

RADIOTRONICS

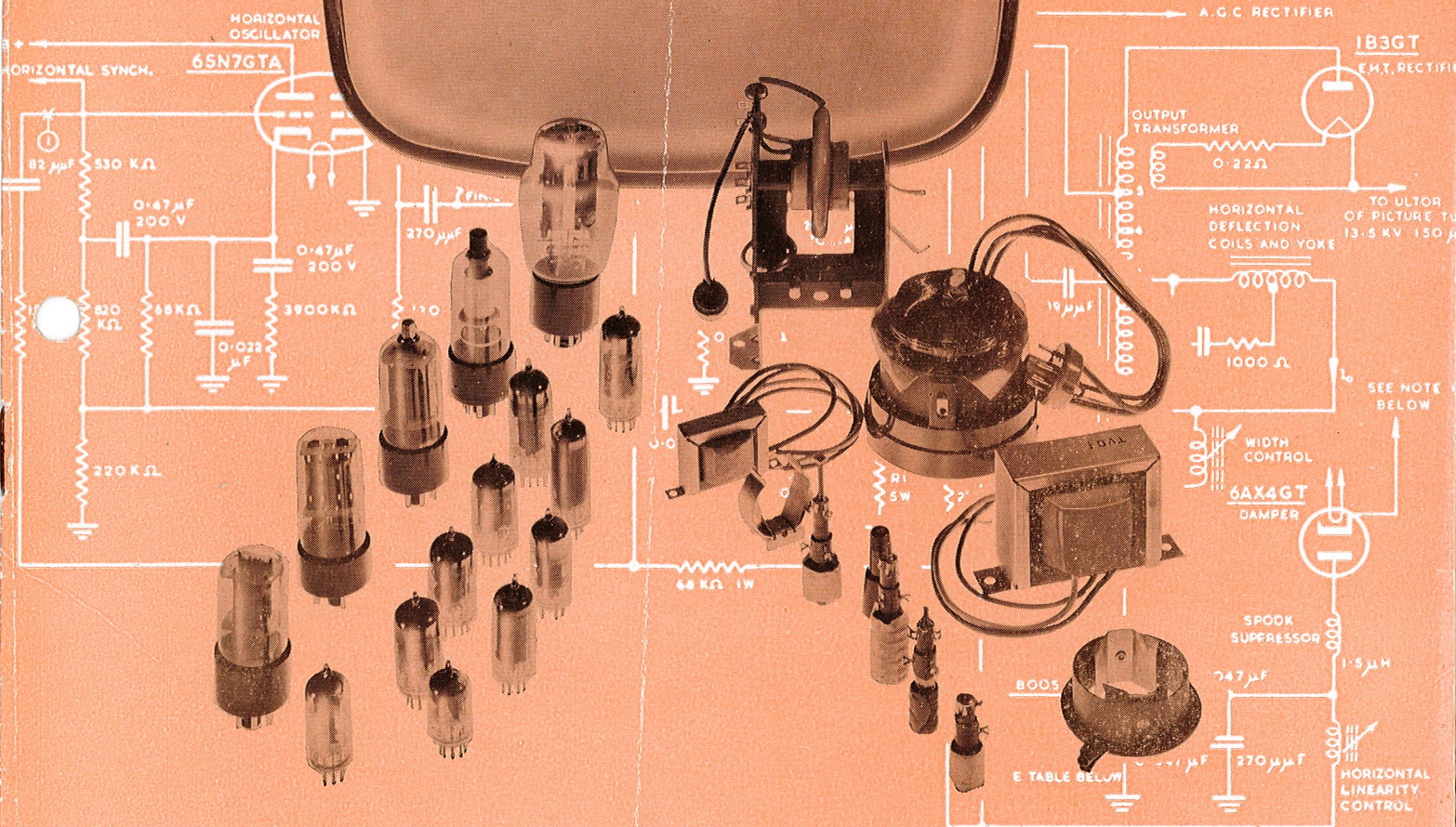
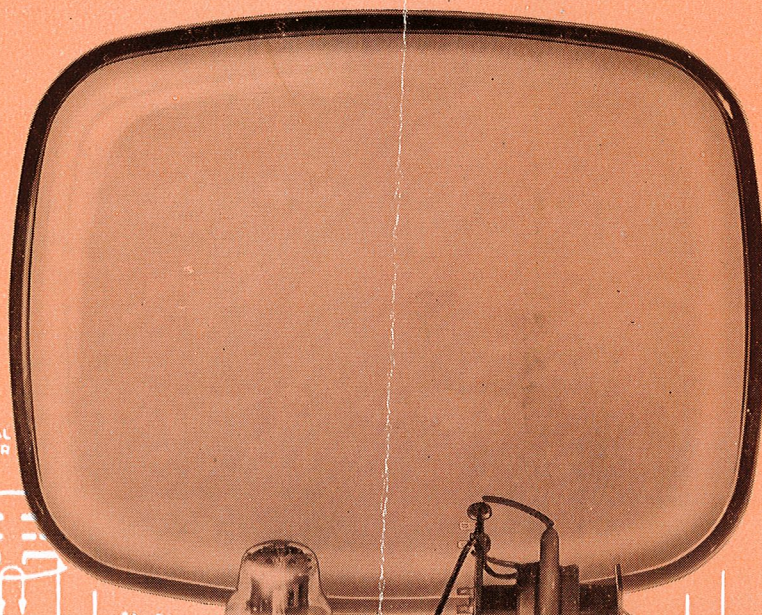
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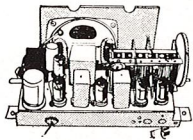
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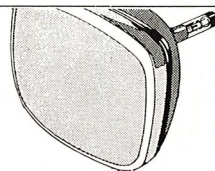
NO. 5



AMALGAMATED WIRELESS VALVE COMPANY PTY. LTD.



IN THIS ISSUE



EDITOR A. J. GABB, B.Sc. (Syd.), A.M.I.R.E. (Aust.)

THE OXIDE-COATED CATHODE 59

The oxide coated cathode, in spite of its sensitivity to poisoning and evaporation, is still the most useful source of electrons. This article outlines the history of cathodes, and discusses the preparation, coating and activation of the oxide. There is continuing research being carried out on the oxide coated cathode which will undoubtedly bring further improvements in the near future.

RADIOTRON 21ALP4A 63

Full technical data on the dimensions, operation and application of the Radiotron 21-inch picture tube are given. Refer also to the May and June 1956 issues of Radiotronics in which were published data on the use of the 17HP4B.

RADIOTRON 6BK8/Z729 68

In the May 1955 issue ^{P.61,} of Radiotronics there was published a report by the Applications Laboratory on the use of this valve. In this present article there are given suitable conditions for this valve when connected as a triode.

ADJUSTMENT PROCEDURE FOR PICTURE TUBE ION-TRAP MAGNETS 71

An R.C.A. Application Note is published giving recommended procedure for adjusting the ion-trap magnet on either the 17HP4B or 21ALP4A.

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THE OXIDE COATED CATHODE

by
R. C. HOWELLS
A.S.T.C.

INTRODUCTION.

The purpose of this paper is to discuss in general terms the more practical aspects of electron emission from the oxide coated cathode. The manufacturing processes and methods of control are dealt with and a necessarily approximate physical picture is included to assist the understanding of these processes.

HISTORY.

The phenomenon of electron emission from heated bodies was explained by Richardson in 1901. In his investigation he had only considered pure metals as electron emitters. Wehnelt¹ was carrying out similar experiments in 1903, when he noticed that certain regions of the heated platinum wire seemed to emit electrons at a lower temperature. He assumed that this was due to metallic oxide impurities. His following investigations showed that the oxides of the alkaline earth metals gave a higher emission than any of the pure metals tried previously. In 1908 Deininger² found that emission from an oxide cathode had no significant dependence on the base metal. Fredenhagen advanced the view that electron emission was the result of a chemical reaction of the alkaline earth metals in the oxide with gases in the valve³. Probably as a result of this idea, Lieben used oxide cathodes in gas filled amplifying valves, and the high vacuum amplifying valves made by de Forest used metallic cathodes. With the improvement of high vacuum techniques during the first World War, the role of gas in the emission process came under much better control. This period marked the beginning of the mass production use of the oxide coated cathode⁴.

In 1925 Koller put forward the theory that excess barium in the barium oxide was responsible for the emission from the oxide coated cathode⁵. Several other workers substantiated the theory, but some of them in order to construct a physical picture considered that islands of barium existed on the surface of the oxide.

This model would give a higher work function than is observed. Koller and Becker held the view that the excess barium existed as a monomolecular layer. The importance of excess barium seems to be well established but its exact site in the structure is still under study.

In 1930 Lowry advanced the idea that the emission took place at the base metal and that oxide reduced the base metal's work function⁶. His idea was later refuted by experiment, when it was shown that emission was a function of the oxide area

and not the area of the base metal⁷. In the meantime, the commercial use of the oxide coated cathode was firmly established. This success was mainly due to a further reduction of gas pressures, achieved by the use of getters. At about this time the conductivity of the oxide coating came under intensive study. There were many contributors to this investigation and their results may be summarised by saying that the emission is proportional to the conductivity of the oxide.

With the development of radar, which demanded valves with high peak emissions, and later electronic computers, with their operation of valves in the cutoff state for long periods, the region between the oxide and the base metal assumes some importance, and was found to have a conductance low enough to affect operation. This led to an intensive investigation of the interface layer, some aspects of which will be mentioned later.

To sum up the work outlined above, the oxide cathode is now considered to consist of four elements:

- (1) The base metal which supports the oxide and makes electrical contact with it.
- (2) The interface layer formed by a chemical reaction between the base metal or impurities in the base metal and the oxide.
- (3) The oxide which is a semi-conductor of conductivity enhanced by the production of electron donors, apparently due to excess barium.
- (4) The emitting surface which may be characterised by a work function, which describes the energy necessary to extract electrons.

PREPARATION OF THE OXIDE.

An incomplete understanding of the physics of electron emission has not prevented its technological development.

While single oxides were tried first it was soon found that a mixture of barium and strontium oxides gave a much higher emission and improved life. A further improvement was later achieved by adding a small percentage of calcium oxide.

The oxides of barium and strontium combine rapidly with water vapour and carbon dioxide,

which would make the processing of the oxides difficult. Fortunately the carbonates of barium, strontium and calcium are stable enough at normal temperatures and are easily reduced to the oxide in later treatment. They are also very pure when prepared by precipitation methods from their respective nitrates. The care to be taken in every step to achieve cleanliness or purity cannot be emphasized too strongly.

The carbonates of these alkaline earths may be precipitated separately and then mixed together. A more homogeneous aggregate will be obtained if the nitrates of either barium and strontium or barium, strontium and calcium are precipitated as a mixture. The method of precipitation and the temperature of the process control the particle size and shape. The following table illustrates this

statement and also the effect that the particle size has on emission. Generally within the particle size range of 100 to 3 microns the emission increases with decreasing particle size.

There are generally two particle shapes resulting from precipitation methods, needles and spherulites. Needles or sharp pointed particles tend to give rougher cathode coatings than spherulites (globular particles). However, experience shows that coating texture and emission depend more on the method of deposition than on the initial particle shape.

After precipitation the carbonates are ball milled for up to 72 hours. This is another control which the manufacturer has over particle size.

The carbonates are then prepared for deposition on the base metal. A binder such as nitrocellulose and a solvent such as acetone or amyl acetate are generally used.

TABLE 1. (Ref. 8.)

Composition	Method of Preparation	Speed of Precipitation (cm. ³ /min.)	Constitution	Particle size before Milling micron	Particle shape after Milling	Emission in ma. at 1 watt per cm ²
Ba, Sr, 50:50 mol. %	Na ₂ CO ₃ added to nitrates solution.	350 750	Homogeneous double carbonate	3	Fair number of prismatic needles.	130
Ba, Sr, Ca, 56:31:13 % by weight	Na ₂ CO ₃ added to nitrates solution. Made alkaline with NaOH.	350 750	Homogeneous triple carbonate	7	Fair number of needles.	140
Ba, Sr, 50:50 mol. %	(NH ₄) ₂ CO ₃ added to nitrates solution. Made alkaline with NH ₄ OH.	350 750	Homogeneous double carbonate	50	Large aggregates, mainly spherulites.	70

Note. In addition to the particle size the method of depositing controls the emission.

COATING METHODS.

These may be classified under the following groups:

- (1) Spraying
- (2) Dragging
- (3) Electrophoresis
- (4) Painting.

Spraying is universally used for depositing the coating on to the indirectly heated type nickel cathode sleeve. This method can give a great variety of coatings. A wet carbonate mixture gives a hard, smooth coating, which is more difficult to activate but is better for closely spaced indirectly heated rectifiers since it does not sputter as readily under the high field conditions. A drier carbonate mixture gives a rougher fluffy coating, which is easier to activate and generally very suitable for indirectly heated receiving valves.

The wetness of the spray is usually controlled by the distance the sleeve is set from the spray gun. Close spacing gives a fine aggregate in a smooth hard coating and distant spacing gives a coarser

aggregate in a fluffy coating. The spray gun air-pressure is an additional control over this characteristic. If the cathode has been coated with a light fluffy aggregate, the oxide surface is open and degases more easily, also a greater area of oxide exists at the emitting surface and tends to give higher emission. A cathode which has a lighter coating on it will run at a higher temperature for the same power input, and it activates at a lower heater dissipation than a heavy coating.

Dragging is used for directly heated filament types like the 1.4 volt series. The filament is dragged through a series of agitated baths containing the carbonate in water suspension and baked after each immersion. Again the wetness of the mixture may be used to control the coating texture.

Electrophoresis is the migration of charged particles in a suspension under an electric field. This method gives a very dense hard coating of lower emission characteristics, which is sometimes preferred for directly heated rectifiers. **Painting** is only used in special cases, such as magnetron cathodes; it gives a dense hard coating.

Extreme care has to be taken in the cleaning of the base metal prior to coating with the carbonate. Typical treatment would be: washing in three consecutive boiling trichlorethylene baths, followed by boiling distilled water and two alcohol baths. The final treatment is firing at 600°C. in a hydrogen atmosphere for 5 minutes.

The density of the coating must be carefully controlled to maintain plate current, mutual conductance and emission. The sprayed diameter and weight may be measured to within 0.0002" and 0.01 milligramme. A general tolerance in the spraying method is ± 0.0005 " and ± 0.5 milligramme.

EVACUATION.

The valve is evacuated by pumps to a pressure of a few microns of mercury. The metallic parts are heated by induction methods and the filament heated up to temperatures of 1300°K. by passing a current through it. Under this treatment the carbonates are reduced to oxides liberating carbon dioxide, which is drawn off by the pumps. The nitrocellulose is reduced leaving practically no residue.

The temperatures to which the cathode is heated during evacuation and activation are higher than the normal running temperature which is 1000°K.-1100°K. It is vital that the cathode temperature be critically controlled during these processes for the following reasons:

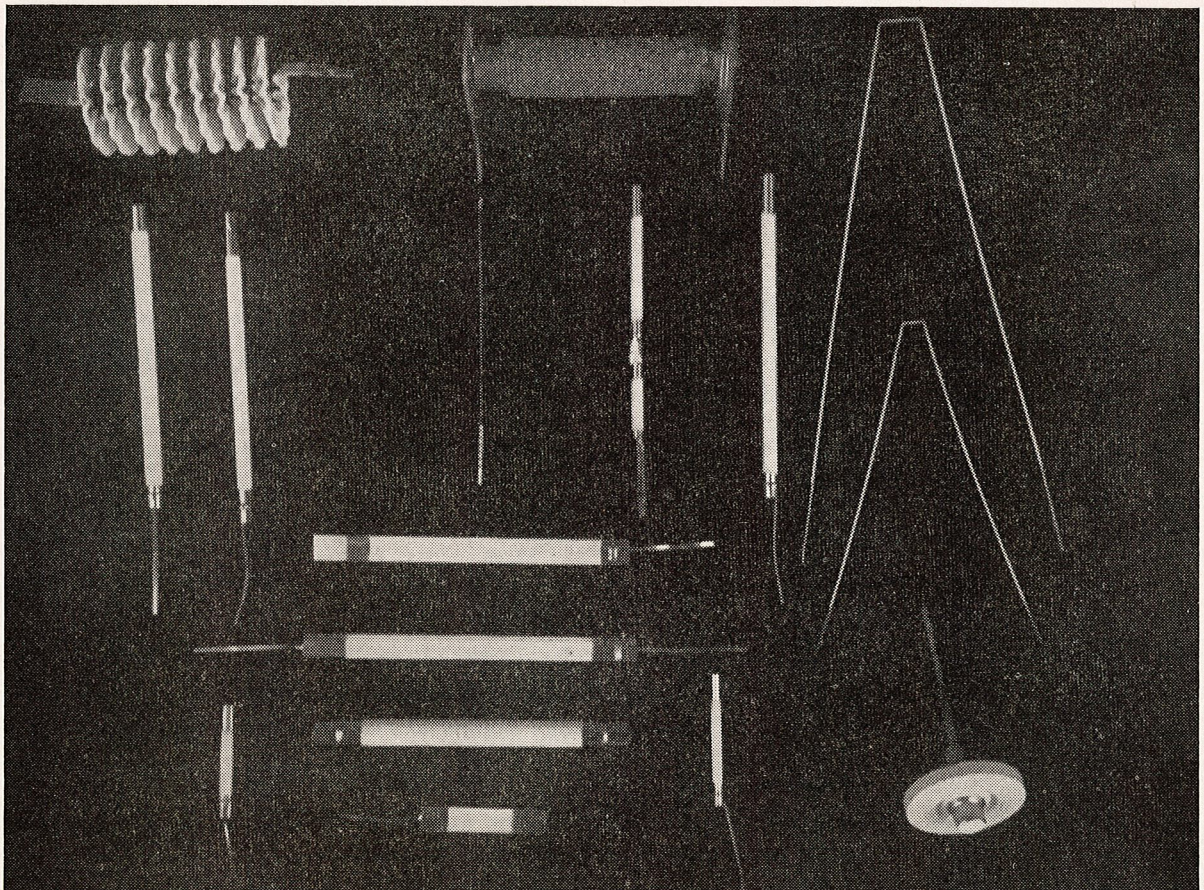
- (1) At temperatures below 1000°K. the carbonate would not decompose easily to the oxide. The oxide coating is prone to poisoning at lower temperatures.
- (2) At temperatures above 1300°K. the nickel sleeve is likely to soften, with consequent reduction in strength. The life of the heater is likely to be impaired by over running. The evaporation of nickel and barium on to mica insulators causes interelectrode leakage and capacitance changes, the evaporation of barium on to other electrodes causing stray emission.

ACTIVATION AND STABILISATION.

The presence of excess barium in the oxide was mentioned earlier. Diffusion and electrolysis also seem to play important roles in the emission process. Research workers at the present time are reluctant to claim any certainty in their ideas of exactly what takes place in the oxide during processing. The following observations can, however, be made.

If the valve is tested after the evacuation process, the emission will be small. It is reasonable to think that at this stage the decomposition of the coating is not complete for two reasons:

- (1) After the valve has been treated for a few minutes at a high cathode temperature and



is retested, the emission will approach its normal value and the valve will also be gassy.

- (2) It has been possible to produce valves experimentally with good emission immediately after evacuation. But this has been achieved only by over-running the heater during the evacuation process.

The first stage of cathode activation is then usually a period lasting a few minutes during which the cathode is heated above its normal operating temperature. If the valve is operated on life test at this stage, its emission characteristics would slump within 2-4 hours and recuperate in about 24 hours. Stall has shown that the metallic parts cannot be degased by heating alone⁸. He showed that carbon monoxide was liberated from the plate of the diode by electron bombardment. This explains the temporary slump on life; it is due to the evolution of gas from the plates and grids, which have been bombarded by the electrons of the plate and screen currents. This trouble may be eliminated by drawing a high current from the cathode to the electrodes bombarding them. If the valve is tested at this stage, the emission characteristics would have decreased and it would be very gassy.

The emission may be increased with a further short "Filament-only" run, which reactivates the cathode.

The final stage is a period in which the valve is run at approximately normal cathode temperatures while a normal cathode current is drawn to the plate and screen. This keeps the cathode hot and the gas in an ionised state which assists the getter to absorb it.

The valve is now ready for testing, and will, under normal conditions show only a gradual decrease in emission characteristics during its life.

ADDITIONAL CONTROLLING FACTORS.

There are other factors which effect the emission characteristic of the cathode. The even heating of a cathode is essential, hence a badly positioned heater may cause trouble. The heat carried away by mica insulators and cathode connections is noticeable and must be allowed for in design. A heavier coating of oxide will reduce the cathode temperature and in a filament type the filament current will noticeably increase as a result. The radiation coefficient of the oxide likewise has the

same effect.

Silicon and manganese are two of the controlled impurities in the nickel used for cathode sleeves. These impurities hasten the activation of the oxide, the exact reason for which is not known, though some investigators think that they act as a catalyst for the oxide.

UNFAVOURABLE EFFECTS ON LIFE.

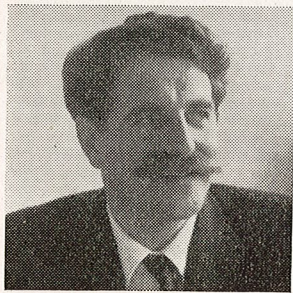
The formation on life of an interface layer between the oxide and the nickel sleeve and the effect this layer has on the valve's operation will be briefly summarised. The layer is the result of a chemical action between barium from the oxide and silicon from the nickel sleeve, forming barium orthosilicate which is a semi-conductor. The equivalent circuit of the layer is a parallel RC circuit in series with the cathode circuit.

The interface problem has now been reduced considerably by using a low silicon content nickel in the cathode sleeve.

The loss of emission characteristics over life can be due to two causes; poisoning and evaporation. Poisoning is the result of reactions between the coating and gasses or solid materials which have originated from components in the valve. Poisoning is unavoidable in a valve after long periods of operation. The rate of poisoning increases inversely as the cathode temperature, since at higher temperatures any foreign poisoning agent will be evaporated from the cathode at a higher rate. Evaporation of the coating from the sleeve during life must also be considered, this trouble is naturally accelerated at higher cathode temperatures. The cathode must then operate at a temperature of equilibrium where evaporation and poisoning effects are minimum. Evaporation causes other serious effects apart from loss of emission. The increase of interelectrode capacitance and leakage on life is usually the result of deposits of a conducting film on the mica insulators.

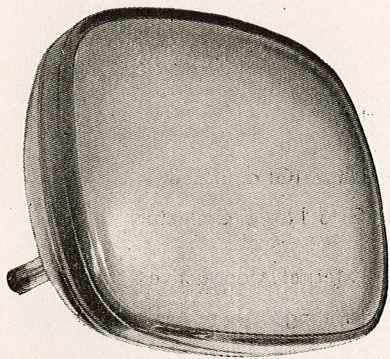
REFERENCES.

- (1) A. Wehnelt, Ann. der Physic, Series 4, 4, 425 (1904).
- (2) F. Deininger, Ann. der Physic, Series 4, 25, 285 (1908).
- (3) K. Fredenhagen, Phys., Zeit., 13 539 (1912); Phys., Zeit., 15 19 (1914).
- (4) H. D. Arnold, Phys. Rev., 16 70 (1920).
- (5) L. R. Koller, Phys. Rev., 25 671 (May, 1925).
- (6) E. F. Lowry, Phys. Rev., 35 1367 (1930).
- (7) J. A. Becker and R. W. Sears, Phys. Rev., 38 2193 (1931).
- (8) G. Herrmann and S. Wagener, The Oxide Coated Cathode, Vol. 1, p. 30.
- (9) S. J. Stoll, Brit. Journal App. Phys., Vol 7, No. 3 (March, 1956).



Mr. R. C. Howells was a cadet mechanical engineer from 1939-1942 when he joined the R.A.A.F. During this period he worked on maintenance and installation problems of U.H.F. and centimetre ground and airborne radar equipment.

He joined the staff of A.W.V. in 1946 and since then has worked on the problems associated with quality test equipment design. He is now engineer in charge of standard type receiving valve production.



RADIOTRON 21ALP4A

PICTURE TUBE

The Radiotron 21ALP4A is a short, directly-viewed, rectangular glass picture tube of the low-voltage electrostatic focus and magnetic-deflection type. It has a spherical filterglass faceplate, an aluminized screen $19\frac{1}{8}'' \times 15''$ with slightly curved sides and rounded corners, and a minimum projected screen area of 255 square inches. Other design features of the 21ALP4A include an external conductive coating, which with the internal conductive coating forms a supplementary filter capacitor and an ion-trap gun requiring an external single-field magnet.

In the May and June 1956 issues of Radiotronics there are two articles which should be read in conjunction with this data. They are "Radiotron 17HP4B Picture Tube, Operation and Application" by F. J. Roberts and "Picture Tube Mounting" by H. Wilshire.

The principle of operation of the 21ALP4A is identical to that of the 17HP4B. For a data sheet suitable for inclusion in the valve data book TV1, "TV and Receiving Valves and Components", write to Radiotronics, and a sheet will be provided free of charge.

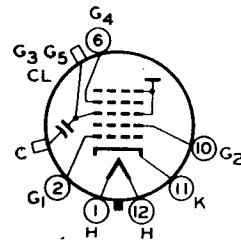
GENERAL DATA

Heater Voltage	6.3 volts	Ion-Trap Gun:	
Heater Current	0.6 amp.		Requires External, Single-Field Magnet
Direct Interelectrode Capacitances:		Tube Dimensions:	
Grid No. 1 to all other electrodes	6 $\mu\mu\text{F}$	Overall Length	20" $\pm \frac{3}{8}$ "
Cathode to all other electrodes	5 $\mu\mu\text{F}$	Greatest Width	20 $\frac{1}{4}$ " $\pm \frac{1}{8}$ "
External conductive coating to ultor	$\left\{ \begin{array}{l} 750 \text{ max. } \mu\mu\text{F} \\ 500 \text{ min. } \mu\mu\text{F} \end{array} \right.$	Greatest Height	16 $\frac{3}{8}$ " $\pm \frac{1}{8}$ "
Faceplate, Spherical		Filterglass	Diagonal
Light transmission (approx.)	75%	Screen Dimensions (minimum):	
Phosphor, metal-backed	P4-Sulphide Type	Greatest Width	19 $\frac{1}{8}$ "
Fluorescence	White	Greatest Height	15"
Phosphorescence	White	Diagonal	20 $\frac{1}{4}$ "
Persistence	Short	Projected area	255 sq. in.
Focusing Method	Electrostatic	Cap	Recessed small cavity (JETEC No. J1-21)
Deflection Method	Magnetic	Bulb	J171
Deflection Angles (approx.):		Base	Small-Shell Duodecal 6-pin (JETEC No. B6-63)
Diagonal	90°	Weight (approx.)	24 lbs.
Horizontal	85°	Mounting Position	Any
Vertical	68°		

SOCKET CONNECTIONS

(bottom view)

- Pin 1—Heater
- Pin 2—Grid No. 1
- Pin 6—Grid No. 4
- Pin 10—Grid No. 2
- Pin 11—Cathode



- Pin 12—Heater
- Cap—Ultor (Grid No. 3
Grid No. 5 Collector)
- C—External Conductive
Coating.

GRID-DRIVE SERVICE

Grid drive is the operating condition in which the video signal varies the grid-No. 1 potential with respect to cathode.

(Unless otherwise specified, voltage values are positive with respect to cathode.)

Maximum Ratings, Design-Centre Values:

Ultor • Voltage	18000	volts
Grid No. 4 Voltage:		
Positive value	1000	volts
Negative value*	500	volts
Grid No. 2 Voltage	500	volts
Grid No. 1 Voltage:		
Negative bias value	125	volts
Positive bias value	0	volts
Positive peak value	2	volts
Peak Heater-Cathode Voltage:		
Heater negative with respect to cathode:		
During equipment warm-up period not exceeding 15 seconds	410	volts
After equipment warm-up period	180	volts
Heater positive with respect to cathode	180	volts

Equipment Design Ranges:

(With any Ultor Voltage (E_{c5k}) between 14000# and 18000 volts
and Grid No. 2 Voltage (E_{c2k}) between 200 and 500 volts)

Grid No. 4 Voltage for Focus with Ultor Current of 100 μ amp	— 0.45% to + 2.2% of E_{c5k}	volts
Grid No. 1 Voltage for Visual Extinction of Focused Raster	— 9.3% to — 24% of E_{c2k}	volts
Grid No. 1 Video Drive from Raster Cutoff (Black Level):		
White Level Drive (Peak Positive)	9.3% to 24% of E_{c2k}	volts
Grid No. 4 Current	— 25 to + 25	μ amp
Grid No. 2 Current	— 15 to + 15	μ amp
Minimum Field Strength of PM Ion-Trap Magnet §	$\sqrt{\frac{E_{c5k}}{16000}} \times 33$	oersteds
Ion-Trap Magnet Current** (average)	$\sqrt{\frac{E_{c5k}}{16000}} \times 30$	mA
Field Strength of Adjustable Centring Magnet	0 to 8	oersteds

Examples of Use of Design Ranges:

With Ultor Voltage of	16000	18000	volts
And Grid No. 2 Voltage of	300	400	volts
Grid No. 4 Voltage for Focus with Ultor Current of 100 μ amp	— 65 to + 350	— 75 to + 400	volts
Grid No. 1 Voltage for Visual Extinction of Focused Raster	— 28 to — 72	— 37 to — 96	volts
Grid No. 1 Video Drive from Raster Cutoff (Black Level):			
White-Level Drive (Peak Positive)	28 to 72	37 to 96	volts
Minimum Field Strength of PM Ion-Trap Magnet	33	35	oersteds

Maximum Circuit Values:

Grid No. 1 Circuit Resistance	1.5	megohms
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CATHODE-DRIVE SERVICE

Cathode drive is the operating condition in which the video signal varies the cathode potential with respect to Grid No. 1 and the other electrodes..

(Unless otherwise specified, voltage values are positive with respect to Grid No. 1.)

Maximum Ratings, Design-Centre Values:

Ultor to Grid No. 1 Voltage	18000	volts
Grid No. 4 to Grid No. 1 Voltage: .		
Positive value	1000	volts
Negative value*	500	volts
Grid No. 2 to Grid No. 1 Voltage	625	volts
Grid No. 2 to Cathode Voltage	500	volts
Cathode to Grid No. 1 Voltage:		
Positive bias value	125	volts
Negative bias value	0	volts
Negative peak value	2	volts
Peak Heater-Cathode Voltage:		
Heater negative with respect to cathode:		
During equipment warm-up period not exceeding 15 seconds	410	volts
After equipment warm-up period	180	volts
Heater positive with respect to cathode	180	volts

Equipment Design Ranges:

(With any Ultor to Grid No. 1 Voltage (E_{c5g1}) between 14000# and 18000 volts
and Grid No. 2 to Grid No. 1 Voltage (E_{c2g1}) between 220 and 620 volts)

Grid No. 4 to Grid No. 1 Voltage for Focus with Ultor Current of 100 μ amp	0% to 2.6% of E_{c5g1}	volts
Cathode to Grid No. 1 Voltage for Visual Extinction of Focused Raster	8.5% to 19.4% of E_{c2g1}	volts
Cathode to Grid No. 1 Video Drive from Raster Cutoff (Black Level): White-Level Value (Peak negative)	8.5% to 19.4% of E_{c2g1}	volts
Grid No. 4 Current	— 25 to + 25	μ amp
Grid No. 2 Current	— 15 to + 15	μ amp
Minimum Field Strength of PM Ion-Trap Magnet (approx.)	$\sqrt{\frac{E_{c5g1}}{16000}} \times 33$	oersteds
Ion-Trap Magnet Current** (average)	$\sqrt{\frac{E_{c5g1}}{16000}} \times 30$	mA
Field Strength of Adjustable Centring Magnet	0 to 8	oersteds

Examples of Use of Design Ranges:

With Ultor to Grid No. 1 Voltage of.....	16000	18000	volts
And Grid No. 2 to Grid No. 1 Voltage of.....	300	400	volts
Grid No. 4 to Grid No. 1 Voltage for Focus with Ultor Current of 100 μ amp	0 to 415	0 to 470	volts
Cathode to Grid No. 1 Voltage for Visual Extinction of Focused Raster	25 to 58	34 to 78	volts
Cathode to Grid No. 1 Video Drive from Raster Cutoff (Black Level): White-Level Value (Peak negative)	25 to 58	34 to 78	volts
Minimum Field Strength of PM Ion-Trap Magnet	33	35	oersteds

Maximum Circuit Value:

Grid No. 1 Circuit Resistance	1.5	megohm
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The "ultor" in a cathode-ray tube is the electrode to which is applied the highest d.c. voltage for accelerating the electrons in the beam prior to its deflection.

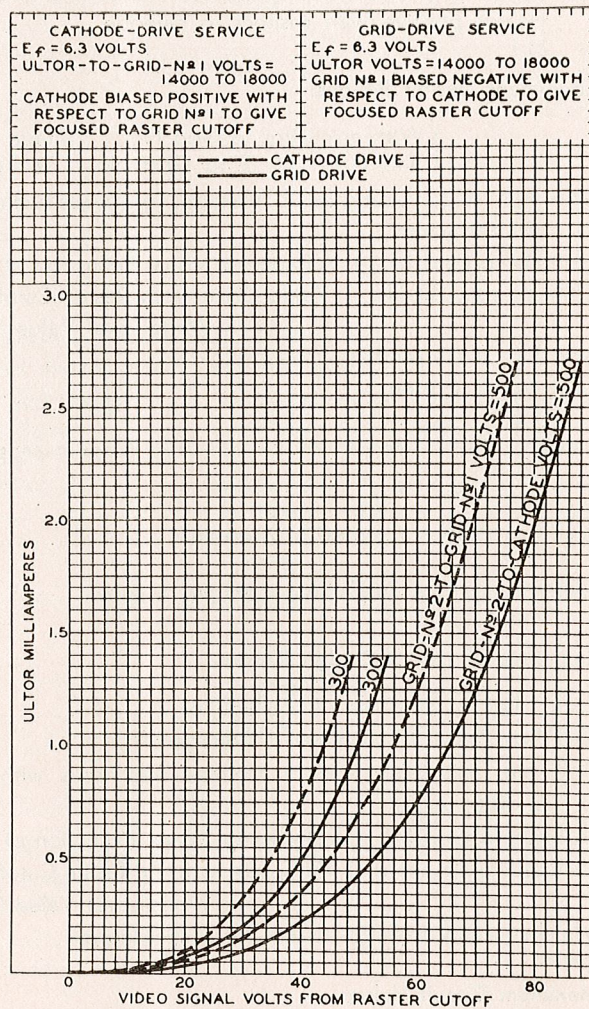
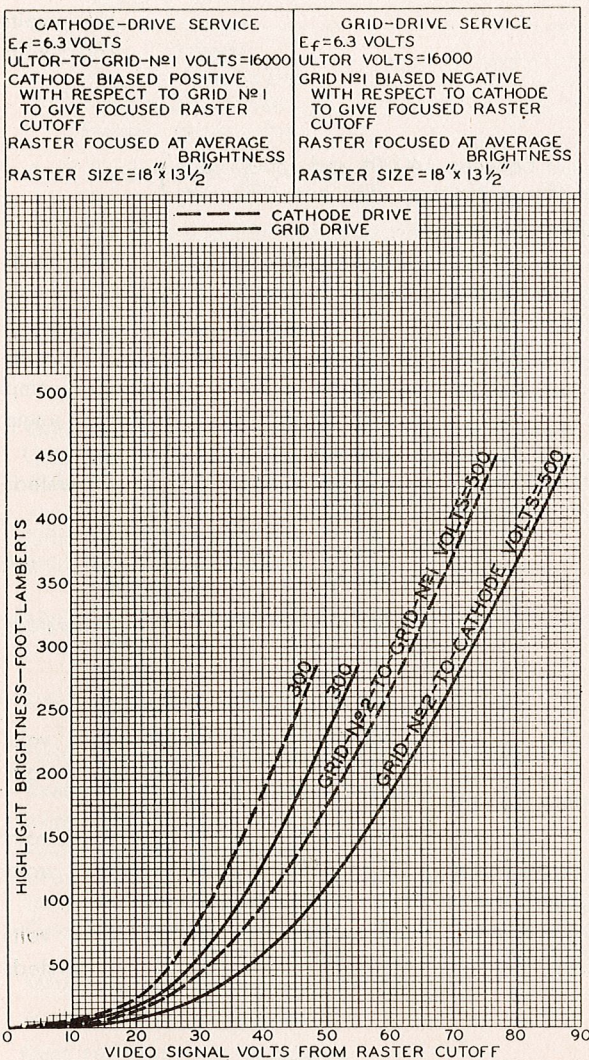
In the 21ALP4A, the ultor function is performed by grid No. 5. Since grid No. 5, No. 3, and collector are connected together within the 21ALP4A, they are collectively referred to simply as "ultor" for convenience in presenting data and curves.

* This value has been specified to take care of the condition where an a.c. voltage is provided for dynamic focusing.

Brilliance and definition decrease with decreasing ultor voltage or ultor-to-grid-No. 1 voltage. In general, the ultor voltage or the ultor-to-grid-No. 1 voltage should not be less than 14000 volts.

** For specimen ion-trap magnet similar to JETEC Ion-Trap Magnet No. 117 located in optimum position and rotated to give maximum brightness.

§ For specimen PM ion-trap magnet located in optimum position and rotated to give maximum brightness. For a given equipment application, the tolerance range for the strength of the PM ion-trap magnet should be added to the minimum value. The maximum strength of this magnet should not exceed the specified minimum value by more than 6 oersteds. This procedure will ensure use of a PM ion-trap magnet allowing adequate adjustment to permit satisfactory performance without loss of highlight brightness.



NOTE 1.

The plane through the tube axis and pin No. 6 may vary from the plane through the tube axis and bulb terminal by angular tolerance (measured about the tube axis) of 30°. Bulb terminal is on the same side as Pin No. 6.

NOTE 2.

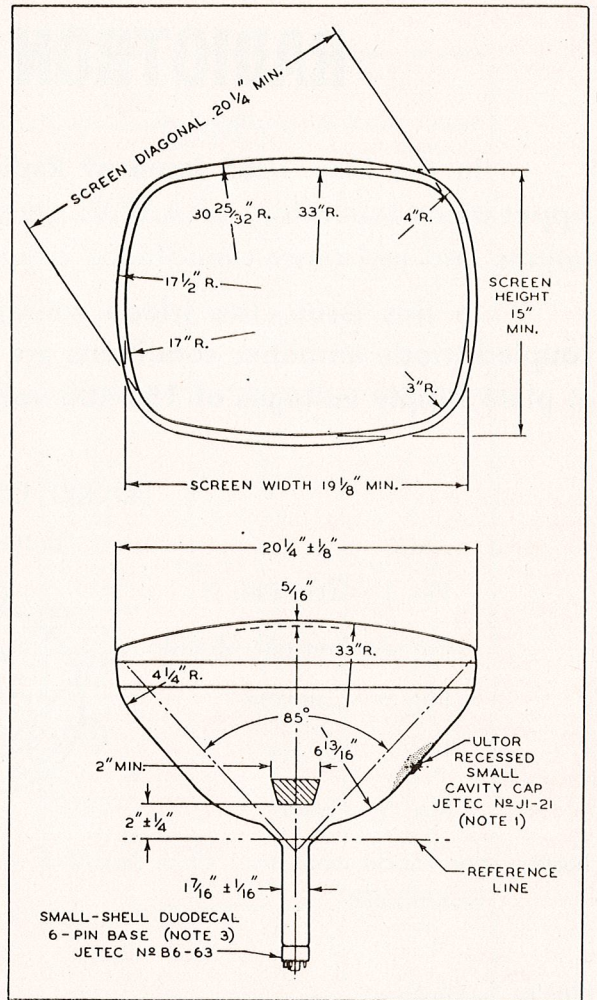
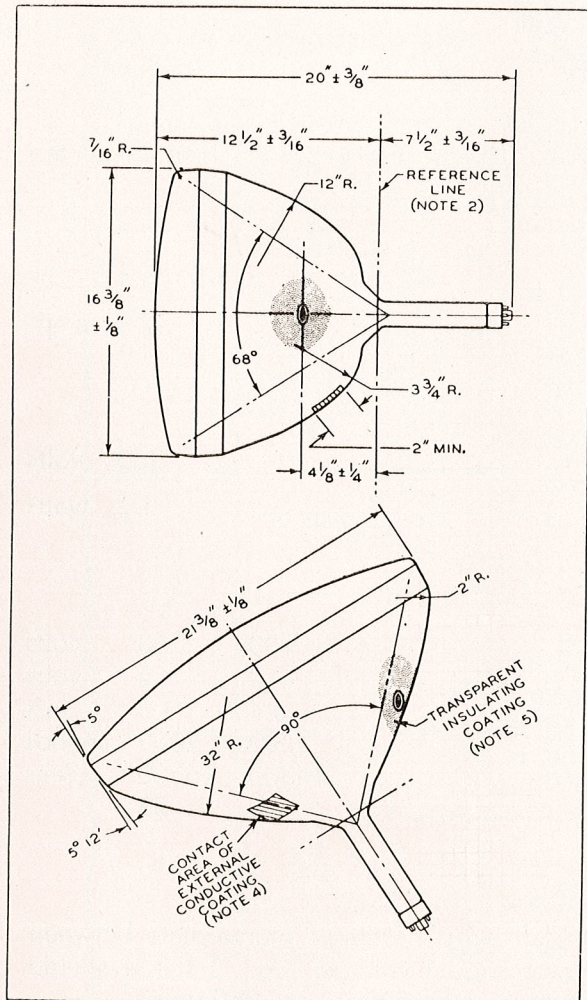
With tube neck inserted through flared end of reference-line gauge (JETEC No. 116) and with tube seated in gauge, the reference line is determined by the intersection of the plane CC' of the gauge with the glass funnel.

NOTE 3.

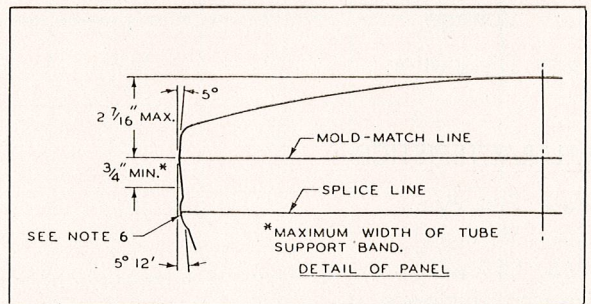
Socket for this base should not be rigidly mounted; it should have flexible leads and be allowed to move freely. Bottom circumference of base shell will fall within a circle concentric with bulb axis and having a diameter of 3".

NOTE 4.

The drawing shows minimum size and location of the contact area of the external conductive coating. The actual area of this coating will be



greater than the contact area so as to provide the required capacitance. External conductive coating must be grounded.



NOTE 5.

To clean this area, wipe only with soft dry lintless cloth.

NOTE 6.

Seal bulge may protrude not more than 1/8 inch beyond maximum indicated value for envelope width, diagonal, or height.

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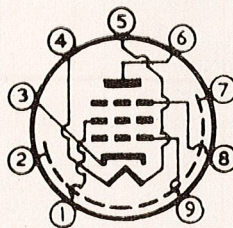
In the May 1955 issue of Radiotronics a report was published by the Applications Laboratory of A.W.V. giving general applicational data on pentode ratings and resistance-capacitance coupled pentode amplifier conditions.

In this issue, the triode ratings are given and resistance capacitance coupled triode amplifier conditions are tabled for outputs of 10 and 33 Vr.m.s. at plate supply voltages of 150-400 volts.

SOCKET CONNECTIONS

(bottom view)

Pin 1—Grid No. 2
 Pin 2—Internal Shield
 Pin 3—Cathode
 Pin 4—Heater
 Pin 5—Heater



Pin 6—Plate
 Pin 7—Internal Shield
 Pin 8—Grid No. 3
 Pin 9—Grid No. 1

Note:—For triode operation Grid No. 2 is connected to plate and Grid No. 3 is connected to cathode.

Heater Voltage 6.3 volts
 Heater Current 0.2 amp.

MAXIMUM RATINGS

Plate Voltage 250 volts
 Plate Dissipation 1.2 watts

CHARACTERISTICS

Plate Supply	100	250	volts
Grid Voltage	0	—5	volts
Plate Current	6.4	3.6	mA
Transconductance	2800	2050	μ mhos
Plate Impedance	14300	16200	ohms
Amplification Factor	40	33	

PLATE SUPPLY VOLTAGE

When conditions are required for a value of plate supply voltage intermediate between the figures published, use the conditions for the lower supply voltage, e.g., if the available supply is 230 volts, use conditions given for 200 volts rather than those for 250 volts.

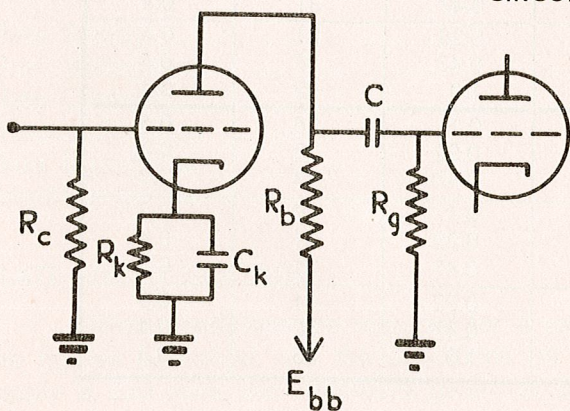
1. Output Voltage 10 volts r.m.s.

Ebb V	Rb M Ω	Rk Ω	Ib mA	Rg M Ω	V.G.	T.H.D. %
150	0.047	2400	1.0	0.1	20	3.4
				0.22	22	2.6
				0.47	22	2.2
	0.1	3600	0.65	0.1	22	3.4
				0.22	24	2.3
				0.47	25	1.9
	0.22	7500	0.30	0.22	24	3.4
				0.47	26	2.2
				1.0	27	1.8
200	0.047	1300	1.7	0.1	23	1.4
				0.22	24	1.1
				0.47	25	0.9
	0.1	2200	1.0	0.1	25	1.7
				0.22	27	1.2
				0.47	28	0.9
	0.22	4300	0.5	0.22	27	1.7
				0.47	29	1.2
				1.0	30	0.9
250	0.047	910	2.1	0.1	24	0.8
				0.22	26	0.7
				0.47	26	0.6
	0.1	1600	1.4	0.1	26	1.0
				0.22	28	0.7
				0.47	30	0.5
	0.22	3000	0.7	0.22	29	1.1
				0.47	30	0.8
				1.0	31	0.7
300	0.047	680	3.4	0.1	26	0.6
				0.22	26	0.5
				0.47	27	0.4
	0.1	1200	1.8	0.1	27	0.7
				0.22	29	0.5
				0.47	30	0.4
	0.22	2400	0.9	0.22	30	0.8
				0.47	31	0.6
				1.0	32	0.5
350	0.047	680	4.0	0.1	26	0.5
				0.22	27	0.4
				0.47	27	0.4
	0.1	1000	2.3	0.1	28	0.5
				0.22	30	0.4
				0.47	31	0.4
	0.22	2000	1.2	0.22	31	0.6
				0.47	32	0.5
				1.0	32	0.4
400	0.047	620	4.7	0.1	26	0.5
				0.22	28	0.4
				0.47	28	0.3
	0.1	1000	2.7	0.1	29	0.5
				0.22	31	0.4
				0.47	31	0.3
	0.22	2000	1.4	0.22	31	0.5
				0.47	32	0.4
				1.0	33	0.3

2. Output Voltage 33 volts r.m.s.

Ebb V	Rb MΩ	Rk Ω	Ib mA	Rg MΩ	V.G.	T.H.D. %
250	0.047	2400	1.6	0.1	22	7.1
				0.22	23	5.3
				0.47	24	4.3
	0.1	3900	1.0	0.1	23	7.7
				0.22	26	5.0
				0.47	27	3.8
	0.22	6800	0.5	0.22	26	6.1
				0.47	28	4.0
				1.0	30	3.0
300	0.047	1500	2.5	0.1	24	3.3
				0.22	26	2.4
				0.47	27	2.1
	0.1	2400	1.5	0.1	26	3.5
				0.22	29	2.4
				0.47	30	2.0
	0.22	4300	0.8	0.22	29	3.5
				0.47	31	2.3
				1.0	32	1.9
350	0.047	1000	3.6	0.1	26	2.0
				0.22	27	1.6
				0.47	28	1.4
	0.1	1800	2.0	0.1	28	2.4
				0.22	30	1.7
				0.47	31	1.3
	0.22	3300	1.0	0.22	30	2.4
				0.47	32	1.7
				1.0	33	1.4
400	0.047	820	4.4	0.1	27	1.5
				0.22	28	1.3
				0.47	29	1.1
	0.1	1300	2.5	0.1	30	1.7
				0.22	32	1.2
				0.47	32	0.9
	0.22	2700	1.3	0.22	32	1.8
				0.47	33	1.4
				1.0	34	1.2

CIRCUIT DIAGRAM



- Ebb — plate supply voltage
- Rb — plate load resistor
- Rg — following grid resistor
- Rk — cathode resistor
- Ib — plate current
- V.G. — voltage gain
- T.H.D. — total harmonic distortion

ADJUSTMENT PROCEDURE FOR PICTURE TUBE ION-TRAP MAGNETS

This note describes a recommended procedure for adjusting ion-trap magnets to obtain maximum picture brightness and to minimise the possibility of damage to picture tubes. Misadjustments of the ion-trap magnet may cause imperfect centring of the picture tube electron beam and result in excessive bombardment of the masking aperture within the electron gun. As a result of such bombardment, ions may be formed beyond the control of the ion trap and produce an ion spot on the fluorescent screen.

RECOMMENDED PROCEDURE

1. Centre the deflecting yoke on the tube neck and press the mounting-bracket cushion firmly against the glass funnel. For a tube using electrostatic focus, a small adjustable centring magnet is usually required. It should be placed on the tube as shown.
2. Place the ion-trap magnet on the tube neck. The initial position of the magnet should be in accordance with the instructions given in the data for the specific tube type. For such tubes as the Radiotron 17HP4B and 21ALP4A, the proper initial position of the ion-trap magnet is as shown in the figure.
3. Adjust the brightness or background control of the television receiver midway between its minimum and maximum positions and set the picture or contrast control to its minimum position. The brightness-control adjustment will provide the picture tube with grid-No. 1 voltage approximately midway between zero and cutoff; the picture-control adjustment will provide a blank raster on the picture tube screen for observation during subsequent adjustments.
4. With the controls set as indicated in (3), apply operating voltages to the tube. As soon as the tube cathode reaches operating temperature, adjust the position of the ion-trap magnet by moving it a short distance forward or backward and rotating it slightly until maximum brightness is obtained at the centre of the raster. It is important that this adjustment be made with the brightness control set, as specified in (3) midway between the minimum and maximum positions so as to keep the beam current low. It is equally important that the adjustment of the ion trap-magnet be completed quickly because operation of the picture tube with the ion-trap magnet improperly positioned may damage the tube. With certain picture tubes, particularly those utilizing electrostatic focus, two positions of the ion-trap magnet may be found in which maximum brightness is produced. The correct position is that which is nearer the base of the tube.
5. Focus the pattern and centre it. If a shadow appears at the edge of the raster, check the position of the deflecting yoke to make sure that it bears firmly against the glass funnel and centred on the picture tube neck. If any shadow remains, eliminate it by adjusting the position of the centring magnet. If this adjustment reduces maximum brightness at the centre of the screen or disturbs centring and focus, repeat steps (4) and (5). Never adjust the ion-trap magnet to centre the pattern; never adjust it to eliminate neck shadow if such adjustment reduces the brightness at the centre of the screen.
6. With the picture control in its minimum position, turn the brightness control to its maximum setting and readjust the ion-trap magnet as indicated in (4) until maximum light output at the centre of the raster is again obtained. Bowing of opposite sides of the raster in the same direction may occur if the ion-trap magnet has improper rotational position.
7. Adjust the brightness and picture controls to obtain a picture of normal brightness. Readjust centring and focus if necessary. If this step requires any appreciable change in centring or focus, repeat operation (6) to recheck position of the ion-trap magnet.

* Printed with acknowledgment to R.C.A.

