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CONTENTS

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EDITORIAL

Electronics is a powerful, but comparatively new, tool, which is finding ever-increasing applications in industry, and it is to be hoped that it will continue to do so. There is, however, one particularly important feature of electronic equipment that may retard, rather than increase its usefulness, unless the designers of electronic devices give it more than passing thought. We refer to the question of reliability. Competent engineers realize that in a sense, electronics has grown up too quickly, and in some degree has even over-reached itself a little. The very fact that many things are more easily done electronically than by other means, together with the ability of electronics to do many more things that cannot be done at all otherwise, has tended to make some workers think that electronics is a panacea or a kind of philosophers' stone. For just as many jobs can be done only by electronics, so too, many more hold no possible application for it. But it is not in either of these categories that the danger lies. It is in a third class of problems, which can be solved either by electronics, or by purely electrical or mechanical means, that electronic designers and engineers must exercise caution. These problems must be examined very carefully, as to cost, reliability, and ease of maintenance, before a decision is made for or against the electronic method. In many cases, first cost can actually be lower when the electronic solution is chosen, but cost may be quite unimportant compared with reliability. There are very few engineering projects where reliability is not of paramount importance, and it is here that responsible engineers have to think twice about the use of valve-operated equipment.

It is an unfortunate thing, but a true one, that many of the fundamental processes upon which electron tubes rely for their manufacture or operation are still not properly understood. For instanc, the exact mechanism by which electrons are made available by a cathode is still a matter for arguement among physicists. Now this may not at first sight appear to have much to do with the reliability of vacuum tubes, but it has. For the most part our valves rely for their supply of electrons on composite cathode materials which are difficult to make, are very easily "poisoned" by minute amounts of impurities, and which even depend for their success on minute traces of other "impurities" whose role is not properly understood. Present-day valves are thus rendered more difficult to apply, because the cathode materials in use are sensitive, among other things, to the exact temperature at which they are run. In equipment which must be as reliable as possible, therefore, it becomes necessary to use controlling devices which regulate the voltage fed to the valve heaters, in order to maintain them at the right temperature. There is always the temptation to do without voltage control, cheapening the product and possibly reducing its reliability below the level that is really required. Who knows but that a fuller fundamental understanding of electron emission may not lead to the development of cathodes whose heating is so uncritical as to make voltage control unnecessary, even for the best equipment?

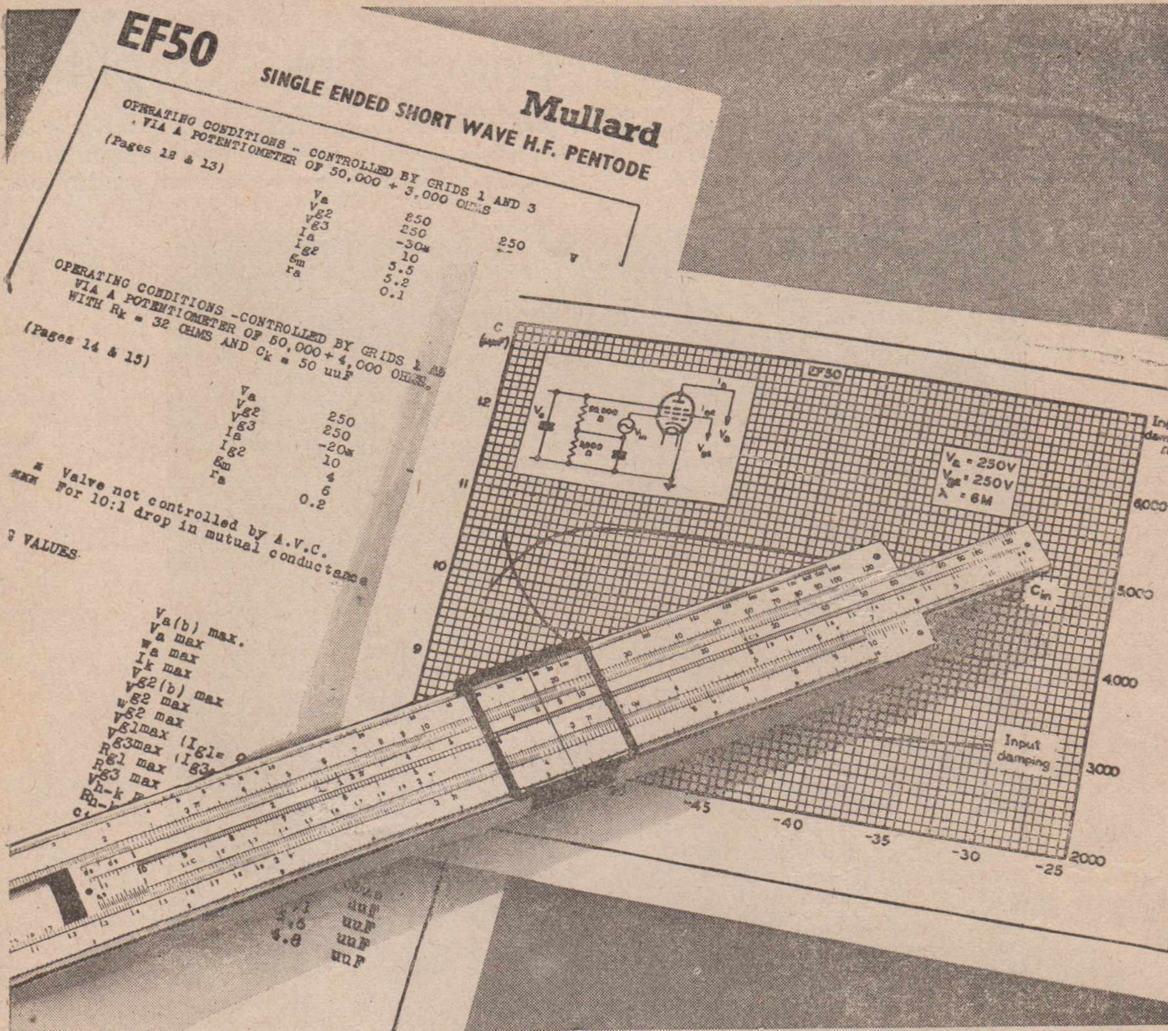
This is merely one example of how increased knowledge could make electronic gear more dependable. But we have to work with the valves that exist, not with the improved ones the makers of such things hope to develop. What, then, can we do to see that dependability is improved?

An analysis of failure in the field has shown that there are three major causes of unserviceability in valve-operated equipment. They are (1) the use of valves when some other device would have been more suitable; (2) the failure to select the best valve for the particular application; and (3) actual errors in design of the equipment, andthe inadequate provision of protective devices which could prevent a breakdown of the complete equipment.

It can be seen, therefore, that the design engineer can do a great deal to improve reliability. In the first place, he must ask himself whether a valve is needed, and if so, why? If the answer to this question is in the affirmative, he must investigate the possibilities should the valve fail. In many cases, failure can cause no more than inconvenience, as when the radio set goes out of action in the middle of an exciting serial, but in others, a valve failure may mean loss of property or even life. Where failures of this sort could occur, it is the designer's responsibility to make any failures "safe." In some equipment this means complete duplication with provision for automatically bringing in the standby gear when a failure occurs, while in others, a simple alarm indicator will suffice.

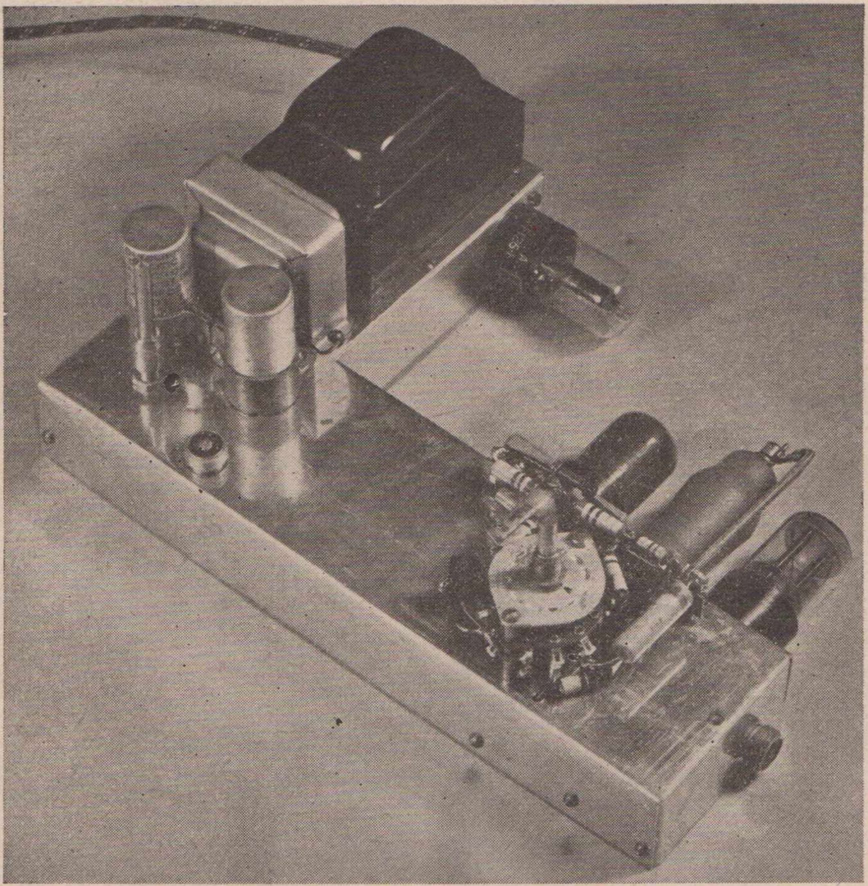
It has been said that the greatest single threat to reliability is the continual pressure on the makers of tubes, by the users, to increase tubes' ratings. The opposite question—that of increasing the life expectancy of valves by working them under their ratings—is hardly ever raised, but by so doing, designers could undoubtedly save a multitude of tube failures which occur at less than the normal life expectancy of the valve concerned.

These, and many other factors all contribute to the unreliability of things electronic, but no discussion of the problem would be complete that does not mention the question of maintenance. Here, education is necessary, not only for the designer, in the way he should go, but for the user, who should know how frequently routine inspections should be carried out, especially in the case of equipment on whose operation life and property depend. Lastly, there is education for those whose direct responsibility the maintenance will be. The equipment itself, or its designer, cannot be blamed for failure which is due to improper maintenance but it is none the less in the interests of the producer of electronic goods to see that the users of his products have a proper appreciation of the maintenance that is required.


EF50
SINGLE ENDED SHORT WAVE H.F. PENTODE
Mullard
OPERATING CONDITIONS - CONTROLLED BY GRIDS 1 AND 3
VIA A POTENTIOMETER OF 50,000 + 3,000 OHMS
(Pages 12 & 13)
OPERATING CONDITIONS -CONTROLLED BY GRIDS 1 AND 3
VIA A POTENTIOMETER OF 50,000 + 4,000 OHMS
WITH Rk = 32 OHMS AND Ck = 50 uuF
(Pages 14 & 15)
* Valve not controlled by A.V.C.
** For 10:1 drop in mutual conductance
EF50
Input damping

The "R. and E." Gramophone Pre - amplifier

Although relatively complicated, the pre-amplifier described in this article fulfils practically all the possible requirements of such a device; and, in addition, has been built in a very unconventional manner so as to be suitable for mounting under the motor-board in any electric gramophone.



INTRODUCTION

Although there has lately been rather a spate of circuits designed for pre-amplification and tone-compensation with modern lightweight gramophone pick-ups, the constructor whose forte is the reproduction of gramophone records has been left somewhat in the air over the whole thing. What we mean by this is that every now and again a "new" circuit is presented in the literature for performing one of the necessary functions of a gramophone pre-amplifier, or perhaps even several of them. The quality enthusiast reads, is impressed, and decides that he would like to incorporate something of a similar nature in his own gear, but on investigating further, he finds that either the valves used are not available to him, or the line-up suggested does not fit in by any means with what he has at present. This means either using different valves, with not much idea whether the replacements will give the same performance as the original ones, or even rebuilding his whole amplifier in order to incorporate the new circuit details. Also, very little is usually given about the construction of such things. Sometimes, they amount to several valves, and the builder only finds out by bitter experience that when these are attached to the main amplifier's power supply, the whole thing oscillates violently, and nothing he can do will make it behave properly.

The present article is therefore designed to describe a pre-amplifier that will do almost anything that requires doing, will be able to be attached to any main amplifier without trouble of any sort, and will work satisfactorily from any of the modern light-weight, medium-output pick-ups that have become so popular of late. In addition, it is so designed physically that it can be mounted under the motor-board in any existing radio-gram or turntable unit without getting in the way of the motor. Also, the controls are brought out at the top of the chassis, so that they can come through the motor-board beside the turntable and do not have to appear on the front of the cabinet.

WHAT THE PRE-AMPLIFIER WILL DO

When one uses any of the modern high-quality pick-ups, it is first and foremost essential to insert an equalizing circuit whose job it is to make the low-frequency response of the pick-up/record combination flat. The response of the pick-up itself is flat, but the response of the record drops off at a rate of 6 db. per octave below 250 to 300 c/sec., and it is this drop that has to be compensated. Needless to say, this is the first function of the pre-amplifier presented here. The equalization can be and in fact is produced by a simple circuit containing only resistance and capacity, but in the process, this network manages to cause a loss in output voltage to about a tenth of the original figure, so that one stage of amplification is needed in order to overcome this loss.

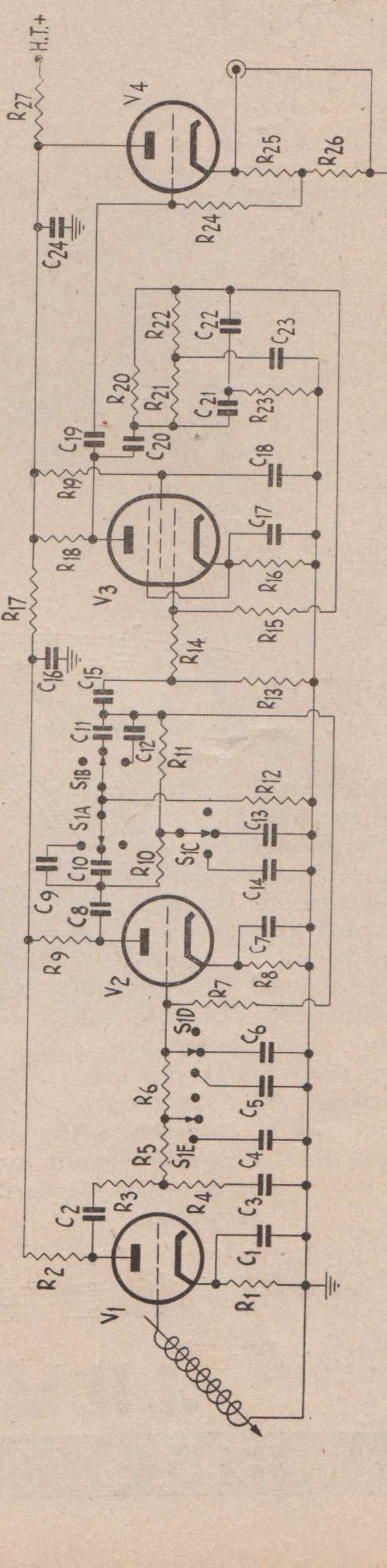
The next function of the circuit is one that will be found very useful, although it is one that is not usually employed. When our amplifier is dealing with records of the brightest and best quality, such as some of the more recent high-fidelity ones, it is desirable to have as wide a frequency range as possible, and the chances are that most of us have gone to considerable time and expense to achieve just this. But it is an unfortunate fact that even if our speaker and amplifier are of the most superb performance (or perhaps we should say **especially** if this is the case) records other than the best frequently sound worse than they do on less ambitious equipment. This is mostly because of the high scratch level possessed by otherwise good records. In the case of the best records, the noise level is very low, so that we can take full advantage of their extended high-frequency response, ignoring the small amount of noise that remains. But there are a multitude of records which, while excellent musically and even technically also, are marred by a high scratch level. When these are played through "ordinary" equipment, which produces very little if anything above, say, 5000 c/sec., the surface noise is not so objectionable as to make them useless, but played on extended range equipment and in comparison with really good records, they sound very poor indeed. It thus becomes advisable to have some means of limiting the high-frequency response of the whole system so that we can get acceptable results from poorer records.

The commonest way of doing this is to use the common or garden "tone-control." This is an inexpensive way out, but one which, from the point of view of getting the best out of the recordings one has, is not at all to be recommended. The trouble is that any ordinary tone-control circuit causes a large loss of frequencies much lower than one wants to lose, especially if it is adjusted so as to give any worth-while reduction in the amount of surface noise. It seems to be fairly well established now among the audio pundits that the best way to combat surface noise is by the use of a low-pass filter

with a sharp cut-off. This has the effect of removing completely all frequencies above the cut-off frequency while allowing all frequencies below this frequency to pass as well as ever. Such a characteristic can never be obtained by simple tone control circuits which, if effective in reducing scratch, make the reproduction sound "wooffy" and muffled. A proper low-pass filter, on the other hand, works so as to be as effective as possible in removing scratch, while at the same time only slightly reducing the brilliance of the reproduction. Many older recordings were made before anything better than 7 or 8000 c/sec. was recorded, so that it can be seen that extending the frequency range of the playing equipment in such a case adds absolutely nothing to the music, but a great deal to the surface noise. Other records will sound much better if a slight sacrifice in high frequencies is made in favour of a large reduction in the scratch. Unlike the tone control, as ordinarily used, the low-pass filter enables this to be done very effectively. Assuming that this is so, there arises the question of what the cut-off frequency should be. This really depends on the individual record to be played, so that an ideal system would have a sharp cut-off filter with the cut-off frequency continuously variable. Such a filter could no doubt be made, but it would be an exceedingly difficult and costly thing to design and build, so that in practice, we must put up with a number of separate filters, with different cut-off frequencies, which may be switched into the circuit at any time, to suit the record that is being played. In the present circuit we have compromised with two filters, and a straight-through position, which has no filter in circuit. The cut-off frequencies of the filters are 5000 and 10,000 c/sec. respectively. It might be an advantage to have an additional filter cutting off at 7000 c/sec., but for the extra trouble involved in providing it, it is hardly thought to be worth while.

Until comparatively recently, sharp-cut-off filters like this were almost impossible to use in ordinary equipment, because they had to be made from inductance and capacity, and were complicated, but with the introduction of methods of making high- and low-pass filters with the aid of only resistors and condensers, assisted by amplifier valves, it is possible to produce the results of costly L/C filters with relatively simple circuitry that is inexpensive to build. One valve is necessary for the low-pass filter circuit, which has an overall gain of little more than unity. Thus, the first two valves, the triodes, do very little more than prevent the rest of the circuitry from giving a large loss of signal voltage. There is actually a gain of approximately 1.5 times over the first two stages. The next valve is a pentode, working under conditions which give it a gain of about 15 times, so that the overall gain of the circuit is approximately 22.5 times. Thus, for the average lightweight pick-up with an output of 200 millivolts, the output of the pre-amplifier will be about 2¼ volts. This is more than enough to load most main amplifiers fully, since the latter are usually arranged to load fully off 0.5 volts or less.

The last valve in the chain is one half of a further 6SN7, used as a cathode follower output coupling valve. Since the pre-amplifier unit will almost always be several feet from the main amplifier, it is very desirable to have the output of the former fed from a low-impedance source. This



V1 + V2, 6SN7-GT
V3, EF37 or EF37A
V4, ½ 6SN7-GT
R1, R8, R25, 2k.
R2, R5, R9, R18, 100k.
R3, R13, R14, R19, 250k.
R4, 20k.
R6, R7, R24, 500k.

R10, R11, 100k. 1% (or matched)
R12, 50k. 1%
R15, 5 meg. 5%
R16, 1.5k.
R17, R26, R27, 50k.
R20, 10 meg. 5%
R21, R22, 2 meg. 1% (or matched)
R23, 1 meg. 1%

C1, C7, C17 25 uf. 25v. electro.
C2, C8, C15, 0.1uf.
C3, 0.05uf 5%
C4, 500 uuf. 5%
C5, 250 uuf. 5%
C6, 50 uuf. 5%
C9, C12, C13, 200 uuf. 5%
C10, C11, 100 uuf. 5%

C14, 400 uuf. 5%
C16, C24, 8 uf. 450 v. electro.
C18, 0.25 uf.
C19, 0.01 uf.
C20, 0.05 uf.
C21, C22, 0.005 uf. 2%
C23, 0.01 uf. 2%

ensures that a shielded lead, which may be necessary to prevent the pick-up of hum by the output lead, will not at the same time cause an undesirable loss in high frequencies, and at the same time it greatly reduces the likelihood of hum pick-up occurring in any case. The output level of 2 volts or so makes it very unlikely that the high heater-cathode voltage of the cathode follower valve will introduce hum itself.

THE CIRCUIT

The complete circuit diagram, given here, looks rather complicated, and perhaps it is a little so, but there is nothing about it that need cause the intending constructor any concern. The low overall gain makes it very unlikely that trouble will be experienced through feed-back and oscillation, and the use of a separate power supply eliminates altogether the possibility of instability when the pre-amplifier is attached to the main amplifier. As the photographs show, the type of construction used is most unconventional, and the circuit has been built in a very compact form indeed. This in itself shows that instability difficulties will not be present, for with such a crowded lay-out of small parts, it would certainly show up were there an inherent tendency to oscillation, due to faulty circuit design or unsuitable lay-out.

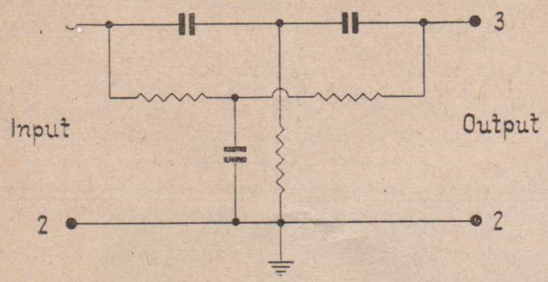


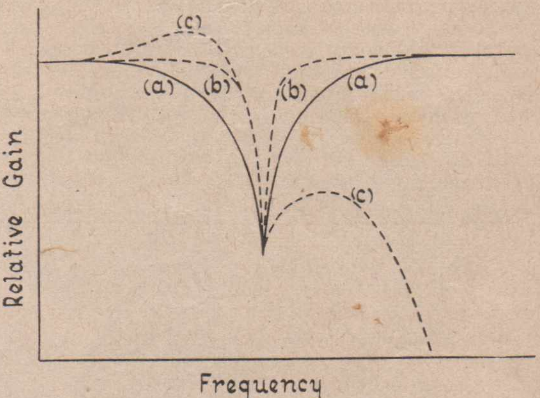
Fig. 1

First in the chain, V1 is one section of the 6SN7. The pick-up is fed straight to the grid of this valve, and the pick-up winding itself acts as the grid return for the valve. R1 and R2 are the normal bias and plate load resistors respectively, and C2 is a large coupling condenser whose job is only the usual one of blocking the D.C. plate voltage from the succeeding circuit. The first portion of the frequency-compensating circuit comprises R3, R4, and C3. This is the official bass-boost network, which provides the rise in response below 250 c/sec. that was mentioned above. It can readily be seen that the valve V1 amplifies the pick-up's output voltage in the normal way by a factor of approximately 14 times—the normal amplification of a section of a 6SN7 with a 100k. plate load. At middle and high frequencies, the condenser C3 has a very small impedance, and can be regarded as virtually a short-circuit to these audio frequencies. Thus, the two resistors R3 and R4 act at middle and high frequencies as a simple resistive voltage divider. Since their values are 200k. and 20k. respectively, they divide the output of V1 by a factor of 11, so that the amplification between the grid of V1 and the junction of R3 and R4 is 14÷11=1.27 times.

The output from this point is supplied to the grid of V2 through the resistors R5 and R6, which in certain positions of S1 are shunted by condensers selected from C4, C5, and C6. However, in the switch position which gives straight-through operation, without any low-pass filter in circuit, none of these condensers are shunted across R5 or R6, which are then acting purely as a series grid stopper, and have negligible effect on the frequency response. Thus, the grid network associated with V2 is concerned with the low-pass filter circuit, which extends on the diagram from the junction of R3 and R4, to the output of C15, following V2. All the circuit between these points is concerned solely with producing the low-pass filter effect, except when the ganged switches are in the extreme anti-clockwise position. In this position, the circuit is modified in such a way that there is no frequency effect, but the gain is the same as when the low-pass filter is in use. How all this comes about, we will now endeavour to explain.

THE LOW-PASS FILTER CIRCUIT

At the outset, we would like to point out that the circuit ideas used in this unit are not original, but are due to D. T. N. Williamson, of Williamson Amplifier fame. Also, the low-pass filter circuit has already been described in an earlier issue of this journal—April, 1950.



The essential portion of the circuit is the network between C8 and C15. Owing to the switching, this is really three separate networks, any of which can be selected at will. Their basic form is shown in Fig. 1. This circuit is well known as one of the comparatively new selective circuits that contain only capacity and resistance. It is called a parallel-T network, because it consists of two T networks in parallel. One T is made up of two series arms which are resistors, with a shunt arm, a condenser. The other T network has a pair of condensers for the series arms, and a resistor for the shunt arm, and a glance at the circuit will show that the complete network consists of these two Ts, with their input and output terminals connected in parallel. It is particularly important to note that there is NO CONNECTION between the centre-points of the two Ts. Now when the resistors and condensers of a network like this have the correct values, there is a frequency at which a very sharp dip occurs in the response. That is, if a variable frequency audio oscillator is fed into terminals 1 and 2, and output is taken from terminals 3 and 2, the response curve looks like that of Fig. 2A. If the values are absolutely correct, the dip is a real null and there will be no output at all at this frequency. In practice, through the tolerances in the component values, the dip is not an absolute zero output, but is still well down, being about 40 db. deep if the values are held within about two per cent. of the calculated ones.

Fig. 2 shows the response of the network itself at curve (a). One disadvantage of this curve is that after the null, the response rises once more to the same level as below the null, while a second is that the attenuation starts to become effective at frequencies much lower than the null frequency. However, by combining the parallel-T network with a valve amplifier, both these difficulties can be overcome. First, the network is made to act as a feedback coupling network between the plate and grid of an amplifier valve. The feedback is negative, with the result that the valve adds to the selectivity of the network, and produces a much sharper null, as at (B) in Fig. 2. This overcomes the second difficulty. The first is then partly fixed by connecting a small condenser between grid and earth on the amplifier. This causes a phase shift in the feedback voltage, and gives a slight amount of positive feedback at frequencies below the null point, and extra negative feedback at frequencies above this frequency. As a result, the response curve is no longer symmetrical, but is like curve (C) on Fig. 2. The only uundesirable thing about this response curve is that there is a rise just before the sharp drop. However, this rise can be counteracted by placing a small by-pass condenser outside the feedback path of the amplifier stage. This gives just enough top cut to prevent the rise from occurring, and also has the advantage of making the unwanted rise after the null point much less pronounced. The final result is a curve in the shape of Fig. 3 which displays the rapid drop from the flat characteristic that we have been trying to achieve. By varying the values of the condensers in this circuit, the frequency at which the null occurs can easily be controlled. A five-pole, three-position switch is needed for this, because there are five condensers to switch, and we have decided on three selectable response curves. The switches are ganged by the simple expedient of making them of the wafer, wave-change type. Since each wafer will have two three-position switches on it, three wafers will be needed, giving a six-pole switch, one pole of which will not be wanted.

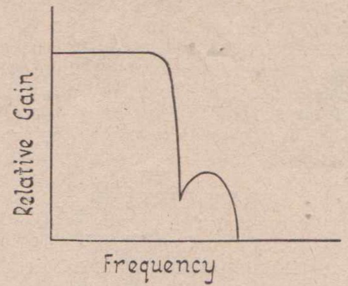


Fig. 3

From the above, it can be seen that though the circuit looks complicated, this is mostly on account of the switching, which really only adds to the number of parts shown on the diagram, and not

Continued on Page 28

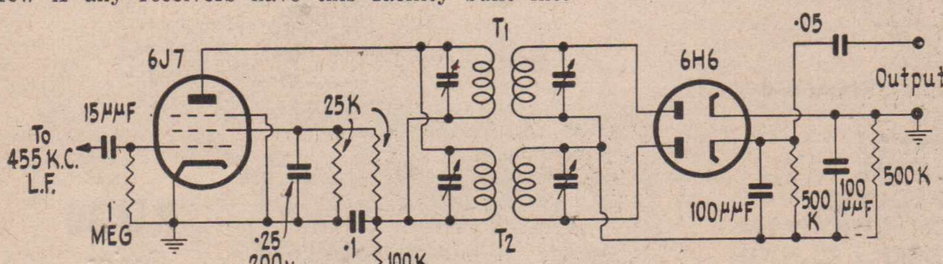
An Adapter for Narrow-Band F.M. Reception

In last month's issue we presented constructional details of a narrow-band F.M. exciter for use in amateur transmitters. This month, to complete the double, we describe a simple adapter unit which can be attached to any superhet. receiver to allow the proper reception of N.B.F.M. signals.

INTRODUCTION

One of the difficulties attached to building a receiver suitable for F.M. reception, whether for wide-band or narrow-band F.M., is the lack of sutable discriminator transformers which can be used in the most popular discriminator circuit—the Foster-Seeley circuit. This arrangement requires a special transformer with a centre-tapped primary winding, and a special design, in which the Q's of the primary and secondary bear a particular relationship to each other, and in which also, the coupling between primary and secondary is quite different from that found in normal I.F. transformers. Even if one is able to design such a transformer electrically, there remains the difficult problem of winding it, if the frequency is low enough to require universal-wound coils. This situation unfortunately obtains at the usual intermediate frequency of most communications receivers, whether commercial or home-built, so that for receiving narrow-band F.M. signals, the usual trick is to use an ordinary receiver, de-tuned on one side of the signal, so as to obtain the so-called slope detection, in which an F.M. signal is converted to an A.M. one by the sloping side of the selectivity curve of the I.F. channel. This scheme works, but not very well, and usually introduces quite considerable amounts of distortion. While the results may be intelligible, it is not possible under these circumstances to give the received station a worthwhile report on his signals, especially as regards quality. It is therefore highly desirable to have a circuit in the receiver which can detect an F.M. signal in a proper manner. Again unfortunately, few if any receivers have this facility built into them, so that the man who wishes to receive N.B.F.M. is faced with the problem of building an adapter for his ordinary set.

This problem is similar to that of building a complete receiver for F.M., since it is only in the discriminator circuit that such a receiver differs markedly from a conventional set, at least from the first detector onwards. The present adapter has been made possible by the use of a circuit that was once popular as a frequency detector, and was used both in F.M. receivers, and as the discriminator circuit in A.F.C. systems. This circuit has the great advantage from the amateur constructor's point of view that it can be built using only standard components, and can be aligned without the use of special equipment he is unlikely to possess. The circuit of the complete unit is shown above, and it can be seen that it is quite a simple arrangement, using very few parts except the two valves and a pair of conventional 455 kc/sec. I.F. transformers.



Above: View of the completed unit.
Left: Circuit diagram.

CIRCUIT DETAILS

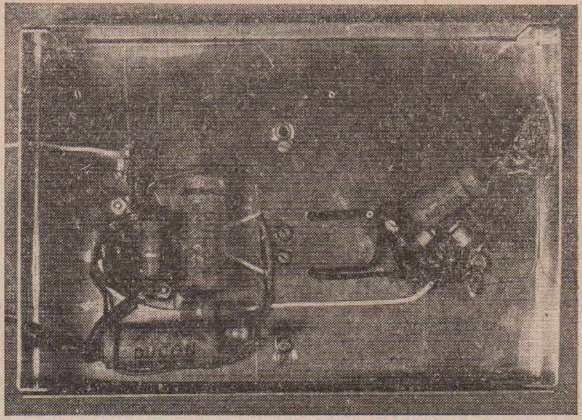
The idea of the adapter unit is that it should be permanently connected to the set at the input end, and provides an audio output terminal which can be plugged into the audio section of the set when F.M. reception is required. All that is necessary as far as the main receiver is concerned is to add a closed-circuit jack at the input to its audio amplifier, if such a jack is not already provided, and to provide a lead from the plate pin of the

last I.F. amplifier stage to a connector somewhere on the receiver's chassis. This connector is then connected to the input terminal of the adapter by a short length of shielded lead, of as low capacity as possible. It will, of course, be necessary, after the adapter has been installed, to re-adjust the tuning of the plate circuit of the final I.F. amplifier to bring it back to resonance, but this adjustment can be done once for all, since the adapter can remain permanently connected. Since the power for the adapter is so small, it can get this from the main receiver, the requirements being 0.6 amps. at 6.3 volts, for the heaters, and approximately 5 ma. at 250 volts, for the H.T.

The 6J7 is used as an isolating stage and an amplitude limiter. It will be noticed that it is run at zero bias, so that with the several volts of signal provided by the main set at the grid, grid current flows, and with the unusually low screen voltage, the tube acts as an efficient limiter removing any amplitude modulation that may be present in the signal.

The most interesting part of the circuit is the discriminator, which uses the two I.F. transformers and the 6H6. These I.F. transformers are standard components, each in its own shield can, as normally used, and the photograph emphasizes this point. As the circuit diagram is drawn, one might be excused for gaining the impression that the windings of the two transformers are electromagnetically coupled together, but such is not the case, since they are shielded each from the other by their respective cans, in the ordinary way. The primary windings are, however, connected in parallel, so that half the I.F. current from the 6J7 flows through each primary. This connection does not affect their tuning, since if two tuned circuits are adjusted to the same frequency and then connected in parallel, the tuned frequency is not altered, but only the L/C ratio and the Q of the combined circuit, which becomes half the Q of each one. The secondary windings are quite independent, however, being shielded from each other, so that if they are both tuned to the I.F., each will have the same voltage output. Now each secondary winding is connected to one diode of the 6H6, and the secondaries are also connected in series. The cathode load circuits of the halves of the 6H6 are so arranged that the voltages produced by the two diodes are subtracted from each other, or, more accurately, are added algebraically. Thus, if the lower diode conducts, it produces at its cathode (which is also the output terminal) a voltage that is positive with respect to earth. But if the upper diode conducts, it produces a negative voltage at the junction of the two 500k. load resistors, and this also appears at the output terminal. Thus, lf both diodes happen to be passing the same current, the two output voltages cancel out, and the voltage at the output terminal is zero. Also, if the lower diode passes more current than the upper one, there will be a net positive voltage at the output terminal, while if the upper diode passes more than the lower one, the output voltage will be negative. How, then, does this arrangement detect a frequency-modulated signal? The answer is that on its own, it will not, but if the secondaries of the I.F. transformers are tuned, not to the exact I.F., but one slightly higher, and the other slightly lower in freqency, then the arrangement will act as an F.M. detector. It is not difficult to see how this comes about. Suppose that the secondaries of T1 and T2 are de-tuned in this manner, and moreover are de-tuned by exactly the same amount. Both will produce an output voltage that is less than the maximum possible, if the signal is a steady one on 455 kc/sec., but because one is, say, 5 kc/sec. higher, and the other, 5 kc/sec. lower, their voltage outputs will be identical. In this case, the diodes will have identical voltage inputs, so that their D.C. outputs will be the same too, and there will be no D.C. voltage between the output terminal and earth.

Now, suppose the signal is now changed to 457 kc/sec., and remains there while we see what will happen. One secondary will now produce more volts, because the new signal is 2 kc/sec. nearer to the 460 kc/sec., to which it is tuned. The other, tuned to 450 kc/sec., will produce less output, because the signal is now farther than ever from its resonant frequency. Thus, the input to one diode is increased, and that to the other, decreased. There will therefore be an output voltage from the detector, and its polarity, positive or negative, will depend only upon which diode is connected to the coil whose output has increased. If now the input frequency is changed to 453 kc/sec., the same things as before will happen, with the exception that the diode which received the larger input will now receive the smaller, and vice versa. The output voltage at the detector output terminal will thus be the same in magnitude as before, but will be reversed in polarity. We have thus seen what happens if three steady frequencies are applied to the circuit, one on the I.F., and the other two at equal distances from it on either side. If instead we present the circuit with a frequency-modulated signal, what we have just described will still happen, the only difference being that it will happen at an audio frequency rate, and with smooth transitions from one extreme of frequency to the other. Thus, there will be an audio frequency output at the detector corresponding in frequency to that at which the signal is modulated. and in amplitude to the extent of the frequency swing of the original signal on either side of the centre frequency.



Under-chassis view of the unit. The output jack can be seen at the right-hand side of the chassis.

CONSTRUCTION

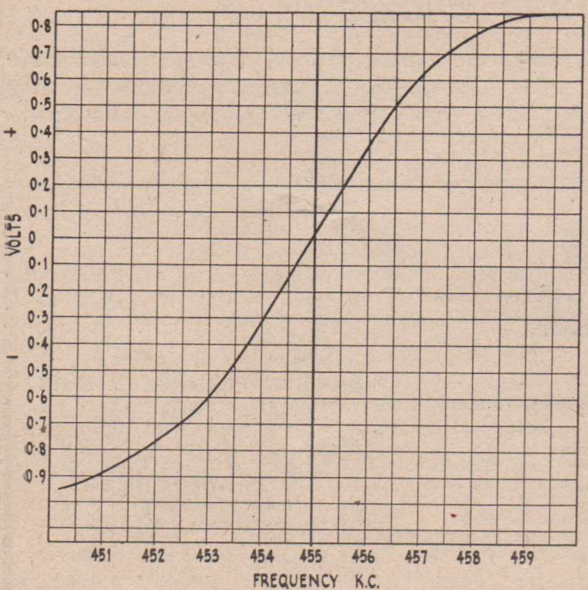
There is so little in the adapter that the circuit diagram and the two photographs can almost be left to speak for themselves. The original was built on a chassis measuring 8 in. x 5½ in. x 1½ in., but this could easily be cut down if individual builders desire. About the minimum size with I.F. transformers in $1\frac{5}{8}$ in. square cans would be 6 in. x 4 in. x $1\frac{1}{2}$ in. As can be seen, there is very little to go in under the chassis, and the wiring could hardly be simpler. One point to note is that in the original two transformers with fixed inductances and variable condensers were used, but there is no reason why variable inductors and fixed condensers should not be used—the so-called permeability-tuned transformers, in other words. In either case, the method of adjustment will be the same, and this is the only part of the construction that needs much care to be given to it.

SETTING UP FOR USE

When the unit has been wired up and is ready for use, the first job is to instal on the main receiver, the output connector and phone jack mentioned above. The adapter should be placed as close as possible to the connector on the set so that as short a lead as possible can be run to its input connector. For aligning the adapter, it is necessary at first to take a temporary audio output from the lower half of the diode load resistor chain, that is, from the 500k. resistor connected between the cathode of the upper diode and earth. With this done, a signal at 455 kc/sec. is injected into the I.F. channel of the main set and with the adaptor fed to the input of the audio amplifier, and an output indicator attached to the output stage, the alignment of the whole I.F. section is checked over. The only thing on the set that should require adjustment is the plate winding of the last I.F. transformer, at which point the adapter is connected, detuning it somewhat. This is adjusted for maximum output in the usual way to bring it back to resonance. Then attention is turned to the adapter itself, and the first job is to align the I.F. transformers T1 and T2 "on the nose." With the output from only one half of the load, as described above, it is possible to tune the primary windings for maximum output. This will require an ordinary amplitude-modulated signal. First of all, one of the primary trimmers (or slugs) is set to about half way, and the parallel primaries are brought to resonance by adjusting the other trimmer or slug. The exact setting of the one that is first set to about half way does not matter at all, as long as it is such that the whole circuit can be brought to resonance by the other. This done, the secondary of T1 is adjusted to give maximum output with the A.M. signal. Since we are using only the output from the top diode, the setting of the T2 secondary will have no effect on this adjustment which is carried out in quite the ordinary way.

After this, the temporary output connection is removed, and output is taken from the proper output terminal. The next step is to take a small condenser of about 5 uuf., and temporarily connect it across the secondary of T2. If a 5 uuf. condenser cannot be got, one can be made by twisting together two pieces of hook-up wire for a length of about $\frac{3}{4}$ in. Now, still with the amplitude-modulated signal into the set, the secondary of T2 is adjusted for **minimum** output from the audio amplifier. Theoretically, this minimum should be actually zero output, but owing to slight differences between allegedly identical I.F. transformers, an actual zero will not usually be obtained. After this, no further adjustments are made to any of the transformers, and all that remains to complete the alignment is to remove the temporary small condenser from across the secondary of T2 and place it permanently across the secondary of T1.

It is easy to see how the above method of alignment works. When output is taken from only half the diode load, only one diode is providing output, so that an A.M. signal can be used to enable the circuits to be aligned to the I.F. by the usual method of adjusting for maximum output. After adjusting the primary, which has to be exactly on the I.F., the T1 secondary is also adjusted to the exact I.F. Now when we take the output from the proper output terminal, both diodes are able to function, and if both secondaries are tuned exactly to the I.F., there should be no output at all. For this reason we are able to adjust the secondary of T2 to resonance by using an A.M. signal and adjusting for minimum output. But in the finish, we want the secondaries to be slightly detuned, one on either side of the I.F., so when the T2 secondary is being adjusted, we put a small extra capacity across it before adjusting it. Then, when this capacity is removed, the T2 secondary will be a few kc/sec. higher in frequency than the I.F. But the secondary of T1 is still tuned to the exact I.F., and because T2 is higher, T1's secondary will have to be lower by the same amount. But if we take the



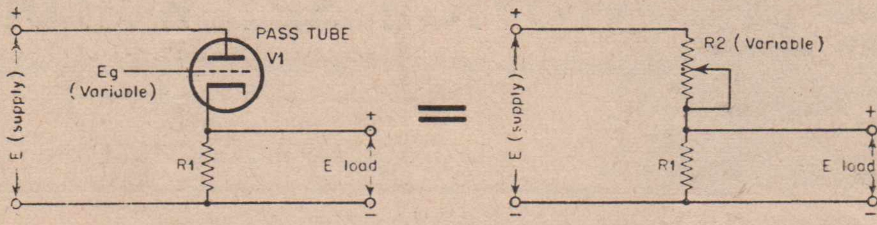
Performance curve showing detector output voltage versus frequency of the input. Centre frequency is 455 kc/sec.

same small condenser and connect it across the T1 secondary, this winding will now be tuned slightly on the low side, as required, and because the capacity removed from the T2 secondary is identical with that connected across the T1 secondary, and is very small, the de-tuning of the two secondaries will be almost identical. Not quite, because the frequency of a tuned circuit is inversely proportional not to the capacity, but to its square root, but the capacity is so small that the difference is not noticeable, and the procedure outlined results in perfectly good alignment for the adapter.

Continued on Page 32

Regulated Power Supply Design

By the Engineering Department, Aerovox Corporation



ILLUSTRATING ACTION OF PASS TUBE
FIG. 1

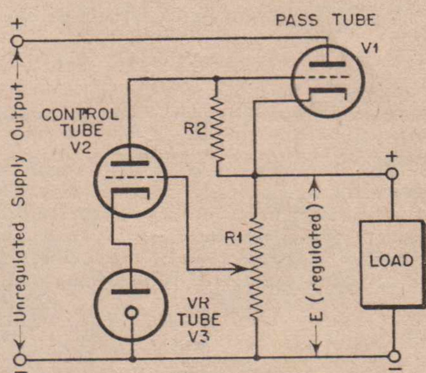
A source of well-regulated plate voltage is a prerequisite for the modern laboratory, service bench or amateur station. An ever increasing number of elecrtonic devices, such as audio amplifiers, R.F. oscillators, amateur V.F.O.'s, oscilloscopes, synchroscopes, timing circuitry, and many others, depend for their proper functioning upon a power supply which is hum free and delivers a constant voltage regardless of load. Fortunately, the development of electronically regulated sources has advanced to the state where their design and construction is well within the scope of the average user. This article outlines the theory, design, and construction of a representative supply of this type. With a firm understanding of the design principles to be discussed, the reader should be able to adapt the practical supply presented here to other requirements which might exist.

Modern regulated supplies of the type to be described make available an output voltage which is continuously variable over a considerable range and which will not vary more than a fraction of one per cent. between no-load and full-load conditions. Normal line voltage fluctuations also have little effect on output voltage. In addition, the regulations may be made of such a high order that ripple voltages in the output are almost entirely cancelled, thus eliminating the need for the usual "brute force" filter. This saving in weight and space helps to compensate for the additional complexity of the electronic regulator.

THEORY OF OPERATION

To achieve precise voltage regulation, an electronic voltage control element must be introduced in the conventional supply circuit. In most regulated supplies, this electronically variable element takes the form of a high current vacuum tube, usually called the "pass tube" or "regulator tube" in this application. This tube is connected in series with the load resistance across the output of the supply, as in Fig. 1. Since the resistance of the triode varies as a function of its grid voltage, this combination acts as an electronically controlled voltage divider. A small change in the regulator tube grid voltage changes the effective ratio of the divider and thus varies the voltage appearing across the output load.

The ability to vary the output voltage of the supply by a minute grid voltage change suggests that automatic voltage regulation could be accomplished by feeding any attempted output voltage fluctuation back to this grid at such a polarity as to oppose that change. In other words, if the voltage across the load in Fig. 1 attempted to rise, the grid of the pass tube (V1) should be made more negative so that its internal resistance would increase and lower the load voltage. If the load voltage attempted to decrease the converse action should occur.



SIMPLIFIED
ELECTRONIC REGULATOR
FIG. 2

This action is achieved by the circuit shown in simplified form in Fig. 2. Auxiliary circuitry consisting of a second vacuum tube, usually called the "control tube," and a constant voltage source such as a battery or "VR" tube is added to the circuit of Fig. 1. A sample of the output voltage is applied to the grid of the control tube by a tap on the output bleeder R1. The control tube determines the bias on the regulator tube (V1) since the load resistor (R2) for the control tube is also the bias resistor for the regulator tube. The control tube therefore performs two functions; it amplifies voltage fluctuations impressed upon its grid by the output circuit, and it reverses the phase of those fluctuations so that they may be applied to the grid of the pass tube in the right direction to effect regulation. The precision of the regulation attained increases with the gain of the control tube since, with greater gain, a small change in control tube

Continued on Page 20

NOVICE SET BUILDING

A SECTION FOR THE BEGINNER
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GETTING STARTED

This section of our journal is primary for the beginner to assist him in GETTING STARTED in the Radio Field, by describing a series of simple receivers in a manner that will allow him to gain valuable, practicable and elementary theoretical knowledge by building the various sets from the circuits given.

Only those who have actually built a radio receiver, switched it on, and heard it work, can know the thrills that lie in the hobby of set-building. Even the cheapest and simplest of sets can give endless hours of enjoyment. With a few simple tools for mounting and wiring of parts anyone can put together a receiver on their own work bench.

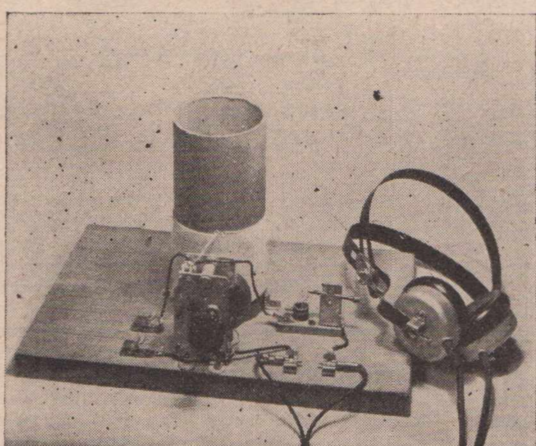
There is no end to the variety of receivers that can be built. Simple crystal and one valve sets are best for a start to gain experience and even with these there are dozens of different circuits to experiment with at your leisure. After the necessary experience has been gained, multi-valve receivers can be built covering short-wave, broadcast and dual-wave operation, of tuned radio frequency or super-hetrodyne types, powered by either batteries or from the electric mains supply.

There is no short cut to a theoretical knowledge of radio, but on the practical side there are many pitfalls beginners can dodge and many useful tips that can be passed on to help those breaking into the radio game. The commonest of these will be dealt with as they crop up from time to time in this series of articles.

THE 4-IN-ONE CRYSTAL SET

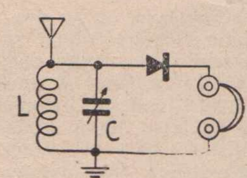
The **4 in ONE** crystal set is so designated because it allows the constructor to build 4 different sets from the circuits shown, with the same kit of parts. Thus, in a practical way the builder can **observe** the different results obtained with each one, thereby increasing his knowledge immediately.

No. 1. This is the simplest of all crystal sets. It gives quite strong signals, but i not selective. Can be used with advantage when only one station can be received, and there is no interference from another. No. 1 also suffers from alteration of the tuning, depending on the length of the aerial. With a long one, some



stations might be off the dial. The photo above shows No. 1 built up and ready to go.

No. 2. This is a simple but good circuit. The tapped aerial coil enables better selectivity to be had with a long aerial. The aerial coil has 30 turns tapped every 5 turns. Where it is difficult to separate two stations, the aerial should be connected to one of the lower taps, but for getting in weak stations, it is better to have the aerial connected to one of the higher taps.



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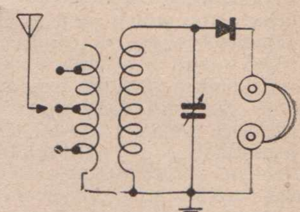

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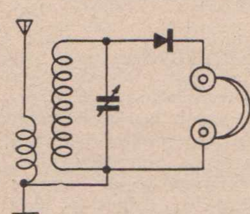

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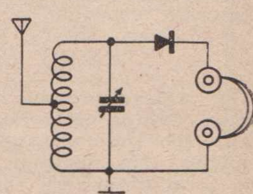


4

No. 3. This is simply the circuit for No. 2, with the taps left out. It will be quite good for most locations, but where more selectivity is needed, No. 2 should be used.

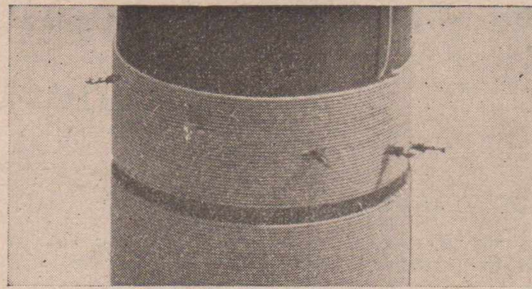
No. 4. Another way of getting the same results as with No. 3. Here a single tap is put on the tuning coil, and no aerial coil is used.

All tuning coils can consist of 70 turns of 24 gauge D.C.C. wire, close-wound on a 3 in. former. The tuning condenser can be 0.0003 mfd. or larger. If slightly different sizes of wire are used for the coil it will not matter.

In all cases, the aerial coil can have 30 turns of the same wire, and can be wound above the tuning coil, as shown in the right-hand photo. The taps are made simply by twisting the wire for about half an inch, and proceeding with the winding. After the whole coil is wound, the cotton is stripped from the wire so that connection can be made to the taps with an alligator clip. The photo shows the aerial coil for Circuit No. 2, where the taps are made every 5 turns.

COMPONENT LIST

1 Chassis or base board. 6″ x 6″
1 Panel to suit above. 6″ x 6″
1 Pointer knob or dial.
1 Crystal Detector.
1 Pair Headphones (high impedance).
1 Coil former 3″ diameter.
1 Single Gang Condenser. 0.0003 mfd. or larger.
4 Terminals.
1 Clip (Alligator type).
Sundries: Wire for coil (see text)
Solder lugs, etc. etc.



COIL DATA

This picture shows the tapped aerial coil at the top of the tuning coil. Note how the tappings are spaced round the former so that they do not come too close to each other. This is done simply by allowing about an inch extra after each five turns has been wound on, before the twist is made in the wire.

* * *

IN OUR NEXT ISSUE we will publish circuit symbols and how to interpret them, and also feature a Wave Trap Tuned Crystal Set for reducing interference (better selectivity) between stations.

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

PART III

THE TIME-BASE CIRCUITS IN DETAIL

The two time-bases are very similar to the simple saw-tooth generators used in oscilloscopes, and will no doubt be familiar to many readers. They both employ gas triodes, and except for one or two simple modifications, have circuits identical with the one used in most 'scope time-bases of this nature. The frame circuit is the simpler of the two, and so will be described first. The tubes in the top row of the complete circuit diagram are, from left to right, V1, V2, and V3 of the block diagram. The left-hand 6SN7 is the multivibrator, working on 50 c/sec., the EN31 is the saw-tooth generator proper, while the remaining 6SN7 is the paraphase amplifier which amplifies the saw-tooth and feeds it to the Y plates of the C.R.T. It would perhaps be best to describe the gas-tube circuit first, since this is the fundamental part of the arrangement.

The EN31 is provided with a plate series resistor of 500k., and a condenser of 1 uf. from plate to earth. The cathode is biased positively by means of a voltage divider network from H.T., consisting of a 75k. and a 10k. resistor in series. This, with an H.T. supply of 300 volts, makes the cathode approximately 35 volts positive with respect to earth, and since the control grid is at earth potential, owing to its 25k. leak resistor being connected directly to earth, this is equivalent to a negative grid bias of the same amount, namely 35 volts. In the usual gas-tube saw-tooth oscillator, the negative grid bias is usually much smaller than this, so that the same circuit is able to act as a self-running saw-tooth oscillator. In this case the mechanism is as follows: When the H.T. is first switched on, the plate condenser commences to charge through the 500k. resistor, and since the plate of the valve is connected directly to the condenser, the plate voltage rises at the same rate as the condenser charges. When the striking voltage of the valve is reached, it suddenly ionizes and starts to conduct, rapidly discharging the condenser and giving the fly-back part of the saw-tooth. But in the present circuit, the negative grid bias is so high that even when the condenser is fully charged to the 300 volts of the H.T. line, the striking voltage of the gas tube is not reached and the flyback does not occur. The circuit will thus not oscillate on its own account, and must be forced to start conducting, to produce the flyback. It is here that the triggering oscillator comes in. The multivibrator oscillates at approximately 50 c/sec., and produces a square-wave at this frequency. This square-wave is fed to the grid of the gas tube through a short-time-constant differentiating circuit, consisting of the 0.02 uf. coupling condenser and the 25k. grid leak. This transforms the square-wave output of the multivibrator into a series of alternate positive and negative pulses, which are applied to the grid of the EN31. Now while the plate condenser of the gas tube is charging up, the grid of this tube receives a sharp positive pulse of about 50 volts amplitude, so that as soon as this comes along, the gas tube is forcibly brought to its critical voltage, and it strikes, discharging the condenser, and causing the flybacks. As soon as the condenser is discharged, the plate voltage on the gas tube is so low that it goes out, and is unable to conduct again until triggered once more by the next positive pulse on the grid. But in the meantime, the condenser has been charging again, giving the forward stroke of the saw-tooth.

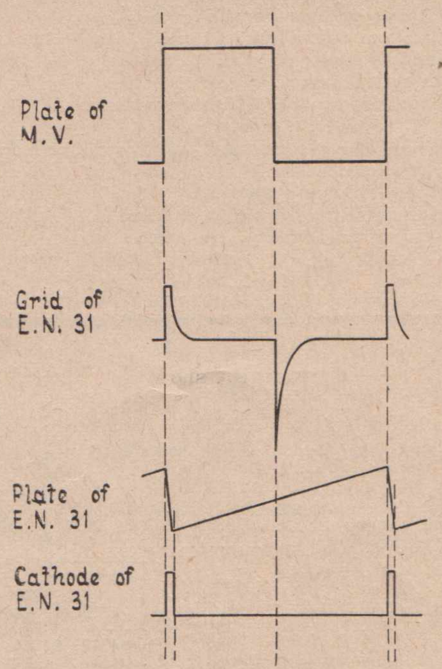


Fig. 4.—Waveforms to be found in the frame time-base circuit.

Thus, it can be seen that by the simple modifications of biasing the gas tube so heavily that it will not perform free oscillations, and then making it conduct only at times governed by the positive pulses sent to its grid, we have transformed the circuit into a triggered time-base, which can run at one frequency, and one frequency only—namely that of the train of pulses provided by the multivibrator. Also, should the multivibrator stop oscillating for any reason, there will be no time-base output from the gas tube. The frequency of the saw-tooth is rigidly controlled, therefore, and is not affected by the value of the plate condenser, or that of the series plate resistor. All these do is to control the amplitude and linearity of the saw-tooth. By increasing these components to high values, as has been done here, it is ensured that the condenser charges to only a small fraction of the available 300 volts before the tube is forced to conduct, and as a result, only the first, almost linear portion of the condenser's charging curve is used. Since there is an amplifier following the saw-tooth generator, there is no necessity for a saw-tooth of large amplitude, so that we can obtain the advantage of improved linearity, at the expense of small amplitude.

There are one or two points about the circuit that have not yet been mentioned, and which readers may wish to have explained. For instance, why are the grid leaks of the multivibrator returned to H.T. positive instead of to earth, as is more usual, and what is the purpose of the 15k. grid stopper in the EN31 circuit?

It is found that if the grid leaks of a multivibrator are returned to H.T.+ instead of to ground, the frequency stability is much improved. This is because the times when the multivibrator flips from one condition to the other, are much more positively controlled if there is a slight positive bias on the valves. It might appear at first that the grids are being worked with a positive bias equal in value to the H.T. voltage, but such is not the case. The reason is that when the valves draw grid current, as they must do, through the 1 meg. grid leaks, a large negative grid voltage is built up which almost completely counteracts the positive voltage. As a result, the grids cannot go more than a fraction of a volt positive even during the portion of the oscillation cycle when their own valve is conducting, and, of course, during the other half cycle the tube is cut off in any case.

A glance at Fig. 4, which shows the wave-forms which occur in the circuit, shows that as well as the positive pulses, at multivibrator frequency, fed to the EN31 grid, there are also negative pulses fed to the grid. These occur almost exactly half-way through the time-base stroke, when the gas tube is cut off. As a result, they have no effect at all on the operation of the circuit, and can be ignored. Since, also, the positive pulses provided at the grid are of greater amplitude than the permanent negative bias on the cathode, these pulses must drive the gas tube's grid positive, and must, therefore, cause grid current to flow. The purpose of the 15k. grid stopper is therefore to limit this grid current to a safe value that will not damage the tube. Again because of the grid current, the appearance of the pulses at the grid is as shown on Fig.4. If the EN31 were removed from its socket, the positive and negative pulses would be found to be of the same size, so that the reason for the positive ones appearing shorter in amplitude in the actual working circuit is that the remaining portions are removed when grid current flows in the gas tube.

It will be seen that in series with the cathode lead of the gas tube there is a 250-ohm resistor. This is put there to enable a pulse to be generated, which can be used for blacking out the flyback of the vertical time-base. The EN31 conducts only during the flyback, and so at this time there is a positive potential developed across the 250-ohm resistor. This potential lasts only as long as the tube is conducting, and so forms the short positive pulse illustrated in Fig. 4. This pulse is amplified by the first section of the ECC35, and fed to the grid of the second section, which acts as a cathode follower output valve for the pulse. In the process the pulse is, of course, turned into a negative one, because of the phase-reversing action of the amplifier valve, it can then be fed to the grid of the cathode ray tube, causing the trace to disappear for the duration of the pulse, and thus for the duration of the flyback, which no longer appears.

The second 6SN7 is a straightforward paraphase amplifier which raises the frame saw-tooth output to a high enough voltage for swinging the deflection plates, and at the same time provides a push-pull pair of deflection voltages so that the plates can be fed in a balanced manner. There is, unfortunately, a slight error on this part of the diagram. The left-hand half of the valve feeds the Y1 deflecting plate, and at the same time supplies input voltage for the grid of the right-hand half. The grid of the latter half is connected to a voltage divider shown as being made up of two 1 meg. resistors in series. The error is that the lower of these resistors should have been shown as a potentiometer, with the grid of the valve attached to the moving arm. This makes a balancing control which enables the output of both halves to be made equal, and once set, this control can either be replaced with two resistors of the correct value, or else left in position as a pre-set adjustment. It would also be advisable to make the 1 meg. grid resistor of the left-hand half of the 6SN7 a potentiometer, to act as an output control.

The circuit for the line time-base is exactly similar in principle to that of the frame circuit, but differs in detail owing to the necessity for generating a saw-tooth at a fairly high frequency. For our 300-line picture, the line frequency will have to be 300 times the frame frequency, which works out to 15,000 c/sec. Now, a saw-tooth of any frequency cannot be amplified without distortion unless the amplifier concerned has a response up to at least ten times the fundamental frequency of the saw-tooth. In the case of the frame saw-tooth, this does not present any difficulty, because ten times 50 c/sec. is only 500 c/sec., and ordinary resistance-coupled amplifiers will do much better than this without the slightest precautions to preserve high-frequency response. For the line time-base, however, the situation is rather different. An ordinary resistance-coupled triode stage has usually started to show distinct signs of falling off even below 15,000 c/sec., so that such an amplifier would be quite useless for amplifying a saw-tooth of this frequency. It is, therefore, necessary to use pentodes for amplification, and in order that the response shall be reasonably flat up to at least 150 k/sec., it will be necessary to apply semi-wide-band techniques. In our case, this amounts to (a) using a pair of high-Gm pentodes in the paraphase amplifier stage, rather than triodes, and for this we have chosen the ubiquitous 6AC7, and (b) limiting the plate load resistors to a low value so that the frequency response will be wide enough. A different type of paraphase amplifier is used, too, in which the phase inverting tube is excited from the unbalanced signal voltage to be found across a common cathode resistor.

The other main point of difference is that we no longer use a multivibrator as the controlling oscillator for the line gas tube. The reason for this is that to get a really good sharp square-wave from a multivibrator at 15,000 c/sec. would itself necessitate the use of two pentodes, also with low load

Continued on Page 30

REGULATED POWER SUPPLY

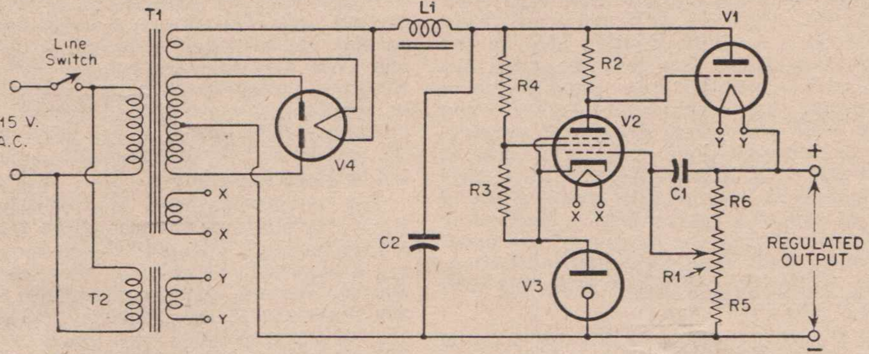
Continued from Page 15

grid voltage will cause a greater control tube current change and hence a greater change in pass tube bias. Thus, smaller attempted output voltage excursions will be corrected.

The battery or VR tube maintains the cathode of the control tube at a constant voltage above ground, and thus provides a standard reference voltage to which voltage fluctuations at the output divider (R1) are compared. The voltage at the grid of the control tube is the difference between the voltage at the output bleeder tap and the reference bias voltage provided by the VR tube. This difference voltage sets the "target" voltage to which the supply regulates. By changing the output bleeder tap with a potentiometer at R1, the regulated output voltage of the supply may be adjusted within certain limits.

standard design only in that considerably more voltage than the required output voltage must be provided since there is an appreciable minimum voltage drop across the regulator tube. Usually the unregulated section of the supply must furnish from 50 to 200 volts more than the desired regulated output.

For a sample design, let us suppose that a regulated output of about 300 volts at 75 milliamperes is required for a general utility supply. The practical circuit for such a supply is shown in Fig. 3. Knowing the current requirement, a suitable pass tube may be selected from Table 1. Any triode or triode-connected pentode capable of passing the required current at a reasonable voltage drop may be employed. Tubes may readily be used in parallel



R1, R5, R6, see text.
R2, 0.5 meg., 1 watt.
R3, 12k. 5 watts.
R4, 18k. 5 watts.
L1, 8H. 100 ma.
V1, 6A3, V2, 6SJ7, V3, VR150, V4, 5U4G.

C1, 0.25 uf. 600v.
C2, 8 uf. 450v. electro.
T1, 550-0-550v., 100 ma., 5v. 3a., and 6.3v. 1 a.
T2, 6.3v. 1a.

Summarized briefly, the action of the electronic regulator of Fig. 2 is as follows: The position of the bleeder tap on R1 determines the output voltage level to which the supply will regulate. If the voltage across the bleeder attempts to rise above that level, the bias on the control tube (V2) becomes more positive, causing it to draw more current through its load resistor (R2). The increased current through R2 causes the grid of the regulation tube (V1) to be driven more negative, with the result that the resistance of the regulator tube increases sufficiently to prevent the original attempted excursion of output voltage and return it to the regulated level. If the output voltage attempts to decrease, the sequence of events is exactly opposite. The action is practically instantaneous, so that excursions are corrected for while still very small.

PRACTICAL DESIGN CONSIDERATIONS

With a working knowledge of the functions of all component parts, the design of regulated power supply equipment is no more complicated than that of other electronic circuitry usually designed and constructed by the user.

As with any power supply design, the first step is to determine the designed output voltage and current requirements. This permits the selection of the proper power transformer, filter components, and pass tube. The supply section differs from where greater current is required or when greater plate dissipation is needed. Special types, such as the 6AS7 which was designed for pass tube applications, are also available. For our present design, a smaller tube such as the 2A3 or its 6.3 volt equivalent, the 6A3, will suffice.

The power transformer and filter choke must be conservatively rated for the full load current. Otherwise, the regulation of the supply will be poor. The required voltage rating for the transformer is determined by finding the sum of the voltage drops around the circuit for the condition of maximum output voltage and current. The drop across the pass tube is minimum for maximum output voltage and may be found by referring to the plate characteristic curves for the pass tube being used. For the 6A3 used in the present design, the minimum tube drop for the required load current is about 80 volts at zero bias. Actually, somewhat greater values should be designed for to provide a margin for low line voltage conditions. For the 6A3, a minimum drop of 140 volts is typical. Thus, the D.C. output of the supply section ahead of the regulator must be about 440 volts; 300 volts for the load and 140 minimum drop across the pass tube. Reference to the rectifier tube operating characteristics will indicate the R.M.S. voltage rating of the power transformer required to supply this voltage when a single section choke-input filter is used. With the 5U4-G employed in the present design, and allowing sufficient margin for voltage drop across the choke, low line voltage, etc., a transformer delivering 550 volts each side of centre-tap at 100 ma. is indicated. The choke should also be rated at 100 ma.

At this point, having selected the pass tube and determined the characteristics of the unregulated supply section, it is well to examine the pass tube operating conditions to determine if the allowable plate dissipation is being exceeded. The 6A3 is rated at 15 watts maximum dissipation. At full current and voltage from the supply, the drop across the pass tube estimated above was 140 volts. The plate dissipation under this condition is 140v. times .075 amps. or 10.5 watts. The low voltage limit to which the supply can safely be adjusted at full

TABLE I

TUBE TYPE	CURRENT (Ma.)
6AS7G	250
6A3	75
2A3	75
6B4G	75
6A5G	75
807 *	80
6L6 *	75
6V6 *	45
6F6 *	40
6Y6 *	60

* Screen connected to plate through 500 Ohm, 1 Watt resistor

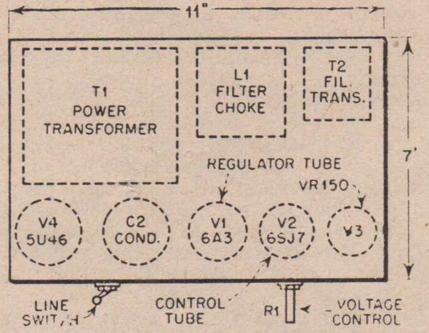
current may now be determined, since the voltage drop across the pass tube, and hence its plate dissipation, is maximum at the lowest regulated output voltage. The allowable drop for 15 watts plate dissipation is now calculated as 15 watts, .075 amp. or 200 volts. With a total unregulated voltage of 440 v. available, the minimum regulated output of the supply is thus 240 volts. By using a larger pass tube, or several in parallel, the range of regulated voltage adjustment can be appreciably extended.

The choice of a control tube is rather arbitrary. Almost any pentode having a sharp cut-off characteristic may be used. The type most frequently employed in electronically regulated supplies is the 6SJ7, which is chosen for its low cost, ready availability, and high gain. Miniature types having similar characteristics may be used in applications where space is at a premium. The 6SJ7 will do nicely for the design under consideration.

Although batteries may be used for the source of control tube reference bias voltage, the gaseous voltage regulator tube is usually preferred. Tubes of the "VR" series give excellent life and stabilization in this application. The choice of VR type, VR75, 90, 105, or 150, depends on the unregulated voltage available and the portion of this which must be reserved for drop across the load-bias resistor (R2) and the control tube. It is desirable to utilize the highest voltage VR tube possible under these conditions, since this subjects the grid of the control tube to a larger portion of output voltage fluctuations. A VR150 is sufficient for the design being discussed, since the bias developed across R2 to reduce the output voltage to minimum is only about —30 volts, as indicated by the plate curves for the 6A3. The plate load resistor (R2) is chosen to be about equal to the plate resistance of the control tube. Values between .47 and .68 megohm are typical for the 6SJ7.

The by-pass capacitor, C1, is usually about .25 uf. It provides a path for 120 cycle ripple voltages and other high frequency fluctuations between the regulated output and the grid of the control tube.

The dropping resistors R3 and R4 are designed to provide 150 volts across the VR tube at the 8 ma. minimum current required for regulation and to provide a tap for control tube screen voltage. In computing the values of these resistors, the minimum unregulated supply output voltage must be used. Allowing for 10 per cent. drop in line voltage, this would be 396 volts in the present case. The required drop is then 396 minus 150 or 246 volts. At .008



SUGGESTED PARTS LAYOUT FOR REGULATED SUPPLY
FIG. 4

ampere drain, the total resistance required (R3 and R4) is 246/.008 or 30,750 ohms. The portion of this resistance between the cathode and screen of the control tube to furnish a screen voltage of 100 volts should be 100/.008 or 12,500 ohms. Thus the nearest standard values of 12,000 and 18,000 ohms will suffice for R3 and R4 respectively.

The total resistance value for the output bleeder is usually about .25 megohm, made up of a 50,000 wire-wound potentiometer for the voltage output adjustment and fixed carbon resistors (R5 and R6) above and below it to complete the total. The exact values of these for any particular regulated supply are most easily determined experimentally by substituting a .25 megohm potentiometer temporarily in place of R1, R5, and R6. Then, with the supply operating, the settings of the potentiometer tap for the minimum and maximum output voltages allowable under full load conditions can be determined. The potentiometer is then disconnected and the resistance measured with an ohmmeter. The resistance between the slider position for low voltage output and the ground end of the "pot" is the value for R5. Similarly, the resistance measured between the slider setting for high output voltage and the "hot" end of the potentiometer is the value of R6. The correct value for R1 is then R5 plus R6 subtracted from .25 megohm.

CONSTRUCTION

Standard power supply wiring practices apply to all portions of the regulated supply except the control tube section. Since this tube is acting as a high gain D.C. amplifier, it is very susceptible to

Continued on Page 32

A Direct-Reading Meter for Measuring Audio Frequencies

PART II

This formula also gives a clue as to what must be done if a less sensitive meter is to be used. Actually, this will hardly be necessary because with the values used in the present design, the maximum allowable meter current is almost 3 ma., and a 1 ma. meter has been specified. This does mean, though, that if a 0-2 ma. meter were to be used, the readings would still be linear up to full scale, and slightly beyond. If, for example, it were desired to use a 0-5 ma. movement, the readings would be linear only up to 3 ma. unless the circuit were altered. From formula (2), it can be seen that the permissible meter current is made greater if V, the square-wave input voltage is increased, and if R the load resistor is decreased. However, it would not be possible to make any improvement just by altering the value of R, because this would also decrease V, the output voltage. So that if R were decreased, the H.T. voltage would have to be increased so that there would not be a corresponding decrease in V. Another way of decreasing R without sensibly affecting V would be to place a cathode follower after the 6V6 squarer tube. The output impedance of the cathode follower would then be of the order of 500 ohms, while the output voltage would remain almost the same.

REMAINDER OF THE CIRCUIT

The remainder of the circuit consists of the power supply, and the switching arrangements which allow the meter to have a number of ranges, and to be correctly calibrated on each range. The H.T. supply is provided by a small power transformer of approximately 210v. a side, at 50 ma., rectified by a 6X5. A single section condenser-input filter is used, and the full H.T. voltage is applied to the cathode followers and the amplifier valve. The plate and screen of the 6V6, however, are supplied from a VR150 regulator tube. This is necessary because changes that may occur in the H.T. voltage applied to the 6V6 would alter the output voltage V, and thus change the meter reading. The series resistor of 3000 ohms in the VR150 circuit was found to be the right value with the transformer used in the laboratory version of the meter, but it does not follow that this will be correct for all power transformers. In practice, this resistor should be made a 10-watt wire-wound adjustable, and its value adjusted until the current through the VR tube is exactly 10ma. This can be measured without disturbing the circuit by measuring the voltage across the 200-ohm resistor below the VR tube. When the tube is passing 10 ma. the voltage should be just 2 volts. Incidentally, the purpose of this resistor, and its connection to the diode circuit is to eliminate the small meter reading that would occur due to contact potential in the meter diode.

It will be noted that a range switch has been provided which not only alters the condenser feeding the diode circuit, but also changes a series of pre-set shunts across the meter. These shunts are used in calibrating the scales, and their use will be described later.

We have not yet mentioned the purpose of the cathode followers before and after the 6J7 amplifier tube. Their purpose is to ensure that whatever the input voltage to the instrument, the reading will be the same after the necessary minimum input has been passed. They provide low-impedance sources to feed both the amplifier and the squarer valves, and their effect is to prevent the grid current, which flows in both valves if the input voltage is large, from altering the effective bias on them. If the grid current is able to build up a kind of grid-leak bias, as it will do if the grid circuit resistances are high, and the source feeding the valves has a high impedance, a disturbing effect occurs. It is that the square-wave no longer has top and bottom portions of equal duration. Then, there is only somewhat less than half the square-wave cycle during which the condenser can discharge, and if this is the case, the linearity will be upset. The effect shows up as a slight change of meter reading when the input frequency is kept constant, but the input voltage is increased. This is obviously to be avoided, since we would not then know which input voltage gives the correct meter reading. The use of the cathode followers reduces this effect to negligible proportions, and after an input of about 0.5 volts is reached, no further increase, up to almost any input voltage (some hundreds, in any case) has any effect on the meter reading.

CALIBRATING THE METER

Since the meter gives a linear indication of frequency, each range we may include starts from zero. Now the most accurate part of the meter's scale (and this applies to any meter at all) is from half-scale to full scale, and below half-scale the accuracy is less. It is thus desirable to have the ranges overlapping to a considerable extent, so that any frequency we may have to measure can be found at least from one-third scale to full scale. For this reason, the ranges have a very generous overlap, and are as follows:— 0-100 c/sec., 0-300 c/sec., 0-1000 c/sec., 0-3000 c/sec., 0-10,000 c/sec., and 0-30,000 c/sec., giving six ranges in all. It has been found, though, that the meter is just as accurate up to a top frequency of about 100 kc/sec., so that if desired, extra ranges may be inserted to accommodate frequencies between 30 and 100 kc/sec.

It is quite an easy matter to work out the theoretically required values of the condensers, to give the desired full-scale readings. This can be done from Equation (1) if the output voltage of the 6V6 is accurately known; however, this is a difficult thing to measure accurately, so the best thing to do is to assume an output voltage, V, of 125 volts, which will not be far out. The required condenser values are then worked out, and the nominal values inserted in the circuit. Then when known frequencies are applied to the meter, corresponding to the desired full-scale readings, it is possible to see whether the meter reads below or above the scale. If slightly above, no change need be made in the condenser value for that range. The calibration is then completed simply by adjusting the meter shunt that is in circuit until exactly full scale is indicated. Then, since the meter indication is linear, no further calibration is needed for that range. Should the meter read less than full scale with the shunt in the maximum resistance setting, and the required frequency fed in, then small amounts of capacity are added to the condenser until the reading is increased to slightly above full scale. Then, the amount is brought into action, and the full scale reading set up. Of course, in order to calibrate the meter, a source of known frequencies will have to be available, so that it will be necessary to beg, borrow, or steal an accurately calibrated audio signal generator for the purpose.

MECHANICAL DESIGN

There is nothing at all critical about the lay-out of this instrument, and builders may please themselves just what form they build the unit up in, as long as ordinary and reasonable precautions are taken. It is, of course, necessary to keep the output of the 6V6 from being too close to the input of the instrument, since this could cause self-oscillation, but this is the only real precaution that need be taken. It is advisable to have a separate earth point for each stage, especially if it is expected to extend the readings up to 100 kc/sec., but if normal constructional practice for audio amplifiers is used, no trouble will occur, and the result will be found an easily built, and very useful instrument.

HAM ACTIVITIES

Conducted by
J. A. HAMPEL, VK5BJ

MAIN topic of conversation between Amateurs, on and off the air these days is that magical word "conditions." Sometimes blamed for any of the many "QSO stoppers," even down to power leaks, this time conditions certainly take the blame for the poor number of stations, DX and local, that can be worked 100%.

Most QSO's these days fold up just as things are getting interesting—and the experts say things will worsen yet!

A good guide to world conditions on all bands is given during the Radio Amateurs' Programme broadcast by the chain of "Voice of America" stations each Sunday at 1915 hrs. E.A.S.T.

Best reception here in VK is provided by the Hawaii relay operating on 6140 kc. and 9540 kc. The best means of keeping informed on Amateur Radio 'politics" and general international news is to tune to this session each Sunday. Incidentally, their predictions are uncannily accurate.

CALLING C.Q.

It is gratifying to hear the comments on this publication under its new management and also the remarks on this Ham session. However, I'm now down to that one staunch reporter 5CH at Mt. Gambier, who never misses with a monthly batch of news. YOU can help make these monthly notes a complete and accurate guide to current Amateur affairs by forwarding news from your district.. Promises are very stimulating, but are only of any material use, when fulfilled.

EMERGENCY v. S/TAX

Biggest blow to all Amateurs was the recent announcement barring the Sales Tax exemption on goods used for transmitting. No doubt your local club and/or local Institute division will be quick to take up the matter and every Ham should press fo raction in this matter. **Is Ham radio a luxury?**

The most democratic of all hobbies which can be conducted with the cheapest and simplest gear or the most expensive, this latter case usually only occurs where the station is to provide reliable service—such as, the authorities look for in time of emergency Let us—and officialdom—not forget the recent work in the N.S.W. floods, the Bushfire Networks, the countless times Amateurs have been able to fill a breach in communications and the thousands of trained operators always available for national service at a moments notice. It's a case of act now or never.

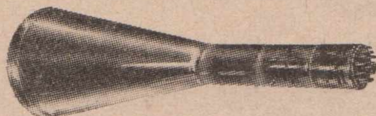
News of the various States parts played in the W.I.A. National Field Day has been very scant, but in VK5 a very successful day was held. More of a social success than an operating day, all those who attended thoroughly enjoyed themselves at this day's outing at the beach. Popular conception of future days is that both a social and an operating day be held each year. A move is already being made to arrange a field day in a country centre late in this year. One lesson has been learnt—lack of publicity can break all efforts to make these days a success. There should be more co-operation between States in advising their plans. The same co-operation could have clinched a recent VK3-VK5 two meter contact, but because of lack of preparation the boys spent most of their time searching for each other on 40 to ascertain the plans made in the other State. Unfortunately, the break through was only one way. Similar misunderstandings have often occurred in the past, sometimes with regard to contests; the Amateur Radio pages of "AUSTRALIAN RADIO AND ELECTRONICS" are at the disposal of societies, clubs and organising committees to publicise their activities so preclude the possibility of such recurrences by forwarding your plans, etc., to the usual address.

AROUND THE SHACKS

3FT has been playing about with his 807 modulator to get it to his satisfaction. Judging by his signal Norm has it working right now .—.—. 5BF has replaced his 814 final with a MC150, an old type tube which still has possibilities up to the 100 watt mark .—.—. 3ABP certainly gets around —this time a trip brought a glimpse down VK1 day on Macquarie Island; Bud's a chap you can expect to deliver your QSL card personally! .—.—.

The number one 50 mc W.A.S. certificate now has pride of place in the 5LC shack. Les literally haunted the six meter band until that coveted award came his way .—.—. 5EN has done this portable business properly—a rig is now installed out at Arwakurra in the mid-north country of VK5. Ern is sending out special cards for contacts made from this QTH when he is on most weekends .—.—. 3AJ1 came Adelaide way recently and threatens to return shortly. Anyway, John promises to bring some disposal gear next trip .—.—.

Continued on Page 27



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12SR7—Duo-diode Triode 20/-
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25A6 GT/G—Power Output Pentode 16/6
3525—Rectifier 14/-
1629—Electron Ray Tube 10/-
CC1—Triode, .2 amp. fil. 15/-
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CL4—Output Pentode, .2 amp. fil. 15/-
CY1—Rectifier, .2 amp. fil. 15/-
C1—Barreter, .2 amp. fil. 15/3
CK1—Mixer, .2 amp. fil. 17/6
EF50—HF, Pentode 15/-
U31—Rectifier 25 volt. .3 amp. fil. 7/6
1941—Barretter, .3 amp. 13/9
6J5GT—Triode 16/-
VR21—2 volt Battery Triode ... 2/6
VR18—2 volt Battery Triode ... 2/6
VR22—2 volt Battery Output Triode 2/6
7193—High Frequency Triode ... 10/-

Please Note.—Trade Prices available on all standard type valves to genuine radio dealers, etc.

Sockets for EF50 Valve. Low loss type for H.F. work ... 3/-
Power Transformer to give 2000 volts for use with 5BP1 or VCR97 Valves 10/-

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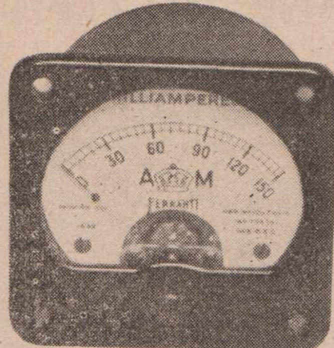
Complete with Rola 6in. Speaker £2/15/6
Extension Speaker Box only, 15/6



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We have the following Meters in stock. They are mostly brand new, and if not, they are in excellent condition:—

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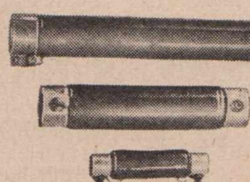
0-20, 0-200 D.C. Volts, 2in. scale, Round 17/6
0-.5 amps. R.F., 2in. scale, Round 22/6
0-40 volts D.C., 2in. scale, Square 19/6
0-3 amps. R.F., 2in. scale, Round 22/6
0-2.5 amps. R.F., 2in. scale, Square 22/6
0-50 MA, D.C., 2in. scale, Square 22/6
0-100 volts A.C., 2in. scale, Square 39/6
0-20 volts D.C., 2in. scale, Square 19/6

Please note the 0-100 volt A.C. Meter is an excellent buy, as it has a 1 MA dry metal rectifier valued at 35/- built into each meter.



BRITISH NAVY RESISTORS

Heavy Duty. Wire wound as illustrated:

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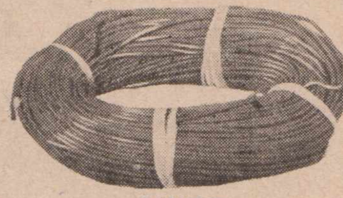
250	20	2/6
350	25	2/6
500	27	2/6
500	55	4/-
1,000	25	2/6
1,000	85	5/-
1,000	120	5/-
1,500	25	2/6
2,000	20	2/6
2,000	25	2/6
2,500	85	5/-
4,000	20	2/6
5,000	55	4/-
5,000	20	2/6



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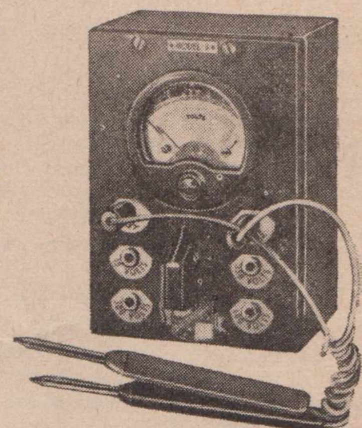
TWIN SHIELDED WIRE, suitable for radio work. Two rubber insulated stranded cores of different colours, enclosed in woven tinned copper metal sheath. Easily worth 2/6 yard. Our price, 1/3 yard.



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VIBRATORS

Ex Disposals in new condition, but shop soiled. 12 volt, 6 pin Ferrocart. Non-Synchronous. Usual price 27/6. Our price 7/6
6 volt 7 pin Mallory Synchronous. Type 525 .... 7/6
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Please Note.—All parcels will be sent registered post unless otherwise stated. Freight must be included with order.

M/S MOTOR SPARES LTD.

547 ELIZABETH STREET, MELBOURNE

HAM ACTIVITIES

(Continued from page 25)

With one of his morse students having been not so lucky at the recent exam, John will still be absent from the bands a certain extent. Yours truly is hoping to be with some of the VK3 boys later this year, but why did I have to pick Melbourne Cup week? They do say accommodation around that time is difficult! .—.—.

Bill, 3XC, has a 6SH7 in an ECO oscillator ending up with 807's in the final. A 12 tube receiver takes care of the receiving side .—.—. Ever bumped into a strange number of stifled yawns mixed with tired voices discussing Ham radio on 7170 kc. on Sunda nights after 2130 hrs. E.A.S.T.? If you have, it's only the Nite Owls Net which any station is invited to join providing he can keep up with the rest. These Nets usually don't finish till after midnight although some drop out before this time. Do you qualify for the Nite Owls Net? .—.—.

With his sons holding the calls 3AFQ and 5IQ, Ham radio has an added interest for 2BM who keeps weekly skeds with them.

Fred runs around 80 watts to the 813 and his receiver is one of those very nice jobs, an AMR300 .—.—. 5DA has been trying clamper tube modulation with successful results; Roy is using a 807 to control an 814 in the final .—.—. The number of stations operating portable of late has no doubt been given impetus by the N.F.D. VK's 7RX, 7SR, 5EN, 3IO, 3ALQ, 2OT and 3ADB have been consistent signals .—.—. Down Mt. Gambier way many of the stations have lapsed into inactivity due to pressure of other activities. 5MA is still dabbling with bricks and mortar—enough to keep anyone off the air.

5KB is apparently lost to the knowledge of the "Mount" boys as they are offering a reward for his safe return to the weekly 2 meter net. 5FD and 5TW are both still not heard—FD through lack of A.C. and TW because of no D.C.—rebuilding his power supplies for higher power .—.—

This lack of A.C. at Mt. Gambier should be rectified soon as Claude, 5CH, is kept off the air installing the town's new Diesel unit at the power station .—.—. Many interstate visitors travel through the 'Mount," recent snoopers around the shacks being 3APF from Shepparton, followed shortly after by John Westley, who is waiting his call to put a signal on .—.—.

ZL2AAH is an ex-VK5 who looks out specially for VK5 stations, the score now being 75. Fred keeps maps of the districts he works into so he can pin point the stations on them. Quite a different twist to the hobby .—.—.

Another ex-VK5 is VK2AKU, who manages to do a fair bit of travelling interstate and sees some of the stations' works. The final is a 15 year old T-20 still going strong modulated by the usual combination of 807's. The receiver is an S.T.C. AMR300 .—.—. Lenny, 5VM, has certainly had his run of bad luck recently with the result he is now convalescing in VK6, but not far from a Ham rig as his familiar voice is being heard from his brother-in-law's station 6VM. All your old friends in VK5 and elsewhere wish you a speedy recovery Len .—.—. 3WR runs a consistent 40 meter transmission with the 100 watts input to a 100TH with 830B's as the mods. Jack uses a simple VFO driving an 807 which is the 100TH driver; the scheme works well and could not be simpler really .—.—.

Cec, 5CD, recently spent 3 weeks at his old home QTH, Keyneton, where he has an AT5 always ready for such visits. Conditions to Adelaide were poor, however, a high number of 2's and 3's were piled up while portable .—.—.

6DX and 5LT have been signing mobile marine while out somewhere in Spencer's Gulf in VK5 waters. Some good fish stories should result from this trip by Bill and Pat .—.—. Many old-timers will remember Maurie Anderwon, ex-5MA, and will be pleased to work him on 40 sometime. The rig these days operated under 3AMA at Sandringham consists of a pair of 807's running only 10 watts. A Hallicrafters SX-28 takes care of reception .—.—.

Once again its 73 de your scribe, but before pulling the big switch, don't you think there is a leaning towards VK5 in regard to news? YOU know how to correct this and the address is Box 1589M, G.P.O., Adelaide—the deadline the 25th of each month. Here's to DX and better conditions.—J. A. H.

PRE-AMPLIFIER (Continued from page 8)

really to the complexity. The output of V2 is therefore (a) bass compensated, and (b) provided with a three-position switch which enables the full frequency response, or two different low-pass filters, to be selected at will to suit the record that is being played. This leaves only V3 and V4. The latter is merely the conventional cathode follower output tube, and requires no comment. V3 provides amplification, and gives a high-pass filter that causes the response to cut off sharply below 20 c/sec. As can be seen from the diagram, the circuit of V3 bears a considerable resemblance to that of V2. This is because V3 also has a parallel T network connected as a feedback network between plate and grid. This time, though, there is only one network, and no switching, so that the circuit looks simpler. The really important difference is that in the case of V3 the output is taken not from the output end of the parallel-T network, but from the plate of the valve itself. This gives us the well-known effect whereby the frequency characteristic of the amplifier becomes the inverse of that of the feedback network,, and as a result, the circuit exhibits a sharp peak at the frequency of the network, instead of a null. This is shown as curve (b) on Fig. 4. Now the response of the rest of the circuit at low frequencies is like (a) on Fig. 4, and when these two curves are added together, the final result is as at (c) on the same figure. Thus we have the required bass boost down to 20 c/sec., after which the response drops away very sharply, and is about 30 db. down at 10 c/sec. This effectively removes the very low-frequency rumbles that are sometimes caused by gramophone motors, and sometimes are actually on recordings due to imperfections in the recording equipment.

It should be emphasized, however, that since the low-frequency cut-off is well below 50 c/sec., and because at 50 c/sec. there is considerable boost, it is essential for the amplifier to be as free of hum as possible. It is partly for this reason that comparatively elaborate precautions have been taken to ensure a completely hum-free H.T. supply. At the same time, the two sections of RC filtering after the main filter act as decouplers, isolating V1 and V2 from V3 and V4.

CONSTRUCTION

The unit is so constructed as to be as flat as possible, so that it can be placed on the shelf under the motor, and will then require a minimum of head room. In many cases it will be possible to instal it in existing motor compartments, without the motor board having to be raised. The greatest height of the unit is just under four inches, and this occurs in such a position that it is well away from the underhang of the motor. In the centre of the motor compartment, the height is only 1¼ in.—the height of a valve lying on its side! The L-shaped chassis is intended to mount in the corner of the motor compartment, so that the control shafts come up clear of the motor, and so that the highest components are also clear. The lowest part of the motor is usually somewhere near the centre of the compartment, so that in allowing space for the pre-amplifier in a new arrangement, only 1¼ in. need be allowed for the height of the unit in the centre. It would have been possible to mount the valves upright on the chassis, but this would not have made nearly as much space available inside for the rather large number of small components that have to be fitted in. Putting the valve sockets on the side of the chassis leaves almost the whole of the underneath free for accommodating these parts.

(To be continued).

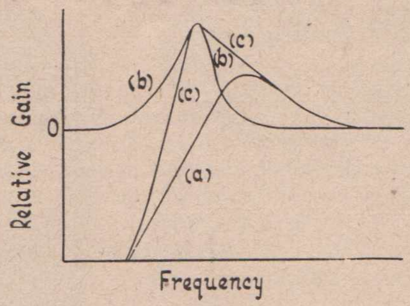
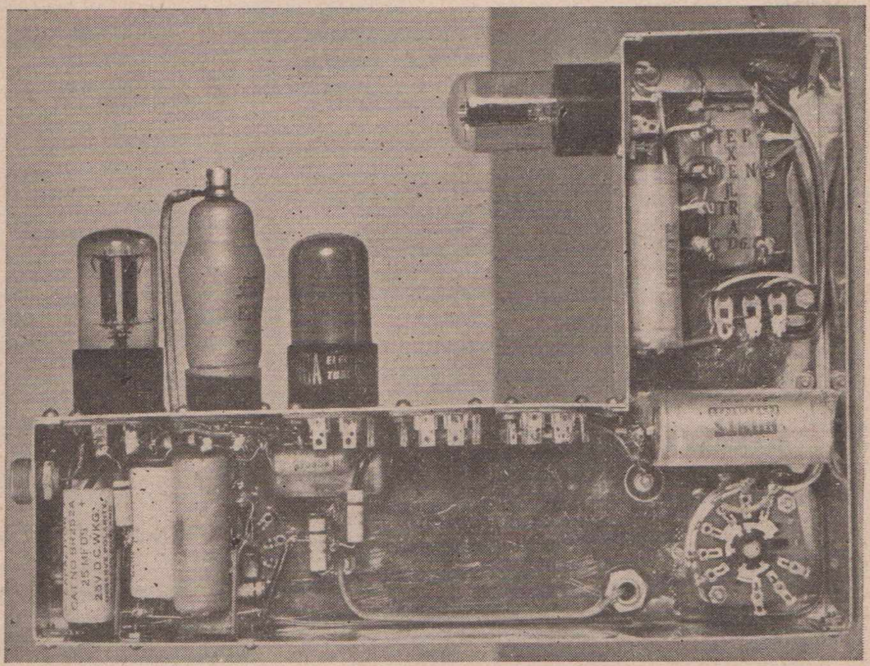


FIG 4



SHORT WAVE REVIEW

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

NOTES FROM MY DIARY

WATCH THAT SWAYING MAST!

Listeners are advised that just about the time this issue should reach them, we will be having our Autumnal Equinoctial Gales.

It is therefore a good time to make sure the guy lines are sufficiently taut and in good order as while the gales last they are pretty severe.

EDITOR'S NOTE:

[Further to Mr. Keast's timely warning, we suggest you also inspect the "lead in" from the aerial to the receiver, and make sure that the insulation has not rubbed through, especially if it passes over the guttering, spouting or other metal objects.

The aerial LEAD IN should be supported away from roofing or other metal with proper insulators, for the reason, that due to the wind blowng the aerial or "lead in" about, terrific crackling noises are created in the receiver by a non-insulated lead in" touching other metal objects, which is sufficient to make short-wave reception unintelligible and nerve-wracking. Check the connection of the lead in" to the aerial proper, making sure that it is still a good joint, as a loose connection here also produces severe crackling, plus a reduction of signal strength].

WELCOME ACKNOWLEDGEMENTS

I have received a letter from Mr. W. R. Anderson of Paddington, N.S.W., who is justifiably proud of having received 19 verifications for a correct report sent to various overseas stations.

As a matter of fact he has logged 7 different countries and is anxiously awating acknowledg-ment of several more reports he has sent.

Mr. Anderson is grateful to the writer for what he terms 'encouraged help" in his New Hobby. Believe me, I am only too anxious to assist newcomers to this delightful hobby and only wish more would send in results of their listening.

RADIO AUSTRALIA

Most shortwave listeners are prone to search the dial for overseas stations, which is quite natural, but I thnk it behoves us to now and again take a look at what our own shortwave stations are doing for listeners at the other end of the globe.

For that reason I have shown at length the latest list received from the A.B.C. overseas service. It is quite a formidable list and indicates the great coverage of the various transmitters.

FOREIGN LANGUAGE BROADCASTS

In the next issue I am showing the B.B.C. service to Europe in foreign languages. This should not only be very welcome to the many 'New Australians" but at the same time be of very great assistance to those desirous of calibrating their receivers.

THE MONTH'S LOGGINGS

B.B.C. SCHEDULES FOR AUSTRALIA AND NEW ZEALAND

Pacific Service—4.00-5.00 p.m.

7.23 mc.	41.49 met.	Aust. and N.Z.
9.69 mc.	30.96 met.	Aust.
11.82 mc.	25.38 met.	Aust. and N.Z.
9.825 mc.	30.53 met.	N.Z.

News at 4.00 p.m. Radio Newsreel at 4.30 p.m.

General Overseas Service

Australia		Time on Air	New Zealand	
6.11 mc.	49.10 met.	4.00- 7.00 p.m.	9.51 mc.	31.55 met.
9.64	31.12	4.00- 7.00 ,,	11.80	25.42
17.715	16.93	7.00- 8.30 ,,	17.79	25.42
21.55	13.92	7.00- 9.15 ,,	15.26	19.66
17.81	16.84	8.30- 9.15 ,,	9.60	31.25
11.75	25.53	10.15-11.15 ,,	15.26	19.66

News at 4.00 p.m., 5.00 p.m., 9.00 p.m.

Radio Ceylon

17.73 mc.	16.92 met.	6.25 p.m.-Midnight
21.62 mc.	13.88 met.	6.25 p.m.-3.05 a.m.
15.12 mc.	19.84 met.	12.10 a.m.-3.05 a.m.

News at 9.00 p.m., 11.00 p.m., Midnight and 2.00 a.m.

Colombo Commercial Transmitter

Radio Ceylon, 21.62 mc., 13.88 met: 8.30-11.30 a.m., 2.30-4.30 p.m.

Radio Ceylon, 15.12 mc., 19.84 met: 11.45 a.m.-5.30 p.m.

Radio Ceylon, 11.975 mc., 25.05 met: 9.30 a.m.-2.30 p.m.

Radio Ceylon, 9.52 mc., 31.51 met: 11.45 a.m.-5.30 p.m.

Radio Ceylon, 7.19 mc., 41.42 met: 9.30 p.m.-2.30 a.m.

Above information from Arthur Cushen.

Continued on Page 31

The "R. and E." Amateur Television Project

Continued from Page 19

resistors, so that in the interests of economy, we have used a single 6AC7, not as a multivibrator, but in an ordinary resistance-capacity oscillator circuit. Normally such a circuit is used to generate a sine-wave, but here it is allowed to oscillate quite hard, with the result that it produces a wave-form which, though not a good square wave, is sufficiently squared off to enable it to produce triggering pulses after having been passed through a differentiating circuit similar to the one following the multivibrator in the frame circuit. The 400 uuf. padder in the oscillator circuit gives some degree of control over the line oscillator frequency, and will be found useful when it comes to operating the whole set-up.

In the line circuit there is a 6H6 which has no counterpart in the frame circuit. Both diode plates are earthed, and one cathode is connected at each end of the 15k. grid stopper for the EN31. It was found that the negative pulses given by the line oscillator after differentiating, were of much greater amplitude than the positive ones. It will be remembered that the negative pulses are merely a by-product, and serve no useful purpose. In the frame circuit, they do no harm either, but in the line circuit, they do have an effect on the charging current of the time-base condenser. The effect is thought to be purely an electrostatic one, due to the small capacity between the plate and grid of the gas tube, and to the large amplitude of the negative pulse. In any event, by connecting the 6H6 as shown, the negative pulse is removed by the conduction of the diodes. These have no effect on the positive pulses, since they cannot conduct when the cathodes are more positive than the plates.

Between the saw-tooth generator and the grid of the first 6AC7 amplifier is a fixed voltage divider, rather than a potentiometer. The reason is that the 6AC7 will not take the whole output of the saw-tooth generator without overloading. At the same time, we want as much voltage output as possible from them, so that the input voltage can be fixed just before the point where they start to overload. Then, in adjusting the shape of the picture, the frame time-base only is controlled as to output voltage. Across the 2 meg. upper portion of the input voltage divider, is a very small variable condenser of 5 uuf. maximum capacity. The purpose of this is to reduce the high-frequency loss sustained because of the high impedance of the grid circuit. In practice it is adjusted until the line time-base, as seen from the output of the amplifier stage, is as linear as possible.

Again because of the high frequency, the tube which amplifies the cathode pulse from the gas tube is made a pentode; note also the low load resistor, of only 10k., and the decoupling network of 10k. and 8 uf. This is used so that the supply to the black-out pulse amplifier shall be as free of hum as possible, and also so that the plate current pulses will not feed back through the power supply to the other stages, and adversely affect their operation.

Continued on Page 32

Short Wave Review

(Continued from Page 29)

"RADIO AUSTRALIA"

Overseas Service—Australian Broadcasting Commission

Call	M.C.	Metres	Time	
VLC	15.20	19.74	6.00- 7.55 a.m.	To New Zealand
VLA-8	11.76	25.51	6.00- 9.11 a.m.	British Isles and Europe.
VLB-11 ..	15.16	19.79	6.29- 9.00 a.m.	Japan, North Pacific
VLC-9 ..	17.84	16.82	8.13-10.50 a.m.	South and South-East Asia
VLA-6 ..	15.20	19.74	9.15-10.50 a.m.	South-East Asia, North-West Australia
VLG-11 ..	15.21	19.72	10.50 a.m.-1.30 p.m.	S.E. Asia and N.W. Australia, except Sat. and Sunday.
VLB-5	21.54	13.93	12.45- 2.15 p.m.	Japan. N. Pacific (Sats. & Sun. 11.56-12.45)
VLA-6	15.20	19.74	12.45- 2.15 p.m.	S.E. Asia (Sat. 12.00-2.15 p.m) (Sun. 11.56-2.15 p.m.)
VLC-9	17.84	16.82	12.45- 2.30 p.m.	S. and S.E. Asia (Sat. and Sun. Noon-2.30 p.m.)
VLB-5	21.54	13.93	12.45- 5.30 p.m.	Japan, N. Pacific, Sporting—Sats. only.
VLC-9	17.84	16.82	2.30- 3.45 p.m.	S. and S.E. Asia
VLB-5	21.54	13.93	2.30- 3.45 p.m.	Africa, except Saturday
VLA-6	15.20	19.74	2.30- 3.45 p.m.	N. America (West Coast)
VLG-11 ..	15.21	19.72	3.45- 5.30 p.m.	S. E. Asia
VLC-4	15.32	19.59	4.00- 4.40 p.m.	In French to French Indo-China
VLH-5	15.23	19.70	4.00- 4.40 p.m.	In French to Tahiti (except Saturday)
VLA-6	15.20	19.74	4.00- 4.40 p.m.	In French to Tahiti, Sunday and Monday
VLA-6	15.20	19.74	4.00- 7.00 p.m.	China in Chinese
VLC-10 ..	21.68	13.84	4.55- 6.15 p.m.	British Isles., South Asia
VLB-9	9.58	31.32	4.40- 6.15 p.m.	New Zealand, British Isles (Sat. 5.45-6.15 p.m.)
VLG-11 ..	15.21	19.72	5.00- 5.30 p.m.	In Thai to Thailand, Fridays only
VLG-11 ..	15.21	19.72	5.45- 6.45 p.m.	In French to New Caledonia
VLB-4	11.85	25.32	6.28- 7.50 p.m.	Japan, North Pacific
VLA-6	15.20	19.74	6.28- 9.30 p.m.	Japan, N. Pacific (Sun. & Mon.) (Tues.-Sat. fr.7.00 p.m.)
VLC-4	15.32	19.59	6.28- 8.30 p.m.	S. and S.E. Asia
VLB-4	11.84	25.32	8.00- 9.30 p.m.	S. E. Asia
VLC-4	15.32	19.59	8.30- 9.00 p.m.	In Indonesian to Indonesia
VLC-4	15.32	19.59	9.00- 9.30 p.m.	S. and S.E. Asia
VLA-6	15.20	19.74	9.30-11.55 p.m.	Japan, N. Pacific
VLB-4	11.85	25.32	9.30-Midnight	S. and S.E. Asia
VLC-7	11.81	25.40	10.00 p.m.-Midnight	North America (East Coast)
VLA-6	15.20	19.74	Midnight-1.00 a.m.	British Isles, Europe
VLB-4	11.85	25.32	Midnight-1.00 a.m.	S. and S.E. Asia
VLC-7	11.81	25.40	Midnight-1.00 a.m.	N. America (Central and Mountain)
VLC-7	11.81	25.40	1.00- 2.15 a.m.	N. America (West)
VLB-4	11.85	25.32	1.00- 2.15 a.m.	S. and S.E. Asia
VLA-6	15.20	19.74	1.15- 2.15 a.m.	Africa.

France

Radio Paris, 6.14 mc., 48.85 met: Has a new English-French lessons session, "The French have a word for it," 6-6.15 p.m., but heard better on 7.25 mc., 41.44 met.

Radio Paris, 620 mc., 48.4 met: Excellent signal at 4.00 p.m. on Sundays (Cushen).

Germany

Radio Frankfurt, 6.19 mc., 48.47 met: News in German at 5.00 p.m.

Greece

Radio Athens, 6.177 mc., 48.58 met: Programmes in Greek 3.00-4.30 p.m., 1.00-3.00 a.m. and 6.30-8.00 a.m.

Radio Athens, 9.607 mc., 31.24 met: Programme in Greek, 7.30-11.30 p.m. Programme for U.S.A. 11.00 a.m.-Noon. English 5.30-5.45 a.m., French 5.45-6.00 a.m.

Radio Athens, 7.30 mc., 41.15 met: Programme in Balkan Languages, 3.30-5.00 a.m.

Hungary

Radio Budapest, 6.247 mc., 48.00 met: English programme at 8.00 a.m.

7.22 mc., 41.55 met: Same as above.

9.833 mc., 30.52 met: Same as above

Poland

Polskie Radio, Warsaw, 9.57 mc., 31.35 met: Signs at 11.30 after giving programme in Russian.

Portugal

Emisora Nacional, Lisbon, 15.375 mc., 19.50 met: This new frequency is heard from 3.00 -9.00 am.

Spain

Radio Nacional De Espana, Malaya. Broadcasts programmes in Swedish on Saturdays at 7.00 a.m. (Sweden Calling). Proposes to give English at this hour on some other day.

China

Radio Peking, 10.26 mc., 29.23 met: At 5.30 a.m. can be heard in Chinese.

Radio Peking, 7.10 mc., 42.25 met: Programme in English at 11.30 p.m.; also heard in 11.688 mc., 25.68 met: and 15.00 mc., 19.92 met.

French Indo-China

Radio France-Asia, Saigon, 9.495 mc., 31.60 met: Midnight-1.30 a.m. Also heard on 11.78 mc., 25.46 met.

Radio France-Asia, Saigon, 9.517 mc. Heard at 8.30 p.m. (Radio Australia).

Korea

HLKA, Seoul, 7.933 mc., 37.83 met: On air from 9.00-9.45 a.m. with English at 9.15.

SCANDINAVIA

Norway

LLP, Oslo, 21.67 mc., 13.85 met: 5.00-6.00 a.m., 9.00-10.00 p.m., 11.p.m.-Midnight.

LLM, Oslo, 15.175 mc., 19.77 met: 9.00-10.00 p.m., 11.00 p.m.-Midnight.

LKV, Oslo, 15.17 mc., 19.78 met: 5.00-6.00 a.m., 9.00-10.00 a.m., 11.00 a.m.-Noon.

LLK, Oslo, 11.85 mc., 25.32 met: 9.00-10.00 p.m., 11.00 p.m.-Midnight.

LKQ, Oslo, 11.735 mc., 25.56 met: 9.00-10.00 a.m., 11.00 a.m.-Noon.

LLG, Oslo, 9.61 mc., 31.22 met: 5.00-6.00 a.m., 9.00-10.00 a.m., 11.00 a.m.-Noon, 9.00-10.00 p.m., 11.00 p.m.-Midnight.

Above information from Rex Gillett.

EUROPE

Czechoslovakia

OLR3B, Prague, 9.504 mc., 31.57 met: News in English at 6.30 a.m.

T.V. PROJECT (From Page 30)

Because of the presence of a high cathode resistor in the amplifier stage, it is necessary to put a small positive voltage on the grids of the tubes so that they shall be properly biased. Without this voltage they would be considerably over-biased, and would distort badly at all output levels. This positive voltage is derived from the H.T. line via a voltage divider consisting of a 100k. and a 10k. resstor in series. There is no need to by-pass the junction as long as the H.T. line is adequately filtered, but it is advisable to do so because this improves the decoupling between the two grids. The grid return of the first 6AC7 is taken to the voltage divider not directly, but through a filter comprising the two 8 uf. condensers and the 50k. resistor. This filter ensures that there is no signal feedback from one grid to the other, because the grid of the second 6AC7 should be at earth potential as far as signal is concerned. A large screen bypass condenser is not needed because the amplifier stage has to handle only frequencies above 15,000 c/sec,. and for the same reason, the grid coupling condensers can be quite small, likewise the condensers blocking the D.C. plate voltage from the deflecting plates.

Again for hum reasons, as well as for decoupling, a filter of 20k. and 8 uf. is placed in series with the plate resistor of the line EN31.

(To be continued).

REGULATED POWER SUPPLY

Continued from Page 21

hum pick-up which will appear as ripple in the output voltage. To minimize this, all leads associated with the control tube, and especially the grid lead from R1, must be as short as possible. The best practice is to mount the voltage control potentiometer adjacent to the control tube socket at a location as far as possible from the power transformer, filter chokes, filament transformers, and other components which produce hum fields.

A chassis lay-out which is suitable for the design discussed above is shown in Fig. 4. All parts are mounted on a 7 x 11 x 2 inch metal chassis. Well-shielded components should be used and all A.C. leads must be twisted in pairs to reduce hum radiation. A separate filament winding is required for the regulator tube since the filament of this tube is operated at the full supply output voltage above ground. When the special 6AS7G pass tube is used, this precaution is not necessary because the heater-cathode insulation in this tube is sufficient to withstand 300 volts.

The completed supply should be checked for satisfactory regulation by varying the load current from the full design rating to zero. Under these conditions, the change in output voltage should be negligible. Ripple content can be checked qualitatively with earphones coupled through a suitable condenser, although an oscilloscope is very much preferable.

N.B.F.M. ADAPTER (From Page 13)

The curve given on page 13 shows the actual input versus output curve for the original model. It can be seen that there is a perfectly straight portion in the centre of the curve that will give substantially distortionless reproduction of a signal that is modulated plus and minus 1½ to 2 kc/sec. about the centre frequency. It also shows that with this order of frequency deviation, the output will approximate 0.5 volts peak, which is enough for fully loading most audio amplifiers.

* * *

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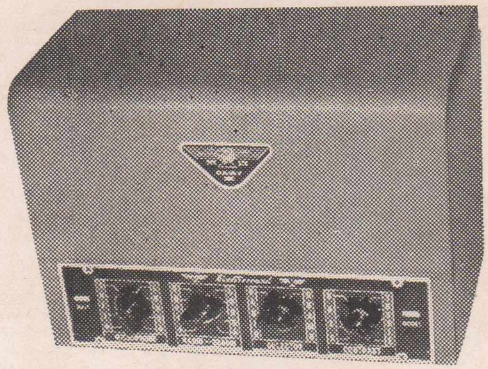


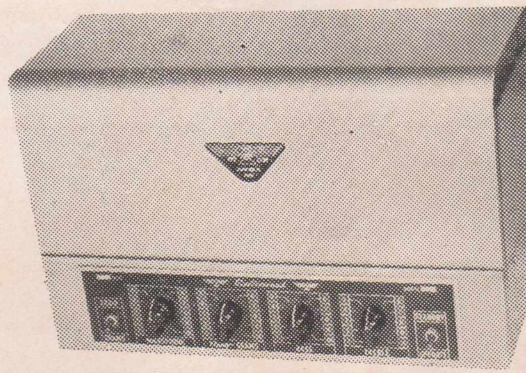
SPECIFICATIONS—MODEL X15

INPUTS, high impedance, gramo .5 meg., microphone .1 meg., radio .5 meg.
SENSITIVITY, gramo .25 volt, microphone .002 volt, radio .25 volt.
POWER OUTPUT, 15 wts. Noise level—50 db.
DISTORTION, maximum 5% at full output.

OPERATING VOLTAGE, AC 220, 240, 260 volts.
OUTPUT IMPEDANCE, 600, 300, 150, 75, 37.5, 18.75 ohms.

VALVES, 2/6AU6, 1/6SN7-GT, 2/6V6GT, 1/5V4G.
DIMENSIONS: $13\frac{1}{4}$in. x $9\frac{1}{2}$in. x $8\frac{1}{4}$in.

☆



SPECIFICATIONS—MODEL XV25

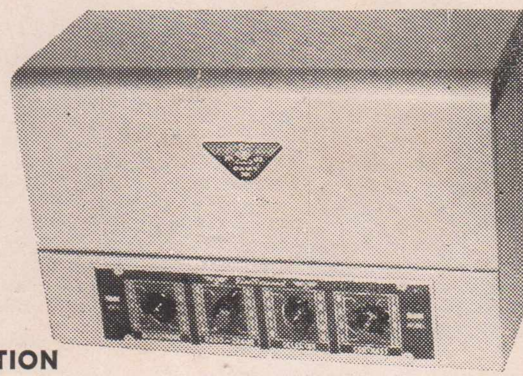
INPUTS, high impedance, gramo .5 meg., microphone .1 meg.

SENSITIVITY, gramo .25 volt, microphone .002 volt.
POWER OUTPUT, 25 wts. Noise level—46 db.
DISTORTION, maximum 5% at full output.

OPERATING VOLTAGE, battery 12 volts or AC 240 volts.
OUTPUT IMPEDANCE, 600, 300, 150, 75, 37.5, 18.75 ohms.
VALVES, 2/6AU6, 1/6SN7-GT, 2/807 2/6X5GT.
DIMENSIONS—16in. x 10 in. x $8\frac{1}{4}$in.

NOTE: This amplifier is designed for use from either battery or A.C. mains. Changeover for either operation is made by simply changing connecting cables supplied with amplifier.

☆



SPECIFICATIONS—MODEL X30

INPUTS, high impedance, gramo .5 meg., microphone .1 meg., radio .5 meg.
SENSITIVITY, gramo .25 volt, microphone .002 volt, radio .25 volt.
POWER OUTPUT, 30 wts. Noise level—50 db.
DISTORTION, maximum 5% at full output.

OPERATING VOLTAGE, AC 220, 240, 260 volts.

OUTPUT IMPEDANCE, 600, 300, 150, 75, 37.5, 18.75 ohms.

VALVES, 2/6AU6, 1/6SN7-GT, 2/807, 1/5V4G.
DIMENSIONS, 16in. x 10 in. x $8\frac{1}{4}$in.

Fidelity AE

PRICES ON APPLICATION

Audio Engineers Pty. Ltd.

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B-46-D CRYSTAL MICROPHONE

GOOD SOUND REASONS

- **FLAT FREQUENCY RESPONSE**
  Total variation less than 6db between 40-8000 c.p.s.
- **HIGH IMPEDANCE**
  Direct connection to grid circuit of amplifier—no transformer required.
- **HIGH OUTPUT**
  Sensitivity—50db referred to 1 volt/dyne/cm2.
- **ACCOUSTIC FILTER**
  New acoustically treated interior filter stops wind and breath blasts. Eliminates wind rumble in outdoor pickup.
- **ECONOMIC INSTALLATION**
  No polarising voltage required.
- **NON-DIRECTIONAL**
  "Live" area around entire circumference.
- **HERMETICALLY SEALED**
  Unaffected by temperature changes or climatic conditions.
- **VERSATILE**
  Equally suited for either close proximity use or distant pickup—indoors or out.
- **EASY MOUNTING**
  Handle threaded for mounting to stand—stand available at slight extra cost.
- **ROBUST**
  Spherical screen casing fully protects element.

B - 46 - D "AUDIO - CELL" MICROPHONE

ATTRACTIVE design and precision workmanship put the B-46-D in the "luxury" class at an **economic price.** Ask your dealer for the B-46-D. Its outstanding performance, attractive oxide finish and discreet decoration will enhance any equipment. Ideally suited for every application where a high degree of fidelity is required—from outdoor P.A. work to the most elaborate studio installation.

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