chassis.
	21AQP4A	Same as for 21AQP4.
	21BSP4	No changes.
21AFP4	21ASP4	No changes.

(Cont.)

TUBE	SUB.	CHANGES NECESSARY
21AFP4	21YP4	Connect external conductive coating to ground.
(Cont.)	21YP4A	Connect external conductive coating to ground.
21ALP4	21ALP4A	No changes.
	21ALP4B	No changes.
	21ANP4	Connect a 500-$\mu\mu$f 20-kv capacitor from anode to chassis.
	21ANP4A	No changes.
	21ATP4	No changes.
	21ATP4A	No changes.
21AMP4	21ACP4	No changes.
	21ACP4A	No changes.
	21AMP4A	No changes.
	21AQP4	Connect a 500-$\mu\mu$f 20-kv capacitor from anode to chassis.
	21AQP4A	No changes.
21AMP4A	21ACP4	No changes.
	21ACP4A	No changes.
	21AMP4	No changes.
	21AQP4	Connect a 500-$\mu\mu$f 20-kv capacitor from anode to chassis.
21ANP4	21ALP4	Connect external conductive coating to chassis.
	21ALP4A	Connect external conductive coating to chassis.
	21ALP4B	Connect external conductive coating tochassis.
	21ATP4	Connect external conductive coating to chassis.
21AP4	21ZP4	This substitute to be used only when changing from metal to glass picture tube. Mask opening must be enlarged. Change anode connector to cavity type.
	21ZP4B	Same as 21AP4 to 21ZP4. Connect external conductive coating to chassis.
21AQP4	21ACP4	Connect external conductive coating to chassis.
	21ACP4A	Connect external conductive coating to chassis.
	21AMP4	Connect external conductive coating to chassis.
	21AMP4A	Connect external conductive coating to chassis.
	21AQP4A	No changes.
21AQP4A	21ACP4	Connect external conductive coating to chassis.
	21ACP4A	Connect external conductive coating to chassis.
	21AMP4	Connect external conductive coating to chassis.
	21AMP4A	Connect external conductive coating to chassis.
	21AQP4	No changes.
21ARP4	21ARP4A	No changes.
	21JP4	No changes.
	21JP4A	No changes.
21ARP4A	21ARP4	No changes.
	21JP4	No changes.
	21JP4A	No changes.
21ASP4	21AYP4	Connect external conductive coating to chassis.
	21XP4	Connect external conductive coating to chassis.
	21XP4A	Connect external conductive coating to chassis.
	21YP4	Connect external conductive coating to chassis.
	21YP4A	Connect external conductive coating to chassis.
21ATP4	21ALP4	No changes.
	21ALP4A	No changes.
	21ALP4B	No changes.
	21ANP4	Connect a 500-$\mu\mu$f 20-kv capacitor from anode to chassis.
	21ANP4A	Connect a 500-$\mu\mu$f 20-kv capacitor from anode to chassis.
	21ATP4A	No changes.
21ATP4A	21ALP4	No changes.
	21ALP4A	No changes.
	21ALP4B	No changes.
	21ANP4	Connect a 500-$\mu\mu$f 20-kv capacitor from anode to chassis.
	21ANP4A	Connect a 500-$\mu\mu$f 20-kv capacitor from anode to chassis.
	21ATP4	No changes.

TUBE	SUB.	CHANGES NECESSARY
21AUP4	21AUP4A	No changes.
	21AUP4B	No changes.
	21AVP4	No changes.
	21AVP4A	No changes.
	21AVP4B	No changes.
21AUP4A	21AUP4	No changes.
	21AUP4B	No changes.
	21AVP4	No changes.
	21AVP4A	No changes.
	21AVP4B	No changes.
21AUP4B	21AUP4	No changes.
	21AUP4A	No changes.
	21AVP4	No changes.
	21AVP4A	No changes.
	21AVP4B	No changes.
21AVP4	21AUP4	No changes.
	21AUP4A	No changes.
	21AUP4B	No changes.
	21AVP4A	No changes.
	21AVP4B	No changes.
21AVP4A	21AUP4	No changes.
	21AUP4A	No changes.
	21AUP4B	No changes.
	21AVP4	No changes.
	21AVP4B	No changes.
21AVP4B	21AUP4	No changes.
	21AUP4A	No changes.
	21AUP4B	No changes.
	21AVP4	No changes.
	21AVP4A	No changes.
21AYP4	21ASP4	Connect a 500-$\mu\mu$f 25-kv capacitor from anode to chassis.
	21XP4	No changes.
	21XP4A	No changes.
	21YP4	No changes.
	21YP4A	No changes.
21BSP4	21ACPYA	No changes.
21JP4	21ARP4	No changes.
	21ARP4A	No changes.
	21JP4A	No changes.
21JP4A	21ARP4	No changes.
	21ARP4A	No changes.
	21JP4	No changes.
21MP4	21YP4	This substitute to be used only when changing from metal to glass picture tube. Mask opening must be altered. Change anode connector to cavity type.
	21YP4A	Same as 21MP4 to 21YP4 procedure.
21XP4	21ASP4	Connect a 500-$\mu\mu$f 25-kv capacitor from anode to chassis.
	21XP4A	No changes.
	21YP4	No changes.
	21YP4A	No changes.
21XP4A	21ASP4	Connect a 500-$\mu\mu$f 25-kv capacitor from anode to chassis.
	21XP4	No changes.
	21YP4	No changes.
	21YP4A	No changes.
21YP4	21YP4A	No changes.
21YP4A	21YP4	No changes.

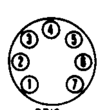
TUBE	SUB.	CHANGES NECESSARY
24BP4		No practical substitute.
24CP4	24CP4A	No changes.
	24QP4	No changes.
	24TP4	No changes.
	24VP4	No changes.
	24VP4A	No changes.
	24XP4	Connect a 500-$\mu\mu$f 25-kv capacitor from anode to chassis.
24DP4	24DP4A	No changes.
	24YP4	No changes.
	24ZP4	No changes.
24QP4	24CP4	No changes.
	24CP4A	No changes.
	24TP4	No changes.
	24VP4	No changes.
	24VP4A	No changes.
	24XP4	Connect a 500-$\mu\mu$f 25-kv capacitor from anode to chassis.
24TP4	24CP4	No changes.
	24CP4A	No changes.
	24QP4	No changes.
	24VP4	No changes.
	24VP4A	No changes
	24XP4	Connect a 500-$\mu\mu$f 25-kv capacitor from anode to chassis.
24VP4	24CP4	No changes.
	24CP4A	No changes.
	24TP4	No changes.
	24VP4A	No changes.
	24XP4	Connect a 500-$\mu\mu$f 25-kv capacitor from anode to chassis.
24VP4A	24CP4	No changes.
	24CP4A	No changes.
	24TP4	No changes.
	24VP4	No changes.
	24XP4	Connect a 500-$\mu\mu$f 25-kv capacitor from anode to chassis.
24XP4	24CP4	Connect external conductive coating to chassis.
	24CP4A	Connect external conductive coating to chassis.
	24QP4	Connect external conductive coating to chassis.
	24TP4	Connect external conductive coating to chassis.
	24VP4	Connect external conductive coating to chassis.
	24VP4A	Connect external conductive coating to chassis.
24YP4	24DP4	No changes.
	24DP4A	No changes.
	24ZP4	No changes.
24ZP4	24DP4	No changes.
	24YP4	No changes.
27AP4		No practical substitute.
27MP4	27EP4	This substitute to be used only when changing from metal to glass picture tube. Mask opening may be altered. Change anode connector to cavity type.
27SP4	27UP4	No changes.
27UP4	27SP4	No changes.
30BP4		No practical substitute.

EUROPEAN — AMERICAN TUBE SUBSTITUTION

EUROPEAN	AMERICAN	PERF.	CIRCUIT CHANGES NECESSARY
B36	12SN7	G	No changes.
B65	6SN7	G	No changes.
B152	12AT7	G	No changes.
B309	12AT7	G	No changes.
B319	7AN7	G	No changes.
B329	12AU7	E	No changes.
B719	6AQ8	G	No changes.
D63	6H6	G	No changes.
D77	6AL5	E	No changes.
D152	6AL5	G	No changes.
DA90	1A3	E	No changes.
DAC32	1H5	E	No changes.
	1LH4	G	Reverse 1LH4 to DAC32 procedure.
DAF91	1LD5	G	Reverse 1LD5 to DAF91 procedure.
	1S5	E	No changes.
	1U5	G	Reverse 1U5 to DAF91 procedure.
DAF96	1AH5	E	No changes.
DC70	6375	G	No changes.
DC80	1E3	E	No changes.
DCC90	3A5	E	No changes.
DD6	6AL5	E	No changes.
DD7	6AL5	G	No changes.
DF33	1LC5	G	Reverse 1LC5 to DF33 procedure.
	1LN5	G	Reverse 1LN5 to DF33 procedure.
	1N5	E	No changes.
DF62	1AD4	E	No changes.
DF91	1T4	E	No changes.
DF92	1L4	G	No changes.
DF96	1AF4	G	No changes.
	1AJ4	E	No changes.
DF904	1U4	G	No changes.
DH63	6Q7	G	No changes.
DH77	6AT6	E	No changes.
DH149	7C6	G	No changes.
DK32	1A7	E	No changes.
	1LA6	G	Reverse 1LA6 to DK32 procedure.
DK91	1R5	E	No changes.
DK92	1AC6	E	No changes.

EUROPEAN	AMERICAN	PERF.	CIRCUIT CHANGES NECESSARY
DK96	1AB6	E	No changes.
DL33	3Q5	E	No changes.
DL35	1C5	E	No changes.
DL36	1Q5	E	No changes.
DL91	1S4	G	No changes.
DL92	3S4	E	No changes.
DL93	3A4	E	No changes.
DL94	3Y4	E	No changes.
DL95	3Q4	E	No changes.
DL96	3C4	E	No changes.
DM70	1M3	G	No changes.
DP61	6AK5	E	No changes.
DY30	1B3	G	No changes.
DY80	1X2A	G	No changes.
EA76	6489	E	No changes.
EAA91	6AL5	G	No changes.
EABC80	6AK8	E	No changes.
	6T8	G	No changes.
EB34	6H6	E	Parallel circuits only. No changes.
EB91	6AL5	E	No changes.
EBC33	1639	G	No changes.
EBC90	6AT6	E	No changes.
EBC91	6AV6	G	No changes.
EBF80	6N8	E	No changes.
EC70	5718	G	No changes.
EC80	6Q4	E	No changes.
EC81	6R4	E	No changes.
EC90	6C4	E	No changes.
EC91	6AQ4	E	No changes.
EC92	6AB4	E	No changes.
ECC33	6SN7	G	Parallel circuits only. No changes.
ECC35	6SL7	G	Parallel circuits only. No changes.
ECC81	12AT7	E	No changes.
ECC82	12AU7	E	No changes.
ECC83	12AX7	E	No changes.
ECC85	6AQ8	E	No changes.
ECC91	6J6	E	No changes.

EUROPEAN	AMERICAN	PERF.	CIRCUIT CHANGES NECESSARY
ECF82	6U8	E	No changes.
ECH35	6E8	E	No changes.
	6P8G	E	Parallel circuits only. No changes.
ECH81	6AJ8	E	No changes.
ECL80	6AB8	E	No changes.
ECL82	6BM8	E	No changes.
EF70	6487	G	No changes.
EF71	5899	G	No changes.
EF72	5840	G	No changes.
EF73	6488	E	No changes.
EF80	6BX6	E	No changes.
EF85	6BY7	E	No changes.
EF86	6267	E	No changes.
EF91	6AM6	E	No changes.
EF92	6CQ6	E	No changes.
EF93	6BA6	E	No changes.
EF94	6AU6	G	No changes.
EF95	6AK5	E	No changes.
EF96	6AG5	G	No changes.
EH90	6CS6	E	No changes.
EK90	6BE6	E	No changes.
EL33	6M6G	E	No changes.
EL34	6CA7	G	No changes.
EL37	6L6	E	No changes.
	5881	E	No changes.
EL38	6CN6	E	No changes.
EL70	6373	G	No changes.
EL81	6CJ6	E	No changes.
EL83	6CK6	E	No changes.
EL84	6BQ5	E	No changes.
EL85	6BN5	E	No changes.
EL90	6AQ5	E	No changes.
EL91	6AK6	G	Rewire as follows: Change pin No. 2 to pin No. 7 & 2 7 to 6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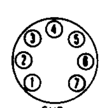

SUB

	6AM5	E	No changes.
EL821	6CH6	G	No changes.

EUROPEAN	AMERICAN	PERF.	CIRCUIT CHANGES NECESSARY
EM34	6CD7	E	No changes.
EM80	6BR5	E	No changes.
EN91	2D21	E	No changes.
EQ80	6BE7	E	No changes.
EY51	6X2	E	No changes.
EY70	5641	G	No changes.
EY80	6U3	E	No changes.
EY84	6374	E	No changes.
EZ35	6X5	E	No changes.
EZ80	6V4	E	No changes.
EZ81	6BW4	E	No changes.
EZ90	6X4	E	No changes.
GZ30	5Z4	E	No changes.
GZ32	5V4	E	No changes.
GZ34	5U4	G	No changes.
H52	5U4	G	No changes.
H63	6F5	E	No changes.
HBC90	12AT6	E	No changes.
HBC91	12AV6	G	No changes.
HD14	1H5	G	No changes.
HD30	3B4	E	No changes.
HF93	12BA6	E	No changes.
HF94	12AU6	G	No changes.
HK90	12BE6	E	No changes.
HL90	19AQ5	E	No changes.
HL92	50C5	E	No changes.
HM04	6BE6	E	No changes.
HY90	35W4	E	No changes.
KBC32	1H6	G	Reverse 1H6 to KBC32 procedure.
KF35	1E5	E	No changes.
KK32	1C6	G	Reverse 1C6 to KK32 procedure.
	1C7	G	No changes.
	1D7	G	Parallel circuits only. No changes.
KL35	1F4	G	Reverse 1F4 to KL35 procedure.
	1F5	G	No changes.
KT32	25L6	G	No changes.
KT63	6F6	G	No changes.
	6J7	G	No changes.

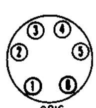
EUROPEAN	AMERICAN	PERF.	CIRCUIT CHANGES NECESSARY
KT66	6L6	E	Parallel circuits only. No changes
KT81	7C5	G	No changes.
KTW63	6K7	G	No changes.
L63	6J5	G	No changes.
L77	6C4	E	No changes.
LN152	6AB8	G	No changes.
LZ319	8A8	G	No changes.
N14	1C5	G	No changes.
N17	3S4	E	No changes.
N18	3Q4	E	No changes.
N19	3V4	E	No changes.
N77	6AM5	E	No changes.
N78	6BJ5	E	No changes.
N144	6AN5	G	No changes.
N148	7C5	G	No changes.
N152	21A6	G	No changes.
N329	16A5	G	No changes.
N359	21A6	G	No changes.
N709	6BQ5	G	No changes.
PABC80	9AK8	E	No changes.
PCC84	7AN7	E	No changes.
PCC85	9AQ8	E	No changes.
PCF80	8A8	G	No changes.
	9A8	E	No changes.
PCF82	9U8	E	No changes.
PL21	2D21	E	No changes.
PL81	21A6	E	No changes.
PL82	16A5	E	No changes.
PL83	15A6	E	No changes.
PY80	19X3	E	No changes.
PY81	17Z3	E	No changes.
PY82	19Y3	E	No changes.
QQV03-10	6360	G	No changes.
QQV03-28	6252	G	No changes.
QV05-25	807	G	No changes.
SP6	6AM6	E	No changes.

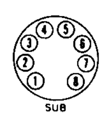
EUROPEAN	AMERICAN	PERF.	CIRCUIT CHANGES NECESSARY
TD03-10	5861	G	No changes.
U50	5Y3	G	No changes.
U52	5U4	G	No changes.
U70	6X5	G	No changes.
U78	6X4	E	No changes.
U147	6X5	G	No changes.
U149	7Y4	G	No changes.
U154	19Y3	G	No changes.
U319	19Y3	G	No changes.
UF41	12AC5	E	No changes.
UBC41	14L7	E	No changes.
UCH42	14K7	E	No changes.
W17	1T4	E	No changes.
W63	6K7	G	No changes.
W77	6065	E	No changes.
W149	7B7	G	No changes.
W179	6BY7	G	No changes.
X14	1A7	G	No changes.
X17	1R5	E	No changes.
X18	1AC6	E	No changes.
X63	6A8	G	No changes.
X79	6AE8	E	No changes.
X81	7S7	G	No changes.
X148	7S7	G	No changes.
Y61	6U5	E	No changes.
Z14	1N5	G	No changes.
Z63	6J7	G	No changes.
Z77	6AM6	G	No changes.
	6064	E	No changes.
Z152	6BX6	G	No changes.
Z179	6BX6	G	No changes.
ZD17	1S5	E	No changes.
ZD19	1S5	G	No changes.
1F3	1T4	E	No changes.
1FD9	1S5	E	No changes.
1P10	3SF	E	No changes.
6A7E	6A7	E	No changes.

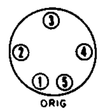
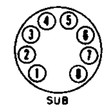
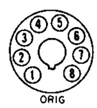
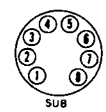
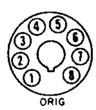
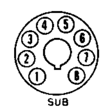
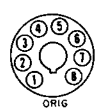
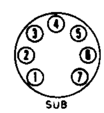
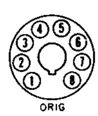
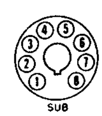
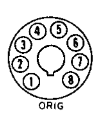
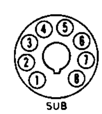
EUROPEAN	AMERICAN	PERF.	CIRCUIT CHANGES NECESSARY
6D2	6AL5	G	No changes.
6F12	6AM6	G	No changes.
8D3	6AM6	E	No changes.
30C1	8A8	G	No changes.
30L1	7AN7	G	No changes.

OA2–1C6 AMERICAN — EUROPEAN TUBE SUBSTITUTION

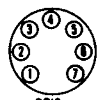
AMERICAN	EUROPEAN	PERF.	CIRCUIT CHANGES NECESSARY
OA2	150C2	E	No changes.
OA4	Z300T	E	No changes.
OB2	108C1	G	No changes.
OD3	150C3	E	No changes.
OE3	85A1	E	No changes.
OG3	85A2	E	No changes.
1A3	DA90	E	No changes.
1A7	DK32	E	No changes.
	X14	G	No changes.
1AB6	DK96	E	No changes.
1AC6	DK92	E	No changes.
	X18	E	No changes.
1AD4	DF62	E	No changes.
1AF4	DF96	G	No changes.
1AH5	DAF96	E	No changes.
1AJ4	DF96	E	No changes.
1B3	DY30	G	No changes.
1C5	DL35	E	No changes.
	N14	G	No changes.
1C6	KK32	G	Rewire as follows. Change socket to six pin. Change Pin No. 1 to pin No. 2 2 to 3 5 to 4 4 to 5 3 to 6 6 to 7

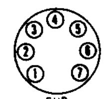




AMERICAN	EUROPEAN	PERF.	CIRCUIT CHANGES NECESSARY
1C7	KK32	G	No changes.
1D7	KK32	G	Parallel circuits only. No changes.
1E3	DC80	E	No changes.
1E5	KF35	G	No changes.
1F4	KL35	G	Rewire as follows: Change to five pin socket. Change pin No. 1 to pin No. 2 2 to 3 4 to 4 3 to 5 5 to 7  
1F5	KL35	G	No changes.
1H5	DAC32 HD14	E G	No changes. No changes.
1H6	KBC32	G	Rewire as follows: Change pin No. 6 to grid cap.
1L4	DF92	G	No changes.
1LA6	DK32	G	Rewire as follows: Change pin No. 1 to pin No. 2 2 to 3 5 to 4 4 to 5 6 to Cap 3 to 6 8 to 7  
1LC5	DF33	G	Rewire as follows: Change pin No. 1 to pin No. 2 2 to 3 3 to 4 6 to Cap 8 to 7 5 to 7  
1LD5	DAF91	G	Rewire as follows: Change pin No. 1 to pin No. 1 4 to 3 3 to 4 2 to 5 6 to 6 8 to 7  
1LH4	DAC32	G	Rewire as follows: Change pin No. 1 to pin No. 2 2 to 3 4 to 5 6 to Cap 8 to 7  
1LN5	DF33	G	Rewire as follows: Change pin No. 1 to pin No. 2 2 to 3 3 to 4 6 to Cap 8 to 7 5 to 7  
1M3	DM70	G	No changes.
1N5	DF33 Z14	E G	No changes. No changes.
1Q5	DL36	E	No changes.

AMERICAN	EUROPEAN	PERF.	CIRCUIT CHANGES NECESSARY
1R5	DK91	E	No changes.
	X17	E	No changes.
1S4	DL91	G	No changes.
1S5	DAF91	E	No changes.
	ZD17	E	No changes.
	ZD19	G	No changes.
	1FD9	E	No changes.
1T4	DF91	E	No changes.
	W17	E	No changes.
	1F3	E	No changes.
1U4	DF904	G	No changes.
1U5	DAF91	G	Rewire as follows:
			Change pin No. 4 to pin No. 3
			3 to 4
			2 to 5
			6 to 6


ORIG


SUB

AMERICAN	EUROPEAN	PERF.	CIRCUIT CHANGES NECESSARY
1X2A	DY80	G	No changes.
2D21	EN91	E	No changes.
	PL21	E	No changes.
3A4	DL93	E	No changes.
3A5	DCC90	E	No changes.
	DL99	G	No changes.
3B4	HD30	E	No changes.
3C4	DL96	E	No changes.
3Q4	DL95	E	No changes.
	N18	E	No changes.
3Q5	DL33	E	No changes.
3S4	DL92	E	No changes.
	N17	E	No changes.
	1P10	E	No changes.
3V4	DL94	E	No changes.
	N19	E	No changes.
5U4	GZ34	G	No changes.
	H52	G	No changes.
	U52	G	No changes.
5V4	GZ32	E	No changes.
5Y3	U50	G	No changes.
5Z4	GZ30	E	No changes.
6A7	6A7E	E	No changes.
6A8	X63	G	No changes.
6AB4	EC92	E	No changes.
6AB8	ECL80	E	No changes.
	SN152	G	No changes.
6AE8	X79	E	No changes.
6AG5	EF96	G	No changes.

AMERICAN	EUROPEAN	PERF.	CIRCUIT CHANGES NECESSARY
6AJ8	ECH81	E	No changes.
	DP61	E	No changes.
6AK5	EF95	E	No changes.
6AK6	EL91	G	Reverse EL91 to 6AK6 procedure.
6AK8	EABC80	E	No changes.
6AL5	D77	E	No changes.
	DD6	E	No changes.
	DD7	G	No changes.
	D152	G	No changes.
	EAA91	G	No changes.
	EB91	E	No changes.
	6D2	G	No changes.
6AM5	EL91	E	No changes.
	N77	E	No changes.
	N144	G	No changes.
6AM6	EF91	E	No changes.
	SP6	E	No changes.
	Z77	G	No changes.
	6F12	G	No changes.
	8D3	E	No changes.
6AQ4	EC91	E	No changes.
6AQ5	EL90	E	No changes.
6AQ8	B719	G	No changes.
	ECC85	E	No changes.
6AT6	DH77	E	No changes.
	EBC90	E	No changes.
6AU6	EF94	G	No changes.
6AV6	EBC91	G	No changes.
6BA6	EF93	E	No changes.
	HMO4	E	No changes.
6BE6	EK90	E	No changes.
6BE7	EQ80	E	No changes.
6BJ5	N78	E	No changes.
6BM8	ECL82	E	No changes.
6BN5	EL85	E	No changes.
6BQ5	EL84	E	No changes.
	N709	G	No changes.
6BR5	EM80	E	No changes.
6BW4	EZ81	E	No changes.
6BX6	EF80	E	No changes.
	Z152	G	No changes.
	Z179	G	No changes.
6BY7	EF85	E	No changes.
	W179	G	No changes.
6C4	EC90	E	No changes.
	L77	E	No changes.
6CA7	EL34	G	No changes.

AMERICAN	EUROPEAN	PERF.	CIRCUIT CHANGES NECESSARY
6CD7	EM34	E	No changes.
6CH6	EL821	G	No changes.
6CJ6	EL81	E	No changes.
6CK6	EL83	G	No changes.
6CN6	EL38	E	No changes.
6CQ6	EF92	E	No changes.
6CS6	EH90	E	No changes.
6E8	ECH35	E	No changes.
6F5	H63	E	No changes.
6F6	KT63	G	No changes.
6H6	EB34	E	Parallel circuits only. No changes.
	D63	G	No changes.
6J5	L63	G	No changes.
6J6	ECC91	E	No changes.
6J7	KT63	G	No changes.
	Z63	G	No changes.
6K7	KTW63	G	No changes.
	W63	G	No changes.
6L6	EL37	E	No changes.
	KT66	E	Parallel circuits only. No changes.
6M6G	EL33	E	No changes.
6N8	EBF80	E	No changes.
6P8G	ECH35	E	Parallel circuits only. No changes.
6Q4	EC80	E	No changes.
6Q7	DH63	G	No changes.
6R4	EC81	E	No changes.
6SL7	ECC35	G	Parallel circuits only. No changes.
6SN7	B65	G	No changes.
	ECC33	G	Parallel circuits only. No changes.
6T8	EABC80	G	No changes.
6U3	EY80	E	No changes.
6U5	Y61	E	No changes.
6U8	ECF82	E	No changes.
6V4	EZ80	E	No changes.
6X2	EY51	E	No changes.
6X4	EZ90	E	No changes.
	U78	E	No changes.
6X5	EZ35	E	No changes.
	U147	G	No changes.
	U70	G	No changes.

AMERICAN	EUROPEAN	PERF.	CIRCUIT CHANGES NECESSARY
7AN7	B319	G	No changes.
	PCC84	E	No changes.
	30L1	G	No changes.
7B7	W149	G	No changes.
7C5	KT81	G	No changes.
	N148	G	No changes.
7C6	DH149	G	No changes.
7S7	X81	G	No changes.
	X148	G	No changes.
7Y4	U149	G	No changes.
8A8	LZ319	G	No changes.
	PCF80	G	No changes.
	30C1	G	No changes.
9A8	PCF80	E	No changes.
9AK8	PABC80	E	No changes.
9AQ8	PCC85	E	No changes.
9U8	PCF82	E	No changes.
12AC5	UF41	E	No changes.
12AT6	HBC90	E	No changes.
12AT7	B152	G	No changes.
	B309	G	No changes.
	ECC81	E	No changes.
12AU6	B329	E	No changes.
	ECC82	E	No changes.
	HF94	G	No changes.
12AV6	HBC91	G	No changes.
12AX7	ECC83	E	No changes.
12BA6	HF93	E	No changes.
12BE6	HK90	E	No changes.
12SN7	B36	G	No changes.
14K7	UCH42	E	No changes.
14L7	UBC41	E	No changes.
15A6	PL83	E	No changes.
16A5	N329	G	No changes.
	PL82	E	No changes.
17Z3	PY81	E	No changes.
19AQ5	HL90	E	No changes.
19X3	PY80	E	No changes.
19Y3	U154	G	No changes.
	U319	G	No changes.
	PY82	E	No changes.
21A6	N152	G	No changes.
	N359	G	No changes.
	PL81	E	No changes.

AMERICAN	EUROPEAN	PERF.	CIRCUIT CHANGES NECESSARY
25L6	KT32	G	No changes.
35W4	HY90	E	No changes.
50C5	HL92	E	No changes.
807	QV05-25	G	No changes.
1639	EBC33	G	No changes.
5641	EY70	G	No changes.
5718	EC70	G	No changes.
5840	EF72	G	No changes.
5861	TD03-10	G	No changes.
5899	EF71	G	No changes.
6064	Z77	G	No changes.
6065	W77	G	No changes.
6252	QQV03-28	G	No changes.
6267	EF86	E	No changes.
6360	QQV03-10	G	No changes.
6373	EL70	G	No changes.
6374	EY84	E	No changes.
6375	DC70	G	No changes.
6487	EF70	G	No changes.
6488	EF73	E	No changes.
6489	EA76	E	No changes.

CUMULATIVE INDEX

The following indices contain all the tubes listed in the *Receiving Tube Substitution Guidebook*, including those given in the First, Second and Third Supplements, for which substitutions are given.

Where (0) precedes the page number, the substitution information is given on the page referred to in the original *Receiving Tube Substitution Guidebook;* where (1) precedes the page number, the substitution information is given on the page referred to in the First Supplement; where (2) precedes the page number, the substitution information is given on the page referred to in the Second Supplement; where (3) precedes the page number, the substitution information is given on the page referred to in the Third Supplement.

Page references to European substitutes for American tubes have been included under the respective American tube numbers, and are asterisked. Page references to American substitutes for European tubes are listed in the European Index.

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