Radio Constructor

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Editorial

A WORD of thanks to our readers who have so kindly written us with their comments, suggestions and criticisms of the first issue of the "Constructor." Taking all in all, we are feeling rather pleased. However, we hasten to assure you all, that, though the first impressions of readers have been most favourable we are not going to be lulled into complacency. We will strive to improve the magazine in any way that we can, and this can be better achieved if we get more and more letters from you all, telling us what you like, what you would like to see and what you do not like.

Here are some typical comments from readers . . . W. Oliver, G3XT: "I was much impressed with the thoroughness with which most of the contributors covered their subjects; so often I have found that articles are spoilt by writers giving full details of the obvious and omitting or dodging the knotty points that one **does** want fully explained!" . . . W. F. Robinson (Clitheroe): "'Radio Constructor' fulfills an urgent necessity in these days. I would suggest the inclusion of articles on construction of commercial signal generators, and multi-meters" . . . G. Lovelock, ISWL/G1111: "The 'Constructor' is top-hole. Could you provide us with an efficient transreceiver for 60 Mcs. field day work?" . . . B. Bayley (Burgess Hill): "Just what is wanted. I should like to see frequency modulation receivers and television for the constructor, with television H.F. amplifiers for distant reception. Articles on trouble-shooting would also be popular. The first number is first class and obviously you could do with more paper" . . . B. J. Carey (Haywards Heath): "I have been looking out for a book of this nature for a long time. I myself am more keen on building receivers especially midget all-dry portables for long and medium wave. I hope you will publish circuits of this type of receiver fairly frequently. Your new book is 'just the job'" . . . G. L. Macpherson (Dundee) "I was greatly impressed by the sensible layout of the articles and the topics chosen. I would like to see a 7-valve short wave superhet described in the near future covering, say, 10-180 metres and then a converter for 5/10 metres to go with it." (Mr. Macpherson then goes on to list 13 points he would like incorporated in the receiver. This letter will be published in full next issue).

Z. Lewis Williams (Cardiff): "My first impression is that you are to be congratulated. Firstly I like the way in which it is set-up as its size is convenient, though I hope that when conditions improve it will grow in thickness. One thing I would like to see is an exhaustive article on the screened-grid and pentode valve as a detector, both from the point of view of theory and method. The article on SW superhets heralds, I hope, many such. Also is it possible to publish with each set described the voltages one may expect to read at each cathode, anode, etc.? The first issue has a freshness that augurs well for the future."

So there we are. Let us have more and more such suggestions. It is only by your suggestions that we can mould the "Constructor" to the type of magazine you need. We cannot obviously please everybody but at least we will have a try! W.N.S.

NOTICES

THE EDITORS invite original contributions on construction of radio subjects. All material used will be paid for. Articles should be clearly written, preferably typewritten, and photographs should be clear and sharp. Diagrams need not be large or perfectly drawn, as our draughtsman will redraw in most cases, but relevant information should be included. All MSS must be accompanied by a stamped addressed envelope for reply or return. Each item must bear the sender's name and address.

COMPONENT REVIEW. Manufacturers, publishers, etc., are invited to submit samples or information of new products for review in this section.

ALL CORRESPONDENCE should be addressed to "Radio Contructor," 57 Maida Vale, Paddington, London, W.9. Telephone CUN 6579.

Radio Miscellany

By Centre Tap

THE appearance of this journal, a new radio monthly, is one more reminder of the gradual reversion to normal conditions after the lean years since 1939. It is, perhaps, opportune to look back on the lengthy parade of radio journals available for British amateurs since the early days. Many had long since been defunct even in 1939 by which time the factory produced radio could not be equalled by the amateur at anything like the price, and it must be admitted that at that time there *were few experimenters* capable of tackling anything more elaborate than a straight receiver.

I have always held the belief that at least some of the magazines that have passed on would have survived up to the War years had they kept more closely in contact with the changing conditions of amateur practice, despite the heavy decline in home construction of broadcast and all-wave receivers. The true amateur is interested in the experimental side of radio, and not simply in building a single receiver on the cheap.

A Bright Future

Although I am not directly associated with those energetic enthusiasts who make the appearance of the RADIO CONSTRUCTOR possible, other than as a guest-contributor, I do share with them the conviction that there is a great demand for a radio monthly of this decription. Quite what form it eventually takes must largely be decided by the readers themselves. The success of any technical journal depends to a great extent on its readers—an Editorship working in the dark is under a heavy handicap.

An Editor is influenced by his readers—not necessarily a clamorous minority—but by fair comment and constructive criticism, he is able to judge the trend of public interest in the magazine side, and, from the technical angle, the experimenter's needs.

In the years prior to the Second World War many enthusiasts felt that the range of radio text-books and magazines was not wide enough to fully cover the needs of experimenters of all grades of advancement from the man with a "handyman" knowledge to the qualified technician. It is for you to make your wants known and make it possible for the Editors to produce a journal that fulfills a real need, and not be just merely another "wireless book."

Today there is a far wider range of text-books than ever before and elementary electricity is included in nearly every school curriculum. This together with technical training in all branches of H.M. Forces, heralds a big future in Amateur Radio and Electronics.

Electronics

The mention of the term "electronics" causes me to pause. The dividing line where radio leaves off and electronics begin, has not yet been defined. Many so-called electronic devices are far removed from radio, particularly those which merely have electronic control such as invisible ray burglar alarms, electronic microscopes, photo-electric devices, UHF heat, calculating machines and the many other pieces of equipment readily called to mind. Others such as radar, sound recording and reproduction, radio deaf-aids, etc., are nearer to what might be included in the term radio in its popular use. Personally I never feel quite easy about these even. I like to reserve "radio" to cover all communication work and class everything for measurement and control as "electronics." It seems the common sense division, but it is only when we reflect on these things that we realise what a wide field the two terms cover. And we haven't mentioned television yet!

Diversity Reception

This looseness of definition of terms reminds me of a recent discussion between two enthusiasts on the uses of diversity reception. They were talking at cross-purposes on the simplicity of its design, one thinking in terms of a simple receiver with a dual tuning system to use for the same broadcast programme when transmitted on two frequencies. The other was thinking of elaborate systems using several channels with the automatic selection at any instant of the strongest signal while the others are suppressed.

From whichever angle you look at it, both uses have great possibilities in overcoming the effects of fading in modern broadcast practice. Signals on different frequencies rarely fade simultaneously and a simple and inexpensive system to take advantage of this, whether using spaced aerials or not, would give a great fillip to DX broadcasting.

Future Developments

To what points in the modern broadcast receiver should we look for immediate improvement? I suppose most of us would have a different answer to this but I think the following points would be included in many readers answers.

1. Means of controlling volume to a really low level without losing quality of reproduction.
2. Simple remote control—tuning as well as switching.
3. Improved tuning methods enabling bandspread.
4. Variable contrast expansion.

Perhaps to the ordinary listener the latter seems the least important, but to those with any pretensions of musical appreciation it is highly important, especially in gramophone reproduction. With many broadcasts, and all gramophone records, the contrast is compressed to suit average reproduction, and it is at times compressed to nearly a third of the original. The pianissimo passages are comparatively stronger than in the original rendering, and the fortisimmo passages much reduced to prevent overloading in the average output stages. While this is, of course, of little importance in Dance or much Light music, in a Symphony Concert the flattening out robs the music of much of its character and unless there is some means of restoring it to its original proportion much of the meaning and true enjoyment by the music lover, is lost. Full contrast expansion is only possible on equipment capable of giving a high undistorted output.

With the simple L.F. stage as used in the average receiver or radiogram, failure to use compression would cause serious overloading of the output valve and speaker with consequent heavy distortion on all the louder passages and it is difficult at the present stage of valve and speaker development to envisage contrast expansion incorporated in anything but the most expensive radiograms for many years yet. Yet for those who demand high fidelity and realism in their reproduction, means of contrast expansion to restore the volume range to its original proportions is essential.

A Simple Experiment

Some measure of contrast expansion can be simply obtained by joining a flash lamp bulb across the speaker voice coil. Obviously a certain amount of power will be absorbed in the lamp and it will glow on the louder passages, so the idea can only be used where there is power to spare.
It will make a surprising difference to the reproduction and reduction in the surface noise of records. The lamp voltage will vary according to the size of the amplifier, two or four volts for single valve outputs and a six volt lamp for push-pull arrangements, would serve as a guide for trial.

High Voltages

Many factors have to be taken into consideration in defining what voltage may be a danger to life, the state of health of the person, the dryness or dampness of the skin and the susceptibility to shock. With home built apparatus care should always be given in layout and wiring, also the protection of exposed parts, to eliminate any risk of shock. In universal sets this includes the grub screws in the knobs which may be alive in respect to earth, and also the aerial wire if not isolated by a condenser. It is safest to use no earth connection.

The electrician has a golden rule when touching live apparatus—keep one hand behind you! This at least prevents one forming a path through the body and heart which may be severe, although an unpleasant shock or burn may still be sustained across the hand or arm. I suppose most of us have "caught a packet" at some time—indeed in time you seem to become gradually inured to them until a specially nasty one runs up your sleeve and reminds you to be more careful.

Even after switching off it is as well to discharge large condensers by shorting with an insulated screwdriver—a charged condenser can give quite a nasty jolt.

There are, of course, many adjustments and tests which must be made with the apparatus working under normal conditions and careful handling is necessary. Normal receiver voltages are rarely harmful to a point of danger unless one is in poor health or in a moist place. The worst aspect is often the damage you do by dropping something or a breakage caused by the sudden jolt—then you get a double shock! The second coming when you have to replace components and valves at their present prices.

THE EDITORS INVITE . .

- **Articles suitable for inclusion in this journal.**
- **Constructive comments and suggestions on the magazine.**
- **Photographs and short descriptions of readers' workshops.**

The Straight Receiver

Part 2.

By H. A. Emm

Reaction.

So far, of the three components appearing in the output of the detectors we have been considering, only the audio frequency component has been made use of. In particular, the RF component has been bypassed to earth. Now this RF current can be re-introduced to the input circuit L1-L2/C1, by means of a coupling winding. If the component so fed back is arranged to be in phase with the current already flowing in this circuit, then the power so introduced will tend to balance out the damping losses. If the amount of energy fed back is sufficient, a point of balance will be reached and the valve will oscillate. This process is called reaction, or regeneration. By making the amount of RF fed back controllable, the damping losses in the input circuit can be practically cancelled out, thereby greatly increasing both sensitivity and selectivity.

When dealing with detection, we were concerned only with modulated RF, or ICW, signals. Unmodulated, or CW, signals would produce no effect in the output of the detector, as the audio frequency component would not be present. On the amateur bands the majority of communication is done by means of CW, and luckily reaction enables us to make these signals audible.

This is achieved by making the RF fed back of such an amount that it is just enough to cause the valve to steadily oscillate, at a constant amplitude, and at a frequency determined by the tuned input circuit. Let us suppose that it is tuned to a frequency of 7,000 kcs. The input circuit, being comparatively unselective, will respond to incoming signals off resonance, so that a CW signal of a frequency of, say, 7005 kcs. will also produce an oscillatory voltage in the input circuit. We thus have two oscillatory voltages superimposed, the result being a variation in amplitude, at a frequency equal to the difference between the frequencies of the two voltages, which is 5 kcs. in the case being considered. In other words, we then have in the output, after detection, a 5000 cs. audio frequency component.

Fig. 4 shows three typical circuits illustrating popular methods of using regeneration. It will be seen that, that at Fig. 4a, is very similar to the circuit of Fig. 3, the one difference being that the anode or RF bypass capacitance is made variable, and is in series with an additional winding L3, which is inductively coupled to the tuned winding L2. As the capacitance is increased, so the reactance is lowered, and the amount of RF fed back increases, until a point is reached where the valve starts to oscillate. Sensitivity is greatest just before this point occurs.

Fig. 4b shows a circuit in which an RF tetrode is used, the feed-back being through L3 and C3 as before. In this case, however, a fixed capacitance is used, reaction being controlled by varying the voltage applied to the screening grid by means of a potentiometer, and so controlling the valve amplification. Part of this potentiometer takes the form of a fixed resistance, which limits the maximum voltage that can be applied, and which results, in practice, in the control becoming more "comfortable" to handle. A bypass capacitance, C5, is connected between the screen grid and cathode or negative line, and this capacitance should have a low reactance to both audio and radio frequencies.

Fig. 4c again uses a tetrode valve, but in this case the RF is fed back via the cathode to a point on L2. Reaction is again controlled by varying the screening grid potential. The amount of regeneration obtainable depends on the position of the tap, and in practice it will be found that a point about one-third up from the earthy end of L2 will give optimum results.

In all cases, regeneration must be smooth if the greatest benefit is to be obtained, and this will be affected by such things as the degree of coupling between the tuned circuit and the aerial or the previous stage, by the potentials of the various electrodes, by the RF bypass capacitance, and by the grid-leak-grid-capacitance combination used.

A detector circuit plus regeneration constitutes the most simple form of practical receiver for short wave work. This type of set is known amongst amateurs as an "0-v-0," the "v" standing for the detector stage, the first figure indicating the number of stages of amplification at radio frequencies, and the final figure the number of stages of audio amplification. Now, short wave conditions vary so considerably that even the most powerful receiver has to confess itself beaten at times, and an 0-v-0, while capable of world-wide reception under favourable conditions, may not be thought reliable enough for everyday use. Extra gain can be obtained by amplifying the signals either before or after the process of detection. Of the two, the latter is the best choice for an extra stage to a simple detector, as speakers and phones being power operated devices, the amount of power developed in the final stage will determine the "loudness" of the signal being received. (To be cont.)

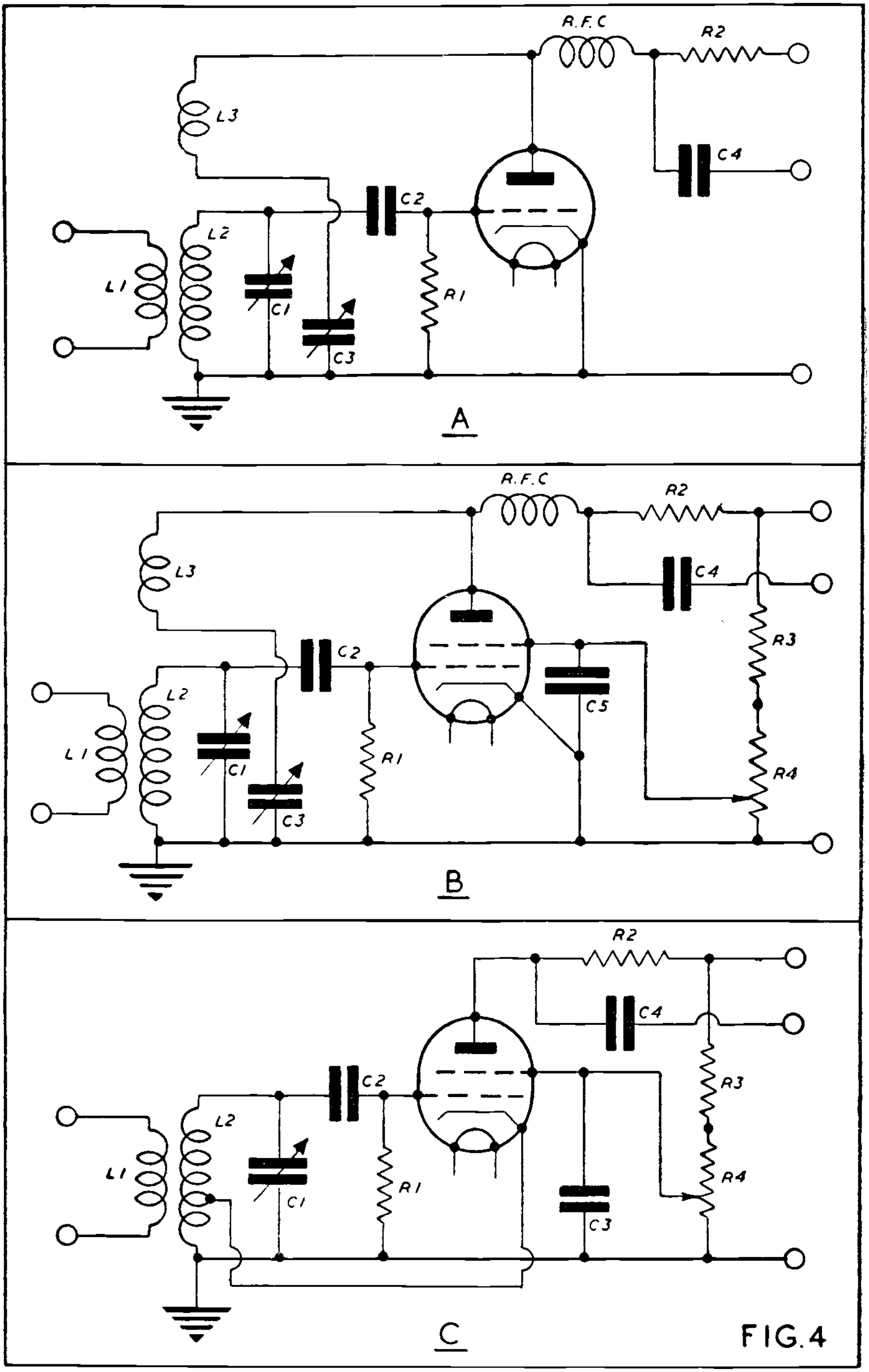
R.F.C
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FIG. 4

"Query Corner"

A "Radio Constructor" service for readers

In a magazine of this nature, a query service for readers is an obvious "want," and we consequently have made all the necessary arrangements for the inauguration of such a service, which is being conducted by a panel of experts.

Here are the conditions governing the Query Service:

(1) A nominal fee of 1/- will be made for each query.

(2) Queries on any subject relating to technical radio or electrical matters will be accepted, though it will not be possible to provide complete circuit diagrams for the more complex receivers, transmitters and the like.

(3) Complete circuits of equipment may be submitted to us before construction is commenced. This will ensure that component values are correct and that the circuit is theoretically sound.

(4) All queries will receive critical scrutiny and replies will be as comprehensive as possible.

(5) Correspondence to be addressed to "Query Corner," Radio Constructor, 57 Maida Vale, Paddington, London, W.9.

(6) A selection of those queries with the more general interest will be reproduced in these pages each month.

In order to show how this scheme will function, we are printing the answer to an enquiry recently selected from our mail-bag. The actual enquiry has been abbreviated in order to economise in printing space, a valuable commodity in these days of paper shortage, and the answer has been given in sufficient detail to cover the points in question. Whenever possible a reason will be given for the particular suggestions raised in the answer. The actual enquiry is this:

"My mains operated short wave receiver has a most annoying mains hum which is only apparent when a signal is being received, no trace of hum however, is audible when there is no signal. The valve line up for this particular receiver is R.F. Amplifier, Detector and Output stage.

W. P. Bristol."

Our Answer

The trouble being experienced with this receiver is generally known as modulation hum. This is due to a hum voltage picked up in either the RF or detector stage, and modulating any incoming signal. This hum voltage appearing upon the carrier of the signal, is detected and amplified and appears at the loud speaker as mains hum. When no radio frequency signal is received the hum does not reach the detector as the tuned circuit present negligible impedance to voltages of this low frequency. In order to correct the trouble the following recommendations should be be followed in the order given.

(1) Check that the cathode bias resistor in the RF stage is effectively by-passed by a capacitor and that the heater winding on the mains transformer is earthed.

(2) Check that the screen and anode by-pass capacitor are in circuit, 0.1 μF capacitors being suitable for this purpose.

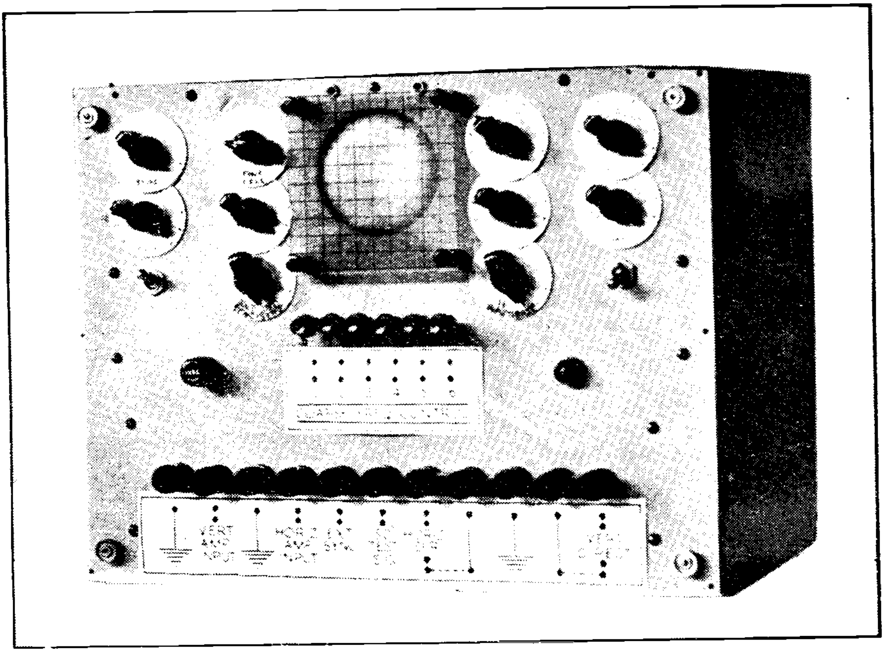
(3) The mains transformer should be so positioned that its stray field does not interact with the tuning coils. Alternatively the coils may be screened by means of some magnetic material, i.e., tinplate.

(4) The RF valve may have bad insulation between heater and one of the electrodes and should be tested accordingly.

RADIOLYMPIA

The International Short Wave League will be organising parties to visit the show. Groups will be organised by local "Chapters" and members travelling individually will be able to meet their fellow members at predetermined places at the show. This will be a wonderful opportunity to meet your fellow members! As the League has not yet any lapel badges, a "utility" identification label will be issued to any members who care to send along a S.A.E. to Headquarters. These labels will ensure recognition of members making their own travelling arrangements.

Any League members who are interested in the Radiolympia gathering may obtain full particulars, and his label, from either his local Chapter or from HQ at 57 Maida Vale, Paddington, London, W.9.



A Cathode Ray Oscilloscope

By Lionel Howes, G3AYA

Applications

MANY may ask what application an oscilloscope has in radio work. The answer is that it may be used to measure either R.F., A.F. or D.C. voltages —and this is not restricted by frequency— and as its input impedence is usually very high (in the order of megohms) its effect upon the circuit under examination is almost negligible.

The electron beam in the cathode ray tube, traces out its own movements on a flourescent screen and is likened to the pointer of an ordinary meter excepting that the measuring indicator has no inertia. With the aid of a calibrated audio oscillator the response of A.F. stages in radio receivers, amplifiers, intervalve and output transformers can be accurately measured and any distortion introduced on the test waveform could be easily traced. Signal tracing in radio receivers can be carried out in conjunction with a modulated signal generator. Direct application on the examined waveform to the deflector plates of the tube is an advantage and is used if the waveform is of sufficient amplitude to give a reasonable picture.

Amplifiers are combined in an oscilloscope to amplify the examined waveform, if it is of insufficient amplitude for direct application to the cathode ray tube. The following is a list of but a few of the applications of the cathode ray oscilloscope in the field of radio:—

Measurement of R.F., A.F. and D.C. voltages.

Alignment of the I.F. stages in a radio receiver.

Checking for overloading in A.F. amplifiers.

Checking the smoothing efficiency of power supplies.

Checking frequency response in A.F. amplifiers.

Studying various waveforms.

Checking modulation percentage in telephony transmitters.

Checking valve characteristics.

Frequency comparison by Lissajou's figures.

The Time Base

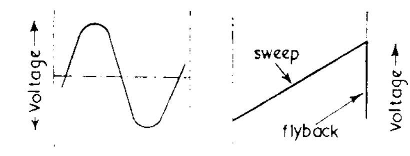
Besides the cathode ray tube, amplifiers and power supplies, needed for a complete oscilloscope, a time-base generator is required. With the examined waveform applied to one pair of deflector plates and the time base waveform applied to the opposite pair of deflector plates, the resultant picture of the examined waveform will be traced out on the screen. The picture will only remain steady if the frequency of both waveforms are the same, or if the time base frequency is a multiple of the signal (or examined waveform) frequency.

The examined waveform is usually applied to the "Y" plates (vertical plates), due to these being the most sensitive of the two pairs of deflector plates. Therefore the time base waveform will be applied to the "X" or horizontal plates. The function of the time base is to produce a sawtooth waveform of which the frequency can be varied at will, ranging from 10 cycles-per-second to either 50,000 c.p.s. or 1,000,000 c.p.s. The last two frequencies depend upon the type and design of the time base. High frequency time bases are usually rather erratic and inability to lock or synchronise them to the frequency of the examined waveform is sometimes rather difficult unless great care in design is taken.

An important point is that the scan or sweep portion of the sawtooth waveform must be perfectly linear. If it is not then the spacing of individual waveforms on the trace will be uneven.

The Trace

To describe how a picture is traced on the screen is not difficult. As an example we will take the 50 cycle AC mains. One cycle will take place in 1/50th of a second.



Waveform as applied to Y plates — Waveform as applied to X plates

If this 50 cycle mains waveform is applied to the Y-plates, a vertical deflection will be all that is seen on the screen, corresponding to the peak-to-peak voltage of the 50 c.p.s. waveform. If, however, a sawtooth waveform also of 50 c.p.s. is applied to the X-plates, a stationary picture of a sine wave will be traced out on the screen. The graphical illustrations above will show exactly what happens, the representation being of a 50 cycle sine wave and a 50 cycle sawtooth waveform. As the voltage of X1 plate rises with respect to X2 the spot is drawn across the screen. At the same time the voltage on the Y plates is varying as shown in the illustration. At the end of the sweep, the voltage on the X plates falls almost instantaneously to the same value as at the beginning of the sweep, therefore, the spot is rapidly returned to the start of the trace again. This process is repeated until the result is a stationary 50 cycle sine wave. This is what happens for examination of any waveform. The frequency of the time base being adjusted to the same frequency as the signal, or any multiple of it, thus produces a number of cycles on the trace.

The Thyratron Time Base

The most common type of time base generator uses a gas filled triode, usually called a thyratron. With an associated circuit, consisting of resistors and capacitors, the various time base frequencies are built up. The sawtooth waveform is produced by the charging of a capacitor through a resistor and then the thyratron strikes, or ionises, at a predetermined voltage and the capacitor is rapidly discharged.

During the charging time, the sweep takes place and during the discharging period the flyback occurs. Due to the fact that a capacitor tends to attain a charge in an exponential fashion the resulting sawtooth waveform will also be of an exponential nature. The attempt to remedy this defect can be carried out in numerous ways, but only one method will be described in this article. In the accompanying description of the home-built oscilloscope, the method of attaining linearity, which the writer found most satisfactory, will be explained.

The Power Supply

The H.T. supply to the cathode ray oscilloscope is of rather a high nature. The **positive** side of the supply is usually earthed and the negative side is "up in the air." This renders the cathode ray tube less susceptible to external interference.

Construction

The instrument about to be described was built over a period of just two weeks, and the photograph in the heading of the article will show clearly the disposition of the various controls. The tube itself is a *Cossor* 23D with a screen diameter of 2¾in. The colour of the screen is green and duration of afterglow is 10 milli-seconds. Trapezium Distortion is encountered but can be cured by symmetrical operation of the X deflector plate waveform. The final H.T., or E.H.T., to the tube is 700 Volts and the heater voltage is 4 volts at 1.1 Amp.

The valve complement is as follows: Two 6J7's, operating in a push-pull circuit in order to produce symmetrical operation of the X plate waveform; A single 6J7 amplifier, providing single deflection to the Y plates; The 884 thyrotron is used for the time base; A 5Z4 is used as full wave rectifier.

The power supplies to the time base and amplifiers follow orthodox practice.

For the cathode ray tube itself a somewhat higher voltage is necessary. An EA50 diode valve is used as a half wave rectifier to supply the 700 volts necessary for satisfactory operation. The EA50 is certainly not designed as an E.H.T. rectifier and it may surprise some that it **does** indeed perform the function demanded of it in this instrument. A separate heater winding on the transformer is not needed as the heater voltage may be obtained from the 6.3 V. winding on T1.

Resistance-capacitance smoothing is used in the E.H.T. supply, due to the low current drawn by the tube and its associated resistance network. The actual current drawn is of the order of 1 mA.

The Amplifiers

Symmetrical operation of the X plate waveform is effected by a push-pull amplifier. The output waveform from each anode is fed separately through large value capacitors to X1 and X2 deflector plates respectively. It will be noticed that the cathode by-pass capacitors are of rather low values, and this is to provide a certain amount of negative feedback at lower frequencies—but none at high frequencies. This is because as the frequency at which the amplifiers are operating is increased, the decoupling effect of the cathode by-pass capacitors becomes more pronounced, therefore reducing the effect of negative feedback. This helps to keep the gain of the amplifier constant at all frequencies.

The anode load resistors are also of low value as this also assists in the maintenance of a linear response. Peaking coils are included in order to extend the high frequency response. The screen grids are fed through a common dropping resistor and decoupled by a .1 μF capacitor. Due to the fact that the screen grid waveforms are 180 degrees out of phase with each other the net variation is nil, therefore only a small value of capacitor is needed for decoupling. The value of the horizontal gain potentiometer is made high, in the region of 2 megohms, to prevent any serious effects or attenuation of the sawtooth waveform. Any leakage across the thyratron would affect the linearity of the trace.

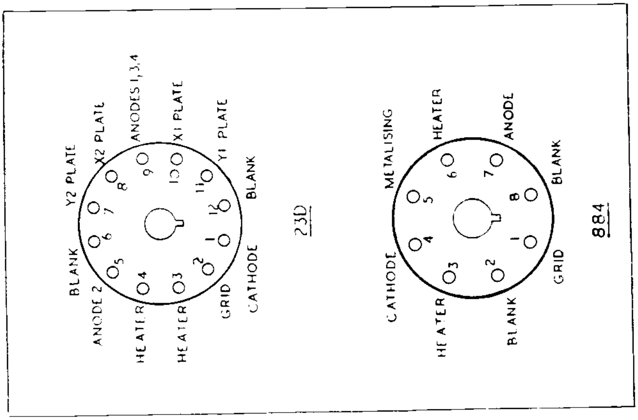
The vertical amplifier, or Y plate amplifier, follows much the same design and characteristics as the X plate amplifiers except that it provides single plate deflection instead of push-pull deflection. Due to the exponential charging of a capacitor, the resulting time base waveform will suffer from non-linearity. There are many ways to remove this defect—by constant current devices and other means. In this circuit, use is made of the linear portion of this characteristic which is at the beginning of the charge and is not more than about 1/10th of the whole waveform. By making the thyratron strike or ionise at 35 Volts for an H.T. supply of 350 V. reasonable linearity will be attained. The point at which the thyratron strikes depends on the bias applied to the grid and on the control volts ratio. Assuming the bias to be 3.5 V. for a control volts ratio of 10, the ionisation or flyback will occur when the potential across the thyratron reached 35 V. This method not only gives good linearity but also an improvement in the response of the time base is noticable in the high frequency spectrum. Operation may be up to 100 kcs., where, as usual with a large output waveform, not only does linearity suffer but operation is restricted to approximately 30 kcs. In conjunction with the push-pull amplifier, adequate sweep is obtained to scan even a 5 in. cathode ray tube.

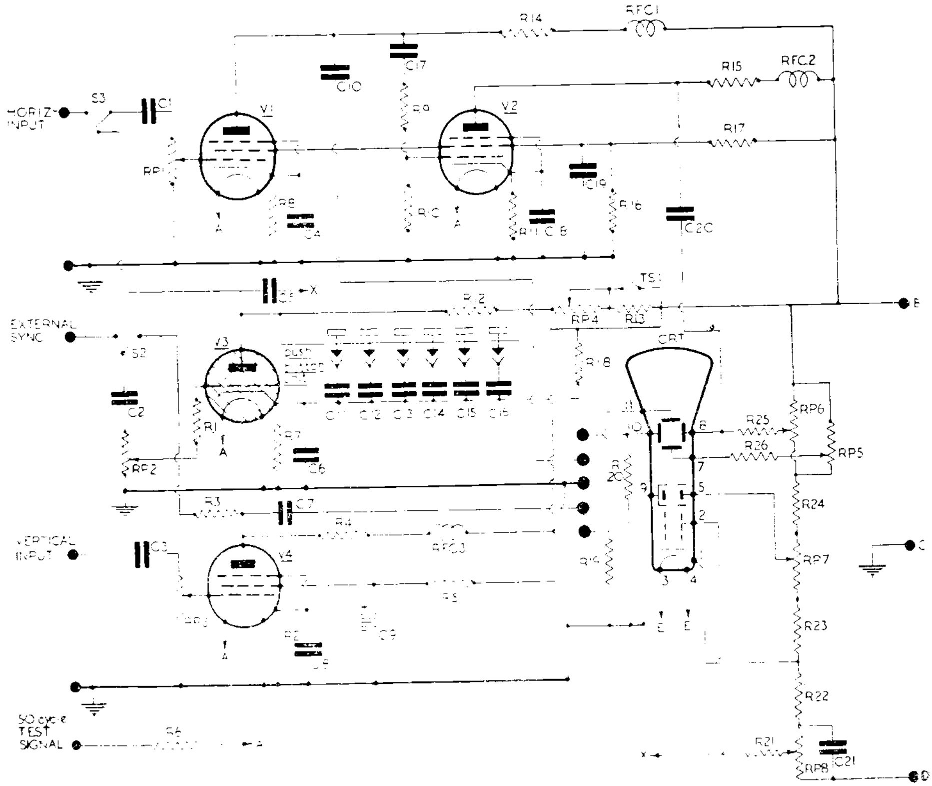
Bias

The bias for the thyratron is obtained from a bleeder network across the 350 V. supply, consisting of a 100000 ohm resistor in series with one of 900 ohms. The cathode of the thyratron is taken to the junction of these two resistors. The voltage developed across the 900 ohm resistor provided bias for the thyratron and a 25 μF capacitor is connected across it for decoupling. A defect of normal thyratron time bases is that not only does the amount of negative bias applied to the grid control amplitude but also effects frequency to a certain extent. In this circuit, the amplitude control is the gain potentiometer of the push-pull amplifier and therefore no noticeable effects on the frequency of the time base will occur.

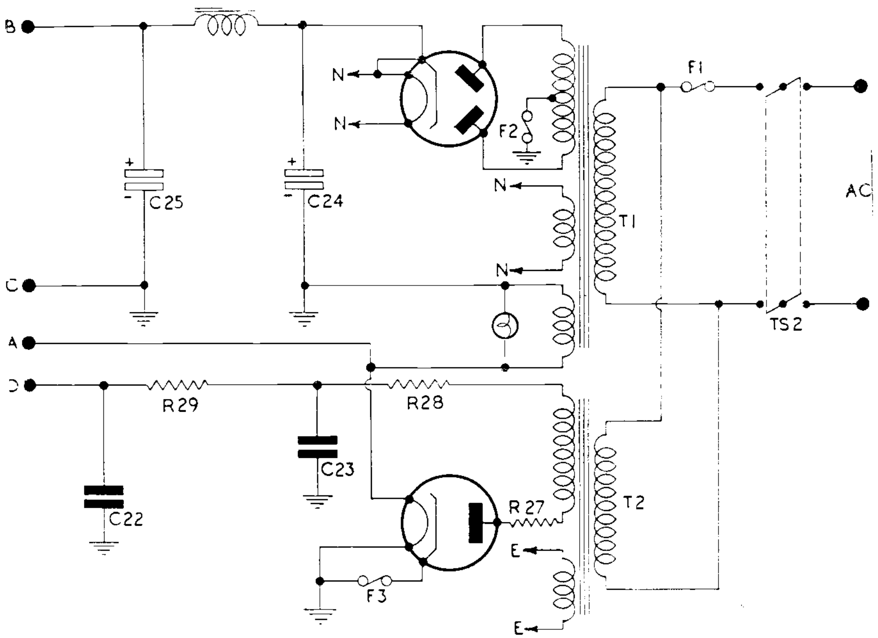
Frequency Control

The course frequency control consists of





Circuit (with cathode ray tube).



The Power Supply Circuit

LIST OF COMPONENTS

Capacitors

C1	.25 μF 400 V wkg.	C10	.25 μF 400 V	C18	.02 μF 400 V
C2	.1 μF 400 V	C11	.25 μF 400 V	C19	.1 μF 400 V
C3	.25 μF 400 V	C12	.05 μF 400 V	C20	.25 μF 400 V
C4	.02 μF 400 V	C13	.01 μF 400 V	C21	.25 μF 200 V
C5	50 μμF 1200 V mica	C14	.002 μF 400 V	C22	.25 μF 1000 V
C6	25 μF 25 V	C15	600 μμF 400 V	C23	.25 μF 1000 V
C7	.25 μF 400 V	C16	150 μμF 400 V	C24	8 μF 450 V
C8	.1 μF 400 V	C17	.25 μF 400 V	C25	16 μF 400 V
C9	8 μF 400 V				

Resistors

R1	50000-ohms	R11	1000-ohms 1 watt	R21	100000-ohms
R2	500-ohms	R12	500000-ohms	R22	1000-ohms
R3	1 M-ohms	R13	2 M-ohms	R23	75000-ohms
R4	22000-ohms	R14	30000-ohms 2 watt	R24	40000-ohms
R5	70000-ohms 1 watt	R15	30000-ohms 2 watt	R25	5 M-ohms
R6	10000-ohms	R16	47000-ohms 1 watt	R26	5 M-ohms
R7	900-ohms 1 watt	R17	60000-ohms 1 watt	R27	5000-ohms
R8	1000-ohms 1 watt	R18	100000-ohms 5 watt	R28	50000-ohms
R9	5 M-ohms	R19	5 M-ohms	R29	30000-ohms
R10	250000-ohms	R20	5 M-ohms		

All ½ watt ratings unless otherwise stated

Potentiometers

Rp1	2 M-ohms
Rp2	100000
Rp3	2 M-ohms
Rp4	2 M-ohms
Rp5	2 M-ohms
Rp6	2 M-ohms
Rp7	100000
Rp8	25000

Fuses

F1 1 Amp
F2 100 mA
F3 5 mA

Toggle Switches

TS1 and TS2

RFC's

RFC1, RFC2, RFC3 30mH

Choke

L1 30 Henry

Rotary Switches

S2 and S3, Yaxley type 2 position switches

Transformers

T1 350-0-350, 120 mA; 5V 2A; 6.3V 3A
T2 700 volts at 5 mA; 4V 1.1A

a 6-way push button unit, which switches in capacitors C11-C16. Fine control of frequency is by Rp4, a 2 Megohm potentiometer in the anode of the thyratron, which controls the value of charging current. In series with Rp4 is R13, a 2 Megohm fixed resistor, and across it is TS1, a toggle switch, which acts as the frequency X1/X2 switch. When the switch is closed, the condition is X2 (twice the frequency).

Synchronisation Control

Rp2 is the synchronisation control and is used to lock or synchronise the frequency of the time base to the frequency of the Y plate waveform. The 50000 ohm grid stopper, R1, is to limit the flow of grid current during the ionisation period. A small value capacitor is connected between the thyratron anode and cathode-ray tube grid, in order to black-out the fly-back on high sweep speeds where it may become objectionable. Differentiation of the saw-tooth waveform takes place and the grid of the tube is driven more negative during the fly-back period, thus reducing the intensity of the beam.

50 Cycle Test Signals

A 50 cycle test signal is available, and is taken from the 6.3 V. heater supply. This can be used as a calibration voltage if it is applied direct to the Y plates. When using the oscilloscope for measuring A.C. voltages, peak values are always referred to and in the case of the 6.3 V. test signal, the peak-to-peak value will be:—

$$6.3 \times 2.828 = 17.8 \text{ Volts}$$

The figure 2.828 is the conversion factor for changing R.M.S. values to peak-to-peak values. This formula only applies for a **sinusoidal** waveform.

The sensitivity of the deflector plates are, respectively:—

$$\left.\begin{matrix}\text{X axis}\\ \text{Y axis}\end{matrix}\right\} \frac{170}{\text{Final anode voltage}} = \text{Millimetres/Volt}$$

therefore as the final anode voltage is 700 positive with respect to cathode, the formula becomes:—

$$\frac{170}{700} \text{ mm/V.}$$

which is 0.24 mm/V. The more appropriate formula is given in Volts/mm, which gives approximately 4 Volts/mm. This means that for every 4 volts D.C. applied to, say Y1 with respect to Y2 the spot will move 1 millimetre, therefore 20 volts D.C. will move the spot 5 mm.

External Waveforms

Provision is made for the application of external waveforms directly to either the X or Y plates. In this condition, the opposite deflector plate in each case is still connected to the shift network. The X and Y plate shift controls—or horizontal and vertical shift controls, as they are sometimes called—produce control over the position of the spot. These controls vary the mean potential of the deflector plates above or below the potential of the final anode. The final anode is connected to chassis or earth.

Other Controls

Internal synchronisation is fed from the anode of the Y plate amplifier, through a 1 Megohm limiting resistor, to switch S2.

S3 is a switch which either connects the push-pull amplifier to the internal time base or to a terminal on the front panel for application of an external time base.

Focus is controlled by Rp7, a 100000 ohm potentiometer, and Rp8 (25000 ohms) is the Brilliance control. C21 is to decouple and stabilise the voltage developed across Rp8, as this potentiometer controls the amount of bias applied to the grid of the cathode-ray tube.

Constructional Points

Good insulation between the cathode-ray tube's heater winding and chassis is most important, as the cathode is at a potential of 700 V. negative with respect to chassis.

The mains transformer T1 is mounted at the back of the chassis, to the left of the tube. A better position would have been directly behind the tube but the chassis would not allow for this owing to its size. The cathode-ray tube transformer, T2, is mounted on the underside of the chassis.

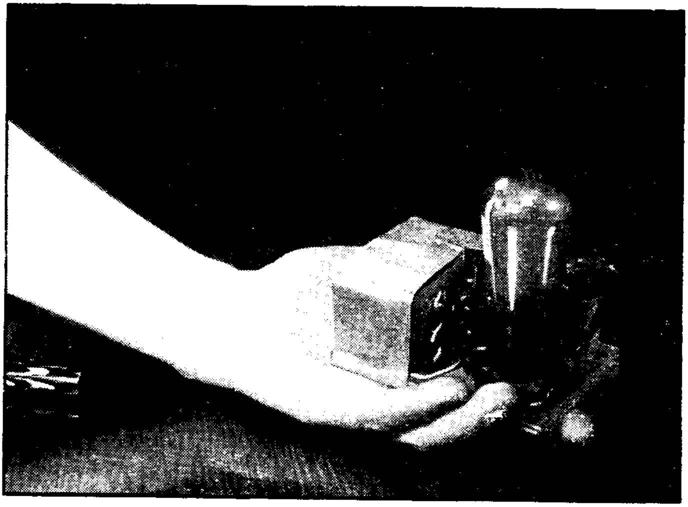
The necessity to screen and decouple various parts of the circuit cannot be over emphasised as any unwanted pick-up or interaction between components will produce distorted effects on the screen of the tube. A mu-metal shield completely enclosing the tube is essential. Other materials have been tried with but little success. All leads carrying raw A.C. should be twisted together to minimise their fields.

It may be said that an oscilloscope is its own test set, since any faults in the circuit will invariably show up on the screen in one form or another!

Finally, here are a few points on the original model. The celluloid graticule marked out in milliameter squares is very useful for the calculation of the amplitudes of various waveforms.

The toggle switch on the extreme left is the mains on/off switch and immediately below this is a fuse. On the right, is the frequency X1-X2 toggle switch and below this is an indicator lamp holder. The complete oscilloscope is housed in an all-metal case, which helps to reduce any effects from external interference caused by electrical fields.

A Midget Signal Generator



Describing an efficient fixed-tuned 465 kcs. oscillator of extreme versatility and portability, for I.F. alignment.

By Robert Daly

THE intermediate frequency of a broadcast-band or all-wave receiver must be aligned to the correct frequency when, as is usually the case, commercially wound tuning coils are employed.

In the case of an intermediate frequency of 465 kcs., the oscillator coils are of such an inductance that when used with the specified padding and trimming capacities, tracking is maintained throughout the tuning range of the particular set of coils in use.

This applies equally when factory made and factory aligned tuning packs are used, these tuning packs usually having the advantage (as far as the constructor is concerned) of being roughly trimmed and padded at the factory, only the smallest amount of adjustment being required when the receiver is completed.

If the I.F's are aligned to any other frequency than that specified, tracking will not hold good, even though it is quite possible to adjust the trimming and/or padding capacitors to get perfect R.F. and mixer alignment at any one part of the band in use.

The Cause of Poor Results

This writer is of the opinion that the reason for poor results on many home-constructed superhet receivers is nearly always due to the I.F's being aligned to some unwanted frequency (when a calibrated signal-generator is not available), the usual procedure being to rely upon the I.F's being sufficiently near to resonance (with each other) that the powerful local station will provide a signal sufficiently strong to enable the I.F. trimmers being peaked for maximum signal strength.

It is also surely true that many constructors, rewarded with dead silence from the speaker (if it is possible to emit "dead silence" from a loud-speaker!), write off their newly-made superhet as a dead loss, and make a solemn vow to stick to T.R.F. next time!

This may be, and probably is, due to each I.F. circuit being peaked to frequencies so far off the **required** resonance that it is impossible for even the local to "get through."

The 465 kcs. Generator

The signal generator to be described herein wins a good half of the battle of superhet alignment. It is fixed-tuned (actually pre-set) to 465 kcs., which enables the I.F's to be peaked to the correct value, after which it is a comparatively simple matter to align the signal frequency circuits with the aid of signals from the broadcasting stations.

The entire unit (including power supplies) is assembled on a wooden baseboard measuring 4½in. x 3in. The H.T. supply, of 22½ volts, is made up from eight penlight batteries, costing 4d. each, and the L.T. is a single U11 cell—total cost 3/11½.

The penlight batteries (which are made up from two 1.5 volt cells in one container), are broken in half, and 15 of the cells are wired in series. They are then bunched together in three rows of five, and held in position with insulation tape, the resultant "H.T. battery" measuring only approximately 2¾in. x 1⅝in. x 2in.

A Wearite B.F.O. (465 kcs.) coil is used in a Hartley oscillator circuit, and tuned with a 60 μμF fixed capacitor in parallel with a 30 μμF trimmer. The only other components used are a grid capacitor of 250 μμF and grid leak of 50,000-Ω.

A low value of grid leak is used to prevent the valve being biassed too far back, which would tend to emphasise the harmonics. An oscillator strong in harmonics could easily give misleading results due to one of the harmonics beating with a broadcast station, and it would be possible to peak the I.F's to one of these harmonics, which would probably be a long way off 465 kcs.

It is for this reason that the generator was not made self-modulating (by using a very high value of grid leak). In practice this is no deterrent, as will be explained later.

The ideal valve to use is a small power valve of the 2 volt battery type, such as the PM2A, LP220, etc. This will oscillate readily when heated from a 1.5 volt dry cell, and actually gave better results than a 1.4 volt "all-dry" valve (one section of a 1G6GT) which was tried by the author.

Construction and Layout

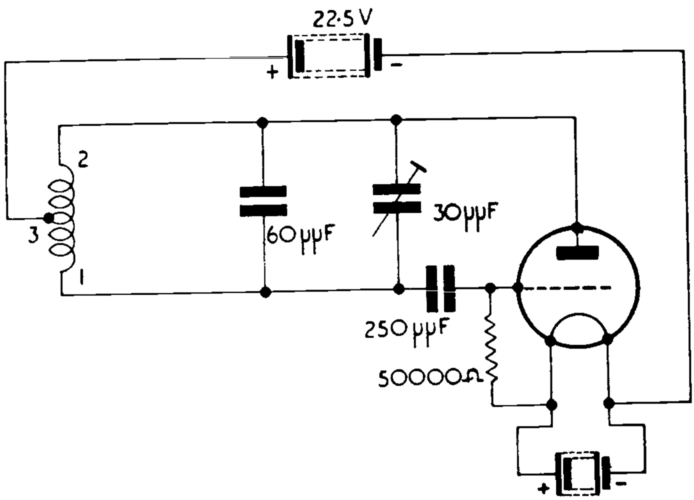
Little need be said about the construction and layout, as the individual constructor may adopt his own methods of fixing the few components. The accompanying photographs illustrate the layout and fixing methods as accomplished by the author. The kitchen larder was raided for an empty tin, which was cut and bent as shown and lapped for half an inch under the baseboard as a means of securing the H.T. battery.

The negative connection for the L.T. cell is by means of a 6 B.A. screw and nut through the baseboard upon which rests the cell, whilst a strip of tin is soldered to the H.T. fixing bracket to provide the positive connection, as shown. Before soldering this strip, a recess was made on the under side of it with a bradawl. This acts as a locator for the positive brass cap of the U11, and holds the cell securely in place.

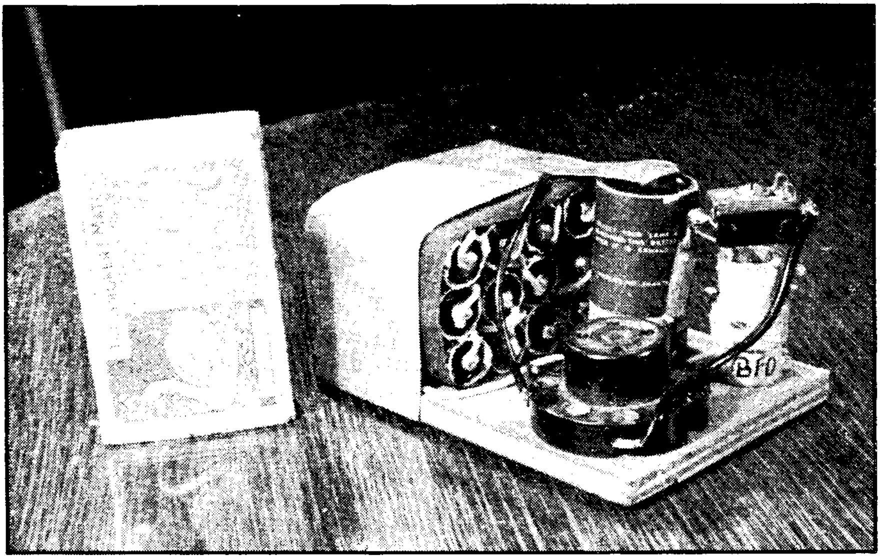
No "On-Off" switch is provided. The writer has learned to his cost that "On-Off" switches in battery operated test equipment have a habit of being left "On"! He takes the valve out when not in use.

Calibration

Calibration is extremely simple, and is accomplished by calibrating to a commercial receiver—preferably a modern one, or one that has been re-aligned by a reputable



Circuit diagram of the oscillator



The oscillator, with valve removed

service-mechanic. It is necessary to ascertain whether the particular domestic receiver available has an intermediate frequency of 465 kcs. The majority are, and your local dealer would no doubt supply this information on any specific receiver.

No coupling is used from the generator to the receiver, as it is unscreened, and has an audible range of roughly two yards, depending upon the thoroughness or otherwise of the particular receiver used.

The generator is placed about a foot away from the receiver, which should be tuned to a station, and the trimmer adjusted for "dead space" or "zero beat," or, in other words, the lowest possible pitch of whistle. The adjustment can be made most accurately when the broadcast station is silent (that is, no speech or music). There are usually plenty of "silent" gaps between programmes on B.B.C. transmissions!

Hand-capacitance effects on the author's model were not at all noticeable, it being possible to pick the generator up with the hand and move it about without affecting calibration. In fact, the author took the generator into his local dealer's shop and tuned it to zero beat with a receiver that happened to be on in the shop, whilst the proprietor was attending to another customer!

Alignment

Alignment can either be carried out orally (by listening for maximum oscillator valve hiss), or by connecting a voltmeter across the bias resistor of one of the valves controlled by the A.V.C., and adjusting each I.F. trimmer for **minimum** voltage reading. The latter method is the most reliable but when it is desired to align a receiver which is already installed in a cabinet, and the underside is not accessible, the oral method is quite satisfactory.

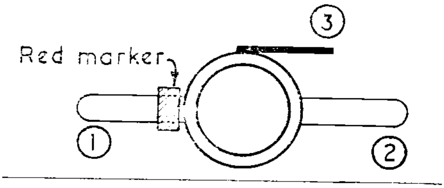
If the I.F's are so hopelessly out of alignment that nothing is heard (or no deflection of the meter is observed), a short length of flex, one end of which is wrapped round the grid lead of the I.F. valve (or the second I.F. valve if two stages are used), the other end being placed near the generator, will provide a very much stronger signal, and it is almost certain that it will be picked up in the receiver, sufficient at least for the I.F's to be roughly peaked.

For the final alignment, the generator should be placed as far away from the receiver as is possible (usually a yard or so) consistent with sufficient meter deflection (or valve hiss) to enable the correct trimming to be achieved.

Stability and Current Consumption

All signal generators are prone to frequency drift, and a battery operated oscillator (or even a mains operated one, unless the voltages are very well regulated) will suffer in this respect, due to changing H.T. and L.T. voltages. For **really** accurate results it is a good plan, where possible, to recalibrate the generator just before it is to be used for alignment. If the reader possesses a domestic receiver which uses a 465 kcs. I.F. (or has easy access to one), it is a simple matter to re-calibrate as and when he has occasion to use it.

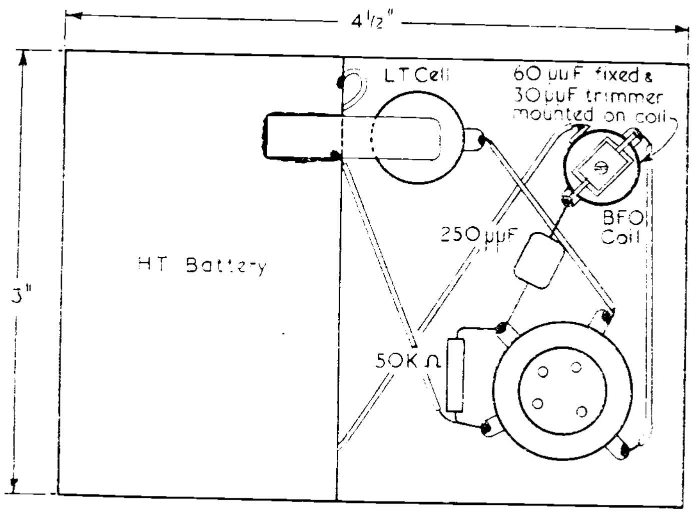
The H.T. consumption is very modest, and with the particular valve used is 1.7 mA., and the L.T. .15 A. A simple way of ascertaining whether the generator is functioning when first built, is to leave the H.T.+ lead disconnected and join a milliameter from this lead to the tap connection on the coil, and note the reading. Then transfer the negative meter lead from the coil tapping to the anode direct (when the valve will be in a non-oscillating condition) and the current should then read higher. On the writer's model, the anode current rose from 1.7 mA. to 2.8 mA.



Coil connections, as seen from above.

The batteries should last a long time. The writer has in his possession a battery operated valve voltmeter, using similar types of valve supplies, which was constructed over a year ago, and the supplies are still well up.

One final note. **Always** use the same valve, otherwise the calibration will not hold good!



Component layout, viewed from above

Radio Conditions

A survey of Conditions on the Broadcast Bands—

By ISWL G211 (Bristol)

All times in GMT

WELL, what a month for reception! Heavy thunderstorms closing down the shack here for several evenings plus a thunderbolt in the district, with temperatures up around 90 deg. in the shade!

Anyway we managed to log a few good catches although conditions were anything but ideal as can be imagined. Best signals were heard on the 15 and 17 Mcs. bands again.

Radio Australia's VLC4 in Shepparton was heard with colossal signal on 15320 kcs. giving beamed transmission to the British Is. at 1500. The best signal of the month easily.

Signals from Asia have been fair and the following have been logged: YHN Djokjakarta, Java, has been R8-9 but suffered bad CW QRM when giving programme beamed to the East Coast of the U.S.A.

The Far Eastern Broadcasting Service stations in Singapore have been heard well over their 15 Mcs. frequencies on the Purple Network at 1630-1700 when they close. The 15275 kcs. channel is the best received here with good R8-9 signals. The other frequency of 15300 kcs. has bad interference from a Russian station near 15295 kcs. R5-6 generally. A newcomer here is Azerbaijan Tabriz which operates on 12180 kcs. and has been heard here from 1654-1730. Signals from this station are poorish and frequency suffers bad CW QRM with heavy static at times. From Australia—VLA6 15200 kcs. has been logged at R7-8 with bad QRM from WBOS (Boston). Carries 1st BC to Forces in Asia. VLC9 has been R6 QSA5 on 17840 kcs. and heard giving an experimental transmission for listeners in South America. Both these stations came on the air at 2110 with a Musical Box rendering of "Waltzing Matilda," prior to transmission at 2115.

PRL7 Rio de Janeiro Brazil has been the best signal from South America being R9 plus at 2225 on 9720 kcs.

From Africa—Radio Addis Ababa ETAA Ethiopia has been logged with R7-8 signals but marred by bad CW QRM. Heard at 1900-1955 when it ends transmission. Operates on 15074 kcs. but frequency varies somewhat occasionally to around 15060 kcs.

(Cont. on p.50)

Amateur Band Predictions

DX PREDICTION FOR MID-AUGUST TO MID-SEPTEMBER

(7 and 14 Mcs. through courtesy of Geoff. Hutson, G6GH 28 Mcs. with acknowledgement to Denis Heightman, G6DH).

7 Mcs. Conditions

0500—W1.
0600-0700—ZL.
2000-2100—VK, ZS.
2300-2400—W1.

14 Mcs. Conditions

0500—W6, W7, VE7.
0600—W6, W7, VE7, VK.
0700—VK.
1400—J, VK, KA, C.
1500—VK, VS1, VS6, C.
1600—VK, W6, W7, C.
1700—VK, PK, VU, VS1, Africans.
1800—KA, KG, Africans
1900—Africans.
2000—PY, VP2, VP4.
2100—PY, VP2, VP4.
2200-2400—PY, LU, CE, OA.

28 Mcs. Conditions

Similar conditions to July but with DX improving somewhat, particularly towards the end of the month. Contact with Africa should be possible most of the day (peaking in the early evening) and with S. America from about 12 until 21 hrs., or later, with a peak rather late in the evening.

Conditions for other countries on or south of a Great Circle east (i.e. VU, VK6, etc.) and west (Central America, etc.) will be reasonably good though rather more "patchy." Best times are difficult to forecast but easterly signals generally peak in the early mornings and again in the afternoons while to the west the peaks occur correspondingly later.

On "peak" days, the band should be watched for VK and ZL signals coming in via the long path, WSW over S. America late at night from 21-24 hrs. Conditions to north of east and west will remain poor with possible occasional appearance of Russia and N. American signals, the latter chiefly in the late evening.

Calibration of Signal Generators

By D. Robertson

ACCURATE calibration of a wave meter or signal generator may be continuously provided by inclusion of a quartz crystal frequency sub-standard either in the instrument itself or separately as an extra unit adaptable to all types of signal generators or wave meters.

The most common type of quartz crystal frequency substandard in the amateur's possession is probably of 100 kcs. or 1000 kcs., fundamental frequency. The method to be described, and the figures included, apply to one of 100 kcs., but would apply equally well to one of 1000 kcs. if the decimal point is displaced a relative amount in all references to frequency. The function of the basic circuit is self explanatory and the procedure for calibration will be dealt with only.

The calibration process may be divided into two parts; firstly it will be obvious that with a 100 kcs. crystal oscillator of the untuned type, harmonics will occur every 100 kcs. throughout the frequency spectrum, providing marker points at every frequency which is a multiple of 100 kcs. within the harmonic limits of the oscillator. The wave meter or signal generator may be tuned to each of these in turn using the zero beat frequency to determine the exact point of resonance and its dial or scale calibrated in accordance.

The second process gives points within the limits of each pair of adjacent marker points referred to in the previous paragraph and retains the same degree of accuracy as in the first. Not only does the crystal oscillator produce harmonics but most signal generators provide harmonics limited to about the 5th or 6th, generally, where the amplitude begins to be too small to be of great value. These will also beat with the harmonics produced by the crystal oscillator and it will be found that a sequence of beat points will occur in between each pair of adjacent 100 kcs. multiples. These are at regular intervals and follow the following table right through the frequency spectrum, limited by the highest harmonics that the crystal oscillator will produce. Starting at 100 kcs. the table neglects 6th and higher harmonics of the signal generator frequency.

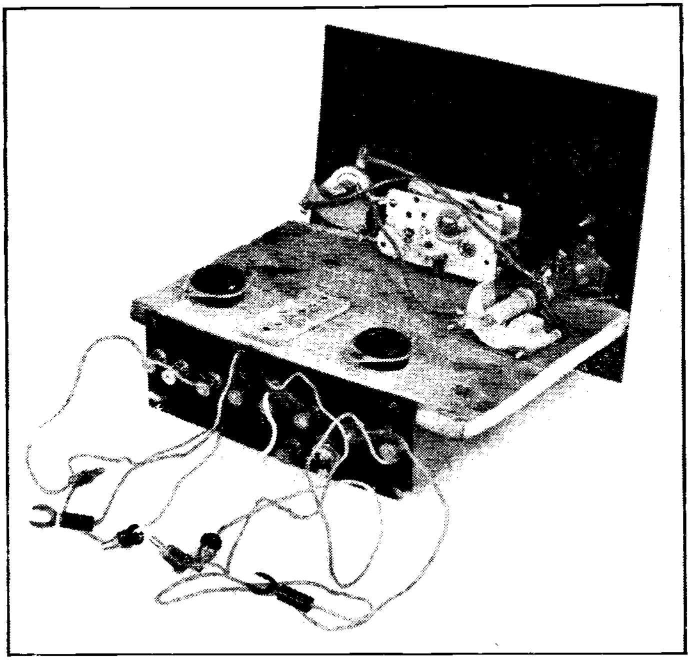
Signal frequency of Generator	Harmonic number of signal frequency	Beats with marker frequency
100 kcs.	1	100 kcs.
120 ,,	5	600 ,,
125 ,,	4	500 ,,
133.3 ,,	3	400 ,,
140 ,,	5	700 ,,
150 ,,	2	300 ,,
160 ,,	5	800 ,,
166.6 ,,	3	500 ,,
175 ,,	4	700 ,,
180 ,,	5	900 ,,
200 ,,	1	200 ,,
220 ,,	5	1100 ,,
225 ,,	4	900 ,,
233.3 ,,	3	700 ,,
240 ,,	5	1200 ,,
250 ,,	2	500 ,,
260 ,,	5	1300 ,,
266.6 ,,	3	800 ,,
275 ,,	4	1100 ,,
280 ,,	5	1400 ,,
300 ,,	1	300 ,,

An interesting series of harmonics appear which make this table easy to compute and to extend to the region that the amateur is most interested. It may have been noticed in the foregoing table that wherever a second harmonic occurs the sequence of crystal oscillator harmonics that they beat with runs 300, 500, 700 kcs., etc. Similar relationships exist between the others; for example the 5th harmonics which run 600, 700, 800, 900, 1100, 1200, etc., the apparently missing harmonics occuring at the same frequency as another harmonic of greater amplitude. This occurs in the case of the 5th harmonics mentioned above where the 5th harmonic of 200 kcs. beating with 1000 kcs. is hidden by the fundamental beating with the 200 kcs. harmonic of the crystal oscillator. The sequence of harmonic numbers is always the same and if the 6th harmonic is included they will occur as follows:—1, 6, 5, 4, 3, 5, 2, 5, 3, 4, 5, 6, 1.

Supposing the crystal oscillator is capable of providing harmonics up to 30 Mcs., the limit of calibration of 5th harmonics is approximately 5.980 Mcs. where the 5th harmonic is 29.90 Mcs. The lower harmonics may be used up to their respective limits however and should provide adequate points for frequency calibration at the higher frequencies.

The order of the harmonics may be judged by ear, as the lower the harmonic number the greater the amplitude of the beat frequency will be. If one wished to have some visual indication however, some simple output meter of the valve volt meter type might be included in the output circuit of the instrument.

Making a Start



A series of Articles describing the progress of a newcomer to constructional work

By G3AKA

RECENTLY, we had a letter from a 13-year-old reader regarding difficulties he encountered in attempting construction of a short wave receiver. As he lived locally, we invited him to bring the set to the office so that we could help. The photo in the heading is of the receiver in question and, quite frankly, we were not surprised that it did not work! Before we go any further, it must be emphasised that the object in using this illustration is not prompted by any feeeling of superiority, nor are we trying to lampoon our friend's efforts at construction. The receiver is reproduced here for two reasons (1) as a record of the original set and (2) as a means of comparison to others just starting.

We need the record of the original set because under our supervision, our young friend, and he must be typical of many, has rebuilt the receiver. This series of articles will be a record of the progress made and the snags and difficulties encountered and how they were overcome. To those who are unable to get assistance from experienced constructors, or who are not able to attend local club meetings, much valuable information will be gained as to how to tackle constructional work.

Only too often does the beginner spend good money on components to be disappointed at the results obtained, through lack of experience and guidance. So often in the past has this happened that a fallacy has grown up that it is an impossibility for a home constructor to turn out, say, a receiver that will perform as well as one mass-produced in a factory. Many would-be constructors have been lost to the hobby simply because their initial effort was a source of disappointment, particularly in cases where the receiver was built from surplus gear and components from the "junk box." A source of knowledgable assistance at their elbow to point out elementary mistakes would have made a world of difference to that constructional effort and encouraged the newcomer's interest in what is the most fascinating of hobbies.

Our 13-year-old enthusiast was shown a finished receiver, built by one of our designers. The first thing he said was that such work was quite beyond his capabilities. This is obviously a false impression as hundreds of exact replicas of this receiver will be built by our readers throughout the country. But it is for the type of readers whose efforts, for economic reasons, are limited to simple inexpensive apparatus that this article will chiefly appeal, particularly if they are "lone hands" who have hitherto had to work in the dark.

If there are any sceptics reading these lines, all we can say is "wait and see"—you will not doubt be just as surprised at what can be accomplished under guidance as our friend was!

The first thing to be considered was, of course, the circuit. We made a list of the components on hand, as extra expense was to be avoided, and from these the circuit shown in figure 1 was evolved. It is obvious that it is of little use for a constructor to tackle any gear unless he has at least a working knowledge of the theory involved in that apparatus. Otherwise if the set does not work "first go," the constructor will not know how to set about tracing the fault. Being very much a beginner, our 13-year-old friend has limited knowledge and so the circuit shown contains nothing in the way of trick arrangements—unless automatic bias comes under this heading.

The receiver is a three-valver, using a detector followed by two stages of audio amplification (this type of set is called an 0-v-2 by the radio fraternity). Many readers wishing to make a start may be not too sure of the symbols and circuit details, so here is a step-by-step description of the receiver.

The aerial is connected via a small series capacitor C1 to the primary of the aerial coil (winding L1). The object of this series capacitor is to reduce the aerial coupling in order to improve selectivity and to minimise the risk of aerial "damping," i.e., the aerial stopping normal regeneration on patches of the bands. This effect is mostly experienced with long aerials. An alternative to the fixed series capacitor is one of the "preset" type. This is a small variable capacitor which can be locked. It is of use when the reaction is rather patchy on certain bands, the object of the variable capacitor being to vary the degree of aerial coupling to suit the band being used. In a well-designed receiver, however, this is unnecessary.

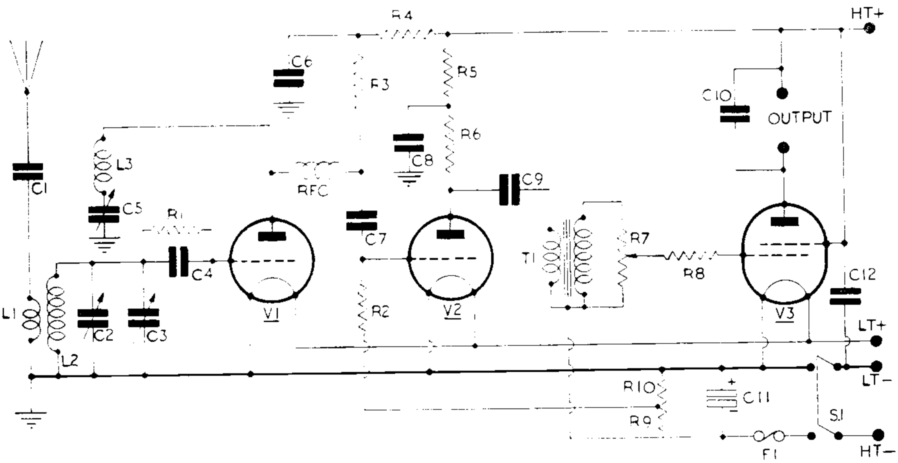
L2 is the secondary, or grid, winding of the coil and R.F. energy induced into it from the primary winding L1 is fed on to the grid of the detector valve V1. R1/C4 is the normal grid leak/grid capacitor combination. This combination is so arranged that the time constant allows the capacitor to discharge with each pulse of R.F. Normal values for ordinary short wave work are 100 $\mu\mu$F for the capacitor and 2-4 megohms for the grid leak.

The variable capacitors C2 and C3 are used to tune the grid or secondary winding of the coil. The larger one, C2, is used for rough tuning and is called the "band-setting" capacitor, whilst the smaller one, C3, is used for very fine adjustment and is termed the "bandspreading" capacitor. Reaction—or regeneration—is carried out by the combination of C5 and L3, the latter being the third winding on the coil. The capacitor C5 is rotated until enough energy has been fed back from the anode to grid circuits (by induction between windings L3 and L2) to slide the valve into self-oscillation. This is heard as a faint hiss in the headphones or speaker. In all too many home constructed receivers, reaction is a source of trouble. The oscillation starts with a loud plop in many cases, sometimes with a high pitched howl. If the receiver goes into oscillation under these conditions then there is faulty construction, either in component values or layout.

The detector valve, then, is operating as a leaky-grid detector, or—as it is sometimes called—a grid current detector. Since the rectified output from the valve contains some R.F. component, a radio frequency choke of the short wave type is inserted in the anode circuit as a precaution against any possible trouble due to R.F. leaking through into subsequent stages. R3 is the anode load resistor and R4/C6 are the anode decoupling resistor and capacitor respectively, the latter combination being another aid to keep the R.F. from parts of the circuit where it is not wanted.

The output from the detector stage is fed to the 1st audio amplifying stage via the capacitor C7. This type of coupling between stages is called resistance-capacitance, or R.C., coupling. The grid leak for this stage is R2. This is taken to the automatic bias combination, about which more later. From the output of V2, we have the usual arrangement of anode load (R6), anode decoupling resistor and capacitor (R5 and C8).

The first and second amplifying stages are transformer coupled, via the coupling capacitor C9 and the transformer T1. In this position, (i.e., parallel-fed transformer coupling) it is more usual to use a special "parafeed" transformer, but in the interests of economy an ordinary L.F. step-up transformer with a 3:1 ratio that happened to be on hand was used. The idea of the parafeed method of coupling a transformer is that, owing to the fact that no direct current passes through the primary, the primary inductance remains sensibly constant. Also useful is the fact that it can be



The circuit of the o-v-2

made physically much smaller since the gauge of wire used can be so much lighter.

The two "earthy" ends of the windings are taken to the bias supply jointly. Across the secondary winding is the potentiometer R7 which is the volume control. R8 is a "grid stopper" which is inserted in the grid circuit as a further precaution against instability caused by R.F. currents which may have seeped through to this final stage.

The output, headphones or speaker, is inserted between the anode of V3, the output pentode, and the H.T. positive line. A capacitor C10 is wired in parallel with the output terminals in order to prevent this stage going into oscillation through A.F. feed-back.

Now we come to the grid bias circuit. There must be an enormous number of receivers still suffering the inconvenience of awkward grid bias batteries—and all for the want of a simple Ohms Law calculation! A receiver with automatic bias does away with untidy bias battery leads: the need for storing the battery itself: the necessity for periodic replacement of bias batteries; the constant variation of bias voltage owing to the battery "running down"; and so on. To ascertain the correct resistors to use, all one has to do is to find out the total anode and screen grid currents for the valves in the receiver, by reference to valve tables and curves, against the H.T. voltages to be used. Then the highest value of bias needed, for the output valve, is referred to, and the voltage drop necessary can be calculated. In our case, with a total current consumption of 10mA. (approx.) the H.T. at 100V. and the pentode grid bias at 4.5V. this worked out at 450 ohms. The formula is simply:—

Resistance required=

$$\frac{4.5\text{V.} \times 1000}{10} = 450 \text{ ohms}$$

The 1000 on the top line is because Ohms Law depends upon the current as given in Amps. As our current was 10 mA., then it must be divided by 1000 to give it in Amps, thus we get

$$\frac{10}{1000} \text{ A.}$$

That gives us the 450 ohms for the 4.5V. bias. Now, as the previous valve (V2) needs 1.5V. bias we have to split the value of the total bias resistance accordingly. Thus we have the V2 bias tapped off one third of the way along (1.5V. and 4.5V.), so that means the resistor must be 150 ohms. Therefore R9 is 300 ohms and R10 is 150 ohms, giving a total of 450 ohms. The value is not critical within fairly wide limits. An increase, for instance, of 50 ohms would mean an increase of bias, but this in turn means a decrease of current, so that the nett result is substantially the same.

The capacitor C11 is for decoupling at audio frequencies. F1 is a 60 mA. fuse. It is surprising how many receivers, and indeed other gear, are built without the inclusion of fuses. We feel that all gear should have fuses fitted, as their low cost certainly more than merits their place as an essential part of the set. A fuse can be replaced for a few pence, but a new set of valves is quite another story!

The on/off toggle switch S1 is of the double pole variety and thus we automatically switch off both the L.T. and H.T. in one operation.

So that is the story of the circuit we used. We will continue the account of the beginner's progress in our next and succeeding issues.

Main Components for the Beginners 0-v-2

Capacitors: C1, C4, 100 μμF; C2, 160 μμF variable; C3, 15 μμF variable; C5, 200 μμF variable; C6, C8, .1 μF; C7, C9, .01 μF; C10, .005 μF; C11, 25 μF, 25 v. wkg. electrolytic; C12, 2μF.

Resistors: R1, 3 M; R2, ½ M; R3, R4, R8, 50 K; R5, 10 K; R6, 30 K; R7 ½ M potentiometer; R9, 300; R10 150.

Valves: V1, HL2; V2, PM2HL; V3, PM22A. Or equivalents.

Miscellaneous: Set of six-pin plug-in coils, with holder; 1 RF Choke; F1, 60 mA. fuse and holder; T1, 3:1, or similar, LF transformer; 2 4-pin and 1 5-pin valve holders; Aerial and Earth terminals; S1, DPST toggle switch; 1 phone jack; 1 epycyclic drive (for C5); 1 large and 1 small mounting brackets; Slow motion drives for C2 and C3.

Metalwork: Panel: 12 in. x 9 in. Chassis: 10 in. x 6 in. x 2½ in.

NEXT MONTH: Starting Construction

(RADIO CONDITIONS—Cont. from p.45)

U.H.F.

The B.B.C. Television Sound Transmissions from Alexandra Palace on 41.5 Mcs. have been heard here at R5-6 QSA5 with Water Polo commentary.

GSK Daventry was heard with a good steady signal at 1315-1330 being R9 QSA5 but afterwards was subject to bad "flutter" QSB. Conditions on the UHF Bands should improve from now on so keep a careful watch for signals there.

Address all letters to: ISWL/G211 c/o "The Radio Constructor." Until next month—73 and good listening.

Trade Notes

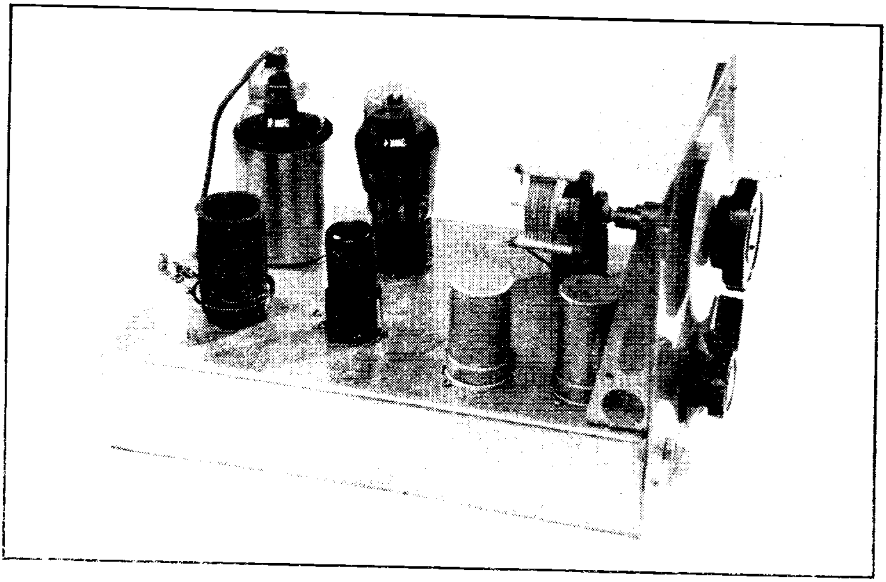
Denco: We have received a copy of the Maxi-Q technical Bulletin DTB1, recently issued by Messrs. Denco (Clacton) Ltd. This is a twelve page publication, attractively mimeographed in two colours on foolscap size sheets. It contains a wealth of information on the useage of the famous "Maxi-Q" plug-in coils. Among the contents are: General data on coil connections, codings, coverage of the various ranges; Design Data for receivers using Maxi-Q coils, suggested circuit, circuit alignment, tracking; V.H.F. converter using Maxi-Q coils; Straight receiver. All these items are well illustrated, with circuit and wiring diagrams. Altogether a most useful publication. The price is 3/- and can be obtained direct from Messrs. Denco, 357-9 Old Road, Clacton-on-Sea, Essex.

M.O.S.: The latest catalogue from this firm contains much of interest in the way of government surplus gear, as well as standard civilian lines. The sixteen-page catalogue lists items ranging from banana plugs to signal generators. Readers may obtain this 1948 catalogue by writing to M.O.S., 24 New Road, London, E.1.

Philco: As from 26th July, the address of the Philco Sales Department will be 204/206 Great Portland Street, London, W.1. (Tel.: Euston 5566).

Airmec International Inc.: In order to make the fullest use of trade opportunities with the U.S.A., the Board of Radio and Television Trust Ltd. have formed a corporation in the U.S.A. under the above title. The Board of Directors of this Corporation are Mr. R. W. Cotton, Mr. L. D. Bennett and Mr. H. R. Kent. The Corporation's address is 347 Madison Avenue, New York, 17.

Radiographic Ltd.: The latest catalogue contains some interesting items for the radio amateur, particularly the Rotary Beam Aerial System (Type 2B) which is being offered. The aerial consists of a 100-124 Mcs. doublet array, with reflectors though it would be fairly easy to convert it for other bands. Drive mechanism, allowing a 360 degree rotation, is included—this being either remote or manually controlled. Other items of interest to the amateur are aerial insulators, dipole aerial rods and a sizeable selection of transmitting valves. Copies of the catalogue may be obtained from Radiographic Ltd., 66 Osborne Street, Glasgow, C.1.



A Versatile 150 Watt TX

Part 2: THE FRANKLIN V.F.O.

By G2UK

Introduction

Last month we described the crystal oscillator, frequency doubler and push-pull P.A. stages of this transmitter and now we present the V.F.O. unit which has been used with much success on frequencies up to 28 Mcs.

FIRST, thanks to those correspondents who pointed out the errors in the circuit diagram of the crystal oscillator stage given last month. The cathode resistor should of course be 500 ohms value, not 50k ohms as shown. The second error is also an obvious one, i.e., the meter jack as shown would be passing RF through the meter. The correct position for the jack being, of course, between L1 and HT+. And now a few words about V.F.O's in general.

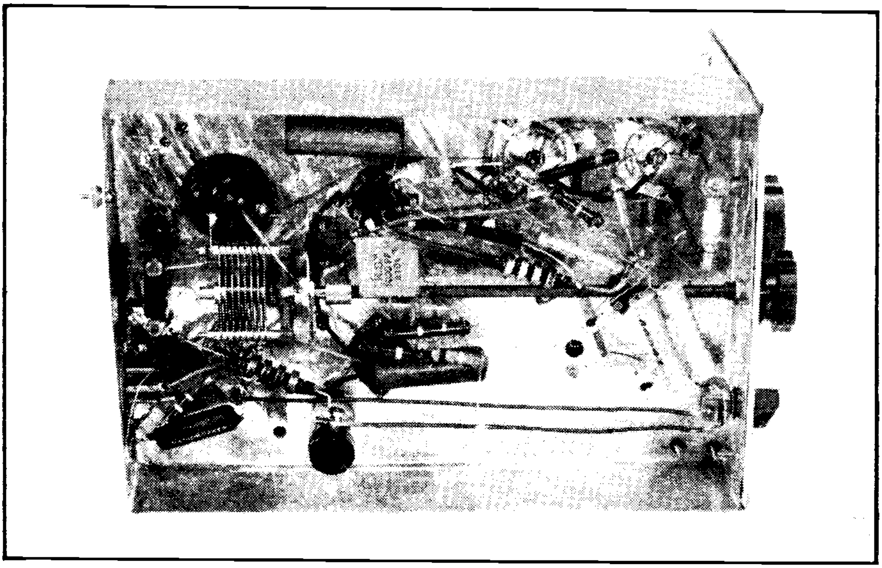
Much has been written about V.F.O's in recent months and a great deal of what has appeared has been in adverse strain. The fact remains that V.F.O's are becoming more and more popular and there can be few real "DX chasers" who do not use one. Even more certain is the fact that once a V.F.O. has been used, one will wonder how one ever did without it. On the credit side of the V.F.O. is the ability to move out of the way of the half kilowatt stations to be found on 14 Mcs. these days, the forming of "spot frequency QSO links" which are to be encouraged as they save much band space, that 5 kcs. shift which can be made with a V.F.O. enabling one to clear QRM when working phone, and the ability to get near the frequency of a wanted station which undoubtedly gives one a better chance of working him. The chief criticism levelled at the V.F.O. is the accusation that some stations pile up on top of the rare DX thus spoiling the chance of a QSO for everybody. So much publicity has been given to this silly procedure that most people know better nowadays. The next most frequently heard criticism is that most V.F.O's are unstable, that they give bad notes and are generally spoiling the good name which the British Amateur has earned in the past for always having a good note.

Of the various V.F.O. circuits, that of the Franklin Oscillator has received most attention in British amateur circles. Unfortunately one or two descriptions of Franklin oscillators have appeared which have tried to simplify this circuit to such an extent that faulty operation has proved inevitable and consequently the Franklin Oscillator has got a bad name. If this type of V.F.O. is built using normal precautions an oscillator will result which is in every way satisfactory. That described herewith has been used with the transmitter featured last month on 7, 14 and 28 Mcs., using both phone and c.w. T9 reports have always been obtained, no reports of drift have ever been received and the circuit has proved thoroughly reliable and trouble free. Some may feel that five valves are an unwarranted expense to get less than a watt or so of R.F., but the valves used are very readily obtainable. Moreover, the rest of the components in the circuit are cheap and easily available. Several attempts have been made to simplify the circuit but the result has always been a marked loss in performance and after a good deal of experimenting we came to the conclusion that money saved in simplification was lost in efficiency. If you build this circuit up as shown, we can confidently say that you will be very satisfied with Franklins in the future.

The Circuit

Most readers will be familiar with the conventional Franklin Oscillator circuit in which two triodes are resistance—capacitance coupled with provision for sufficient feedback to ensure steady oscillation in the circuit as a whole. A resonant circuit is provided to determine the frequency of the oscillations and by ensuring that the coupling of this resonant circuit to the valves is very loose, no changes in valve operating conditions will effect the frequency of the resonant circuit.

In the circuit used for this V.F.O., two EF50s are used for the oscillator valves. The first is strapped as a triode; the second has grids 2 and 3 strapped to form the anode of the triode section of the Franklin Oscillator whilst its own anode is used to afford coupling to the next valve. The resonant circuit is provided by the fixed capacitance C1, the variable capacitance C2 and the inductance L1. C1 is of 800 $\mu\mu$F (silver mica) and forms a very stable basic capacitor. Frequency variation is provided by C2—an Eddystone 100 $\mu\mu$F variable which will spread the amateur bands over just under half a 180 degree scale. The inductor L1 consists of 22 turns of 22 SWG cotton covered wire, close wound on a ⅜ inch former. We used an old RF choke, the former of which is ideal for winding this inductance on, but some polystyrene rod can be easily obtained if no old chokes are



Underchassis wiring of the Franklin

available in the shack. This combination of inductance and capacitance tunes to the 3.5 Mcs. range. The V.F.O. described is designed to give output on 7 Mcs. for feeding into the crystal oscillator stage of the transmitter described last month. Subsequent frequency multiplication gives drive to the P.A. stages on 14 and 28 Mcs. The L/C ratio of L1 and C2 gives 40 degrees bandspread on a 180 degree dial to cover the 14 Mcs. band.

The third valve, V3, is a 6V6 coupling the oscillator to the subsequent stages. It is a simple untuned buffer amplifier, whose main function is to isolate the oscillator valves from "pulling" by subsequent stages. The next valve, V4, is a 6L6 with a 3.5 Mcs. resonant choke, L2, in its anode circuit. This in turn feeds an 807 doubler stage, with its anode circuit tuned to 7 Mcs. This tuned circuit is link coupled to the crystal oscillator stage, the "end" of the link being simply plugged into the crystal sockets on the crystal oscillator stage.

Construction

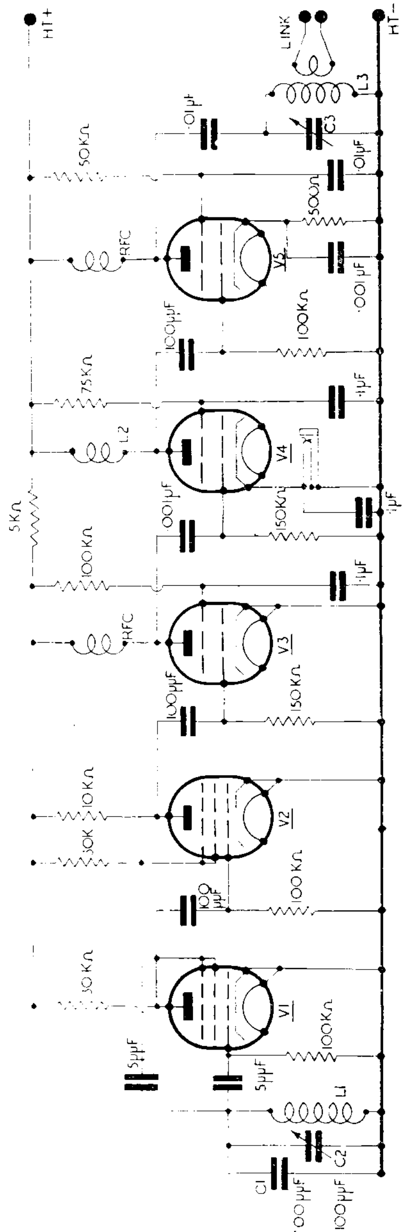
Rigid construction is essential in any V.F.O. and it is really worthwhile getting a stout chassis and panel and providing additional supporting brackets for the latter as shown in the photo. Similarly a good quality dial and drive and a rigid support for the tuning capacitor should be used.

The chassis measures 12 by 8 by 2½ inches and the panel is 8 by 8 inches. The dial shown is a Muirhead Type D-83-A with a slow motion drive of 8-1. It is a really solid job ideal for this type of work. It is provided with a clearly engraved scale graduated 0-180 degrees in a half circle and a vernier scale.

The other controls on the panel are the tuning control knob for the 807 doubler and an on/off switch in the H.T. lead. A small panel indicator light is also fitted.

The position of the various valves and components can be seen from the illustrations. The two EF50s are in the right foreground. The tuning capacitor is placed on the centre line of the chassis and behind it is inductance L1. This is somewhat obscured in the photo, but it is located on the right hand side of the chassis. The 6V6 and 6L6 are shown in the photo in the centre foreground and centre back. The 807 and its anode coil are shown at the left hand of photo. The 807 should have a screening can fitted as shown and the link for coupling its anode coil to the transmitter should be so arranged that it is at the earth end of the inductor.

A single loop of 14 SWG wire is sufficient, supported on stand off insulators as shown.



Circuit diagram of the Franklin

Capacitor C3 is a .0001 variable, similar to C2. It is supported underneath the chassis in the centre line, in close proximity to inductance L3. All fixed capacitors and resistors are mounted beneath the chassis. Their exact positions are not critical but they should be grouped around their appropriate valves.

The various inductances call for some comment as they are quite critical in value. Both L1 and L2 are wound on ⅞ inch formers. L1 consists of 22 turns of 22 SWG d.c.c. close wound and doped with Denco cement. L2 consists of 60 turns of the same wire, also close wound and fixed with polystyrene cement. L3 is tuned to 7 Mcs. and consists of 20 turns enamelled wire, 20 SWG spaced 1/16th inch on standard four pin plug-in former.

Operation

After having checked over the wiring, plug in power supply of 250-300 volts at 60-100 mA. and 6.3 volt, 3 Amp. filament supply. Set C1 about halfway. Switch on the receiver and tune across the eighty metre band, when the Franklin oscillator signal should be heard. If the circuit has been wired up correctly, no difficulty should be experienced, the Franklin stage will go into oscillation immediately.

Now tune C3 with a lamp loop indicator held over the top of L3. Several spots will be located at which oscillation occurs and the lamp lights. It is necessary to identify the correct harmonic and the only way to sort out the correct one is to use an absorption wavemeter.

Once the correct harmonic is found, the link can be plugged into the crystal oscillator stage and the transmitter driven as though the V.F.O. were acting as the crystal.

There is no doubt some opportunity for useful experimentation with this circuit. L2 for instance, might well be tuned with a variable capacitor, when more output from the following 807 doubler stage could be obtained. The two 5 $\mu\mu$F Franklin coupling capacitors could be reduced in value, thus increasing the stability still further. The description given is of the V.F.O. as built and it is recommended that readers build it up as shown to start with. No troubles have been experienced in six months' operation on 40, 20 and 10 metres, using both phone and C.W. There is just one point however, to which particular attention should be paid, and that is the smoothing of the power supply. If preliminary reports are not T9, look to the power supply filter capacitors first. Ours needed a total of 16 μF to give a T9 note. Apart from this precaution no special features such as voltage stabilisers are needed in the power supply.

In conclusion, the writer would like to thank Les Coupland, G2BQC, for the original circuit and for much help and advice in working out a practical design.

MALAYAN SCHOOL BROADCASTS

Tests have recently been carried out under the auspices of Radio Malaya, the government operated radio network for the Malayan Union, in order that the organisation might be in a position to recommend receivers for use in schools. The broadcast coverage includes, incidentally, the surrounding islands and will, eventually, also include Borneo.

The sets were judged by a committee of experts who had special knowledge of the essential requirements. This "jury" was appointed by Mr. Lloyd Williams, the Director of Education for Radio Malaya, and included the Musical Director, school inspectors, Chinese, English and Indian school teachers. Eight receivers were tried, all of them of well-known manufacture.

After the final test it was unanimously decided that the G.E.C. Overseas 7 Receiver (BC4672) was the most suitable and, in fact, this is the only receiver now being recommended by the broadcasting authorities. It is understood that further tests of a similar nature will be held from time to time.

SMALL ADVERTISEMENTS

Readers' small advertisements will be accepted at 3d. per word, minimum charge 3/-. Trade advertisements will be accepted at 6d. per word, minimum charge 6/-. If a Box Number is required, an additional charge of 1/6 will be made. **Terms:** Cash with order. All copy must be in hand by the 10th of the month for insertion in the following month's issue.

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