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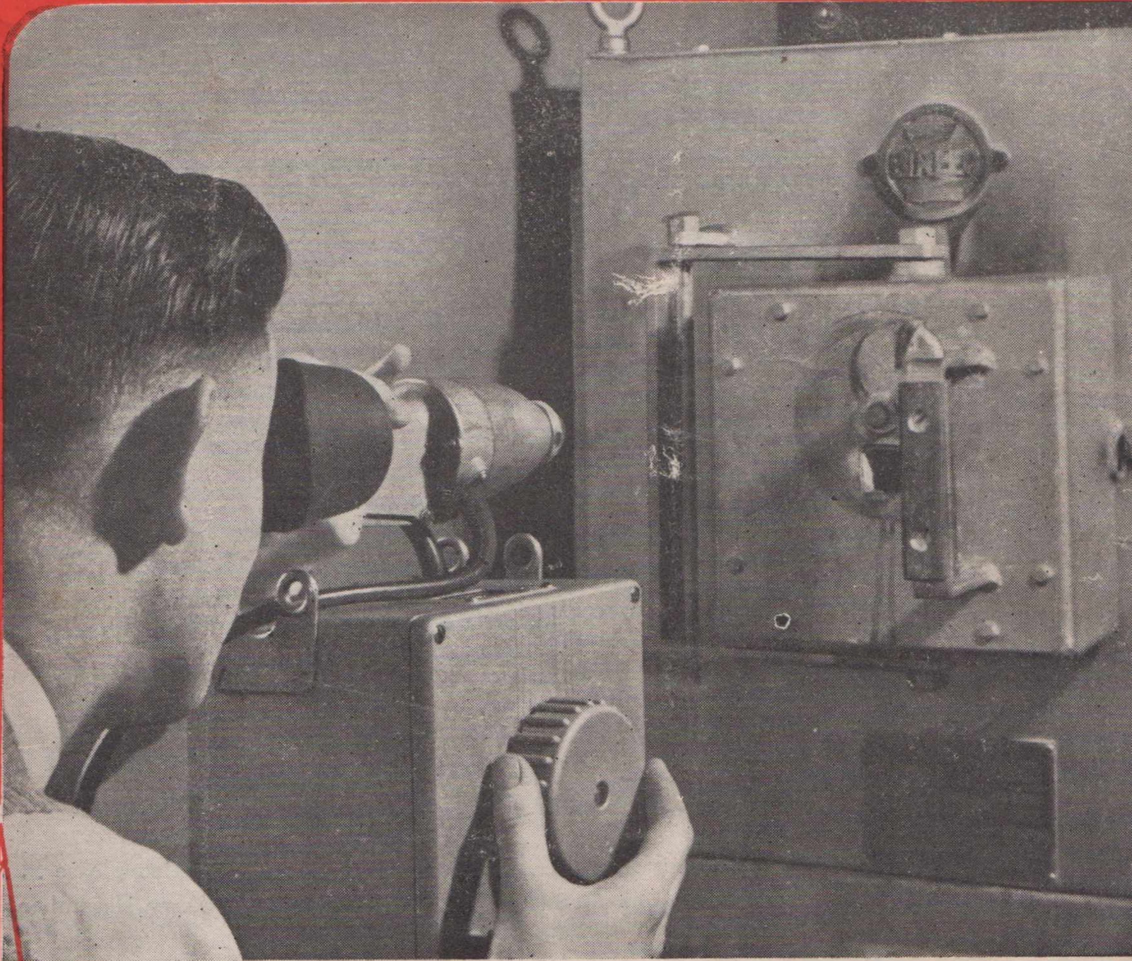

JANUARY, 1951

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VOL. 15, NO. 6

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Vol. 15 JANUARY, 1951 No. 6

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EDITORIAL

MAY the "learned men" of the Nations of the World produce a formula that will enable "peace to reign" in our time, thus allowing us to pursue the science of Radio and Electronics to our own satisfaction and for the ultimate benefit of mankind.

With the commencement of this New Year, our first Jubilee edition of Australian Radio and Electronics also coincides, and we feel sure that you will appreciate the fact "that no stone has been left unturned" to present to our readers articles on various subjects which adhere to our policy of producing a monthly technical journal, having National coverage, for the advancement of Radio and Electronic knowledge.

In this issue the R. & E. Television Project commences, and we trust that readers building this equipment will gain first hand practical knowledge of the subject, so that when T.V. is "on the air" in "X" number of years time, that the Serviceman, Hobbyist and Home Constructor will be able to still hold his own in the new field.

For those interested in the reproduction of disk recordings, and for that matter Tape, Wire, or Home Recording, we heartily recommend the P.P.6L6 Compensated Amplifier fully described on page 7 of this issue.

Recording engineers have striven for years to give us better and better fidelity of reproduction, with lower noise level, and one method used is to attenuate frequencies above or below a certain frequency range whilst recording, and use response compensation in the playback amplifier.

It is for this purpose that the Amplifier described herein has been designed, as both high and low boost, or combination of both, may be obtained without sacrificing threshold level as far as the ear is concerned. Coupled to a good speaker, suitably baffled, you will be delighted with the tone colour that can be obtained.

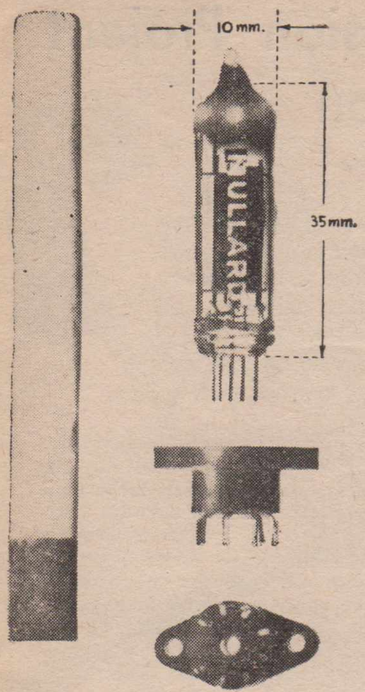
No doubt you have made your New Year resolutions . . . so have we . . . most of which we hope to keep . . . and one of them is to assure you that everything humanly possible is being done to bring out our journal regularly each month and to maintain the high standard of our technical articles.

It will be noted that we have obtained 100% co-operation and advertising support from our various friends in the Radio and Electrical Industry, and we commend you to support these people, who have helped us to help you. May we also suggest you mention Australian Radio & Electronics when making your purchases.

Finally, we have many excellent constructional articles in the course of preparation, but to list them now would be "spilling the beans," so to speak.

We are looking forward to the future with optimism, and trust that the New Year brings to you "everything you wish yourself."

—LAY W. CRANCH.



SUB-MINIATURE VALVES

For Communications and Industry

—no advantage having sub-miniature components without sub-miniature valves—or vice versa—*both* are now available for the Australian Design Engineer and the Mullard Sub-miniature Range includes dry battery and 6.3 volt mains type VHF valves, voltage stabilisers, thyratrons and electrometer valves, and sub-miniature valve sockets. Diameter 10 mm. (3/8 inch)—compare the size with a cigarette—also the tiny silica loaded polystyrene sockets (available for both chassis and panel mounting).

Data on a few of the Mullard sub-miniature valves is listed below. Further details available on application.

Mullard

Thermionic Valves and Electron Tubes

TYPICAL CHARACTERISTICS

Type	Description	Length (mm)	Filament or Heater (V)	(mA)	Va (V)	Vg2 (V)	Vg1 (V)	Ia (mA)	gm (ma/V)	ra (KΩ)	Pout (W)
DF72	Sharp cut-off R.F. Pentode	41.2	1.25	25	67.5	67.5	0	1.7	1.0	650	—
DF73	Variable-mu R.F. Pentode	41.2	1.25	25	67.5	67.5	0	1.7	0.8	450	—
DAF70	Single Diode A.F. Pentode	41.2	1.25	25	67.5	67.5	0	0.9	0.45	200	—
DL75	A.F. Output Pentode	41.2	1.25	25	90	90	−3	1.3	0.67	500	0.047
EF70	High Slope R.F. Pentode with Short g3 base	38	6.3	200	100	100	−2	3.0	2.3	100	—
EF72	High Slope R.F. Pentode	38	6.3	150	100	100	−1.4	7.0	5.0	200	—
EF73	High Slope non-R.F. Pentode	38	6.3	200	100	100	−2.0	7.5	5.0	250	—
EC70	R.F. Triode for use as Oscillator up to 500 Mc/s	38	6.3	150	100	—	−2.0	13	5.5	3.6	0.75 500 Mc/s
*EA76	Single Diode	25.4	6.3	150	150 (r.m.s.)	—	—	9 (max)	—	—	—
70B1	Voltage Stabiliser	50.7	V burning = 70V., Current range = 5-15mA., A.C. resistance = 300Ω.								

* 5 mm diameter bulb. Leads disposed on pitch circle of 2.3 mm diameter.

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The "R. & E." Amateur Television Project for Home Construction

Part I—The Proposed System

THOSE who have read the Editorial in the last composite issue of this journal and who are interested in following the Amateur Television Project through our pages, will have some idea of what this first instalment is about. In it will be found a description of the first part of the project—the production of images on a cathode ray tube screen, the pictures being obtained from still transparencies—negatives or slides. The whole process is broken up into its component parts, and it is shown how it is proposed to tackle the various problems that will be met.

INTRODUCTION

When it was decided that the time was perhaps ripe for presenting our readers with some television information, the question of just how we should go about this turned out to be perhaps the most difficult one to solve. One way, beloved of technical magazines when they are about to burst forth with an entirely new phase of activity, is to embark on a series of elementary theoretical articles, often in the form of a "course". This approach is excellently suited to those who wish to take up the new subject seriously and to learn the elements without diving into the more advanced text-books, which can be tackled at a later stage. Another possibility was to present, without further warning, the circuits and construction of some transmitting and receiving gear, so that amateur transmitters could undertake the provision of the transmitted signals, while anyone who wished could build a receiver. This one is ruled out on several counts. In the first place, the special gear necessary for putting a television signal on the air is not available in this country as yet, and if it were, it would be so expensive as to preclude its use by all but the most opulent of "Hams." If the transmitters could not take it up for these reasons, then there would be no interest or incentive for the builder of receivers, for he would have no transmissions to receive.

Having rejected both these solutions, therefore, we hit upon one which we think is new, and which should enable a great many of our readers, **whether amateur transmitters or not,** to participate, at little expense to themselves. For this reason, the first equipment to be described will not directly enable amateurs to put a television signal on the air. With subsequent modification it will, but the initial equipment will be so excellent for demonstrating the basic principles of television transmission that it is considered that very few amateurs will object to this feature of it. One very great advantage is that in order to operate it, no complex synchronizing gear is needed, thereby bypassing at one fell swoop, as it were, many of the difficulties associated with producing an image in the conventional manner.

As to the gear required, this takes on a very simple form, too. Briefly, what will be required is as follows:

(1) Two cathode ray tubes, one to act as a "camera" tube, and the other as a receiving tube, on which the image will be produced.

(2) A video amplifier, to amplify the signal from the "camera" tube.

(3) A photo-electric cell, to convert the light from the face of the camera tube into a video signal.

(4) Two time-base circuits, one at a high frequency, and producing the horizontal or line scan for both C.R.T.s, and the other at a low frequency, making the vertical or frame scan for the tubes.

(5) A power supply (high voltage) for the cathode ray tubes. The same supply can feed both tubes, thereby reducing the expense.

(6) A low voltage power supply for the time-base circuits. This has very light current drain, and an ordinary receiving type power supply is quite satisfactory.

WHAT THE ABOVE WILL DO

At the outset, we would like to emphasize that this series of articles will not attempt to give detailed theoretical discussions of the principles of television, for anyone who follows the series through, and particularly who builds the experimental circuits to be presented will have no difficulty in understanding the principles involved. Rather, the articles are designed to give enthusiasts something about television that they can DO, for it is thought that Mr. Wackford Squeers' maxim about "learning by doing" is perhaps more practical in this case than ever his originator foresaw. Besides, we suspect that most of those who will take an interest in television at this stage will be doing so, not from ultra-serious motives, but simply for fun. Nevertheless, we must give some explanation of how the above six pieces of gear produce a picture for us.

First of all, let us imagine that the cathode ray tube that is to be the camera tube has been set up with its power supply, so that when turned on, a spot is present that can be focused, adjusted as to brilliance, and then deflected across the face of the tube. Thus far, the arrangement is quite conventional, and is exactly equivalent to the same part of an ordinary oscilloscope. At this stage, then, we have a C.R.T. with its focused spot, as yet undeflected. The next step is to apply a saw-tooth deflecting voltage to the X plates, just as is done in an ordinary oscilloscope. This will give us a horizontal line on the face of the tube, and this line is repeated some thousands of times a second, so that it appears to the eye to be a continuous, unvarying line, whereas, in fact, it is merely the spot moving so fast, and repeated so often that the eye cannot follow its movement.

Continued on Page 32

A Response-Compensated 6L6 Amplifier

This amplifier has been designed in the first place for those who require the comparatively high output that can be provided by class A, 6L6's in push-pull, and secondly to fulfil the requirement for an amplifier incorporating independent control of amplification at high and low audio frequencies.

In spite of the rival claims of triodes and of other more modern tetrodes and pentodes, the 6L6 remains a very popular tube, although one seldom hears of its use these days in high-powered amplifiers, for which its companion type, the 807, is more suited.

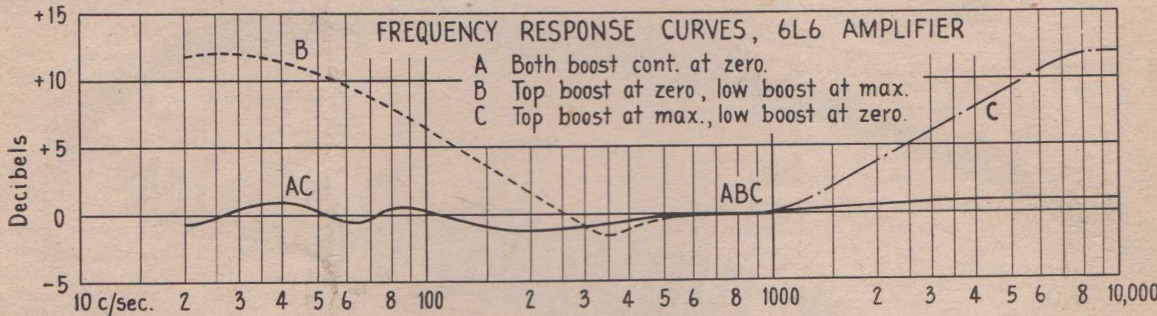
SPECIFICATIONS.

This amplifier has therefore been designed for the high quality reproduction of gramophone records, without the use of any expensive components. Even the output transformer is a standard 20-watt P.A. type, whose performance is considerably improved by its incorporation in the amplifier chassis so that it has been possible to apply inverse feedback from the voice coil winding back to the cathode of the voltage amplifier stage.

Rated output (at the plates of the 6L6's) is 18.5 watts. A gain reduction factor of 3 is used with the feedback. The amplifier may be fully loaded by a signal of 0.35 volts peak, or 0.87 volts peak, according to whether or not R_{15} is shunted by a high-capacity electrolytic condenser. The frequency response on a loudspeaker load is flat within plus or minus 1 db. from 20 to 10,000 cycles per second, and over-all distortion is very low. The independent high and low boost controls have no effect on the apparent volume, since they leave the amplifier gain at middle frequencies entirely unchanged. No provision has been made for "cutting" the high and low frequencies, the frequency characteristic being "flat" when both boost controls are at zero. The setting of the main gain control has no effect upon the frequency response.

CIRCUIT FEATURES.

It is customary when designing amplifiers to start at the loudspeaker end and work backwards towards the input. This procedure was followed here. The 6L6's are operated under self-biased conditions with 270 volts on plates and screens. R28, the common bias resistor, has a value of 125 ohms, and in our case had to be made up from two 250-ohm 10-watt resistors in parallel. A point to note about the output stage is the use of grid stoppers, R27 and R29. These are necessary as a precaution against parasitic oscillation, and should on no account be omitted. It is a safe bet that by far the majority of beam-tube amplifiers that do not perform properly, for no apparent reason, are afflicted with this "bug." Very often such an oscillation takes place only at high input levels, and results in amplifier overload long before rated output is obtained. Faults such as this cannot be spotted without an oscilloscope, so that the only safe thing is to include the grid stoppers. Even, if they were not needed, they would have no adverse effect in any other way, so that they form a very cheap insurance premium against one of the most troublesome of amplifier faults.



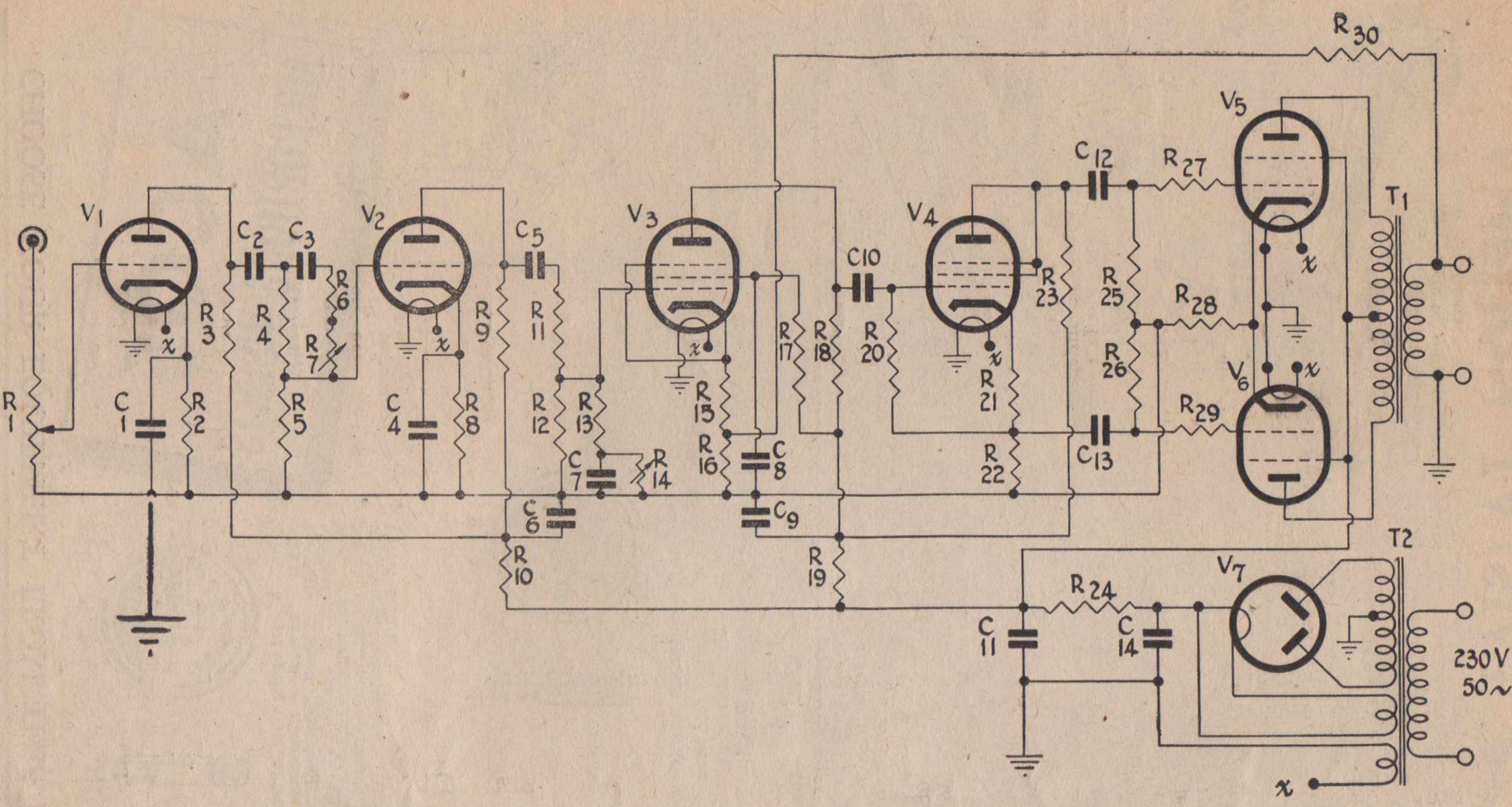
Response curves of the amplifier, taken on loud-speaker load.

The phase inverter is the well-known split-load type, which is even more satisfactory than usual in an amplifier of this type, because of the low driving voltage (only 20 volts peak per tube) required by the 6L6's. It uses a 6SJ7, strapped as a triode, because almost any tube will do in this circuit, and so as to make it the same type as the voltage amplifier, V_3, which is also a 6SJ7.

This tube is operated with a 100k. plate load, which normally gives it a gain of about 98 times. R_{15} is its normal cathode bias resistor of 1500 ohms. In the circuit this has been shown unbypassed, as doing so slightly improves its performance at full output. It has the disadvantage, however, of reducing the gain of V_3 by a factor of 2.5 times, but if the amplifier is used with a high-level pick-up, as it normally will be, this is no disadvantage, as the amplifier as a whole still requires only 0.85v. peak to drive it to full output.

IMPORTANT NOTE ON FEEDBACK CIRCUIT.

The feedback is taken over the whole of the amplifier proper, from the voice coil to the cathode of V_3. This has the excellent effect of reducing the distortion which may arise in any part of the amplifier included in the feedback network, including the output transformer, which is by no means a high-fidelity one, nor is such performance claimed for it by the manufacturers. However, with feedback applied, the frequency response and distortion are good enough to be exceeded only by a really expensive output transformer.



COMPONENT LIST.

V1, V2 = 6C5.
V3, V4 = 6SJ7.
V5, V6 = 6L6-G.
V7 = 5Z3.
R1 = 0.5 meg. pot.
R2, R8 = 2.5k.
R3, R9, R18, R22,
R23, R27,
R29 = 100k.
R4, R11,
R12, R17, R20,
R25, R26 = 500k.

R5, R13 = 50k.
R6 = 25k.
R7, R14 = 2 meg. pot.
R10 = 100k. 1 watt.
R15 = 1500 ohms.
R16 = 10 ohms.
R19 = 50k. 1 watt.
R21 = 1000 ohms.
R24 = 1000 ohms 20 watt.
R28 = 125 ohms 10 watt.
R30 = 250 ohms.
C1, C4 = 25 mfd. 25v. electro.

C2, C5 = 0.1 mfd. 600v.
C3 = 250 mmfd.
C6, C9 = 16 mfd. 350v. electro.
C7, C10 = 0.01 mfd. 600v.
C8 = 0.5 mfd. 600v. paper.
C11 = 50 mfd. 350v. electro.
C12, C13 = 0.25 mfd. 600v.
C14 = two 8 mfd. 450v. electros. in series, each shunted by 1 meg.

T1 = Output transformer 5000 ohms p-p to voice coil.
T2 = 400-0-400v. 150 ma.; 5v., 3 amp.; 6.3v., 4 amp.

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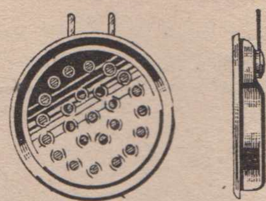

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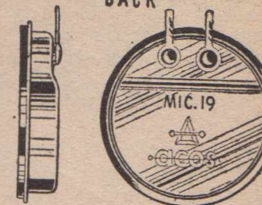

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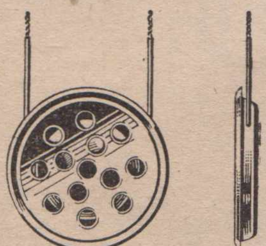

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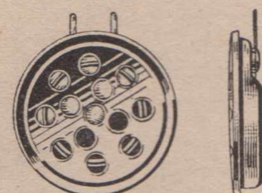

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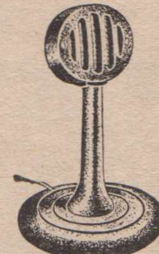

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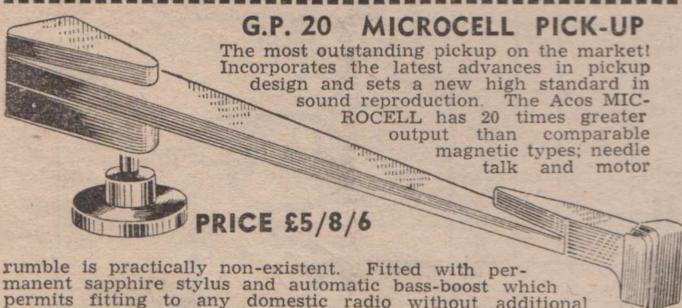

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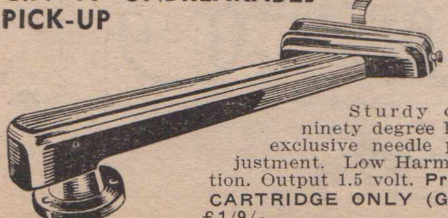

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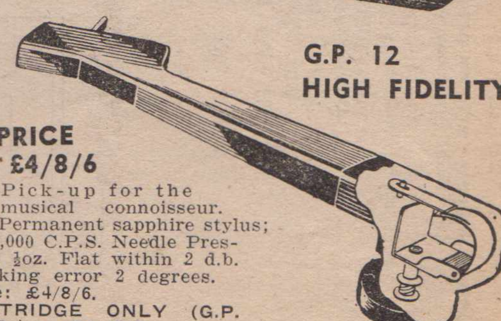

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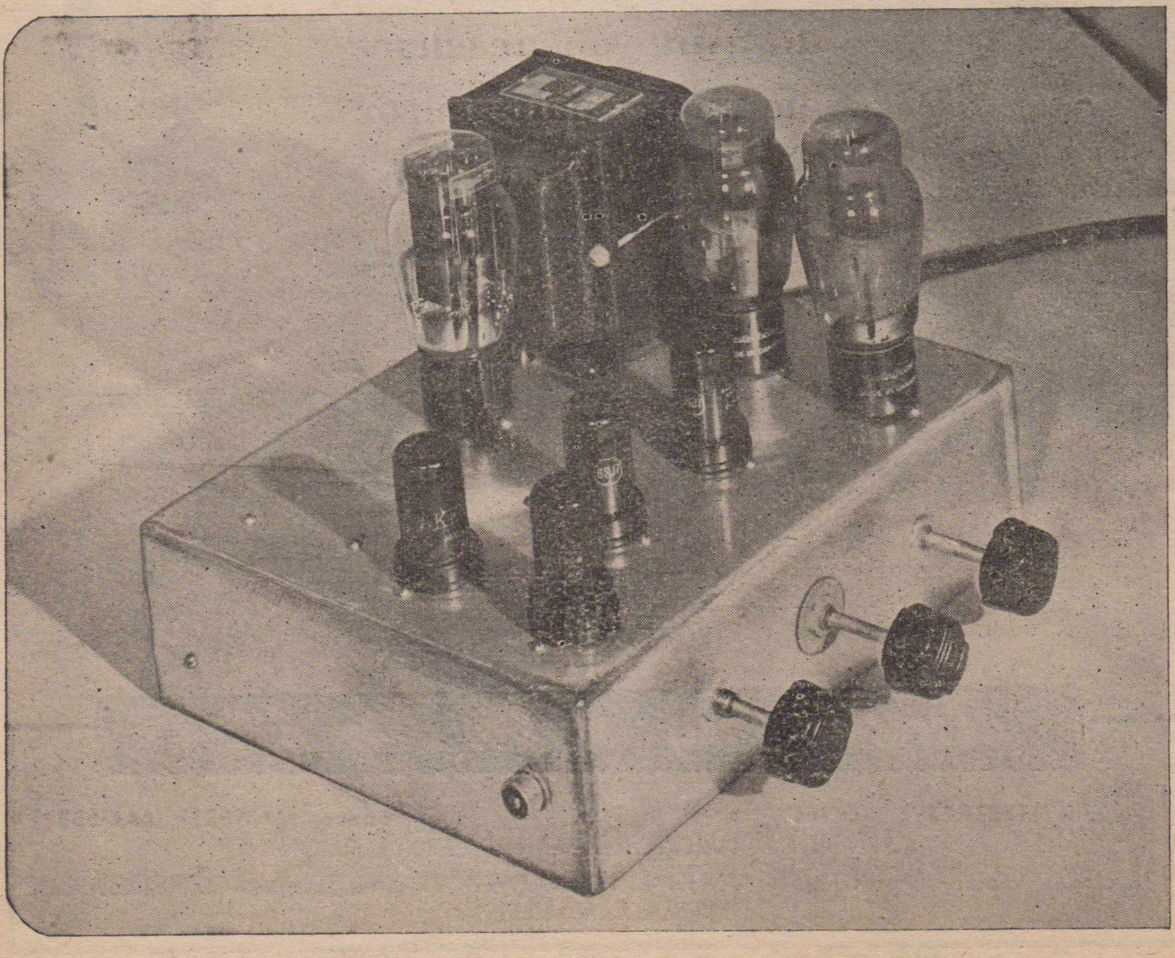
It should be noted that the degree of feedback realized in practice depends not only on the value of R30 and R16, but also upon the voice-coil impedance of the loud-speaker used with the amplifier. The constants shown have been worked out in theory and practice for a 15-ohm speaker, and so will not be correct for a speaker of any other voice-coil impedance. A table given later in this article shows what values of R30 should be used with speakers of voice-coil impedance other than this, and should be strictly followed. If it is desired to use a speaker of any other impedance, it is best to draw a curve from the table and to read off the required value of R_{30} from the curve.

CONNECTING THE FEEDBACK

The feedback can be connected the wrong way round, with the circuit used, since the correct side of the voice-coil winding must be found. This can be done quite simply by running the amplifier at low level without R30 connected to the voice-coil and therefore without feedback. One side of the voice-coil winding is temporarily earthed, and R30 is touched on to the other side. If the volume decreases, the polarity is correct, and permanent connections can be made. If the volume level increases when R30 is connected, the feedback is positive, and the connection must be made to the other side of the winding. The indication is quite positive, and the check will be easily made.

POWER SUPPLY

It will be noted that this amplifier has been arranged for use with a permanent magnet speaker, and that no smoothing choke has been used. R24 is a 1000-ohm 20-watt wire-wound resistor, which, in conjunction with the 16 mfd. electrolytic condensers C11 and C14, gives quite adequate smoothing for the plates and screens of the output stage. The filters R19C9 and R10C6, as well as providing adequate decoupling for the early stages, and therefore preventing any possibility of low frequency instability or motor-boating, are absolutely necessary in order to provide a smooth enough H.T. voltage for V1, V2, and V3. Constructors who are not used to seeing smoothing chokes dispensed with need have no fear, however, that the amplifier is subject to hum, for in practice the hum level is exceedingly low—in fact, better than is normally realized with an electro-magnetic speaker when the field coil is used as the second choke in a two-stage filter. C14 is made up from two 450-volt 8 mfd. condensers in series, but C11 can be of 450v. working rating.



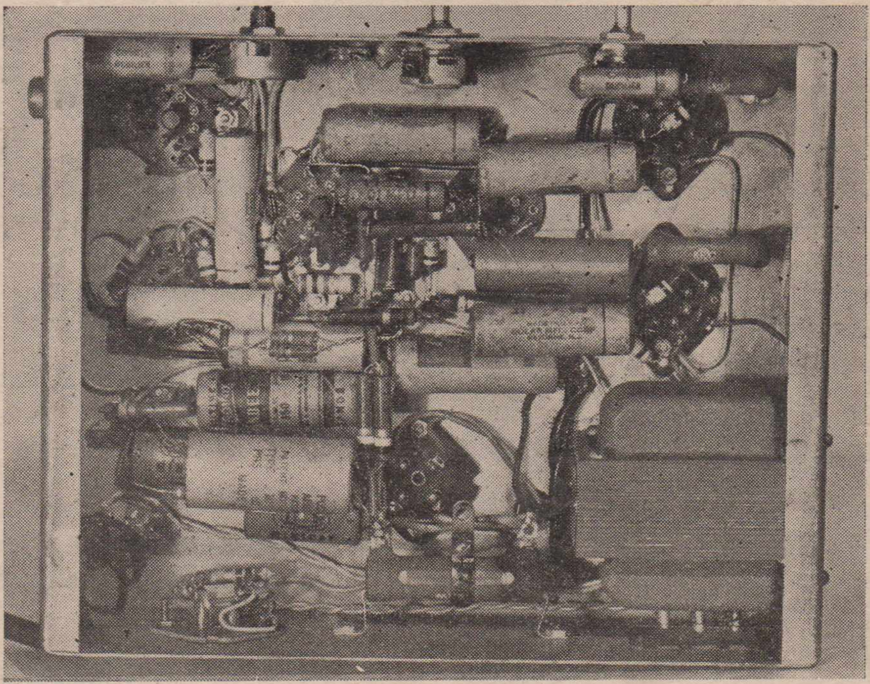
THE HIGH AND LOW BOOST STAGES.

The response curves on the first page of this article show clearly the effect of varying the settings of the boost controls. The full line shows the response with both controls at zero. The two very slight peaks at the low-frequency end of the scale show how effective is the bass-reflex or vented baffle which was used with the speaker and amplifier when the curves were taken. Without feedback, and without the reflex baffle, there would have been a very pronounced peak at about 70 cycles per second, the resonant frequency of the speaker which was used.

The portion marked ABC, on the curves remains identical, whatever the setting of the boost controls. Since the over-all volume is determined mostly by the frequency range between 300 and 1000 cycles per second, the curves show why there is no apparent change in volume when the boost controls are manipulated. If the top boost control only is in use, the total response will consist of the portions AC, ABC, and C of the curves. Similarly, when the low-boost only is in use, the high-frequency end of the response curve will remain unchanged, while the low-frequency end will be as at B. Of course, with intermediate settings of the controls, the boosted portions of the curve will slope less steeply.

These desirable characteristics are brought about by the use of V1 and V2, which act quite independently of each other and of the rest of the amplifier in providing high frequency and low frequency boost respectively. It will be seen from the circuit that these tubes, which are 6C5's, are quite normal resistance-coupled stages, except for the complex coupling networks in their plate circuits. First of all, let us take the case of V1, the treble boosting stage. R3 is a normal plate load resistor of 100k., and C2 is a 0.1 mfd. coupling condenser. If we imagine C3, R6, and R7 to be removed from the circuit, we are left with R4 and R5, which simply make a voltage divider or fixed gain control at the input of V2. Now, the value of C3 is only 10 mmfd., so that at low and middle frequencies its reactance is so high that it can be regarded as a virtual open circuit. Thus at middle and low frequencies the coupling circuit boils down to C2, R4, and R5. These two resistors have values of 500k. and 50k. respectively, so that at middle and low frequencies one-eleventh of the output of V1 is passed on to V2. Since V1 has a gain from grid to plate of 14 times, the effective gain of the V1 circuit at middle and low frequencies is 14/11, or 1.27 times.

Now let us see what happens when R7, the top boost control, is at minimum. At very high frequencies C3 has a low reactance, and can be regarded for purposes of illustration as a short-circuit. We therefore have a new voltage divided comprising R5 in series with R4 and R6 in parallel. Since R6 has a value of 25k., we now have approximately two-thirds of the total output of V1 applied to the grid of V2, so that the gain of the V1 circuit at high frequencies is 2/3 × 14, or 9.33 times. Thus the high-frequency gain is 9.33/1.17, or 7.35 times the middle and low-frequency gain. This means that at the maximum boost setting of R7 (i.e., with no resistance in) there should be a maximum of 17.3 db. However, examination of the response curves shows that in practice only 12 db. is realized at high frequencies. The main reason for this is that the above calculation assumes that the gain of V1 is the same at very high audio frequencies as at low frequencies, but in practice this is not so, the reason being that at high frequencies the effective plate load for V1 is



reduced to 43,000 ohms, as against 83,000 ohms at low frequencies. This is enough to reduce the valve gain quite appreciably. However, since V1 is a 6C5 with a low plate resistance of about 10,000 ohms, it can be seen that the frequency discriminating circuit will not produce any distortion due to too great reduction of the load impedance.

A point of interest is that the amount of boost obtainable with R7 at minimum setting is dependent entirely on the relative values of R4, R5, and R6. The value of C3 has no effect on this, and altering its value affects only the point at which the boost commences. For instance, if C3 were made smaller, the boost would start at a higher frequency, and if it were made larger the top boost would start at a lower frequency.

The action of R7 in controlling the degree of boost can be seen when it is noted that R7 has a maximum value of 2 megohms. When it is set at maximum it is almost equivalent to open-circuiting

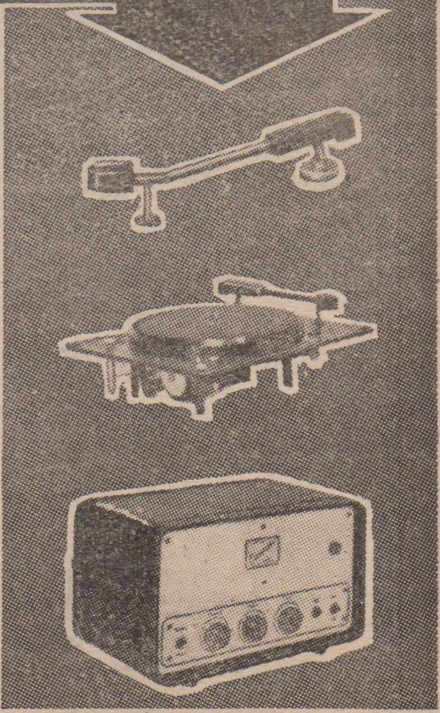
the C3R6R7 branch, so that there remains only C2, R4, and R5 in circuit, giving voltage division without frequency discrimination. A little thought will show, too, that as R7 is increased in value the amplification at middle and low frequencies remains unchanged, so that there is no effect on the overall volume level, while all that happens is that the high end of the response curve becomes progressively flatter, until there is no boost at all.

The low-frequency boost control works in a similar manner to the circuit of V1, except that in this case the voltage divider R11 R12 has its lower section shunted by the combination C7 R13. At middle and high frequencies C7 has a low reactance, being a 0.01 mfd. condenser, and therefore acts as a short-circuit. Thus, at middle and high frequencies the circuit of V2 has an overall gain of 1.27 times. However, at very low frequencies, C7 can be regarded as almost an open circuit, with the result that R11 and R12 control the voltage division and increase the overall gain of the circuit. In this case the boost control R14 has to be connected in parallel with C7 in order that the gain at middle and high frequencies may be unaffected when the control is operated.

POSITION OF THE RESPONSE-CONTROLLING STAGES

It will have been noticed that in this amplifier no attempt has been made to produce the bass and treble lift by modifying the voltage amplifier stage of the amplifier proper, namely, V3. This has the great advantage that the amplifier proper is normal in all respects, and is not affected adversely by the varying load which is always imposed by a response-controlling network. Instead, the boosting function is concentrated in V1 and V2, which are both working at signal levels in the region of a volt or so. This ensures that overloading cannot occur in the boosting stages, under any circumstances. Also, the gain control of the whole amplifier is at the grid of V1, which ensures that whatever degree of bass or treble boost is being used, the voltage stages of the amplifier cannot be overloaded before the output stage.

It has the added advantage that if the response-controlling stages are not wanted, the amplifier can be built with V1 and V2 omitted, in which case it is a straightforward high quality amplifier. Similarly, the part of the circuit up to the grid of V3 can be incorporated at the front end of any good amplifier, and can be relied upon to give the same boost characteristics as with the present amplifier, without in any way prejudicing the performance of the main amplifier to which it is attached. This can be said of very few response-controlling stages, most of which provide undesired gain and introduce the possibility of amplifier overloading if care is not taken in their application. If the circuit of V1 and V2 is being applied to another amplifier, care should be taken to keep the gain control at the input of V1 if overloading troubles are to be avoided.



OSCILLATION OF THE MAIN AMPLIFIER

We have already discussed the use of grid stoppers with the 6L6's in order to prevent oscillation of the output stage, but with this circuit there is a further possibility of oscillation of the amplifier as a whole. If a high-fidelity output transformer were used, its phase shift would be small enough for the possibility of oscillation to be fairly remote, but here we are not using such a transformer. As a result, it is possible that at some high frequency, outside the audio range, the phase shift in the output transformer may be sufficient to change the feed-back from negative to positive, and for oscillation to result. This can be guarded against by connecting a small condenser, not greater than 100 mmfd., from the plate of V3 to earth. This should be just large enough to stop the oscillation, if it occurs, but not any larger, so that it will not reduce the high-frequency response of the amplifier.

If an oscilloscope is available, the easiest check for the presence of oscillation is to examine the output wave-form of the amplifier with it. Oscillation will be readily seen as a high-amplitude high-frequency deflection, which bears little or no relation to the amplitude of the input signal. If it occurs only at some signal levels, it can be seen by feeding a signal into the amplifier and working the gain control from zero to full output. If it is happening all the time, it will show as a high-frequency output on the 'scope, even when no input is applied to the amplifier. If a 'scope is not available, such oscillation can be suspected if the reproduction does not sound quite "clear" or if unaccountable distortion takes place at medium or low signal levels.

CONSTRUCTION

The top-view photograph gives a good idea of the lay-out of the amplifier, if used in conjunction with the under-chassis picture. The input socket is on the side of the chassis, adjacent to V1, which is the valve shown in the front left-hand corner of the top view. The tube directly behind this is V2. The only point of any importance about the lay-out is the way in which the boost controls are wired. This can be seen from the under-chassis photograph.

The control in the centre of the chassis front is R7, and the one to the right of it is R14. Wired right at the controls can be seen R6 and C3, and R13 and C7. The leads from C2 to C3 and from R7 to the grid of V2 are unshielded and run close to the chassis and with right-angled bends so as to be as far away as possible from the socket of V3. The leads from the junction of R11 and R12 to R13 is run in shielded wire, as in this case it can have very little effect on the performance of the stage, and because the distance to R14 is much greater. With the wiring lay-out shown in the photograph, everything worked perfectly, with no trace of instability or undesired coupling between circuits. For those who wish to use a similar chassis lay-out it may be mentioned that the prototype illustrated here was built on a chassis $10\frac{1}{2}$in. x $8\frac{1}{2}$ in. x 3 in. This is just deep enough to accommodate the output transformer, and although there is no waste space on the chassis, there is no need for the parts to be overcrowded if suitable tie-points are provided by means of small terminal strips where necessary. The amplifier is not a difficult one to build if the few points mentioned are given a due amount of care, and for its quality and power output it is a most inexpensive one that will easily repay a little time and thought put into its construction.

R.C.S. RELEASES NEW 14/60 FILTER CHOKE

R.C.S. 14/60 FILTER CHOKE

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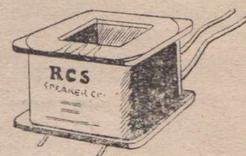

R.C.S. also announces a completely redesigned range of Transformers and Chokes

R.C.S. have redesigned the complete range of transformers and chokes, the most noticeable features being the former, which is now moulded from high melting point polystyrene powder (so that solder tags will not melt out) and completing the componen} with an aluminium bracket.

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TC81	200 M/A 30 Henries	£1	10	0

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F133	Single High Impedance Triode	5	0
F134	Push Pull Low Impedance Triode	5	6
F135	Push Pull High Impedance Triode	5	6
F136	Single Low Impedance Pentode	5	0
F137	Single High Impedance Pentode	5	0
F138	Push Pull Low Impedance Pentode	5	6
F139	Push Pull High Impedance Pentode		

VIBRATOR TRANSFORMERS

TP81	135 volts 6 volts ..	£1	2	6

SPEAKER TRANSFORMERS

TS23	Single Low Imp. Triode	10	0
TS24	Single High Imp. Triode	10	0
TS25	Push Pull Low Imp. Triode	10	6
TS26	Push Pull High Imp. Triode	10	6
TS27	Single Low Imp. Pentode	10	0
TS28	Single High Imp. Pentode	10	0
TS29	Push Pull Low Imp. Pentode	10	6
TS30	Push Pull High Imp. Pentode	10	6

AUDIO CHOKES

TA4	100 Henries 1000 Ohms D.C. Res. .25 M/A ..	18	6

VIBRATOR CHOKES

TC58	Low Tension 3 Amps 50 M/H .5 Ohms D.C. Res.	15	0
TC70	High Tension 50 Henries 450 Ohms D.C. Res. 75 M/A	15	0

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TP1	2.5 volts 2 Amps 7 Watt	12	6
TP2	4.0 volts 1 Amp 7 Watt	12	6
TP3	6.3 volts .3 Amp 7 Watt	12	6
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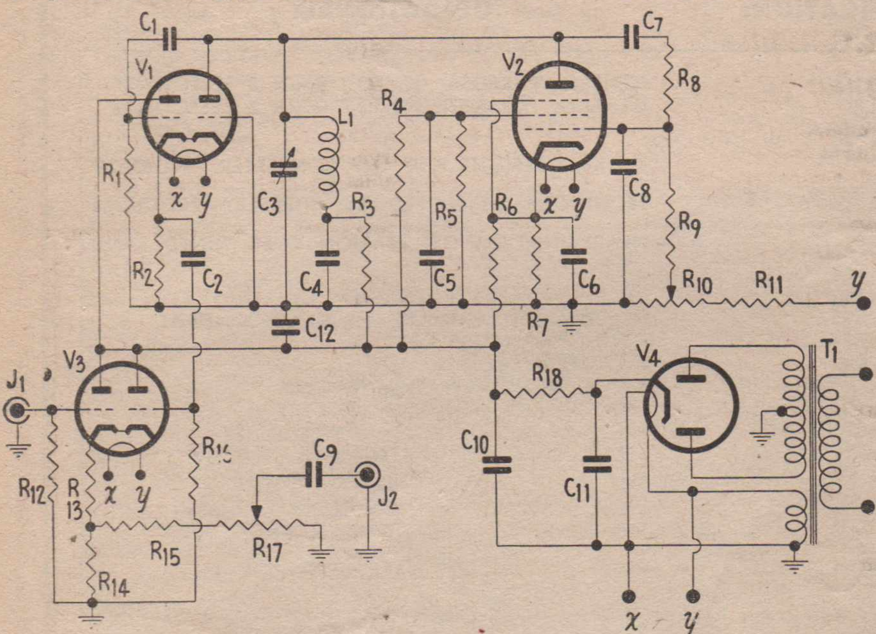
A Frequency-Modulated Test Oscillator for Visual Alignment

INTRODUCTION

We have often been asked for the circuit of an F.M. oscillator, suitable for the visual alignment of receivers in conjunction with an oscilloscope. This instrument has been designed to fulfil all the requirements of an F.M. test oscillator, and at the same time to be simple to construct and devoid of circuits requiring ticklish adjustment. It has provision for aligning both at I.F. and at R.F., and is suitable for any receiver. At the same time, it has been arranged for the speediest possible working with sets whose intermediate frequency lies in the most frequently used range, 450-480 kc/sec.



COMPONENT LIST

R1, 50k.
R2, R3, 3k.
R4, R5, R6, R8, 25k.
R7, 350 ohms.
R9, 1 meg.
R10, R17, 1000 ohms pot.
R11, R12, R15, 10k.
R13, R14, 5k.
R18, 2500 ohms 10 watt.
C1, 10 μμf. mica.
C2, 100 μμf. mica.
C3, 50 μμf. variable.
C4, C5, 0.1 μf.
C6, 0.25 μf.
C7, 250 μμf. mica.
C8, 300 μμf. mica.
C9, 0.01 μf.
C10, C11, 16 μf. 450v. electro
V1, V3, 6N7.
V2, 6SK7.
V4, 6X5.
L1 (see text).
T1 =

It employs only four tubes, inclusive of its own rectifier, and uses the unmodulated signal from the usual signal generator in order to give frequency-modulated output on frequencies other than the I.F. band. It can be used with any oscilloscope at all.

SCHEME OF OPERATION

V1 is the frequency-modulated oscillator, which uses a 6N7 in a cathode-coupled two-terminal circuit. The special virtue of this circuit is that it allows a single tuned winding to be used as the oscillator coil, without tickler or tappings having to be provided. The variable condenser, C3, enables the **centre frequency to be** varied over a range of 320 to 510 kc/sec., and is provided with a dial on the front panel of the instrument. This scheme enables the oscillator to be used independently of an external oscillator for aligning any receiver whose I.F. falls within this band.

V2 is the modulator, which is a 6SK7. It is arranged as a conventional reactance tube. Its plate circuit is in parallel with that of one half of the oscillator, and therefore with L1, through which it obtains its D.C. plate supply voltage. It is cathode-biased, and has its screen supplied by the voltage divider R4, R5. Its grid is fed by the phase-changing network C7, R8, C8, whose job is to provide an R.F. voltage at the grid, which is 90 deg. out of phase with the R.F. plate voltage. It is this connection which causes the plate circuit to look like an inductance, which can be varied in value by means of varying the voltage on the control grid. Thus, through R9, R10, and R11, a portion of the 6.3v. 50 c/sec. heater voltage is applied to the 6SK7 grid, and varies the oscillator frequency. In other words, it produces frequency modulation of the oscillator.

The third tube, V3, has two functions. It is used as a buffer and attenuator in the event that no input is applied through J1. The oscillator output is taken from J2, via the output control, R17. When a frequency-modulated signal with a centre frequency within the range 320-510 kc/sec. is required, no use is made of J1, but if an output on some other frequency is needed, then V3 is made to act as a mixer by feeding a second, external oscillator into J1. For example, if an output is wanted on 5 mc/sec., then the external signal generator can be tuned to either 4.5 or 5.5 mc/sec. and fed in to J1. Then, the tuning condenser, C3, of the F.M. oscillator is set to 500 kc/sec. The two signals are "mixed" in V3, so that the output contains an F.M. signal with a centre frequency of 5 mc/sec. Thus, with the aid of the ordinary signal generator, this unit is able to give out an F.M. signal on any desired frequency.

WHYS AND WHEREFORES

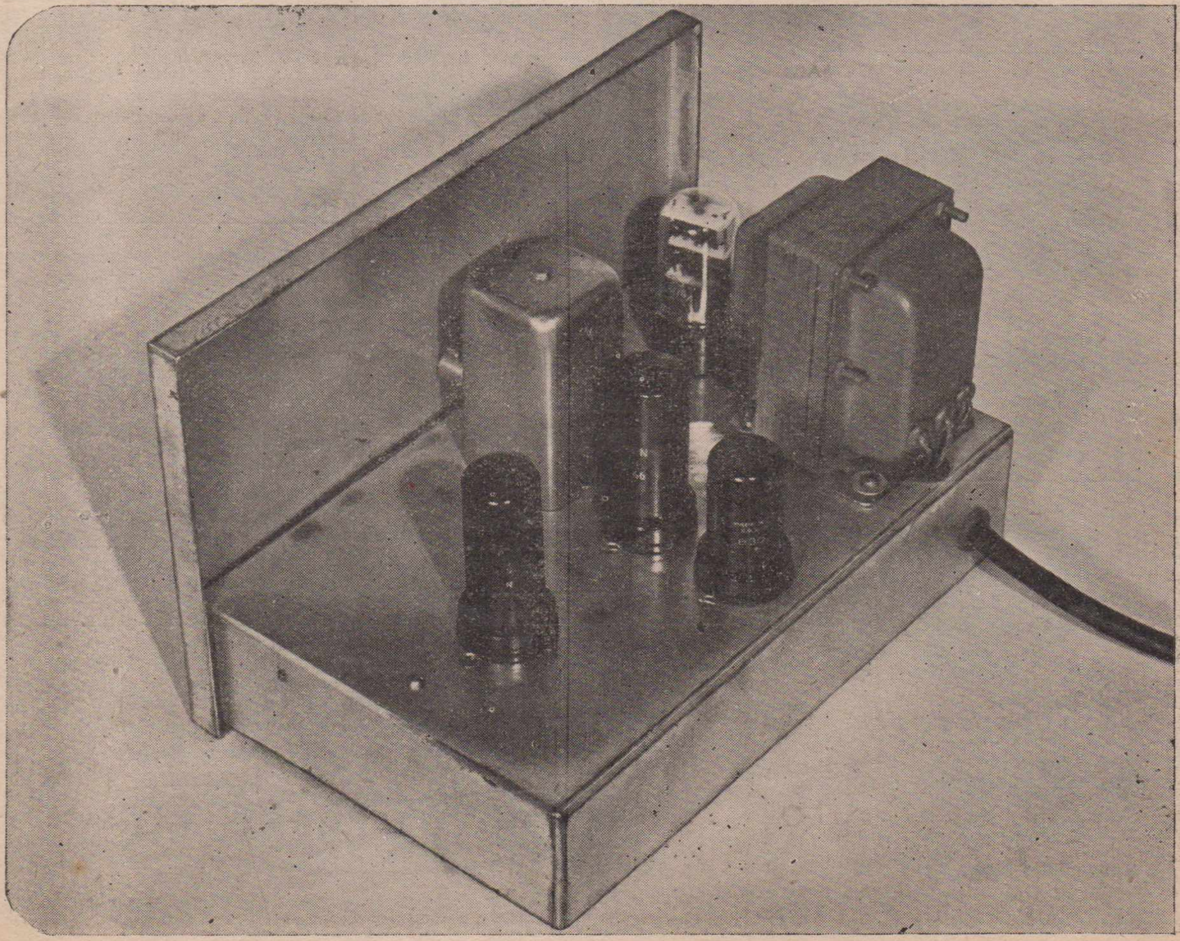
Most commercial "wobbulators" are a good deal more complex than this one, and it may interest readers to know just why this is so, and what, if anything, has been sacrificed in the interests of simplicity and ease of construction.

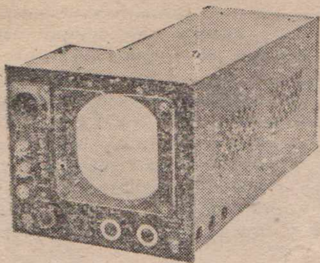
In the first place, most commercial instruments of this type have a variable frequency oscillator incorporated in them, and use the beat method to produce the F.M. signal, whatever frequency is required. The idea of using a beat method of obtaining the output frequency is that in this way the frequency deviation of the modulation is kept constant irrespective of actual output frequency. If an attempt were made to modulate directly an oscillator whose centre frequency is variable over a wide range, the amount of frequency sweep attained in practice would vary greatly over the frequency band. However, if a "fixed" oscillator is frequency-modulated by a given amount (say, plus and minus 30 kc/sec.) and higher output frequencies are obtained by beating this oscillator with an unmodulated variable frequency oscillator, then the frequency sweep of the output signal remains at the value of plus and minus 30 kc/sec., irrespective of the tuning of the variable oscillator, and therefore of the output frequency.

In our case, this is exactly the system used in order to get F.M. outputs at frequencies other than 320-510 kc/sec. However, by far the greatest use that is found for an F.M. oscillator is in aligning I.F. stages. Few modern receivers have an I.F. outside the range given above, so that providing a slight amount of tuning on the modulated oscillator obviates the necessity for having a second oscillator built in. At the same time, the tuning range is so small that little variation of frequency sweep occurs over the range of the oscillator.

In any case, the present instrument is intended only for visual alignment, and not for making fairly precise estimates of band-width or for other purposes which require the frequency sweep to be accurately known.

The above paragraph explains also why we have not gone to the trouble of providing a linear saw-tooth or triangular wave-form with which to modulate the oscillator. This is required only where it is necessary to calibrate the trace for frequency. Here, all we are interested in is providing enough sweep for the selectivity curve which is displayed on the screen of the oscilloscope to have the right shape for viewing. In other words, since the oscillator is modulated by a sine-wave and not a saw-tooth, the





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All enclosed in neat metal case as illustrated.
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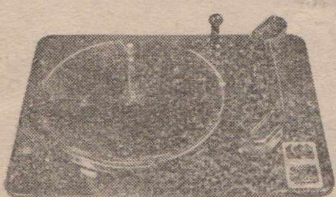

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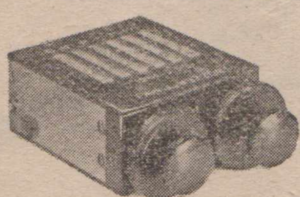

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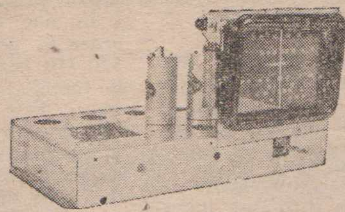

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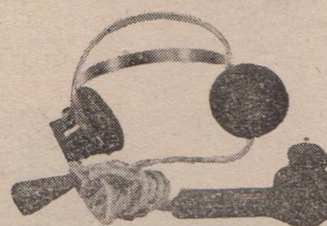

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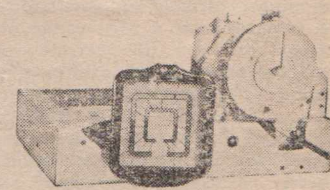

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frequency scale of the picture on the 'scope will be approximately linear in the middle, but will be crowded at each end. This does not interest us very much, for we are interested in obtaining a selectivity curve which shows the receiver circuits to be correctly tuned by displaying the selectivity curve at the centre of the trace—which is where it is almost linear, anyway! A linear frequency sweep is really only of interest when the trace needs to be calibrated in terms of frequency, and this is not the case for purely alignment purposes.

Just as a superheterodyne receiver is subject to image reception, so a system of two oscillators fed to a mixer can give what may be called an "image signal." For instance, take the case given earlier, where we wanted an output, frequency-modulated, with a centre frequency of 5 mc/sec. Here we set the "fixed" oscillator to 500 kc/sec., and the variable one, fed in through J1, to 4.5 mc/sec. If this were not realized it could have serious consequences, because the receiver could be tuned to 4 mc/sec. by mistake. For this reason, commercial "wobbulators" sometimes have tunable filters which are ganged with the variable frequency oscillator and attenuate the "image" frequency—either the sum or difference between the two oscillators, whichever is not wanted.

This is quite difficult to accomplish, and involves the tracking of circuits exactly as in a superheterodyne receiver. Also, if the image suppression is to be complete, quite complex filtering would have to be employed. The image signal is little disadvantage as long as its presence is realized, and care is taken to prevent the receiver from being tuned to it by mistake.

In short, the simplification that has been achieved by omitting such features as rejection of the "image" signal, and linear modulation has not affected to any appreciable extent the usefulness of the instrument as an alignment tool. On the other hand, such simplifications bring the "wobbulator" within the scope of the average constructor, who does not possess the specialized equipment necessary to build and adjust an instrument designed on a commercial scale.

DETAIL OF CIRCUITS

Once the principle of the oscillator has been outlined, there is very little need to go into detail about the circuits themselves. The only controls are the output pentiometer R17, the sweep-width control R10, and the tuning control C3, all of which are brought out to the front panel. Also appearing on the front panel are the two jacks, J1 and J2, which are the input and output jacks respectively.

Since the chief use of the "wobbulator" is in aligning I.F. amplifiers, there is no necessity for a high quality attenuator at the output of the oscillator, because a fairly high output level is necessary for this work. When signal frequency alignment is being carried out, fine control of output can be obtained by using the attenuator of the external signal generator used for mixing, so that even where a very small signal is needed, there is still no necessity to provide good attenuation in the "wobbulator" itself.

The sweep-width control has been included because it is a help in using the "wobbulator" if the frequency modulation can be cut off altogether without cutting out the signal, and because more accurate final alignment can be had by reducing the frequency deviation. The maximum sweep is required to be great enough to show the whole selectivity curve of comparatively inselective circuits. This situation is met when the "wobbulator" is fed straight to the last I.F. transformer

or to the grid of the last I.F. stage, and if the sweep of the oscillator is not great enough, only the top part of the selectivity curve can be shown on the screen, the "skirts" being outside the swept range of the oscillator. At the same time, there is a limit to the sweep that can be obtained with the reactance tube modulator before the frequency modulation becomes non-linear. If this happens, through applying too much modulating voltage, the effect on the picture is the same as is seen when the circuits under alignment are detuned from resonance. The basic reason is that when the modulation no longer takes place in a linear manner, the centre frequency is altered just as if the tuning control had been operated. This must be avoided at all costs, because, if it is allowed to occur, the circuits will be aligned to a centre frequency which is **not** that marked on the tuning dial. It is prevented simply by limiting the modulating voltage applied to the grid of the reactance tube. Thus we have one-eleventh of the 6.3v. from the heater supply used as the maximum modulating voltage. When R10 is turned to its zero position, there is no frequency modulation.

The 6N7 mixer has been used because an ordinary triode hexode requires more components and would give gain that is not required. By the same token, intermodulation and harmonic outputs would be greatly increased in amplitude, which is very undesirable.

CONSTRUCTION

There is nothing difficult about the construction of the oscillator. The exact lay-out of parts is not important, and a good idea of the arrangement used in the prototype can be gained from the photograph, which shows a rear view of the unit. The oscillator coil is mounted in an ordinary I.F. transformer can, which is placed centrally on the chassis. Also mounted in the can is the midget tuning condenser, C3, which has a small extension shaft through the front panel, where a plain dial is used for control purposes. The tube directly behind the coil can is the oscillator, V1, and behind it again is the 6SK7 modulator, V2. The mixer is the second 6N7, directly to the left of the oscillator tube, while the 6X5 rectifier may be seen behind the power transformer.

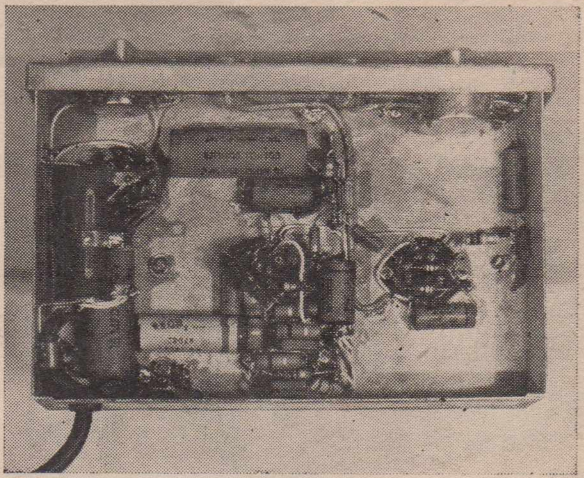
The front panel is made in the form of a lid which fits on to the metal box which totally encloses the unit. The chassis shown in the illustrations measures 9½in. x 6in. x 2in., and gives ample room, as can be seen from the under-chassis photograph. The only leads which need to be kept short and direct are those carrying R.F.; that is to say, the oscillator and modulator wiring. The output lead from the mixer causes no trouble, as it is run in shielded wire.

COIL CONSTRUCTION

In order to get a coil of the proper inductance to tune to 465 kc/sec. with about 25 mmfd. of tuning capacity, it is necessary either to have one specially wound or to make one from a coil whose inductance is too great.

For the average constructor, the latter is by far the easiest method, especially as suitable windings may be obtained in the form of bobbins intended for 175 kc/sec. I.F. transformers. One of these is obtained and cut in half between the two windings, since only one is required. The spare one comes in handy in case of accident with the first. The best plan in adjusting the inductance of the coil is to wire the "wobbulator" completely with the exception of the coil and tuning condenser. The latter can be mounted in the can temporarily and a pair of leads brought out. Then, turns are removed from the 175 kc/sec. coil until, with the plates of C3 half-meshed, the oscillator works at 465 kc/sec. In doing this, care should be taken that V2 is in position, but that R10 is either disconnected or set at minimum, because frequency modulation is definitely not wanted while the adjustment process is going on, and yet the added capacity due to the modulator tube must be in circuit at the same time.

The easiest way to check the oscillator frequency is to feed the signal generator in to J1, and to connect a pair of headphones at J2. The signal generator can



then be adjusted to zero beat with the internal oscillator, and the frequency read off. It should be remembered that when the coil is finally installed in the can its inductance will be slightly reduced so that the final adjustments to its inductance should be made by mounting it in the can and wiring it up properly before testing it for frequency. Once 465 kc/sec. has been hit with the condenser at half-scale, the coil can be permanently placed in the can and the final wiring-up done. Calibration of the dial for frequency can be done with the signal generator and a pair of phones exactly as when adjusting the coil. Perhaps the most important point is to see that 500 kc/sec. comes on the scale. If it does not, more turns must be removed from the coil, because this frequency is required when using the "wobbulator" in conjunction with the signal generator.

USING THE "WOBBULATOR"

There are a number of ways in which the instrument can be used, and a number of different 'scope patterns that can be obtained, so that a few words on operating it in conjunction with the oscilloscope will not be out of place.

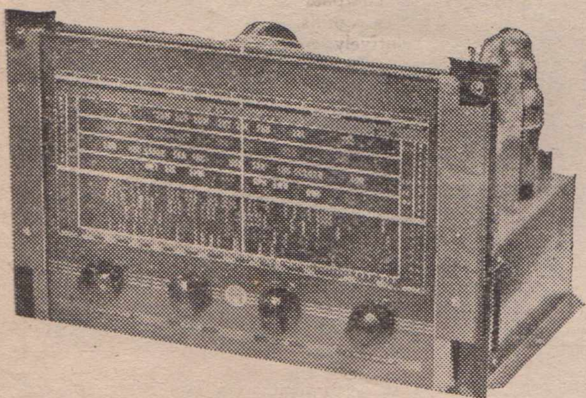
The easiest and probably the best method is to use the time-base already possessed by the 'scope to show what is known as a "double trace" picture. The connections for this type of operation are made as follows: (1) The output of the modulated oscillator is applied to the input of the I.F. amplifier in the set to be aligned; (2) the Y-amplifier input terminal of 'scope is connected to the "high" end of the detector diode load resistor in the receiver; (3) the oscilloscope "synch." terminal is connected to the Y input terminal. If the 'scope has an internal synch' connection which synchronizes the time-base from the output of the Y amplifier, this can be used instead.

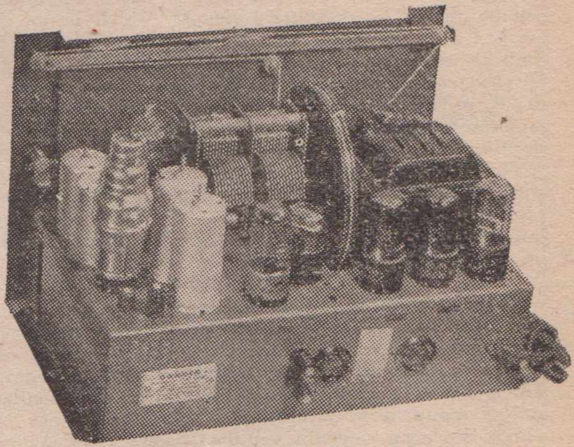
Continued on Page 29

8 VALVE WORLD RANGE RADIOGRAM CHASSIS

WITH MATCHED DUAL SPEAKER

£29/10/- FREIGHT EXTRA





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Eight valve world range chassis with push-pull output. Uses new Philips ECH33 converter valve for better long distance reception. High gain audio with inverse feed back and tone control gives you the best reproduction from your favorite recordings. Radiogramo switch combined with short-wave switch. A.C. switch incorporated with tone control. Large calibrated edge lit dial with main stations in each State in prominent type, with counterweight drive. Provision for F.M. or television tuner. Permatuned iron cored coils and intermediates.

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HABERFIELD.
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HAM ACTIVITIES

BECAUSE of the change of publishers entailing an earlier closing date for notes, the news this month, which is usually received from various interstate and country correspondents, has had to be omitted. Would correspondents please note that their notes must now reach me at Box 1589M, G.P.O., Adelaide, S.A., by the 25th of each month.

FROM MY LOG

Conditions seemed to improve on all bands during the past few weeks and as referred to in "Going Up," things were favourable on the VHF bands at times also. The noticeable feature of this ionosphere change was the poor shape of the lower bands during these break-throughs.

As the National Field Day week-end nears, more and more stations are being heard testing their portable gear in preparation for the big day.

In VK2 there is to be a large Hamfest, organised, I understand, by 2JU and the VHF Committee in that State.

Conducted by
J. A. HAMPEL, VK5BJ

Here in VK5 there will be an outing at the beach near Outer Harbour, a location famed for its noiseless characteristic for portable operating. Many novel features have been included in the South Australian programme; every one from the children up has been catered for with Sand Castle Competitions, Treasure Hunt, the traditional throwing the rolling-pin for the XYL's and there is even a prize for the best home made sponge brought along by an XYL or YL! Up to date there have been 23 applications to join the judging committee!

It is certainly refreshing to note the swing back to Field Days again as very little activity has been shown in the past from some quarters including, especially, VK5 where the recent Northern Network outing revived interest again.

As Amateurs we should all be able to co-operate in such a day as it is this preparedness which governs our chances of capably handling Emergency operation should the occasion arise.

National Field Day is to be held over the week-end of 27th and 28th January, 1951, commencing at 1500 hrs., E.A.S.T., on the Saturday and closes at 2359 hrs., on the Sunday night, 28th. Full details appeared in last month's issue.

Recently the writer had an opportunity to try real QRP work with a 108 transceiver using 1 watt input to a 1Q5 in the PA. On local contacts using an antenna 50ft. high, little difference could be discerned between this diminutive rig and a Type III; the only report was that the modulation was rougher, due to the use of a Carbon mike against a Crystal type on the bigger rig. Using this power, 3TT, in Ballarat, was contacted and he gave S7.

Originally the 108 was bought for the excellent quality parts contained therein and the stripping was almost complete when 5RO dropped by to relate how he had heard several VK6's calling after a CQ on a recent evening. Too late now!

The little jobs were referred to in their hey-day as a species of "Walkie-Talkie", but after carrying one only a short distance it is hard to imagine anyone walking and talking very long.

Out at his farm location at Manmanning about 140 miles north-east of Perth, 6BS is getting the most out of his 32 volt lighting plant by using genemotors for all supplies.

The jobs in use are ex-SCR522 units and are used to power a TA12D which is modulated by zero-bias 807's. A MN26C compass receiver with converters is used to pull in the signals.

3AAP is a relatively newcomer to the bands and runs 60 watts to 807's. Evan uses a 20 metre W8JK on 40 and finds it contradicts all theory. Two metres is another interest, a transceiver "Walkie-Talkie" being on the way for the band.

Alan, 2SJ, at Parkes must certainly be enthusiastic to stop up till 2 a.m. putting up a new antenna. It uses the now common water thirsty 300 ohm ribbon and Alan has been playing around with twin lamps and the like.

At 2UN the choice of antennas is a vertical working against ground. After hearing Ron's 40 metre signal there is no doubt that it works out.

Those unmodulated carriers still appear on 40 at intervals. The best of these was heard t'other night when the offender left the carrier going for near enough to a half hour. During this a voice was heard to pop up and mention about a call sign. "Don't be silly, you don't sign your call when you're testing" was the reply. OM, with the quality you were putting out I shouldn't blame you really.

Ken, 5AL, is having trouble with two "ghosts"—one on twenty, the other on forty. One is understood to be operating from Europe considering the QSL's and SWL cards Ken is receiving from that area. 5AL number two is apt to pop up while Ken is in QSO with someone and cause QRM the whole time he is on. This chap is in VK5, it would appear, as the signal is equal to the orthodox 5AL's strength at only a few miles from Ken's QTH.

6RT, 450 miles north of Perth at Cue uses 24 watts from DC mains and derives filament supplies through vibrators.

When not experimenting on 144, 3AJ1 still appears on 40 metres. His time these days is further taken up with conducting Morse Classes for the local AOCP aspirants.

5GY at Whyalla has a new rig on the air and managed to clear up the trouble he was experiencing with room resonance by, of all things, changing his pre-amp tube.

5DK is back on the air from his new QTH after recently taking unto himself an XYL. The new rig is a BC-459 modified to use NBFM at 20 watts.

2ARQ, who is ex-5RG, will shortly be back in VK5 for a short while during a brief respite from studies and is anxious to contact old friends.

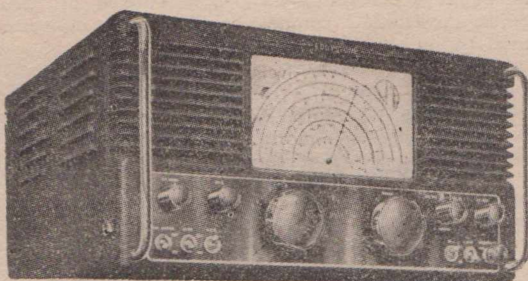
Keith, 7RX, is running the full quota to push-pull 807's and is consistently on 40.

VK1HV and VK1PG are on 20 most evenings but sometimes they frantically call CQ for hours without an answer!

5EN is being heard operating portable at Arwakurra in the north of S.A., most week-ends; Ernie is issuing special portable QSL cards for all contacts he makes. YL co-operation is proving invaluable in acting as QSL manager.

EDDYSTONE RECEIVERS

for perfect reception under all conditions!



MODEL 680

(At left)

A superior 15 valves communication receiver with world's latest features. Designed for professional and discerning amateurs. Price, £192/10/0.

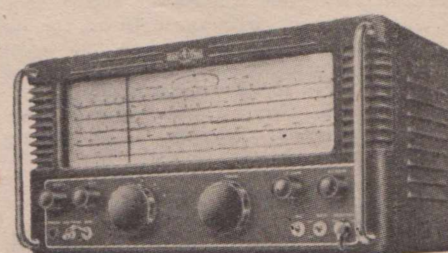
FREQUENCY RANGE
1.— 30-13 Mc.
2.—1.2-5.5 Mc.
3.—5.8-2.5 Mc.
4.—2.5-1.12 Mc.
5.—1120-480 Kc.

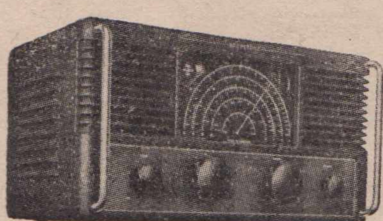
MODEL 750

(At right)

Eddystone's latest 11-valve communications
version (1600-85 Kc). Excellent band spread.
Operates from main or with Cat. 687 Eddy-
receiver. Replaces famous 640 Double con-
stone vibrator. Price, £122/18/9.

FREQUENCY RANGE
1.— 32-12 Mc.
2.— 12-4.5 Mc.
3.— 4.5-1.7 Mc.
4.—1465-480 Kc.





ALL WORLD SIX

(At left)

Model 710, a 6-valve high-grade receiver, for the man on the land or in the Islands. Operates from 6-volt accum. with less than 2.5 amps drain. Internal speaker. Price, £105/2/6.

FREQUENCY RANGE
1.—30.6-10.5 Mc.
2.—10.6- 3.7 Mc.
3.— 3.8- 1.4 Mc.
4.— 205- 1.4 Mc.

NOTE: All above prices include Sales Tax.

As well as the communication receivers illustrated above, a complete range of Eddystone radio components is now obtainable, ex stock. Write to John Martin and have your name put on the mailing list. The new Eddystone catalogue is now available, containing all additions and amendments to this famous range of receivers and components.

JOHN MARTIN PTY. LTD.

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3BH recently related how the VK3 boys are ganging up to track down the signal which appears unmodulated on their signals during a QSO. 3RV is ready to go portable with a loop antenna to D/F the offending signal.

Bert, 5DR, is back at Cape de Couedie Lighthouse on Kangaroo Island after holidays in Adelaide. He has now rebuilt and a new heavy duty power supply has gone over so he can push the 807's to higher input.

3RV is doing a fine job with a portable rig which uses a 7193 as the final running about 4 watts. The rig is completely portable being used in conjunction with a small receiver.

Radio Leopoldville have a special session for Amateurs each week on Wednesdays at 2040 G.M.T. on 9767K.C.

3AUP has one of those new English "Commander" receivers which he finds very excellent; it takes bad conditions like those prevailing at present to show up the receivers, good—and bad!

5BZ and 5MD are operating portable most weekends, both using Type III's with very simple antennas but receiving good results nevertheless.

5MX has finished his home-brew 35ft. wooden tower which will soon sport a three element beam for 20. John now finds, he could have bought a ready-made steel job for less than the cost of wood, but maybe the wood will not detract from the beam's performance as would a metal one.

SEVERAL 50mc break-throughs occurred during December and the consistent stations on this band reaped the reward of their listening. Early summer changes with their inherent temperature inversions caused most of the openings with the presence of cloud formations over the transmitting and receiving stations having an effect too.

There are many devotees of the VHF bands who consider that this summer will produce outstanding results and perhaps with things the way they are they will prove correct. At a recent field day in VK5, not one station was worked on the lower frequencies, due to ionospheric trickery, whilst the VHF stations worked 'em "high, wide and handsomely."

Conditions on the lower bands would indicate that should this be a pointer, the VHF bands this summer should be exceptionally good.

Regulars on the band who have been heard during the recent openings are 2RU, 2AMF, 2BT, 2WJ, 4BT, 4HR (on C.W.), 2VU, 2ANL, 4KK, 5MA, 5MK, 5GF, 5BC and 5HD.

5AX at Gawler has now modified his 6 metre beam with a folded dipole driven element and at the same time has put up a "4-over-4" for 2 metres. 5XL, like a lot of others, is getting everything ready for National Field Day on VHF after seeing the excellent job done by 5GF at the last outing he attended.

An interesting letter came during the month from 7MY giving details of his self-excited transmitter on 2 metres with which he is running automatic transmissions.

The circuits etc. will appear next month as they arrived a little late for inclusion this time.

And so once again the log is closed, the big switch pulled. In regard of this section of the magazine, I would like to hear from YOU and what you are doing. Some chaps are getting around in their own district to find out all the news and then sending it all on to me at Box 1589M, G.P.O., Adelaide, S.A. Also, I would be glad to hear from Club Secretaries, and be only too pleased to include news of their activities in these pages. Till next month, best of everything you can work. —J.A.H.

F.M. TEST OSC (Continued from Page 23)

For initial operation, in getting to know the use and habits of the "wobbulator," it is best to connect it to a set which has already been lined up by the ordinary method. Having made connections as above, the controls should now be adjusted as follows: (1) The output control of the "wobbulator" is turned full on; (2) the Y gain control of the oscilloscope is turned well up; (3) the sweep control R10 is turned to maximum; and (4) the set's volume control is advanced.

The F.M. oscillator is now tuned with C3 until a growling noise is heard in the loudspeaker, and is adjusted for maximum output as judged by ear. The volume control may now be turned off. Now, if the 'scope is examined, there should be a considerable deflection in the vertical direction. The Y gain control is adjusted so that its amplitude is reasonable, and attention is now turned to the time-base and synch. controls, which will enable the correct picture to be obtained. First of all, set the synch. control at zero and the time-base to its lowest frequency. The picture will now consist of a number of vertical pips, in all probability travelling along the screen, since the time-base has not been locked.

The time-base frequency is now increased slowly until only two of the vertical deflections are visible on the trace and until these do not drift at all. The time-base is now adjusted to 50 c/sec., the same frequency as that of the modulation. The two "humps" are each a plot of the selectivity curve of the amplifier under test, but this picture is not very useful for alignment purposes, as can be seen by a slight adjustment of the tuning control on the oscillator, and a consideration of what is happening to the oscillator frequency during one cycle of the time-base. When this picture is arranged so that the space between the two selectivity curves is central on the trace, then the centre of the trace represents one extreme of the frequency sweep, and the peaks of the curve represent the centre frequency of the sweep. There is thus no adjustment of the picture, which indicates whether or not the circuits are correctly aligned. This type of picture is therefore of no use except for viewing the shape of the selectivity curve after the adjustment process has been completed.

The correct time-base adjustment is the one where it is running at twice the modulation frequency, or 100 c/sec. In order to find this adjustment, the F.M. oscillator is again adjusted for maximum output from the set being examined, and the time-base frequency is gradually increased again. After a time a stationary picture is again found in which two selectivity curves can be seen, but in which the curves are superimposed, or nearly so. This is because one time-base trace takes place during each half-cycle of the A.C. which sweeps the oscillator frequency. Thus, on each cycle of the time-base, the oscillator sweeps through the frequency band once, but on alternate time-base cycles, the sweep is in the opposite direction. Since alternate time-base cycles are superimposed on the C.R.T. screen, there are two selectivity curves displayed on the same trace. Now, the centre of the trace with this picture always represents the centre frequency of the modulated oscillator, so that when the two selectivity curves are superimposed, or as nearly so as will occur, the circuits are aligned on the oscillator centre frequency. Now, the effect of misalignment on the picture can be illustrated (up to a point) simply by detuning the F.M. oscillator. As the centre frequency is tuned away from the alignment frequency of the circuits, the two peaks separate by travelling in opposite directions along the trace. When the oscillator is retuned, the two peaks appear from the edges of the trace and can be superimposed by further tuning.

It should be clearly understood that the foregoing is **NOT** a description of how to go about lining up a set with the oscillator, but merely serves to enable those who have never used a "wobbulator" before to obtain the correct sort of picture so that it has been seen and observed before trying to use the oscillator properly.

When the time-base has been adjusted as closely as possible to the required frequency, the picture can readily be locked on the screen by slightly advancing the synch. control, which has been set up in the manner previously described.

The best possible way in which to learn the use of the F.M. oscillator and oscilloscope is by actually using them. One ounce of practice is worth a pound of description, but if the directions given here are followed, then no difficulty will occur, and the user will quickly become adept at visual alignment.

In teaching oneself to perform visual alignment the best way, after having found and recognized the correct pattern in the manner set out above, is to detune the I.F. circuits of the receiver and start from scratch. The connections are the same as before, except that the output of the "wobbulator" is first connected to the grid of the last I.F. stage, and that the Y amplifier control needs to be turned right up. First of all, the oscillator is set to the correct mid-frequency, and both frequency sweep and output controls are turned to maximum.

If the set is a long way out, no deflection will be seen on the 'scope trace at all. The last trimmer (i.e., the one feeding the diode) is adjusted until the two deflections are seen to appear and is set at the spot where they become superimposed at the centre of the trace. Next, the I.F. plate trimmer is brought into line, and will result in greatly increased amplitude of deflection. The Y amplifier gain or the oscillator output can now be reduced in order to show a reasonably sized picture, and the oscillator output can be removed to the input of the previous I.F. stage or to the mixer grid, whichever is applicable, and the preceding I.F. transformer is aligned in a similar manner. With the F.M. oscillator, the whole business can be performed much more quickly than it can with the amplitude-modulated signal generator and output meter.

A great deal more could be written about this oscillator and its use, but space forbids, and this will have to be made the subject of a separate article.

SHORT WAVE REVIEW

By the time this issue is published, a good many readers would have celebrated the coming of the New Year in the good old-fashioned way, and also quite a number would have taken advantage of the magic of radio and tuned into many countries, and listened to their festivities.

And what a choice of countries we now have.

Conducted by L. J. Keast

7 Fitzgerald Rd., Ermington, N.S.W.

Phone: WL 1101

I remember when we could have listened to all, or at any rate logged all that were audible within thirty minutes—but to-day, the complete list would occupy many many pages of this magazine.

But how have we come to find so many stations,—chiefly by the Dx-ers making known to one another, the new stations they have heard, the change in schedule or frequency of the old favourites—and it is to those who have been so good in passing on this information to me, I want to say, thank you!—I refer particularly to those old timers:— Arthur Cushen, Rex Gillett, Miss Dorothy Sanderson, Roger Legge, "Sweden Calling", and I am also grateful to the many Consulate Officers for keeping me informed of the schedules of their respective countries.

There must be many new listeners who could greatly assist us in supplying information that will assist me in keeping these notes right up to date, and I hope that this year will see many more short-wave enthusiasts.

Let me take this opportunity to wish all Dx-ers a Happy New Year.

ARE YOU CALIBRATING?

In order to assist those keen dx-ers who are anxious to check their receivers and make notes of their logging hands, this issue affords a grand opportunity. I refer to the Morocco station in Tangier. This station uses the 49, 40, 31, 25 and 19 metre bands and in the latter particularly a unique opportunity is afforded from m/n to 8.30 a.m.—See details elsewhere.

13 METRE BAND

Those who have sets that tune in the 13 metre band will have a grand opportunity during this month to listen to some fine signals from U.S.A. stations, two from 'Frisco, 10 East Coast and also an American operated station from Manila.

San Francisco can be heard on KCBR-2, 21.74 m.c., 13.80 met., from 8-10 a.m. and KRCA-1 from 10 a.m. till 1 p.m. on 21.40 m.c., 13.98 met.

The 10 East Coast stations I am showing in order of frequency and the times are from the latest air-mail list from Washington:

WABC-6, 21.50 m.c., 13.95 met.: 2-5 a.m.
WLWO-3, 21.52 m.c. 13.93 met.: 2-6.45 a.m.
WABC-1, 2157 m.c. 13.90 met.: 2-4.45 a.m.
WGEO-2, 21.69 m.c. 13.89 met.: 2-4.30 a.m.
WRCA-1, 21.61 m.c. 13.88 met.: 2-6 a.m.
WLWO-2, 21.63 m.c. 13.86 met.: 1.30-4 a.m.; 6-9 a.m.
WLWO-7, 21.65 m.c. 13.85 met.: 10 p.m.-1 a.m.; 2-8.30 a.m.
WRCA-3, 21.73 m.c. 13.81 met.: 2.15-4.30 a.m.
MANILA-2, 21.57 m.c. 13.90 met.: 6.35-6.45 p.m.

THE MONTH'S LOGGINGS

RADIO AUSTRALIA

Australia Broadcasting Commission

Schedule for Lyndhurst Transmitter VLG for use in overseas & inland shortwave service.

VLG-11 15.21 m.c. 19.72 met.:

Mon.-Fri.—6.00-10.30 a.m. To New Guinea.
Sat.—6.00 a.m.-3.45 p.m. To New Guinea.
Sun.—7.00 a.m.-3.45 p.m. To New Guinea.
Daily—10.50 a.m.-1.40 p.m. To S.E. Asia & N.W. Australia.
1.45-3.45 p.m. To New Guinea.
4.00-4.40 p.m. To Tahiti in French.
Fri. only—5.00-5.30 p.m. To Thailand & Thai.
Daily: 5.45-6.45 p.m. To New Caledonia in French.

VLG-10 11.76 m.c. 25.51 met.:

Mon.-Fri.—6.59-11.30 p.m. To New Guinea.
Sat.—6.59-Midnight. To New Guinea.
Sun.—6.59-11.30 p.m. To New Guinea.

OCEANIA

New Zealand

ZL-3, WELLINGTON 11.78 m.c. 25.46 met.: 4.00-6.45 a.m.; 5.00-8.30 p.m.

ZL-10, WELLINGTON 15.22 m.c. 19.72 met.: 7.00 a.m.-4.45 p.m.

ZL-4, WELLINGTON 15.28 m.c. 19.64 met.: 4.00 a.m.-8.30 p.m. (9.30 p.m. Saturdays).

THE EAST

Ceylon Commercial Service

Radio Ceylon, Colombo, 9.52mc, 31.53 met: Noon-5.30 p.m.
Radio Ceylon, Colombo, 11.775mc, 25.47 met: Midnight-2.30 a.m.
Radio Ceylon, Colombo, 15.12mc, 19.83 met: Noon-5.30 p.m.

Philippines

Manila-3, 6.12mc, 49.02 met: 7.00 p.m.-2.15 a.m. 8.00 a.m.-12.15 p.m.
Manila-1, 11.89mc, 25.23 met: 7.00 p.m.-2.15 a.m. 8.00 a.m.-1.00 p.m.
Manila-2 15.25mc, 19.68 met: 7.00 p.m.-2.15 a.m. 8.00 a.m.-6.15 p.m.
Manila-3 15.33mc, 19.56 met: 1.00-6.35 p.m.
Manila-1, 17.78mc, 16.87 met: 1.15 p.m.-6.45 p.m.
Manila-2 21.57mc, 13.9 met: 6.35-6.45 p.m.

India

Radio Pakistan, 9.645mc. 31.11 met: Noon-4.30 p.m. 12.15-4.30 a.m.
Radio Pakistan, 11.885mc, 25.24 met: 4.30-11.15 p.m. 2.00-4.30 a.m. 5.00-5.45 a.m.

Morocco

Tangier-1, 6.04mc, 49.67 met: 7.00-8.30 a.m.
Tangier-1, 7.20mc, 41.66met: 2.00-4.00 p.m.
Tangier-1, 7.214mc, 41.61 met: 11.00 p.m.-midnight.
Tangier-5, 7.27mc, 41.27 met: 2.15-8.30 a.m.
Tangier-1, 9.54mc, 31.45 met: 5.00-5.30 a.m.
Tangier-4, 9.54mc, 31.45 met: 6.00-8.30 a.m.
Tangier-2, 9.56mc, 31.38 met: 6.00-8.30 a.m., 2.00-4.00 p.m.
Tangier-1, 9.68mc, 30.99 met: 6.00-7.00 a.m.
Tangier-3, 11.79mc, 25.44 met: 2.15-8.30 a.m.
Tangier-1, 15 21mc, 19.73 met: 12.15-5.00 a.m.
Tangier-2, 15.24mc, 19.69 met: 12 15-1.45 a.m.
Tangier-4, 15.25mc, 19.68 met: 2.15-5.30 a.m.
Tangier-2, 15.28mc, 19.64 met: 2.15-7.00 a.m.

AFRICA

Belgian Congo

OTC-2, Leopoldville, 9.767mc, 30.72 met: English 5.00-6.00 a.m.

OTC Leopoldville, 9.80mc, 30.61 met: English 1.00-2.00 p.m.

CANADA

CKCX, Montreal, 15.19mc, 19.75 met: 9.50-10.40 a.m. Portuguese, 10.40-11.45 Spanish.

CKLX, Montreal, 15.09mc, 19.88 met: 1.35-2.20 p.m. To Aust. and N.Z.

CKRA, Montreal, 11.76mc, 25.51 met: 9.50-10.40 a.m. Portuguess, 10.40-11.45 a.m., Spanish, 11.45-noon French, noon-12.45 p.m. English, 12.30-12.45 Dutch (Sats.), 12.45-1.35 p.m. Spanish

CHOL, Montreal, 11.72mc, 25.60 met: 1.35-2.20 p.m. To Aust and N.Z., 6.40-8.30 p.m. to S.W. Pacific in English (Sun.).

CKLO, Montreal, 9.63mc, 31.15 met: Noon-12.45 p.m. English., 12.30-12.45 p.m. Dutch (Sat. only), 12.45-1.35 p.m. Spanish, 6.40-8.30 p.m. to S.W. Pacific in English (Sun.).

U.S.A. (WEST COAST)

KCBR-2, 6.04mc, 49.67 met: 5.45 p.m.-12.15 a.m.
KRCA-2, 6.06mc, 49.5 met: 5.15-6.45 p.m., 7.00 p,m,-1.15 a.m.
KCBR-2, 6.12mc, 49.02 met: 3.30-5.30 p.m.
KRCA-1, 6.185mc, 48.51 met: 7.00 p.m.-1.15 a.m.
KRCA-1, 9.515mc, 31.55 met: 5.15-6.45 p.m.
KRCA-3, 9.515mc, 31.55 met: 7.00 p.m.-1.15 a.m.
KWID-1, 9 57mc, 31.35 met: 10.00 p.m.-1.15 a,m.
KWID-2, 9.57mc, 31.35 met: 11.15 a.m.-6.45 p.m.
KCBR-1, 9.60mc, 31.25 met: 7.00 p.m.-1.15 a.m.
KGEI-1, 9.77mc, 31.02 met: 3.30-6.45 p.m., 7.00 p.m.-12.15 a.m.
KCBR-3, 9.70mc, 30.93 met: 5.45 p.m.-12.15 a.m.
KGEI-2, 11.73 mc, 25.58 met: 3.30-6.45 p.m., 7.00 p.m.-1.15 a.m.
KRCA-2, 11.79mc, 25.44 met: 3.00-3.15 p.m.
KCBR-3, 11.81mc, 25.40 met: 11.15 a.m.-3.15 p.m., 2.30-5.30 p.m.
KWID-2, 11.86mc, 25.29 met: 7.00 p.m.-12.15 a.m.
KWID-1, 11.90mc, 25.51 met: 3.30-9.30 p.m.
KRCA-2, 15.13mc, 19.82 met: 10.00 a.m.-1.00 p.m.
KRCA-1, 15.31 mc, 19.82 met: 3.00-3.15 p.m.
KRCA-3, 15.24mc, 19.69 met: 3.30-6.00 p.m.
KCBR-1, 15.31mc, 19.60 met: 8.00-10.00 a.m.
KCBR-2, 15.31mc, 19.60 met: 11.15 a.m.-3.15 p.m.
KWID-1, 17.76mc, 16.89 met: 10.00 a.m.-1.00 p.m.
KCBR-3, 17.77mc, 16.88 met: 8.00-10.00 a.m.
KRCA-3, 17.83 mc, 16.82 met: 3.00-3.15 p.m.
KRCA-1, 21.46mc, 13.98 met: 10.00 a.m.-1.00 p.m.
KCBR-2, 21.74mc, 13.81 met: 8.00-10.00 a.m.

SOUTH AMERICA

HCJB, Quito, 9.958mc, 30.12 met: Programme in Russian at 9.00 p.m.

HCJB, Quito, 12.455mc, 25.11 met: Programme in Russian at 9.00 p.m.

HCJB, Quito, 15.115mc, 19.84 met: Programme in Swedish at 3.00 a.m.

HCJB, Quito, 17.89mc, 16.77 met: Programme in Swedish at 3.00 a.m.

Haiti

4-VGA, Port-au-Prince, 6.165mc, 48.66 met: 9.00 p.m.-1.00 a.m., 3.00-6.00 a.m., 8.00 a.m.-2.00 p.m.

EUROPE

Czechoslovakia

OLR3A, Prague, 9.55mc, 31.41 met: English, 5.00-5.45 a.m., 6.30-6.45 a.m., 8.15-8.30 a.m. Music, 9.00-9.45 a.m.

OLR4A, Prague, 11.84mc. 25.34 met: English, 8.15-8.30 a.m., Music, 9.00-9.45 a.m. This station is also reported as being heard in English around 10.30 p.m.

France

Radio Paris, 6.09mc, 49.26 met: Heard from 1.00-1.45 p m.
Radio Paris, 6.20mc, 48.40 met: Also heard from 1.00-1.45 p.m.

Holland

PCJ, Hilversum, 21.48mc, 13.96 met: English, 8.00-8.45 p m.
PCJ, Hilversum, 17.775mc, 16.88 met: English, 8.00-8.45 p.m.
PCJ, Hilversum, 15.22mc, 19.72 met: English, 8.00-8.45 p.m.

Hungary

Radio Budapest, 6.247mc, 48 07 met: News in English at 7.00 a.m. and 9.10 a.m.

Radio Budapest 9.83mc, 30.52 met: News in English at 7.00 a.m., 9.10 a.m.

Italy

Radio Italiana, Rome, 21.57mc, 13.91 met: English, 9.00-9.30 p.m.

Radio Italiana, Rome, 17.80mc, 16.85 met: English, 9.00-9.30 p.m.

Radio Italiana, Rome, 15.12mc, 19.87 met: Special Pacific Service with News at 6.15 p.m. Reports asked for.

Greece

Radio Athens, 9.607mc, 31.23 met: Daily, 3.00-5.30 p.m., 7.30-11.00 p.m., Sundays, 7.00-11.00 p.m.*

Radio Athens, 7.30mc, 41.10 met: 1.30-8.00 a.m., English at 1.45 a.m., French at 2.00 a.m.

Radio Athens, 15.345mc, 19.53 met: 8.30-9.30 a.m., English at 8.30-8.45 a.m.

Germany

Munich-3, 6.08mc, 49.34 met: 2.00 a.m.-6.00 p.m.
Munich-2, 6.095mc, 49.22 met: 5.30-8.00 a.m.
Munich-2, 6.10mc, 49.18 met: 8.15 a.m.-5.45 p.m.
Munich-5, 6.14mc, 48.85 met: 2.00-1.45 a.m.
Munich-1, 6.17mc, 48.62 met: 4.00-4.45 p.m.
Munich-4, 7.25mc, 41.38 met: 2.00-1.45 a.m.
Munich-3, 9.54mc, 31.45 met: 6.15 p.m.-1.45 a.m., 2.00-5.00 a.m.
Munich-1, 11,87mc, 25.27 met: 2.15-3.45 a.m.
Munich-1, 15.28mc, 19.64 met: 5.15 p.m.-12.15 a.m.
Munich-2, 15.34mc, 9.55 met: 5.45 p.m.-1.15 a.m.

Switzerland

HER-3, Berne, 6.165mc, 48.66 met: 8.30-9.15 a.m., 11.30 a.m.-2.00 p.m.
HER-4, Berne, 9.535mc, 31.46 met: 8.30-9.15 a.m., 11.30 a.m.-2.00 p.m.
HEU-3, Berne, 9.665mc, 31.04 met: 4.45-6.30 a.m., 6.45-8.15 a.m., 9.30-11.00 a.m.
HER-5, Berne, 11.865mc, 25.28 met: 8.30-9.15 a.m., 5.15-7.45 p.m., 10.45 p.m.-12.30 a.m., 12.45-2.30 a.m., 2.45-4.30 a.m., 4.45-6.30 a.m., 6.45-8.15 a.m., 9.30-11.00 a.m., 11.00 a.m.-2.00 p.m.
HEI-5, Berne, 11.715mc, 25.61 met: 9.30-11.00 a.m.
HER-6, Berne, 15.505mc, 19.60 met: 10.45 p.m.-12.30 a.m., 3.15-4.40 p.m., 1.00-8.00 a.m.
HER-7, Berne, 17.784mc, 16.87 met: 5.15-7.45 p.m., 12.45-2.30 a.m., 2.45-4.30 a.m., 10.45 p.m.-12.30 a.m.
HER-8, Berne, 21.52mc, 13.94 met: 5.15-7.45 p.m., 8.00-10.30 p.m.

SCANDINAVIA

Finland

OIX-5, Helsingfors, 17.80mc, 16.85 met: News in English 10.15 p.m.

OIX-4, Bjorneborg, 15.19mc, 19.75 met: News in English 10.15 p.m.

OIX-2, Lahiti, 9.55mc, 31.40 met: News in English 10.15 p.m.

Sweden

SBO, Stockholm, 6.065mc, 49.40 met: 10.00-11.30 a.m., 3.15-5.35 p.m., (Home Service 3.15-5.15 p.m.), (Home Service 4.00-8.00 a.m.).

SDB-2, Stockholm, 10.78mc, 27.83 met: 10.00-11.30 a.m., 3.15-5.35 p.m., 1.15-4.00 a.m. (Home Service 3.15-5.15 p.m.), (Home Service 1.15-4.30 a.m.), (Home Service 5.00-8.00 a.m.).

SBP, Stockholm, 11.705mc, 25·63 met: 5.35 p.m.-1.15 a.m., (Home Service 11.30 p.m.-midnight), (Home Service 5.35-11.15 p.m.).

SBT, Stockholm, 15.155mc, 19.80 met: 5.35 p.m.-4.00 a.m., (Home Service 5.35-11.15 p.m.), (Home Service 11.30 p.m.-midnight), (Home Service 1.30-4.00 a.m.).

Denmark

OZF, Copenhagen, 9.52mc. 31.51 met: Radio Denmark gives programmes in Danish daily noon-1.00 p.m., and English daily except Mondays 1.00-1.30 p.m.

OZH-2, Copenhagen, 15.165mc, 19.78 met: 10.00-11.00 a.m., 8.00-9.00 p.m. Mail Bag programmes on Fridays 8.00-9.00 p.m.

Norway

LLR, Oslo, 7.24mc, 41.44 met: "UKESENDEREN," the station of the Oslo Students is being heard from 8.00-8.30 a.m. Verification cards are promised for correct reports "SWEDEN CALLING."

TURKEY

TAS, Ankara, 7.285mc, 41.19 met: Heard in English 7.00-7.45 a.m.

TAT, Ankara, 9.515mc, 31.45 met: English from 7.00-7.45 a.m.

TAP, Ankara, 9.465mc, 31.7 met: English from 7.00-7.45 a.m.

T.V. PROJECT (From Page 4)

The next step in the development of the picture is to apply a saw-tooth deflecting voltage to the vertical plates of the cathode ray tube. This time, though, the frequency will be much lower—only about 50 times a second. Now let us see what evolutions the spot will perform, with both deflecting voltages on at once. It continues to travel across the screen from left to right, and back again, even though it is simultaneously being deflected downward from top at a much slower rate. Because the horizontal deflection takes place several thousands of times a second, and the vertical deflection occurs at only 50 times a second, there will be several hundred horizontal sweeps for several vertical sweeps. The resultant composite trace will thus consist of a large number of almost horizontal lines one above the other, and filling the face of the tube. Clearly, the lines will not be **quite** horizontal, because if the spot is moving slowly downward, each line must slope very slightly downwards, too. The direction of slope will be from left to right in the present case, since we have said that the horizontal trace travels in this direction. We have assumed, of course, that the flyback of each saw-tooth is so fast that it cannot be seen. In practice, this is not generally true, but it is easily arranged for the spot to be blacked out during both flyback periods.

Such a pattern of horizontal lines, equally spaced in a vertical direction is known as a **raster**, and is the basis of every television image. By controlling the output voltage of the amplifiers which feed the X and Y deflecting plates, the width and height of the raster can be controlled, and in the standard television systems the raster is adjusted to a width-height ratio of 5/4 or 4/3, both of which give a picture of pleasing shape. However, if the greatest possible area of the C.R.T. face is to be made use of, the raster should be square.

The raster is the first requirement for producing a picture. It is traced by the spot in the time taken for one whole vertical sweep and its characteristics have much to do with determining the quality of the final picture. If we remember that the whole raster is traced out every fiftieth of a second, it is easy to see how it can be used as the basis of the picture. The rate of fifty times a second is still great enough to delude the eye into believing that what it sees is a continuous pattern rather than a rapidly moving spot. Now if some means exists of dimming and brightening the spot as it travels along, the result will be that the image is produced on the screen just as if it were a photograph. The control grid of the C.R.T., whose voltage is varied in order to regulate the brilliance of the trace, provides the means by which the spot may be modulated in accordance with the light and shade of a picture. This indicates how a picture may be reproduced on the screen of a second C.R.T., but not how an original picture may be made to produce the modulating signal which will enable the receiving tube to be brightened and darkened in the correct manner.

But suppose we have our camera tube, with a uniformly bright raster on it, made by the two deflections we have been considering. Suppose further that we have a photograph in the form of a transparency. This can be placed in front of the raster, which will shine through it. Thus as the spot travels over the surface of the tube, its brightness, as viewed **through** the transparency of the picture in the place where the spot happens to be at the instant we are considering. Now, if this light transmitted by the transparency is allowed to fall on a photo-electric cell, an output voltage will be produced, proportional to the brightness of the spot at every instant, and therefore at every part of the picture in succession. This voltage can be amplified, and applied to the control grid of the receiving cathode ray tube. Thus, the brightness of the spot on the receiving tube will at all times be proportional to the brightness of the transmitting spot, as seen by the photo-cell through the transparency. This result, however, does not represent a picture on the receiving tube, but merely a spot that varies in brightness in a very rapid manner. But all we have to do now in order to re-create the picture is to deflect the spot of the receiving tube in the same way as we do the transmitting spot. The easiest way of doing this is simply to connect the deflecting plates of the receiving tube to the same deflecting voltage as we use for the transmitting one. This produces a raster on the receiving tube that corresponds exactly to that on the transmitting tube. Because of this, the light and shade produced on the receiving tube **corresponds exactly in position** to the light and shade on the original transparency, and the picture is reproduced. In standard television transmission, it is not possible to send out the actual deflecting wave-forms as part of the transmission, but instead, each receiver has to make its own saw-tooth deflecting voltages. In order that the picture may be a stationary one, therefore, the locally-generated deflecting voltages must be exactly synchronized with those of the transmitter. This is accomplished by sending out **synchronizing pulses**, which are received along with the brightness signal, and made to keep the receiver's raster in step with the transmitter's one.

However, the above description shows that to show a picture on the screen of a C.R.T., synchronizing difficulties may be avoided by sending the deflecting waveforms directly to the receiving tube, and this is what we propose to do in our next part of the "R. & E. Amateur TV Project."

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