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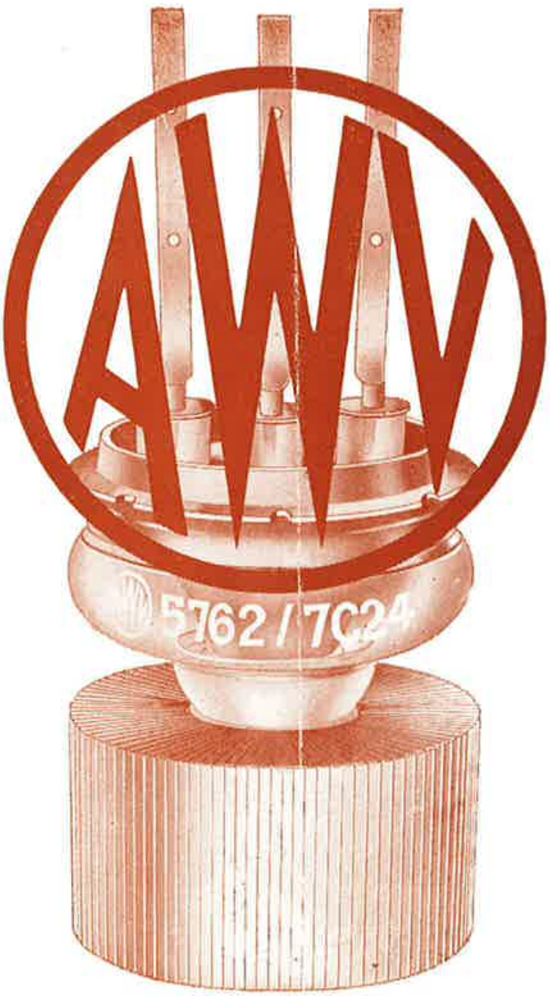

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AMALGAMATED WIRELESS VALVE COMPANY PTY. LTD.

IN THIS ISSUE

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

HAVE YOU ENTERED YOUR SUBSCRIPTION FOR 1957?

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VIDEO I-F AMPLIFIER

By R. DARNELL, A.S.T.C., A.M.I.R.E. (Aust.), Grad. I.E. (Aust.).

The requirements of a video i-f amplifier for a television receiver are discussed and some design details of an amplifier using the Radiotron 6CB6 to fulfil these requirements given. The alignment procedure with some relevant problems is also detailed.

Requirements of the I-F Amplifier

Much has been written about the requirements of the i-f amplifier in a television receiver. The Australian Broadcasting Control Board has allotted a frequency spectrum for use by television receiver manufacturers for the i-f channel which will be kept as free from interfering signals as is possible. The recommendation is to use 36 Mc/s as the i-f vision carrier frequency and 30.5 Mc/s as the i-f sound carrier frequency.

Where the r-f channels are directly adjacent it is possible to get interference from the adjacent channel vision or sound carriers which can hetrodyne with the oscillator frequency in the tuner to produce 29 Mc/s and 37.5 Mc/s interference signals. To minimise the possibility of this interference showing on the picture, trap circuits are provided in the i-f amplifier to attenuate these signals. A trap circuit is also used to attenuate the accompanying sound i-f carrier relative to the vision i-f carrier for two reasons:—

1. To allow the vision carrier to be predominant at the second detector (video detector) to ensure satisfactory demodulation of the sound i-f carrier.
2. To prevent frequency modulation patterns from reaching the picture tube. Further attenuation is usually provided in the video amplifier circuit.

Vestigial side-band transmission has been standardized for television broadcasting in Australia. This means that one sideband and a "vestige" or "remnant" of the other are transmitted. This is used because of the smaller transmitter bandwidth required. A further advantage is that the possibility of ghosts appearing due to phase differences between the two sidebands is eliminated. The transmitter amplitude characteristic is then as shown in Fig. 1 (a). The detected output amplitude characteristic obtained from such a transmission is shown in Fig. 1 (b). Here twice the output is obtained for the low frequencies where energy is obtained from both sidebands. To overcome this and obtain a flat overall response, the receiver response curve must be suitably shaped as shown in Fig. 1 (c).

The actual bandwidth of the video i-f channel is left entirely to the manufacturer. A db bandwidth

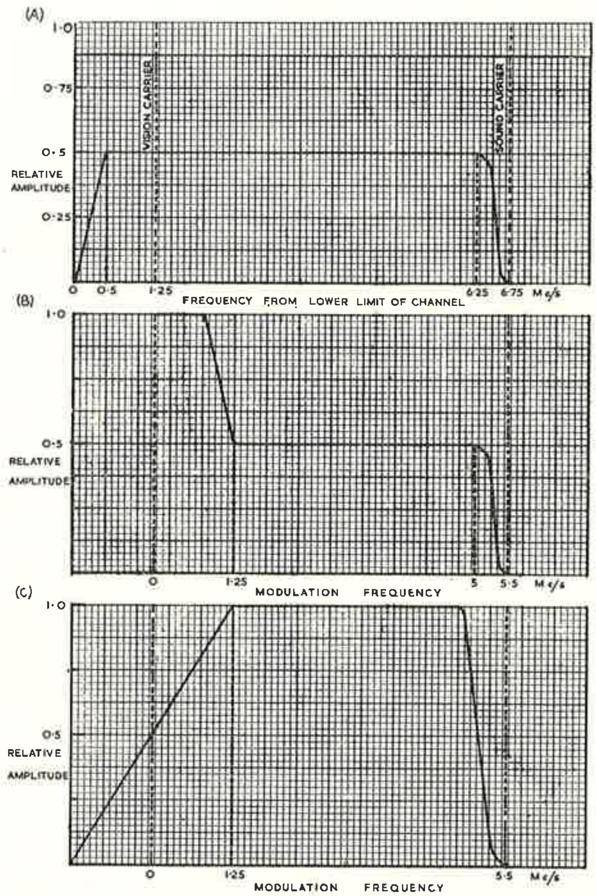


Fig. 1. (A) Transmitted Amplitude Characteristic.
(B) Detected Amplitude Characteristic.
(C) Ideal Receiver I-F Response Curve.

of 4.25 Mc/s will give very good resolution. Any increase over this will be increasing the noise spectrum for additional resolution which would be practically impossible to see, particularly on a moving picture.

Bifilar wound transformers are commonly used for interstage coupling in stagger-tuned i-f amplifiers. The additional winding cost is considered to be quite negligible when compared with the saving of a coupling capacitor. Adequate insulation between the two windings must be provided because the plate winding will be at the plate supply voltage.

The use of bifilar transformers also ensures better noise immunity. Where a coupling capacitor and grid leak are used, with the coupling coil in the plate circuit, high noise peaks can cause the following valve to draw grid current, causing a charge to be built up on the coupling capacitor and the valve to be biased off. If the time constant of the coupling capacitor and grid leak resistor are high enough this bias can be maintained long enough to affect the picture. A noise impulse causes the gain of the stage to drop and although the noise impulse itself, which pushes the modulation into the black level, is not very noticeable, it is followed by a white tail due to the drop in gain of the amplifier. This can be overcome, of course, by placing the coil in the grid circuit and feeding the plate through the damping resistor, but this requires a higher supply voltage.

Input Circuit

It is common practice to feed from the r-f tuner through a low impedance circuit to the i-f strip. The impedance of this circuit will vary for tuners of different manufacturers but is normally below 100 ohms. Hence the first requirement is a step-up transformer to match the low impedance "link" circuit to the grid of the first valve. This circuit may take several forms, perhaps the simplest and easiest to adjust being the one used here and illustrated in Fig. 2.

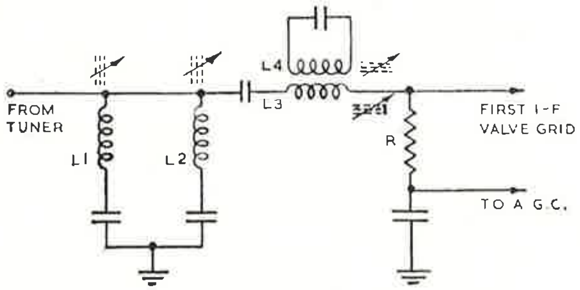


Fig. 2. Input Circuit.

The inductances L_1 and L_2 with their associated capacitances form the adjacent channel sound and vision traps, and the coil L_3 as part of a pi-matching network. The coil L_4 is coupled to L_3 and is tuned to the intermediate sound carrier frequency. The coupling may be adjusted to give the desired attenuation. Overseas experience has been that for equivalent effect on the picture, the interfering signal from the adjacent channel on the lower side (adjacent channel vision carrier) must be 11 db stronger than the interfering signal from the adjacent channel on the higher side (adjacent channel sound carrier). Hence, the attenuation of the adjacent channel sound carrier (37.5 Mc/s) should be greater than that for the adjacent channel vision carrier (29 Mc/s). For this reason the 37.5 Mc/s coil is usually a high Q coil wound on a large former from about 16 gauge copper wire whereas the 29 Mc/s trap coil L_2 can be wound on a smaller diameter former with a small gauge wire.

Valves

Four valves have been used, the first three (a Radiotron 6AU6 and two Radiotron 6CB6's) forming a staggered triple and the fourth (a 6CB6) feeding the video detector via a wide-band transformer. A.G.C. has been applied to the first two stages. From the curves given in the previous article, a value of unbypassed cathode resistor can be chosen for which the input impedance changes in the 6CB6 for different a.g.c. voltages are a minimum.[1] In this circuit the cathode resistor in the first valve (6AU6) is left unbypassed but the cathode resistor of the controlled 6CB6 is bypassed. The values of cathode resistance have been chosen to give the desired change in overall response with a.g.c. voltage changes. The effect is to broaden the response when weak signals are being received and thus reduce the difference in level between the vision and sound carriers. This effect can be seen in Fig. 3.

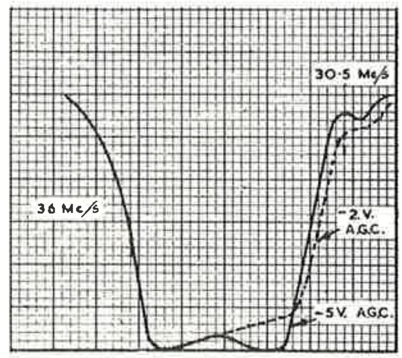


Fig. 3. Effect of a.g.c. on overall response.

Staggered Triple

The staggered triple has been designed to have a 4.25 Mc/s bandwidth with a centre frequency of 33.88 Mc/s. The following information can be obtained by calculation[2]:—

	Stage 1	Stage 2	Stage 3
Centre Frequency	32 Mc/s	35.7 Mc/s	33.9 Mc/s
Bandwidth	2.13 Mc/s	2.13 Mc/s	4,25 Mc/s
Q	15.1	16.8	8
Damping Required	3040 ohms	3810 ohms	1705 ohms
Added Resistor	5.6 K ohms	8.2 K ohms	2.2 K ohms

The damping resistance is the parallel combination of the equivalent parallel resistance of the coil, the resistance of added resistor and the grid input resistance of the following valve (the plate resistance of the preceding valve is large enough to be neglected).

The input resistance of the following valve can be obtained from information given on page 55 of Radiotron Designers' Handbook. An extrapolation of the frequency-input conductance curve is shown in Fig. 4. From this curve at 34 Mc/s the input resistance is approximately 17,000 ohms.

These values provide a starting point, but adjustment must be made on a properly wired pilot model.

Normally a slight change in the damping resistors is necessary to get the response exactly as required. The resistors in stages 1 and 3 have been changed to 6.8 KΩ and 4.7 KΩ respectively.

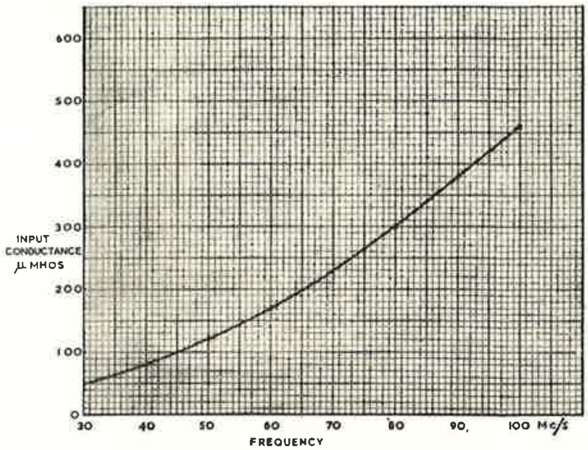


Fig. 4. Input conductance versus frequency.

Alignment

The circuit for the i-f amplifier is shown in Fig. 5. Complete alignment can only be achieved when the amplifier is used with the associated tuner and it is done with 5 volts a.g.c. applied. This is considered to be a typical a.g.c. voltage. As the a.g.c. voltage falls below this value the response shape of the amplifier changes in the manner already described. A 7.5 volt battery and 10,000 ohm potentiometer can be used to provide this bias as shown in the circuit. This bias must be measured with a high impedance meter.

Spot Frequencies

Connect a signal generator, suitably terminated, to the grid of the mixer valve in the tuner through a 1000 µµF capacitor with no more than one inch of lead unshielded. With a d.c. meter of impedance at least 50,000 ohms at the detector output align the bifilar coils as below for maximum output, keeping the detector output level at about 2 to 3 volts:—

T1	32 Mc/s
T2	35.7 Mc/s
T3	33.9 Mc/s

The three traps should then be adjusted to give minimum output at their respective frequencies, as below:—

L_1 (Adjacent channel sound carrier trap)	37.5 Mc/s
L_2 (Adjacent channel vision carrier trap)	29 Mc/s
L_4 (Accompanying sound trap)	30.5 Mc/s

Then disconnect the signal generator and connect a sweep generator, again suitably terminated, through a 1000 µµF capacitor to the mixer valve grid with no more than one inch of lead unshielded. A sweep of from 27 Mc/s to 38 Mc/s is required for proper alignment. Care must be taken not to overload the amplifier when using the sweep generator. Overloading in the amplifier shows as a very distorted and peaky pattern on the oscilloscope. The first step is to align the input, or link circuit. This must be done in conjunction with the output transformer in the tuner. It may be necessary to disable the oscillator by shorting the grid to earth. Sometimes, one channel is selected in which the oscillator does not have a very great effect on the pattern on the oscilloscope. The important thing is to select a method and use the same method for all adjustments and measurements. In a tuner with "stacked" oscillator and mixer sections in the mixer valve, shorting the oscillator grid to ground will alter the d.c. operating conditions of the pentode section, and hence the output impedance will change. This will affect the alignment of the link circuit slightly but can be tolerated as any slight misadjustment will be set right when aligning from the antenna terminals.

It is then necessary to detect the output of the link circuit. To do this properly, no tuned circuit other than those between the mixer valve plate and first i-f valve grid should influence the detected pattern. The plate of the first i-f valve is the logical take-off point, but, to eliminate the selectivity, the plate circuit has to be heavily damped. A detector probe to do this is shown in Fig. 6. The first valve then acts as a buffer with approximately unity gain. Now short the grids of V3 and V4 to ground with leads as short as possible, and loosely couple a marker generator to the mixer grid, or to the detector probe input. Coupling through a 5 µµF capacitor to the mixer grid will normally give sufficient input to the amplifier to provide reasonable markers without affecting the sweep generator output. If there is insufficient gain to provide a reasonable pattern on the oscilloscope the a.g.c. voltage can be reduced to as low as 3.5 volts for this step.

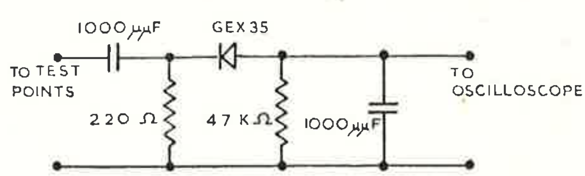


Fig. 6. Detector probe (negative output).

Adjust the slug in the tuner output transformer to give maximum output at 36 Mc/s. Now adjust

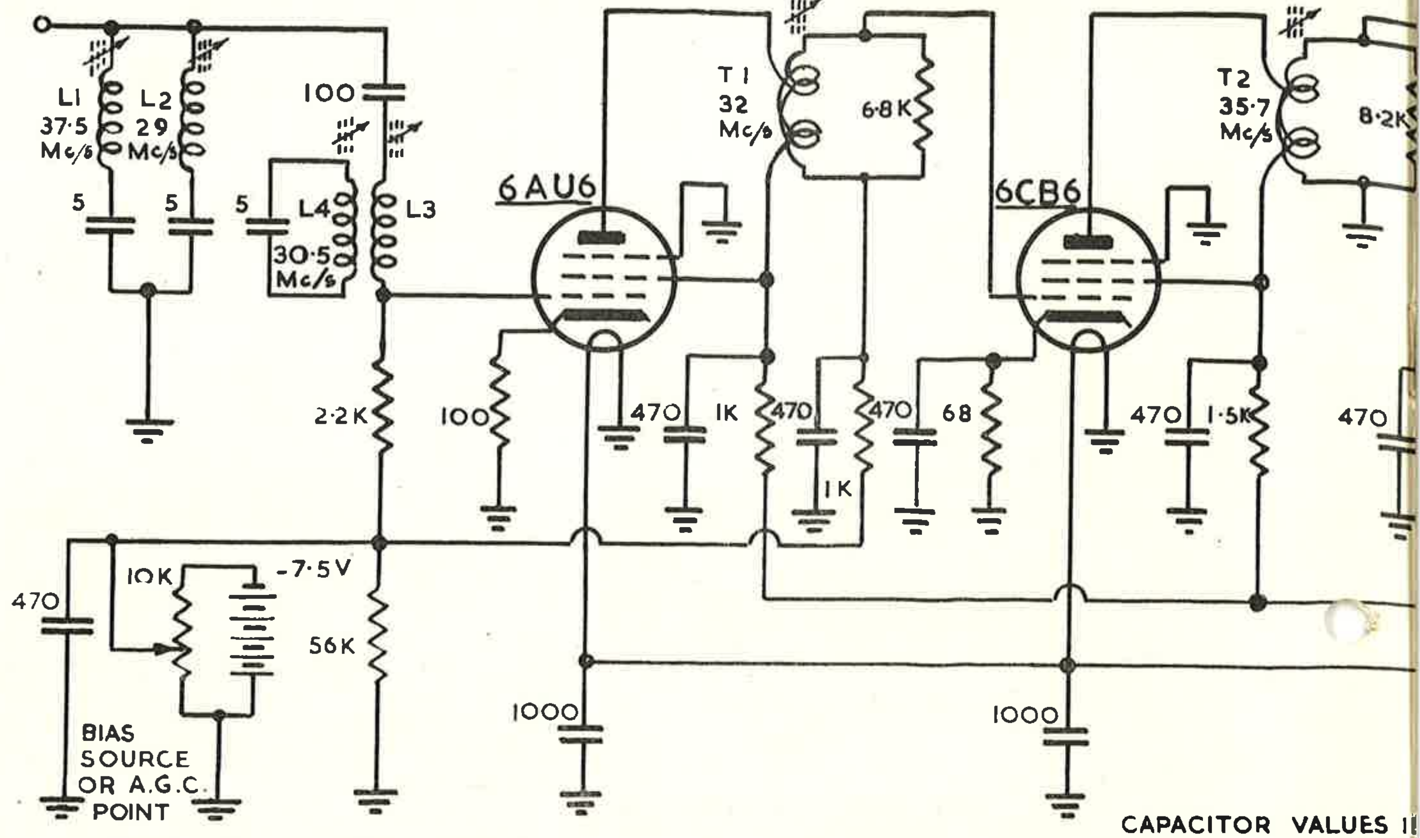


Fig. 5. Video i-f amplifier circuit.

the series coil L_3 to bring the 31.75 Mc/s marker to 75% of maximum amplitude. Readjust each control in turn if necessary to give a response as illustrated in Fig. 7. A slight dip between the two shoulders can be tolerated but should be kept below 10% of maximum amplitude.

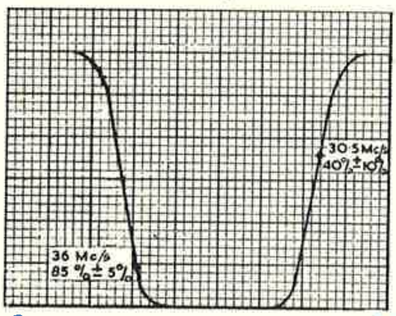


Fig. 7. Link circuit response.

The next step is the adjustment of T4. Connect the sweep generator, correctly terminated, to the grid of V4 and loosely couple the marker generator. (It may be sufficient to leave the lead from the marker generator lying on the bench near the grid terminal.) Now connect the oscilloscope directly to the detector output and adjust the top and bottom cores in T4 to get maximum gain and the response shown in Fig. 8.

The sweep generator is now connected to the mixer valve grid through a 1000 $\mu\mu$F capacitor with the marker generator loosely coupled, and the

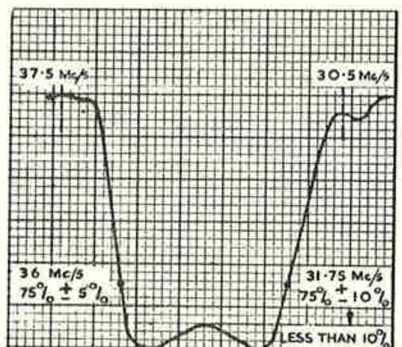


Fig. 8. T4 response.

shorting leads removed from the grids of V3 and V4. Retouch various adjustments as necessary to obtain the response shown in Fig. 9.

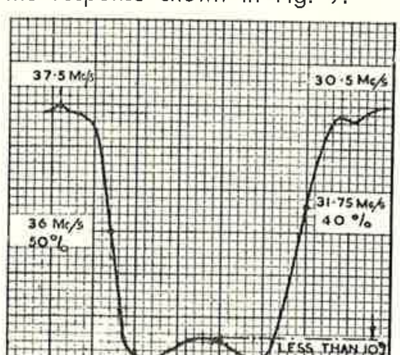
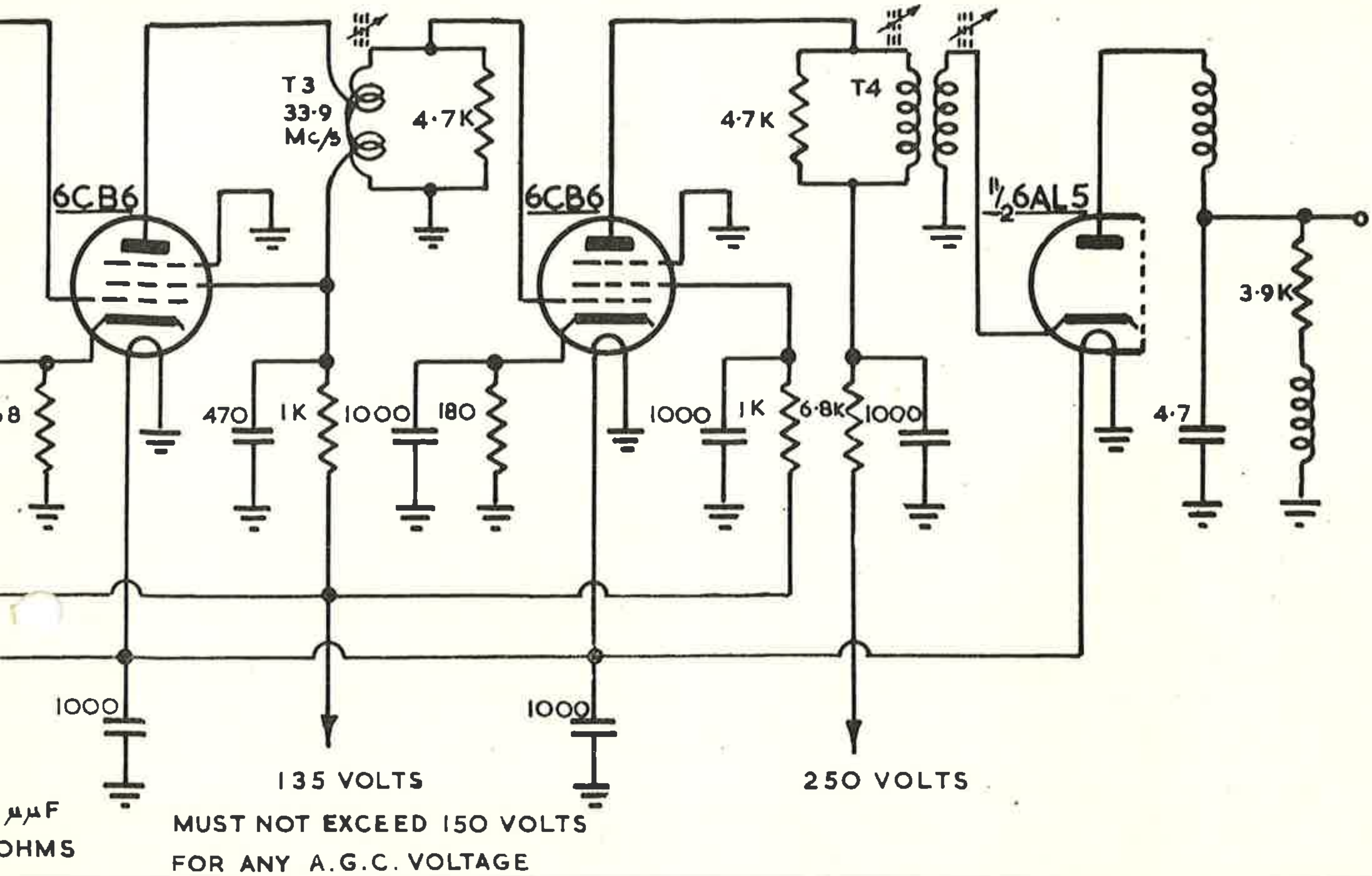


Fig. 9. Overall response.



The associated sound carrier level should be about 26 db below the picture carrier level. As mentioned previously, this difference will be reduced on low values of a.g.c. voltage. The adjacent channel carrier traps should give attenuations at their respective frequencies of 50 db with respect to the picture carrier level. Although, as previously explained, the attenuation of the adjacent channel sound carrier is most important, the desired attenuation is much more difficult to achieve because it is so close to the high frequency end of the desired "pass band" of the video i-f amplifier. Hence, although a high Q coil is used here it is quite normal to find the attenuation at this frequency the same or less than that at the adjacent channel picture carrier frequency which is already very much attenuated by the various tuned circuits and the associated sound carrier trap.

Having correctly aligned the i-f amplifier, the next thing is to check the response shape at different a.g.c. bias levels. This should be done with bias voltages down to zero to ensure that the amplifier is quite stable when the gain is at a maximum.

The power supplies both to the i-f amplifier and the other sections of the receiver should be so designed that maximum ratings of valves are not exceeded for any a.g.c. voltage. It must be remembered that for high values of a.g.c. voltage when some valves are operating near plate-current cut-off, the high tension voltage will rise and voltage or dissipation limits of valves in other sections of the receiver may be exceeded.

Measurement of Gain

The method of gain measurement depends on the way in which it is desired to express the performance of the amplifier. One method is to measure the input to the mixer valve grid required to give a nominal d.c. voltage at the detector output, e.g., three volts, or three volts above noise level. This must be done at the picture carrier frequency using the mixer valve as an amplifier, disabling the oscillator if required.

To measure the gain up to the detector input, the method is as follows:—

Connect a vacuum tube voltmeter from the cathode of the detector to ground, using a diode probe, to measure alternating volts, and a high impedance meter across the diode load to measure direct volts. An input signal of frequency 36 Mc/s is applied to the mixer valve grid and its level adjusted to give a direct output voltage of say three at the diode load. The alternating voltage at the detector is noted and the meter removed. The input level is now adjusted to give three volts output again and noted. The gain is then the alternating voltage measured divided by the latter input level.

The method chosen is not very important, but should be specified so as to avoid confusion.

REFERENCES:

1. Radiotron Designers' Handbook by F. Langford-Smith, page 56.
2. Vacuum Tube Amplifiers, by G. E. Valley Jr. and H. Wallman.

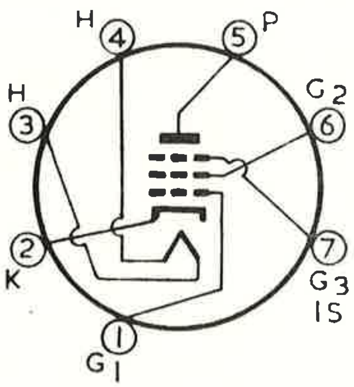
{Corrns. ex Jan 57. P.12}

RADIOTRON 6CB6

SHARP-CUTOFF PENTODE

The Radiotron 6CB6 is a sharp-cutoff pentode of the miniature type designed especially for use as an intermediate-frequency amplifier operating at frequencies in the order of 45 megacycles, and as an r-f amplifier in vhf television tuners.

A very high transconductance (6200 micromhos) combined with low interelectrode capacitance values gives this valve a high wide-band factor. It is provided with separate base pins for grid No. 3 and the cathode. These permit the use of an unbypassed cathode resistor to minimize the effects of regeneration.



(bottom view)

SOCKET CONNECTIONS

Pin 1—Grid No. 1
Pin 2—Cathode
Pin 3—Heater
Pin 4—Heater
Pin 5—Plate
Pin 6—Grid No. 2
Pin 7—Grid No. 3, Internal Shield.

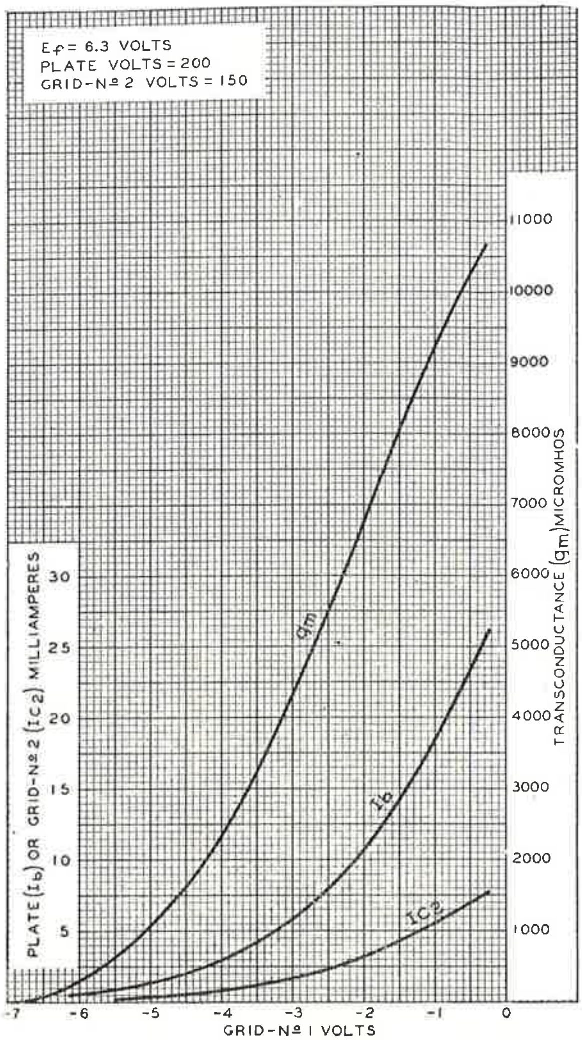
GENERAL DATA

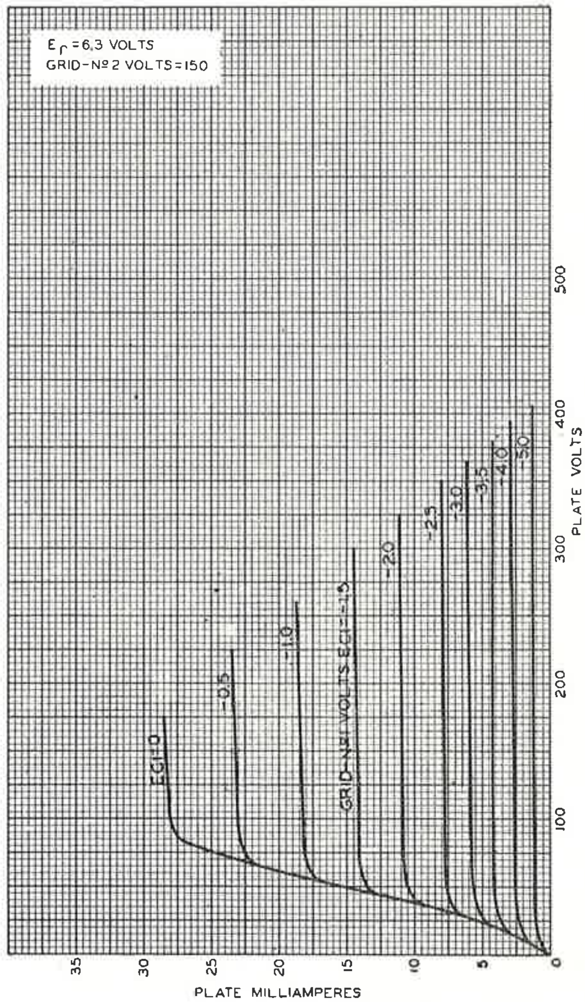
ELECTRICAL:

Heater Voltage	6.3	volts
Heater Current	0.3	ampere
Direct Interelectrode capacitances (no external shield):		
Grid No. 1 to Plate	0.020	$\mu\mu$F
Input	6.5	$\mu\mu$F
Output	1.9	$\mu\mu$F

MECHANICAL:

Mounting Position	Any
Maximum Overall Length	$2\frac{1}{8}''$
Maximum Seated Length	$1\frac{7}{8}''$
Length from Base Seat to Bulb Top (Excluding tip)	$1\frac{1}{2}'' \pm \frac{3}{32}''$
Maximum Diameter	$\frac{3}{4}''$
Bulb	T-5-$\frac{1}{2}$
Base	Small-Button Miniature 7-Pin





CLASS A$_1$ AMPLIFIER

MAXIMUM RATINGS

Plate Voltage	300 max. volts
Grid No. 2 (Screen) Voltage	150 max. volts
Plate Dissipation	2.0 max. watts
Grid No. 2 Input (for voltages up to 150V)	0.5 max. watt

PEAK HEATER-CATHODE VOLTAGE:

Heater negative with respect to cathode	200 max. volts
Heater positive with respect to cathode	200* max. volts

TYPICAL OPERATION AND CHARACTERISTICS:

Plate Voltage	200 volts
Grid No. 3 (Suppressor)	Connected to cathode at socket
Grid No. 2 Voltage	150 volts
Cathode Bias Resistor	180 ohms
Plate Resistance (approx.)	0.6 megohm
Transconductance	6200 μmhos
Grid No. 1 Bias (approx.) for plate current of 10 μamp	8 volts
Plate Current	9.5 mA
Grid No. 2 Current	2.8 mA

* The direct component must not exceed 100 volts.

TECHNICAL LIBRARY

"HI FI YEAR BOOK"

Published by:
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What is Hi-Fi? This question has long been a source of constant headaches to the average person. There have been many books published on this subject telling what equipment to purchase, how to install it and what to listen for. But, unfortunately, a great many of these have only succeeded in increasing this headache called High Fidelity. Now the field of Hi-Fi welcomes a book that sets out in clear and concise terms the correct translation of High Fidelity.

"Hi-Fi Year Book" contains over 180 pages of sound knowledge. There are chapters dealing with "grooves and style"—"Acoustics"—"Hi-Fi requirements" — "Pickups" — "Motor Units" — "Amplifiers" and "Radio Tuners", not to mention excellent articles by leading men in the Radio and Hi-Fi field. These articles cover such topics as: History of the Phonograph, Making a Record and What is Hi-Fi?

Being an English publication, the equipment listed in the "Hi-Fi Year Book" is for the most part available to the Australian public. A further point worthy of note is that only top quality equipment is listed in this publication, thus offering the reader a choice of the best possible equipment for the money available.

Enthusiasts of tape recording and tape recorders will find much of interest in this book as the top names in the field of tape recording are to be found in the chapter on magnetic recording.

Though this is only the first issue, we are certain that "Hi-Fi Year Book" will become a must for all "Fidelity lovers" throughout Australia.

"HI-FI NEWS"

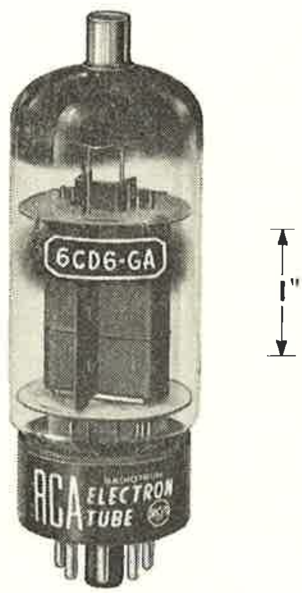
For those who wish to keep up with the latest in Hi-Fi equipment, this publication is just what you have been looking for. Hi-Fi News is the monthly counterpart of the year book and contains the same interesting and informative articles. The copy we have on hand is Volume 1, No. 3, and a few of the chapters in this forty-page booklet are: "Hearing High Fidelity"—"F.M. Tuners"—"The Speaker in Your Home" and "Tape Recorders". These are just some of the many fine articles to be found in this monthly magazine.

(B. A. Baker)

NEW RCA RELEASES

RADIOTRON 6CD6-GA
BEAM POWER VALVE

The 6CD6-GA — a high-perveance beam power valve of the glass-octal type — is designed especially for use as a horizontal-deflection amplifier valve in television receivers. Utilizing a button-stem construction in a T-12 envelope, the 6CD6-GA is smaller and more compact than the 6CD6-G, but features a modified mount design to maintain the same high perveance and to permit operation at higher ratings.



The 6CD6-GA has a maximum peak positive-pulse plate voltage rating of 7000 volts, and a maximum plate dissipation of 20 watts. These ratings in addition to low mu-factor, high plate current rating at low plate voltage, and a high operating ratio

RADIOTRON 3WP1, 3WP2, 3WP11
OSCILLOGRAPH TUBES

Radiotron 3WP1, 3WP2 and 3WP11 are 3 inch oscillograph tubes of the electrostatic-focus and electrostatic-deflection type featuring extremely high deflection sensitivity. Each has a flat face, a minimum useful screen diameter of 2¾ inches, and a maximum overall length of 11⅝ inches.

The 3WP1 has a medium-persistence phosphor for general oscillographic use. The 3WP2 utilizes a long-persistence phosphor especially useful in applications where a temporary record of electrical phenomena is desired. The 3WP11 employs a short-persistence phosphor particularly for those applications involving photographic recording of electrical phenomena.

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