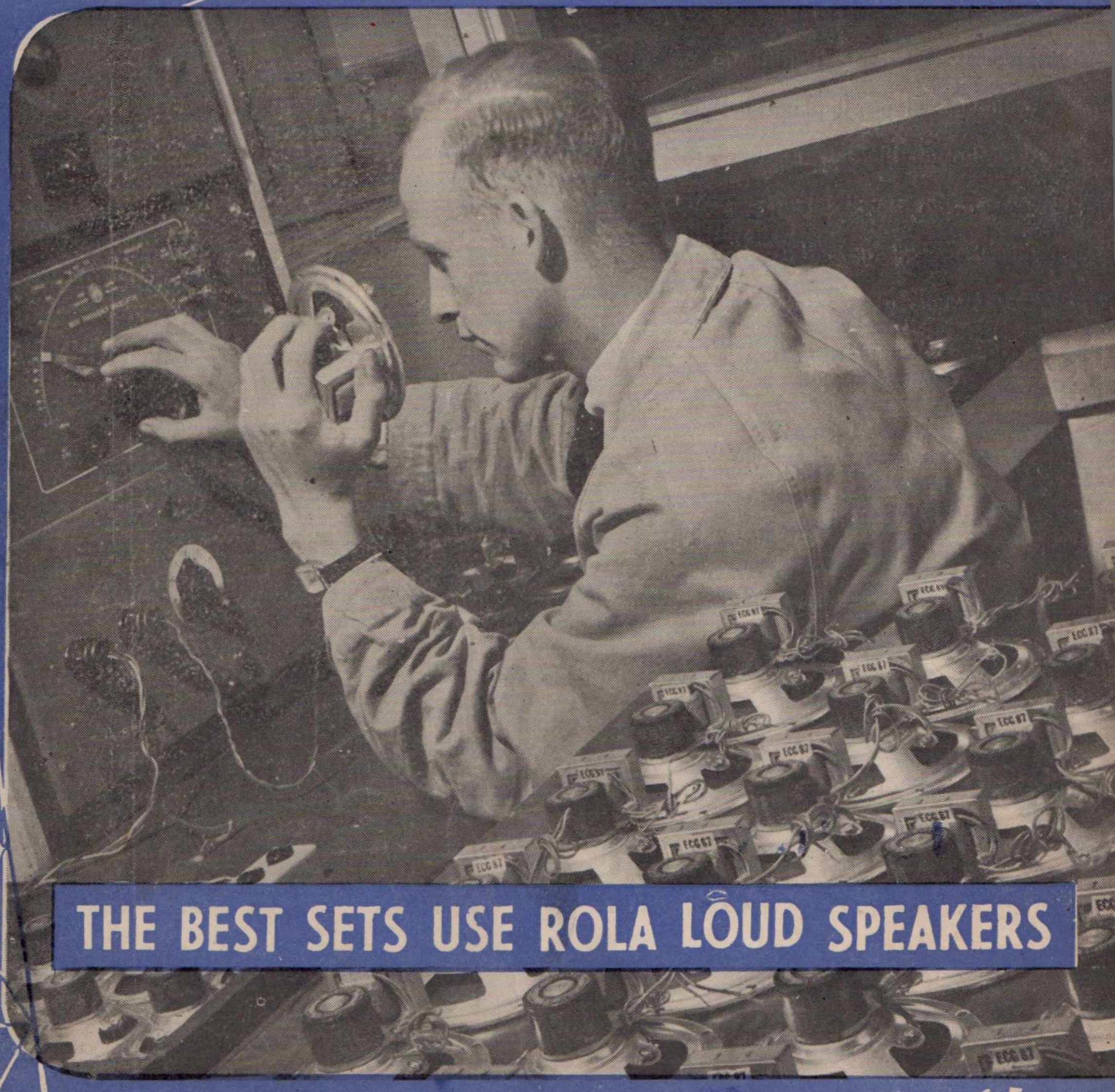
RADIO and AUSTRALIAN ELECTRONICS

INCORPORATING AUSTRALASIAN RADIO WORLD



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Radio and Electronics

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AUSTRALASIAN RADIO WORLD

Vol. 15 APRIL, 1951 No. 9

CONTENTS

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The Importance of Television

In a recent press interview, Mr. C. O. Stanley, chairman of directors of a large British television manufacturing firm, had some very interesting remarks to make on some of the aspects of television that seem to have escaped consideration here. At the moment, the Government is no doubt deliberating whether, in view of the international situation, it would be wise to expend money and effort in establishing a television service. Except for the fact that the Minister of Broadcasting has expressed himself as being very much in favour of the early introduction of television, other things being equal, nothing is known of the Government's intentions, but it is only natural to assume that the recent rapid deterioration in world relations must have had an effect on whatever views the Government may hold. The question will now be one, not of estimating the desirability or otherwise of our taking a practical interest in the newest and most potent means of home entertainment and education, but of considering whether every effort of which we are capable will not soon be needed for more urgent purposes. In this connection, some of Mr. Stanley's remarks are worth more than passing consideration by the powers that be.

It has been estimated, said Mr. Stanley, that a third world war would require electronic equipment to be manufactured and used on a scale fourteen times greater than during the last war. He did not say by whom this estimate was made, but it is not unreasonable to suppose that a man in Mr. Stanley's position should be close enough to official quarters for such a statement to have been made with "inside" knowledge.

Those of us who had some opportunity to observe the vast use to which electronic equipment was put during the last war will realise just what this statement signifies. Surely even the combined capacity of Britain and America will be hard put to it to produce equipment on such a colossal scale, and if this is so, then not even the relatively smaller manufacturing capacity of Australia and New Zealand will be of negligible importance. In both countries, however, the radio industry is, in the main, concerned with the production of domestic radio receivers, and there is a vast difference between the knowledge and technique required for this job and that needed for making highly specialised war equipment. Considered in this light, television assumes a new importance. It is a fact that only the possession of a flourishing television industry enabled Britain, during the last war, to put radar out of the laboratories and into the field, with a speed great enough to be of practical assistance, first to the defence of the country, and later to the highly successful offensive operations that were made possible only by electronic means.

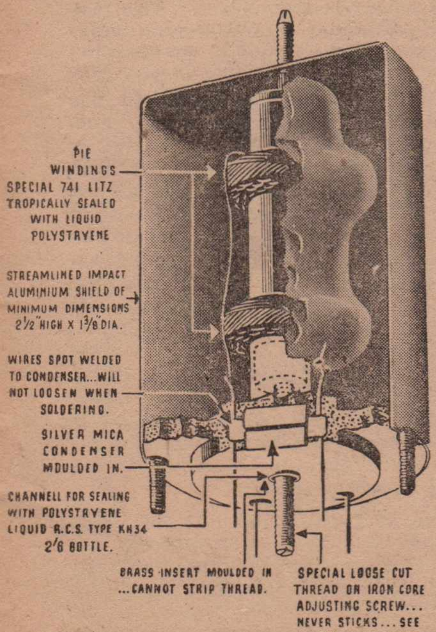
It may not at first be apparent just why the television industry was such a telling factor. There were two main reasons. The techniques which distinguish television engineering from "ordinary" radio work are exactly those which similarly differentiate radar and most other of the war-time electronic developments. Thus, a large section of the British radio industry was able, through its knowledge of television practice, to turn this to immediate practical account in switching over to radar manufacturing. It was even possible, by a lucky chance (aided by some thoughtful planning) to make direct use of a large amount of equipment that had actually been designed for TV receivers, thereby short-circuiting a great deal of development time on one particularly important project. We do not suggest that the same thing can happen again, but there is no doubt that the second great advantage of having had television actually operating before the war was to be found in the relatively large number of men who, knowing something of TV, were able to be converted into radar engineers and technicians in a very short time. It is a noteworthy fact that many of the most notable television engineers in Britain at the time became equally famous among those in the know for their work in developing radar and other electronic projects from the stage of laboratory curiosities to being major war-winning factors. If ever Britain had a successful "secret weapon," it was her supremacy at the time in the knowledge and application of electronics. And it was this same supremacy which enabled the unparalleled manufacturing capacity of the United States to play the part it did in winning the war.

These statements, which we and many others, too, hold to be incontrovertible facts, show just how great a premium we should at this moment place on electronics. Here in Australia the radio industry rose to the occasion and played a very important part, albeit a small one in producing radio equipment not only for our own forces, but for British and American ones as well. At the moment, however, we are hardly "in the swim" as far as practical knowledge of the latest electronic weapons is concerned. Nor do we have the facilities for making great contributions towards the development of new devices, but when, and if it comes to the point, we shall again be able to make a worthwhile contribution to the overall electronic war effort.

The point we wish to make here is that our usefulness will be in direct proportion to the experience we shall have gained in modern electronic technique by the time we are called upon to assist, and that by embarking on a television programme we can do a great deal, in a strictly peaceful manner, to fit ourselves for what may be the greatest emergency ever. This point, we believe, should be given the most serious consideration by the Government when they are weighing up the pros and cons of TV in this country.

PROGRESS FOR RADIO AND TELEVISION

NEW BUILDING for R.C.S.



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The Short-Wave Miniature Three

This little set is a living example of the fact that the regenerative T.R.F. still has its usefulness in spite of the universal popularity of the superhet for more ambitious purposes. With its modern miniature battery valves, and its miniature batteries, it represents a considerable advance on what could be done with the same basic circuit in the past, when regenerative sets were used much more than they are to-day.

INTRODUCTION.

It has for some time been the habit of many radio enthusiasts to decry the once-popular regenerative set. Nothing less than the latest commercial communications receiver for them, they say, completely forgetting that there are many occasions when this sort of set, however superlative its performance may be, is quite useless. For example, the newcomer to radio as a hobby, whether as a constructor, or a budding "ham," often realises that to outlay a hundred pounds or more on a commercial receiver will not teach him anything about the practical side of radio design and construction. Nor, if he is new to the game, will it do him much good to tackle the construction of a complex superhet whose principles of operation he barely understands, as yet. For him, the logical set to start off with is the regenerative. The outlay for parts and valves is not excessive, the possible faults in building and components are much smaller in number, and he has a perfectly good chance of "making it go" if it does not at first work properly. Again, once he has built such a set, it will be extremely useful to him, because in spite of the limitations of a simple receiver, it will very rarely show up to such great disadvantage that he longs for a large and lusty superhet instead. Indeed, many of us who have been in the game for a long time, and who have become quite blase about everything except the "hottest" multi-valve receivers, have quite forgotten how well a set of this nature can perform. For low noise level and high sensitivity, together with quite adequate selectivity for all ordinary purposes, and combined with low first cost, the set that used to be described as "one of R.F., detector, and one of audio" takes quite a lot of beating, even to-day. And where a small, easily portable receiver is needed, as when camping, there is no kind of set which will give comparable performance for the same size and weight.

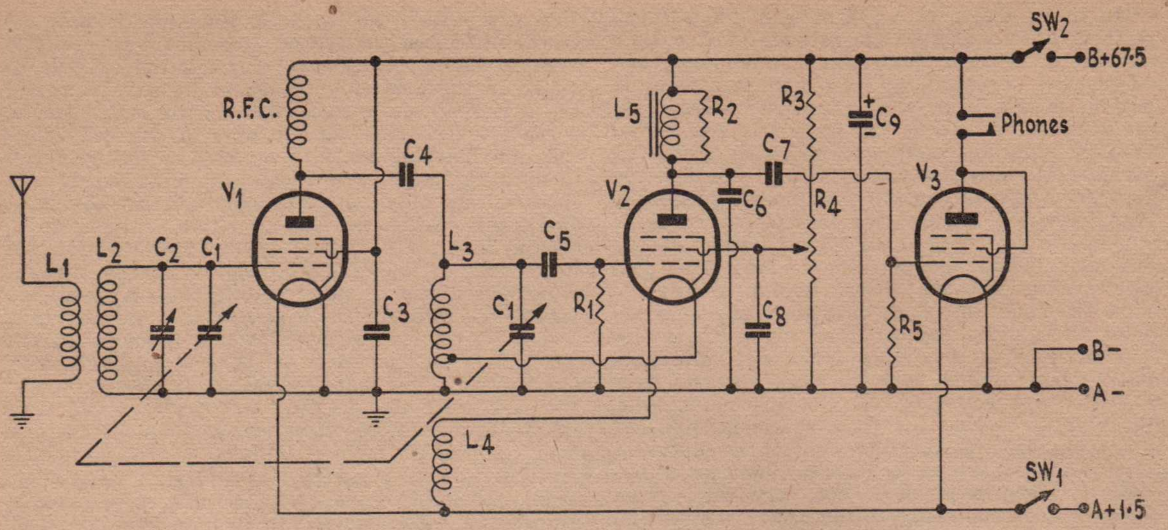
It is with these ideas in view, then, that we present this little set. It is intended for short-wave only, and covers from 3.5 to over 30 mc/sec., with three sets of plug-in coils. It uses three 1T4's, which with their diminutive size and small current drain, make an ideal line-up. Their characteristics are a great improvement compared with those of the older battery valves—30, 32, and 34—so that with modern components used throughout, it is possible to make from them a receiver which will give a much better performance, on many counts, than would be the same theoretical circuit several years ago. If there are any who wish to build it as a standby receiver for the ham shack, for emergency use (and we think there should be many) they will be amazed at its sensitivity and at the way it can bring in the distant and weak signals. For the DX-er, who wants to carry on his hobby while away from his main receiver, or the amateur transmitter "gone mobile," we think it will fill the bill exactly, and at very small cost too.

CIRCUIT FEATURES.

Perhaps the first thing to note about the circuit is that it uses the same valve type in all three positions in the set. For emergency or portable use, this is a distinct advantage, as it should be necessary to carry only one spare valve instead of possibly three. In addition, there is no loss of efficiency in so doing, since the modern sharp-cut-off pentode, as exemplified by the 1T4, is designed as a radio frequency amplifier, can act as a very reliable and sensitive detector, and can also be strapped as a triode, making an excellent audio amplifier.

The R.F. amplifier circuit is one which has never been very popular in any kind of set, but which in this application, has much to recommend it. We refer to the method of coupling from the plate of the R.F. amplifier to the grid of the detector valve. In the early days of regenerative sets, this scheme was frowned upon because mica condensers were not all they might have been, so that leakage was able to damage the detector, and at the best to cause unwanted crackling noises in the output. Also, the older valves had rather higher inter-electrode capacities than their modern counterparts, so that the direct connection of the output capacity of the R.F. valve across the detector's grid circuit had the double effect of limiting the tuning range, and, which was probably more important, of making it difficult to obtain good tracking between the R.F. and detector tuned circuits. In fact, it was almost unheard of to gang the tuning of such a set without using a panel-controlled trimmer in the aerial circuit. In this set, however, it has been found entirely practical to dispense with an aerial trimmer, and yet to have accurate tracking between the two circuits. This is done by using a pre-set trimmer, C2 on the circuit diagram. This is set at the right value to make the stray capacities across the aerial circuit equal to those across the detector circuit, as a result of which the coils can be adjusted to have identical inductances, thereby keeping the circuits in tune with each other at all points on the dial, and on all coil ranges.

The method of regeneration used is a variation of one which has always been very popular for regenerative detectors employing an indirectly heated cathode, but which requires a slight modification to make it usable with a filament type tube. We

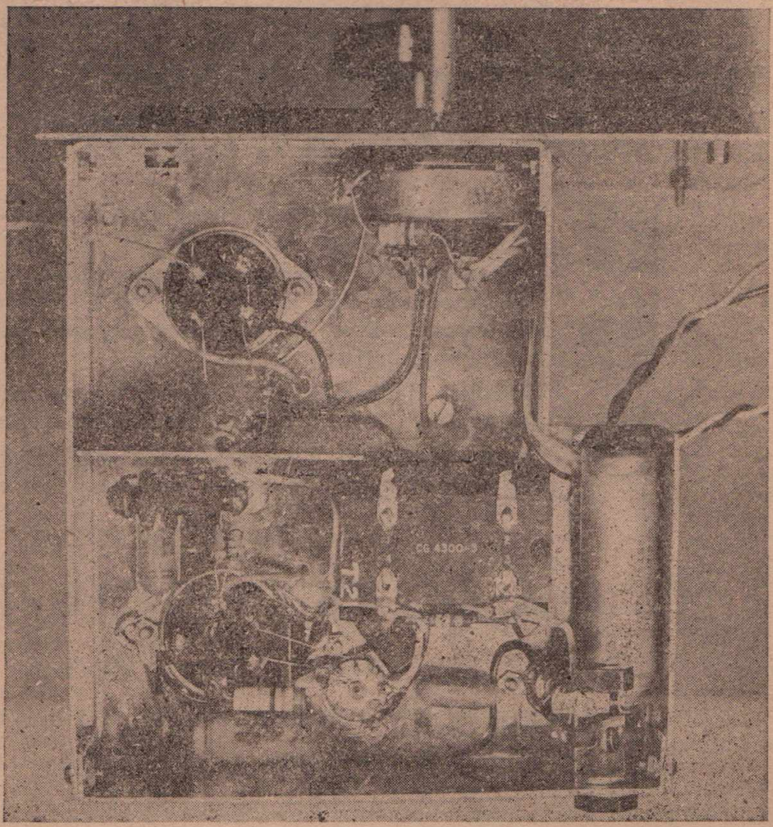


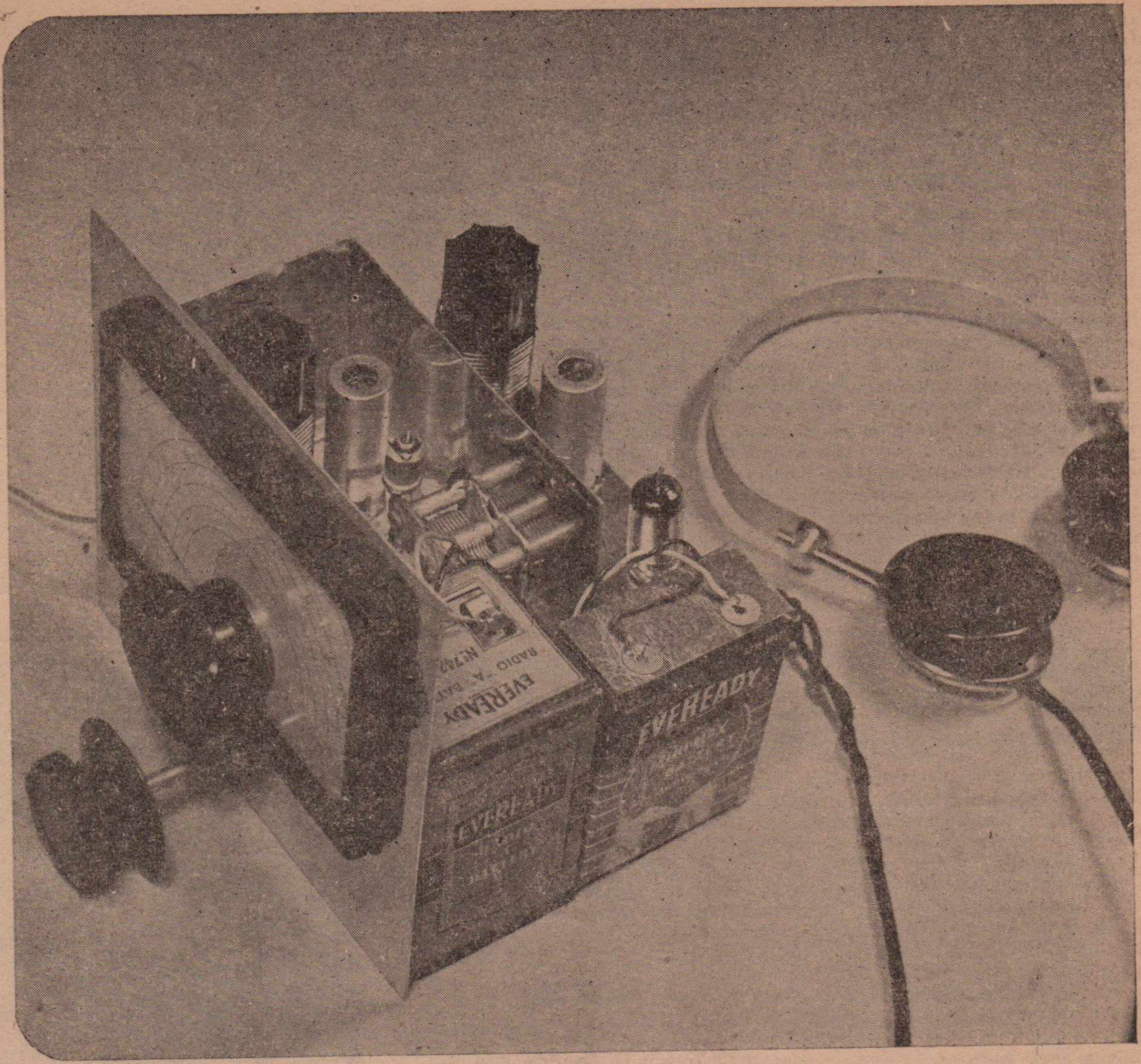
R1, 2 meg.
R2, 250k. (See text.)
R3, 25k.
R4, 50k. pot. with D.P.D.T. switch.
R5, 10 meg.
L1, L2, L3, L4 (see text).
L5, audio transformer primary (see text).
R.F.C., 2.5 mH. R.F. choke.
V1, V2, V3, 1T4.

A battery, 1.5v. type 742.
B battery, 67.5v. type 467.
C1, midget 2-gang, 100 uuf. max. capacity per sec.
C2, 3-30 uuf. trimmer.
C3, 0.05 uf.
C4, 50 uuf.
C5, C6, 100 uuf.
C7, 0.01 uf.
C8, 0.1 uf.
C9, 8 uf. electrolytic.

refer to the use of a grid coil tapped a few turns from the "cold" end, with the cathode of the valve connected to the tap. With this arrangement, the usual method of obtaining regeneration control is to provide a panel control of the tube's screen-grid voltage, and this feature has been retained. This method of obtaining and controlling regeneration is perhaps the best that has yet been devised. It gives a very smooth control, with no suggestion of "plops" when the circuit goes in and out of oscillation, and causes practically no de-tuning of the signal, even when the detector is very near the threshold of oscillation. These two attributes are perhaps the most important ones for a regenerative detector to possess, because they make it easy to adjust the set for maximum sensitivity, and particularly easy to tune, even on weak signals. Another important advantage of the scheme is that, unlike others, it does not require widely different settings of the regeneration control at different positions of the tuning condenser; and as a by-product, the sensitivity does not vary much from one end of the wave range to the other. Those who have built many sets of this kind will remember how annoying it is to have to try and adjust a detector that plops in and out of oscillation instead of taking up smoothly and almost imperceptibly, and how, with a set that does this, one always knows that with a smooth control, the usable sensitivity would be greatly increased. Also, there is nothing more annoying than a set in which small changes in the setting of the regeneration control necessitates constant adjustment of the tuning condenser. In bad cases, a slight movement of the reaction control is often sufficient to cause the signal to disappear altogether, so that one has to start searching again in order to find it. Actually, although the regenerative set is often despised, or discounted as "elementary," there is a real art in getting the best out of a circuit when it has to be designed and built from scratch, and there are many whose objections to it really arise from the fact that they themselves have never been able to build a satisfactory one through insufficient attention to the several apparently small points, that nevertheless make quite a difference to the final performance. However, there is seldom any difficulty in duplicating the results from a well-designed regenerative set, as long as the necessary precautions, as recommended by the designer, are adhered to, and those who decide to build this one need make no apologies to the scoffers, if any!

The cathode-tap-cum-screen-control method of regeneration is certainly less trouble to apply when the detector valve has the heater-cathode type of construction, but as we have tried to point out, its advantages are such that it really pays to go to the slight extra trouble necessary to adapt the scheme to filament tubes. The system works because by returning the cathode to a tap on the grid coil instead of directly to earth, the R.F. plate current, as well as the D.C. ditto, is caused to flow through the part of the coil below the tap, inducing an R.F. voltage in the grid coil in the right polarity to cause regeneration. Now a cathode has only one terminal, and by having a single tap on the coil and taking the cathode to it, all the R.F. plate current has to flow through the lower part of the grid coil. But when the filament tube is used, the situation is different. We have the tap on the grid coil, as before, and to this we take one of the filament leads. The D.C. filament current has to flow through part of the grid coil, therefore, but this does not matter, because the resistance of the short piece of wire that makes up the coil is so small as to have no effect on the filament current. Now suppose we take the other end of the filament straight to the A battery. The latter, as well as providing direct current at 1.5 volts, acts towards alternating currents, and therefore towards R.F., as a very efficient bypass condenser. Thus, if we were foolish enough to expect such a scheme to work, we would be disappointed, because the A battery would act as a very effective short circuit for R.F., making the part of the coil below the tap completely ineffective, both as part of the tuning coil, and as a means of coupling part of the plate current into the grid circuit. One way out of the difficulty would be to insert an R.F. choke in the





lead between the A battery and the free end of the filament. This would prevent the battery from short-circuiting the R.F. present on the filament, and would enable the scheme to work. The only difficulty would be that the choke used would have to have a very low D.C. resistance, so as not to drop the voltage actually applied to the filament. The usual short-wave R.F. choke of about 2.5 millihenries has a resistance of around 30 ohms, so that these could not be used. If a suitable low-resistance R.F. choke were specially made, it would be very bulky, and would almost certainly give trouble in other ways, so that the R.F. choke scheme is not really practicable. What we do instead is as follows. Suppose, for example, that the negative filament terminal is connected to a tap on the grid coil five turns up from the bottom of the coil. We now wind five turns over the the top of the bottom five of the grid coil, take the upper end of this extra winding to the positive filament pin of the valve, and the other end to the positive terminal of the battery. How does this scheme work?

Well, we now have two parallel paths by which R.F. components of plate current can flow to earth from the filament of the valve. One through the negative filament pin and the lower five turns of the grid coil, and the other through the positive filament pin and the extra five-turn winding we have added. These two paths enable half the R.F. plate current to pass through each, and this will actually happen, because whatever the impedances of the paths may be at any particular radio frequency, they will always be equal, because each path consists of the same number of turns of wire, wound in the same way exactly, and coupled to the grid coil in the same way. Anyway, all the R.F. plate current must pass through one or other of the filament legs, and both legs are coupled to the grid coil, and will thus produce regeneration. This brief description of the working of the arrangement may not be strictly accurate, but from the functional point of view it is close enough to the truth to enable one to see why it works, as compared with the use of only one filament leg, which does not.

The plate circuit of the detector is choke-capacity coupled to the grid of the audio amplifier. This is very much better than the somewhat cheaper one of using resistance-capacity coupling, which is not very desirable as a means of coupling a regenerative detector to a succeeding audio amplifier stage. The reason is that a resistor considerably drops the voltage applied to the detector plate, thereby reducing the sensitivity of the detector. It is necessary to have a very high impedance in the plate circuit, and as far as the detector sensitivity is concerned, the higher the better. But it is undesirable to have a D.C. resistance of more than a few thousands of ohms, so that the A.F. choke is obviously the best sort of load impedance to use. Its impedance may be several hundred thousand ohms, but its D.C. resistance may be only a few thousand ohms. Thus, the plate voltage is kept high, and the gain is increased, both because of the high plate voltage and the high impedance of the choke. In commercial receivers and amplifiers, audio frequency chokes are very rarely used these days, but it is a simple matter to buy a small and cheap audio transformer and use one of its windings as a choke, the other being left unconnected. The correct transformer to use is any small interstage transformer with a step-up ratio of 3:1 or higher. An output transformer **could** be used as long as care was taken not to use the secondary winding, but it would not be likely to give as much gain as a small inter-stage transformer. The best method of using the transformer is to tape up the secondary leads so that they cannot come into contact with each other or with anything else, and then pretend that the secondary winding does not exist. The primary is then wired into the circuit. The purpose of the resistor R2 should now be explained. Old hands will know all about "fringe howl," but for those who are perhaps building their first regenerative set, it will be a treat in store! Fringe howl is a very annoying and troublesome defect that often occurs in regenerative receivers. If one knows the cure (which is very simple) all is well, but should one not, it can render the set almost useless. It functions this way. When the

Continued on Page 26

A Low-Powered P.A. Amplifier for Accumulator Operation

There are many possible applications for a small P.A. system in places where no A.C. mains exist, and a good many public address operators have probably felt the need for just such a system as the one described in this article. The circuit is for use from the battery of a car or small van. It thus shows alternative arrangements for 6 or 12 volt operation.

INTRODUCTION.

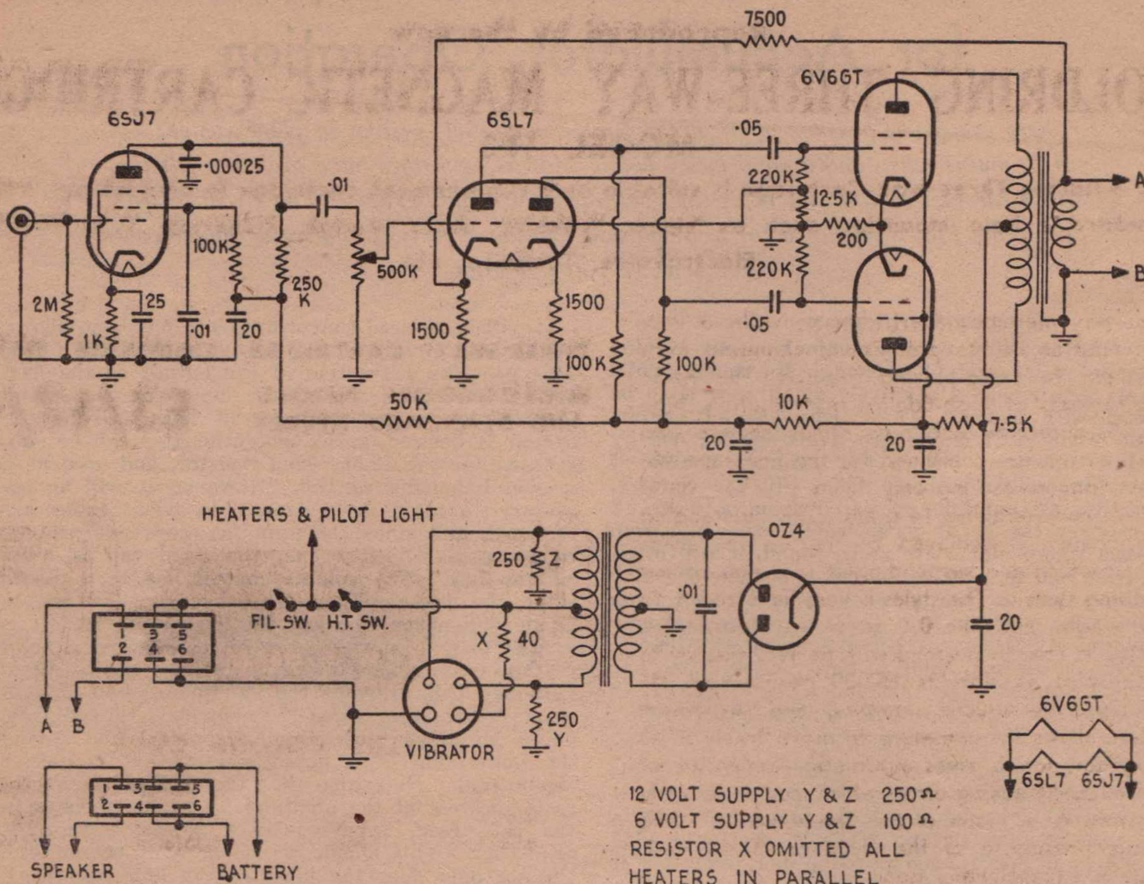
A small amplifier with a nominal output of nine watts or so is amply big enough for small public address jobs where a relatively small area is to be covered with sound. These jobs are, of course, simple when A.C. mains are available for use by the P.A. operator, but in the ordinary course of events, impossible without them. In the country, especially, an amplifier powered from a 6 or 12 volt battery can be of considerable use, while even in areas where mains are to be found, it will often be easier and quicker to set up a battery-operated amplifier than to run great lengths of lead from an operating position near the A.C. outlet that may be available. In fact, those P.A. men who do not already possess something of this kind will find one or two amplifiers like this one a very useful and inexpensive addition to their equipment.

THE CIRCUIT.

For small jobs, it often occurs that a single microphone is all that is required, and so the circuit is a straightforward single-channel one, with a good performance, but no "frills." A single 6SJ7 is used as a microphone pre-amplifier, and this is followed by a 6SL7 as a high-gain phase-inverter, feeding a pair of 6V6s in push-pull. Overall feedback is used from the voice-coil winding back to the cathode of the first section of the 6SL7, and this is instrumental in reducing distortion to a low level. Since feedback is taken over only two stages, it is unlikely that trouble will be experienced from self-oscillation of the amplifier. It should be mentioned in passing that the values shown for the feedback network, and in particular that of the 7500-ohm resistor from the voice-coil to the valve cathode, have been chosen for a 15-ohm loudspeaker. If a speaker of lower voice-coil impedance is used, the value of this resistor will need to be changed if the overall amplifier gain is to remain constant. With the lower impedance, and the same resistor, the amount of negative feedback would not be so great, with the result that the gain would be higher, and the distortion also. The effect would probably not be serious, however, but even so there is no reason why an increase in distortion should be tolerated, especially since there is plenty of amplification without reducing the amount of feedback. The value of the resistor directly determines the latter, and should have a value proportional to the square root of the speaker impedance. That is to say, if the impedance is a quarter of the standard 15 ohms, the resistor should be one half the one shown, or 3750 ohms, and so on.

It will be noticed that a fixed tap has been shown in the grid circuit of the second half of the 6SL7. This provides a fraction of the output of the first half of the same tube as the input for the second so that the output voltages of both will be the same. If desired, a 25k. potentiometer can be substituted for the 12.5k. fixed resistor, and used as a pre-set balancing control. However, it will be necessary to alter its setting only when tubes are replaced, and since the amplifier does not pretend to be a high-fidelity one, the fixed tap is quite satisfactory. The volume control has been placed after the pre-amplifier tube, because the microphone will never overload the first stage, and it is a good plan to have the control working at a point in the circuit where there is an appreciable signal voltage. This prevents the inevitable small amount of noise occurring when the control is shifted from being amplified more than necessary, and giving the impression of a potentiometer that is noisier than usual. Note also that the 6SJ7 is decoupled from the rest of the amplifier by a 50k. resistor in the H.T. feed, bypassed by a 20 uf. electrolytic condenser. This should on no account be omitted, for not only does the filter reduce hum and hash, but it is necessary in that without it there would be a danger of motor-boating. In order to make assurance doubly sure, there is also a decoupling filter of 10k. and 20 uf. in series with the H.T. feed to the 6SL7. In theory, this is not necessary to prevent low frequency oscillation, but it is nevertheless desirable in a circuit of this kind, where it will be observed that in order to reduce weight and cost, resistance-capacity smoothing has been used. This type of smoothing is more effective with a vibrator power supply than with an ordinary A.C. supply, because the A.C. turned out by the vibrator is much higher in frequency (approximately 115 c/sec.) and this makes the fundamental ripple frequency 230 c/sec. as against 100. It will be found that the R.C. smoothing shown on the circuit is perfectly adequate, in spite of its rather meagre appearance. Note that the plates of the 6V6's are fed straight from the reservoir condenser, while the screens are fed from the output of the main filter, with the 6SL7 plates taken off after the next filter stage. A graded filter of this sort is excellent practice, since it reduces expense to a minimum, and at the same time makes the degree of filtering suitable to the various H.T. feeds.

An OZ4 rectifier is shown. This has no heater, and thus economises in current drain from the battery—always a worth-while point. The vibrator



supply is very straightforward, and it will be noticed that there is no necessity to go in for elaborate R.F. filtering to remove "hash." It is important that the resistors shunted across the primary be of the values shown, and that the correct values be put in according to the operating voltage. The 40-ohm resistor in series with the coil of the non-synchronous vibrator enables a 6-volt vibrator to be run from a 12-volt supply, and saves the necessity of carrying spares of two kinds of vibrator should more than one amplifier, with different supply voltages, be carried to the one job. A standby switch enables the heaters of the valves to remain warm while the amplifier is not actually in use, and yet permits instant operation when the H.T. switch is thrown. This saves battery drain during long standby periods. Note that the pilot light is taken from the same point as the heaters, so that the operator can tell whether the whole amplifier is switched off or not. A further refinement would be a further pilot light fed from the other side of the standby switch, to show when the H.T. is on.

CONSTRUCTION.

The construction can follow ordinary audio practice, and it is possible to make the whole amplifier, including the power supply, very compact and handy to carry about. Of course, if the power supply is included in the same chassis as the amplifier proper, it will be necessary to keep the pre-amplifier stage as far away from it as possible. From this point of view, it would be advisable to leave a little spare room on the chassis so as to prevent overcrowding. Another necessary precaution is to take the feedback lead as far from the pre-amplifier circuit as possible, so that there will be no possibility of positive feedback arising through undesirable coupling to the 6SJ7.

If these points are looked after, no difficulty should be encountered, and the builder will find himself with an excellent amplifier with a multitude of applications that are not served at all by conventional A.C.-operated gear.

AUDIO ENGINEERS Invite You to Call and Hear MICROGROOVE RECORDS

Reproduced by the new

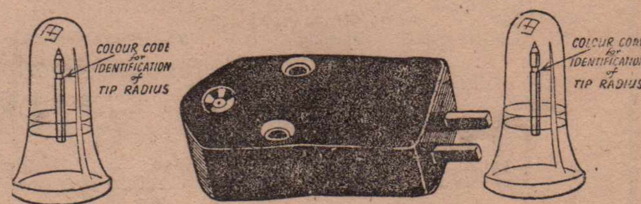
GOLDRING THREE-WAY MAGNETIC CARTRIDGE

MODEL 150

The Goldring Three-way Cartridge is suitable as a replacement cartridge in all pick-ups using standard 2 hole mounting such as Shure, Webster, Acos, Audak, Pickering, G.E. Var-rel, Electrovoice, Technico, etc.

Three-way magnetic Cartridge provides a very neat solution of the problem of changing from Standard to Long-playing records. The basic requirements of high-fidelity reproduction, high output, durability and easy stylus change and replacement, are combined for the first time—in a cartridge measuring only $1\frac{5}{8}$" x $\frac{3}{4}$" x $\frac{7}{16}$" deep overall, and weighing 14 grams. This outstanding performance is achieved by making the stylus the armature and suspending it in a non-ageing damping system. The stylus is very light and rigid and weighs less than 0.1 gram. As a result the pick-up is able to respond with perfect fidelity to frequencies as high as 15,000 per second. In addition, the special damping and suspension system allows the armature to move freely in all directions, which gives automatic elimination of the residual tracking errors which exist in all pick-up arms. As a result of this the wave form and transient-response of the Goldring 3-way cartridge is exceptionally good.

THREE-WAY CARTRIDGE, COMPLETE WITH MICROGROOVE NEEDLE AND STANDARD NEEDLE £3/12/-

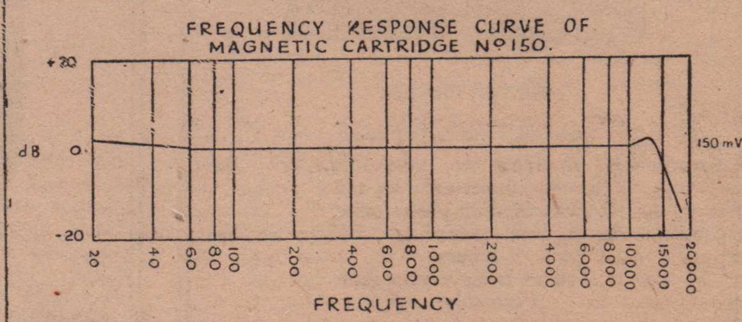


STYLUS COLOUR CODE

Tip Radius	Colour	Tip Radius	Colour
0.001"	Yellow	0.003"	Blue
0.0025"	Green	0.0035"	Orange

SPECIFICATIONS

Output (at 3.16 cms/secs. RMS velocity)	150 millivolts
Frequency range	30-16000 cps.
Stylus pressure 78 RPM	14 grams
$33\frac{1}{3}$, 45 RPM	7 grams
Coil impedance (at 1,000 cps.)	3,000 ohms
Coil resistance	2,000 ohms
Optimum load	50,000 ohms
Cartridge fixing	standard $\frac{1}{2}$" centres
Cartridge weight	14 grams



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Vacuum Tube Methods of Measuring Insulation Resistance of Condensers

By the Engineering Department, Aerovox Corporation.

Users of condensers often do not have an accurate way of determining the insulation resistance or leakage of a paper condenser. The leakage of a good condenser is so small that ordinary milliammeters will not give a reliable indication. The methods usually employed by servicemen and experimenters are rather indefinite and leave the radioman still in doubt regarding the true condition of the condenser under test. In response to many requests this number of the Research Worker is devoted to the accurate measurement of insulation resistance of paper condensers by means of a vacuum-tube-voltmeter.

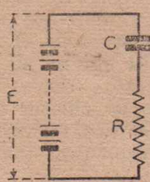


Fig. 1

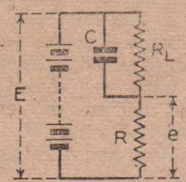


Fig. 2

Fundamentally the measurement is very simple. Fig. 1 illustrates the test circuit; the condenser under test, C, is connected across a direct current source of a convenient high voltage in series with a resistance, R. After the condenser is charged, a small current will still flow which is the leakage current. The equivalent circuit of Fig. 2 shows the condenser as a condenser with a resistance R_L across it. It is now required to find the magnitude of R_L. This can best be done by measuring the voltage drop, e, across R; the value of R can then be calculated if the voltage of the battery is known. How this is done is perhaps best shown by a numerical example.

Suppose the battery delivers 400 volts and the value of the resistor R is 1 megohm. After connecting the condenser in series with R and waiting for the condenser to be charged, the voltage drop across R is found to be 1 volt. Since 1 volt out of the 400 is across R the other 399 must be across R_L. In a series circuit the voltage drops across two resistors are proportional to the resistance so R_L must be 399 megohms. Similarly, if the voltage across R had been 2 volts, the insulation resistance would have been 398/2 = 199 megohms. A voltage drop of .1 volt across R would mean that the insulation resistance R_L would be 3999 megohms.

Generalizing the above statements we can express the relations in an equation, as follows:

$$R_L = \frac{(E-e)\,R}{e}$$

In this equation the results will be in megohms when R is in megohms. E is the voltage of the battery and e is the voltage drop across R.

Let us postpone for a while the problems of getting a satisfactory sensitivity, the discussions of the limits for the values of R, etc., and concentrate on the circuit itself.

Fig. 3 shows the simplest circuit of a vacuum tube voltmeter connected across R. In this case the vacuum tube voltmeter is used for measuring a steady voltage and therefore can work on the straight part of its characteristic and not on a bend. However, in order to have a larger range and to save on battery drain the bias of the tube can be larger than the regular amplifier bias so long as the operating point is still on the lower end of the straight portion.

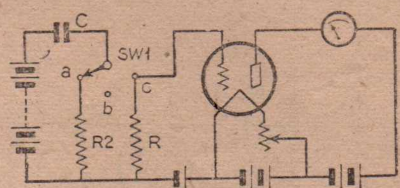


Fig. 3

In Fig. 3 the switch Sw1 has been introduced in order to charge the condenser first. The method of operation is now to heat the tube and connect the condenser, then to set the switch at a. The condenser will now be charged through the resistor R2. This resistor has been placed there for protection of the battery in case the condenser were shorted. In fact, it would be best to place a meter in series with R2 making the combination

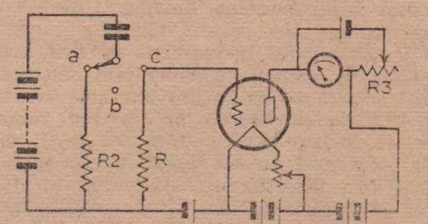


Fig. 4

a voltmeter. The value of R2 should be such that together with the meter it makes a voltmeter with a maximum range equal to the voltage of the battery. It is also possible to use a neon light instead of a meter and R2. The neon light will first light up when the condenser is being charged, thereafter it should go out altogether. If the lamp remains glowing, the condenser is shorted; if it flashes intermittently the condenser is leaky.

Now that the condenser is charged and it has been established that it is not shorted or so leaky as to place a high voltage on the grid of the tube, set the switch Sw1 to c. The vacuum tube voltmeter now should show an increased plate current and this can be read as a voltage across R. The value of R_L is now found with the equation which was given above.

The circuit of Fig. 3 would not be sensitive enough for most purposes but it can be improved upon by balancing out the steady plate current which will then permit the use of a more sensitive meter. There are several ways to accomplish this.

One of them is shown in Fig. 4; a 1.5-volt cell and a 1000-ohm rheostat will accomplish the desired result. These values are correct for most cases where a low resistance meter is employed (with a range of 0—1 ma.). More sensitive meters may have a higher resistance and then it is better to use a higher voltage source and a higher value of the rheostat R3. The rheostat is across the meter and constitutes a shunt; unless its resistance is large compared with the internal resistance of the meter, the sensitivity will be seriously reduced.

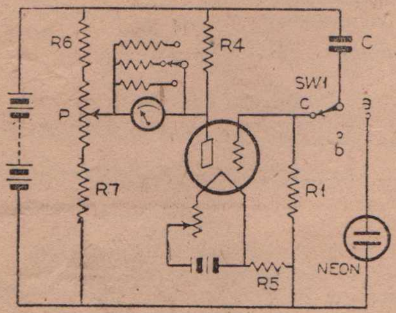


Fig. 5

Now a word of warning; it is unlikely when first adjusting the circuit that R3 will be set at once to the correct position for zero current through the meter. Consequently there might be a rather high current flowing through it which might damage the meter. Therefore, wherever we show a measuring instrument in this article it is advisable to employ a sensitive instrument with several shunts so as to prevent any overload. Suppose the meter to be an 0—100 micro-ampere range, it should have shunts for 0—1, 0—10, and 0—100 ma. and an off position. In this way, the balance can first be approximated on the higher ranges where the danger of overload is not present. Then, if the balance is obtained, switch to a lower range and make finer adjustment and repeat this until the instrument shows zero current at its lowest range.

Another method of cancelling the steady plate current is by means of the bridge circuit of Fig. 5. A load resistor, R4, is in series with the plate circuit of the tube. Its value should be calculated so as to obtain the rated voltage at the plate of the tube with the plate current which is desired. Also, instead of the added C-battery for the tube, a bias resistor can be employed. This is possible in Figs. 3 and 4 as well. The meter—with its shunts—is connected between the plate of the tube and a point on the bleeder resistance having the same voltage so that no current will flow. The potentiometer, P, will enable the user to find the correct point.

This circuit has the advantage that the adjustment and calibration will not be affected very much by the dropping of the battery voltage. On the other hand it increases the drain on the high voltage battery but the total drain need not be

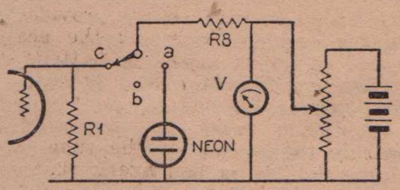


Fig. 6

high. The tube itself might draw about 2 ma. and the bleeder about the same. It is possible to obtain a similar balance by omitting the bleeder and connect P across one or two cells of the battery but then the adjustment will not be so well maintained with the variations in battery voltage. The value of R6 and R7 can so be chosen as to make the potentiometer P less critical which will also be a safeguard against overloading the meter.

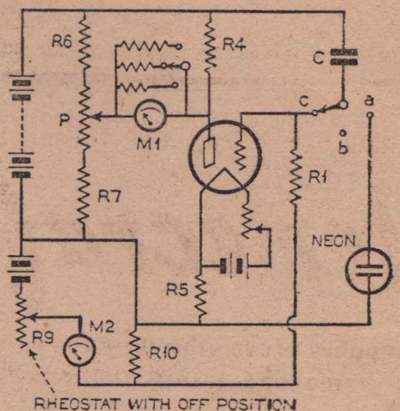


Fig. 7

CALIBRATION

There are two ways of actually reading the desired voltage, e. The vacuum tube voltmeter can be calibrated with known battery-voltages or the slide-back method can be used. This latter method requires no calibration.

A suitable circuit for calibration is shown in Fig. 6. The presence of a high resistance in the grid circuit of the tube may result in some gas current with consequent lowering of the input impedance of the tube which might change in turn the value of R1. We shall show later how to test for this error but when calibrating the meter, the resistance should not be paralleled by a low resistance. The series resistance R8 might be nine times R1 and then the voltage applied to the grid of the tube is one-tenth of that shown on the voltmeter V.

Changes in battery voltages and in the tube characteristics may affect the calibration. It is a good idea to check it frequently. If different ranges are to be obtained by using different values of R1, a separate calibration should be made for each range. It may be that it is satisfactory to multiply all reading with a fixed number, but this had better be checked.

For a fixed battery voltage and a fixed value of R1 the meter can be calibrated directly in megohms.

The slide-back method really provides a new calibration for each reading and the accuracy is not influenced by the changes in battery voltages or tube characteristics. Moreover if there is any voltage drop across R1 due to gas currents, this voltage would not cause any error. The only critical part is the circuit of the tube containing the resistance R1. It is important that there be no leakage in the socket or insulation and that the input impedance of the tube is sufficiently larger than R1 so as not to lower its value.

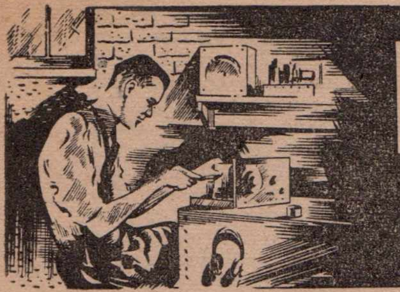
Fig. 7 shows the slide-back circuit added to Fig. 5. It consists in adding a negative voltage to the grid bias in opposition to the voltage drop across R1. When this voltage is equal to e, the meter will again indicate zero. The value of e is then indicated on the meter, M2. The procedure of a measurement is now as follows. Set Sw1 on a and connect the condenser; assuming that the light goes out after the charge we proceed with the measurement. With the tube filament heated, obtain the balance of the meter M1 by adjusting P. This must be done with R9 on the off position. For purposes of accuracy it is best to adjust the meter M1 to some sharply defined division on the scale preferably as near as possible to the zero point rather than to zero itself. It should be a fine line so that the least change in the position of the needle can be easily detected. When the adjustment of P has been made, set Sw1 on c and the needle should move up. Now adjust R9 until the needle returns to its original position. When this is done read the milliammeter M2. Suppose R10 is 100 ohms, and the meter M2 a 0—1 ma. meter, a meter reading of .5 would mean that the voltage drop across R10 (and also across R1) is .05 volt. In order to get different ranges it might be found advisable to switch R10 and to use values of 100, 1,000, and 10,000 ohms or to use a multi-range meter or both. In reality the meters M1 and M2 can be the same. They can be switched as shown in Fig. 8. The resistance R11 should equal the meter resistance so that the adjustment of R9 can be done while the meter is in the other circuit; the switching over then will not change the current through R10. It is also possible to calibrate the rheostat R9 using a dial and do away with M2 altogether.

When the value of e has been found, the insulation resistance of the condenser is found from the equation

$$R_L = \frac{E\ R1}{e}$$

Note that the equation for the slide-back method is slightly different from the one for the calibrated meter.

Continued on Page 31



NOVICE SET BUILDING

A SECTION FOR THE BEGINNER
sponsored by
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GETTING STARTED – Part 2

For some time it has been felt that we should cater, not only for those versed in the art, but also for those just setting out on the road to radio. Some will be boys at school, but others will be older, and possibly will have the advantage of having studied electricity and magnetism at secondary school, if only in an elementary way. However, all beginners feel the need of a little guidance at one time or another, and it is to fill this need that we embarked on NOVICE SET BUILDING.

In it, the emphasis will always be on the practical side of radio, and theoretical matters will be touched on as lightly as possible. This policy will suit those readers who wish to concentrate upon building things and making them work.

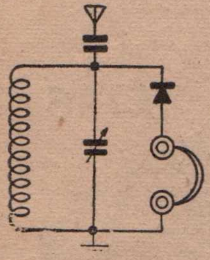
APOLOGY.—We had intended to publish circuit symbols in this issue, but due to the late arrival of the printing block, we had to go to press without it. However, this will be remedied in a future issue.

MORE CRYSTAL SET EXPERIMENTS

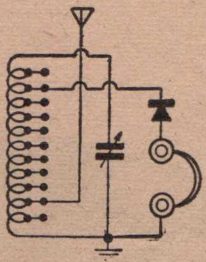
The first two circuits shown in this article can be constructed with the same kit of parts as the "4 in 1 Crystal Set" (described in Part 1 of this series), but No. 7 and No. 8 require an additional single gang condenser and coil, etc. (See parts list.)

NOTES ON THESE CIRCUITS

No. 5. Still another way of getting better selectivity than No. 1 will give. The condsener in series with the aerial should be about 0.0001 or less, and should be smaller the longer the aerial.

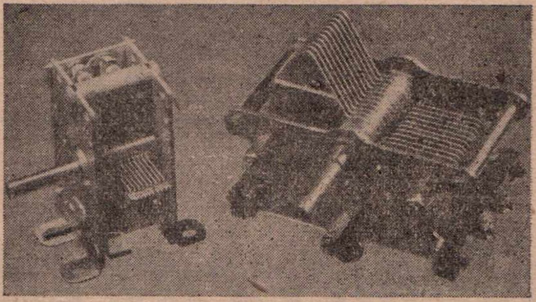


No. 5



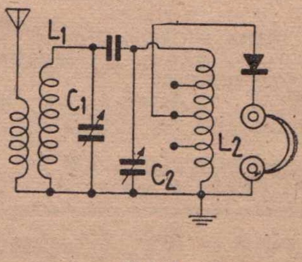
No. 6

No. 6. A very flexible arrangement, which is much more selective than any of the others on this page. No aerial coil is used, but the tuning coil is tapped every 5 turns. The more the crystal and aerial are tapped down towards the earthed end, the more selective the set will be, but the weaker the signal becomes. For best signal strength, combined with the best selectivity, this circuit is hard to beat, especially when a long, high aerial is used.



Two types of tuning condenser that can be used to build any of these crystal sets.

No. 7 is another selective circuit. L1 and L2 are identical, and so are C1 and C2. The same sizes are used as in all the other crystal sets. The unmarked condenser should be very small — no bigger than 50 mmfd. Both condensers are tuned to make the station as loud as possible.



No. 7

USING A WAVE-TRAP WITH A CRYSTAL SET

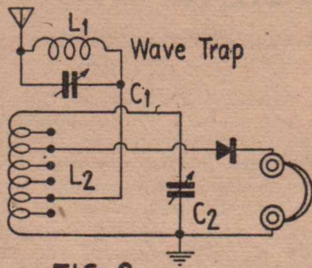


FIG. 8

No. 8. The wave-trap is a device for helping to weaken the signal from a strong station, which is interfering with a weak station. Circuit No. 8 shows a wave-trip, L1 C1, connected to the set of Circuit No. 6, but the trap can be placed in the aerial lead of any of the other sets on page 7. C1 should be identical with the tuning condenser, while L1 can be a coil exactly similar to the tuning coil. To work the trap, the interfering station is tuned in with the tuning condenser, until it is loudest. Then the wave-trap condenser is tuned until the station is as weak as possible. After this, the trap is left alone, and the set is tuned in the usual way as though the trap were not there at all.

COMPONENT LIST

FOR No. 7 SET:

1......4 in ONE Crystal Set Kit (refer March issue).

PLUS

1......Single Gang Condenser.
1......Coil Former, 3in. diam.
1......50 mmfd Fixed Mica Condenser (0.00005 mfd).
1......Dial or Pointer Knob.
Sundries: Wire for Coil (refer March issue).

FOR WAVE TRAP ONLY:

1......Coil Former.
1......Single Gang Condenser.
1......Knob.
Sundries: Wire for Coil (refer March issue).

FOR No. 8 SET:

1......4 in ONE Crystal Set Kit

PLUS

Components listed above for Wave Trap only.

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

PART IV

A SUMMARY OF PROGRESS TO DATE

In the last instalment of this series, we described in detail the circuits that have been prepared, to act as the initial deflection unit for the cathode ray tubes. We do not intend to imply that the circuits used are the only ones that could be devised, or even that they are the best. Some readers will no doubt be surprised to find that they are so complicated, and use so many valves, but as was pointed out earlier, there is some virtue in using valves freely in unfamiliar applications. It is that very frequently, so-called "simple" circuits, which use only a small number of parts and valves, are in practice much more difficult to deal with than others which scatter valves about quite liberally. The reason for this is not hard to find. The circuit with many valves can be arranged in such a way that each valve has a separate and specific job to do. As long as each job and its purpose is understood, it then becomes a relatively simple matter to find out whether each valve is doing its work properly, thus making it very much easier to track down faults that may occur, or to make the initial adjustments necessary to put the gear, once built into proper operating condition. In circuits where several functions are embodied in the same valve, which may have a disarmingly small number of components associated with it, it is often exceedingly difficult to make the arrangement work properly should it not do so at first switching on. The trouble usually is that such circuits are difficult to understand, not only for the tiro, but often for the expert as well, so that it is sometimes a very much hit or miss affair when it comes to making things work properly. Also, should a fault develop, it can be exceedingly difficult to track down unless the defect is a simple one to find with ordinary test instruments, such as a multimeter and a condenser-leakage tester. In addition, the circuit values in such composite arrangements are very often critical, in which case, they may not work, in spite of the complete absence of components that can be called really faulty.

As an example of how easy it is to make our own circuit work, supposing it does not do so at first, let us take a few imaginary faults, and see what their effects would be. This will have the added advantage of giving a few leads to those who may have built the circuit already, but not with the proper results.

SOME FAULTS AND THEIR EFFECTS

Suppose, for example, that the line time-base is running satisfactorily, but that there is no frame time-base. This will be obvious from a glance at the face of the cathode ray tube, to which the time-bases are attached. This illustrates one automatic advantage of TV equipment over ordinary receivers. It is that the TV set-up has its own built-in oscilloscope, with the result that many faults will become immediately noticeable from their effects on the pattern, and often, such faults will be partly, at least, localized simply by the appearance of the tube. Since the frame time-base is not working, the picture will revert to a single horizontal line. We can therefore completely ignore the line time-base and amplifier circuits for the time being, and concentrate on the frame circuit, which consists only of the multivibrator, the gas tube and the paraphase amplifier, the pulse amplifier being regarded as an extra. Now a simple test of the paraphase amplifier, by temporarily connecting a signal to the input grid, will tell whether this circuit is at fault. If no audio signal generator is available, one can use the 50 c/sec. heater voltage as a signal source by tapping a wire simultaneously on to the live heater terminal and the input grid of the amplifier. If the latter clearly is O.K., there are only the multivibrator and the gas tube to suspect. Next, obvious thing to do is to see if the multivibrator is oscillating. To do this, the C.R.T. can be used as a 'scope by taking off the Y-plate leads from the amplifier output, and temporarily touching either of them on to one of the MV grids (NOT to plate, unless you have left the blocking condensers in the lead to the deflecting plates).

If a large deflection, almost off the screen of the tube is obtained, the MV is clearing working, and the trouble must lie elsewhere. Now unless the EN31 is itself defective, about the only things that can stop the circuit from operating if the MV is running are (a) no triggering voltage reaching the EN31 grid, and (b) too much bias on the EN31, or insufficient amplitude (voltage output) of the triggering pulse. In the first case, the trouble can only be due to an open coupling condenser between the multivibrator plate and the EN31 grid. (Note: If the condenser were shorted, the MV would not be working). In the second, the cure will obviously be to reduce slightly the bias on the EN31. This can be done by decreasing the 10k. resistor in the cathode circuit of the EN31 slightly, or by increasing slightly the 75k. resistor connected to the H.T. line.

Now, since the mode of operation of the line time-base is similar to that of the frame time-base, similar faults in the two circuits will display similar symptoms, and there should be little difficulty in tracking down and curing any faults. It would be a good idea for anyone who is putting this gear together but who does not have a regular oscilloscopes to build as a separate piece of equipment, a simple self-running time-base of the sort used in oscilloscopes. Then, when this time-base, the cathode ray tube will become a test oscilloscope, simply by connecting the free-running time-base to one set of plates, and using the other set for examining the waveforms throughout the deflection unit. The separate time-base, together with the usual multimeter, will be able to perform most of the necessary tests for the time-base unit, since the final criterion of its operation is the correctness or otherwise of the wave-forms it produces.

Now let us imagine some particular component failures, and try to estimate their effect on the 'scope pattern.

(1) Complete open-circuit of the 1 uf. condenser from plate to earth on the frame EN31.

This will leave only stray capacity across the plate circuit of the EN31. The EN31 plate will thus be able to reach full H.T. voltage in the very short time taken for the stray capacities to charge up. When the triggering pulse comes along, the gas tube will still conduct, causing the strays to discharge, so that the result will be a very quick charge—not linear, though—at the end of each discharge stroke. However, for the bulk of the time, the voltage at the plate of the EN31 will be steady, so that visually the effect will be much the same as if the gas tube were not there at all.

(2) Short-circuit in the 1 uf. condenser.

No frame output, and probably overheating of the 500k. plate resistor, unless this is 1-watt size or larger.

(3) Open-circuit of one of the 1 meg. grid-leaks in the MV circuit.

This probably will not stop the MV from oscillating altogether, but will greatly reduce the frequency. This will show up as a very flickery raster, since the frame frequency will be well below the frequency at which flicker is imperceptible. It will also be extremely non-linear, which will be shown up by the raster being much brighter at the bottom than at the top. If the brightness is the other way about, it simply means that the frame time-base is running from bottom to top instead of from top to bottom.

(4) Only half the usual deflection on either of the axes.

This means that one of the amplifier sections in the corresponding circuit is completely inoperative. In each case, it must be the right-hand section, for with both amplifier circuits, there will be no output at all if the left-hand valve of the paraphase pair is inoperative.

(5) A black band running slowly (or quickly) over the raster from top to bottom or vice versa.

This is caused by 50 c/sec. hum from the mains or power supply getting to the control grid of the cathode ray tube. It could be due to a fault not connected with the time-base unit at all, for hum arising in the part of the circuit that feeds the C.R.T. grid will give these symptoms. If it runs from top to bottom, this means that the frame time-base is running slightly slower than 50 c/sec. If the other way, slightly faster. Should the band be stationary, it means the time-base is exactly on 50 c/sec. If the band runs slowly, the frequency difference is slight, and if fast, great. This is why it is not advisable to have the frame time-base locked hard to the 50 c/sec. mains, because then, part of the picture would be permanently blacked out should hum get to the C.R.T. grid. The hum may be due to a poor 6SN7 or 6AC7 in the black-out circuit.

There are many other manifestations that could be cited, but most of them are unlikely to occur at all, and the above list will give some idea of what to look for, should all not be well at the start.

AN UNFORTUNATE DISCOVERY

We said at the beginning of this Project, that some of the things we proposed to do were not at all certain to be successful, but that our primary intention was to try them, and see what happened. It was also stated that the whole progress of the experimental work would be set out in these articles, so that readers should have the benefit of all the experience gained—successful or otherwise. There is often a temptation—natural enough—to say little or nothing about one's failures, but in describing this Project, we are committed to so doing, and this is really a good thing, beacuse it is just as important to know what does **not work** as it is to know what does. It often happens in scientific work that negative results are as important as positive ones, so that we have good precedent for telling all and sundry when and why an idea has come to naught.

The unfortunate discovery referred to is just this, that it is not possible, as we had hoped, to use the common green-screened cathode ray tube as the picture signal generator. The same by no means applies to the same tubes for use as the picture tube, because in this case, the feature of the tube which makes it unsuitable as a picture generator makes it rather better as a tube on which to show the final picture. The trouble is the long persistence of the image on the green-screened tubes. That is to say, if the electron beam impinging on the fluorescent screen material is suddenly cut off, then the brightness of the trace does not disappear altogether. It decays more or less gradually, depending on the material of which the screen is made. Now in the case of Phosphor No. 1, which is the screen material that gives the well-known green trace, the image lasts for several milli-seconds. Just how this will affect the picture is not easy to visualize unless the effect has actually been observed, but once seen, there is little doubt about it, and it will certainly not be forgotten! In order to see how it works, it is necessary to have a picture in the mind's eye of the complete system, from the camera tube (for want of a better term) to the receiving or picture tube.

Let us suppose that we have the raster on the camera tube, and for simplicity's sake, suppose that the "picture" we want to televise consists of a black horizontal bar. Being horizontal, the bar is parallel with the lines of the raster. Thus, all the lines above the black bar will be full white, while all those covered by the bar will not be seen at all by the photo-cell. The video output signal will therefore take up a very simple form—that of a pulse occurring during every frame, and lasting for a length of time which depends directly on the thickness of the bar, and therefore on how many lines it obscures. Since the pulse occurs once for every frame scan, its frequency will be 50 c/sec., the same as the frame frequency, and ideally should have absolutely vertical sides, and a perfectly flat top. Also, on the received picture, we should have

Continued on Page 23

Some Wave-Forms and How to Make Them

Now that television has become rather more than something which requires a telescope to see, many radio men will be interesting themselves in TV circuitry, much of which makes use of valves in, to the uninitiated, very peculiar ways. Those familiar with radar circuits will know what we mean by this, but we think that some of the wave shapes that are produced by the said valves are becoming of basic importance in a number of fields other than TV and radar, and should therefore be more familiar to people who hitherto have confined their interests mainly to distortionless amplifiers.

INTRODUCTION

Electronics is a very wide field, as everyone is aware, and the things that valves are called upon to do are many and varied, and far removed from the stereotyped amplification of signals with as little distortion as possible. Unless our activities have brought us into direct contact with devices which use tubes, but which make no attempt to amplify in a distortion-free manner, it usually comes as a shock when we encounter for the first time circuits where small receiving valves are provided with no (or even positive) bias, and input signals of several hundred volts R.M.S.! Such things just do not seem right, and it is difficult at times to visualize what they do and how they work, unless one has been "primed," as it were, beforehand. The purpose of this article, then, is to describe some waveforms that seem to bear no relation to the familiar and ubiquitous sine-wave, and to outline some of the methods by which they are produced. Of course, one non-sinusoidal that occasions no raised eyebrows at all, and for which various recipes are familiar to most, is the saw-tooth, which has gained such prominence, owing entirely to the extensive present-day use of the oscilloscope as a test instrument.

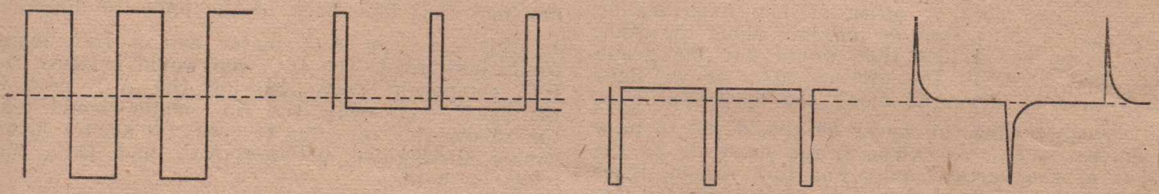
The waveforms to which this article refers are illustrated in Fig. 1. At (a) is a square-wave, at (b) and (c) are two kinds of narrow pulse, and at (d) is a series of alternate positive and negative narrow spikes, usually known as "pips." These by no means exhaust the non-sinusoidal waves that can be encountered, but are all of considerable importance, and are themselves the starting points from which more complex wave-forms are made. In this article in is intended to show some of the methods by which such wave-forms are made —methods which are in very common use, and which are of fundamental importance to many different types of equipment.

DEFINITIONS

Unfortunately, the classification of wave-forms into square-waves and pulses is not a very satisfactory one. There do not seem to be any fool-proof definitions of either, which sometimes causes confusion to the uninitiated, so that it might be as well to say a few words on this aspect before proceeding to the question of how they are made.

SQUARE-WAVES

While there is, as we have said, no hard and fast definition, it can be conceded that the one feature of a square-wave that seems common to every writer on the subject is the fact that it has square corners, in direct contrast to the sine-wave, which is a smooth curve. If we simply define square-waves as waves that possess only square corners, then clearly the three waves shown in Fig. 1 (a), (b), and (c) all come within the scope of the definition. For reasons that will appear, it seems safest to use something like this as a standard definition, with the additional proviso that pulses are simply special cases of square-waves. If we accept the definition of a square-wave suggested above, then the latter proviso is really self-evident. But in order to talk more easily about pulses, and to have a ready method of distinguishing between the two main kinds of pulses shown at (b) and (c), it is necessary to go a little further. First of all, one should have clear in one's mind the fact that a wave-form is a graph. It is simply a graph showing how a particular kind of alternating current or voltage behaves with respect to time. That is to say, if the voltage (or current) at a certain point in a circuit varies in a particular manner, and goes on repeating that same variation indefinitely, the voltage is said to be recurrent, or cyclic, and every complete variation is said to be one cycle of a wave. Thus, in order to describe in the shortest possible time the precise manner in which the



(a) Square Wave (b) Positive Going Pulse (c) Negative Going Pulse (d) Positive and Negative "Pips"

Fig. 1

recurrent variations in voltage occur, the best thing to do is to draw a graph in which time is represented by distance along a horizontal line, while the voltage or current whose behaviour we are describing is represented by distance above and below this horizontal axis, and thus by distance along the vertical axis. Should the voltage be a true alternating one (i.e., going first in one direction and then in the other) some of the graph will appear on one side of the horizontal axis and some of it on the other side. This is because the horizontal axis itself represents zero on the voltage or current scale, and because the area on one side will then represent, say positive voltages, while the part of the graph on the opposite side will represent negative voltages. In the case of currents, the area on one side will represent current flowing in one direction, while that on the other side of the horizontal axis will represent current flowing in the opposite direction. In mathematics, it has been decided that above the horizontal, or x axis, will be called **positive**, so that points below the x axis must represent **negative**. Also, to make a graph completely general, the part to the **right** of the vertical axis is called **positive** for the quantity measured along the x axis, while the part to the **left** of the vertical axis is called negative. Those who are not clear on these points are strongly recommended to consult an elementary algebra book, where the chapter on graphs should make the whole thing clear. For some purposes, we do not require the area on one side or other of one axis, simply because the thing that we measure along the other axis never has values that would put the graph into that area. In the present case, as we have said, time is measured along the horizontal axis, and because time can never be considered to have negative values, the whole graph must lie to the right of the vertical axis. For this reason, there is no need to show the position of the vertical axis except where the graph has actual time values, and therefore a time scale, drawn on it. But for the full meaning of the graph to be apparent, it is necessary to show the position of the horizontal axis. This has been done in Fig. 1 by means of the dotted line in all cases. This is an important point, and when in a moment we get back to more practical considerations, its practical significance will be immediately apparent.

Let us consider the usual sine-wave for a moment. If it is true sine-wave, the shape and size of the parts above the x axis are identical with the shape and size of the parts below it. In other words, the positive and negative voltage or current changes occur in exactly the same way, except for the fact that they **are** positive and negative respectively. Thus, for a sine-wave or for any wave in which the parts below the x axis are of the same shape as the parts above it, the wave must extend by equal amounts on either side of the axis, or **datum line** as it is often called.

Now let us see if this fact has any physical meaning. Suppose our sine-wave represents the current flowing at a certain point. During one half-cycle, the current flows in one direction, and by the time the half-cycle has finished, a certain amount of current has flowed. On the next half-cycle, exactly the same amount of current flows, **but in the opposite direction**, so that averaged over the whole cycle, and at the end of it, the electrons that move and cause the current are in the same position as at the start of the cycle.

In this sense, therefore, the average current at that point can be said to be zero. And if we are thinking about current in one particular direction, this is true. That is to say, if the current is observed by a meter or other instrument **which is sensitive to the direction of the current flow**, it will not read at all, and will tell us that NO CURRENT HAS FLOWED AT ALL. We know this is not true, because if we had used some means of detecting the current that is not affected by the direction of the flow, but only by its presence, it would tell us that current has in fact flowed. This it will be seen is the difference between A.C. and D.C. meters.

Now, to get back to our waves and their shapes, suppose our graph shows us a sine-wave, but with the x axis, or datum line nearer one side than the other; the question arises, "is this possible, and if so, what does it mean?" The answer is that it is possible, and that it means that as well as the alternating current, or sinusoidal shape, we have present some D.C. which keeps on flowing in the same direction, regardless of the presence of the A.C. In this case, the parts of the wave above the datum line will **not** be equal in area to those below it, and therefore the quantity of current (or number of electrons) flowing in one direction is not balanced by the quantity (or number) that flow back in the opposite direction.

In this case, an A.C. meter and a D.C. meter would both read. The D.C. one would measure the D.C. component only, ignoring the A.C. part in the usual way, while the A.C. meter would read the effective current due to both, for such a meter cannot distinguish between A.C. and D.C., and reads on both.

All this may seem a bit theoretical and academic, but it is not in reality, as those who read on will find out! What we are leading up to is the fact that every waveform has its axis or datum line, and it is important to know, in the case of all but the obvious ones, where the datum line is. The whole question is actually rather easier to see when referred to a square-wave like Fig. 1 (a) than when applied to a sine-wave. In Fig. 1 (a) the datum line has been drawn mid-way between the peak values in either direction. Remembering what has been said, and assuming that there is no D.C. component present, it is not difficult to see that this is correct. With the square-wave, we have a rather simple state of affairs, in that the flat portions obviously represent a steady current of the same value, for as long as they last, so that each half-cycle can be regarded as D.C. of a certain value, lasting for a certain time. The vertical portions of the wave mean simply that at the end of each period of D.C., there is an instantaneous change to another value of D.C., on the other side of the datum line.

Now, if the whole wave is a pure alternating current, the number of electrons flowing during each half-cycle must equal the number flowing back in the opposite direction during the next. And our term "current" actually means a rate of flow of electrons, so that if we multiply the current, or the rate of flow, by the time for which the flow takes place, we will obviously have a measure of the number of electrons, or the quantity of electricity that has passed during the time under consideration. It was pointed out earlier, moreover, that on our graph, distance vertically means the strength of the current, while distance from left to right represents time. Thus if we take the area of one half-cycle, it must represent the quantity of electrons that has flowed during that half-cycle. But for no direct current to be present, the quantity flowing during each positive half-cycle must equal the quantity flowing during each negative half-cycle, so that the areas of the half-cycles must be equal. This is the first important point. The second is that in the square-wave shown in Fig. 1 (a) the positive and negative half-cycles are of equal duration. Thus, for their areas to be equal, the heights above and below the datum line must be equal.

By using a square-cornered wave for an illustration, it has been possible to show by simple arithmetic that for any wave that is a pure alternating current, containing no D.C. component, the areas of the half-cycles on either side of the datum line must be equal, and also, whatever the wave shape, the datum line must be in such a position that this is true. Thus we come to the question of pulses.

WHAT ARE PULSES?

Pulses may be defined as square-cornered waves in which the portions above and below the datum line are **not** equal in amplitude.

Take, for example, Fig. 1 (b). Here, the current flows in one direction for a much longer time than it does in the other. For this reason, remembering that this is a pure alternating current, it follows that the datum line must be in some position like the one shown. The exact position is the one which makes the positive half-cycle's area equal to that of the negative half-cycle. In general, such waves are produced in the plate circuit of a valve, as we shall find out, and in this case, there will be the D.C. plate current of the valve added to the A.C. current which is the wave, but if we insert the usual coupling condenser, the D.C. component is blocked in the usual way, leaving only the A.C. wave, and it is because of this that we need to know where the datum line of the wave lies. Such waves are made not to look at, but to use, and as we shall see, it is important from this point of view to be able to estimate where the datum line is. For example, the wave in Fig. 1 (b) could well be used to trigger off a time-base, or to cause an oscillator to function only for the duration of the short positive portion. If we are to use the wave for this purpose, one of the things we must know is its effective voltage **in the positive direction,** because circuits which are triggered in this way usually have a critical voltage, so that if the triggering pulse is smaller than this voltage, triggering will not take place. We can quite easily display the pulse on the oscilloscope, and also use the 'scope to measure the voltage amplitude between the positive and negative limits of the wave. One hundred volts, for example. But in applying the wave to the circuit it has to trigger, the chances are that it has to be passed through a blocking condenser, so that at the grid of the triggered valve, for example, we have not only positive voltage excursions, but negative ones as well. For triggering purposes, the negative ones are useless, so that unless we know where the datum line is, a measurement of the peak-to-peak amplitude, such as we can make on a 'scope will not tell us the amplitude of the positive portion—the only bit in which we are really interested. But by measuring the relative durations of the positive and negative portions, as well as the peak-to-peak amplitude, we can work out by simple arithmetic how much of that amplitude is positive with respect to earth, and how much negative. For example, if the positive portion is one-fifth of the whole cycle, and the negative portion lasts, therefore, for four-fifths of it, then the amplitude of the positive pulse must be four-fifths of the peak-to-peak voltage, and the negative portion, one-fifth. Only if this is so can the areas on either side of the datum line be equal.

In Fig. 1 (c), we have a wave of exactly the same shape as in (b), except that the long-duration portion now goes positive, while the short bit is negative. It is really the same wave-form as (b), but in practice it is regarded as different because it can be used in a different way. A sine-wave, or a wave like Fig. 1 (a) not only looks the same whichever way up it is, but if passed through a circuit, of whatever kind, does the same things. A pulse, on the other hand, will obviously do very different things in a circuit, according to which way up it is. In our imaginary case of the triggered oscillator or time-base, we may have required a voltage of 75 in order to perform the triggering action. The wave of (b), if 100 volts peak-to-peak, would easily do this, but if we passed it through another valve for some reason before using it to do the triggering, it would not work at all, because what was the positive portion is now the negative portion. Pulses, therefore, have to be subdivided into two kinds, even if their shapes are identical, as in (b) and (c). Unfortunately, there is no standard naming for pulses, and this frequently causes confusion.

(To be continued.)

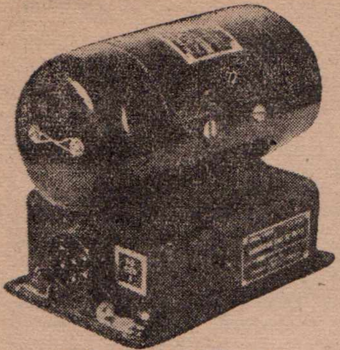
T.V. PROJECT

Continued from Page 20.

a bar of exactly the same width as the original, and with perfectly sharp edges. When the photo-cell and video amplifier were connected, and a bar was tried across the camera tube, it was found that a bar of a kind was reproduced on the picture tube, but that instead of having both edges clearly defined, there was a gradual falling-off in the intensity of the trace at the upper edge of the bar, and a sharp clear edge at the bottom of the bar. This can easily be accounted for in the following way.

At the upper edge of the bar, the light output to the photo-cell is cut off by the bar, but because of the persistence of the screen, the cell is still receiving light from scanning lines that have passed earlier. Because of this, the cell gives output in spite of the bar across the screen of the tube, until such time as the light from previous lines has decreased to zero. Of course, the light from the previous lines decreases in brilliance, and the output of the cell gradually decreases until, at some time after the

Continued on Page 30



GENEMOTORS

We have recently procured the following types of genemotors which are ideally suited for operating radio sets, amplifiers, etc., off 32 volt lighting plants.

Type No. K.S. 557201. Input 28 volts D.C. Output 250 volts D.C. at 60 amps. PRICE 35/-

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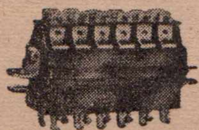
Genemotor for S.C.R. 522. Input 28 volts. Output 300 volts at 260 M.A. 150 volts at 10 M.A. 14.5 volts at 5 amps. PRICE £3/19/6

HEADPHONE SET

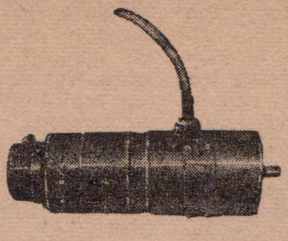
Dynamic Headphone Sets with lead, in excellent condition. These sets are easily worth £4 per set. OUR SPECIAL PRICE is only 15/-. Transformers to suit headphones, 4/6 each. Transformers to suit microphones, 4/6 each.



Jones Plugs and Sockets

As illustrated. Available in following sizes, all brand new and perfect.

6 pin 5/6
8 pin 5/6
12 pin 8/6



REVERSING ELECTRIC MOTORS

(As Illustrated)

These motors operate off a 24 volt supply, and are geared down to operate aeroplane cowl gills, etc., have automatic braking device, particularly suitable for beam aerials, etc. They are very powerful, but light in weight.

PRICE only £4/19/6.

PERISCOPES

(As Illustrated)

Consists of 2 mirrors, size $4\frac{1}{2}$ x $3\frac{3}{4}$, with collapsible metal frame. Will extend to 30 inches overall. Ideal for rear vision mirrors or periscopes for any purpose. In canvas case for 7/11 each.

DRY METAL RECTIFIERS

1 Amp dry metal suitable for making battery charger to charge up to 12 volt battery at 1 amp. worth £2

OUR PRICE 22/6.

2 Amp Selenium, suitable for battery charger to charge up to 18 volts at 2 amps. Worth £3/10/-.

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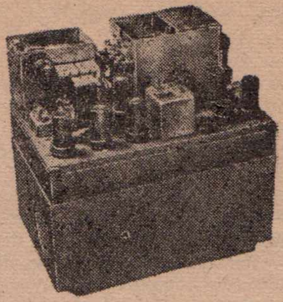

AMERICAN I.F.F. SET

Parts include six 6 S.H. 7 valves and sockets, three 6H6 valves and sockets, three 7193 valves and sockets, four relays and one carbon pot., one genemotor, 18 volts input with 450 volts at 60 M.A. output, one 2 mfd. 600 volt working condenser, 1 mfd. 100 volt working condenser, five H.D.W. wire wound resistors. One voltage regulator, ten paper condensers, assorted valves. Thirty-six mica condensers, one 7 plate slit stator condenser, sixty small carbon wire wound resistors, one 10 pin Jones plug and socket. Many other parts such as resistor strips, sockets, etc. Easily worth £60. OUR PRICE £6.

RECORD PLAYER

This record player uses a well-known brand of English electric motor, and a good English magnetic pick-up. The unit has a 2-pin socket for A.C. connection and shielded lead for pick-up.

It is extremely light in weight and is beautifully finished in black or brown leather cloth. Usual Price £15/10/-.

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NOTE

All parcels will be be sent registered post, unless otherwise stated. Freight or postage must be included with order.

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HAM ACTIVITIES

Conducted by
J. A. HAMPEL, VK5BJ

DX STATION ADDRESSES

VP3FD—124 Parade Street, Kingston, British Guiana.
VP3YG—22 Sussex Street, Charlestown, British Guiana.
VP9ZZ—Box 315, APO856, c/o P.M., New York, U.S.A.
3V8BB—23 Bis Rue de Marseille, Tunis, Tunisia.
MI3ZJ—P.O. Box 247, Asmara, Eritrea.
C1BC—P.O. Box 409, Shanghai, China.
TI2TY—Box 2268, San Jose, Costa Rica.
OA4ED—Box 1138, Lima, Peru.

NEWS AROUND THE WORLD

The news that the C.A.V., the Czechoslovakian amateur society, has recently resigned from the I.A.R.U., has not come as a surprise to those who have known of the exchange of correspondence between the C.A.V. and the International body. In a letter to the C.A.V., W1BUD, secretary of the I.A.R.U. expressed regret that they should have seen fit to resign. Crux of the situation is believed to be the I.A.R.U.'s refusal to condone the dissemination of political propaganda amongst member societies. Much attention has been focussed on the QSL cards arriving from certain European countries because of the details of conferences, peace meetings, etc., printed on the backs of them. It might be wise if Australian amateurs discontinued sending cards printed by Tourist Bureau, etc., to European countries as the C.A.V. for one considers this a means of propaganda when members of the other societies send cards with Government-sponsored information printed on them.

This news was gleaned from a recent "Voice of America" Radio Amateurs' programme on KCBR on 9.6 mcs. on Sundays at 1915 E.A.S.T.

In another quarter-hour recently it was interesting to hear W4BTD interviewed by Hank Miller. This enterprising American ham finds time to run a radio shop in between hamming periods! However, he leaves everything in the capable hands of PAOK who he recently nominated for migration from Holland. The two men met during a QSO in 1934 and about 18 months ago the PA said it would be the last of their many QSOs as he intended coming here to Australia or New Zealand. W4BTD immediately went to work on the U.S. migration authorities with the result he was able to nominate his Dutch fellow-ham for the U.S.A.

Perhaps it's just as well he has this additional help as W4BTD is always rushing off home to his "antenna farm" to keep a sked with some distant corner of the globe. The "farm" is no idle fancy or misnomer as there are sixteen rhombics disposed about the shack in a 150 acre field! From this set-up 237 countries have been worked, 221 of them confirmed, the latest to arrive being every DX man's coveted prize—a card from AC4YN.

The W's have just recently had the rest of 80 metres allocated in the region of 3800-4000 Kcs. With more frequencies available there, VK's should be able to do better with 80 metere DX now.

From Switzerland comes news of a new award, the "Helvetia 22 Award." To be eligible for this certificate a station must produce evidence of working a station in each of Switzerland's 22 cantons. Another one for the certificate-minded is the W.A.C.E. award of the Radio Club of Chile. It is awarded on the verification of working one station in each of the seven Chilean Zones on either phone or C.W. on, or after, 19th November, 1945. QL's should be forwarded to Radio Club of Chile, Box 761, P.O., Santiago.

Over in G-land, ex-VK5JA is licensed under the call G3GYO, but has been so busy in his line of business that any activity so far has been out of the question. John is more used to working with very V.H.F. equipment now, on 9000 mcs. or 3 cms! The radar gear operating on this frequency is capable of, say guiding a boat up the Thames River in total darkness or fog, and going to within 2 inches of any object in the river. John was fortunate to be asked to prepare three exhibits utilising radar principles for the much-publicised British Industries Fair.

To illustrate the rapid growth of our hobby and the sign of the times in England, John recently wrote that a G ham exhibited a home made television transmitter which, in true ham spirit, was entirely constructed of "junk" yet performed equally as well as commercial rigs of similar power and other capabilities.

FROM MY LOG

3ARL has recently installed "clamper tube" modulation and has it working to good effect. Lyn reports a five watt input with no speech rising to twenty-five on voice peaks; normal C.W. rating for the final is 35 watts,

Elgar Treherne, ex-3AFQ, is now resident in South Australia, and has been allotted 5ED, is heard keeping schedules with brother Ross, 5IQ, and his father, 2BM. But, Elgar, why did you pick Prospect? With four new tickets recently issued that makes twenty hams all within about a square mile!

2CJ has a cold spot from which to operate—Mt. Kosciusko. Gordon is using a pair of 1625's (12 volt version of the 807) in parallel and another pair in push-pull as the modulators. Most of the line-up in the shack consists of 12 volt tubes from disposal sources.

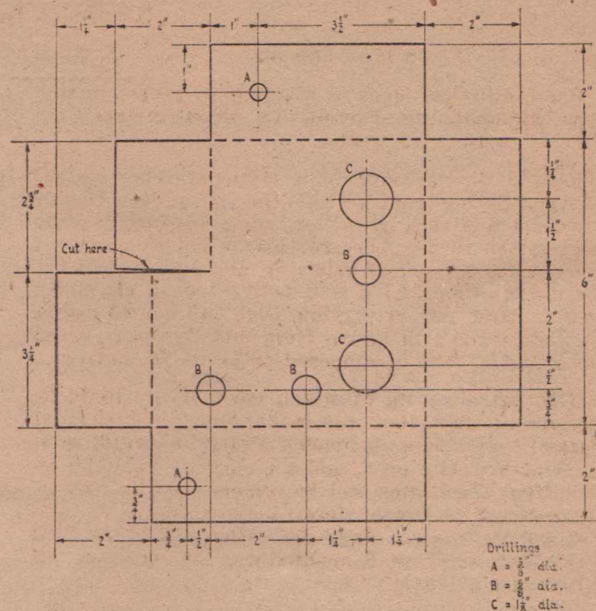
Everyone who has received a QSL card from 2AYE has remarked on the very nice job he has had printed. Very colourful, it depicts two Australian natives sitting by a glowing camp fire watching a series of smoke-signal "CQ's" rising upwards from the opposite side of the river. For a fine QSO and a very fine follow-up for the wall, don't pass by giving

Continued on Page 27

THE SHORT WAVE MINIATURE THREE

Continued from Page 8

reaction control is advanced in order to bring the set just to the point of oscillation (at which point the sensitivity is greatest) a loud howl is heard in the output, just **before** the proper R.F. oscillation of the detector commences. As a result of this howl, it is quite impossible to set the controls so that the detector is **just not** oscillating. It is either quite a long way from oscillation, in which case the sensitivity is too low for all but the strongest signals to be heard, or else it is actually oscillating, when 'phone stations cannot be listened to, even though their presence can be deected. Or, of course, it is producing this ear-splitting howl, too strong for anything else but an air-raid siren to be heard! This is what fringe howl does. Actually, it is an oscillation at some audio frequency, and its mechanism is rather too advanced for description in an article such as this. The main point is to know how to cure it should it occur. This is effected simply by shunting a resistor of high value across the detector's audio choke. The value needed to stop it will vary from set to set, so that builders may have to experiment with values to find just what is necessary. The idea is to use as high a value as possible, consistent with removing the howl. A very low value would certainly stop the howl, but it would also greatly reduce the sensitivity of the detector. In the original model the best value was 250k., but since no two transformers are the same, readers can expect to find quite large variations in the value required. Another point to remember is that fringe howl starts more easily when the batteries are nearing the end of their



Note that all folds should be made downwards.

life, and is harder to cure the greater the internal resistance of the B battery. Thus, when the value of R2 is chosen with new batteries in use, it may

Continued on Page 28

HAM ACTIVITIES

(Continued from page 25)

Dave a call if you hear him on.

Basil, 6B5, has ideas of starting up on six metres from Manmanning. Present Tx on 40 metres is a TA12D running 40 watts.

5AL is the call sign of a National relay station at Alice Springs and VK5AL the call of Ken Harris down in Adelaide. However, some confusion must have arisen in the Alice recently when Ken arrived there to do a spell of relieving at 5AL! Incidently, there are other 5AL's still active too; a character with a poor fist is signing that call on 40 metre c.w. and cards still arrive from mid-European areas for a "5AL" who is supposed to be on 20 metres.

3NZ has a set-up of which most of us would be envious—a fifty-foot tower carrying a 3-element parasitic on 20, a 3-element Franklin on 10, a 4-element Franklin on 6, and a 6-element Franklin on 2 metres. The beams will be remembered as part of the gear of the late Howard Love, VK3KU. The transmitter is a six stage job with a 813 in the final and 830b's as Class B modulators; the receivers, an AR88 and a HRO.

Ernie, 5EN, must have a lot of the necessary to be able to send out four different types of QSL cards for his contacts. Ern has a very efficient QSL manager in the form of an Amateur Radio-minded YL.

Very little news from the VHF boys so its no good pointing the bone at your scribe. Do know that the last attempt at an interstate 144 mc. QSO was of no avail due to conditions not favouring a break-through. The recent idea that the VK2's should institute their own schedules for sending and listening was not taken well in many quarters. Various stations were heard on forty expressing the lack of co-operation and their intentions of disregarding the schedules and beaming wherever they wanted to.

No doubt the N.S.W. stations would have done well if the other States had acceded to their wishes when conditions came good on 2 metres. As stated recently, close co-operation between the States in arranging V.H.F. schedules and contests is essential—the most poignant features seems to be the need of organised schedules on 40 metres between States as a warning channel when things are only "one way."

Latest bit of advice heard being offered by an OT to a newcomer " . . . and leave those 807's alone. they're susceptible to screen current." Can you tell me a pentode or tetrode that isn't, OM?

3ZP heard testing with his class A modulator—a 211 with 1200 volts on it. With all the tests and adjustments a couple of 807's with a mere 400 volts on them would clinch it.

The recent Corio disaster has brought interest to the Mount Gambier gang as one of their group, 5KU, has been salvaging the radio gear on the fast-breaking-up wreck. "Erg's" family bought the boat and naturally he was quick off the mark to get hold of the excellent marine equipment on board.

2AHM and 5RR were both able to see the lighter side of what really is a serious situation for both. Reg, 5RR, was bemoaning in a recent QSO the fact that Adelaide was experiencing an acute water shortage, that the ground round the reservoirs was parched and cracked. Back came 2AHM who is at Wentworth saying that his whole property of 25000 acres was 20 feet under water and that he would send Reg a few tins full by air-mail.

Well, gang, the covers close on the Log once again until next month. News from your area is welcome at Box 1589M, G.P.O., Adelaide, by 25th of each month. Co-operation is the keynote of success; can you lend a little from time to time? Thanks, OM's.

J.A.H.

* * *

CLASSIFIED ADVERTISEMENTS

Readers! Have you anything to Sell, Buy or Exchange? Then use this column. Classified advertisements cost 1/6 per line, based on approximately 7 words to the line. (Minimum, 3 lines.)

THE S/W MINIATURE THREE

Continued from Page 26

be found that when the B battery is nearly finished, the howl reappears. All that will have to be done, should this occur, is to put in a new R2, of low enough value to stop the howl, even with the flat batteries. Then, it will not be necessary to change the value of R2 again.

CONSTRUCTION.

Many radio enthusiasts in the past have not paid sufficient attention to the mechanical construction of their gear, and no doubt there are many who will do the same thing in the future also. Because we are primarily interested in circuits, we have a perhaps natural tendency to say, "Is this a good circuit?" rather than, "Is it a good set?" The two things have quite different meanings. Because any set is only as good as its construction, whatever the theoretical advantages of the circuit may be. The circuit is less than half the story, because it tells us only the electrical part of the design, and does not indicate in the slightest degree how the set can be built, or what is a suitable way of building it. How many people have admired a certain set, and its performance, gone away impressed with the "circuit," and had no success in building one for themselves because they used a different mechanical lay-out, or a different method of wiring it up? What these people should have admired is the set, of which the circuit is only a shorthand way of saying **what** electrical connections should be made, not **how** they should be made. Of course, there is actually a great deal of latitude with some electronic devices. They can be laid out and wired up in a multitude of different ways, each of which will produce as successful results as the other. But other things, of which radio receivers are a good example, must be built in accordance with certain mechanical principles if they are to work properly. This does not mean that there is only one lay-out that will give a successful set from a given circuit—far from it. But we would like to impress on builders, and especially on newcomers to set building, that it is much more likely to be a successful receiver if it is built according to the recommended lay-out, because this one is one that has been tried out in practice, and found to work well. Even with a particular lay-out, there is some degree of latitude in the way in which the actual wiring can be performed, but it is our practice in this magazine to mention, as far as possible, all points about the wiring that need to be carefully followed. The photographs cannot give the exact position of all the small parts under the chassis, because some are unavoidably obscured, but we ourselves think, and there will be many that agree with us, that to give every detail, down to the exact position of the last ½-watt resistor, does not help anyone to become proficient at set-building. To get the greatest enjoyment out of building electronic equipment, one must learn enough to design one's own gear, both the circuit and the physical construction, and it is only by leaving a little to the initiative of the constructor that he is able to profit by experience. We hope, therefore, that our readers will agree that it is a good thing that we do not print detailed wiring diagrams showing the position of every component on the chassis. The complete tyro will in any case do better to get an experienced radio man to show him the small points about actual construction that he is unsure about, thereby learning a practical craft in the most practical way.

We have embarked on this rather long dissertation on construction in order to impress new readers with the fact that the way in which a set is built is every bit as important as the circuit it is built from. Ask anyone who now makes a neat, workmanlike job of his wiring whether or not it really pays! And then witness the disappointment of one who has made a very rough, untidy job of wiring, and finishes up with a set that does not work—and probably will not unless it is rewired!

The general appearance of the set can be seen from this month's large photograph, which gives a partial view of the front panel and the top of the chassis. Unfortunately, this photo suffers rather from reflections occurring in the polished aluminium of the shield partition that separates the R.F. stage from the detector and audio tubes. However, if this photograph is taken in conjunction with the diagram of the chassis it will be quite easy to follow the lay-out. The two large (1⅛in. diameter) holes on the chassis are for the valve sockets which hold the plug-in coils. The one near the front edge of the chassis is for the R.F. coil, and immediately behind it is the R.F. amplifier valve, V1. Then comes the shield partition, and directly behind the R.F. valve, but on the other side of the shield, is the detector coil. The valve next to this coil is, of course, the detector, while the remaining ⅝in. hole is for the audio valve's socket. On the chassis front is a ⅜in. hole which takes the reaction control potentiometer, R4. This hole is so placed that it comes in the centre of the front panel, but, owing to the cut-out which allows the A battery to be set in flush with the outside of the B battery, when the latter is placed against the side of the chassis, the hole is **not** in the centre of the front of the chassis. The main dial is centred on the hole for the potentiometer shaft, but is directly above it, so that if on the chassis drawing a line is drawn parallel to the sides, and passing through the potentiometer's mounting hole, this line will show the position occupied on the top of the chassis by the shaft of the tuning condenser. The latter is a midget two-gang type, and in the photograph looks as if it is all on the panel side of the shield partition. But what appears to be the second half of the gang is really a reflection of the front half. Actually, the shield partition is cut out so as to fit round the centre plate of the gang condenser, and the back section is hidden behind the shield in consequence of this. If the under-chassis photo is consulted, it will be noted that mounted right across the socket of the R.F. valve is a small partition. Its purpose is to shield the portion of the aerial and grid circuit that is under the chassis from the similar portion of the detector grid circuit (and R.F. plate circuit therefore).

In this view can be seen the four-pin Amphenol-type valve socket used for the aerial coil, the five-pin socket for the detector coil, and the miniature

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SHORT WAVE REVIEW

Conducted by L. J. Keast 7 Fitzgerald Rd., Ermington, N.S.W. Phone: WL 1101

[I am printing herewith in full a cutting from "London Calling" dated January 4th, 1951, which I think will be of great interest to all shortwave listeners; so much so, that I am devoting the whole of my space to the article.]

SHORT WAVES IN 1951

T. W. Bennington gives his annual review of reception conditions on the short waves used by the B.B.C. in its overseas services, and forecasts that decreasing sunspot activity in 1951 will mean, in general, more and more use of the longer of the short-wave bands.

At the end of each year it is useful to review the changes which have occurred in the conditions for transmission of the short radio waves, and to see how they may vary in the immediate future. "London Calling" has briefly done this for several years past, and this article deals with 1950 in retrospect, and with 1951 in prospect.

Short waves travel to their destination by way of the reflecting layers of air in the upper atmosphere—the ionosphere, as it is called. The ionosphere is produced by the sun, and its condition—and hence the conditions for transmission of the short waves—varies with the sun's activity.

This activity varies constantly, and is indicated by the sunspots, which wax and wane over a period lasting, on the average, about eleven years. Thus the sunspot activity increases towards a maximum and then decreases towards a minimum again, which variation is the well-known sunspot cycle.

When sunspot activity is at a maximum the condition of the ionosphere is such that the shortest of the short waves are best transmitted; when the minimum approaches, the shorter short waves fail, and more and more use of the longer short waves must be made.

The sunspot activity reached its last maximum in 1947, and since then it has been decreasing, though it has done so in a far from regular manner. Up to the end of 1949, in fact, the downward trend was only faintly apparent, but during 1950, and particularly during the latter half of the year, the general decrease in sunspot activity became much more rapid.

The Critical Frequency

The state of the ionosphere is ascertained by measuring its critical frequency. This is directly related to the wavelengths of use for short-wave broadcasting, in that when it is high the shortest waves must be used, and **vice versa.**

The records show that the critical frequencies have followed the sunspot number faithfully, and that, at the end of 1950, in response to the fall in sunspot activity, they too were falling rapidly. As a result, the general run of useful wavelengths for broadcasting was, during the autumn and winter of 1950, much longer than had earlier been expected, and, particularly at night, only the longest short wavelengths gave good results.

How, then, is the situation likely to change during 1951? Well, no one has yet succeeded in accurately forecasting the sunspot-cycle changes for very long ahead, so we should, perhaps, be a little diffident in making precise statements about things which are entirely dependent on them—like the useful wavelengths for short-wave broadcasting.

But of one thing we can be fairly sure: the sunspot activity will go on decreasing—or, at least, will not show any very large subsidiary increase—until it has reached a value something like that which prevailed in 1944, the year of the last minimum.

Use of Longer Waves

Whether it will continue to decrease at its present rate is very difficult to say, but the chances are that it will not: that is to say, the activity should soon begin to decrease more slowly. So the ionospheric critical frequencies, following the sunspot number, may, during 1951, continue to decrease, but, after a time, begin to do so at a decreased rate.

During 1951, therefore, the wavelengths of most use for short-wave broadcasting are likely to become even longer than they are at present, and account will have to be taken of this. Of course, there will be the usual seasonal changes in the transmitting schedule, but, over and above these, there will be a general tendency—forced upon us by the changing conditions—to make more use of longer wavelengths.

During the summer it is probable that 11 metres will fail in southerly directions, and that 13 metres will be of less utility than at present. For daytime broadcasting, more use will therefore have to be made of the 16-metre and 20-metre bands. But it is at night-time that things are likely to become serious. During the summer, all should be well, the 25-metre and 31-metre bands being usable over many circuits. But next winter only 42 and 49 metres are likely to be usable for nearly all services.

And, unfortunately, as increased use of these bands will be made by nearly all the world's broadcasting services, the congestion in them is likely to be severe. A considerable amount of interference is, therefore, to be expected.

Suming up, we may say that during 1951 sunspot activity will most likely go on decreasing, and, as a result, the shorter wavelengths now in use, both by day and night, will become of less utility. During the summer, the situation is not likely to become severe, but, during the winter, and particularly at night, the crowding of stations into the only usable bands of 42 and 49 metres is likely to cause some increase in mutual interference.

—"London Calling."

B.B.C.

FOREIGN LANGUAGE BROADCASTS

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TELEVISION PROJECT (FROM PAGE 23)

first line to be obscured by the bar, there is no output at all. The cell's output then remains at zero until the last scanning line to be covered by the bar occurs. Then, when the first scanning line below the bar appears, there is an instantaneous full light output, since there is no delay in the production of light by the screen, only in its disappearance.

If the wave-form of the video output is examined, it will confirm the above description by showing that a sort of square wave is indeed produced, but one with a very sloping leading edge, and a quick, vertical trailing edge.

WHAT CAN BE DONE ABOUT THIS?

The next question to exercise us, having discovered that the tubes with the P1 phosphor are useless for camera purposes, is that of finding a suitable tube that will work in the way we required. Fortunately there is a surplus tube, that has been available in New Zealand, and is still available in England, and possibly in Australia, too, that should perform in the required manner, since it has one of the very short-persistence light blue screens that used to be quite common. This is the VCR112. It is a five-inch tube, of rather unusual appearance in that some of its deflecting plates are not brought out to base pins, but to caps on one side of the glass neck. The idea of this was to make a tube that could be used for very high-speed (and therefore high-frequency) phenomena. The caps on the side, for connection to the L-plates give the latter very short leads, and make the tube specially suitable for examining radio frequency waveforms. However, this is by the way, for we are concerned mainly with the characteristics of the screen. As yet we have not actually tried the VCR112 ourselves, but have heard from someone who is doing somewhat the same tricks independently, that it is quite successful. Those who are desirous of continuing along the same lines as we are, would therefore be well advised to try to acquire one of these tubes.

As for the remainder of the project, we have already procured our own multiplier photo-cells, and have built up a small two-stage pre-amplifier for a 931A, and it is with this that confirmation was made of the unsuitability of the green-screen P1 tubes. However, even with a short-persistence tube, it seems likely that a rather special video amplifier will be needed, with a response rising sharply at the high-frequency end of the video spectrum, so as yet we will not describe this pre-amplifier unit, since it is likely to be considerably altered before being fit for actual picture-making.

Next month, therefore, it is proposed to describe a simpler deflection unit that will be more suitable for the VCR112 than the one already described. The latter was really designed with the VCR97 in view, and not the VCR112. The latter is not nearly so sensitive as the VCR97, and so requires much greater deflecting voltages to get the same amount of deflection. The new time-base unit will therefore have to include more amplification at least for the line time-base. Since this will necessitate more valves, it will probably be desirable to simplify the saw-tooth generator, if possible, so as not to bring the whole set-up up to an inordinate number of valves.

(To be continued)

(Continued from Page 29)

B.B.C. SERVICES TO EUROPE IN FOREIGN LAUGUAGES SHOWN IN WAVE LENGTHS (METRES)

Albanian.
2.30— 2.45 a.m. — 31.50; 31.06; 25.30.
5.15— 5.30 a.m. — 31.12; 25.30.

Bulgarian.
2.45— 3.00 p.m. — 41.32; 31.50.
9.45—10.00 p.m. (Mon., Wed.) 41.49; 31.50.
3.00— 3.15 a.m. — 41.49; 31.50.
4.00— 4.30 a.m. — 41.49; 31.50.
6.30— 6.45 a.m. — 30.96; 25.30.

Czech and Slovak.
3.15— 3.30 p.m. — 49.59; 41.21.
4.00— 4.15 p.m. — 49.59; 41.21.
11.00—11.15 p.m. — 25.30; 19.61.
3.00— 3.15 a.m. — 30.96; 25.30; 19.61.
6.30— 7.30 a.m. — 41.49; 31.50.

Greek.
3.00— 3.15 p.m. — 41.31; 31.50; 25.30.
10.15—10.30 p.m. — 30.96; 25.30; 19.61.
4.30— 5.00 a.m. — 41.49; 31.50; 19.61.

Hungarian.
4.15— 4.30 p.m. — 49.59; 41.21.
2.15— 2.30 a.m. — 41.49; 31.50.
5.30— 6.00 a.m. — 41.49; 31.50; 25.42.
8.00— 8.15 a.m. — 41.49; 31.50; 25.42.

Italian.
4.30— 4.45 p.m. — 41.32; 31.50; 25.30.
10.45—11.00 p.m. — 30.96; 25.30; 19.61.
2.30— 3.00 a.m. — 30.96; 25.30.
4.30— 5.00 a.m. — 30.96; 25.42; 25.30.
7.00— 7.45 a.m. — 41.49; 30.96; 25.30.

Luxembourg Patois.
6.30— 6.45 p.m. (Sundays) 41.61; 31.88.

Norwegian.
9.00— 9.15 p.m. — 49.67; 31.01; 25.68.
5.30— 4.00 a.m. — 49.67; 31.01; 25.68.

Polish.
3.30— 3.45 p.m. — 49.59; 41.21.
11.30—11.45 p.m. — 40.98; 31.17; 25.15.
2.15— 2.45 a.m. — 40.98; 31.17; 25.15.
4.30— 5.00 a.m. — 49.59; 40.98; 31.17.
7.30— 8.00 a.m. — 49.49.

Portuguese.
11.30—11.45 p.m. — 31.01; 25.68.
5.45— 6.15 a.m. — 31.01; 25.68.

Rumanian.
2.15— 2.30 p.m. — 41.32; 31.50.
2.00— 2.15 a.m. (Tues. and Thurs.) 41.49; 31.50.
5.00— 5.30 a.m. — 41.49; 31.50; 25.42; 19.61.
7.45— 8.00 a.m. — 41.49; 31.50; 25.41; 19.61.

Russian.
1.15— 1.45 p.m. — 49; 41; 31; 25; 19; 13 Met. bands.
12.15—12.45 a.m. — 49; 41; 31; 25; 19; 16: 13 Met. bands.
7.15— 7.45 a.m. — 49; 41; 31; 25; 19; 16: 13 Met. bands.

Spanish.
10.30—10.45 p.m. — 31.01; 25.68.
6.15— 7.00 a.m. — 49.67; 31.01; 25.68.
8.00— 8.30 a.m. — 41.67; 31.01.

Swedish.
4.30— 5.00 a.m. — 49.67; 31.01; 25.68.

Turkish.
3.30— 3.45 p.m.
3.30— 4.00 a.m.
8.15— 8.30 a.m.

AUSTRALIA.

"Radio Australia" announces that "Listeners' Choice" programmes will be extended and will be broadcast from April at the following times:—

Mondays:
12.40—12.58 a.m. to Britain, Europe, U.S.A. and Asia.

Wednesdays:
12.02—12.15 a.m. to Britain, Asia, Europe and U.S.A.
1.02— 1.15 a.m. to U.S.A. and Asia.

Thursdays and Saturdays:
12.02—12.15 a.m. to Britain, Asia, Europe and U.S.A.

Requests are welcomed and played after notification has been sent to listeners by letter.

DUTCH NEW GUINEA.

YDZ. BIAK. 4.895mc. 61.3 met: According to Radio Sweden" this transmitter has now been moved to Hollandia. Broadcasts daily 7.45—10.00 p.m. on 15.40mc. 19.48 met. Reports can be sent to DE RADIO-OMRUEP NIEUW GUINEA TE HOLLANDIA, HOLLANDIA, DUTCH NEW GUINEA.

V.T.V. METHODS

MEASURING INSULATION RESISTANCE

Continued from Page 15

SENSITIVITY

The equations indicate that the sensitivity depends on the value of the battery voltage and the resistor R1 as well as on the sensitivity of the voltmeter. The apparatus can be made more sensitive by increasing the value of R1. Since it is necessary to measure insulation resistances as high as say 10,000 megohms it is important to know how far we can go in increasing R1.

All tubes have some gas left in them; if a high resistance is used in the grid circuit, the gas current flowing through this resistor will cause a voltage drop across it which may cause an error with a calibrated meter. However, the presence of the gas current means that the tube acts as a resistance connected across R1 and thus may considerably change the resistance of the circuit. In that case the wrong value for R1 is used in the computation and this causes another error. Poor insulation of the grid terminal will have the same effect.

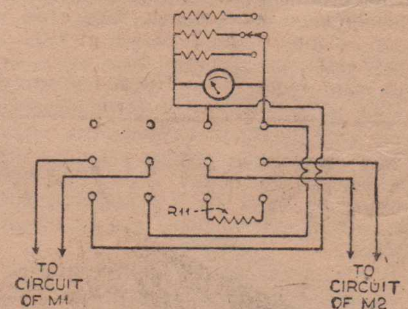

Fig. 8

The remedies are to employ a tube which has its grid coming out on top, such as the 32, 36, 24, etc. These can be used as triodes by connecting plate and screen together. A grid-leak of 1 megohm can usually be employed with these tubes. It may be possible to go to 5 megohms, but then the following test is recommended. Employing the slide-back voltmeter, connect a known high resistance of 20 or more megohms (but accurately known) in series with R1 as in Fig. 5 and measure a known voltage. This should then check up with the reading on M2.

The voltage E should be some convenient high voltage near the rating of the condenser under test, 400 or 500 volts is recommended; even 200-volt condensers can be tested at this voltage. Unfortunately, it is not practical to employ a power pack here; batteries must be used. The customary power supply is subject to continuous small fluctuations in the voltage. These small fluctuations charge and discharge the condenser which results in amplified variations in the voltage across R1. These are amplified still more by the tube and result in violent variations in the meter reading. This is especially

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THE S/W MINIATURE THREE

Continued from Page 28

ceramic R.F. amplifier valve's socket, with the shield across it. Also visible is the reaction potentiometer, the transformer used for L5, the detector's ceramic socket, the phone jack, and a number of the small parts. The large condenser under the phone jack, and tucked into the corner of the chassis, is the electrolytic C9. Also to be seen are the leads out to the batteries, and the cut-out on the right-hand side of the chassis in which the A battery is fitted. The socket for the audio tube can be glimpsed at the left-hand side of the phone jack, with C7 running between the plate pin of V2 to the grid pin of V3. Between the five-pin coil socket and the underneath shield partition can be seen the four-pin 2.5 mH. R.F. choke in the plate circuit of the R.F. tube. One end is connected directly to the plate pin of the tube's socket, while the other end is securely anchored to an insulated solder lug mounted on the chassis near the valve socket.

PERFORMING THE WIRING.

In a set of this nature the best results are obtained if the wiring is done by the shortest and most direct routes, except in cases where the length of a lead is of no consequence. In building any gear that uses valves, it is essential to know which leads must be kept as short as possible, and which can be made of any desired length. This knowledge alone can make all the difference between the gear working well or not at all, and is very worth-while knowledge to acquire. Partly it comes from experience, and partly from common sense, and as one's radio knowledge grows, so does one's innate "wiring sense," for want of a better term. For the newcomers (and be it whispered for some of the not-so-newcomers) here are the main rules to be watched:—

(1) Leads carrying R.F. currents or voltages should be as short as possible.

(2) R.F. leads in the grid and plate circuit of the same valve should be as far as possible from each other as is consistent with (1) and should preferably be on opposite sides of a shield partition.

(3) Coils in the grid and plate circuits of the same valve should be shielded from each other, either by enclosing them in shield cans, or by the use of partitions or compartments built into the chassis.

(4) Bypass condensers should be connected as close as possible to the points which they are supposed to bypass, e.g., C6 in the present circuit, whose job it is to make the R.F. voltage at the plate of V2 as small as possible without affecting the audio output voltage of the valve.

(5) If possible, it is desirable, but not always essential, to make one point on the chassis (e.g., a single solder lug) an earth-point to which are taken all earths belonging to a single stage. This becomes progressively more important, the higher the operating frequency, and at very high frequencies should be made a major matter of policy.

The above points cover the main requirements for wiring any set, and are sound constructional principles, to be adhered to as far as possible. Sometimes they are mutually opposed, because it is clearly impossible to satisfy both (1) and (2) simultaneously, in that a miniature socket is a small affair, in which the grid and plate pins are actually close together, so that for at least some distance the grid and plate leads cannot be far apart. But here (3) comes to the rescue, for if opposite sides of the socket are shielded from each other then it clearly does not matter if the leads referred to are close together. The whole question is one which must be regarded with ordinary common sense, both when the lay-out of the chassis is being decided, and also in actually performing the wiring. If the chassis is badly laid out, it may be impossible to obey the rules of wiring set out above, and the art of laying out a chassis is simply that of arranging things so that the wiring can bedone in accordance with the rules, while retaining, say, good accessibility and appearance, to mention only two things.

In the next and final instalment of this article the construction of the coils will be described in detail, and for the beginner, hints will be given on the operation of regenerative sets, that will apply not only to this one, but to any of the type.

(To be continued.)

V.T.V. MEASURING INSULATION RESISTANCE

(Continued from Page 21.)

so for large condensers. It is then quite impossible to obtain a balance or a reading. None of the usual schemes for automatically regulating the supply have been found accurate enough to permit their use with this measuring instrument at its sensitive settings. Consequently batteries are the only solution.

RANGES

There is considerable variation in the insulation resistance of condensers. The large ones have considerably more leakage and it will be found that a single value of R1 will not be found satisfactory for all purposes. It is recommended to use two or three different values of R1 so as to obtain different ranges. In addition the resistor R10 may have to be changed.

INTERPRETATION OF READINGS

The insulation resistance of paper and mica condensers is inversely proportional to their capacity A .1 uf. condenser will have ten times the insulation resistance of a 1 uf. condenser of the same type. Consequently in order to compare the merits of condensers of different sizes, the insulation resistance is multiplied with the capacity. The insulation resistance is then expressed in megohm-microfarads; this quantity being the same for condensers of different sizes. A good condenser would have an insulation resistance of say 450 megohm-microfarads. This means that its resistance would be 450 megohms for a capacity of 1 uf., or 4500 megohms for a capacity of .1 uf.

Finally, the fact that a condenser has an insulation resistance which is low, is no definite indication that it cannot be used. It all depends in what circuit it is to be placed.

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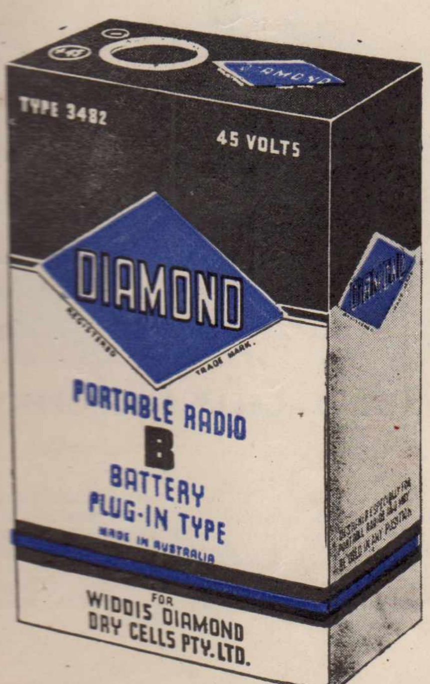

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BATTERIES

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