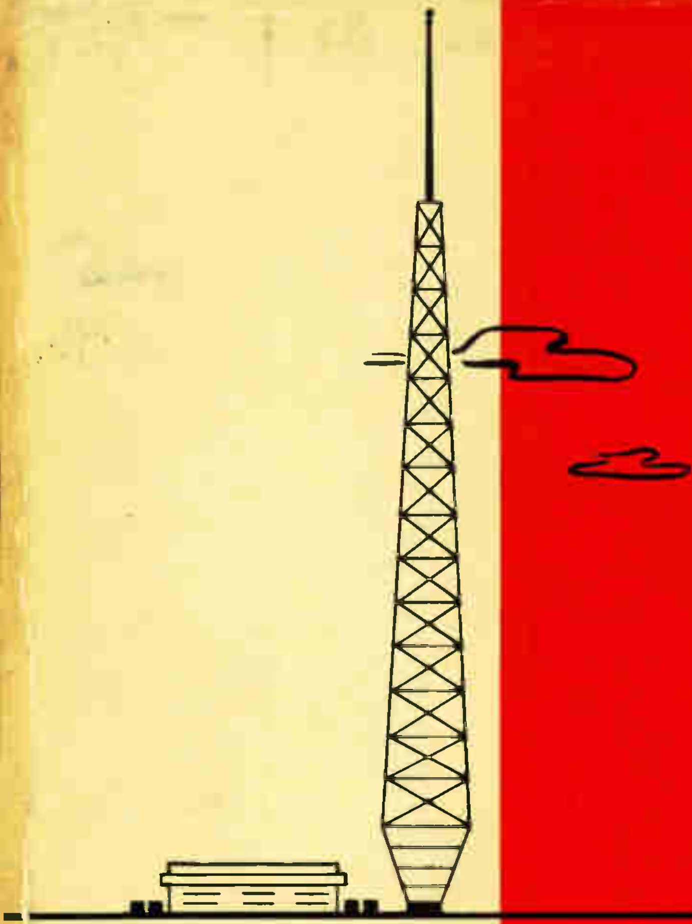
TV Station Brochure



FOR DEPENDABLE SERVICE on the complete line of RCA Industrial Tubes

RADIO PRODUCTS SALES COMPANY
1214 1st Avenue
Seattle 1, Wash.
Main 1035

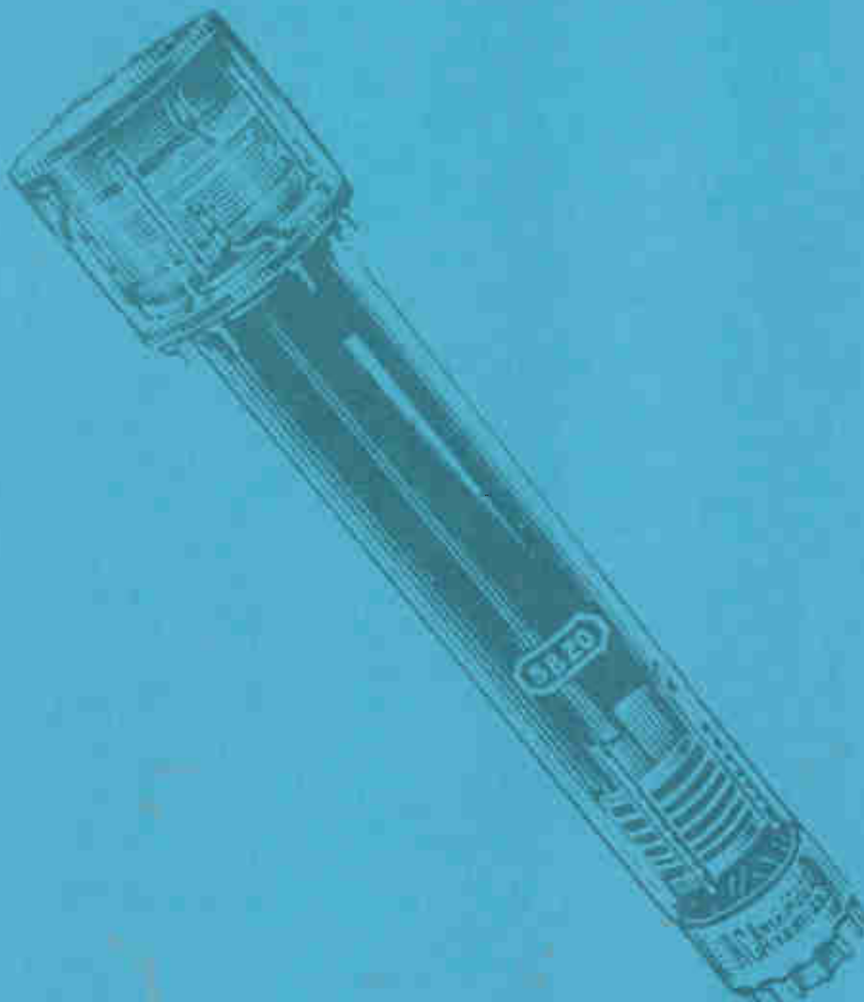
AUTHORIZED RCA DISTRIBUTOR

RADIO CORPORATION of AMERICA

ELECTRON TUBES — HARRISON, N. J.

3F856 PRINTED IN U.S.A. TMK

GETTING THE MOST OUT OF YOUR IMAGE ORTHICON



by

RALPH E. JOHNSON

BROADCAST TUBE SPECIALIST

RADIO CORPORATION of AMERICA

TUBE DEPARTMENT HARRISON, N. J.

3F856-A

GETTING THE MOST OUT OF YOUR IMAGE ORTHICON

A talk by

R. E. Johnson, Broadcast Tube Specialist
Radio Corporation of America, Harrison, N. J.

Ever since the introduction of the RCA image orthicon in 1946, a program of technical development has been carried on by RCA Tube Department engineers in an effort to bring you camera tubes of ever-increasing quality. Among the more important refinements resulting from this work are: better resolution, higher sensitivity, and color response more closely matching that of the human eye. Much information has been provided in the way of tube bulletins, technical articles, and other publications. However, the image orthicon is a very complicated device. It is different in almost every respect from the electron tubes ordinarily encountered in broadcasting. Consequently, some special guidance and instruction in the use of the RCA image orthicon has been found helpful to television station engineers. The purpose of this article is to give the personnel of new stations as much information as possible on the operation of this tube, so they may more easily make the many precise and critical adjustments necessary to generate the very high-quality pictures of which it is capable.

The subject material selected for this presentation is based on the requirements of television stations throughout the country as revealed through extensive discussions with their technical personnel. It is necessary to relate these practical problems to basic theory of operation governing the use of these camera tubes. Therefore, much of the presentation will take the ideal approach to operating procedures, although we would be the first to admit that ideal conditions seldom prevail. This is done with the expectation that a good knowledge of the conditions under which the tube will operate best should enable you to make the best compromise possible in any "unusual" situations that you may be called upon to cope with.

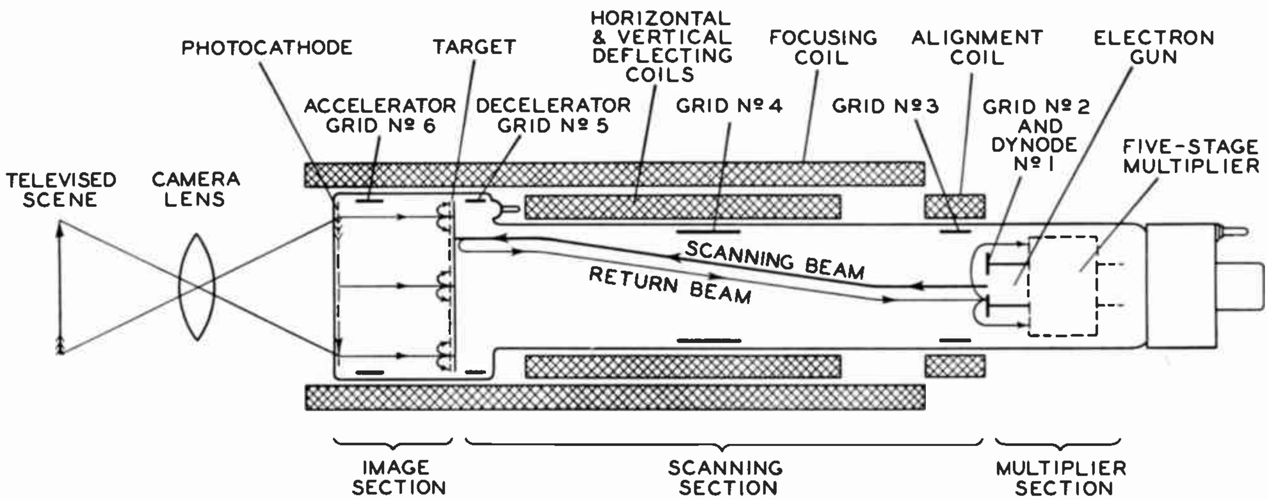


Figure 1 92CS-6692

PRINCIPLES OF OPERATION - IMAGE SECTION

To be assured of a good reference point, let's start off with a cross-section view of the image orthicon that will be familiar to everyone, and review briefly just how the image orthicon functions in order to generate a television picture. In Fig. 1 the solid line shows the envelope outline of the image orthicon proper, and the cross-hatched areas are the various coils that provide the electro-magnetic fields essential to the tube's operation. You will note that the image orthicon is divided into three sections, labeled the image section, the scanning section, and the multiplier section, for convenience in describing the operation of the tube. In ordinary service the scene to be televised is focused onto the front of the image orthicon through a conventional optical system. The front face of the tube is manufactured from optically clear glass and on its inside surface photo-sensitive materials have been deposited to form the light sensitive photocathode. When light falls on the photocathode, electrons are emitted in direct proportion to the intensity of the illumination. These electrons are then accelerated and focused in the image section by the electromagnetic fields set up by the focusing coil and the potentials applied to the photocathode, the grid No. 6 and the target. These electrons then strike the target at high velocity in focus. As a result of the impact, secondary electrons are generated, as shown by the additional arrows around the arrow representing the initial stream of electrons. The secondary electrons so generated are collected by a fine mesh screen mounted in very close proximity to the glass target. As a result, the target then becomes positively charged. When the tube is operated properly the electron charge pattern built up on the glass target will correspond to the light and dark areas as they appear in the original scene being televised. The tube at this stage has been successful in transforming the light image to an electrical image. It should be noted that when the potential of the target under this charging action becomes equivalent to the potential applied to the fine mesh screen, the electrons will no longer be collected by the screen. Instead, they will be repelled and rain down on the target, redistributing themselves over the target in a manner more or less dependent upon the charge pattern that may exist at any particular time on the target. Thus, the ultimate charge that can be accumulated by the target in a frame time is limited. This action is responsible for the exceptional stability of the image orthicon over a very wide range of light levels.

SCANNING SECTION

The charge built up on the target in a frame time is removed from the target by the action of a scanning beam operating in a more or less conventional fashion. The beam, originating from a cathode operating at zero potential is accelerated to 300 volts, and emerges to the main body of the image orthicon through the exit aperture shown as grid No. 2 and dynode No. 1. The alignment coil provides a transverse magnetic field of variable intensity that can be rotated through 360 degrees to center the electron beam on the electrical axis of the image orthicon. The main field is provided by the focusing coil, which is essentially a solenoid extending for almost the full length of the image orthicon. Both of these fields are necessary, as we shall see later, to guide the low-velocity beam to the target and cause it to land uniformly over the target. The beam is then focused electronically by the action of the grid No. 4 in combination with the main focus field, and deflected horizontally and vertically by the deflection coils. After it has been deflected and is fairly close to the target, the beam is decelerated by the field between grid No. 4 and the target. Grid No. 5 serves to adjust the shape of this decelerating field in order to obtain uniform loading of electrons over the entire target area. The beam will then deposit electrons to just neutralize the charge that appears at that particular portion of the target. The remaining portion of the beam will be repelled and return along essentially the same path that it followed coming up to the target. In order for the beam to have uniform forward velocity over the entire target area, it is of course necessary for the decelerating field to be symmetrical and, of course, the position of the undeflected beam should be at the center of the symmetry. The alignment coil, previously mentioned, when adjusted properly, will insure that the beam arrives at the target at as close to the same forward velocity at all points as possible, other associated adjustments having been properly made.

MULTIPLIER SECTION

When the beam scans the target in the prescribed manner, electrons in excess of that required to discharge the target will not land and will be turned back in the tube. This return beam then constitutes a video signal by virtue of the modulation by subtraction that occurred continuously as the beam scans the target. This video signal then returns to the general vicinity of the exit aperture on grid No. 2 and the dynode No. 1. If the electron optical system of the tube were perfectly symmetrical, the return beam would go through the hole from which it emerged originally and the signal would be lost. However, since this is not the case, the return beam scans the dynode over a finite area that is somewhat dependent on the particular fields that it has gone through. When the beam strikes the flat surface of the dynode, secondary electrons are again produced much in the same manner as they were produced earlier in the image section when photoelectrons struck the target. These secondary electrons are directed into a second dynode stage. This action is facilitated by the local fields set up by grid No. 3. There are five stages of such dynode amplification making up the electron multiplier; these raise the average level of the video signal about 500 times. The signal thus produced and amplified is collected on an anode and coupled to the first stage of a video preamplifier in the conventional manner. The generated picture signal then goes through additional stages of amplification and through the various elements of the television system until it is ultimately reproduced on the face of a kinescope located in the home or other viewing place.

IMAGE ORTHICON CHARACTERISTICS

You will find that most of the important static and dynamic characteristics of the image orthicon that affect your daily operation have to do with the front end of the tube. For example, any image orthicon to give satisfactory service must have a good beam, proper focusing parameters, and a high level of gain in the multiplier system. However, each of these are built into the tube and there is little you can do operation-wise to make them better or worse. For example, you will ordinarily find that the voltages on the multiplier stages are fixed. This means that you should not have occasion to change them to obtain improved performance in day-to-day operation, and such is actually the case. Also, grid bias voltage will ordinarily have to be set at some operating point to provide just enough beam to discharge the target with no further or continuous adjustment required. Although the alignment-coil adjustment is of the utmost importance in the operation of the tube, its setting is also straightforward, and does not require an understanding of what we might term "characteristics" in order to set it properly. On the other hand, the photocathode is also one of the most essential parts of the tube and its particular characteristics are very important to you in day-to-day operations.

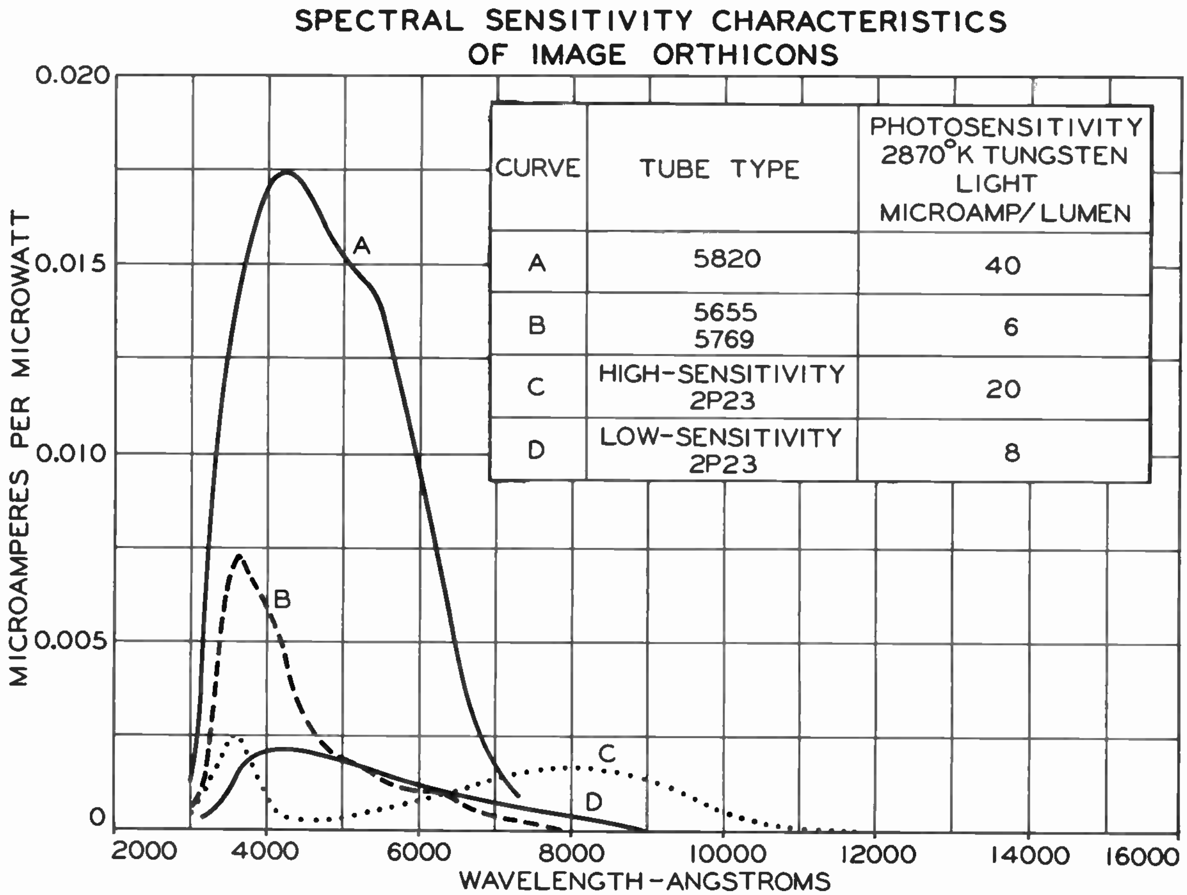


Figure 2

SENSITIVITY AND SPECTRAL RESPONSE

Two characteristics of the photocathode are of special interest to anyone using the image orthicon for pickup purposes in television. They are photosensitivity and spectral response. The excellent sensitivity characteristics of image orthicons in general have been well publicized. However, many users probably do not realize how much the sensitivity of the new 5820 has been increased over the earlier image orthicons. In the spectral response and sensitivity curves shown on the chart in Fig. 2, the response of the photocathode in microamperes per microwatt of light energy striking it, is plotted against the wavelength of the light source in angstroms. The curves are plotted from the blue end of the spectrum in the neighborhood of 4000 angstroms on through the yellow and green at 5000 and 6000 angstroms to the red and infrared which occur at 7000 angstroms and beyond. We have shown representative curves for the new type 5820 plotted alongside of the curve for the older 5769, and two additional curves representing both as high-and low-sensitivity 2P23 which was the very first image orthicon introduced commercially. Since these curves are plotted on an absolute scale the area under the curves is proportionate to the sensitivity of the tubes.

When you compare the 5820, represented by curve "A", to former models of the image orthicon represented by curves "B" "C" and "D" the high sensitivity of the 5820 is readily apparent. To translate this comparison into quantitative terms, you will note in the table shown in the upper right hand corner of Fig. 2, that type 5820 has a typical sensitivity of 40 microamperes per lumen, compared to 6 microamperes per lumen for the 5769, and an average sensitivity of 15 microamperes per lumen for the 2P23. This means that the 5820 is roughly three times as sensitive as the old style 2P23, which was particularly noted for its high sensitivity at the time it was introduced, and a full six times as sensitive as the 5769, which was introduced later. Measured another way, the 5769 required a minimum of 36 foot candles on the average scene to give an acceptable on-the-air picture, while the 2P23 could operate satisfactorily down to a minimum light level of some 18 foot candles. The 5820 under the same conditions can give a good on-the-air picture at light levels as low as 6 foot candles. A more normal figure for scene illumination with the 5820 is about 100 foot candles. The average tube will then operate with a lens opening between f11 and f16 for optimum performance without a filter. These calculations are based on illumination intensity measured in the vertical plane facing the camera and with average scene reflectance assumed. In the case of minimum light levels under which the tube will operate, it was assumed that the lens would be open to a stop of f-3.5.

COMPARISON WITH EYE RESPONSE

The excellent sensitivity characteristic associated with the 5820 is even more impressive when it is noted that response is largely confined to the visible spectrum. It is very important, of course, for the camera-tube response to be essentially the same as that of the human eye if the reproduced picture is to appear the same as the original scene. Unfortunately, the earlier image orthicons and particularly the 2P23, had characteristics that were not very close to that of the human eye. The 5769 had unusually high blue response, which was not particularly objectionable in the picture since the relative response to yellow, green and red was in pretty good balance. However, the 2P23's had more or less high red and infrared sensitivity, which as you can estimate from the curve, was a radical departure from the average eye response.

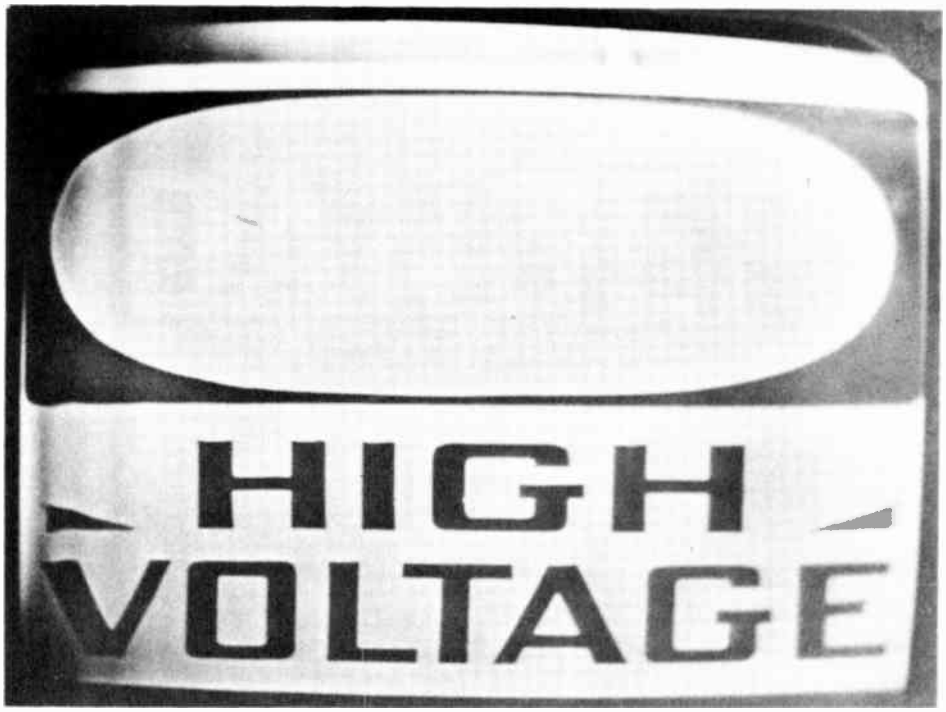
As a graphic illustration of how this departure from eye response can effect your television operations, the photograph in Fig. 3 is a kinescope reproduction of an ordinary "danger sign" as picked up by the average 2P23 image orthicon. As you know, these signs usually consist of white letters, painted on a brilliant red background which results in exceptionally high visual response. However, the very high response of the 2P23 camera tube in the red region, generates a signal comparable to that produced by the higher intensity of the white letters. Thus the red background of the sign is reproduced as white, making the lettered warning of "danger" virtually invisible. Fig. 4 shows the same subject reproduced by the 5820 image orthicon. Here the contrast between the white letters and the red background has been effectively preserved as a result of the better spectral-response characteristic of the 5820.

It is surprising how often red is used in the average scene encountered in television operations. For example, decorative schemes and signs quite often use a liberal amount of red to please the eye or to attract attention. Furthermore, flesh tones are predominantly red and since a lot of people appear on television, correct reproduction of their facial features is of the utmost importance. In general the audience does not know the color of an item of wearing apparel. However, they do know how the face of the average person should look when reproduced in black and white half-tones, and any deviation from a natural appearance is very easily detected.

The photographs in Figs. 5 & 6 illustrate the difference between good and poor spectral response as they relate to a life-like subject. All photographs are kinescope reproductions, made with the same equipment, except that in one picture a type 5820 has been substituted for the type 2P23. The "mannequin" in Fig. 5 has a moderate amount of lipstick, face powder, and eye shadow, and has a fairly dark shade of brown hair. Because of the high red response of the 2P23 camera tube, the lips show no color whatsoever, the face is pasty, devoid of all natural contrast, and detail is lacking around the eyes and in the hair itself. Furthermore, the hair appears more blond than brown and a critical TV audience might easily be led to believe it was gray, which would not be at all flattering to the subject. Fig. 6 shows the same "mannequin" picked up by the type 5820 image orthicon. The lips now appear in the correct shade of gray, in pleasing contrast to the general facial tones, and the complexion is no longer pasty but seems to have a very natural appearance. Furthermore, the eyes are clear, indicating that the detail contrast has been improved and the same carries through to the detailed reproduction of the hair. You will also note that the hair now more closely resembles the brunette shade that it is.

The improvement in detail contrast is not entirely due to spectral response although it is a result of the new photocathode material used in the type 5820. The photocathode is semi-transparent so that a certain percentage of the light striking the tube will pass directly through the photosurface where it can be reflected from elements inside the tube back onto the photosurface. In this manner spurious signals are generated, which tend to spoil the detail contrast. Because of the higher density of this new photosurface, which incidentally is associated with its higher sensitivity, a smaller percentage of the light passes through the photo surface and consequently less spurious signal is generated. This results in the higher contrast and the sharper picture which is characteristic of the 5820. In quantitative terms, the 5820 operated under optimum conditions will, on the average, show an improvement in resolution of about 100 lines on the conventional RTMA chart over that obtained from earlier image orthicons.

The pictures shown in Figs. 4 & 6 represent the natural response of the 5820 and no attempt has been made to improve this response by means of filters. Steps to improve the spectral response of all tubes to date have always been considered. In the earlier tubes, however, the response was so far removed from the desired response that no improvement was possible without sacrificing sensitivity to a prohibitive degree. In the new 5820 we have seen that in the first instance the sensitivity is very much higher than that of earlier image orthicons, and in the second place, the spectral response much more nearly approximates the average eye response than has been achieved before. Curves "A" and "B" in Fig. 7 demonstrates this very close approximation. In the very critical green, yellow and red regions (5000 to 7000 angstroms) referred to previously, the curves are almost coincident. The curves depart only in the deep blue or ultraviolet regions of the spectrum, which are not especially significant. As a result, most television stations are perfectly satisfied to use the tube without filters in their operations. However, by placing a Wratten No. 6 filter in front of the 5820 the spectral response curve can be altered to that shown as solid line "B" which is a very close approximation to the eye response curve "C". Pictures generated by the 5820 under these conditions have correspondingly high color fidelity and therefore scenes are reproduced in black-and-white half-tones in the exact proportions that the eye views it. The difference in sensitivity, represented by curves "A" and "B", is only of the order of two to one, or one lens stop. Therefore, from a sensitivity standpoint, it is entirely practical to use filters in this fashion with the 5820 to get exceptionally accurate spectral response if it should be desired.



COLOR RESPONSE WITH TYPE 2P23

Figure 3

COLOR RESPONSE WITH TYPE 2P23

Figure 5

COLOR RESPONSE WITH 5820

Figure 4

COLOR RESPONSE WITH 5820

Figure 6

Uniformity of spectral response from tube to tube is almost as important as the spectral response itself. Most television broadcasts employ at least two cameras on each show. If the pictures generated by each camera are to appear the same, the spectral response of the two camera tubes must be almost identical. Fig. 8 illustrates the high degree of uniformity characteristic of the 5820 spectral response. Curves "A" and "B" show that, for average sensitivities, the spectral response curves follow each other very closely. When sensitivity is unusually high or unusually low, however, a definite shift in the curve can be detected. For example, in the case of a tube having a sensitivity of 18 microamperes per lumen illustrated by curve "C" the peak response is shifted toward the blue end of the spectrum; correspondingly, a tube having a sensitivity of 70 microamperes per lumen, would show a definite shift toward the red end of the spectrum. However, sensitivity limits are set at the factory to eliminate the extremes of high and low sensitivity. The very radical departure from normal, shown by curve "C", can therefore be avoided and all tubes that are shipped for use in television stations would be of the uniformity indicated by curves "A" and "B". In many cases the difference in spectral response from tube to tube are so slight that it is almost impossible to measure them within the limits of accuracy of good laboratory equipment used for this purpose.

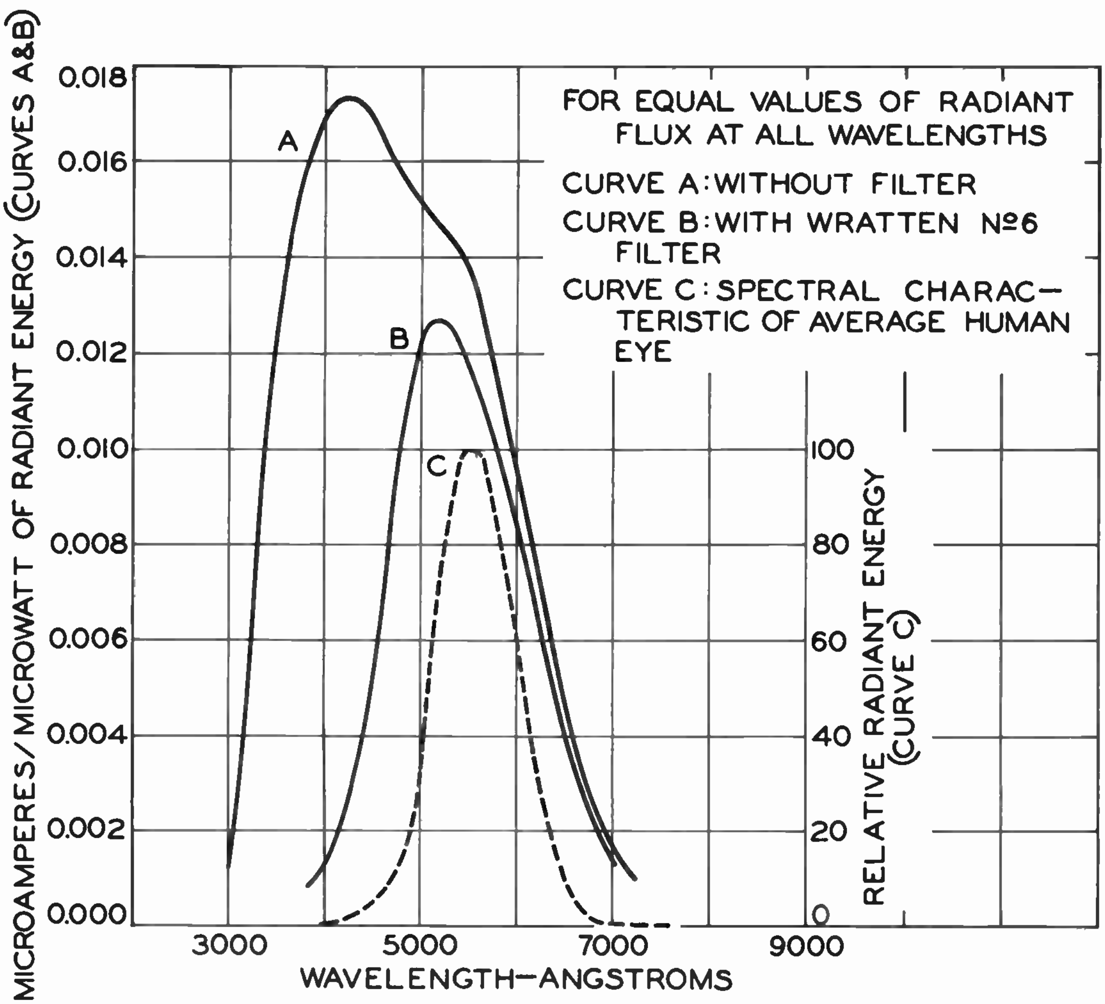


Figure 7

TRANSFER CHARACTERISTICS

The characteristics of the photocathode surface described so far are very important to you because it means the present-day image orthicon is capable of faithfully reproducing all colors in black and white half-tones of relative intensities equivalent to that of the average eye response. Furthermore, different tubes have practically identical responses, so that pictures generated bv

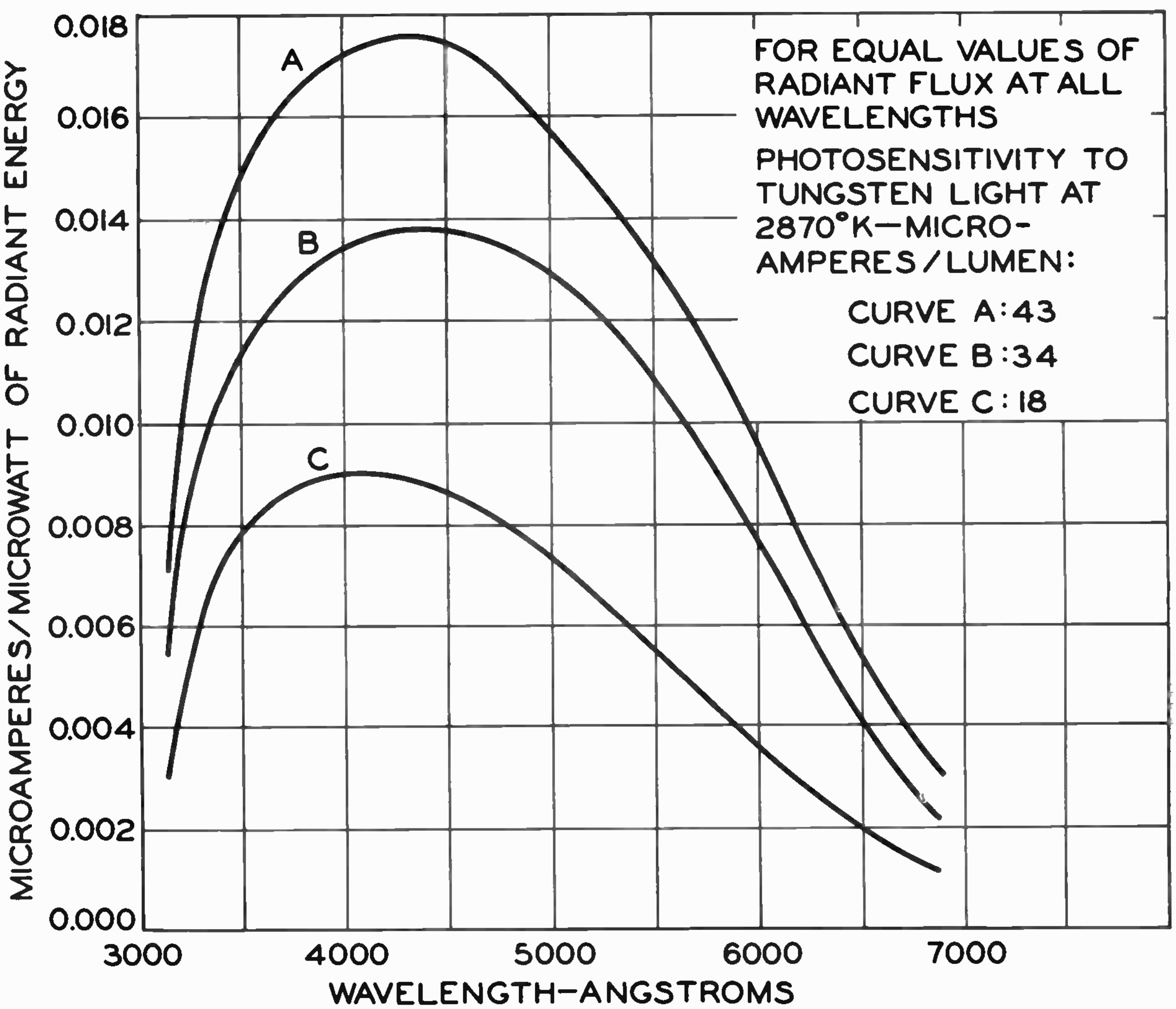


Figure 8

different cameras should be expected to match almost perfectly insofar as the photocathode response is concerned. If at any time it appears that pictures generated from different cameras do not match, it is best to look for the source of trouble at other points in the picture-generation cycle, rather than in the spectral response of the particular image orthicon being used. In this regard the transfer of charge that takes place at the target is a very important process. Consequently, what might be regarded as very small changes in adjustments that affect this transfer characteristic can result in very obvious and objectionable mismatch in pictures generated by two different cameras. In particular, the level of illumination admitted to the image orthicon and the target drive are especially important adjustments that must be carefully controlled in day-to-day operations if apparent mismatch is to be avoided. Let's take a look at the transfer characteristic curves shown on the chart in Fig. 9 and review the fundamentals that govern optimum performance of the camera tube.

The transfer curves are obtained by plotting signal output in microamperes against the highlight illumination on the photocathode in foot-candles. You will note that as the illumination increases, signal output increases linearly until the knee of the curve is reached. At this point the potential of the target just equals the potential applied to the mesh. The target is not able to acquire further charge and we come into the saturated or level portion of the curve in which no increase in signal output from the tube is realized by increased illumination. This level of signal represents the whites in the scene; the blacks are reproduced as the very lowest signal level. The linear part of the curve between black and white is used to reproduce various levels of intermediate half-tones. Therefore, it is desirable to have the linear portion of the curve as long as possible in order to reproduce more finite steps of gray. In actual practice, however, the amount of charge that can be stored, and subsequently discharged, is dependent upon the capabilities of

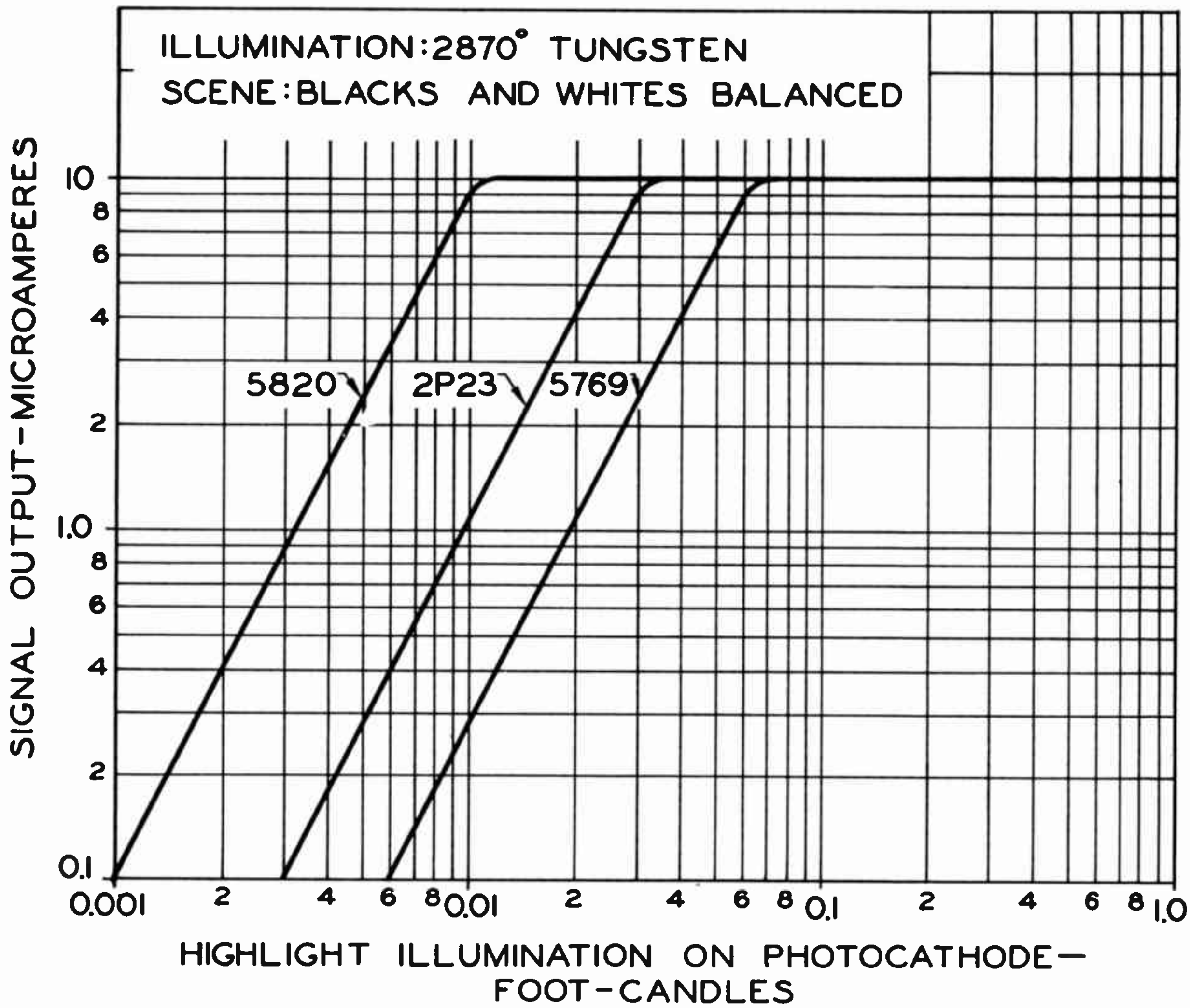


Figure 9

the image orthicon being used. From experience it has been determined that a drive of 2 volts from cutoff on the target is very nearly optimum for all image orthicons. Since the electron gun cannot successfully discharge higher potentials, and picture quality will be reduced by lower potentials, this value of target drive has become almost a standard or universal setting for best over-all performance.

Furthermore, from the standpoint of uniformity mentioned earlier, it is also obvious that each image orthicon must have the same target drive as a general rule if the gray scales which they generate are to correspond. If different target drives are used one tube will appear in greater contrast than the other and the result will be an obvious mismatch in the pictures transmitted. Consequently, the setting of target drive potential becomes very important for a number of different reasons.

After the proper target drive adjustment is made on any particular tube, it is then essential that the tube be properly exposed to light. It is obvious that if insufficient light is admitted to the image orthicon to drive the tube over the knee of its characteristic, you will not be storing the maximum charge that the image orthicon is capable of. Consequently, the tube will appear to have poor signal-to-noise ratio and the gray scale will be poor. On the other hand, if too much light is admitted to the image orthicon the whites will be driven far out on the flat portion of the curve and the blacks will be lifted up along the transfer curve to somewhere near the top. This condition will have a tendency to cause reduced contrast and limit the gray scale near the white or very light end of the scale so as to give the picture a washed out appearance.

The photograph shown in Fig. 10 is representative of the good quality that can be expected from the 5820 image orthicon when it is adjusted in accordance with the instructions thus far. Note that the subject has been particularly selected to contain some blacks, some whites, and a large number of intermediate grays. In addition to the normal adjustments, the camera tube used was operated with a target drive of exactly 2 volts above cutoff on the target, and with the high-lights driven just over the knee of the curve. When the target voltage is slightly reduced and the iris is opened two full lens stops above what would be considered optimum, you will note, in the photograph in Fig. 11, that the blacks are no longer black, and the whites are not as prominent as they were in Fig. 10. Furthermore, the picture itself tends to take on a nondescript gray appearance as a result of this loss of contrast and has a washed-out appearance. Note that the changes made to obtain these two totally different pictures were relatively small.

As mentioned earlier in conjunction with spectral response characteristics, a great many people appear on television and it is interesting to note just what effect the preceding maladjustment will have on live subjects. In Fig. 12 we see a person seated in front of the lathe and machinery used in the earlier photograph. Here again the presence of blacks, whites, and intermediate grays are in good proportion. Notice the reproduction of the facial features, the details of the hands and fingers, and particularly that the girl has naturally dark hair. When we overexpose the image orthicon and reduce target voltage as in Fig. 13 the good gray scale has again been lost and the girl's hair instead of appearing dark as it should, now takes on the same silvery appearance which we had earlier associated with high red response in the photo-cathode. Furthermore, with reference to facial features and reproduction of detail in her hands and fingers, note how harsh and unflattering the picture becomes when the image orthicon is overexposed and highlights are run way out on the flat portion of the transfer characteristic.

Admittedly, it is not always possible to control either the lighting condition or the exposure of the image orthicon in every instance. However, when you can exercise control over these variables you should make every effort to do so in order to obtain the best picture quality possible.

The effect of different sensitivities on the transfer characteristic may be noted with reference to the curves in Fig. 9. For example, the 5820 is more sensitive than the 2P23, and the 2P23 is more sensitive than the 5769. Therefore, although the shape of the transfer characteristic in each case is identical, as we go from the least sensitive 5769 to the more sensitive 2P23 to the most sensitive 5820, the transfer curves move successively toward the left of the chart, or to lower and lower illumination levels. Consequently, tubes of varying sensitivity can be accurately matched, provided they have the same spectral response and transfer characteristic, by adjusting the iris to accommodate their difference in sensitivity. However, if the spectral response is also different, as in the case of the 2P23, the 5769, and the 5820, then you will be unable to match the tubes regardless of the similarity of their transfer curves. By the same token you will also find it difficult to match image orthicons having the same spectral response, but different transfer characteristics. This situation is encountered in the 5820 and the 5826. These tubes are usually referred to as companion types and are identical in every respect except for target-to-mesh spacing. The 5820 target-to-mesh spacing is relatively wide, while the 5826 has close target-to-mesh spacing. Although both tubes have identical photocathodes, the substantial difference in target-to-mesh spacing will result in significantly different transfer characteristics that seriously interfere with any attempt to match their gray scales.

COMPARISON OF 5820 & 5826

Illustrated on the chart pictured in Fig. 14 are the transfer curves for the 5820 and 5826. Note that the knee of the curve for the 5820 in this figure occurs at a lower value of signal-output current than shown in Fig. 9. Saturation occurs at a lower level in Fig. 14 because the anode potential is 1250 volts instead of 1500 volts. In any case, the transfer characteristic of the 5820 follows the 5826 as light intensity is increased, until the 5820 reaches the saturation point. The 5826, however, because of its closer target-to-mesh spacing and the resultant increased capacity for storing charge, does not saturate at this point but continues to a much higher signal output level before it reaches the corresponding saturation point. Several conclusions may be reached relative to tube performance from this difference in transfer characteristics. First of all, the close spaced 5826 is capable of storing more charge for the same target potential.

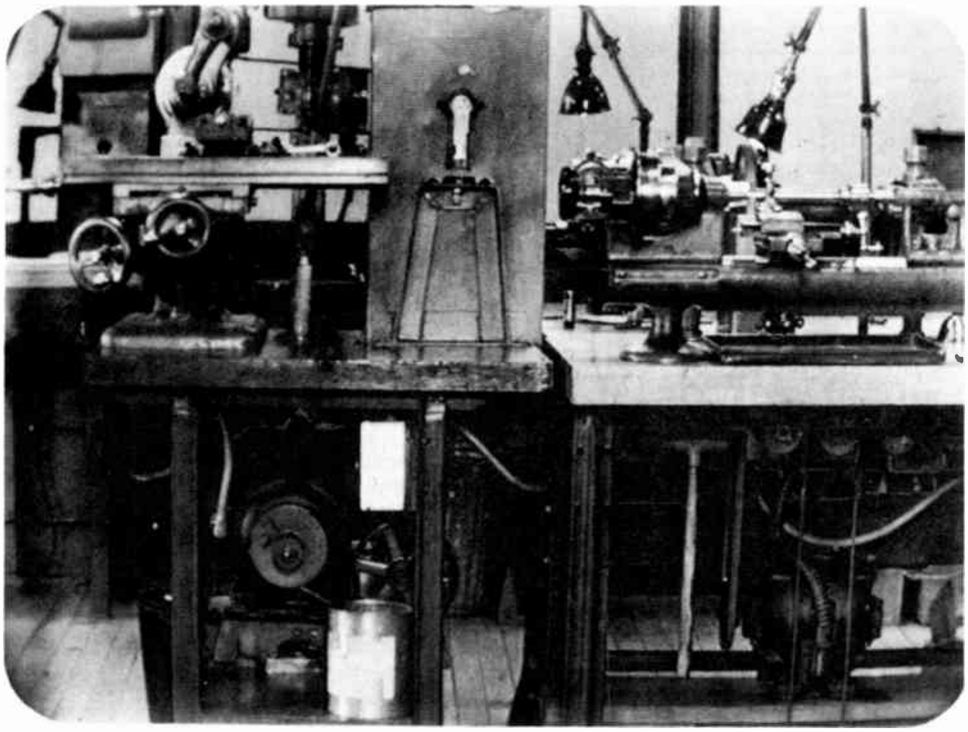


Figure 10

Figure 12

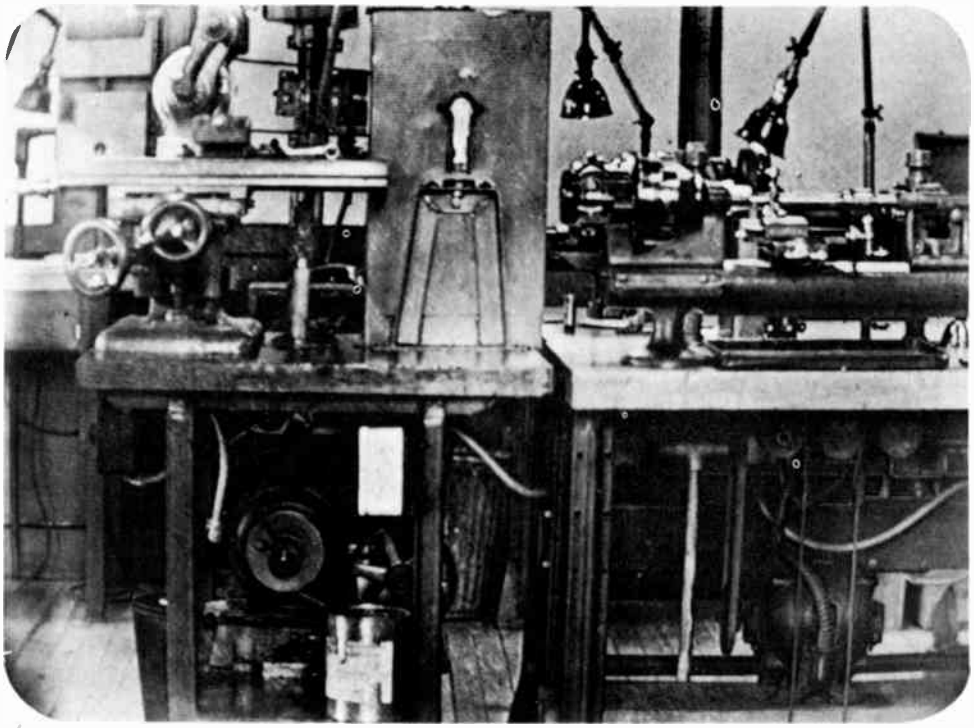


Figure 11

Figure 13

Therefore, it can be expected to have an appreciably higher signal-to-noise ratio, and it does. Also, the linear portion of the transfer curve is longer in the case of the 5826 and it should be expected to have a better gray scale in the sense that more finite shades of gray can be reproduced. This better gray scale is another advantage of the close-spaced image orthicon type 5826. Another advantage that can be demonstrated but might not necessarily be anticipated is the increase of about 50 lines resolution on the average that the 5826 has over the 5820. This increase is probably due to the higher signal-to-noise ratio of the closer-spaced 5826. As quite often happens in the design and construction of most intricate devices, these three advantages of the 5826 have to be paid for and are balanced off to some extent by certain disadvantages. In the first place the higher charge stored on the target places additional burden on the electron beam when it undertakes to discharge the target.. As a result close-spaced tubes, in general, demand more skill of the operator and more attention to adjustments in day-to-day operation. In effect, they are more critical of adjustment under any conditions than the wider-spaced tubes. Over and above this, it is found that close-spaced tubes for the same reason will be more or less limited in their application. That is, they will have to be used where the range of light intensity is restricted because where large-area bright lights are encountered, charges stored will tend to be in excess of what the image orthicon can handle in the practical sense. Hence, the picture will tend to bloom, or become unnaturally shaded in certain areas so that the resultant picture quality will not be satisfactory. As a third disadvantage, the 5826 will be called upon to carry a higher average signal current through the target in the discharge process than would be the case for the wider-spaced 5820. In carrying the signal currents, the glass target of every image orthicon undergoes some change in composition, possibly due to migration of ions within the glass itself. This ultimately will change the resistivity characteristics of the glass so that charges that remain on the gun side of the glass as a result of the discharge cycle will not be neutralized in a frame time by leakage through the glass. Consequently, a latent image will remain on the target and give rise to what we have called "sticking". In every image orthicon this tendency to "stick" will increase with the life of the tube and, in perhaps as many as 90% of the cases, it determines the useful life of the tube. That is, when sticking becomes intolerable, the tube must be retired from service. Although this happens eventually in the 5820 as well as in the 5826, it will happen on the average sooner in the close-spaced 5826 because of the heavier signal currents that are drawn through the target. Consequently, it is generally found that the average life of the 5826 will be only 75% to 80% of the average life of the 5820. Therefore, in deciding whether in your operations you would use the type 5826 or the type 5820, these disadvantages must be compared with the advantages, in order to arrive at a decision for any particular station.

TEMPERATURE CONSIDERATIONS

Thus far we have covered those characteristics common to the image orthicon which are most likely to evidence themselves during daily operation. Equally important to obtaining maximum performance of the tube, are the actual adjustments necessary in order to employ these characteristics to advantage. First of all, the memory or sticking characteristic of image orthicons previously referred to, is closely associated with operating temperature even on new tubes. Specifically, in new production tubes, the resistivity of the glass used in the target has been selected so that the image orthicon will operate satisfactorily in the range of temperature between 35 degrees centigrade and 65 degrees centigrade (this operating range is restricted to 45 degrees centigrade to 65 degrees centigrade for close-spaced tubes). If by chance the image orthicon is operated below 35 degrees centigrade, then the resistivity will be abnormally high and the tube will show a great tendency toward sticking. On the other hand if the operating temperature exceeds 65 degrees centigrade, resistivity will be too low, resulting in a leakage of charge during the frame time sufficient to lose resolution. As a rule, manufacturers of television cameras have taken this temperature limitation into account in designing their equipment, and consequently, in normal usage, no difficulty should ordinarily be experienced with tubes due to operation outside recommended ratings. However, it is a very good item to check up on periodically, especially if pickup has to be made under unusually high or unusually low ambient temperatures.

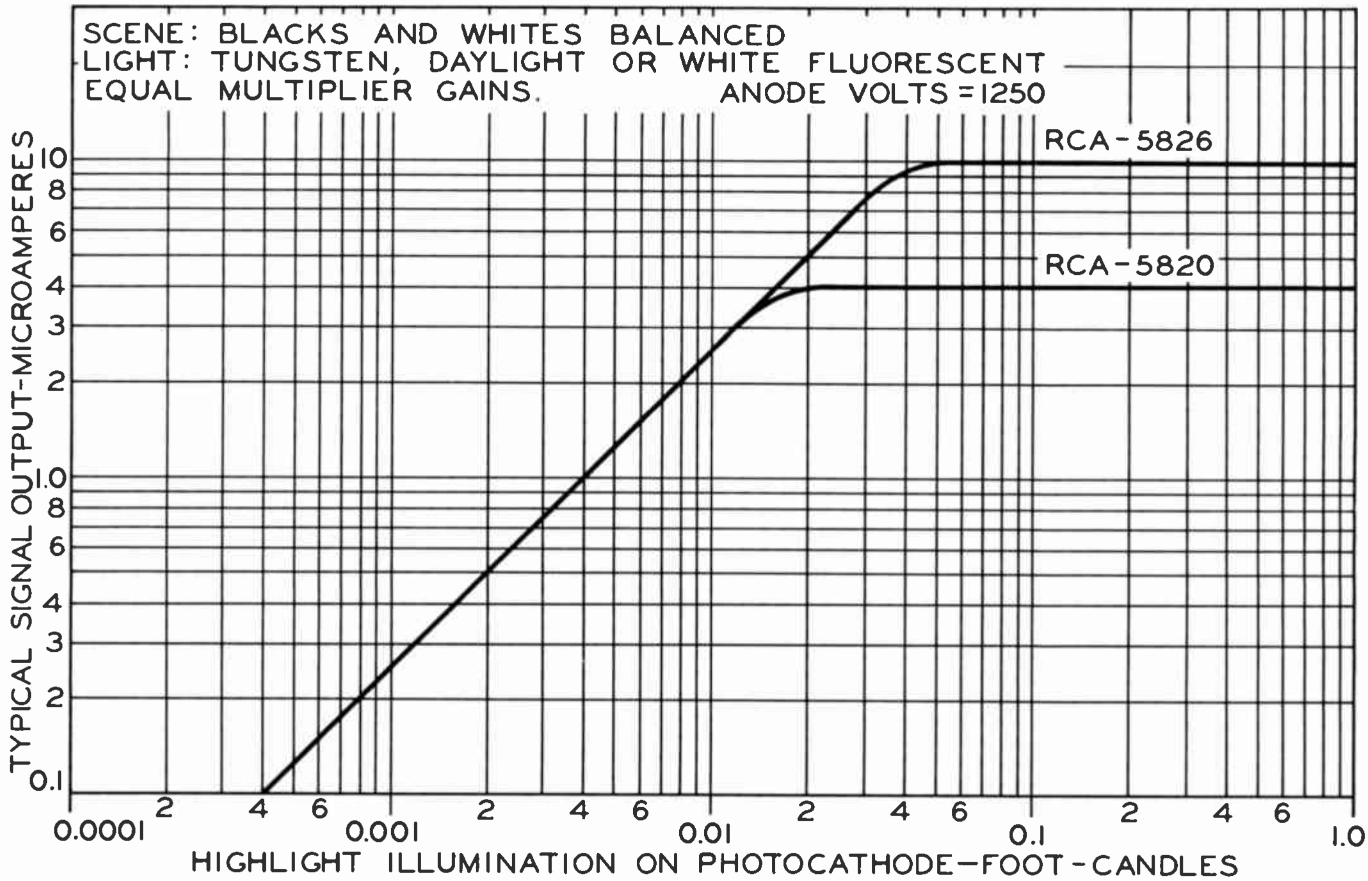


Figure 14

WARM-UP TIME

In normal service, the image orthicon camera should be turned on and allowed to warm up for 15 to 30 minutes before any attempt is made to set up the picture in its final form. At any time after this warm-up period final adjustment may ordinarily be made and pictures subsequently put on the air without encountering any difficulty from excessive sticking. From experience it is strongly recommended that the target heaters normally installed in the cameras, not be used to accelerate this warm-up period because in the first instance there is no way of actually knowing what the temperature of the target is as a result of such extra heat being applied, and secondly, it is very easy to forget about the heaters being on, in which case the image orthicon can be temporarily and sometimes permanently damaged by overheating. On the other hand, it is generally always good practice to make sure the blowers are functioning unless there is definite indication that the tube is running too cool as a result of blower action. Target heaters, of course, serve a very useful purpose when pickup is being made under unusually low temperature conditions. When they are needed to maintain temperature in the normal operating range, station engineers should not hesitate to use them.

After the tube has been temperature stabilized in the normal manner a certain small amount of drift due to temperature change may be experienced at times, particularly if the camera is used on the air for long periods of time. Therefore, it will be necessary on occasion to make minor adjustments to the image orthicon to accommodate these latent slow changes.

BEAM ALIGNMENT

The first adjustment to be made in the actual mechanical process of setting up the tube is to align the electron beam on the electrical axis of the image orthicon. The fastest adjustment can be made by uncapping the lens of the camera tube, pointing it at some representative scene, and "rough-aligning" the tube so as to get a flat-shaded, uniform picture. When this has been accomplished more precise alignment can be obtained by capping the lens and using the exit aperture of the dynode as a guide. Since this exit aperture is in reality an image of the electron beam, slight misalignment is indicated when the spot rotates about a center point as the beam focus control is varied. On the other hand, when the beam coincides with the electrical axis of the image orthicon, this spot will come directly in and out on the axis of the viewing monitor as the beam focus control is varied. After the alignment is set in this fashion it is natural for the spot to show some rotation when a lighted scene is projected on the tube. This rotation is due to various charges built up on the target which serve to deflect the beam. From experience it has been found that such rotation should be disregarded in setting alignment because best average performance can be obtained when the beam is on the electrical axis of the image orthicon. This result is achieved when the beam is aligned in darkness or on a uniform gray background. Changes in alignment to accommodate the scene may result in temporarily improved picture quality. However, this adjustment will vary with the scene currently being picked up by the tube. Consequently, setting it for one particular scene will not result in the operator having the best setting to accommodate a wide range of scenes.

IMPORTANCE OF CORRECT ALIGNMENT

The desirability of achieving "pin-point" alignment cannot be emphasized too strongly. It is the cornerstone upon which all other adjustments of the tube depend. With perfect alignment other settings will often be very easy to make, and in many cases they will actually fall into place. Also, misadjustment of other parameters are not nearly so obvious when alignment is right. Conversely, if alignment is wrong an operator will often get the impression that he can never get optimum adjustment of many of the other elements in the tube. For example, resolution might always appear just the least bit soft, or the corners won't shade in properly, or the beat pattern may be persistent, or dynode spots may be very hard to defocus. Since it is possible to accurately align every image orthicon, adequate time should be taken to develop the best alignment technique and to insist on nothing short of perfection for the alignment of each tube.

FOCUSING CONSIDERATIONS

When alignment is complete, the lens is usually uncapped again and other settings made on the tube. First the picture should be focused both optically and electronically. Electronic focus includes a focus adjustment in the image section and in the electron beam. Optical focus and the focusing adjustment in the image section are fairly straightforward because there is only one point under a given set of conditions at which this focus can be accomplished. However, the electron beam in the image orthicon will ordinarily focus at three different points within the range normally supplied on the beam-focus control. It is important that you get the correct order of beam focus. The highest value of voltage that results in beam focus will ordinarily provide the sharpest resolution. However, the tube is more critical of adjustment at this point and it may not be at all possible to get flat shading under these conditions. At the other extreme, with the lowest value of voltage, the tube will be much easier to handle but invariably some loss in resolution will be experienced. Therefore, it is important in setting up the tube that you use the intermediate focus voltage which is on the order of 200 volts plus or minus 10% when a field current of 75 milliamperes is maintained in the main focus field. After the tube is focused, it is customary to adjust multiplier focus voltage (grid No. 3) for good collection of secondaries from the dynode No. 1 and to set the grid No. 5 (decelerator) voltage at the optimum point for flat shading. Either or both of these voltages may affect the beam-focus setting so that some adjustment may need to be made to this control after focus voltage and the decelerator voltage have been adjusted. In going through the range of voltage normally supplied on most of these controls it will be possible to produce a number of spots due to blemishes on any one of a number of surfaces within the image orthicon. Blemishes, for example, can occur on the photocathode, on the target, or on the first dynode of the multiplier stages. Unfortunately, it is not always possible to eliminate these spots completely but they should not be of a nature as to be particularly objectionable in the transmitted picture. Also, it is normal for these spots to appear in their worst fashion when the various electrodes are off the operating point. Therefore, blemishes should be assayed when the picture itself is in best focus.

TARGET DRIVE ADJUSTMENT

Next to setting the proper alignment current, the most important adjustment is the target-drive potential. Balancing the capabilities of the image orthicon against the best possible performance, this value has been set at plus 2 volts from cutoff. Most of the new cameras have calibrating voltages built in so that you will be able to set this 2-volt drive very easily. Also a great many of the old cameras have been revised to include it because television station operators have found it to be of great advantage to them. In certain cases where lighting is exceptionally flat, it may be possible to drive the target above 2 volts and benefits by the increased signal-to-noise ratio and better gray scale that will result. In other cases, pickup conditions may be very adverse so that it will be necessary to drop the target drive to about 1.8 volts. However, these are exceptional conditions and should be employed only when the operating conditions warrant it.

It has been noted that under normal conditions most experienced operators automatically select a target drive of two volts to get the best picture, confirming to some extent our recommendations. This might raise the question as to why television stations find the calibrating voltage desirable. The answer is that even though experienced men are setting up the tube, they will on occasion be setting up new tubes with which they are not familiar. The calibrating voltage is very useful in these instances in setting the target drive and eliminates one more variable control that the operator needs to worry about. You will also find that it may be necessary on occasion to train new men to operate image orthicon cameras. When this happens it is very difficult to impart in a few minutes the experience and skill necessary to set the target at the proper operating point. However, it is no problem at all to instruct them in the use of the calibration voltage.

CORRECT SCAN SIZE

So far the alignment and target settings have been emphasized as the most important adjustments on the image orthicon. This is very true in the individual setup. However, for the long haul, an equally important setting is the correct scan size on the target. This means that the rectangular scan area traversed by the beam should be circumscribed by the circular rim of the target and all four corners of the raster should strike this boundary. This setting can be most easily made by increasing the deflecting power so that the circular rim of the target is clearly visible in the picture, and then focusing the RTMA test chart which has a 4 x 3 aspect ratio onto the target so that all four corners strike the rim of the target. When this has been accomplished the sweeps can then be pulled in so that the edges of the test chart coincide with the raster on the monitor kinescope. Thus the operator can be sure of making use of the full target area.

This precaution is very well known to anyone who has used image orthicons for an appreciable period of time because some of them have learned about it the hard way. For example, it is entirely possible for a station to receive an image orthicon that will produce a picture which is completely satisfactory even though the tube is underscanned. However, if the tube is used in this manner for very long its performance will fall off very rapidly. The tube will become low in resolution, the picture will become very noisy, and it will tend to stick abnormally in a very short time. When this happens there is no way the station can improve the performance of the tube. If the sweeps are expanded to make use of the full target area and recover lost tube performance in this manner, the operator will find that the small area that has already been scanned by the beam will be appreciably darker than the rest of the target. Consequently, there will be a very heavy white border around any picture which he tries to generate from the larger normal area of the tube. When this happens it is usually not possible to put such a picture on the air and we as a manufacturer can make no recommendation for restoring the uniform surface to the target. To protect themselves against this situation you will find most TV station personnel overscanning the target during standby periods so that they can pull the sweep into just exactly the right position each time they go on the air. In this way they can avoid underscanning the target and reducing the life of the tube as a result of such underscan.

FOCUSING-COIL CURRENT

As a final recommendation in the operation of the image orthicon, it is advisable to keep the field current in the focusing coil constant at about 75 milliamperes. Varying the field current within small limits will not appreciably affect the quality of the picture generated and will only necessitate the resetting of almost every control in the image orthicon. Therefore, from the standpoint of maintaining standard conditions a definite field current should be selected and maintained for all image orthicons. If the main field current is reduced below about 70 milliamperes there will be a very noticeable drop in resolution and sharpness in the image orthicon. On the other hand, increasing the field current above 75 milliamperes will not appreciably improve picture quality because the full capabilities of the image orthicon are already being used. Under these conditions it becomes necessary to supply more deflecting power to scan the full target area and no compensating benefits from improved picture quality are obtained. It is recommended that some value of field current in the neighborhood of 75 milliamperes be selected and maintained in all cameras for all image orthicons without deviation.

CONCLUSION

In conclusion, let us review very briefly the significant points in setting up and operating image orthicons.

No. 1 - Remember the new type 5820 image orthicon has much higher sensitivity than earlier types. Be careful therefore, not to apply too much light to the tube and be prepared to use neutral-density filters outdoors where the ambient illumination is very intense.

No. 2 - Have faith in the tube's spectral response. Thus, if tubes do not seem to match or to reproduce the scene as the eye sees it, look for differences in target drive, camera angle, or iris settings as they may affect the transfer curve, because one of these is more likely to be responsible for differences in half-tone reproduction than differences in the photocathode itself.

No. 3 - Transfer curves among different tubes are also very nearly alike. So again, if you have difficulty matching tubes of the same type, look for differences in target drive or lens opening to explain this mismatch rather than to inherent differences in the gray scale of image orthicons. However, first make sure that the tubes compared have had comparable hours of life. Remember especially not to set position on the transfer curve by using the same lens stop for different tubes because tubes do not usually have exactly the same sensitivity. The more sensitive tubes will, therefore, require less illumination than the less sensitive tubes to be driven to the same point on their characteristic curves.

No. 4 - If you decide to use the 5826 be sure to use it under conditions that make full use of its advantages. Also, even under controlled conditions expect the 5826 to be more critical in adjustment and to require more attention in operation to obtain its better performance.

No. 5 - Keep target heaters off unless it is a very cold day when they are essential to maintain the target temperature in the operating range. Otherwise, you will be taking an unnecessary chance of accidentally damaging the tube.

No. 6 - Make sure that the alignment of each image orthicon is perfect when you are using it for television pickup. Do not try to compensate for possible maladjustment of other elements by throwing the alignment off. In this instance, as surely as it applies to everything else, two wrongs cannot possibly make a right.

No. 7 - Be sure to make use of the target-drive calibrating voltage so as to obtain the full capabilities of the tube.

No. 8 - Be sure to use the proper beam focus loop to realize best performance from the image orthicon. On new cameras or new tubes it is often advisable to put a VoltOhmyst* on the potentiometer supplying this voltage to make sure that you are operating in the correct voltage range.

No. 9 - Scan the full target area always. Remember that once the tube is used for an appreciable length of time with the target under-scanned it will no longer be possible to recover the normal performance of the tube simply by setting proper scan size.

No. 10 - Keep the focusing-coil field current fixed at some predetermined value. Experimenting with different values won't help obtain an improvement in the image orthicon picture. Using a fixed value makes it easier to establish and maintain correct values for the other adjustments.

These ten cardinal points of operating procedure constitute the most significant characteristics and adjustments that must be observed in obtaining good image orthicon service and performance. If you follow all these instructions very carefully, your pictures can be the very best the image orthicon and the associated electronic equipment are capable of producing.

*Registered trademark

3F856 A

1850-A

ICONOSCOPE

RCA-1850-A is a television camera tube recommended particularly for pickup from motion-picture film or slides. It requires a steady highlight illumination of 4 to 6 foot-candles on the mosaic for slides and an average value of pulsed highlight illumination of 10 to 20 foot-candles for motion-picture film.

The photosensitive mosaic of the 1850-A is characterized by a spectral response having good sensitivity over the entire visible spectrum. Maximum sensitivity occurs in the blue region as shown by the spectral-response curve in Fig.1.

The 1850-A has a very high ratio of signal to noise but relatively low sensitivity. In applications where higher sensitivity is desired, as in outdoor and studio live pickups, the use of an image orthicon is recommended.

DATA

General:

Heater, for Unipotential Cathode:		
Voltage (AC or DC)	6.3 ± 10%	volts
Current	0.6	ampere
Direct Interelectrode Capacitances (Approx.):		
Grid No.1 to All Other Electrodes	6.5	μμf
Signal Electrode to Grid No.4 (With external shield)	10	μμf
Mosaic, Photosensitive:		
Response		See Fig.1
Useful Size of Rectangular Image (4 x 3 Aspect Ratio)		5.75" max. diagonal
Focusing Method		Electrostatic
Deflection Method		Magnetic
Deflection Angle (Approx.)		55°
Max. Width of Mounted Tube		8-1/8"
Height of Mounted Tube		10-3/16" ± 3/4"
Depth of Mounted Tube		12-13/16" ± 3/4"
Caps (Two)		Medium (JETEC No.C1-5)
Base		Long Medium-Shell Small 6-Pin
Mounting Position		Mosaic in vertical plane
Minimum Deflecting-Coil Inside Diameter		1-1/2"
Maximum Deflecting-Coil Length		2-1/4"

Maximum Ratings, *Absolute Values*:

AVERAGE MOSAIC ILLUMINATION•	50 max.	ft-c
OPERATING TEMPERATURE OF BULB AT LARGE END OF TUBE	40 max.	°C
SIGNAL-ELECTRODE VOLTAGE	1200 max.	volts
GRID-No.4 (COLLECTOR) VOLTAGE	1200 max.	volts
GRID-No.3 VOLTAGE	450 max.	volts
GRID-No.2 VOLTAGE	1200 max.	volts

Maximum Ratings, ***Absolute Values (Cont'd):***

GRID-No.1 VOLTAGE:		
Negative bias value	125 max.	volts
Positive bias value	0 max.	volts
PEAK HEATER-CATHODE VOLTAGE:		
Heater negative with respect to cathode	125 max.	volts
Heater positive with respect to cathode	10 max.	volts
GRID-No.4 CURRENT	0.5 max.	μamp

Typical Operation and Characteristics:

Signal-Electrode Voltage	1000	volts
Grid-No.4 Voltage	1000	volts
Grid-No.3 Voltage (Beam Focus)-- 24% to 36% of Grid-No.4 Voltage	240 to 360	volts
Grid-No.2 Voltage	1000	volts
Max. Grid-No.1 Voltage for Pattern Cutoff-- 7% of Grid-No.4 Voltage	-70	volts
Grid-No.4 Current (With no illumination on mosaic)*	0.1 to 0.2	μamp
External Load Resistance	0.1	megohm
Illumination on Mosaic:		
Steady Highlight Value for Slides	4 to 6	ft-c
Average Pulsed Highlight Value for Motion-Picture Film	10 to 20	ft-c
Ratio of Peak-to-Peak Highlight Video-Signal Current to RMS Noise Current (Approx.)	100	
Minimum Peak-to-Peak Blanking Voltage	20	volts
Deflecting-Coil Current (Approx.):**		
Horizontal (Peak to peak)	600	ma
Vertical (Peak to peak)	140	ma

Maximum Circuit Values:

Grid-No.1-Circuit Resistance	1.0 max.	megohm

● Averaged over any interval of 1 sec. max.
* Allowance should be made for leakage currents.
** For RCA Deflecting Yoke Type No.201D76.

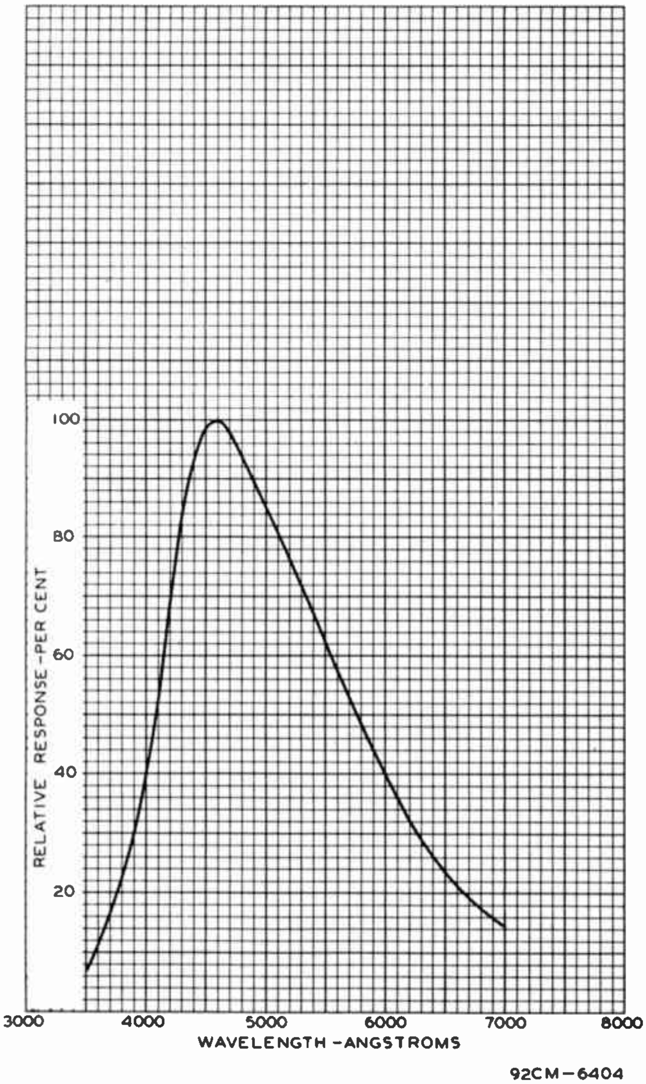


Fig. 1 - Spectral Sensitivity Characteristic of Type 1850-A Mosaic. Curve is taken for Equal Values of Radiant Flux at All Wavelengths.

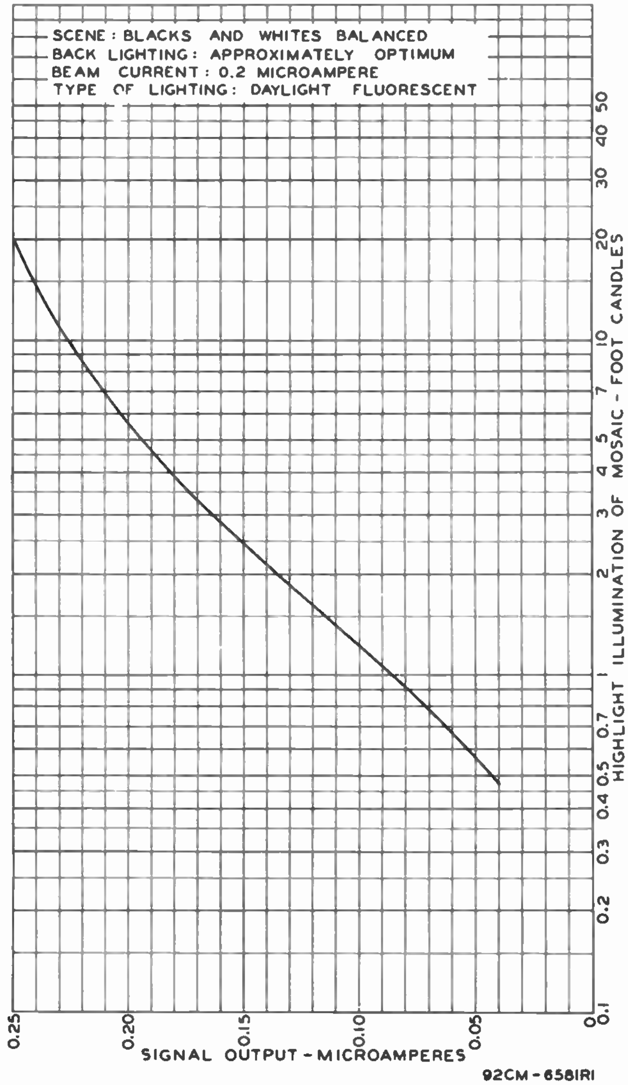
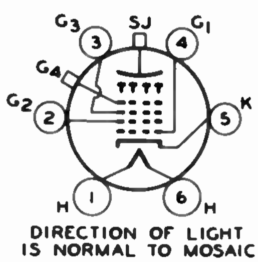


Fig. 2 - Typical Signal-Output Characteristic of Type 1850-A Under Continuous Illumination.

SOCKET CONNECTIONS

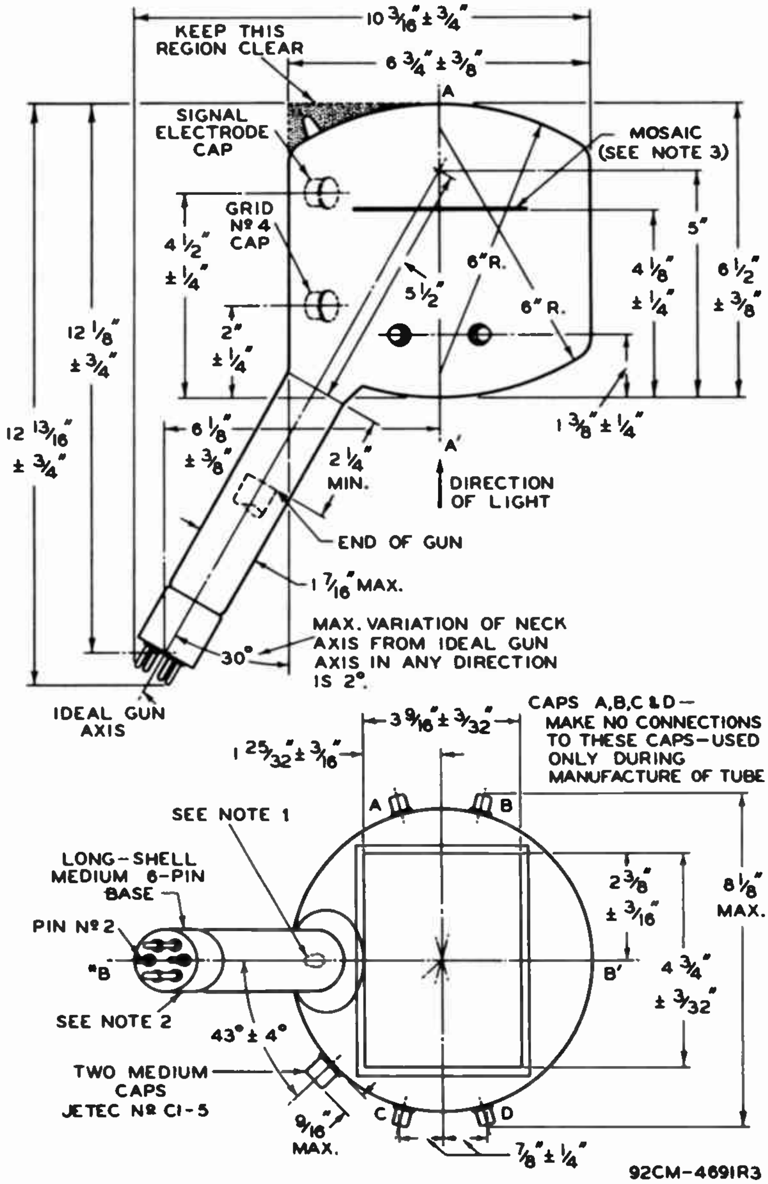
Bottom View

PIN 1 - HEATER
PIN 2 - GRID No. 2
PIN 3 - GRID No. 3
PIN 4 - GRID No. 1
PIN 5 - CATHODE



PIN 6 - HEATER
CAPS {SEE OUTLINE DRAWING
S_J - SIGNAL ELECTRODE
G_4 - GRID No. 4 (COLLECTOR)

DIMENSIONAL OUTLINE



* BB' IS THE PLANE THROUGH THE BULB AXIS AA' AND THE IDEAL GUN AXIS.

NOTE 1: VARIATION OF TIP CENTER FROM PLANE BB' IS 1/2".

NOTE 2: MAXIMUM ROTATION OF LINE THROUGH PINS 2 AND 5 ABOUT IDEAL GUN AXIS IS ± 10°, MEASURED FROM PLANE BB'.

NOTE 3: DEVIATION OF PLANE OF MOSAIC FROM PLANE PERPENDICULAR TO THE BULB AXIS AA' IS 2.5° MAX. ROTATION OF MOSAIC ABOUT THE BULB AXIS AA' WITH RESPECT TO A LINE OF INTERSECTION FORMED BY MOSAIC PLANE AND PLANE BB' IS 2.5° MAX.

Custom-Built
MONOSCOPE
RCA-1699

TUBE DEPARTMENT
RADIO CORPORATION OF AMERICA, HARRISON, NEW JERSEY

1699-7-48
Photolithographed in U. S. A.

Pattern No. 1

1699
CUSTOM-BUILT MONOSCOPE

Electrostatic Focus
Magnetic Deflection

Individually Styled Pattern

5"-Diameter Bulb
12-1/2" Length

TENTATIVE DATA

RCA-1699 is a monoscope like the RCA-2F21 except that its pattern is individually styled to customer requirements. It is intended primarily for use by television stations in providing a video signal of a specific pattern for station identification or for other purposes, such as television receiver installation and adjustment. The 1699 can also be used by equipment manufacturers to provide a local video signal for testing television receivers, but unless a custom pattern is desired, the 2F21 is recommended for such service.

Three stock designs of patterns intended to meet the requirements of television stations are shown in this bulletin. These designs are graduated in complexity to permit choice as to degree of test data to be transmitted, and provide a variety of area arrangements into which call letters, location, channel number, and insignia of a station can be inserted. The patterns are designed with due consideration of the limitations of the scanning process. For example, the scanning spot has finite size and obviously can not resolve detail smaller than its own dimension. This limitation establishes a minimum element size on the pattern electrode itself in the order of 0.0045 inch for critical testing work.

Monoscope patterns provide for measurement of the resolution capability of a television system. Measurement along a horizontal line is made with vertical wedges or bar devices, and measurement along a vertical line is made with horizontal wedges. The wedges generally have their highest resolution calibration nearest the center of the pattern, and their lowest near the pattern boundary.

Other devices found to be useful in monoscope patterns are (1) circles and lattices for revealing faulty scanning distribution, (2) lines at 45° across the pattern area for checking deflection distribution, (3) long wide horizontal bars for revealing trailing caused by improper circuit compensation, and (4) tone scales for testing amplitude distortion of the video signal, and for adjusting the background level of the picture at the receiver.

PATTERN No. 1

Pattern No. 1 is designed for maximum simplicity and provides a large open area for station information. A suggested arrangement for call letters, location, and channel number of the station is shown.

The group of circles at the center of the pattern consists of an inner series which indicate a resolution capability of 350 lines, and an outer series for indicating 250 lines.

Three tone scales are provided in the group of concentric circles at either side of the central group of circles. The shadings progress from the outer series of circles to the bull's-eye (100% black) of each group and have values of 25%, 50%, and 75% black.

The large circle enclosing the three groups of circles and the two outside arcs provide a test for linearity of scanning. Small departures from linearity cause easily noticeable distortion of the circle and the arcs. The aspect ratio of the pattern and the ratio of the radius for the large circle (outside edge) to the radius for either arc (outside edge) is 3:4.

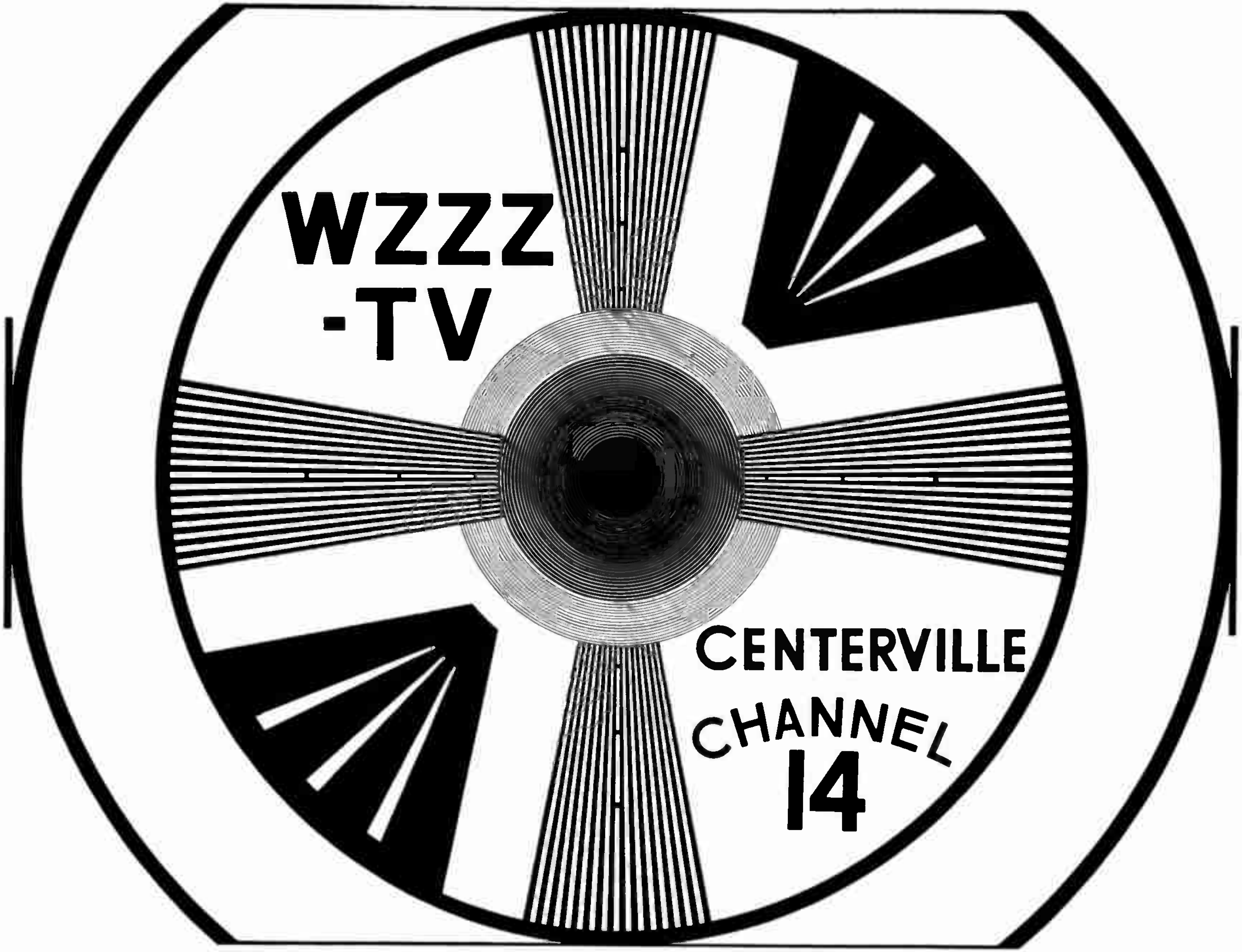
PATTERN No. 2

Pattern No. 2, with a typical arrangement of station call letters, location, and channel number, offers more test features than Pattern No. 1.

The four calibration wedges provide a measure of resolution from 150 to 350 lines. The outer end of each wedge, the three black dots in the center spacing of each wedge, and the inner end of each wedge are calibration points for 150, 200, 250, 300, and 350 lines, respectively.

Three tone scales with shadings of 25%, 50%, and 75% black are provided in the group of concentric circles at the center of the pattern. The bull's-eye is 100% black.

Black solid wedges have been inserted in the upper right and lower left corners to provide



Pattern No.2

for a more accurate 50% black adjustment. These wedges may be removed if desired to provide more space for station information.

The large circle enclosing the wedges and the two outside arcs provide a test for linearity of scanning as explained under Pattern No. 1.

PATTERN No. 3

Pattern No. 3 is the same as that supplied in the RCA-2F21 Monoscope except that the Indian head has been deleted to provide space for station call letters, location, channel identification, and other information. A typical arrangement of such information for a hypothetical station is shown in the pattern.

This pattern is designed especially for critical testing and is, therefore, not intended for use in connection with general television broadcasting. The present state of the television art utilizing 4.5-megacycle separation of audio and video carrier frequencies, permits the practical transmission and reception of only about 350 lines resolution. Hence, use of this pattern with its 500-line calibration for general television broadcasting will unnecessarily emphasize the limited resolution capability of present television equipment. This pattern, however, can be used to advantage in testing picture tubes, television receivers, and associated television equipment in a closed system such as is used in a laboratory or in a factory-production testing line.

The six concentric circles at the center (30) of the pattern have the same radial spacing as would exist between 300 horizontal lines equally spaced in the vertical dimension of the pattern. If these circles can be reproduced separate and distinct by a television receiver, it is capable of resolving 300-line detail.

Four resolution wedges are provided in the central portion of the pattern. Each of the wedges has variable line spacing. The upper vertical wedge varies in spacing from 350 lines at the outer end to 500 lines at the inner end, while the right-hand horizontal wedge varies in spacing from 300 lines at the outer end to 500 lines at the inner end. Intersection by extension of the concentric arcs designated as 35 and 45 with the wedges marks the linear distances from center along the radii of each wedge at which the line spacing is equivalent to 350- and 450-line detail, respectively. The lower vertical wedge and the left-hand horizontal wedge vary from 150 lines at their outer ends to 350 lines at their inner ends. The arcs designated as 20 and 30, when extended to intersect the wedges, mark the linear distances from center along the radii of each wedge at which the line spacing is equivalent to 200- and 300-line detail.

It is to be noted that when the reproducing equipment is capable of resolving vertically a number of lines comparable with the number of scanning lines, a spurious diamond-shaped pattern appears in the reproduction of the horizontal wedges. This spurious pattern is made up of the intersections of wedge lines with scanning lines, and does not indicate a defect in the reproducing equipment.

Two tone-scale wedges, whose common axis is at 45° to the horizontal, are provided in the central portion of the pattern. Each wedge has three shaded sections. The shading of the sections, from outer end to inner end of each wedge, is approximately 25%, 50%, and 75% black. These wedges provide a test for amplitude distortion of the video signal when calibrated against a known standard signal, and facilitate adjustment of the picture-background control to give proper tone values.

Two vertical rows of small rectangles, one to the right and one to the left of the central wedges, are useful in testing for undesired transients, such as "trailing" which is sometimes shown up more clearly by the rectangles than by the wedges. In the row to the right, the number 50 above the top rectangle indicates that this rectangle has a width equal to 1/50 of the pattern height, and, therefore, provides a test of a receiver's ability to reproduce 50-line detail. The other rectangles in this row have successively narrower widths to provide for testing in steps of 25 lines up to 300-line detail. In the row to the left, the rectangles provide for testing in successive 25-line steps from 325 lines to 575 lines.

The set of 11 horizontal lines below the central wedges provides a test for frequency response at the low end of the video band. Trailing in the reproduction of these lines usually indicates improper adjustment of low-frequency compensating circuits. The lines vary logarithmically in length. The ratio of the lengths of any two adjacent lines is approximately equal to the square root of 2. The shortest line has a length 1/50 of the pattern height, and the longest line is 1/1.5 times the height.

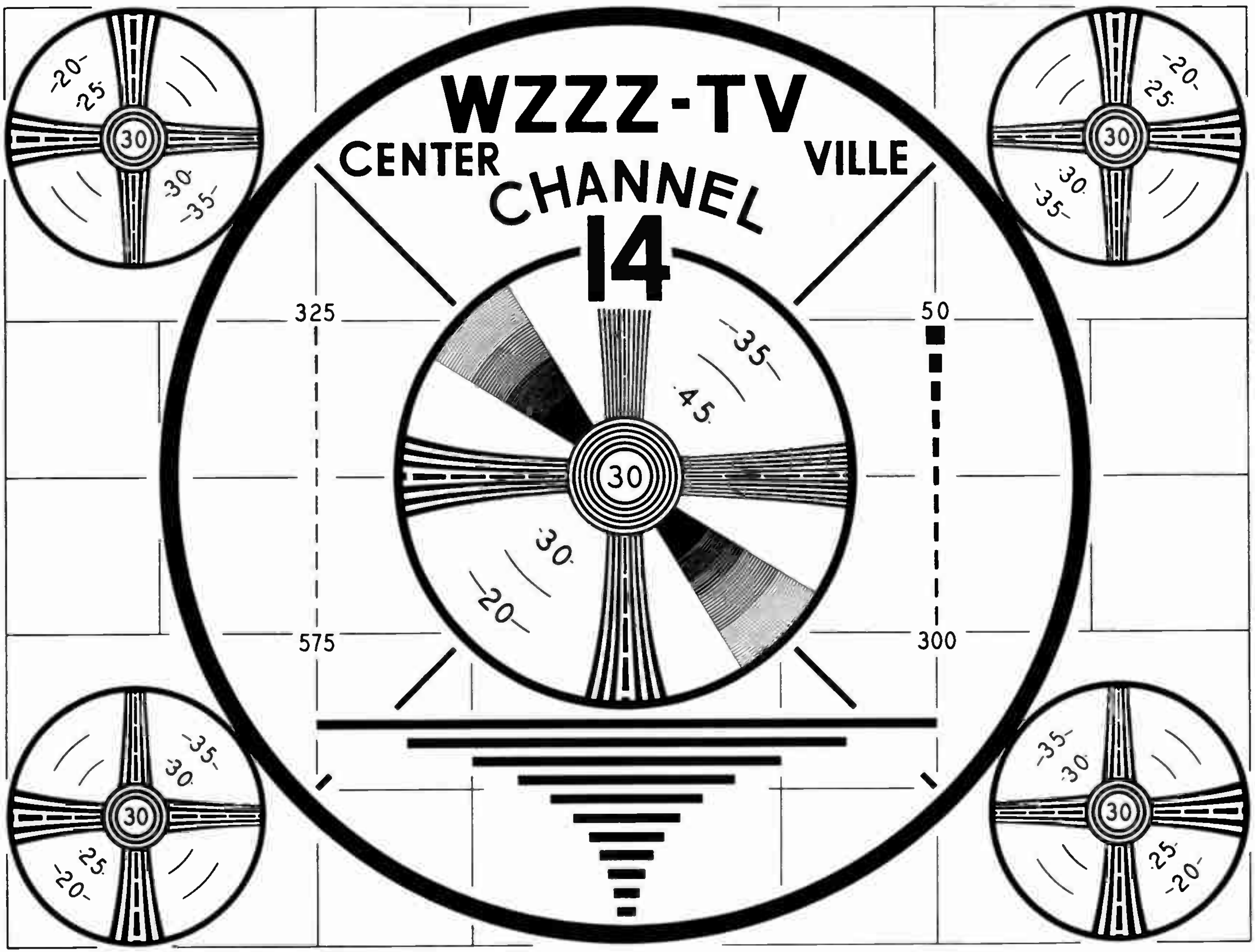
The two concentric circles enclosing the central wedges provide a test for linearity of scanning. Small departures from linearity cause easily noticeable distortion of these circles.

The 45° lines in the large circle and the equal squares into which the pattern is divided also provide a test for linearity of scanning. The fine lines which form these squares have a width of about 1/500 of the pattern height.

The four corners of the pattern contain resolution wedges which provide a test for spot defocusing. Resolution of less detail in a corner than in other parts of the pattern is an indication that the scanning spot is defocused in that corner. Some defocusing in the corners is to be expected even with proper receiver adjustment.

ADAPTING STOCK PATTERNS TO INDIVIDUAL REQUIREMENTS

When choice has been made of one of the above three stock patterns, a sketch showing as



Pattern No.3

accurately as possible the size and placement of desired call letters, station location, channel number, etc., to be inserted in the basic design should be submitted with order. Portions of the basic design of each of the three patterns may be eliminated if the space gained thereby is desired for some other purpose, but wedges, shaded areas, and large circles can not be relocated in the basic designs.

It is strongly recommended that the height of letters employed in the sketch be not less than 1/4 inch for the scale in which the accompanying patterns are shown. Also, it is important that the amount of copy to be inserted be held to a minimum for most satisfactory results. The smallest detail in the rectangle shall not be less than 1/500 of the rectangle height on the basis of 500-line resolution, if that detail is to appear in the monitor picture. Since present-day television broadcasting permits the practical transmission and reception of only about 350 lines resolution, the smallest detail shall not be less than 1/350 of the rectangle height in a pattern having 350-line resolution capability for general television use.

CUSTOM PATTERNS

Custom patterns incorporating designs other than the basic designs of Patterns No.1, No.2, and No.3, will be prepared on order for use in the 1699. A dimensional sketch of any proposed design should be submitted for approval as to its suitability for execution. Pattern designs must conform to the following requirements.

1. The rectangular pattern area to be scanned shall have an aspect ratio of 3:4. The boundaries of the rectangle shall be indicated by (a) complete perimeter lines, (b) partial perimeter lines, or (c) corner index lines. When boundary lines are not desired in the monitor picture, notation to that effect should accompany the sketch.
2. The sense of the sketch shall be the same as that intended for the monitor picture, i.e., (a) any legible matter shall read correctly when directly viewed, and (b) areas to appear black shall be black and areas to appear white shall be white.

   Patterns made in the above sense are for monoscopes to be operated in monoscope cameras with an odd number of video amplifier stages, such as the RCA Monoscope Camera TK-1A, or in iconoscope cameras for film pickup with an odd number of video amplifier stages.

   In case the monoscope equipment has an even number of video amplifier stages, the sketch of the desired pattern shall nevertheless be prepared as indicated in requirement (2) but shall carry notation that pattern is for monoscope to be used with an even number of video stages. The blacks and whites will then be reversed photographically during the manufacture of the monoscope pattern.
3. The smallest detail in the rectangle shall not be less than 1/500 of the rectangle height on the basis of 500-line resolution, if that detail is to appear in the monitor picture. Since present-day television broadcasting permits the practical transmission and reception of only about 350 lines resolution, the smallest detail shall not be less than 1/350 of the rectangle height in a pattern having 350-line resolution capability for general television use.
4. Shading tones shall be limited to three, and shall be 25%, 50%, and 75% black. They shall, in general, be restricted in area to a small percentage of the pattern area and shall be placed within an area described by an imaginary circle whose center is at the center of the pattern area and whose diameter is equal to the pattern height. The lines and spaces forming a tone scale may be curved or straight. For each desired tone scale, the percentage black should be indicated on the sketch.

   NOTE: The line and space widths used to create shaded effects must be carefully determined as to dimensions so that the resolving capability of the scanning beam in relation to line or space width results in the approximate shading tone desired. When the line and space widths are properly determined, they can be seen in the monitor picture on close viewing, but at normal viewing distances, they appear to merge to give a half-tone effect. Because of the limitation imposed by the relation between beam size and element size needed to form shaded tones, the use of conventional half-tone screens is not feasible for producing gray tones in monoscope patterns.

DATA

General:

Heater, for Unipotential Cathode:		
Voltage (AC or DC)	6.3	volts
Current	0.6	ampere
Direct Interelectrode Capacitances:		
Grid No.1 to All Other Electrodes	7	μμf
Pattern Electrode to Grid No.4	5	μμf
Pattern:		
Type		Custom
Dimensions		2.25" x 3"
Calibration		Up to 500 lines
Focusing Method		Electrostatic
Deflection Method		Magnetic
Deflection Angle (Approx.)		40°
Overall Length		12-7/16" + 1/4" - 7/16"
Greatest Diameter of Bulb		5-1/16"
Caps (Two)		Recessed Small Ball
Base		Long Medium-Shell Small 6-Pin
Mounting Position		Any

Maximum Ratings, *Design-Center Values*:

PATTERN-ELECTRODE VOLTAGE	1500 max.	volts
GRID-No.4 (COLLECTOR) VOLTAGE	1500 max.	volts
GRID-No.3 (FOCUSING ELECTRODE) VOLTAGE	600 max.	volts
GRID-No.2 (ACCELERATING ELECTRODE) VOLTAGE	1600 max.	volts
GRID-No.1 (CONTROL ELECTRODE) VOLTAGE:		
Negative bias value	125 max.	volts
Positive bias value	0 max.	volts
Positive peak value	2 max.	volts
PEAK HEATER-CATHODE VOLTAGE:		
Heater negative with respect to cathode	125 max.	volts
Heater positive with respect to cathode	125 max.	volts

Typical Operation:**

Pattern-Electrode Voltage.	1000	volts
Grid-No.4 Voltage.	1050	volts
Grid-No.3 Voltage for Focus at grid-No.4 current of 0.5 microamp # . .	300 approx.	volts
Grid-No.2 Voltage.	1000	volts
Grid-No.1 Voltage for Visual Cutoff on monitor ##. . .	-50 approx.	volts
Internal Resistance Between Grid No.4 and Pattern Electrode. .	Greater than 1 megohm	
Grid-No.4 Current.	0.5 approx.	µamp
Pattern-Electrode Signal Current (Peak to peak). .	0.3 to 0.7	µamp
Resolution Capability°°.	500	lines

Maximum Circuit Value:

Grid-No.1-Circuit Resistance	1.5 max.	megohms

Component:

Deflecting Yoke.	RCA Type No. 201D77

** Deflection must be maintained at all times. When scanned area does not cover entire pattern, the beam current should be reduced accordingly and time of operation limited to prevent damaging the pattern.

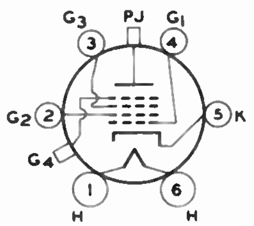
Individual tubes may require between +20% and -20% of this value.

Supply should be adjustable between +40% and -80% of this value.

°° With full scanning.

SOCKET CONNECTIONS

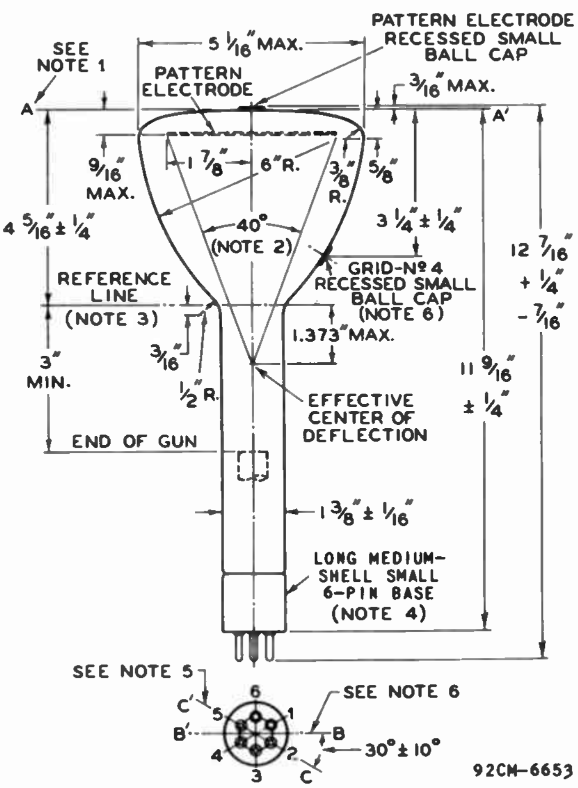
Bottom View



6BV

PIN 1: HEATER
PIN 2: GRID NO.2
PIN 3: GRID NO.3
PIN 4: GRID NO.1
PIN 5: CATHODE
PIN 6: HEATER
END CAP: PATTERN ELECTRODE
SIDE CAP: GRID NO.4

DIMENSIONAL OUTLINE



NOTE 1: LINE AA' IS PERPENDICULAR TO THE AXIS OF THE TUBE AND INTERSECTS THE FACE CONTOUR 1/2" FROM THE AXIS OF THE TUBE.

NOTE 2: DEFLECTION ANGLE BETWEEN DIAGONALLY OPPOSITE CORNERS OF PATTERN.

NOTE 3: REFERENCE LINE IS DETERMINED BY POSITION WHERE GAUGE 1.438" ± .003" I.D. AND 2" LONG WILL REST ON BULB CONE.

NOTE 4: ℄ OF BULB WILL NOT DEVIATE MORE THAN 2° IN ANY DIRECTION FROM THE PERPENDICULAR ERECTED AT THE CENTER OF THE BOTTOM OF THE BASE.

NOTE 5: MINOR AXIS OF PATTERN ELECTRODE MAY VARY FROM PLANE CC' THROUGH PIN 2 AND TUBE AXIS BY 10°. TOP EDGE OF PATTERN IS ON SAME SIDE OF TUBE AS PIN 5.

NOTE 6: BB' INDICATES PLANE THROUGH TUBE AXIS AND GRID-NO.4 TERMINAL.

RCA INTERCHANGEABILTY DIRECTORY

OF NON-RECEIVING ELECTRON TUBES

- Vacuum Power Tubes
- Thyratrons
- Vacuum and Gas Rectifiers
- Ignitrons
- Cold-Cathode (Glow-Discharge) Tubes
- Phototubes
- Ocillograph Tubes
- Camera Tubes and Monoscopes
- Special Tubes

RADIO CORPORATION of AMERICA
TUBE DEPARTMENT HARRISON, N. J.

Form ID-1020

RCA Interchangeabilty Directory

This Interchangeability Directory of non-receiving electron tubes has been prepared to assist distributors, dealers, servicemen, broadcast stations, and individual users in selecting the proper RCA tube type as a replacement.

Listing 1600 type designations, this Directory covers Vacuum Power Tubes, Vacuum and Gas Rectifiers, Thyratrons, Ignitrons, Cold-Cathode (Glow-Discharge) Tubes, Phototubes, Oscillograph Tubes, Camera Tubes, and Special Types.

In using this Directory, note that the basic type designations of different manufacturers may have been assigned according to different systems. Some basic designations consist only of a number; others consist of a combination of letters and digits. In either case, the basic designation may or may not have a prefix composed of one or more letters, such as EL, GL, WL, WT, F, ML, UE, etc., which indicates the particular manufacturer. In certain cases, this prefix becomes an essential part of the type designation when as sometimes happens, two or more manufacturers utilize the same basic designation for different tube types.

Identifying information about the **Type To Be Replaced** including the manufacturer's prefix, if any, the basic type designation in bold face, symbol to designate the manufacturer, and symbol to indicate class of tube is charted in the first four columns. The next two columns show the **RCA Direct Replacement Type,** or the RCA Similar Type, respectively, when one or the other is available.

Basic designations shown in Column 2 of the tabulation are listed in numerical-alphabetical sequence. Those starting with a digit are given first; those starting with a letter appear at the end of the tabulation.

How to Use

1. Look in Column 2 for basic designation of type to be replaced.

2. If type to be replaced has a prefix, look for that prefix in Column 1.

For example: If type FG-17 is to be replaced, find the basic designation 17 in Column 2 and the prefix FG in Column 1.

For example: If type WT-T-106 is to be replaced, find the basic designation T-106 in Column 2 and the prefix WT in Column 1.

3. Consult Column 5 for corresponding **RCA Direct Replacement Type.**

4. If no Direct RCA Replacement Type is shown, consult Column 6 for RCA Similar Type. Such a type usually is not directly interchangeable with the type to be replaced but can be substituted provided space permits and relatively minor changes are made in the socket, the cathode voltage, or in circuit adjustments.

Litho in U.S.A. 5-50

1	2	3	4	5	6
Type To Be Replaced				Replace by RCA Type*	Similar RCA Type†
Mfr. Prefix	Basic Designation	Mfr.	Tube Class		
	1B59/ 1130B	S	G		
	1C/3B22	E	R		
	1C21	RCA	G	1C21	
	1D21/ SN4	S	G		
	1P21	RCA	P	1P21	
	1P22	RCA	P	1P22	
	1P28	RCA	P	1P28	
	1P29	RCA	P	1P29	
GL	1P29	GE	P	1P29	
WL	1P29	WL	P	1P29	
	1P32	C	P	927	
	1P37	RCA	P	1P37	
GL	1P37	GE	P	1P37	
	1P39	RCA	P	1P39	
GL	1P39	GE	P	1P39	
	1P40	RCA	P	1P40	
GL	1P40	GE	P	1P40	
	1P41	RCA	P	1P41	
	1P42	RCA	P	1P42	
CE	1V(A-D)	CE	P		917, 919
CE	1(A-D)	CE	P	868, 918	
	2AP1	RCA	CR	2AP1-A	
	2AP1	S	CR	2AP1-A	
GL	2AP1-A	GE	CR	2AP1-A	
	2BP1	RCA	CR	2BP1	
	2BP1	S	CR	2BP1	
	2BP11	RCA	CR	2BP11	
	2BP11	S	CR	2BP11	
	2B4	D	T	885	
GL	2B22	GE	VPT		559
GL	2B23	GE	VPT		
	2C21/ 1642	RCA	VPT	2C21/ 1642	
	2C22	RCA	VPT	2C22	

1	2	3	4	5	6
Type To Be Replaced				Replace by RCA Type*	Similar RCA Type†
Mfr. Prefix	Basic Designation	Mfr.	Tube Class		
	2C33/ RX233A	R	T		
	2C36	S	VPT		
	2C37	S	VPT		
	2C39	EM	VPT		
ML	2C39	ML	VPT		
GL	2C39	GE	VPT		
	2C40	RCA	VPT	2C40	
GL	2C40	GE	VPT	2C40	
	2C43	RCA	VPT	2C43	
GL	2C43	GE	VPT	2C43	
	2C50	RK	VPT		
	2C51	WE	VPT		12AT7
	2D21	RCA	T	2D21	
	2D21	NU	T	2D21	
GL	2D21	GE	T	2D21	
WL	2D21	WL	T	2D21	
	2D21	CH	T	2D21	
CE	2V	CE	P		
CE	2(A-D)	CE	P		930, 1P40
	2E24	RCA	VPT	2E24	
GL	2E24	GE	VPT	2E24	
	2E24	RK	VPT	2E24	
	2E25	HY	VPT		2E24
	2E26	RCA	VPT	2E26	
GL	2E26	GE	VPT	2E26	
	2E26	RK	VPT	2E26	
	2E26	S	VPT	2E26	
	2E30	HY	VPT		5618
	2F21	RCA	CM	2F21	
GL	2H21	GE	VPT		
	2K26	RCA	K	2K26	
	2K56	RCA	K	2K56	
	2P23	RCA	CM	2P23	
GL	2P23	GL	CM	2P23	

* RCA types shown in this column are direct replacements under all circumstances for corresponding types to be replaced.

† RCA types shown in this column are not directly interchangeable with the types to be replaced because of mechanical and/or electrical differences. For more information as to degree of interchangeability, refer to respective tube data or write to Commercial Engineering, RCA, Harrison, New Jersey.

KEY TO SYMBOLS IN COLUMN 3

A = Amperex
CE = Continental Electric (Cetron)
CH = Chatham Electronics
D = Dumont
EE = Electronic Enterprises
EL = Electrons Inc.
EM = Eitel-McCullough (Eimac)
F = Federal Telephone and Radio
GE = General Electric
GES = General Electronics
HK = Heinz and Kaufman
HY = Hytron
ML = Machlett Laboratories
NL = National Electronics
NU = National Union
R = Rauland
RK = Raytheon
S = Sylvania
T = Taylor
TS = Tung-Sol
UE = United Electronics
WE = Western Electric
WL = Westinghouse
WT = Weltronic

KEY TO SYMBOLS IN COLUMN 4

CM = Camera Tube or Monoscope
CR = Cathode-Ray Tube
G = Glow Tube
GA = Gauge Tube
I = Ignitron
P = Phototube
R = Rectifier
RT = Receiving Tube
T = Thyratron
VPT = Vacuum Power Tube

1	2	3	4	5	6
Type To Be Replaced				Replace by RCA Type*	Similar RCA Type†
Mfr. Prefix	Basic Desig-nation	Mfr.	Tube Class		
	2X2/879	RCA	R	2X2-A	
GL	2X2/879	GE	R	2X2-A	
	2X2A	RCA	R	2X2-A	
	2X2A	RK	R	2X2-A	
	2X2A	TS	R	2X2-A	
	2X2A	NU	R	2X2-A	
	3AP1	RCA	CR	3AP1-A	
	3AP1	S	CR	3AP1-A	
	3AP1	D	CR	3AP1-A	
	3AP1-A	S	CR	3AP1-A	
	3AP1-A	D	CR	3AP1-A	
GL	3AP1-A	GE	CR	3AP1-A	
	3A4	RCA	VPT	3A4	
	3A4	TS	VPT	3A4	
	3A4	NU	VPT	3A4	
	3A5	RCA	VPT	3A5	
	3A5	TS	VPT	3A5	
	3A5	HY	VPT	3A5	
	3AP1-A	RCA	CR	3AP1-A	
	3BP1	RCA	CR	3BP1-A	
	3BP1	S	CR	3BP1-A	
	3BP1-A	RCA	CR	3BP1-A	
	3BP1-A	S	CR	3BP1-A	
GL	3BP1-A	GE	CR	3BP1-A	
WL	3B22/1C	WL	R		
	3B24	R	R		
	3B25	RCA	R	3B25	
	3B27	EE	R		836
	3B27	GES	R		836
	3B28	CH	R		866-A
	3B28	UE	R		866-A
	3B29	GES	R		
EL	3C/4B24	EL	R		
	3C21	A	VPT		838
GL	3C22	GE	VPT		
	3C23	RCA	T	3C23	
GL	3C23	GE	T	3C23	
	3C23	UE	T	3C23	
NL	3C23	NE	T	3C23	
WL	3C23	WL	T	3C23	
	3C24	EM	VPT		1623
	3C33	RCA	VPT	3C33	
	3DP1-A	RCA	CR	3DP1-A	
	3DP1-A	D	S	3DP1-A	
GL	3DP1-A	GE	CR	3DP1-A	
	3DP1-S2A	RCA	CR	3DP1-S2A	
	3D22	RCA	T	3D22	
	3D22	NU	T	3D22	
	3E22	RCA	VPT	3E22	
	3E29	RCA	VPT	3E29	
	3E29	NU	VPT	3E29	
	3FP7-A	RCA	CR	3FP7-A	
	3FP7-A	S	CR	3FP7-A	
	3JP1	RCA	CR	3JP1	

1	2	3	4	5	6
Type To Be Replaced				Replace by RCA Type*	Similar RCA Type†
Mfr. Prefix	Basic Desig-nation	Mfr.	Tube Class		
	3JP1	S	CR	3JP1	
	3JP1	D	CR	3JP1	
	3JP7	RCA	CR	3JP7	
	3JP7	S	CR	3JP7	
	3JP7	D	CR	3JP7	
	3KP1	RCA	CR	3KP1	
	3KP1	S	CR	3KP1	
	3KP11	RCA	CR	3KP11	
	3MP1	RCA	CR	3MP1	
GL	3MP1	GE	CR	3MP1	
	3MP1	S	CR	3MP1	
	3RP1	RCA	CR	3RP1	
	3RP1	S	CR	3RP1	
	3RP1-A	D	CR	3RP1	
	4B26/2000	RCA	R	4B26/2000	
	4B26/2000	NU	R	4B26/2000	
	4B32	UE	R		
GL	4C21	GE	VPT		211
	4C22	A	VPT		8005
	4C33	RCA	VPT	4C33	
	4C35	S	T		
WL	4D21/4-125A	WL	VPT	4-125A/4D21	
GL	4D21/4-125A	GE	VPT	4-125A/4D21	
	4D21	RK	VPT	4-125A/4D21	
	4E27/8001	RCA	VPT	4E27/8001	
	4E27A/5-125B	RCA	VPT	4E27A/5-125B	
	4E27A/5-125B	EM	VPT	4E27A/5-125B	
CE	4	CE	P		923
	4X100A	EM	VPT		
	4X150A	RCA	VPT	4X150A	
	4X150A	EM	VPT	4X150A	
GL	4X150A	GE	VPT	4X150A	
WL	4X150A	W	VPT	4X150A	
	4X150G	EM	VPT		4X150A
	4X500A	EM	VPT	4X500A	
	4X500A	RCA	VPT	4X500A	
WL	4X500A	WL	VPT	4X500A	
CE	4	CE	P		923
CE	4-V	CE	P		
	4-65A	RCA	VPT	4-65A	
	4-65A	EM	VPT	4-65A	
	4-125A/4D21	RCA	VPT	4-125A/4D21	
AX	4-125A	A	VPT	4-125A/4D21	
	4-125A	EM	VPT	4-125A/4D21	
	4-250A	RCA	VPT	4-250A/5D22	

Type To Be Replaced				Replace by RCA Type*	Similar RCA Type†
Mfr. Prefix	Basic Desig-nation	Mfr.	Tube Class		
1	2	3	4	5	6
AX	4-250A	A	VPT	4-250A/ 5D22	
	4-250A	EM	VPT	4-250A/ 5D22	
GL	4-250A/ 5D22	GE	VPT	4-250A/ 5D22	
	4-400A	EM	VPT		
	4-1000A	EM	VPT		
CE	5(A-D)	CE	P		927
EL	5BS/ 4B22	EL	R		
EL	5BHD/ 4B23	EL	R		
	5BP1	RCA	CR	5BP1-A	
	5BP1-A	RCA	CR	5BP1-A	
	5BP1-A	S	CR	5BP1-A	
	5BP1-A	D	CR	5BP1-A	
GL	5BP1-A	GE	CR	5BP1-A	
	5BP11-A	D	CR		
	5CP1	RCA	CR	5CP1-A	
	5CP1-A	RCA	CR	5CP1-A	
	5CP1-A	S	CR	5CP1-A	
	5CP1-A	D	CR	5CP1-A	
GL	5CP1-A	GE	CR	5CP1-A	
	5CP7	RCA	CR	5CP7-A	
	5CP7-A	RCA	CR	5CP7-A	
	5CP7-A	S	CR	5CP7-A	
GL	5CP7-A	GE	CR	5CP7-A	
	5CP7-A	D	CR	5CP7-A	
	5CP11-A	RCA	CR	5CP11-A	
	5CP11-A	S	CR	5CP11-A	
	5CP11-A	D	CR	5CP11-A	
	5FP4-A	RCA	CR	5FP4-A	
	5FP4-A	S	CR	5FP4-A	
	5FP7	RCA	CR	5FP7-A	
	5FP7-A	RCA	CR	5FP7-A	

Type To Be Replaced				Replace by RCA Type*	Similar RCA Type†
Mfr. Prefix	Basic Desig-nation	Mfr.	Tube Class		
1	2	3	4	5	6
	5FP7-A	S	CR	5FP7-A	
GL	5FP7-A	GE	CR	5FP7-A	
	5C22	S	T		
GL	5C24	GE	VPT		8000
	5D21	WE	VPT		715-C
	5D22	UE	VPT	4-250A/ 5D22	
WL	5D22	WL	VPT	4-250A/ 5D22	
	5D23/ RK65	RK	VPT		
	5R4-GY	RCA	R	5R4-GY	
	5R4-GY	RK	R	5R4-GY	
	5R4-GY	TS	R	5R4-GY	
	5R4-GY	NU	R	5R4-GY	
	5R4-GY	GE	R	5R4-GY	
	5UP1	RCA	CR	5UP1	
	5UP1	S	CR	5UP1	
	5UP7	RCA	CR	5UP7	
	5UP11	RCA	CR	5UP11	
	5WP11	RCA	CR	5WP11	
	5WP15	RCA	CR	5WP15	
	5WP15	S	CR	5WP15	
CE	5(A-D)	CE	P		927
WT	6	WT	RT	6L6	
	6AG7-Y	RCA	VPT	6AG7-Y	
	6AS6	RCA	VPT	6AS6	
	6AS6	WE	VPT	6AS6	
EL	6B	EL	R		
EL	6C	EL	R		
	6C22	F	VPT		
	6C24	RCA	VPT	6C24	
ML	6C24	ML	VPT	6C24	
	6D22	RK	VPT		
	6F4	RCA	VPT	6F4	
	6J4	RCA	VPT	6J4	

* RCA types shown in this column are direct replacements under all circumstances for corresponding types to be replaced.

† RCA types shown in this column are not directly interchangeable with the types to be replaced because of mechanical and/or electrical differences. For more information as to degree of interchangeability, refer to respective tube data or write to Commercial Engineering, RCA, Harrison, New Jersey.

KEY TO SYMBOLS IN COLUMN 3

A = Amperex
CE = Continental Electric (Cetron)
CH = Chatham Electronics
D = Dumont
EE = Electronic Enterprises
EL = Electrons Inc.
EM = Eitel-McCullough (Eimac)
F = Federal Telephone and Radio
GE = General Electric
GES = General Electronics
HK = Heinz and Kaufman
HY = Hytron
ML = Machlett Laboratories
NL = National Electronics
NU = National Union
R = Rauland
RK = Raytheon
S = Sylvania
T = Taylor
TS = Tung-Sol
UE = United Electronics
WE = Western Electric
WL = Westinghouse
WT = Weltronic

KEY TO SYMBOLS IN COLUMN 4

CM = Camera Tube or Monoscope
CR = Cathode-Ray Tube
G = Glow Tube
GA = Gauge Tube
I = Ignitron
P = Phototube
R = Rectifier
RT = Receiving Tube
T = Thyratron
VPT = Vacuum Power Tube

1	2	3	4	5	6
Type To Be Replaced				Replace by RCA Type*	Similar RCA Type†
Mfr. Prefix	Basic Designation	Mfr.	Tube Class		
	6L4	RCA	VPT	6L4	
	6SN7-GTY	RCA	VPT	6SN7-GTY	
	6Q5-G	D	T	884	
	7BP7	RCA	CR	7BP7-A	
	7BP7-A	S	CR	7BP7-A	
GL	7BP7-A	GE	CR	7BP7-A	
F	7C27	F	VPT		5762
F	7C30	F	VPT		5762
	7CP1	RCA	CR	7CP1	
	7CP1	S	CR	7CP1	
	7CP4	RCA	CR	7CP4	
	7CP4	S	CR	7CP4	
	7C24	RCA	VPT	7C24	
ML	7C24	ML	VPT	7C24	
F	7C25	F	VPT		5762
F	7C26	F	VPT		
GL	7D21	GE	VPT		
GL	7D29	GE	VPT		
	7MP7	RCA	CR	7MP7	
CE	8	CE	P		
PJ	8	GE		5556	
	8D21	RCA	VPT	8D21	
	9C21	RCA	VPT	9C21	
GL	9C21	GE	VPT	9C21	
	9C21	A	VPT	9C21	
ML	9C21	ML	VPT	9C21	
	9C22	RCA	VPT	9C22	
GL	9C22	GE	VPT	9C22	
	9C22	A	VPT	9C22	
ML	9C22	ML	VPT	9C22	
F	9C23	F	VPT		
GE	9C24	GE	VPT		
	9C25	RCA	VPT	9C25	
ML	9C25	M	VPT	9C25	
	9C27	A	VPT	9C27	
	10KP7	S	CR	10KP7	
	10-Y	RCA	VPT	10-Y	
	10-Y	S	VPT	10-Y	
BW	11	UE	VPT	834	
RK	11	R	VPT	1623	
CE	11V(A-D)	CE	P	917	
	12DP7	RCA	CR	12DP7-A	
	12DP7-A	RCA	CR	12DP7-A	
	12DP7-A	S	CR	12DP7-A	
GL	12DP7-A	GE	CR	12DP7-A	
	12K8-Y	RCA	VPT	12K8-Y	
	12L8-GT	RCA	VPT	12L8-GT	
	12L8-GT	NU	VPT	12L8-GT	
	12SW7	RCA	VPT	12SW7	
	12SX7-GT	RCA	VPT	12SX7-GT	
	12SY7	RCA	VPT	12SY7	
HV	12	UE	VPT		806
RK	12	RK	VPT		809
CE	13	CE	P		868
CE	13V	CE	P		917
EL	16B	EL	R		
EL	16F	EL	R		
DR	17	GES	R		
FG	17	GE	T	5557	
FG	17	NU	T	5557	
TT	17	T	T	5557	
	17	CH	T	5557	
CE	18	CE	P		
HV	18	UE	VPT		810
CE	20	CE	P	927	
FV	20	UE	VPT		8000
TV	20	T	VPT		810
T	20	T	VPT		1623
TZ	20	T	VPT		809
RK	20A	RK	VPT	804	
CE	21(A-D)	CE	P	920	
PJ	21	GE	VPT		5556
RX	21A	EM	R		
CE	22(A-D)	CE	P		1P41
PJ	22	GE	P		917
CE	23(A-D)	CE	P	923	
KU	23	NU	VPT		
KU	23	UE	VPT		
PJ	23	GE	P	868	
RK	23	RK	VPT		802
RK	23A	RK	VPT		802
	24-G	A	VPT		808
	24-G	GES	VPT		808
	25T	EM	VPT		
CE	25(A-D)	CE	P	927	
HY	25	HY	VPT		809
RK	25	RK	VPT	802	
RK	25B	RK	VPT	802	
	26A6	RCA	VPT	26A6	
	26A7-GT	RCA	VPT	26A7-GT	
	26C6	RCA	VPT	26C6	
	26D6	RCA	VPT	26D6	
RK	27	RK	VPT		806
FG	27A	GE	T		5559
CE	28(A-D)	CE	P	928	
RK	28	RK	VPT	803	
RK	28A	RK	VPT	803	
CE	29(A-D)	CE	P	929, 1P39	
CE	30(A-D)	CE	P	930, 1P40	
CE	30V	CE	P	925	
RK	30	RK	VPT	800	
HY	30Z	HY	VPT		809
CE	31V	CE	P		919
FG	32	GE	R	5558	
FG	33	GE	T		1904
RK	33	RK	VPT	2C21/1642	
WL	33	WL	T		

1	2	3	4	5	6
Type To Be Replaced				Replace by RCA Type*	Similar RCA Type†
Mfr. Prefix	Basic Desig-nation	Mfr.	Tube Class		
CE	34	CE	P	934	
GL	35T	GE	VPT		808
	35T	EM	VPT		808
	35TG	EM	VPT		808
CE	36(A-D)	CE	P		927
RK	36	RK	VPT		806
RK	37	RK	VPT		808
RK	38	RK	VPT		806
RK	39	RK	VPT	807	
HY	40	HY	VPT		812-A
HY	40Z	HY	VPT		811-A
T	40	T	VPT		812-A
TZ	40	T	VPT		811-A
CE	41	CE	P	921	
WL	41	WL	T		
RK	41	RK	VPT		807
CE	42	CE	P	922	
RK	44	RK	VPT	837	
RK	46	RK	VPT		804
RK	47	RK	VPT	814	
RK	48A	RK	VPT		813
UH	50	UE	VPT	834	
SR	50	WL	P		917
	51-A	HY	VPT		830-B
R	51A	RK	P	927	
HY	51B	HY	VPT		830-B
HY	51Z	HY	VPT		838
RK	51	RK	VPT		830-B
RK	52	RK	VPT		811-A
	53AWB	RK	P		927
SR	53	WL	P		917
CE	54	CE	P		
HK	54	HK	VPT		808
CE	55	CE	P	924	
T	55	NU	VPT		8005

1	2	3	4	5	6
Type To Be Replaced				Replace by RCA Type*	Similar RCA Type†
Mfr. Prefix	Basic Desig-nation	Mfr.	Tube Class		
T	55	UE	VPT		8005
T	55	T	VPT		8005
HY	57	HY	VPT		812-A
FG	57	GE	T	5559	
RK	57	RK	VPT	805	
RK	58	RK	VPT	838	
R	58A	RK	P		927
CE	59	CE	P	5581	
R	59A	RK	P	868, 918	
EL	60B	EL	R		
CE	60	CE	P		917
HF	60	A	VPT		8005
SK	60	WL	P		868
T	60	T	VPT		8005
R	60A	RK	P	920	
HY	61/807	HY	VPT	807	
R	61A	RK	P	930	
RK	63	RK	VPT		806
SK	63	W	P		918
CE	64	CE	P	5583	
RK	64	RK	VPT		807
FG	67	GE	T	1904	
HY	69	HY	VPT		1624
R	71A	RK	P		930, 1P40
R	71AV	RK	P		925
	75TH	EM	VPT		
	75TL	EM	VPT		
WL	81A	WL	T		
R	85A	RK	P		928
FP	85	GE	R		8020
	89-Y	RCA	VPT	89-Y	
CE	91R	CE	P	1P37	
FG	95	GE	T	5560	
CE	98	CE	P	5582	

* RCA types shown in this column are direct replacements under all circumstances for corresponding types to be replaced.

† RCA types shown in this column are not directly interchangeable with the types to be replaced because of mechanical and/or electrical differences. For more information as to degree of interchangeability, refer to respective tube data or write to Commercial Engineering, RCA, Harrison, New Jersey.

KEY TO SYMBOLS IN COLUMN 3

A = Amperex
CE = Continental Electric (Cetron)
CH = Chatham Electronics
D = Dumont
EE = Electronic Enterprises
EL = Electrons Inc.
EM = Eitel-McCullough (Eimac)
F = Federal Telephone and Radio
GE = General Electric
GES = General Electronics
HK = Heinz and Kaufman
HY = Hytron
ML = Machlett Laboratories
NL = National Electronics
NU = National Union
R = Rauland
RK = Raytheon
S = Sylvania
T = Taylor
TS = Tung-Sol
UE = United Electronics
WE = Western Electric
WL = Westinghouse
WT = Weltronic

KEY TO SYMBOLS IN COLUMN 4

CM = Camera Tube or Monoscope
CR = Cathode-Ray Tube
G = Glow Tube
GA = Gauge Tube
I = Ignitron
P = Phototube
R = Rectifier
RT = Receiving Tube
T = Thyratron
VPT = Vacuum Power Tube

Mfr. Prefix (1)	Basic Designation (2)	Mfr. (3)	Tube Class (4)	Replace by RCA Type* (5)	Similar RCA Type† (6)
	100R	EM	R		8020
	100TH	EM	VPT		810
	100TH	NU	VPT		810
	100TL	EM	VPT		8000
HF	100	A	VPT		8005
ML	100/5575	ML	R		
ML	102	ML	R		
ML	103	ML	R		
FG	104	GE	R	5561	
	105	RCA	T	105	
FG	105	GE	T	105	
WL	105	WL	T	105	
ML	106	ML	R		
ML	108	ML	R		
ML	110	ML	R		
	111H	A	VPT		812-A
ML	115	ML	R		
ML	120	ML	R		
HF	120	A	VPT	211	
ZB	120	A	VPT		838
F	123-A	F	VPT		806
F	124-A	F	VPT		
F	124-R	F	VPT		
HF	125	A	VPT		8005
T	125	T	VPT		810
F	127-A	F	VPT		810
F	128-A	F	VPT		851
HF	130	A	VPT		835
HF	140	A	VPT		211
GL	146	GE	VPT		805
AB	150	A	VPT		845
GL	152	GE	VPT		805
	152TH	EM	VPT		806
	152TL	EM	VPT		806
FG	154	GE	T		
HK	154	HK	VPT		808
T	155	T	VPT		806
GL	159	GE	VPT		
	172	RCA	T	172	
FG	172	GE	T	172	
WL	172	WL	T	172	
ML	200/5576	ML	R		
HF	200	A	VPT		8000
T	200	T	VPT		806
HF	200	ML	VPT		8000
DR	200	GES	VPT		
CE	202	CE	R		
CE	203	CE	R		
	203-A	RCA	VPT	203-A	
WL	203-A	WL	VPT	203-A	
GL	203-A	GE	VPT	203-A	
	203-A	NU	VPT	203-A	
	203-A	UE	VPT	203-A	
	203-A	A	VPT	203-A	
	203-A	T	VPT	203-A	

Mfr. Prefix (1)	Basic Designation (2)	Mfr. (3)	Tube Class (4)	Replace by RCA Type* (5)	Similar RCA Type† (6)
	203-H	A	VPT		203-A
	203-Z	T	VPT		838
	204-A	RCA	VPT	204-A	
WL	204-A	WL	VPT	204-A	
GL	204-A	GE	VPT	204-A	
F	204-A	F	VPT	204-A	
	204-A	UE	VPT	204-A	
	204-A	A	VPT	204-A	
CE	204-A	T	VPT	204-A	
	205D	WE	VPT		10-Y
	205E	WE	VPT		10-Y
CE	205	CE	R		
	206	CE	R		
	207	RCA	VPT	207	
WL	207	WL	VPT	207	
GL	207	GE	VPT	207	
UE	207	UE	VPT	207	
	207	A	VPT	207	
ML	207	M	VPT	207	
WT	210-0001	WT	T	2D21	
WT	210-0003	WT	T	884	
WT	210-0004	WT	T	2050	
WT	210-0005	WT	RT		
WT	210-0006	WT	RT	6H6	
WT	210-0007	WT	RT	6L6	
WT	210-0008	WT	R	866-A	
WT	210-0009	WT	RT	84/6Z4	
WT	210-0011	WT	G	0C3	
WT	210-0012	WT	RT	80	
WT	210-0013	WT	RT	5Z3	
WT	210-0014	WT	RT	5W4-GT	
WT	210-0015	WT	T	5557	
WT	210-0016	WT	G		
WT	210-0018	WT	G	0D3	
WT	210-0019	WT	RT	83	
WT	210-0021	WT	RT	6X5	
WT	210-0021	WT	RT	6X5-GT	
WT	210-0025	WT	RT	117Z6-GT	
WT	210-0027	WT	R	872-A	
WT	210-0028	WT	RT	3Q5-GT	
WT	210-0029	WT	RT	6C5	
WT	210-0030	WT	RT	6E6	
WT	210-0031	WT	CR	902-A	
WT	210-0037	WT	RT	117L7/N7-GT	
WT	210-0038	WT	T	172	
WT	210-0040	WT	RT	6X4	
WT	210-0042	WT	RT	5Y3-GT	
WT	210-0044	WT	T	575-A	
WT	210-0045	WT	VPT	892	
WT	210-0048	WT	RT	5U4-G	
WT	210-0052	WT	CR	2AP1-A	
WT	210-0053	WT	CR	3AP1-A	
WT	210-0056	WT	T	5559	

Type To Be Replaced: Mfr. Prefix (1)	Basic Designation (2)	Mfr. (3)	Tube Class (4)	Replace by RCA Type* (5)	Similar RCA Type† (6)
WT	210-0057	WT	T	5560	
WT	210-0058	WT	T	676	
WT	210-0060	WT	G	0Z4	
WT	210-0061	WT	RT	117N7/ L7-GT	
WT	210-0062	WT	T	5557	
WT	210-0067	WT	T		3C23
WT	210-0069	WT	T	5557	
WT	210-0070	WT	I	5550	
WT	210-0071	WT	I	5551	
WT	210-0072	WT	I	5552	
WT	210-0073	WT	I	5553	
WT	210-0074	WT	T	105	
WT	210-0078	WT	T	172	
WT	210-0079	WT	T	105	
WT	210-0081	WT	RT	6SJ7	
WT	210-0082	WT	RT	6V6	
WT	210-0083	WT	RT	7K7	
WT	210-0084	WT	RT	6N7	
WT	210-0084	WT	RT	6N7-GT	
WT	210-0085	WT	RT	50B5	
WT	210-0086	WT	VPT	833-A	
WT	210-0087	WT	RT	6K8	
WT	210-0087	WT	RT	6K8-GT	
WT	210-0088	WT	RT	6J5	
WT	210-0088	WT	RT	6J5-GT	
WT	210-0089	WT	RT	6G6-G	
WT	210-0090	WT	RT	6C6	
WT	210-0091	WT	G	0A4-G	
	211	RCA	VPT	211	
WL	211	WL	VPT	211	
GL	211	GE	VPT	211	
	211	NU	VPT	211	
UE	211	UE	VPT	211	
	211	A	VPT	211	
	211	T	VPT	211	
T	211C	T	VPT		835
	211C	A	VPT		835
	211D	WE	VPT	211	
	211D	A	VPT	211	
	211E	WE	VPT		835
	211H	A	VPT		211
RX	212	RK	R		
F	212E	F	VPT		
CE	213	CE	R		
	214E	WE	R		217-C
CE	215	CE	R		
RX	215	RK	R		
	217-C	RCA	R	217-C	
GL	217-C	GE	R	217-C	
	217-C	NU	R	217-C	
	217-C	UE	R	217-C	
	220C	WE	VPT		892
F	222A	F	VPT		
	Z-225/ 866A	NU	R	866-A	
	Z-225/ 866A	UE	R	866-A	
CE	225	CE	R		4B26/2000
CE	226	CE	R	4B26/ 2000	
FG	235A	GE	I	5552	
FG	235B	GE	I	5555	
	241B	WE	VPT		833-A
	242A	WE	VPT	211	
	242B	WE	VPT	211	
	242C	WE	VPT		211
WT	245	WT	T	884	
WT	246	WT	T	2050	
	248-A	WE	VPT		
	249A	WE	R		866-A
	249B	WE	R		866-A

* RCA types shown in this column are direct replacements under all circumstances for corresponding types to be replaced.

† RCA types shown in this column are not directly interchangeable with the types to be replaced because of mechanical and/or electrical differences. For more information as to degree of interchangeability, refer to respective tube data or write to Commercial Engineering, RCA, Harrison, New Jersey.

KEY TO SYMBOLS IN COLUMN 3

- A = Amperex
- CE = Continental Electric (Cetron)
- CH = Chatham Electronics
- D = Dumont
- EE = Electronic Enterprises
- EL = Electrons Inc.
- EM = Eitel-McCullough (Eimac)
- F = Federal Telephone and Radio
- GE = General Electric
- GES = General Electronics
- HK = Heinz and Kaufman
- HY = Hytron
- ML = Machlett Laboratories
- NL = National Electronics
- NU = National Union
- R = Rauland
- RK = Raytheon
- S = Sylvania
- T = Taylor
- TS = Tung-Sol
- UE = United Electronics
- WE = Western Electric
- WL = Westinghouse
- WT = Weltronic

KEY TO SYMBOLS IN COLUMN 4

- CM = Camera Tube or Monoscope
- CR = Cathode-Ray Tube
- G = Glow Tube
- GA = Gauge Tube
- I = Ignitron
- P = Phototube
- R = Rectifier
- RT = Receiving Tube
- T = Thyratron
- VPT = Vacuum Power Tube

1	2	3	4	5	6
Type To Be Replaced				Replace by RCA Type*	Similar RCA Type†
Mfr. Prefix	Basic Desig-nation	Mfr.	Tube Class		
	250R	EM	VPT		
	250TH	EM	VPT		810
DR	250TH	GES	VPT		810
	250TL	EM	VPT		806
HF	250	A	VPT		8000
	251A	WE	VPT		851
	251A	A	VPT		851
	254B	WE	VPT		865
HK	254	HK	VPT		810
	255A	WE	R		869-B
	255B	WE	R		869-B
HK	257(B)	HK	VPT	4E27/ 8001	
FG	258A	GE	I	5553	
	258B	WE	R		866-A
	258B	A	R		866-A
FG	259B	GE	I	5554	
	260A	WE	VPT		860
WT	261	WT	RT	6H6	
	261A	A	VPT		835
	261A	WE	VPT	835	
WT	262	WT	R	866-A	
WT	263	WT	R	6Z4	
F	266B	F	R		857-B
	266B	WE	R		857-B
GL	266B	GE	R		857-B
	266C	WE	R		857-B
	267B	A	R		872-A
	267B	WE	R		872-A
WT	269	WT	G	0C3	
WT	270	WT	RT	80	
WT	270X	RT	RT	5Z3	
FG	271	GE	I	5551	
WT	271	WT	RT	5W4-GT	
WT	272	WT	T	5557	
WT	274	WT	G		
	274A	WE	R		5R4-GY
	274B	WE	R	5R4-GY	
FG	280	GE	R		
	284A	WE	VPT		845
	284B	WE	VPT		845
	284D	WE	VPT		845
T	282A	T	VPT		8000
WL	285	WL	VPT		
	287A	WE	T		5557
	289A	WE	R	4B26/ 2000	
WT	294	WT	G	0D3	
	295A	WE	VPT	203-A	
	298A	WE	VPT		862-A
DR	300	GES	VPT		806
HF	300	ML	VPT		806
HF	300	A	VPT		806
WT	301	WT	R	83	
CE	302(722-A)	CE	R		

1	2	3	4	5	6
Type To Be Replaced				Replace by RCA Type*	Similar RCA Type†
Mfr. Prefix	Basic Desig-nation	Mfr.	Tube Class		
UE	303A	UE	VPT	203-A	
	304A	WE	VPT	834	
	304B	WE	VPT	834	
	304TH	RCA	VPT	304-TH	
	304TH	EM	VPT	304-TH	
DR	304TH	GES	VPT	304-TH	
CE	305	CE	T		
CE	306	CE	T		676
F	307A	F	VPT	207	
	307A	WE	VPT		807
WT	308	WT	RT	6X5-GT	
CE	309	CE	T	5557	
	310B	WE	VPT		1620
UE	311	UE	VPT	211	
UE	311-T	UE	VPT		8003
UE	311-CT	UE	VPT		8003
CE	311	CE	T	3C23	
	312A	WE	VPT		828
	313C	WE	G	1C21	
F	315A	F	R		673
	315A	WE	R		673
	315A	A	R		673
ML	315A	ML	R		673
UE	317C	UE	R	217-C	
F	318A	F	R		
ML	319A	ML	R		872-A
F	319A	F	R		872-A
	319A	WE	R		872-A
F	320B	F	VPT		
	321A	WE	R		673
ML	321A	ML	R		673
	322A	WE	VPT	803	
UE	323B	UE	T		3C23
NL	323B	NE	T		3C23
	331A	WE	VPT	805	
	339A	WE	VPT		807
	341AA	WE	VPT		891-R
F	342A	F	VPT		858
	343A	A	VPT		858
F	346A	F	VPT		
	348A	WE	VPT		1620
	350A	WE	VPT	807	
	350B	WE	VPT		807
F	353-A	F	R		872-A
	356A	WE	VPT		806
	356B	WE	VPT		806
	357B	WE	VPT		833-A
	359A	WE	G		1C21
	361A	WE	VPT		835
	366A	WE	R	866-A	
F	375A	F	R		575-A
	376A	WE	VPT		835
	376A	F	VPT		835
WT	377	WT	RT	117Z6-GT	
WT	389	WT	RT	3Q5-GT	

Type To Be Replaced				Replace by RCA Type*	Similar RCA Type†
Mfr. Prefix	Basic Desig-nation	Mfr.	Tube Class		
WT	390	WF	RT	6C5	
	393A	WE	T		3C23
UE	393A	UE	T		3C23
NL	393A	NE	T		3C23
CE	393A	CE	T		3C23
	394A	CH	T		627
	394A	WE	T		627
	395A	WE	T		5823
	397A	WE	K	2K56	
	403A	WE	VPT	6AK5	
	403B	WE	VPT	6AK5	
FJ	401	GE	P	1P29	
GL	411	GE	R		
WL	414	WL	T		
GL	415	GE	I	5550	
GL	427	GE	I		
WT	431	WT	RT	6E6	
	450TH	EM	VPT		
	450TL	EM	VPT		
GL	451	GE	R	8020	
WL	456	WL	R		
WL	463	WL	VPT		806
WL	468	WL	VPT		810
WL	481	WL	R		8013-A
WL	471	WL	VPT		8003
	502-A	RCA	T	502-A	
GL	502-A	GE	T	502-A	
WL	502-A	WL	T	502-A	
GL	546	GE	T		5696
	559	RCA	VPT	559	
	575-A	RCA	R	575-A	
WL	575-A	WL	R	575-A	
GL	575-A	GE	R	575-A	
F	575-A	F	R	575-A	
ML	575-A	ML	R	575-A	

Type To Be Replaced				Replace by RCA Type*	Similar RCA Type†
Mfr. Prefix	Basic Desig-nation	Mfr.	Tube Class		
DR	575-A	GES	R	575-A	
	575-A	A	R	575-A	
	575-A	NU	R	575-A	
	575-A	EE	R	575-A	
GL	592	GE	VPT		
	579-B	RCA	R	579-B	
WL	579-B	WL	R	579-B	
NL	600	NE	R		
NL	602	NE	R		
NL	604	NE	R		
WT	606	WT	T	2D21	
NL	615	NE	R		5558
	627	RCA	T	627	
NL	627	NE	T	627	
KU	627	WL	T	627	
GL	627	GE	T	627	
	629	RCA	T	629	
WL	629	WL	T	629	
WL	630	WL	T	2050	
WL	631	WL	T	5559	
WL	632A	WL	T	5560	
WL	632B	WL	T	5560	
KU	634	WL	T	677	
NL	635	NE	R		
NL	649/5834	NE	R		
WL	651/656	WL	I	5552	
WL	652/657	WL	I	5551	
WL	653B	WL	I	5555	
NL	653/5835	NE	R		
WL	655/658	WL	I	5553	
	672	RCA	T	672-A	
GL	672	GE	T	672-A	
WL	672	WL	T	672-A	
	672-A	RCA	T	672-A	
WL	672-A	WL	T	672-A	
	673	RCA	R	673	

* RCA types shown in this column are direct replacements under all circumstances for corresponding types to be replaced.

† RCA types shown in this column are not directly interchangeable with the types to be replaced because of mechanical and/or electrical differences. For more information as to degree of interchangeability, refer to respective tube data or write to Commercial Engineering, RCA, Harrison, New Jersey.

KEY TO SYMBOLS IN COLUMN 3

A = Amperex
CE = Continental Electric (Cetron)
CH = Chatham Electronics
D = Dumont
EE = Electronic Enterprises
EL = Electrons Inc.
EM = Eitel-McCullough (Eimac)
F = Federal Telephone and Radio
GE = General Electric
GES = General Electronics
HK = Heinz and Kaufman
HY = Hytron
ML = Machlett Laboratories
NL = National Electronics
NU = National Union
R = Rauland
RK = Raytheon
S = Sylvania
T = Taylor
TS = Tung-Sol
UE = United Electronics
WE = Western Electric
WL = Westinghouse
WT = Weltronic

KEY TO SYMBOLS IN COLUMN 4

CM = Camera Tube or Monoscope
CR = Cathode-Ray Tube
G = Glow Tube
GA = Gauge Tube
I = Ignitron
P = Phototube
R = Rectifier
RT = Receiving Tube
T = Thyratron
VPT = Vacuum Power Tube

1 Mfr. Prefix	2 Basic Desig-nation	3 Mfr.	4 Tube Class	5 Replace by RCA Type*	6 Similar RCA Type†
GL	673	GE	R	673	
	676	RCA	T	676	
KU	676	WL	T	676	
	677	RCA	T	677	
WL	677	WL	T	677	
WL	678	WL	T		5563
GL	678	GE	T		5563
WL	679	WL	I	5554	
WL	681/686	WL	I	5553	
WT	699	WT	RT	117L7/ N7-GT	
NL	710	NL	T		676
NL	714	NL	T		5557
NL	715/5557	NL	T	5557	
	715-C	RCA	VPT	715-C	
RK	715C	RK	VPT	715-C	
DR	715C	GES	VPT	715-C	
WL	734	WL	P		917
WL	735	WL	P	868	
WL	739	WL	P		927
WL	741	WL	P		923
	750TL	EM	VPT		
T	756	T	VPT		809
WL	759	WL	T		
WL	787	WL	VPT		
	800	RCA	VPT	800	
GL	800	GE	VPT	800	
	801	RCA	VPT	801-A	
	801-A/ 801	S	VPT	801-A	
	801-A/ 801	HY	VPT	801-A	
	801-A	RCA	VPT	801-A	
DR	801-A	GES	VPT	801-A	
	801-A	A	VPT	801-A	
WL	801-A	WL	VPT	801-A	
GL	801-A	GE	VPT	801-A	
	801-A	NU	VPT	801-A	
	802	RCA	VPT	802	
	802	A	VPT	802	
WL	802	WL	VPT	802	
GL	802	GE	VPT	802	
	802	NU	VPT	802	
	803	RCA	VPT	803	
DR	803	GES	VPT	803	
	803	A	VPT	803	
WL	803	WL	VPT	803	
GL	803	GE	VPT	803	
T	803	T	VPT	803	
	803	NU	VPT	803	
	804	RCA	VPT	804	
	804	NU	VPT	804	
	805	RCA	VPT	805	
ML	805	ML	VPT	805	
	805	A	VPT	805	
UE	805	UE	VPT	805	
GL	805	GE	VPT	805	
DR	805	GES	VPT	805	
WL	805	WL	VPT	805	
T	805	T	VPT	805	
	805	NU	VPT	805	
	806	RCA	VPT	806	
	806	A	VPT	806	
WL	806	WL	VPT	806	
GL	806	GE	VPT	806	
	807	RCA	VPT	807	
	807	NU	VPT	807	
	807	A	VPT	807	
WL	807	WL	VPT	807	
GL	807	GE	VPT	807	
	807	TS	VPT	807	
	807	RK	VPT	807	
DR	807	GES	VPT	807	
	808	NU	VPT	808	
	808	RCA	VPT	808	
DR	808	GES	VPT	808	
WL	808	WL	VPT	808	
EE	808	EE	VPT	808	
	809	RCA	VPT	809	
	809	NU	VPT	809	
WL	809	WL	VPT	809	
GL	809	GE	VPT	809	
	809	S	VPT	809	
DR	809	GES	VPT	809	
	810	RCA	VPT	810	
	810	NU	VPT	810	
ML	810	ML	VPT	810	
T	810	T	VPT	810	
	810	S	VPT	810	
WL	810	WL	VPT	810	
DR	810	GES	VPT	810	
	810	A	VPT	810	
UE	810	UE	VPT	810	
GL	810	GE	VPT	810	
	811	RCA	VPT	811-A	
	811	NU	VPT	811-A	
	811	A	VPT	811-A	
WL	811	WL	VPT	811-A	
GL	811	GE	VPT	811-A	
	811	S	VPT	811-A	
DR	811	GES	VPT	811-A	
	811-A	RCA	VPT	811-A	
	812	RCA	VPT	812-A	
	812	NU	VPT	812-A	
	812	A	VPT	812-A	
WL	812	WL	VPT	812-A	
GL	812	GE	VPT	812-A	
	812	S	VPT	812-A	
DR	812	GES	VPT	812-A	
	812-A	RCA	VPT	812-A	

1	2	3	4	5	6
Type To Be Replaced				Replace by RCA Type*	Similar RCA Type†
Mfr. Prefix	Basic Desig-nation	Mfr.	Tube Class		
ML	813	M	VPT	813	
	813	RCA	VPT	813	
	813	NU	VPT	813	
T	813	T	VPT	813	
RK	813	RK	VPT	813	
WL	813	WL	VPT	813	
DR	813	GES	VPT	813	
	813	A	VPT	813	
GL	813	GE	VPT	813	
	813	S	VPT	813	
	814	RCA	VPT	814	
	814	NU	VPT	814	
WL	814	WL	VPT	814	
GL	814	GE	VPT	814	
RK	814/RK47	RK	VPT	814	
T	814	T	VPT	814	
	815	RCA	VPT	815	
	815	NU	VPT	815	
WL	815	WL	VPT	815	
GL	815	GE	VPT	815	
	815	S	VPT	815	
	816	RCA	R	816	
	816	NU	R	816	
DR	816	GES	R	816	
	816	A	R	816	
WL	816	WL	R	816	
GL	816	GE	R	816	
	816	S	R	816	
	826	RCA	VPT	826	
	826	NU	VPT	826	
ML	826	ML	VPT	826	
DR	826	GES	VPT	826	
WL	826	WL	VPT	826	
GL	826	GE	VPT	826	
	827-R	RCA	VPT	827-R	
	828	NU	VPT	828	

1	2	3	4	5	6
Type To Be Replaced				Replace by RCA Type*	Similar RCA Type†
Mfr. Prefix	Basic Desig-nation	Mfr.	Tube Class		
	828	RCA	VPT	828	
ML	828	ML	VPT	828	
WL	828	WL	VPT	828	
GL	828	GE	VPT	828	
	829	RCA	VPT	829-B	
	829-A	RCA	VPT	829-B	
	829-B	RCA	VPT	829-B	
	829-B	NU	VPT	829-B	
ML	829-B	ML	VPT	829-B	
WL	829-B	WL	VPT	829-B	
	829-B	A	VPT	829-B	
GL	829-B	GE	VPT	829-B	
RK	829-B	RK	VPT	829-B	
UE	830	UE	VPT	830-B	
	830-B	RCA	VPT	830-B	
	830-B	A	VPT	830-B	
	830-B	NU	VPT	830-B	
UE	830-B	UE	VPT	830-B	
GL	830-B	GE	VPT	830-B	
T	830-B	T	VPT	830-B	
	832	RCA	VPT	832-A	
	832-A	RCA	VPT	832-A	
	832-A	NU	VPT	832-A	
ML	832-A	ML	VPT	832-A	
DR	832-A	GES	VPT	832-A	
WL	832-A	WL	VPT	832-A	
GL	832-A	GE	VPT	832-A	
RK	832-A	RK	VPT	832-A	
	833	RCA	VPT	833-A	
	833-A	RCA	VPT	833-A	
ML	833-A	ML	VPT	833-A	
DR	833-A	GES	VPT	833-A	
	833-A	A	VPT	833-A	
WL	833-A	WL	VPT	833-A	
	834	RCA	VPT	834	
	834	A	VPT	834	

* RCA types shown in this column are direct replacements under all circumstances for corresponding types to be replaced.

† RCA types shown in this column are not directly interchangeable with the types to be replaced because of mechanical and/or electrical differences. For more information as to degree of interchangeability, refer to respective tube data or write to Commercial Engineering, RCA, Harrison, New Jersey.

KEY TO SYMBOLS IN COLUMN 3

A = Amperex
CE = Continental Electric (Cetron)
CH = Chatham Electronics
D = Dumont
EE = Electronic Enterprises
EL = Electrons Inc.
EM = Eitel-McCullough (Eimac)
F = Federal Telephone and Radio
GE = General Electric
GES = General Electronics
HK = Heinz and Kaufman
HY = Hytron
ML = Machlett Laboratories
NL = National Electronics
NU = National Union
R = Rauland
RK = Raytheon
S = Sylvania
T = Taylor
TS = Tung-Sol
UE = United Electronics
WE = Western Electric
WL = Westinghouse
WT = Weltronic

KEY TO SYMBOLS IN COLUMN 4

CM = Camera Tube or Monoscope
CR = Cathode-Ray Tube
G = Glow Tube
GA = Gauge Tube
I = Ignitron
P = Phototube
R = Rectifier
RT = Receiving Tube
T = Thyratron
VPT = Vacuum Power Tube

Type To Be Replaced				Replace by RCA Type*	Similar RCA Type†
Mfr. Prefix	Basic Desig-nation	Mfr.	Tube Class		
UE	834	UE	VPT	834	
	834	NU	VPT	834	
	835	RCA	VPT	835	
	835	A	VPT	835	
GL	835	GE	VPT	835	
	836	RCA	R	836	
	836	NU	R	836	
	836	A	R	836	
WL	836	WL	R	836	
GL	836	GE	R	836	
EE	836	EE	R	836	
	837	RCA	VPT	837	
DR	837	GES	VPT	837	
	837	NU	VPT	837	
	837	A	VPT	837	
WL	837	WL	VPT	837	
GL	837	GE	VPT	837	
	837	S	VPT	837	
RK	837	RK	VPT	837	
	837	HY	VPT	837	
DR	838	GES	VPT	838	
	838	RCA	VPT	838	
	838	NU	VPT	838	
	838	A	VPT	838	
UE	838	UE	VPT	838	
WL	838	WL	VPT	838	
GL	838	GE	VPT	838	
T	838	T	VPT	838	
	841	RCA	VPT	841	
	841	A	VPT	841	
	841	HY	VPT	841	
	842	RCA	VPT	842	
	842	A	VPT	842	
GL	842	GE	VPT	842	
	843	RCA	VPT	843	
	843	NU	VPT	843	
GL	843	GE	VPT	843	
	843	A	VPT	843	
	845	RCA	VPT	845	
	845	NU	VPT	845	
	845	A	VPT	845	
UE	845	UE	VPT	845	
WL	845	WL	VPT	845	
GL	845	GE	VPT	845	
T	845	T	VPT	845	
ML	846	ML	VPT	846	
	846	RCA	VPT	846	
	846	A	VPT	846	
UE	846	UE	VPT	846	
GL	846	GE	VPT	846	
	849	RCA	VPT	849	
F	849	F	VPT	849	
	849	A	VPT	849	
GL	849	GE	VPT	849	
ML	849	ML	VPT	849	

Type To Be Replaced				Replace by RCA Type*	Similar RCA Type†
Mfr. Prefix	Basic Desig-nation	Mfr.	Tube Class		
WL	849	WL	VPT	849	
	849A	A	VPT		849
	849H	A	VPT		849
DR	851	GES	VPT	851	
	851	RCA	VPT	851	
	851	A	VPT	851	
WL	851	WL	VPT	851	
GL	851	GE	VPT	851	
	857	RCA	R	857-B	
	857-B	RCA	R	857-B	
DR	857-B	GES	R	857-B	
F	857-B	F	R	857-B	
WL	857-B	WL	R	857-B	
ML	857-B	ML	R	857-B	
	857-B	A	R	857-B	
GL	857-B	GE	R	857-B	
	858	RCA	VPT	858	
F	858	F	VPT	858	
	858	A	VPT	858	
GL	858	GE	VPT	858	
	859	A	VPT		893-A
	860	RCA	VPT	860	
WL	860	WL	VPT	860	
	861	RCA	VPT	861	
DR	861	GES	VPT	861	
WL	861	WL	VPT	861	
	862	RCA	VPT	862-A	
	862-A	RCA	VPT	862-A	
F	862-A	F	VPT	862-A	
WL	862-A	WL	VPT	862-A	
GL	862-A	GE	VPT	862-A	
	864	RCA	VPT	864	
	865	RCA	VPT	865	
	865	NU	VPT	865	
	866	RCA	R	866-A	
	866-A	RCA	R	866-A	
	866-A 866	RCA	R	866-A	
	866-A/ 866	HY	R	866-A	
WL	866-A	WL	R	866-A	
	866-A	EM	R	866-A	
ML	866-A	ML	R	866-A	
	866-A	CE	R	866-A	
	866-A	A	R	866-A	
DR	866-A	GES	R	866-A	
	866-A	NU	R	866-A	
UE	866-A	UE	R	866-A	
GL	866-A	GE	R	866-A	
	866-A	S	R	866-A	
	866-A	CH	R	866-A	
RK	866-A	RK	R	866-A	
EE	866-A	EE	R	866-A	
T	866-A	T	R	866-A	
	866-JR	NU	R		816
	866-JR	CH	R		816

1	2	3	4	5	6
Type To Be Replaced				Replace by RCA Type*	Similar RCA Type†
Mfr. Prefix	Basic Desig-nation	Mfr.	Tube Class		
T	866-JR	T	R		816
	868	RCA	P	868	
	869-A	RCA	R	869-B	
	869-B	RCA	R	869-B	
F	869-B	F	R	869-B	
WL	869-B	WL	R	869-B	
ML	869-B	ML	R	869-B	
	869-B	A	R	869-B	
GL	869-B	GE	R	869-B	
DR	869-B	GES	R	869-B	
	872	RCA	R	872-A	
	872-A/ 872	RCA	R	872-A	
ML	872-A/ 872	ML	R	872-A	
WL	872-A 872	WL	R	872-A	
RK	872-A/ 872	RK	R	872-A	
	872-A	RCA	R	872-A	
GL	872-A	GE	R	872-A	
	872-A	EM	R	872-A	
DR	872-A	GES	R	872-A	
	872-A	CE	R	872-A	
	872-A	A	R	872-A	
EE	872-A	EE	R	872-A	
UE	872-A	UE	R	872-A	
	872-A	S	R	872-A	
	872-A	CH	R	872-A	
F	872-A	F	R	872-A	
	872-A	NU	R	872-A	
DR	873	GES	R		872-A
	874	RCA	G	874	
GL	874	GE	G	874	
T	875-A	T	R	575-A	
	876	RCA	G	876	

1	2	3	4	5	6
Type To Be Replaced				Replace by RCA Type*	Similar RCA Type†
Mfr. Prefix	Basic Desig-nation	Mfr.	Tube Class		
	878	RCA	R	878	
	879	RCA	R	2X2-A	
	880	RCA	VPT	880	
ML	880	M	VPT	880	
WL	880	WL	VPT	880	
UE	880	UE	VPT	880	
GL	880	GE	VPT	880	
	884	RCA	T	884	
	884	NU	T	884	
	884	A	T	884	
WL	884	WL	T	884	
GL	884	GE	T	884	
	884	CH	T	884	
RX	884	RK	T	884	
DR	884	GES	T	884	
	885	NU	T	885	
	885	NU	T	885	
	885	A	T	885	
WL	885	WL	T	885	
GL	885	GE	T	885	
	885	CH	T	885	
RX	885	RK	T	885	
	886	RCA	G	886	
	889	RCA	VPT	889-A	
	889-A	RCA	VPT	889-A	
F	889-A	F	VPT	889-A	
ML	889-A	ML	VPT	889-A	
GL	889-A	GE	VPT	889-A	
	889-A	A	VPT	889-A	
UE	889-A	UE	VPT	889-A	
WL	889-A	WL	VPT	889-A	
	889R	RCA	VPT	889R-A	
	889R-A	RCA	VPT	889R-A	
F	889R-A	F	VPT	889R-A	
GL	889R-A	GE	VPT	889R-A	
ML	889R-A	ML	VPT	889R-A	

* RCA types shown in this column are direct replacements under all circumstances for corresponding types to be replaced.

† RCA types shown in this column are not directly interchangeable with the types to be replaced because of mechanical and/or electrical differences. For more information as to degree of interchangeability, refer to respective tube data or write to Commercial Engineering, RCA, Harrison, New Jersey.

KEY TO SYMBOLS IN COLUMN 3

A = Amperex
CE = Continental Electric (Cetron)
CH = Chatham Electronics
D = Dumont
EE = Electronic Enterprises
EL = Electrons Inc.
EM = Eitel-McCullough (Eimac)
F = Federal Telephone and Radio
GE = General Electric
GES = General Electronics
HK = Heinz and Kaufman
HY = Hytron
ML = Machlett Laboratories
NL = National Electronics
NU = National Union
R = Rauland
RK = Raytheon
S = Sylvania
T = Taylor
TS = Tung-Sol
UE = United Electronics
WE = Western Electric
WL = Westinghouse
WT = Weltronic

KEY TO SYMBOLS IN COLUMN 4

CM = Camera Tube or Monoscope
CR = Cathode-Ray Tube
G = Glow Tube
GA = Gauge Tube
I = Ignitron
P = Phototube
R = Rectifier
RT = Receiving Tube
T = Thyratron
VPT = Vacuum Power Tube

1	2	3	4	5	6
Type To Be Replaced				Replace by RCA Type*	Similar RCA Type†
Mfr. Prefix	Basic Desig-nation	Mfr.	Tube Class		
	889R-A	A	VPT	889R-A	
UE	889R-A	UE	VPT	889R-A	
WL	889R-A	WL	VPT	889R-A	
	891	RCA	VPT	891	
F	891	F	VPT	891	
GL	891	GE	VPT	891	
ML	891	ML	VPT	891	
	891	A	VPT	891	
UE	891	UE	VPT	891	
WL	891	WL	VPT	891	
	891-R	RCA	VPT	891-R	
F	891-R	F	VPT	891-R	
GL	891-R	GE	VPT	891-R	
ML	891-R	ML	VPT	891-R	
	891-R	A	VPT	891-R	
UE	891-R	UE	VPT	891-R	
WL	891-R	WL	VPT	891-R	
	892	RCA	VPT	892	
F	892	F	VPT	892	
GL	892	GE	VPT	892	
ML	892	ML	VPT	892	
	892	A	VPT	892	
UE	892	UE	VPT	892	
WL	892	WL	VPT	892	
	892-R	RCA	VPT	892-R	
F	892-R	F	VPT	892-R	
DR	892-R	GES	VPT	892-R	
GL	892-R	GE	VPT	892-R	
ML	892-R	ML	VPT	892-R	
	892-R	A	VPT	892-R	
UE	892-R	UE	VPT	892-R	
WL	892-R	WL	VPT	892-R	
	893	RCA	VPT	893-A	
	893-A	RCA	VPT	893-A	
F	893-A	F	VPT	893-A	
GL	893-A	GE	VPT	893-A	
ML	893-A	ML	VPT	893-A	
	893-A	A	VPT	893-A	
UE	893-A	UE	VPT	893-A	
WL	893-A	WL	VPT	893-A	
	893A-R	RCA	VPT	893A-R	
F	893A-R	F	VPT	893A-R	
ML	893A-R	ML	VPT	893A-R	
	893A-R	A	VPT	893A-R	
WL	893A-R	WL	VPT	893A-R	
GL	893A-R	GE	VPT	893A-R	
ML	895	ML	VPT		
WL	895	WL	VPT		
GL	895	GE	VPT		
	895	A	VPT		
ML	895-R	ML	VPT		
WL	895-R	WL	VPT		
GL	895-R	GE	VPT		
	895-R	A	VPT		
	898-A	RCA	VPT	898-A	

1	2	3	4	5	6
Type To Be Replaced				Replace by RCA Type*	Similar RCA Type†
Mfr. Prefix	Basic Desig-nation	Mfr.	Tube Class		
F	898-A	F	VPT	898-A	
	898-A	A	VPT	898-A	
GL	898-A	GE	VPT	898-A	
	902	RCA	CR	902-A	
	902-A	RCA	CR	902-A	
	905	RCA	CR	905-A	
UE	905	UE	VPT	805	
	905-A	RCA	CR	905-A	
	906-P1	RCA	CR	3AP1-A	
	908	RCA	CR	908-A	
	908-A	RCA	CR	908-A	
	912	RCA	CR	912	
	913	RCA	CR	913	
	914	RCA	CR	914-A	
GL	914-A	GE	CR	914-A	
	917	RCA	P	917	
WL	917	WL	P	917	
GL	917	GE	P	917	
	918	RCA	P	918	
WL	918	WL	P	918	
GL	918	GE	P	918	
	919	RCA	P	919	
WL	919	WL	P	919	
GL	919	GE	P	919	
	920	RCA	P	920	
WL	920	WL	P	920	
GL	920	GE	P	920	
	921	RCA	P	921	
WL	921	WL	P	921	
GL	921	GE	P	921	
	922	RCA	P	922	
WL	922	WL	P	922	
GL	922	GE	P	922	
	923	RCA	P	923	
WL	923	WL	P	923	
GL	923	GE	P	923	
	924	RCA	P	924	
WL	924	WL	P	924	
	925	RCA	P	925	
WL	925	WL	P	925	
	926	RCA	P	926	
WL	926	WL	P	926	
	927	RCA	P	927	
WL	927	WL	P	927	
GL	927	GE	P	927	
	928	RCA	P	928	
WL	928	WL	P	928	
	929	RCA	P	929	
WL	929	WL	P	929	
GL	929	GE	P	929	
	930	RCA	P	930	
WL	930	WL	P	930	
GL	930	GE	P	930	
UE	930B	UE	VPT	830-B	
	931	RCA	P	931-A	

Type To Be Replaced: Mfr. Prefix (1)	Basic Designation (2)	Mfr. (3)	Tube Class (4)	Replace by RCA Type* (5)	Similar RCA Type† (6)
WL	931-A	WL	P	931-A	
GL	931-A	GE	P	931-A	
	934	RCA	P	934	
	935	RCA	P	935	
GL	935	GE	P	935	
UE	938	UE	VPT	838	
UE	945	UE	VPT	845	
UE	949	UE	VPT	849	
	954	RCA	VPT	954	
GL	954	GE	VPT	954	
	954	TS	VPT	954	
RK	954	RK	VPT	954	
	954	HY	VPT	954	
	955	RCA	VPT	955	
	955	NU	VPT	955	
GL	955	GE	VPT	955	
	955	TS	VPT	955	
RK	955	RK	VPT	955	
	955	HY	VPT	955	
	956	RCA	VPT	956	
GL	956	GE	VPT	956	
	956	TS	VPT	956	
RK	956	RK	VPT	956	
	957	RCA	VPT	957	
GL	957	GE	VPT	957	
RK	957	RK	VPT	957	
	958-A	RCA	VPT	958-A	
GL	959	GE	VPT	959	
UE	966	UE	R	866-A	
UE	966-A	UE	R	866-A	
UE	967	UE	T	5557	
	967	NU	T	5557	
UE	972	UE	R	872-A	
UE	972-A	UE	R	872-A	
UE	975-T	UE	R		575-A
	975-A	NU	R	575-A	
	991	RCA	G	991	
WL	1000T	WL	VPT		
	1000T	EM	VPT		
R	1111	S	GA		1947
R	1111-M	S	GA		1947
E	1148	HY	VPT		2C22
	1237	S	R		
	1266	S	G		5823
	1267	S	G		0A4-G
GL	1367	GE	T		5696
	1603	RCA	VPT	1603	
	1603	TS	VPT	1603	
GL	1603	GE	VPT	1603	
	1608	RCA	VPT	1608	
	1609	RCA	VPT	1609	
	1610	RCA	VPT	1610	
	1612	RCA	VPT	1612	
GL	1612	GE	VPT	1612	
	1613	RCA	VPT	1613	

Type To Be Replaced: Mfr. Prefix (1)	Basic Designation (2)	Mfr. (3)	Tube Class (4)	Replace by RCA Type* (5)	Similar RCA Type† (6)
GL	1613	GE	VPT	1613	
	1614	RCA	VPT	1614	
	1614	GE	VPT	1614	
	1616	RCA	R	1616	
	1616	NU	R	1616	
GL	1616	GE	R	1616	
	1616	A	R	1616	
DR	1616	GES	R	1616	
	1616	HY	R	1616	
	1616	S	R	1616	
	1619	RCA	VPT	1619	
	1619	NU	VPT	1619	
	1620	RCA	VPT	1620	
GL	1620	GE	VPT	1620	
	1620	NU	VPT	1620	
	1621	RCA	VPT	1621	
	1621	NU	VPT	1621	
GL	1621	GE	VPT	1621	
	1622	RCA	VPT	1622	
	1622	NU	VPT	1622	
GL	1622	GE	VPT	1622	
	1623	RCA	VPT	1623	
WL	1623	WL	VPT	1623	
GL	1623	GE	VPT	1623	
	1624	RCA	VPT	1624	
	1624	NU	VPT	1624	
GL	1624	GE	VPT	1624	
	1625	RCA	VPT	1625	
GL	1625	GE	VPT	1625	
	1625	NU	VPT	1625	
	1625	A	VPT	1625	
DR	1625	GES	VPT	1625	
	1625	HY	VPT	1625	
RK	1625	RK	VPT	1625	
	1625	TS	VPT	1625	
	1625	S	VPT	1625	
	1626	RCA	VPT	1626	
	1626	A	VPT	1626	
	1626	HY	VPT	1626	
	1626	TS	VPT	1626	
	1626	S	VPT	1626	
	1629	RCA	G	1629	
	1629	TS	G	1629	
GL	1629	GE	G	1629	
	1631	RCA	VPT	1631	
	1632	RCA	VPT	1632	
	1633	RCA	VPT	1633	
GL	1633	GE	VPT	1633	
	1634	RCA	VPT	1634	
	1635	RCA	VPT	1635	
	1642	RCA	VPT	2C21/ 1642	
	1644	RCA	VPT	1644	
	1654	RCA	R	1654	
	1654	NU	R	1654	

Type To Be Replaced				Replace by RCA Type*	Similar RCA Type†
Mfr. Prefix	Basic Desig-nation	Mfr.	Tube Class		
	1701	A	T		5557
	1702	A	T		5563
	1802-P1	RCA	CR	5BP1-A	
	1811-P1	RCA	CR	7CP1	
	1816-P4	RCA	CM	1816-P4	
	1847	RCA	CM		5527
	1848	RCA	CM	1848	
	1849	RCA	CM	1850-A	
	1850	RCA	CM	1850-A	
	1850-A	RCA	CM	1850-A	
GL	1850-A	GE	CM	1850-A	
	1851	RCA	VPT	1851	
	1899	RCA	CM		2F21
	1904	RCA	T	1904	
	1945	RCA	GA	1945	
	1946	RCA	GA	1946	
	1947	RCA	GA	1947	
	1949	RCA	GA	1949	
	1950	RCA	GA	1950	
	2000	RCA	R	4B26/ 2000	
	2050	RCA	T	2050	
RK	2050	RK	T	2050	
	2050	A	T	2050	
	2050	CH	T	2050	
	2050	NU	T	2050	
WL	2050	WL	T	2050	
GL	2050	GE	T	2050	
	2051	RCA	T	2050	
	2051	A	T	2050	
RK	2051	RK	T	2050	
	2051	CH	T	2050	
	2051	NU	T	2050	
	2051	GE	T	2050	
ZB	3000	A	VPT		
ZB	3200	A	VPT		
F	5303	F	VPT		
	5331	A	VPT		830-B
	5332	A	VPT		830-B
	5514	HY	VPT		811-A
	5516	HY	VPT		2E24
CK	5517/ CK-1013	RK	R		
	5527	RCA	CM	5527	
ML	5530	ML	VPT		5762
ML	5541	ML	VPT		
GL	5544	GE	T		
GL	5545	GE	T		
	5550	RCA	I	5550	
GL	5550/ GL-415	GE	I	5550	
WL	5550/681	WL	I	5550	
	5551	RCA	I	5551	
GL	5551/ FG-271	GE	I	5551	

Type To Be Replaced				Replace by RCA Type*	Similar RCA Type†
Mfr. Prefix	Basic Desig-nation	Mfr.	Tube Class		
WL	5551/652	WL	I	5551	
	5552	RCA	I	5552	
GL	5552/ FG-235A	GE	I	5552	
WL	5552/651	WL	I	5552	
	5553	RCA	I	5553	
GE	5553/ FG-258A	GE	I	5553	
WL	5553/655	WL	I	5553	
	5554	RCA	I	5554	
GL	5554/ FG-259B	GE	I	5554	
WL	5554/679	WL	I	5554	
	5555	RCA	I	5555	
GL	5555/ FG-238B	GE	I	5555	
WL	5555/ 653B	WL	I	5555	
	5556	RCA	VPT	5556	
GL	5556/PJ-8	GE	VPT	5556	
	5557	RCA	T	5557	
GL	5557/ FG-17	GE	T	5557	
WL	5557/17	WL	T	5557	
	5558	RCA	R	5558	
GL	5558/ FG-32	GL	R	5558	
WL	5558/32	WL	R	5558	
	5559	RCA	T	5559	
GL	5559/ FG-57	GE	T	5559	
WL	5559/57	WL	T	5559	
	5560	RCA	T	5560	
GL	5560/ FG-95	GE	T	5560	
	5561	RCA	R	5561	
GL	5561/ FG-104	GE	R	5561	
WL	5561/104	WL	R	5561	
	5563	RCA	T	5563	
F	5563	F	T	5563	
	5581	RCA	P	5581	
	5582	RCA	P	5582	
	5583	RCA	P	5583	
	5584	RCA	P	5584	
	5588	RCA	VPT	5588	
GL	5588	GE	VPT	5588	
ML	5588	ML	VPT	5588	
	5591	WE	VPT		6AK5
	5592	RCA	VPT	5592	
ML	5592	ML	VPT	5592	
GL	5593	GE	R		
ML	5604	ML	VPT		889R-A
WL	5604	WL	VPT		889R-A
ML	5606	ML	VPT		892
ML	5609	ML	VPT		

Mfr. Prefix	Basic Desig-nation	Mfr.	Tube Class	Replace by RCA Type*	Similar RCA Type†
	5618	RCA	VPT	5618	
	5651	RCA	G	5651	
	5652	RCA	P	5652	
	5653	RCA	P	5653	
	5653	CE	P	5653	
RK	5654	RK	VPT		6AS6
GL	5654	GE	VPT		6AS6
	5655	RCA	CM	5655	
GL	5655	GE	CM	5655	
ML	5658	ML	VPT		880
GL	5662	GE	T		5696
ML	5666	ML	VPT		889-A
ML	5667	ML	VPT		889R-A
F	5667	F	VPT		889R-A
ML	5668	ML	VPT		892
ML	5669	ML	VPT		892-R
GL	5670	GE	VPT		
	5671	RCA	VPT	5671	
ML	5671	ML	VPT	5671	
WL	5671	ML	VPT	5671	
	5675	RCA	VPT	5675	
F	5680	F	VPT		
WL	5685	WL	T		676
RK	5686	RK	VPT		5763
	5691	RCA	VPT	5691	
GL	5691	GE	VPT	5691	
WL	5691	WL	VPT	5691	
	5691	S	VPT	5691	
	5692	RCA	VPT	5692	
GL	5692	GE	VPT	5692	
WL	5692	WL	VPT	5692	
	5692	S	VPT	5692	
	5693	RCA	VPT	5693	
GL	5693	GE	VPT	5693	
WL	5693	WL	VPT	5693	

Mfr. Prefix	Basic Desig-nation	Mfr.	Tube Class	Replace by RCA Type*	Similar RCA Type†
	5693	S	VPT	5693	
EE	5695	EE	R		816
	5696	RCA	T	5696	
	5713	RCA	VPT	5713	
CK	5725	RK	VPT		6AS6
	5728	GE	T	1904	
	5734	RCA	VPT	5734	
WL	5736	WL	VPT		5762
ML	5736	ML	VPT		5762
	5762	RCA	VPT	5762	
	5763	RCA	VPT	5763	
	5769	RCA	CM	5769	
	5770	RCA	VPT	5770	
	5771	RCA	VPT	5771	
ML	5771	ML	VPT	5771	
	5786	RCA	VPT	5786	
	5794	RCA	VPT	5794	
	5819	RCA	P	5819	
	5820	RCA	CM	5820	
	5823	RCA	T	5823	
	5825	RCA	R	5825	
	5826	RCA	CM	5826	
	5831	RCA	VPT	5831	
	5879	RCA	VPT	5879	
	5890	RCA	VPT	5890	
WL	5934	WL	R		579-B
	7193	RCA	VPT	2C22	
	8000	RCA	VPT	8000	
ML	8000	ML	VPT	8000	
GL	8000	GE	VPT	8000	
WL	8000	WL	VPT	8000	
	8003	RCA	VPT	8003	
DR	8003	GES	VPT	8003	
WL	8003	WL	VPT	8003	
	8005	RCA	VPT	8005	
	8005	NU	VPT	8005	

* RCA types shown in this column are direct replacements under all circumstances for corresponding types to be replaced.

† RCA types shown in this column are not directly interchangeable with the types to be replaced because of mechanical and/or electrical differences. For more information as to degree of interchangeability, refer to respective tube data or write to Commercial Engineering, RCA, Harrison, New Jersey.

KEY TO SYMBOLS IN COLUMN 3

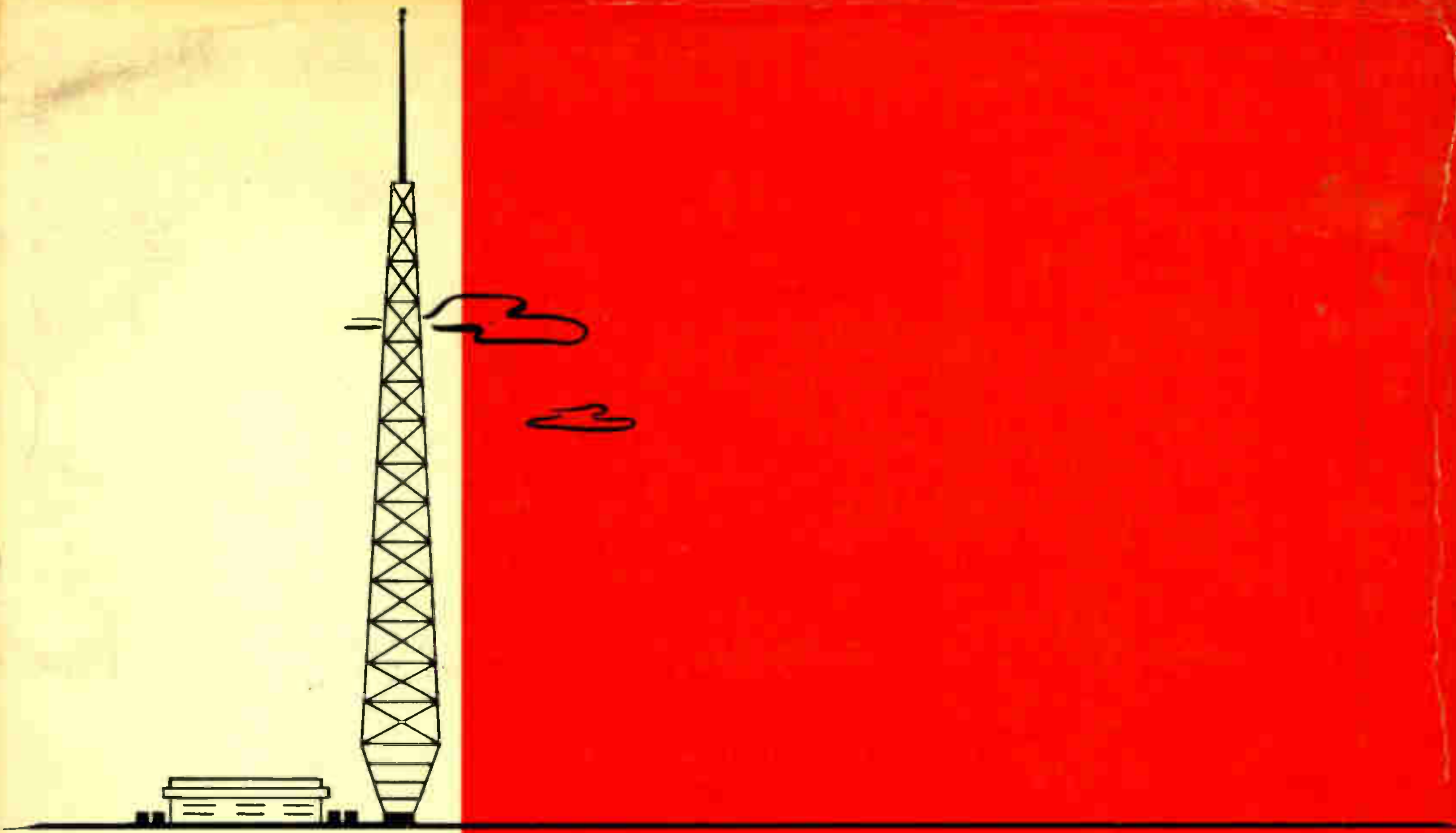
A = Amperex
CE = Continental Electric (Cetron)
CH = Chatham Electronics
D = Dumont
EE = Electronic Enterprises
EL = Electrons Inc.
EM = Eitel-McCullough (Eimac)
F = Federal Telephone and Radio
GE = General Electric
GES = General Electronics
HK = Heinz and Kaufman
HY = Hytron
ML = Machlett Laboratories
NL = National Electronics
NU = National Union
R = Rauland
RK = Raytheon
S = Sylvania
T = Taylor
TS = Tung-Sol
UE = United Electronics
WE = Western Electric
WL = Westinghouse
WT = Weltronic

KEY TO SYMBOLS IN COLUMN 4

CM = Camera Tube or Monoscope
CR = Cathode-Ray Tube
G = Glow Tube
GA = Gauge Tube
I = Ignitron
P = Phototube
R = Rectifier
RT = Receiving Tube
T = Thyratron
VPT = Vacuum Power Tube

1	2	3	4	5	6
Type To Be Replaced				Replace by RCA Type*	Similar RCA Type†
Mfr. Prefix	Basic Designation	Mfr.	Tube Class		
	8005	A	VPT	8005	
ML	8005	ML	VPT	8005	
WL	8005	WL	VPT	8005	
GL	8005	GE	VPT	8005	
	8008	RCA	VPT	8008	
GL	8008	GE	VPT	8008	
WL	8008	WL	VPT	8008	
GL	8008	GE	VPT	8008	
UE	8008	UE	VPT	8008	
	8008	A	VPT	8008	
	8008	C	VPT	8008	
DR	8008	GES	VPT	8008	
T	8008	T	VPT	8008	
EE	8008	EE	VPT	8008	
	8012	RCA	VPT	8012-A	
GL	8012	GE	VPT	8012-A	
	8012-A	RCA	VPT	8012-A	
	8013-A	RCA	VPT	8013-A	
GL	8013-A	GE	R	8013-A	
	8014-A	RCA	VPT		6C24
	8016	RCA	R	1B3-GT	
GL	8016	GE	R	1B3-GT	
	8020	RCA	R	8020	
	8020	A	R	8020	
WL	8020	WL	R	8020	
DR	8020	GES	R	8020	
WL	8020	W	R	8020	
EE	8020	EE	R	8020	
	8020	NU	R	8020	
	8025-A	RCA	VPT	8025-A	
GL	8025-A	GE	VPT	8025-A	
ML	8025-A	ML	VPT	8025-A	
WL	8025-A	WL	VPT	8025-A	
	9001	RCA	VPT	9001	
	9001	HY	VPT	9001	
GL	9001	GE	VPT	9001	
	9001	HY	VPT	9001	
	9001	NU	VPT	9001	
	9002	RCA	VPT	9002	
GL	9002	GE	VPT	9002	
	9002	HY	VPT	9002	
	9002	NU	VPT	9002	
	9003	RCA	VPT	9003	
	9003	NU	VPT	9003	
GL	9003	GE	VPT	9003	
	9004	RCA	VPT	9004	
GL	9004	GE	VPT	9004	
	9005	RCA	VPT	9005	
GL	9005	GE	VPT	9005	
	9006	RCA	VPT	9006	
GL	9006	GE	VPT	9006	
	9006	NU	VPT	9006	
	9006	TS	VPT	9006	
EL	C1A	EL			

1	2	3	4	5	6
Type To Be Replaced				Replace by RCA Type*	Similar RCA Type†
Mfr. Prefix	Basic Designation	Mfr.	Tube Class		
EL	C1B	EL			
EL	C1B/A	EL			
EL	C1J	EL			
EL	C1J/A	EL			
EL	C3J	EL			
EL	C3J/A	EL			
EL	C5B	EL			
EL	C6A	EL			
EL	C6J	EL			
EL	C6J/A	EL			
EL	C6L	EL			
EL	C16J	EL			
WT	T-100	WT	RT	6X4	
WT	T-102	WT	RT	5Y3-GT	
WT	T-103	WT	RT	6H6	
WT	T-104	WT	T	575-A	
WT	T-105	WT	VPT	892	
WT	T-106	WT	T		
WT	T-107	WT	T		
WT	T-108	WT	T		
WT	T-109	WT	T		
WT	T-110	WT	T		
WT	T-111	WT	T	5559	
WT	T-112	WT	T	5560	
WT	T-113	WT	T	676	
WT	T-114	WT	G	0Z4	
WT	T-115	WT	RT	117N7-GT	
WT	T-117	WT	T	5557	
WT	T-118	WT	T	105	
WT	T-119	WT	T	172	
WT	T-122	WT	RT	6SJ7	
WT	T-123	WT	RT	6V6	
WT	T-123	WT	RT	6V6-GT	
WT	T-124	WT	RT	7K7	
WT	T-125	WT	RT	6N7	
WT	T-125	WT	RT	6N7-GT	
WT	T-126	WT	RT	50B5	
WT	T-127	WT	VPT	833-A	
WT	T-128	WT	RT	6K8	
WT	T-128	WT	RT	6K8-GT	
WT	T-129	WT	RT	6J5	
WT	T-129	WT	RT	6J5-GT	
WT	T-130	WT	RT	6G6-G	
WT	T-131	WT	RT	6C6	
WT	T-132	WT	G	0A4-G	
WT	T-135	WT	RT	5U4-G	
WT	T-136	WT	CR	2AP1-A	
WT	T-137	WT	CR	3AP1-A	
WT	T-149	WT	T	172	
WT	T-133	WT	T		
WT	T-134	WT	T		
WT	T-139	WT	T		
	V-70-D	UE	VPT		8005
	V-70-D	NU	VPT		8005



RADIO CORPORATION of AMERICA

ELECTRON TUBES HARRISON, N. J.

3F856 PRINTED IN U.S.A. TMK®