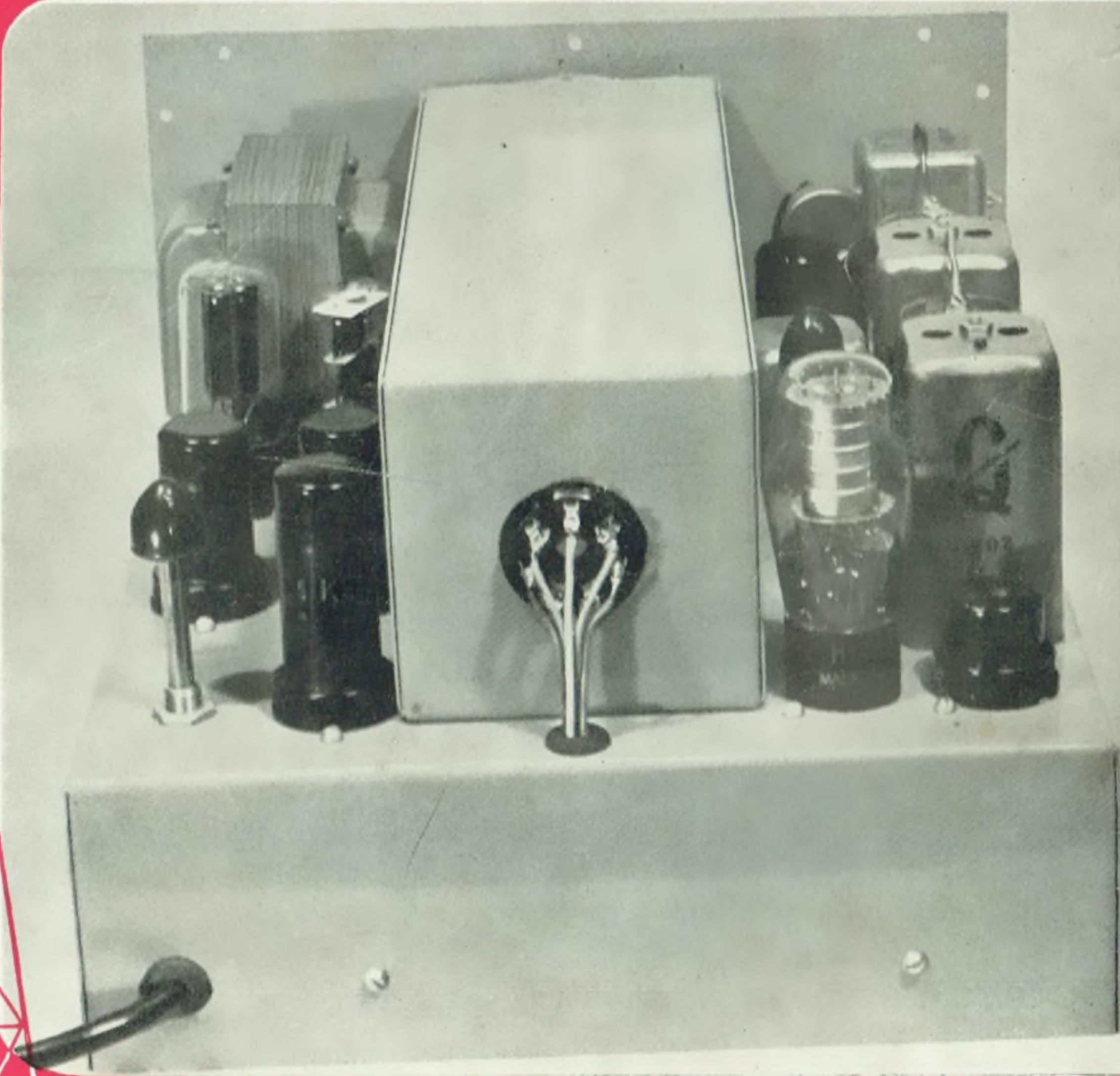
RADIO and ELECTRONICS

ELECTRICITY — COMMUNICATIONS — SERVICE — SOUND



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RADIO and ELECTRONICS

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OUR COVER:

Our cover picture this month shows a rear view of the panoramic adaptor, a description of which begins in this issue.

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The "Radio and Electronics" Portable Competition

The competition for amateur-designed portable receivers has come and gone, and the judges have burned a good deal of midnight oil in their deliberations, with the results that appear below.

Judging the entries was an interesting experience, if somewhat reminiscent of marking examination papers (two judges) and of interviewing applicants for jobs (the remaining one). The subject was admittedly a difficult one, in that a limited choice of suitable valves exists, and that it is difficult, without departing from sound practice, to introduce a great deal of original thought into the circuit, which is perhaps the most important single item. Nevertheless, some interesting ideas emerged. A number of entrants rebelled against the low acoustic efficiency of the very small speakers, as compared with the larger ones, and designed their sets to use 5", and in some cases even 8" loud-speakers.

Several entries made use of midget single-tuned I.F. coils in preference to conventional midget double-wound transformers, but some of them failed to take advantage of the small cubic content of these coils in adding to the possible compactness of the whole.

On the whole, the ideas of the competitors were sound, and the number of circuits which would definitely not have worked, had they been built according to the strict letter of the designer's instructions, was very small. A number of minor imperfections in circuit drawing were apparent, such as the failure to draw I.F. transformers correctly, or to show any means of tuning them, but some periodicals set a particularly bad example in this respect. A notable omission in many circuits was a bypass condenser across the H.T. supply. This is essential in any portable.

However, the entrants are to be congratulated on their efforts. It would have been pleasant to have been able to give extra points to not a few, purely as a bonus on the amount of time and hard work put into their material.

We have much pleasure, then, in presenting the list of prize-winners which follows, and would like to take this opportunity of once more thanking all those who submitted entries, and in particular, Mr. Billing, of Messrs. Turnbull & Jones Ltd., and Mr. Hall, of the Department of Scientific and Industrial Research, who gave valuable service in the arduous task of judging.

1st PRIZE:

Radio parts to the value of £25, made up as follows:—

S.O.S. Radio Ltd., Auckland	£5
Fears Radio & Cycle Co. Ltd., Wellington	£5
'Tricity House, Christchurch	£5
Eclipse Radio, Dunedin	£5
Radio and Electronics	£5

Won by Mr. Ian Ogilvie, 31 Grass St., Wellington.

2nd PRIZE:

Radio parts to the value of £10, made up as follows:—

The National Electrical & Engineering Co. Ltd., Radiotron valves worth £5

Won by Mr. H. E. Pattinson, c/o P.O. Box 448, Masterton.

3rd PRIZE:

Radio parts to the value of £5, donated by Inductance Specialists.

Won by Mr. R. A. Kelly, 574 Sandringham Road, Mt. Albert, Auckland, S.W.1.

4th PRIZE:

Radio batteries to the value of £2 10s., donated by The National Carbon Co. Ltd.

Won by Mr. K. H. Miller, Opaku, Patea.

5th PRIZE:

Radio batteries to the value of £2 10s., donated by The National Carbon Co. Ltd.

Won by Mr. G. B. Gerard, Black Hills, Hororata.

6th PRIZE:

Radio parts to the value of £2 10s., donated by Webbs Radios Ltd.

Won by Mr. C. D. Johnson, 34 Bridge Street, Te Aroha.

7th PRIZE:

Radio parts to the value of £2 10s., donated by Webbs Radios Ltd.

Won by Mr. L. Yeoman, 470 Armagh Street, Christchurch.

The pick-up you've waited for

. . . a new miniature light-weight moving iron pick-up

A fascinating piece of precision engineering—the head being only half the size of its competitors—constant velocity type—no attempt being made to compensate for the loss in recording frequencies below 300 C.P.S. This has enabled the removal of bass resonance below 30 C.P.S. and allowed a very free needle mounting and good tracking down to this figure. At double pianissimo or double forte there is no distress, and at full amplification on a three-stage amplifier there is no distortion of bass or treble notes. Needle chatter is reduced to the point of inaudibility.

Moving Masses: Reduction in moving weight reduces record and needle wear.

Armature: Oil damping eliminates treble resonance above useful recording and width of magnet gap reduces possibility of amplitude distortion to minimum.

Coil: Of high impedance—1,300 ohms at 1,000 C.P.S.; the correct working load required across pick-up is 10,000 ohms.

Output: Direct from pick-up terminal is 1/10 volt which will fully load a three-stage amplifier. Bass lifting in the amplifier is required at a lift of 15 db. at 50 C.P.S. from the 300 C.P.S. mark; a treble control is advised to suit the individual recording, as the response of the pick-up falls only 5 db. at 8,500 C.P.S. and 9 db. at 12,000 C.P.S. A coupling transformer is supplied to slip the voltage up to 5 volts, which will then fully load the standard Commercial set.

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A Panoramic Adaptor Unit for Amateur Transmitters and Others

Some time ago, there appeared in these pages an article describing the principles and uses of the panoramic adaptor. At that time, it was felt that although this interesting and useful device would be very popular if it could be built, at a reasonable cost, the high post-war price of cathode-ray tubes would prevent many of those interested from building one. Now, however, the situation is rather different, and many amateurs have C.R.T.'s, obtained very cheaply; we have therefore designed the instrument to be described here. It can be built to incorporate its own C.R.T., or, just as easily, can be connected to a normal oscilloscope circuit.

Introductory

In the October, 1947, issue of *Radio and Electronics*, we printed an article entitled "The Panoramic Receiver." In this article, the outline was given of the way in which such a receiver works, and of the uses to which it could be put. For those who have not seen the above article, a few words of explanation of the panoramic receiver, and of the things that can be done with its aid, would be desirable, so that at the expense of some repetition, this will be done.

Purpose of the Panoramic Receiver

The primary purpose of a panoramic receiver is to show *visually, on a cathode-ray tube*, the signals that are present at the receiving location within a band of frequencies centred on the frequency to which the receiver is tuned. The whole system therefore consists of two parts. The first is a normal receiver, of any desired type, communications or otherwise, while the second is a unit, containing the cathode-ray tube and associated circuits, which enables the special function stated above to be fulfilled. Thus, the complete scheme lends itself very well to the production of the second portion as an adaptor, capable of being attached to and used with any communications receiver, within limits. These limits are not very severe, either, and the design given here could easily be applied to any receiver at all, with only slight modification, depending on whether or not the main receiver has an I.F. in the region of 465 kc/sec.

The rather numerous applications of the panoramic receiver will be left for enumeration and description until the circuit and construction of the adaptor has been dealt with. The reader is at liberty either to take the usefulness of the device on trust, in the meantime, or else to read the article referred to above, which gives considerably more detail than we have space for here.

Block Diagram of the Unit

This is to be found in Fig. 1. It will be assumed in this description that the main receiver has an I.F. of 465 kc/sec. This does not limit in any way the usefulness of the explanation, or the basic design of the unit for that matter, as will be seen in due course. The plate circuit of the main receiver's mixer is shown on the block diagram, because it is here that the inter-connection between the two units is made. The panoramic unit itself starts off with a transformer, with a nominal frequency of 465 kc/sec. This feeds immediately into a second mixer, which with its associated oscillator, heterodynes the 465 kc/sec. signal from the receiver to a frequency of 100 kc/sec. There is no compulsion about using this frequency for the second I.F. the main point about it is that it is much lower than the first I.F.—that of the receiver. Should the latter have an I.F. of a different value, then the only differences made to the panoramic unit would be (1) that the input transformer would tune to this frequency, and (2) that the second oscillator would have its frequency altered so that the heterodyne frequency was still 100 kc/sec. Following the mixer is a stage of amplification at 100 kc/sec. This is standard in all respects. Then comes a diode detector, which may or may not be followed by an audio stage, and whose output feeds the detected signal to the Y-deflection plates of the cathode-ray tube. For simplicity, this has not been shown on the block diagram. Its circuit is quite standard, and includes the high-voltage power supply, circuits for shifting the spot to any part of the screen, and the brilliance and focus controls. These are common to any cathode-ray tube, whether used with a panoramic adaptor or not, and the

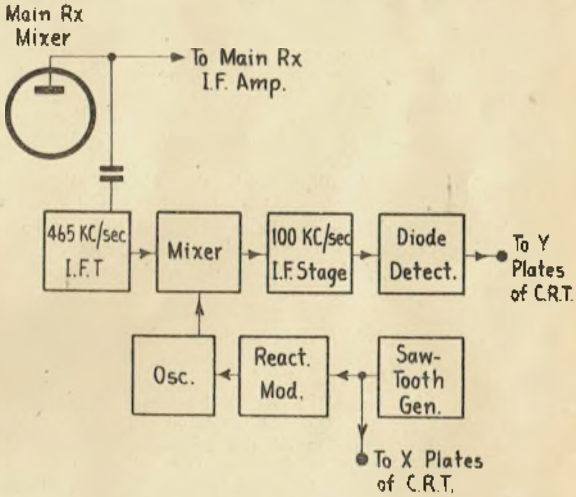


Fig. 1.—Block diagram showing the main components of the panoramic system.

leaving of them out of the block diagram serves to emphasize that, if desired, an already constructed oscilloscope can be used in conjunction with the panoramic unit, rather than building in a tube which would then belong solely to the unit, and would not be available for other purposes.

The remaining three blocks in the diagram are the oscillator, a saw-tooth generator, or time-base circuit, and a reactance modulator, whose purpose is to frequency modulate the heterodyne oscillator of the panoramic adaptor. The time-base generator feeds both the reactance tube, in order to frequency modulate the oscillator, and the X-deflection plates of the cathode-ray tube, in order to produce a horizontal trace on the screen in the same way as is done in many oscilloscope tests that use a linear time-base.

How it Works

Let us now consider just what this set-up does, and what sort of picture it produces on the screen of the cathode-ray tube.

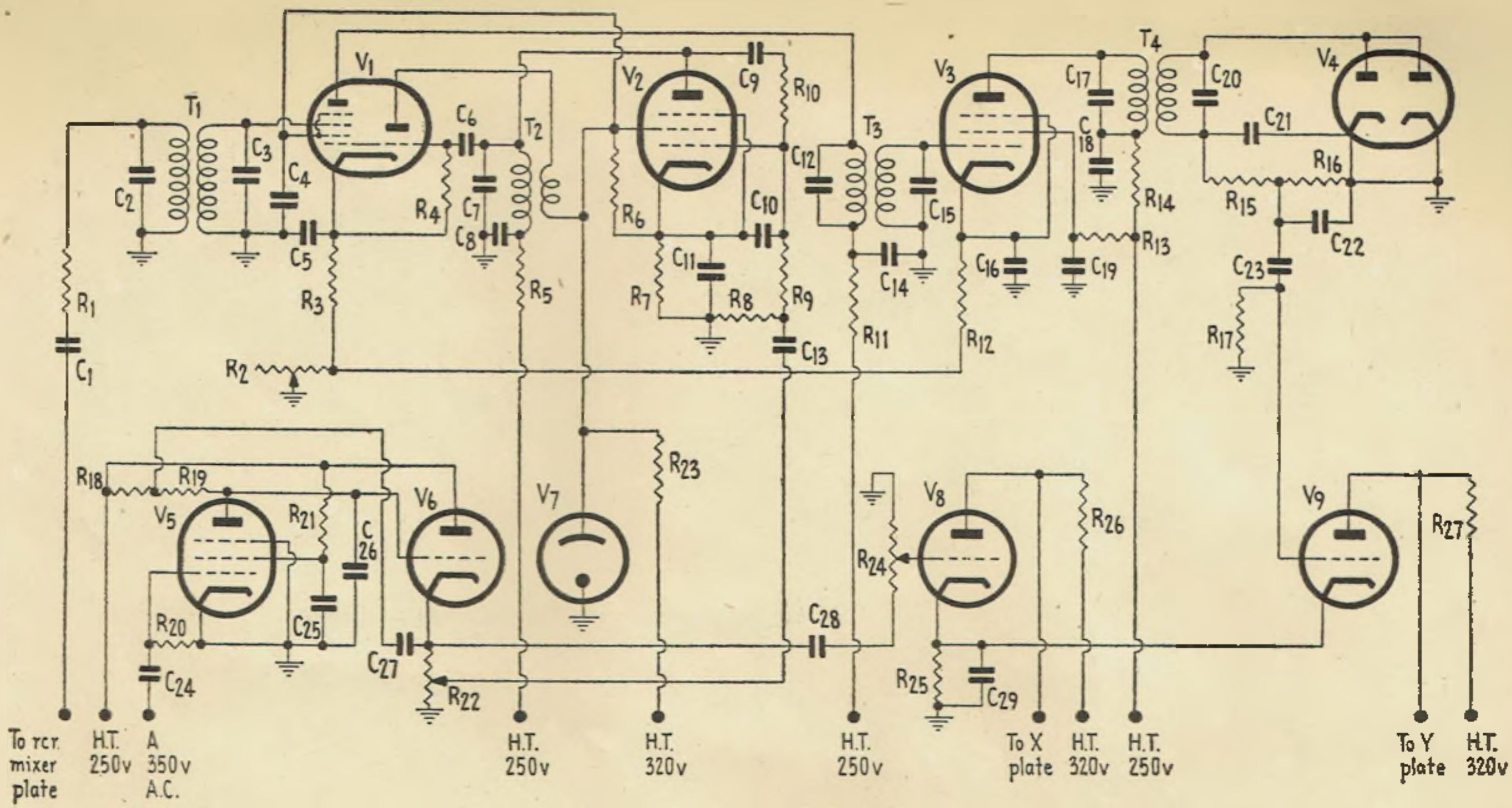
First of all, if the fact of the frequency modulation of the adaptor's oscillator is forgotten for a moment, it is clear that the upper row of blocks represents nothing more than a fixed-frequency receiver, designed to receive 465 kc/sec. It is a superheterodyne, and has an intermediate frequency of 100 kc/sec. Thus, the local oscillator must have a frequency of either 565 or 365 kc/sec., either of which will produce the necessary heterodyne frequency of 100 kc/sec. So far so good. All we have left to cope with now is the effect of frequency-modulating the oscillator and of placing the output of this receiver on the Y plates, and the saw-tooth modulating voltage on the X plates of the cathode-ray tube.

Another obvious similarity between the block-diagram and a well-known type of receiver test set-up will explain this very quickly to many readers. The lower three blocks form an exact representation of the now well-known frequency-modulated signal generator, used for displaying on a cathode-ray tube the selectivity curve of a receiver, for alignment purposes. The receiver portion just mentioned, namely, the upper line of blocks, represents the receiver whose selectivity curve is to be drawn on the face of the C.R.T., and together the block diagram represents exactly the system of visual alignment. By analogy, then, the picture on the tube must therefore be a plot of the selectivity curve of the 100 kc/sec. amplifier stage. This is why the low I.F. is used. The more selective the 100 kc/sec. amplifier, the smaller and narrower will be the "pip" on the screen representing a signal coming into the receiver, and so the more signals that can be resolved, or separated visually from each other.

For those not familiar with the visual alignment process, a little more detailed explanation will be necessary, so that at this point those who feel that no more explanation is necessary can skip to the next heading where a start is made with the detailed description of the circuit.

Suppose now that the main receiver is accurately tuned to a signal, which it is producing from the speaker or phones. Since it is accurately tuned, there will be a signal in the I.F. channel of the receiver, of exactly 465 kc/sec. This signal is fed to the input of the panoramic unit. Now suppose that we have a manual tuning control on the oscillator of the adaptor, and that the frequency modulation is disconnected. If we vary the tuning of the oscillator by hand, we can get exactly the same effects as with the frequency modulator, with the sole exception that the latter works at a very great rate, and by hand we can only make slow adjustments to the oscillator frequency. First of all, with our oscillator tuning dial we can tune in the 465 kc/sec. signal coming from the receiver. Let us imagine, too, that the saw-tooth generator is not working, but that the output of the adaptor is fed to the Y plates of the C.R.T. When the signal is tuned in, if it is a modulated one, there will be a vertical line on the face of the tube, and in addition, its length can be used as an indicator of relative signal strength, or in other words, as a simple output indicator. Thus, when we have tuned in the 465 kc/sec. signal with the oscillator tuning control, the line will have its greatest length. Now suppose that by manipulating the tuning control we reduce the frequency of the oscillator by 5 kc/sec. The I.F. is now no longer exactly 100 kc/sec., but is, say, 95 kc/sec. Since the I.F. amplifier is tuned to 100 kc/sec., the adaptor's output voltage will have decreased, and this will show on the screen as a reduction in the length of the vertical line. Suppose now that we retune the oscillator, through the correct frequency, and on to the other side of the signal. Again the output of the adaptor drops, and if we detune by 5 kc/sec. on this side also, and measure the length of the line on the 'scope, we will find that it is the same length as it was when the oscilloscope was detuned on the other side of resonance. If we detune again, but by a different amount, first on one side of resonance, and then on the other, we will find again that the oscillator frequencies give identical outputs from the adaptor, but that the actual value is different from what we had when the detuning was 5 kc/sec. Thus, if we start with the oscillator frequency too low for correct tuning, and slowly increase the frequency, the following series of events takes place. The output gradually increases, and reaches a maximum when exact tuning of the 465 kc/sec. signal is reached. As the oscillator frequency changes to the high-frequency side of resonance, then the output voltage drops again. Our imaginary tests with spot frequencies tell us that if we plotted a curve of output voltage against oscillator frequency this curve would show a peak where the oscillator was at 565 kc/sec., because at this frequency the actual I.F. output would be exactly 100 kc/sec., and the falling response would be symmetrical, on either side of resonance. In other words, we would have a plot of the selectivity curve of the 100 kc/sec. I.F. amplifier. Now the job of the saw-tooth generator and frequency modulator is simply to do all that we have been describing, automatically, and at high speed.

How, then, does this come about? Well, in the first place, the frequency modulator is simply an automatic means of sweeping the oscillator frequency from a frequency below 565 kc/sec., through this frequency, and beyond. The Y deflection displays the amplitude of the output voltage while this is going on, just as has been described for hand operation. Unfortunately, we need the C.R.T. to do more than this, because if there were no deflection in the horizontal direction, the changes in height of the line representing the output voltage would not show up, so fast do they occur. Now, in using a saw-toothed voltage for sweeping the oscillator frequency, all we are doing is to sweep the frequency at a uniform rate, just as if we were using a tuning control which had a straight-line-frequency law. At the end of the comparatively slow, uniform rise of voltage which makes up the sloping part of the saw-tooth voltage, there is a sudden change, lasting only a fraction of the time taken by the rise, and during which the voltage returns to where it started from, in order to commence a new slow rise. Ideally, this flyback to the beginning should be able to be ignored, and so for the meantime we will do so. Finally, the same saw-tooth which sweeps the oscillator frequency is applied to the X deflection plates of the C.R.T., and here its effect is to sweep the spot from left to right across the face of the tube. The important thing to remember is that it does this at the same rate as it sweeps the oscillator frequency. That is to say, for each time the oscillator frequency is swept past the signal, the spot on the C.R.T. travels once across the screen. During the quick flyback of the oscillator, the C.R.T. spot also flies quickly back across the screen from right to left. This jump is made so quickly that the trace it makes on the screen is much fainter than the main trace, and can therefore be ignored. If the sweep of the C.R.T. spot, and the sweep of the oscillator frequency took place only once, it would not be possible to see what had happened. The whole cycle of events is therefore made to repeat itself at the rate of



COMPONENT LIST

R_1, see text.
R_2, 25k. pot.
R_3, 250 ohms.
R_4, R_9, R_{10}, R_{18}, R_{22}, 50k.
R_5, 2k.
R_6, R_{23}, 10k.
R_7, 300 ohms.
R_8, R_{20}, R_{27}, 250k.
R_{11}, R_{14}, 5k.
R_{12}, 350 ohms.
R_{13}, R_{15}, R_{19}, R_{21}, 100k.
R_{16}, 500k.
R_{17}, 1 meg.
R_{26}, 5 meg.
R_{24}, 500k. pot.
R_{25}, 3k.
C_1, see text.
C_2, C_3, C_{12}, C_{15}, C_{17}, C_{20}, I.F. trimmers.
C_4, C_{19}, C_{23}, 0.05 μf.
C_5, C_8, C_{14}, C_{16}, C_{18}, C_{24}, 0.1 μf.
C_6, C_{10}, 50 $\mu\mu$f.
C_7, 3–30 $\mu\mu$f. Philips trimmer.
C_9, C_{21}, C_{22}, 250 $\mu\mu$f.
C_{11}, 50 μf. electro.
C_{13}, C_{25}, C_{27}, C_{28}, 0.5 μf.
C_{26}, 1 μf.
C_{29}, 25 μf. 25v. electro.
T_1, 465 kc/sec. I.F. transformer.
T_2, 365 kc/sec. osc. coil (see text).
T_3, T_4, 100 kc/sec. I.F. transformers.
V_1, 6K8.
V_2, 6SJ7.
V_3, 6K7.
V_4, 6H6.
V_5, 6SJ7.
V_6, 6AC7 (triode-connected).
V_7, VR150/30.
V_8, ½6N7.
V_9, ½6N7.

50 times a second. In the short time of one cycle, namely 1/50 of a second, conditions in the circuit have not altered to any appreciable extent, so that one sweep of the spot is exactly superimposed upon the next, with the result that the persistence of vision makes the eye believe that it sees a continuous picture, just as it does in viewing moving pictures, or a television picture. The way in which this effect is gained is simplicity itself, because it consists simply in making the saw-tooth recur at the rate of 50 times a second. This in turn is done by making the saw-tooth from the 50 c/sec. mains voltage. Since the same voltage sweeps the oscillator and the cathode-ray tube, there is no question of having to synchronize the two operations, this being done automatically.

The Question of Receiver Selectivity

In the first paragraph of this story, it was stated that the purpose of the adaptor is to display on the tube any signals present within a *band* of frequencies centred on that to which the receiver is tuned. This seems incompatible with the requirements of the receiver itself, which, being a communications job, is usually required to be as selective as possible. However, this is only an apparent difficulty, as will be realized when it is remembered that the adaptor takes the I.F. output of the receiver *at the mixer plate*. At this point, even if the receiver has one or two R.F. stages, the overall selectivity is not very great. Thus, the receiver's oscillator is able to beat with any signals that are accepted by the R.F. stages within quite a wide band about the frequency to which these stages are officially tuned. In other words, "I.F." signals are produced by the mixer at frequencies several kilocycles removed from 465 kc/sec., and on either side of it. These are rejected in the receiver itself by the high selectivity of the I.F. amplifier, but the panoramic adaptor actually makes use of them. Saying that the selectivity at the mixer plate in the receiver is not very great does not mean that the response is broad enough for the panoramic adaptor to be able to respond to, say, 50 kc/sec. on either side of the signal frequency. If the oscillator in the adaptor is swept to this extent, any signal within that band will be seen as a trace of the selectivity curve of the 100 kc/sec. amplifier as long as its amplitude is great enough for the gain available in the adaptor to bring it up to a useful deflection in the vertical direction. Thus, if the selectivity at the input of the adaptor is too great, there will be no signals visible at the ends of the C.R.T. trace, and the labour of sweeping the frequency of the oscillator over so wide a band is lost. It is in order to guard against this defect that the 465 kc/sec. transformer at the input of the adaptor is specially tuned, or rather, detuned. A normal type of 465 kc/sec. I.F. transformer is used, but its windings are detuned, one on either side of 465 kc/sec. This detuning is quite substantial, and is great enough for a pronounced dip in response to occur, exactly on 465, with corresponding peaks 20 to 30 kilocycles away. The idea is that when this rather unusual response is combined with that of the receiver, up to and including the mixer plate, the "hole" in the input transformer is filled in by the peaked response of the receiver. The overall result is a comparatively flat response over the frequency range required. The exact shape of this response is unimportant, as long as there is adequate sensitivity for all signals within the sweeping range of the adaptor's oscillator.

Some Finer Points

The explanation given so far should have made clear how the main functions of the adaptor are fulfilled, but there are one or two finer points that readers will no doubt want cleared up.

The first of these has to do with the reception and display on the C.R.T. screen of a number of signals simultaneously. This is really a very simple one. The signals within the pass-band of the adaptor each act independently as far as the F.M. oscillator is concerned. If there are two signals there at a given time, each will appear as a plot of the 100 kc/sec. selectivity curve. The position is probably confused a little by the fact that the input transformer is nominally tuned to 465 kc/sec. Since the adaptor's oscillator is sweeping across a wide band, it passes through a wide enough range to give a complete response curve every time it sweeps past a signal, thus there is theoretically no limit to the number of signals within the pass-band that can be simultaneously displayed. In practice, however, there is a limit, and this is concerned solely with the selectivity of the 100 kc/sec. amplifier. Ideally, this should have infinite selectivity, in which case each response from a signal would be a single vertical spike, and it would actually be possible to accommodate any numer of signals on the trace. However, the selectivity of the single stage 100 kc/sec. amplifier is quite high, so that although each signal occupies appreciable space on the trace, it is still possible to accommodate a large number of signals.

The next point to be cleared up is this: if there are a large number of signals visible, how do we know which one is the one to which we are listening on the main receiver? This point is looked after by the reactance modulator which sweeps the frequency of the oscillator. The saw-tooth is fed to the grid of the modulator valve through a condenser, so that the excursions of the grid voltage, while following the wave-form of the saw-tooth, take place equally in a positive and negative direction. If this is the case, and if the modulator and swept oscillator circuits are properly designed, the centre frequency of the oscillator sweep is made equal to (in our case) 365 kc/sec. This is the frequency which allows a signal which is properly tuned on the receiver to give an I.F. in the adaptor of exactly 100 kc/sec. Therefore, if a single signal is fed to the receiver from a signal generator, and the gain control of the adaptor is turned down so that off-tune weaker signals do not show appreciable deflections, this signal will be the only one to be seen on the screen of the C.R.T. If now the oscillator trimmer condenser is tuned so that the response is in the centre of the trace *when the main receiver is also properly tuned to the signal*, then the centre of the trace becomes the reference point which tells us which signal on the screen is the one we are listening to. It is possible to draw a vertical hair-line on the screen of the C.R.T., at the centre of the trace, and label this frequency **Zero**. That is to say, a signal appearing here is spot on the frequency to which the receiver is tuned. If now the signal generator is shifted, say, 10 kc/sec. higher in frequency, and the receiver remains untouched, the only effect on the screen is that the response moves off to one side of the centre mark. A further vertical line can then be drawn, corresponding in horizontal position with the tip of the signal peak, and this can be labelled **10 kc/sec.**, meaning that a signal appearing in this position is 10 kc/sec. higher in frequency than that to which the receiver is tuned. A similar procedure is followed for every 10 kc/sec. above and below the centre frequency until the whole trace is calibrated. This process will need to be remembered later in connection with final adjustment of the adaptor after construction is completed.

Any other points that the builder needs to know will be taken care of when we come to describe the setting-up procedure in full. For those who might wish to start

(Continued on page 48.)

PORTABLE RECEIVERS

MAIN REQUIREMENTS FOR GOOD DESIGN

A well-designed portable receiver should give maximum performance with long battery service life. Good sensitivity and power output with new batteries is important, but equally important is the maintenance of these properties with decreasing battery voltages. With all dry batteries, the voltage on load decreases steadily as the battery is used, and, therefore, if the portable receiver gives reasonably good performance to lower A and B battery voltages, the useful life of the batteries will be greatly extended.

The A battery end point voltage is largely determined by the characteristics of the valves used. In tests which the Products Engineering Department of the National Carbon Co. has carried out on portables produced by all the leading Australian radio manufacturers, it has been found that 1.4 volt G.T. series valves operate satisfactorily to a filament voltage of 1.1 volts, but the new miniature valves will generally perform well to 1.0 volt or lower.

The B battery end point voltage is influenced mainly by loop efficiency, coil and I.F. transformer design, and general circuitry. The oscillator coil should be so designed that the oscillator grid current does not drop below the lowest recommended value at an A battery voltage of 1.0 volt and a B battery voltage of 0.8 volt per cell. Placement of the loop aerial clear of large metal parts is important because a high-Q loop can have its efficiency ruined by having the chassis, speaker, batteries, or other metal parts within the area of its field. In this connection, it might be mentioned that most personal portables give surprisingly good loop pick-up considering their small size, and this is due to the fact that the loop is generally contained in a plastic lid which swings clear of the metal case when it is opened.

The presence of regeneration is most undesirable in battery-operated receivers. This gives a falsely high initial sensitivity which disappears as soon as the B battery voltage starts to fall.

A good portable should give reasonably good sensitivity and power output to a B battery end point of 1.0 volt per cell or lower. That is to say, in a receiver using two 45-volt B batteries, these should be usable down to a total voltage of 60 volts or less. Good commercial portables have shown less than 10 db. drop in sensitivity at this end point.

The efficiency of the speaker and speaker transformer used is important. New magnet alloys increase the efficiency by about 3 db., and this means that 200 milliwatts output will provide as much volume as 400 mw. with an old-type speaker.

The use of a type of circuit where the bias for the output valve is derived from the voltage developed across the oscillator grid resistor is undesirable because the B battery drain of the output valve, which is a substantial proportion of the total B drain, is controlled by the actual strength of the oscillation. This in turn depends upon a number of other factors, and unless the oscillator circuit is very carefully designed, the B battery drain will vary, depending on the frequency to which the receiver is tuned. It is also dependent upon oscillator gm, and as this decreases with reduced filament voltage, it follows that the B battery drain increases as the A battery voltage falls. Cases have been noted in some personal portables where a combination of new B battery and run-down A cells has resulted in an increase in B drain of greater than 50 per cent., and this naturally results in shortened B battery life.

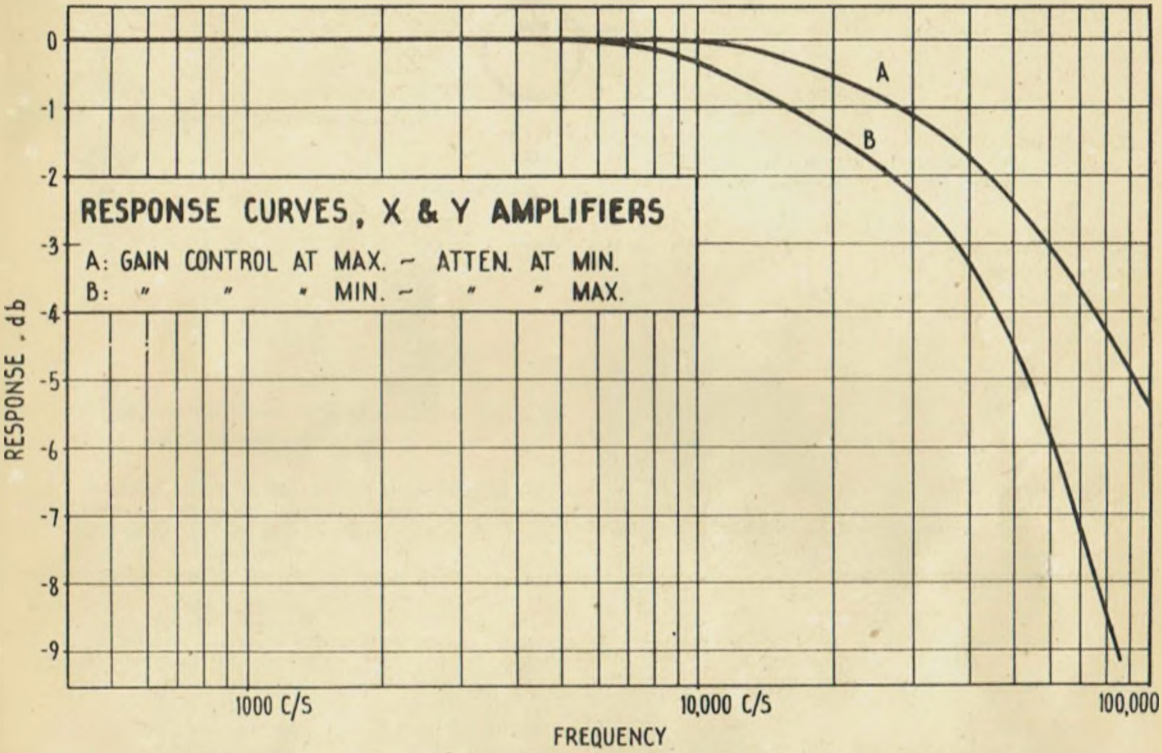
Another disadvantage of this type of circuit is that when the converter valve ages, loss of emission will cause a decrease in bias, and the B drain of the output valve will show a marked increase. Furthermore, replacement of the converter valve with a new one will generally lead to a change in total B drain, and instances have been found where changing from one converter to another, both valves having characteristics within the normal limits, has resulted in a 50 per cent. increase in B battery current.

It is naturally desirable to maintain a balance between the A and B battery service life. That is to say, it is generally more convenient if all batteries require replacement at the one time. Using one "Eveready" No. 745 A battery and two No. 482 "Mini-Max" B batteries with a five-valve receiver of conventional design, a B drain of about 11 ma. will give approximately balanced service life to A and B end points of 1.0 volt per cell, but as these figures are based on the average B drain over the useful life of the batteries, it is possible that individual receivers may show small variations in B battery life, even if the initial drain is equal to the figure mentioned. For this reason, when testing and reporting on commercial portable receivers, the B drain is measured at all voltages throughout the operating range, and in such cases it is possible to supply to the manufacturer an accurate estimate of the A and B battery service life.

Five-inch Oscilloscope Employing Unit Construction

PART 3.—Using the Completed Oscilloscope

Parts 1 and 2 of this article described the circuits and construction of the cathode-ray-tube unit and the amplifier-and-time-base unit. The instrument is now complete, and this part is devoted to detailed instructions dealing with some of the many uses to which the 'scope can be put. While referring mainly to this particular 'scope design, much of the information given here is completely general, and therefore applies to making the various tests and measurements with any good instrument.



Response curves of the amplifiers described in Part 2 of this series of articles.

Introduction

The number of uses that can be found for an oscilloscope are indeed legion, and whole books have been written on the subject of what to do with a 'scope when you have one. This being the case, the information presented in this article cannot hope to be even moderately comprehensive. All that we can hope for is to outline as many of the commoner applications as possible. The ones given here are all simple to carry out, and give accurate results if they are faithfully done, and if due precautions are observed. In their turn, they will no doubt suggest other ways of using the 'scope, and other things for which it can be used. The following tests and measurements are dealt with:—

(1) The measurement of percentage modulation of A.M. transmitters and the detection of various types of distortion in the modulating process.
(2) The measurement of audio frequencies when one or more known frequencies are available, and the comparison of unknown frequencies with each other.
(3) The observation and measurement of phase-shift between voltages of the same frequency, as, for example, the phase-shift between various parts of an amplifier.
(4) The observation and estimation of the onset of distortion in amplifiers.
(5) The measurement of the amount of distortion in amplifiers for harmonics up to the seventh.
(6) Measurement and comparison of the sizes of resistors and condensers.
(7) The neutralization of R.F. amplifiers in transmitting circuits.
(8) The use of the 'scope as a simple output voltage indicator, for drawing response curves, and for other purposes.

These applications will be dealt with, not in the above order, but in order of complexity, the simplest ones being treated first.

The C.R.T. as an Output Indicator

Perhaps the simplest, and one of the most useful ways of using the oscilloscope is as an indicator of the output voltage of any device which generates or handles alternating currents. This classification is a very broad one, but has been made so on purpose, since not only is it meant to include more or less obvious cases such as the output voltage of amplifier stages and complete amplifiers (audio, that is), but also oscillators and amplifiers at any frequency at all, audio, video, or radio, up to the ultra-high frequencies, where the time taken for the electron beam to traverse the region between the deflection plates becomes an appreciable fraction of the R.F. cycle. The reason for this remarkable frequency range is to be found in the extremely light weight of the electron beam, which acts almost as a meter pointer with no weight, and therefore without inertia. This property enables the deflections of the beam to follow voltages which alternate at rates up to hundreds of millions of times a second, which is to say that the beam can be used as a "pointer" at frequencies up to hundreds of megacycles per second. No other device yet invented is able to do this. Moving-coil meters give up the struggle to respond to alternating current at frequencies well below 50 c/sec., because the mass of the moving parts is so great that they have no time to move in response to a voltage in one direction before the voltage reverses, and tries to move the pointer in the opposite direction. The net result is therefore no movement at all. Other kinds of meters, such as hot-wire instruments, are able to respond at radio frequencies because they depend on the heating effect of the electric current, but become unworkable at very high frequencies on account of other deficiencies. Even the thermo-galvanometer has distinct limitations because it cannot be made sensitive enough to act as a voltmeter when multiplying resistors are placed in series with it, and for other reasons. Thus the cathode-ray tube is the only instrument which can indicate voltages at high frequencies directly. All that has to be done to make it act as a voltage indicator is to connect the output terminal of the device whose output voltage is to be indicated to one of the deflecting plates. It can be one of the X or one of the Y plates. It does not matter which, as for this purpose the other set of plates is unused. The only question that must be answered is, "What should one do with the other plate belonging to the axis that is being used?" This is easily disposed of, as the answer is that it must be earthed. If it is not, the free bit of lead from the plate to the terminal may pick up A.C. hum from the power supply, or simply from the A.C. field that is present in almost any room to which the mains wiring comes. The same thing applies to the other two plates. For example, if the voltage is being applied to one Y plate, the other should be earthed to the 'scope chassis, and unless they are being used for some other purpose, the X plates should also be earthed in the same way.

Even in such a simple application as this there are precautions which must be taken if the results are to be true ones. The first is the earthing of the unused deflection plates, described above, and the second is the connecting together of the chassis of the 'scope and the piece of equipment under test. It is not always enough to rely for this common earthing on the third wire of their respective power leads. The third wire is not always present in any case, even if a three-pin plug *is* attached to the line cord. The chances are, if the 'scope chassis is not directly connected to that of the amplifier or other gear that is being used, that the screen will be filled with a hum voltage, or at least a substantial hum signal will be present which would render the length of the trace worthless as an indicator of the output voltage. This proper earthing and inter-connection is necessary in all tests carried out with the oscilloscope, and so has been mentioned here in connection with the first one in order to avoid repetition.

How, then, is the 'scope used as a voltage indicator when the connections have been made as above? Simply by observing the length of the line made on the screen by the output voltage. This scheme might at first seem so simple and self-evident as to be ridiculous, but here, as in many things, there is more than meets the eye. For example, it is well known that amplifiers, whether A.F. or R.F., sometimes oscillate. This is a very

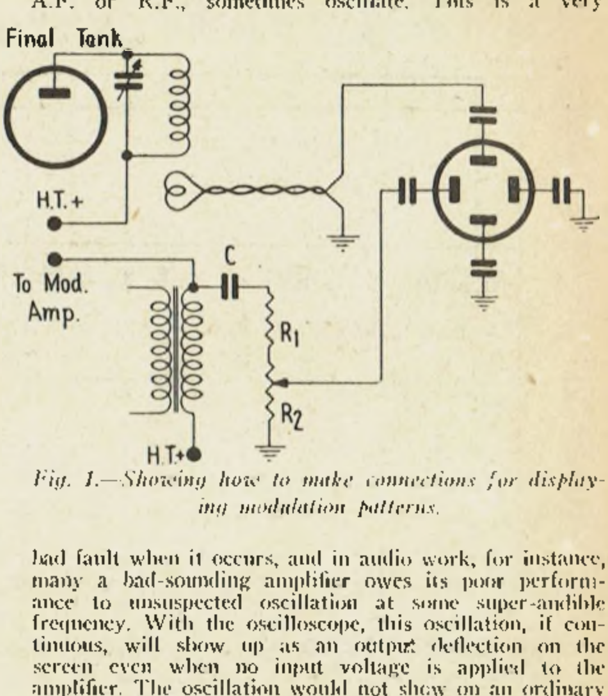


Fig. 1.—Showing how to make connections for displaying modulation patterns.

bad fault when it occurs, and in audio work, for instance, many a bad-sounding amplifier owes its poor performance to unsuspected oscillation at some super-audible frequency. With the oscilloscope, this oscillation, if continuous, will show up as an output deflection on the screen even when no input voltage is applied to the amplifier. The oscillation would not show on an ordinary output meter because its frequency would in all probability be too high. The cathode-ray tube is thus the only instrument which can show up such a fault.

As an output indicator, the tube is used by noting the length of the line drawn by the output voltage. If response curves are to be drawn, or if gain measurements are to be made, the indication of output voltage can be used in one of two ways. If the oscillator has constant output voltage, it can be fed to the input of the amplifier under test, and the length of the line on the 'scope measured at each test frequency. The response curve can then be plotted using these lengths, since they are proportional to voltage, or they can all be expressed as a ratio of the length obtained at some convenient frequency in the range covered. The "convenient frequency" is usually somewhere in the middle range, such as 1000 c/sec., where the gain of the amplifier is at its maximum. The response at this frequency is then called 1, and the output at all other frequencies is expressed as a fraction of the output at the reference point.

This part of the business is not properly part of the oscilloscope application, as this ends with the taking of the readings of output voltage as lengths of trace. It will be noted that for drawing a response curve in this way, the actual output voltage does not need to be measured at all.

The other way of taking response curves is to have, in addition to the oscillator, a calibrated attenuator, scaled usually in decibels. This is placed after the amplifier output, and in front of the oscilloscope. It is set to some convenient position which gives a useful deflection on the 'scope when the normal input voltage is fed to the amplifier from the oscillator. Then, as the response falls off, as it normally does at high and low frequencies, less attenuation has to be included in order to keep the output voltage constant, as revealed by the length of the trace on the screen. The number of decibels by which the attenuator has to be moved in order to keep the output voltage constant is the number of decibels by which the response of the amplifier is down at the frequency of the test. Of course, if the attenuation has to be increased to keep the output level constant, then the gain of the amplifier must have risen, and the number of decibels by which the attenuation has been increased gives the number of decibels by which the response is *up*. This method has the advantage that its accuracy is that of the attenuator, and does not depend on the accuracy by which one can measure the length of the line on the 'scope face.

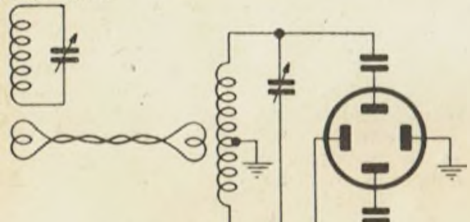


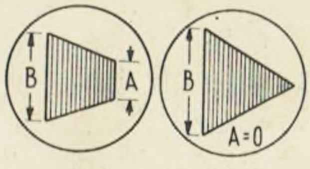
Fig. 2.—A better method of drawing trapezoidal modulation patterns.

The Display and Measurement of Trapezoidal Modulation Patterns

Perhaps the most useful function of the cathode-ray tube in transmitting practice is the display of trapezoidal modulation patterns. Any amplitude-modulated transmitter should have checks taken to find out (1) whether it is capable of 100 per cent. modulation without distortion, and (2) what the approximate audio gain control settings will be for 100 per cent. modulation.

The easiest, and in many ways the most informative way of doing this is to use the so-called trapezoidal pattern. This requires only the modulated transmitter itself and the simplest oscilloscope, consisting only of the cathode-ray tube and its power supplies. In other words, the tube unit only is needed. A linear time-base is not used, and it is unnecessary to have a pure sine-wave input to the speech amplifier, or, for that matter, any sort of sine-wave at all. For trapezoidal tests, any steady signal can be used, irrespective of wave-form. Thus, a very rough oscillator of the code-practice type will do admirably. If even this is not available, a low-frequency (say, 500 c/sec.) saw-tooth from the time-base unit can be used, as neither the time-base nor the 'scope amplifiers are wanted otherwise.

The connections to the tube unit are made as follows. A small pick-up loop is connected to a twisted pair of wires, which act as a transmission line, and the loop is coupled to the tank circuit of the modulated amplifier. This will in general be the final amplifier, as indicated on Fig. 1. One X and one Y plate are grounded at the back of the tube unit. That is, the terminals are grounded, which effectively earths the plates as far as signals are concerned, without short-circuiting the shift voltage. One side of the transmission line is earthed at the 'scope, and the other is connected to the unearthed Y terminal. Also shown on Fig 1 is the modulation transformer. From the "hot" end of the secondary, a voltage divider, R_1, R_2, is connected to earth, with, of course, a blocking condenser interposed to keep the D.C. from the resistors. R_2 is made a potentiometer so that the size of the picture can easily be regulated. The moving arm of the potentiometer is then connected to the free X terminal.



(a) (b)

Fig. 3.

One or two points arise in connection with the resistors and condenser used across the modulation transformer secondary. Since they have to supply voltage only, and no power, they should be made as high as convenient, so that they will not form an extra load on the modulator. Also, the size of the coupling condenser is important if the best picture is to be obtained. Its reactance at the lowest audio frequency used for the test should be not more than one-twentieth of the sum of R_1 and R_2, and preferably less. Also, its voltage rating should be at least equal to the sum of the Mod. Amp.'s plate voltage plus the peak modulating voltage from the transformer secondary. It does not matter a great deal if this rating is adhered to if the test is only to be of short duration, but a safety factor of several times is advisable if the connection is to be permanent for monitoring purposes.

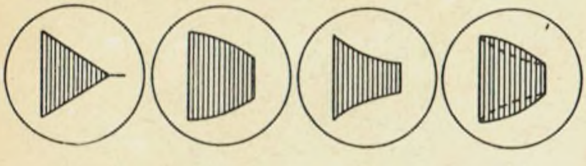
First of all, to make the test, the carrier should be turned on, with no modulation applied. Next, the modulated stage should be properly loaded by the aerial or following stage, if any. Then, the coupling loop should be adjusted until the vertical line on the screen is about 3 in. high. Now, modulation is applied, and the pattern spreads out so as to look like one of the pictures in Fig. 3. This will necessitate some adjustment of both the horizontal shift control and the pot. R_2, so as to centre the picture, and to get a suitably sized deflection in the horizontal direction.

The pictures illustrated in Fig. 3 will occur only if the modulation is taking place in a distortionless manner. However, we will assume this to be the case, and first of all describe how the percentage of modulation can be estimated from such a picture. Fig. 3 (a) represents distortionless modulation, less than 100 per cent., while Fig. 3 (b) represents distortionless 100 per cent. modulation. In order to measure the percentage modulation in a case like that of Fig. 3 (a), the lengths A and B are measured and applied to the formula—

$$\text{Mod. percentage} = \frac{100\,(B - A)}{(B + A)}$$

This is clearly equal to 100 per cent. when the picture is a complete triangle, so that A = 0. If B equals twice A, then the formula shows that the percentage modulation is only 33.3 per cent. When B equals three times A, the percentage is 50 per cent., and so on.

With a five-inch tube, the R.F. coupling system of Fig. 1 may not give enough output voltage to swing the spot far enough in the Y direction, resulting in a small figure. If this is so, a better coupling scheme is shown in Fig. 2. Here, a separate tank circuit is used, and is fed by a link circuit whose coupling is variable at the transmitter end. This circuit has three advantages over that of Fig. 1. First, it enables full deflection on the screen to be obtained very readily. Secondly, it gives balanced deflection voltages, eliminating cathode-ray tube trapezium distortion. Thirdly, it enables very loose coupling to be used between the link and the transmitter tank circuit. There is then no de-tuning due to its presence, and it is specially suitable where a permanent hook-up is to be used for monitoring. If desired, better balance can be obtained by using a split stator condenser in the tank circuit attached to the C.R.T. A further advantage of this arrangement is that the capacities between the Y plates are made use of as part of the tuned circuit. The L/C ratio of the C.T.R. tank is not important, and can be anything convenient. A good scheme is to mount the tuning condenser on the back of the tube unit, as a permanent institution, with a coil socket wired to it. Wander-leads can be provided for connecting and disconnecting the whole thing from the Y plates. It is then ready for use on any band simply by connecting the deflection plate leads and then plugging in the appropriate coil.



(a) (b) (c) (d)

Fig. 4.

Fig. 4 shows some distorted modulation patterns, obtained by the method described: (a) represents over-modulation, with an otherwise distortionless system. This picture is obtained when the modulation is increased beyond the point where the trapezoid just turns into a triangle. The horizontal tail to the triangle in this figure represents the presence of modulating voltage (since it is a deflection in the X direction) without any R.F. output, since there is no deflection in the Y direction. The narrow end of all such pictures represents the negative peak of the modulation cycle, as a little thought will show. Fig. 4 (a) therefore shows that at some time before the negative peak is reached, the carrier is completely cut off, so that it remains cut off until the same instantaneous negative modulation voltage is reached after the peak has passed.

Fig. 4 (b) has curved sides, and therefore indicates distortion. This is taking place in the modulating process, and has nothing to do with the shape of the modulating wave at all. The trouble here is usually that of insufficient excitation for the modulated stage. The direction of the curvature shows that the carrier amplitude does not grow in a linear fashion as the modulating voltage increases.

Fig. 4 (c) indicates R.F. regeneration, caused by imperfect neutralization.

Fig. 4 (d) does not represent distortion at all, but simply improper coupling of the audio voltage to the cathode-ray tube. If an attempt is made to take the audio signal to the X plate from any point in the modulator system other than the secondary of the modulation transformer, this picture is liable to result in spite of the whole system being free from distortion. It is due to phase-shift between the place at which the audio voltage is sampled and the plate of the modulated stage. It would also result if the condenser C were so small as to cause appreciable phase-shift, and is the reason why C has to be chosen on the large side. Sometimes, if the modulation system has more than one fault, the patterns are very difficult to interpret even without the complication introduced by this phase-shift, so that it is best to eliminate it from the start.

The four pictures of Fig. 4 are illustrative only, and could be amplified almost indefinitely, with corresponding descriptions of faults; in this article there is not room to enlarge further upon the interpretation of modulation patterns, but interested readers can find any amount of this style of thing in the literature—especially that devoted to amateur transmitting.

There is another method of examining modulation behaviour, but this will not be dealt with in detail here. Briefly, it consists in putting the modulated R.F. output on the Y plates of the 'scope, just as in the above method, and then using a linear time-base on the X plates, locked at a sub-multiple of the modulation frequency. The R.F. envelope type of pattern results. This pattern is much less useful in tracking modulation faults than the trapezoidal method, and requires that the audio input wave-form be available for comparison with the shape of the modulation envelope, which should be identical if there is no distortion. It is much more difficult to observe the onset of distortion by the envelope method, and it is not nearly so frequently used as the trapezoidal one for this reason.

(To be continued.)

TUBE DATA: THE 815 DOUBLE BEAM-POWER TRANSMITTING TETRODE

The 815 is a beam-tetrode specially designed for transmitting circuits up to frequencies as high as 200 mc/sec., or 1½ metres. It has the following features, which make it admirable for transmitters on any frequency, but particularly for those which cover one or more of the bands higher than 30 mc/sec.

(1) Each 815 consists of two identical beam tetrodes in the one envelope.
(2) The plate connections are brought to caps on top of the valve.
(3) The grid pins are symmetrically disposed with respect to the keyway in the socket. This makes possible a high degree of circuit symmetry.
(4) The tube uses a standard octal socket.
(5) As with all beam-tubes, the driving power needed is very small.
(6) It may be used with full ratings up to 125 mc/sec., and with reduced ratings up to 200 mc/sec.
(7) It requires a maximum plate voltage of only 400 or 500 (CCS and ICAS ratings respectively).
(8) It can give power outputs of up to 56 watts on C.W., and a carrier of 45 watts on phone.
(9) Neutralizing is not usually needed, but is easy to apply if necessary.

APPLICATION

As a Class C C.W. amplifier stage, the 815 can be operated with the screen voltage supplied from a separate power supply, from a voltage divider across the main power supply, or from a voltage-dropping resistor from the main H.T. supply. If the series resistor method is used, care should be taken to see that the plate voltage does not exceed 600v. when the key is up. For C.W. use, any of the recognized systems of providing grid bias may be used, except where a preceding stage is keyed. In this case, enough fixed bias or cathode bias should be used to ensure that the D.C. plate current is kept to a safe value when the key is up.

As a plate-modulated Class C R.F. amplifier, the screen voltage should preferably be obtained by means of a dropping resistor from the **modulated** plate voltage. If this is not done, distortionless modulation will not be obtained, and 100 per cent. modulation will not be obtainable. An alternative is to use a separate winding on the modulation transformer for modulating the screen voltage in such a way that the ratio of plate to screen voltage remains constant during modulation.

CHARACTERISTICS AND RATINGS

(Unless otherwise stated, values are for both units.)

Heater:

Voltage	6.3 or 12.6 volts
Current	1.6 or 0.8 amps

Mutual Conductance:

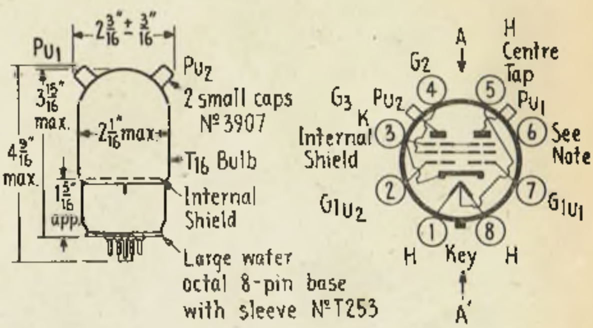
At plate current of 25 ma.	4 ma./v.

Amplification Factor:

Between grid and screen	6.5

Inter-electrode Capacities (each unit):

Grid-plate	0.2 μμf. Max.
Input	13.3 μμf.
Output	8.5 μμf.



MAXIMUM RATINGS (CCS AND ICAS) AND TYPICAL OPERATING CONDITIONS

(1) Push-Pull Class C Amplifier for C.W.:

	CCS max.	ICAS max.
D.C. Plate Voltage	400	500 volts
D.C. Screen Voltage	225	225 volts
D.C. Control-Grid Voltage	— 175	175 volts
D.C. Plate Current	150	150 ma.
D.C. Grid Current	7	7 ma.
Plate Input Power	60	75 watts
Screen Input Power	4.5	4.5 watts
Plate Dissipation	20	25 watts

Typical Operation:

	CCS	ICAS
Plate Voltage	400	500 volts
Plate Current	150	150 ma.
Screen Voltage:		
Fixed Supply	145	200 volts
From a Dropping Resistor of	15k.	17.5k. ohms
Screen Current	17	17 ma.
Grid Voltage:		
Fixed Supply	— 45	— 45 volts
or Cathode Resistor of	260	265 ohms
or Grid Leak of	15k.	17.5k. ohms
Peak R.F. Grid Voltage per section)	58	56 volts
Driving Power (approx.)	0.23	0.18 watts
Output Power (approx.)	44	56 watts

(2) As Push-Pull C Amplifier, Plate-modulated Telephony:

	CCS max.	ICAS max.
D.C. Plate Voltage	325	400 volts
D.C. Screen Voltage	225	225 volts
D.C. Control-Grid Voltage	— 175	— 175 volts
D.C. Plate Current	125	150 ma.
D.C. Grid Current	7	7 ma.
Plate Input Power	40	60 watts
Screen Input Power	4	4 watts
Plate Dissipation	13.5	20 watts

Typical Operation:

	CCS	ICAS
D.C. Plate Voltage	325	400 volts
Plate Current	123	150 ma.

Screen Voltage:		
From Fixed Supply	165	175 volts
or From Series Resistor of	10k.	15k. ohms
Screen Current	16	15 ma.
Grid Voltage	—45	—45 volts
From Resistor of	11.25k.	15k. ohms
Grid Current	4	3 ma.
Driving Power (approx.)	0.2	0.16 watts
Output Power (approx.)	30	45 watts
Maximum Modulation	100%	100%

V.H.F. RATINGS

The table below gives the plate voltage and plate input power that can be used at the frequencies stated, in terms of percentage of the values given above for the various types of operation.

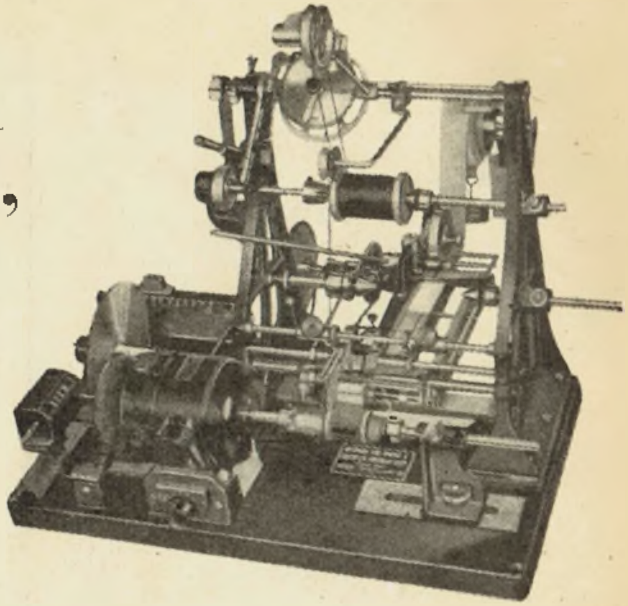
Frequency, mc/sec.	125	175	200
Percentage	100	80	70

NOTES

The resistance in the grid circuit of the 815 should never exceed 15,000 ohms for the valve, or 30,000 ohms per section, where separate grid resistors are used for each section.

The tube may be operated in any position, and, in order to shield the input and output circuits from each other, a good plan is to place it horizontal.y, with the socket mounted on a vertical partition, which can be extended so as to make an effective shield between the tuned circuits. This applies equally where lumped circuits or tuned lines are used in one or both positions. At moderate frequencies—say, up to 125 mc/sec.—lumped circuits in both grid and plate circuits will be satisfactory. Above this, tuned lines are to be recommended.

Do your COIL-WINDING on "DOUGLAS"



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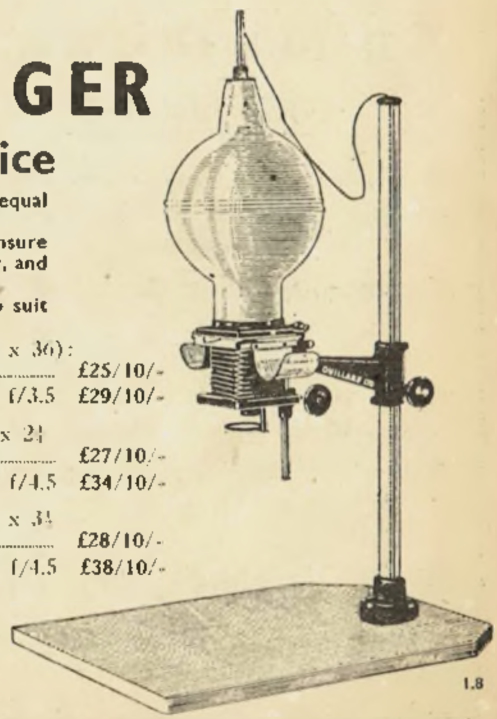

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1.8

The Proper Use of Resistors to Extend Meter Ranges

By the Engineering Department, Aerovox Corporation

Most readers are familiar with the use of resistors as shunts and multipliers to extend the range of measuring instruments. However, inquiries show that there exists a good deal of confusion when it comes to determining the correct resistance values and the best circuits for multi-range instruments. It is the purpose of this article to show again the proper way of arriving at the correct value of shunts or multipliers for a given case and to show the different circuits now in use, discussing their respective merits.

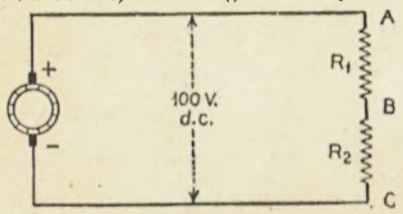


Fig. 1

VOLTMETERS

A voltmeter is nothing but a milliammeter with a high resistance in series with it. It should be clear that when the current is known which flows through this high resistance, the voltage at the terminals can be found by Ohm's Law. The user has been spared this computation since the instrument is calibrated directly in volts. The same meter movement will serve for instruments of different ranges because the voltage at its terminals at full-scale deflection is proportional to the resistance of the meter plus its multiplier; so, by providing additional resistors, higher ranges can be obtained. The resistance value of the multiplier for each additional range depends on the sensitivity of the meter movement. This brings us to the important point of "sensitivity."

OHMS PER VOLT

The sensitivity of a voltmeter is expressed in "ohms per volt" and equals the total resistance of the meter divided by the number of volts indicated at full-scale deflection. This figure indicates how much current it takes to operate the meter. For instance, if a 0–10 voltmeter has a resistance of 10,000 ohms, the sensitivity would be 1,000 ohms per volt, and from Ohm's Law it is easily found that the meter requires a current of 1 ma. at full-scale deflection. Similarly, if the 0–10 voltmeter had a resistance of but 1,000 ohms, the sensitivity would be 100 ohms per volt, and it would require 10 ma. to move the needle to full-scale deflection. This illustrates that **the higher the resistance of the voltmeter—for a given range—the greater the sensitivity.**

The lack of sufficient sensitivity results in inaccuracy when the instrument is used in high-resistance circuits. This is shown best by an example. In Fig. 1, two resistors are connected across a D.C. generator delivering 100 volts. Neglecting for this purpose the resistance of the generator itself, the 100 volts will divide across the resistors in proportion to their resistance. Suppose R_1 is 6,000 ohms and R_2 is 4,000 ohms. Then the voltage across R_2 would be 40 volts. But what would a voltmeter show?

Employing a voltmeter of 100 ohms per volt sensitivity and having a 50-volt range, the voltmeter resistance would be 5,000 ohms. Suppose this is connected across R_2 to measure the 40 volts. The presence of the voltmeter places a resistance of 5,000

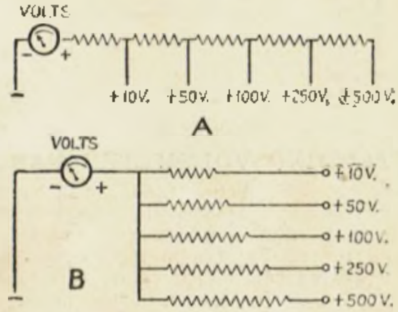


Fig. 2

ohms in parallel with the 4,000, making a resultant resistance between B–C of

$$\frac{5000 \times 4000}{5000 + 4000} = \frac{20,000,000}{9000} = 2,222 \text{ ohms}$$

The total resistance in the circuit is now 6000 + 2,222 = 8,222 ohms and the voltage across R_2 as shown by the meter is now

$$\frac{2,222}{8,222} \times 100 = 27 \text{ volts}$$

This does not mean that the meter itself is inaccurately calibrated because the voltage is actually 27 volts when the voltmeter has been connected. However, it was desired to know the voltage between B and C before the voltmeter was connected, and so the answer was unsatisfactory. It is obvious, then, that the resistance of the voltmeter must be such that it will not materially alter the conditions in the circuit to be measured. This is satisfied by an instrument of higher sensitivity. Let us apply the same example to a meter of 1,000 ohms per volt sensitivity. Employing again a 50-volt range, the meter resistance becomes 50,000 ohms. When this is connected across R_2, the resistance between B and C becomes

$$\frac{4,000 \times 50,000}{4,000 + 50,000} = \frac{200,000,000}{54,000} = 3,700 \text{ ohms}$$

and the meter would show

$$\frac{3,700}{9,700} \times 100 = 38.1 \text{ volt.}$$

If the range of the voltmeter used had been the 100-volt range, it would have indicated 39 volts. This illustrates the trend of the reduction in error when the resistance of the meter is increased. It shows that even with a 1,000 ohms per volt instrument there is still an error of 5 per cent. The example did not contain as high resistance as one often uses in radio work. It should therefore be clear that there are many cases in radio circuits where the voltage cannot be measured with any degree of accuracy with any voltmeter which draws any current at all. This happens in resistance-coupled amplifiers. In those circuits it is necessary to arrive at the voltage by measuring the current through the resistances in question and then calculate the voltage by Ohm's Law. Instruments which do not take any current from the circuit can also be used; these are: vacuum tube voltmeters and potentiometers.

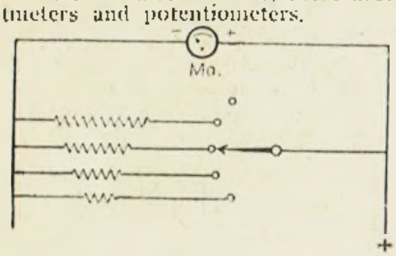


Fig. 3

EXTENDING VOLTMETER RANGES

In order to extend the range of a voltmeter, a multiplier resistor is placed in series with it. Although it seems almost needless to say so, one cannot extend the range of a meter downward, neither can the sensitivity be increased by resistors. If it is possible to get at the inside of the meter and take a tap directly from the meter movement it may sometimes be possible to obtain a lower range.

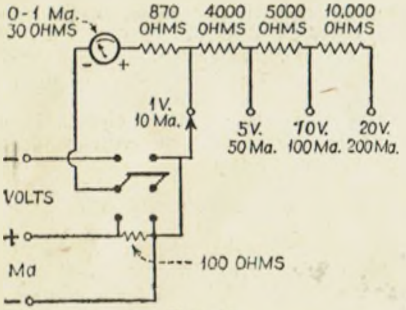


Fig. 5

The proper value of the multiplier resistor is found from the equation:

$$R = (n - 1)\ R_m$$

where R_m is the meter resistance and n is the factor whereby the range is to be multiplied. When a 10-volt range is to be increased to a 100-volt range, the multiplier should equal 9 times the meter resistance. When the meter resistance is not known, it will have to be measured.

If the sensitivity of the meter is known, the following rule may be found convenient. The multiplier range should be equal to the sensitivity in ohms per volt, times the volts which are to be added to the range. For instance, a 1,000 ohms per volt meter requires 1,000 ohms for every volt added. Increasing the range from 10 to 100 volts (adding 90 volts) requires a 90,000 ohm multiplier. Changing a range from 150 to 750 volts takes 600,000 ohms for a 1,000 ohms per volt meter.

MULTI-RANGE VOLTMETERS

It is obvious that a multi-range instrument can be made by tapping the multiplier resistors and to connect the circuit to the taps by means of a switch or by separate terminals. Two possible circuits are available. They are shown in Fig. 2A and 2B. In Fig. 2A the most economical use is made of the resistors, but it has the drawback that if the multiplier for a low range burns out accidentally, all the other ranges are useless. In Fig. 2B, more resistors are needed, but if one multiplier is defective all other ranges can still be used.

MILLIAMMETERS

The range of a milliammeter can be extended by

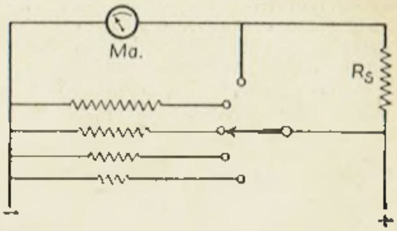


Fig. 4

shunting it with a resistor. The proper size of the shunt is found from the following consideration: Suppose the shunt was equal to the meter resistance. Equal currents would then flow through the two branches, or the meter would show half of the current, and the range has been multiplied by two. For similar reasons, a shunt equal to one-half of the meter resistance will multiply the range by three. A shunt of one-third of the meter resistance multiplies the range by four, etc.

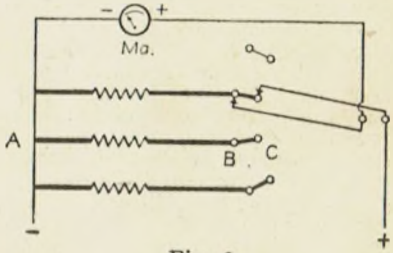


Fig. 6

A milliammeter of low range can be converted to a multi-range milliammeter by the addition of several such shunts. Large errors may be introduced and the instrument may be damaged unless proper precautions are taken when designing the switching circuits. The most obvious circuit for the purpose is shown in Fig. 3. In the first position, no shunt is in the circuit, therefore the original range of the meter is now in use. In the other positions one of the shunts is employed. Suppose that one switches from one range to another and the switch arm breaks contact with one terminal before it makes contact with the next. During the time that the shunt is open the lowest range is in use, and if this is done while measuring relatively heavy current the meter will burn out. Also, should the switch fail to make contact at any point, this point will represent the lowest current range, and the unsuspecting user may again overload and damage the meter.

There is still another drawback to this arrangement. The switch contact is a part of the shunt, and if a switch should make a bad contact, the resistance of the shunt is increased, with a consequent error in reading. Since shunts have very low resistance, especially for high ranges, the contact resistance does not have to be very high before it becomes large enough to cause errors. On high ranges it will be difficult to get the same reading twice if the switch contact is anything less than perfect.

A "shorting" type switch will eliminate the first objection, but the second and third disadvantages remain unless a perfect switch is found. Several schemes are in use for eliminating these troubles. One of these is illustrated in Fig. 4. A series resistor

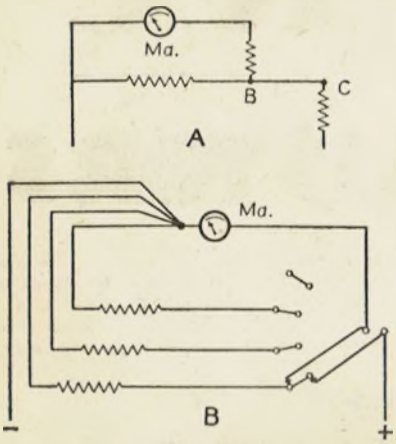


Fig. 7

is used in the meter branch; in order to multiply the meter range by n, the shunt must now be

$$R = \frac{R_m + R_s}{n - 1}$$

If R_s is chosen sufficiently large, the shunt does not have to be of so low a resistance. The importance of perfect switch contacts then becomes less,

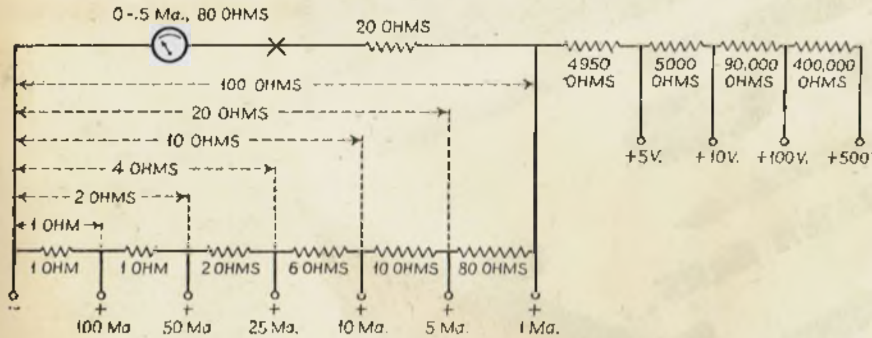


Fig. 9

but the milliammeter will have a higher resistance. This has the same effect as a voltmeter of low sensitivity; it changes conditions in the circuit and may give an erroneous reading. Radio circuits generally have rather high resistance, which makes the high-resistance milliammeter still usable. In the circuit of Fig. 4 the lowest range has the normal resistance of the meter only because R_s is shorted in that position.

It is now possible to keep the shunt constant and to obtain different ranges by providing different values of R_s. These series resistors can often be the same ones which are used when the meter is employed as a voltmeter. Fig. 5 shows an example of this type of circuit. A common error is to neglect the current flowing through the meter itself and to consider that the meter with the series resistor is a voltmeter measuring the drop across the shunt. Fig. 5 shows values for an 0-1 ma. meter with an internal resistance of 30 ohms. If the value of the shunt is taken as 100 ohms, the value of R_s should be 100 ohms less than its corresponding voltmeter multiplier value. This is accomplished with the d.p.d.t.

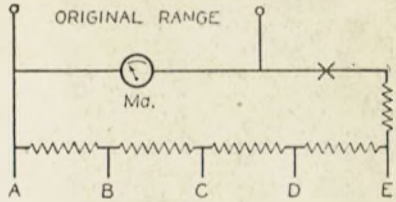


Fig. 8

switch. No doubt, this circuit is very economical on precision resistors, but it has the drawback of too high resistance, and it is not used very much to-day.

Fig. 6 shows a switching system which overcomes all the dangers of open switch contacts and the effects of bad contacts. It requires a double-deck switch. Considering an individual range, the shunt extends from A to B. If the contact at B is open, the meter circuit is open and the instrument will not indicate. If the contact at C is open, the main circuit is open and the meter again is not in a dangerous position.

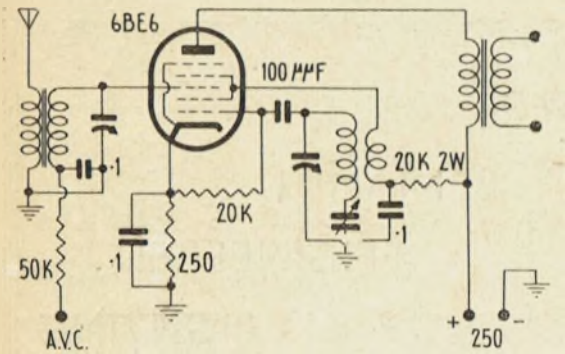
The switch contacts at B and C are not a part of the shunt. If any resistance exists at these points, the circuit becomes as in Fig. 7. These added resistances are in such parts of the circuit that their effect on accuracy is unimportant. In this circuit it is important to make the wires which are shown heavy, as short as possible, and to use bus bar. The shunts should all be connected together to a short piece of bus bar and they should not have individual wires running to the meter, because these wires become a part of the shunt. Fig. 7B shows the wrong way; Fig. 6 shows the right way.

A third system, now becoming popular, employs a tapped shunt and does away with the switch altogether. It eliminates burning-out dangers when moving from one range to another, and it introduces no errors due to faulty contacts. The circuit is shown in Fig. 8. When the test prods are connected to A and E, the entire resistor A–E becomes the shunt. When the test circuit is connected to A–C, the resistor C–D–E becomes a part of the meter branch and A–C is the shunt. When the sum of all the resistors plus the meter is some round number, such as 100 ohms, the taps come at even values of resistance, and no odd-value shunts are required. This is why: It was shown that, in order to multiply the range by any number, n, the resistance of the shunt, should be $1/(n-1)$ times the resistance of the meter branch. Or, the resistance of the meter branch is $(n-1)$ times the resistance of the shunt. The sum of the two branches, or the total resistance of the circuit A–B–C–D–E and back through the meter to A equals n times the resistance of the shunt, or, the

(Continued on page 48.)

QUESTIONS and ANSWERS

"P.A.," of Wellington, writes as follows: "I have a 6BE6 which I am using as a self-excited oscillator-mixer in the circuit below. The values of grid leak and screen dropping resistor are those recommended by the R.C.A. handbook, but the screen current measures 10 ma., instead of 7 which it should be. This has me rather worried, and nothing I have done has succeeded in improving matters. Could you please advise me what, if anything, can be done about it? Would it improve matters if I used a separate oscillator, with oscillator voltage injected into G_1, and with the grid-current in G_1 adjusted to the optimum value?"



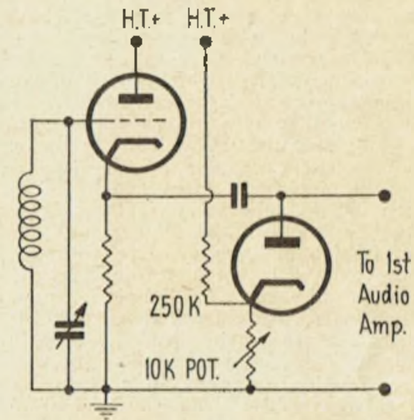
The probable cause of the excessive screen current is under-excitation of the oscillator, and it is thought that if the oscillator grid-current were measured, it would be found to be less than the recommended value. However, as long as the gain from the converter system at present in use is sufficient, there should be no need to make any changes, or to worry about the extra screen current. This is because the screen voltage with the circuit shown is only about 50v., so that the screen dissipation rating is not exceeded. The latter is the most important thing. If the oscillator coil were changed for one with tighter tickling coupling, the oscillator grid current should increase, and the screen current should decrease. At the same time, if now the oscillator grid current is less than the recommended value, after the change is made the conversion gain should increase, both because of the greater grid current and because of the increased screen voltage.

An alternative method of attack, which may have been tried, is to increase the value of the grid leak, without altering the oscillator coil. This might be found to bring about the same improvements as closer coupling of the tickler.

With regard to the suggestion of a separate oscillator, this is an excellent one, and would enable the best converter operating conditions to be realized regardless of the oscillator circuit. With a separate oscillator it will be easy to get a greater output than is strictly necessary, after which the oscillator grid leak, and the oscillator plate voltage, or both, can be juggled to give the recommended D.C. current through G_1. To measure the current through G_1 without upsetting the operation of the circuit, a 0–1 ma. meter can be connected in series with the grid leak, at the cathode end. In other words, the connection of the grid resistor to the cathode is broken, and the milliameter is inserted to complete the circuit again. The presence of the meter, and later, its removal, will not affect the operation of the circuit in any way.

Still another way of improving the circuit would be to use an oscillator coil designed for a 6SA7. This has a cathode tap brought out, so that the oscillator circuit is an electron-coupled one, which enables the screen grid of the 6BA6 to be bypassed to earth by the usual condenser, thus improving the converter's operation.

USING A DIODE NOISE-LIMITER WITH AN INFINITE-IMPEDANCE DETECTOR



"J.S.G." writes from Auckland as follows: "An item in 'Radio and Electronics' which has interested me very much is the use you have made of the 6H6 as a noise-limiter. However, my receiver has a 6J5 infinite-impedance second detector. I am therefore at a loss to know whether it is practicable to incorporate a 6H6, all or half of which can be used as a noise-limiter, without eliminating the infinite-impedance detector. If it is possible, will you please show how this can be done."

It is possible to do what J.S.G. suggests, but only at the expense of the feature which gives automatic threshold control. This is on account of the high D.C. voltage (about 15v.) found across the load resistor of the infinite-impedance type of detector, even when no signal is applied. The circuit above shows a successful limiter circuit, which, however, has to have the diode bias control brought out to the front panel so that it can be adjusted for best results on each signal as it is received.

The control is turned on so that the bias on the diode is great enough to allow the audio signals form the detector to pass on through the coupling condenser, but as soon as a noise pulse comes along whose amplitude is greater than that of the audio signal, the diode conducts, chopping the amplitude of the noise pulse is then much less than before the limiter was installed, and at the same time there is no effect at all on the signal. In practice, the control is adjusted AFTER the signal has been tuned in, until the limiter just fails to cause distortion of the signal. Under these conditions, the limiter is in its most effective condition. The coupling condenser is the usual one already in use, and does not need to be specified as to size.

PUBLICATIONS RECEIVED

"Radio Laboratory Handbook," by M. G. Scroggie, B.Sc., M.I.E.E. Publishers, Iliffe & Sons, Ltd., London.

This is the fourth edition of a book that is an old friend to many, and which deserves to be better known in this country than it already is. Mr. Scroggie has succeeded admirably in his aim, stated in the preface, to produce a book which is useful not only to experienced engineers, but to amateur experimenters as well.

For those who have not met the "Radio Laboratory Handbook" before, some description of it is essential. In the first place, it is built round the one word, in its best sense, Experiment. An introductory chapter makes clear what is not often enough formulated, and upon which too many have only the haziest ideas—namely, the nature and purpose of organized experiment, after which the book goes on to discuss what apparatus is needed for experimental work in radio, whether by a fully-fledged commercial laboratory, or by an amateur, with his limited means. There is an excellent chapter on the fundamental principles of measurement, after which follow four chapters devoted to laboratory instruments, under the headings of "Sources of Power and Signals," "Indicators" (which includes an excellent resume of the oscilloscope and its uses), "Standards of Comparison," and "Equipment as a Whole." Then follow three chapters on measurements themselves. It is in these chapters that the main content of the book is to be found. This does not mean that the preceding chapters form nothing more than a padded-out introduction to the subject of radio measurements. Far from it. These chapters are a veritable mine of information for anyone who wishes he had more instruments with which to work, and particularly for those who have only a limited amount of money to spend on equipping themselves with the necessary instruments for the type of work they intend to do.

However, the chapters on measurements and how to make them are those that will appeal to almost anyone who has a more than theoretical interest in radio, or any other branch of electronics. These chapters are very complete, and as well as indicating the standard methods of doing things, put forth some ingenious and sound ideas of the author's. Always Mr. Scroggie is concerned that a measurement should be taken by the most suitable method, having regard to available equipment, accuracy required, simplicity, and time-saving. He sets forth impartially the advantages and disadvantages of this method or that, and where space will allow of only small mention of techniques that have been proved but which need more explanation than he can spare space for, he supplies the most important references to the periodical literature. He is up to date, as evinced by his reference to such recent developments as the use of inter-modulation measurements for testing amplifiers (and other parts of a reproducing system), and by the new chapter on very high-frequency work. This chapter, however, the writer found a little disappointing, but then space, rather than the author, was felt to be responsible for this. It seemed, however, that more of the space allotted could have been devoted to the use of transmission lines as circuit elements, which, if one is not going as high as to reach micro-wave technique, forms the most significant difference between H.F. and V.H.F. practice.

To round off the book, the two final chapters describe how results should be dealt with in order to arrive at the final experimental conclusions, and, in the last, give some very useful reference data.

Summing up, the handbook is one that should be in every radio library. It has something in it for everyone, and can be the source of much saving of time, money, and headaches. Not the least pleasing feature of it is Mr. Scroggie's eminent readability and his happy knack of finding the analogy that is just right, and which brings home an important point in a way which can not be done otherwise. The writer read the fourth edition from cover to cover with as much pleasure—and, he hopes, profit—as he did when making his first acquaintance with an earlier edition of the same work.

—W.D.F.

The "Radio and Electronics" Abstract Service

AUDIO EQUIPMENT AND DESIGN:

Co-axial and separate two-way speaker design. Discussion upon design problems and various factors to be considered in manufacture and use of either system.

—**Communications (U.S.A.), July, 1948, p. 22.**

Impedance matching technique. Mathematical consideration of subject, to show that relationship between source impedance, load impedance, and degree of match is determined by which network components are variable, and whether maximum voltage, current, or power to be developed across the load impedance.—**Communications (U.S.A.), July, 1948, p. 26.**

Transcription recordings for the home. Description of new 33 1/3 r.p.m. recording system to produce long-playing records. New U.S. system cuts up to 300 groves per inch. As much as 50 minutes of recording time on two sides of 12-inch disc.

—**Electronics (U.S.A.), September, 1948, p. 86.**

A peaked audio amplifier for communications receivers. Circuit and construction of an amplifier unit adaptable for use with either regenerative or superhet. receiver. Circuit based upon twin-"T" resistance-capacitance bridge and is of uncomplicated construction.

—**QST (U.S.A.), September, 1948, p. 16.**

ANTENNAE AND TRANSMISSION LINES:

The radiation resistance of end-fire and Collinear arrays. Expressions for the radiation resistance of end-fire and Collinear arrays of half-wave dipoles obtained in terms of circular functions in a form convenient for computations.

—**Proc.I.R.E. (U.S.A.), June, 1948, p. 736.**

Stub tuners for power division. At F.M. and T.V. frequencies, when it is desired to divide the power between two antennae (in transmission), as between vertically and horizontally polarized components, a stub-tuner system may be used. Mathematical analysis and description of system used by one U.S. station.—**Communications (U.S.A.), August, 1948, p. 22.**

CIRCUITS AND CIRCUIT ELEMENTS:

A low-noise amplifier. Analysis of an R.F. amplifier circuit which results in very low noise factor and consisting of grounded-cathode triode first stage and grounded-grid triode second stage. The "Cascode" circuit (see "Radio and Electronics" Abstracts, November, 1948, p. 33). Grounded-cathode stage uses valve 6AK5 triode connected; grounded-grid stage consists of one-half of valve 6J6. Predicted that 30 mc. communications receiver could be built with cascode technique to give noise factor of 1.4 db. Suggestion that circuit also adaptable for use as low-pass amplifier. Practical circuits and details of experimental results.

—**Proc.I.R.E. (U.S.A.), June, 1948, p. 700.**

Pseudosynchronization in amplitude-stabilized oscillators. Discussion of effect of external signals on amplitude-stabilized oscillator of either (a) A.V.C. or (b) non-linear bridge-stabilized types to show that "pulling" does not exist, but that there is an apparent synchronizing effect due to the system acting as a regenerative amplifier of the injected signal.

—**Proc.I.R.E. (U.S.A.), June, 1948, p. 800.**

Distributed amplification. Details of a new principle in wide-band amplifier design applicable to either low-pass or band-pass types. Ordinary valves are distributed along artificial transmission lines to produce much greater bandwidths than ordinarily possible. Possible to design low-pass amplifiers with uniform frequency response from D.C. to frequencies as high as several hundred mc.

—**Proc.I.R.E. (U.S.A.), August, 1948, p. 956.**

Cathode-coupled negative-resistance circuit. Mathematical analysis of circuit at medium, low, and high frequencies, leading to an investigation of its potentialities and demonstration of its usefulness.—**Proc.I.R.E. (U.S.A.), August, 1948, p. 1034.**

Applications of screen-grid supply impedance in pentodes. Screen-grid voltage supply normally of low internal impedance, and in single stage amplifier there is phase reversal between input and output voltages. Increase of s-g supply impedance through degenerative effect reduces gain of amplifier, which may progressively be reduced to zero. Further increase of impedance causes amplifier gain to increase from zero, but in opposite phase. Development from this fact leads to phase-inverter, trigger circuits, relaxation oscillator, and negative-resistance oscillator circuits.

—**Communications (U.S.A.), August, 1948, p. 10.**

The transistor, a crystal triode. Description and theory of operation of newly-developed germanium crystal device having characteristics of grounded-grid amplifier. A triode form of germanium crystal diode, it has a gain of 20 db. and delivers 25 milliwatts output on frequencies up to 10 mc. Transistor still in experimental stage and is likely to eventually replace valves for many purposes.

—**Electronics (U.S.A.), September, 1948, p. 68.**

Frequency modulation of an oscillator. By coupling a tuned circuit to a self-oscillatory circuit, the frequency deviation of the oscillator may be increased. Description of simple method for securing the effect.

—Wireless Engineer (Eng.), September, 1948, p. 290.

Valve oscillator circuits. Analysis of oscillator circuits suggesting that most oscillators of the feed-back type are developments of a basic circuit which is given. The special developments are divided into three main classes: (1) Phase-restored circuits, (2) zero phase-shift circuits, and (3) tapped resonant circuits. These three main classes are further subdivided for analysis.

—Wireless Engineer (Eng.), September, 1948, p. 297.

Miller integrator. Second article deals with extent of departures from linearity in this circuit, and gives some practical circuits.

—Electronic Engineering (Eng.), September, 1948, p. 279.

Super-regenerative detection theory. An investigation of the mode of operation, the object being to develop a theory identifying factors controlling selectivity, optimum quenching, and signal-noise ratio. These properties shown to depend upon a function called the time aperture function, of basic importance.

—Electronics (U.S.A.), September, 1948, p. 96.

Super-regenerator design. Article summarizes theory of operation developed in 1942 by one U.S. radio engineer; also deals with method for calculating gain; discusses sensitivity limitations, design data, and gives equations for gain and selectivity.

—Electronics (U.S.A.), September, 1948, p. 99.

FREQUENCY MODULATION:

Theory of frequency counting and its application to detection of frequency-modulated waves. Principle discussed; detection generally and general outlines of the counting circuit.

—Proc.I.R.E. (U.S.A.), July, 1948, p. 828.

INDUSTRIAL APPLICATIONS:

High-speed revolution counter. Device does not impose any load nor is it attached to rotating shaft. Circuit of capacitance transducer. Two other items required are a pick-up and an electric meter, or tachometer. Equipment used with aircraft supercharger impellers at 30,000 r.p.m. and may be adapted for use with turbines, etc.

—Electronics (U.S.A.), September, 1948, p. 80.

Dielectric heating of thin films. Industrial application of dielectric heating has in some instances been restricted through difficulty in designing suitable electrodes. Article describes method of heating thin film of considerable length and width, using stray field system to produce longitudinal currents, rather than parallel plate system. Electrodes are arranged in array form. Principle applications: Drying plastic coatings, drying liquid films, heating solid films, and drying impregnants.

—Electronics (U.S.A.), September, 1948, p. 83.

MICROWAVE TECHNIQUES:

Recent developments in frequency stabilization of microwave oscillators. Discussion of a new circuit resulting from modification of Round stabilization system, to increase range of frequencies of stabilizing circuit.

—Proc.I.R.E. (U.S.A.), June, 1948, p. 794.

Frequency and stabilization at 10,000 mc. Procedure: Feedback and frequency multiplication methods. Brief description of frequency multiplier unit using klystrons. Details of recommended system using reflex klystron oscillator, H.F. discriminator, direct-coupled amplifier, and a power supply.

—Communications (U.S.A.), July, 1948, p. 6.

A new approach to tunable resonant circuits for the 300-3,000 mc. frequency range. Investigation into the use of distributed inductance lines as a new approach to design of resonant circuits at above frequencies. Types of circuits with discussion of advantages and disadvantages.

—Proc.I.R.E. (U.S.A.), August, 1948, p. 1017.

MEASUREMENTS AND TEST GEAR:

Noise measurements. Making precise measurements in rooms and studios. Consideration of effect of reflected sound on measurements. Relationship between direct and reverberant sound. Communications (U.S.A.), July, 1948, p. 21.

Sensitivity and gain of R.F. amplifiers and converters in receivers for F.M. and T.V. bands. Usual system of measurement, with signal generator, on low frequencies, when applied to frequencies under consideration leads to misleading results. Description of a method whereby a measured amount of power is injected into receiver by impedance adjustment between signal generator and receiver.

—Communications (U.S.A.), August, 1948, p. 18.

Low-frequecy oscillator. Circuit and details of oscillator with range from 0.3-252 c.p.s. in three steps. Frequency cannot be varied continuously, but in close steps. Non-linear negative feedback obtained with 6-watt lamps as resistances.

—Electronics (U.S.A.), September, 1948, p. 109.

Calculating mutual inductance. Simple formulae and graphs for calculation of mutual inductance and coupling factor for (a) identical coaxial coils, (b) different coaxial coils, (c) concentric coplanar coils.

—Wireless Engineer (Eng.), September, 1948, p. 286.

PROPAGATION:

Restricted-range sky-wave transmission. Report on a study to prove feasibility of restricting reception range of signals after reflection by the E layer. For "one-hop" range, experiments were conducted between 4-10 mc. using a single horizontal dipole, one-half wavelength long and one-quarter wavelength high, vertically directive system.

—Proc.I.R.E. (U.S.A.), June, 1948, p. 787.

Antennae for circular polarization. Examination of aspects of circularly polarized antennae and, in general, the elliptically polarized systems. Methods of producing circular polarization outlined and experimental results reported.

—Proc.I.R.E. (U.S.A.), August, 1948, p. 997.

Circular polarization in F.M. broadcasting. Field intensity measurements to substantiate theoretical advantages over plane polarization.—Electronics (U.S.A.), September, 1948, p. 103.

RECEPTION AND RECEIVERS:

Servicing A.C.-D.C. models, old and new. Useful servicing suggestions for locating and curing the most frequently occurring troubles in these receivers.

—Service (U.S.A.), July, 1948, p. 10.

Analysis of circuits of some portable receivers in current production in U.S.A. Includes battery-operated and battery/A.C.-D.C. receivers.—Service (U.S.A.), July, 1948, p. 28.

Modern single-sideband equipment of the Netherlands Postals Telephone and Telegraph. Description of, inter alia, the receiver used for s-s transmission reception and method of automatic tuning.—Proc.I.R.E. (U.S.A.), August, 1948, p. 970.

Post-war receiver design (U.S.), Part 3. Automatic frequency control circuits in F.M. receivers. Fremodyne detector circuit.

—Radio News (U.S.A.), August, 1948, p. 44.

Building a communications receiver, Part 1. Design and construction of audio amplifier (p.p. 6L6) and power supply of a receiver built on unit-construction principle.

—Radio News (U.S.A.), August, 1948, p. 46.

Building a communications receiver, Part 2. Unit comprising I.F. channel. Variable selectivity in three steps through use of separate I.F. channels with low-impedance input circuits and system of switching. A.V.C., B.F.O., R-meter, F.M. limiter, and F.M. discriminator included. Narrow- and wide-band second detectors.

—Radio News (U.S.A.), September, 1948, p. 50.

Super-selective C.W. receiver. Details of a double-conversion superheterodyne receiver. First I.F. 1600 kc., second I.F. 72 kc.—Q.S.T. (U.S.A.), August, 1948, p. 16.

A converter for 144 mc. (amateur) band. Circuit and construction of a well-designed converter giving high gain and good stability. Uses 956, 6J6, and 955 valves.

—Q.S.T. (U.S.A.), September, 1948, p. 44.

Triple conversion for communications receiver. Construction of a compact 85 kc. I.F. channel for use with a communications receiver. 6BE6 pentagrid converter, with untuned input and 585 kc. cathode-oscillator coil, 6BJ6 low-gain I.F. amplifier. 1N34 detector, 1N34 noise limiter.

—Q.S.T. (U.S.A.), September, 1948, p. 53.

TELEVISION:

Frame deflector-coil efficiency. Examination of deflector-coil operation and characteristics, stressing equal importance of resistance and inductance of coil.

—Wireless World (Eng.), August, 1948, p. 289.

Modern television receivers, Part 5. Operation and alignment of sound channel in commercially-built (U.S.) receivers. Includes chart with details of T.V. receivers made by 15 U.S. firms. Radio News (U.S.A.), August, 1948, p. 63.

Modern television receivers, Part 6. Servicing procedure and methods for locating faults.

—Radio News (U.S.A.), September, 1948, p. 67.

D.C. amplifiers. Improved circuits, with explanation of operation and application.

Radio News (U.S.A.), August, 1948, p. 88.

Distortion correction in television waveforms. Brief outline of network system used to correct distortion caused by (1) incorrect amplitude of one or more signal components, (2) incorrect phasing, and (3) generation of spurious components.

—Electronic Engineering (Eng.), August, 1948, p. 252.

Television power supplies. Use of selenium rectifiers in T.V. receiving sets (mobile and A.C.-D.C.). Six circuits of compact, lightweight power supplies.

Radio News (U.S.A.), September, 1948, p. 54.

TV picture-tube. Voltage and signal systems. Includes a useful discussion on high-voltage power supplies, including R.F. supplies. Service (U.S.A.), July, 1948, p. 22.

TV antennae installation. Summary of various types of antennae available; elimination, in the receiver, of reflections; method of analyzing signal-noise ratio for maximum efficiency.

—Service (U.S.A.), July, 1948, p. 25.

TV picture tube. Voltage and signal systems. Commentary upon four U.S. types of receivers and the respective signal and voltage circuits employed.

—Service (U.S.A.), August, 1948, p. 18.

Use of mathematics in 12-channel TV antennae installations. Simple explanation of methods for calculating decibel gain and gain or broad-band antennae. A number of full-band coverage problems of a practical nature are worked out.

—Service (U.S.A.), August, 1948, p. 14.

TV transmitter design. Linear amplifier; output load. Further consideration of linear amplifier design features.

—Communications (U.S.A.), July, 1948, p. 10.

TV transmitter design. Concluding article covers measurement of power output, transmitter regulation, and output variation, amplitude versus frequency response, and measurement of transient response.

—Communications (U.S.A.), August, 1948, p. 8.

A Practical Beginners' Course

PART 28

A Two-valve Audio Amplifier for Attaching to any of our previous One-valve Sets

We have now discussed audio amplifiers at some length, and have described both transformer and resistance coupling. There are other types of coupling to be met with, but these are the main ones, and the remaining ones can be dealt with as and when necessary. We now return to more practical things, and describe how to add a two-valve audio amplifier to any of the crystal or one-valve sets that have already been described in this course.

The Circuit

The circuit is given in Fig. 37. It is not the most economical in the way it uses batteries, since it needs a 7.5v. battery for supplying the grid bias for the valves, but it is the simplest possible two-valve amplifier circuit which will operate a loud-speaker at good volume. Apart from the valves, batteries, and the transformers, it uses only two fixed resistors, one volume control potentiometer, and two small fixed condensers. A transformer is used to couple the detector to the input of the amplifier, while resistance-capacity coupling is used between the first and second valves of the amplifier. The output valve is transformer-coupled to the loud-speaker, thus completing the chain.

Connections

The only thing about the circuit which may cause the novice a little uncertainty is the way in which the output of the crystal set or one-valve set is connected to the amplifier input terminals. In the case of the crystal set, it is a very simple mater, as all that has to be done is exactly what the diagram states. In the case of the valve detector, we have to consider the battery connections to the detector.

Suppose first of all that the detector, which formerly fed the headphones, is complete with its own batteries, and that the amplifier has been built, and is also supplied with its own separate set of batteries, "A," "B," and "C." In this case, too, the connection between the two is very simple, and consists only in connecting the leads to the phone terminals. However, it seems rather wasteful in batteries to use two "A" batteries, when one would do for both the amplifier and the detector, and also to use two "B" batteries when the 45 volts for the detector can be obtained from the junction between the two 45v. batteries that are connected in series to make up the 90 volts for the amplifier. In order to use the one set of batteries, it is only necessary to connect the filament terminals of the two units in parallel, and to take the phone lead on the first detector which is connected to "B" 45v. to the positive terminal of the first 45v. battery. Then, to complete the connection, the terminals of the input transformer, T_1, are connected to the phone terminals of the detector.

This arrangement is illustrated in Fig. 38. This kind of diagram, which shows how inter-connections are made between two or more pieces of equipment, is known as a *block diagram* and makes clear at once what a great deal of explanation is otherwise needed for.

If the same batteries are used for the two units, then the earthed sides of both circuits are connected through the "A" battery connections, but when the amplifier is used with a crystal set, the earthed sides are connected through the headphone connections.

Building the Amplifier

The construction of an amplifier such as this is very easy, and has no hidden difficulties at all. Either of two methods of construction can be used. The whole thing can be set up on a "broad-board," or else a small metal chassis can be used. The latter is much to be recommended, as every beginner has to make a start with metal construction at some time or other, and a straightforward job like this amplifier serves as an excellent introduction to this style of building. Another good reason for the metal type of chassis is that it makes a job that can be kept as permanent, if desired, and which takes little if any more work in the first place than the

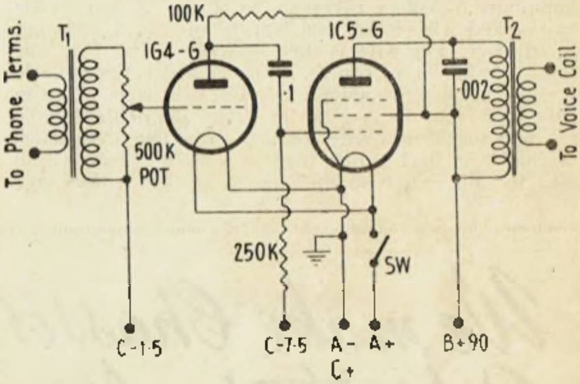


Fig. 37.

bread-board lay-out. In addition, it is safer for the valves, because it is not possible, when the wiring is hidden under a chassis, to short-circuit the batteries, or to accidentally connect "B" to the filaments of the valves by some metal object being inadvertently placed on the wiring. Even a stray piece of wire has been known to cause disaster, and it is a bitter blow inded to see two brand-new valves "go west" through some such accident. To build the amplifier, a small metal chassis, 6" x 3" x 1½" is needed. This can be ordered from some firm who does this sort of metal work, or can be made by the constructor himself. If the latter, it is a good plan to make it out of some 18-gauge aluminium sheet, especially if he is not used to performing on metal. The only tools needed are a hack-saw, or a small hand-saw, like a miniature wood-saw, which has a short blade about 5" long, which fits on to the handle. In addition to this, a small hand or breast drill, and one or two sizes of bits for it, and a punch, operated with a hammer, for banging out the 1¼" holes needed for mounting octal valve sockets, are about all that are needed apart from such usual items as pliers and screwdrivers.

For mounting valve sockets, and the input transformer, some small nuts and bolts are needed. The volume control and the filament on/off switch can be mounted on the front side of the chassis, and the input terminals can be mounted at the end nearest the input transformer. The usual way to connect the speaker is to use a four-pin valve socket, and a plug, which can be home-made out of the base of an old valve, or can be bought ready made. Instead of terminals, the battery leads can be connected to another valve socket, on the back of the chassis, and a plug with five leads used to connect to the battery terminals. It does not matter which pins on the socket are used for what, as long as the leads that connect to them are suitably labelled. A good plan is to decide on a colour-code for the wires, make the connecting cord by soldering the wires to any desired pins of the socket before wiring up the amplifier, and then do the wiring to the battery socket with the plug *in position* so that it can be seen what coloured wire goes to each pin.

After the chassis has been made, and all the valve sockets mounted, the wiring can be started. The best way of doing this is to wire the filament circuit first. Having decided, say, that No. 1 pin on the battery socket is to be used for the lead that goes to A —, B —, and C +, No. 1 pin is connected to the chassis. If a copper or steel chassis is used, it will be possible to solder a wire directly to the chassis, making the lead as short as desired. If of aluminium, it will be necessary to bore a ¼" hole in the chassis, and with a nut and bolt, firmly fix a soldering lug in place. The wire is then soldered to this lug. The reason for this is, of course, simply that it is not possible to solder anything to aluminium. The next wire to put in is the lead from the A — to the Fil. — pin of the 1C5-G. It is best to put in a wire for this connection, even when the chassis is steel, rather than by soldering a short lead from the Fil. — pin to the chassis. If this is done, the "A" battery current has to flow through the chassis, which is not always a good thing. Next, the A — leads are completed by connecting a wire from the Fil. — pin of the 1C5-G to that of the 1G4-G. The wire can run by the most direct route, and should be bent so that it runs along in contact with the chassis, thus keeping it out of the way of other wires and components. The next wiring to be done is the A + lead, which completes the filament wiring. The first lead to wire in is the one from the A pin on the battery socket to one terminal of the switch. For the sake of neatness (which always pays) this wire can run first, down to the chassis corner, and along the back, down the side, and along the front to where the switch is. If it runs in the corner of the chassis all the way, it is right out of the way, and looks neat. Finally, a wire is put in connecting the Fil. + pins of the two valves, and another from the Fil. + pin of one of them (it does not matter which) to the remaining switch terminal. With this done, it would now be possible to plug in the valves, connect the "A" battery, and switch on the filaments. It is not a bad idea to do this before going any further just to see that it works as it should. Placing the hand round the valves, or taking the whole thing into the dark will enable the slight, dull red glow of the filament to be seen.

We do not intend to go through the whole wiring in detail, as it would take up too much room, but we will content ourselves with giving one or two important tips on wiring in the small parts. The transformer, T_1, will offer no difficulty, either in mounting or wiring, as it will have four small holes (or perhaps two) by which it can be screwed to the chassis, and for connections, four leads are brought out underneath. If these come out on top of the chassis, it is necessary to bore two small holes, one on each side of the transformer, to take the primary and secondary leads respectively. In doing this, make sure that there are no burrs left on the holes to cut through the wire insulation and short-circuit the winding to earth.

The output transformer, T_2, will not concern us as far as mounting goes, because it will be found screwed to the chassis of the speaker itself. Thus, it has to be remembered that the two leads from this transformer are the *primary* connections, one of which goes to the plate of the 1C5-G, and the other to the B + pin of the battery socket. The small condenser, 0.002 μf., connected between plate and screen of the output valve can be wired right at the socket, and so needs no other support.

Similarly, the 0.1 μf. coupling condenser from the plate of the 1G4-G to the grid of the 1C5-G can wire directly to the appropriate socket pins. Now, when it comes to putting in the 100k. plate load resistor, and the 250k. grid-leak, there will be no connecting lug nearby to which the B + and C — ends of these resistors can go for support, as well as for electrical connection. It thus becomes necessary to provide an insulated solder lug which can be used for both purposes. It is possible to buy strips of insulating material on which are mounted one or more solder lugs, for this very purpose. These are often provided also with one or two small feet, and may or may not have the foot extended so as to act as an earth connection at the same time. In this case, we need two insulated lugs, one for the end of each resistor. The strip can be mounted between the valve sockets so that each resistor can be brought to one of the lugs. The plate and grid ends of the resistors can be soldered directly to the correct valve socket pins, so that now both ends are supported firmly. One sometimes sees beginners (and often others, who should know better) who make a habit of anchoring resistors only at the end that connects to a valve socket pin, and allowing the other end to float about in a most unsightly and dangerous way, simply asking for short-circuits to the chassis. Even in temporary work there is no excuse for construction that is inefficient, because many a "temporary" piece of gear has done duty for years. Also, it is more than annoying if a newly-constructed circuit refuses to work simply because of badly constructed wiring. Naturally, time and trouble are saved if the fullest use is made of the lugs already provided on many components, but there is no excuse for not anchoring resistors and condensors

(Continued on page 48.)

NEW PRODUCTS: LATEST RELEASES IN ELECTRONIC EQUIPMENT

THE "H.M.V." 4-VALVE PERSONAL PORTABLE BATTERY RECEIVER

His Master's Voice (N.Z.), Ltd., announce the presentation of the above "Personal Portable Receiver," which is one of the first of its type to be produced in New Zealand. This set is in the really small class, measuring only 9 in. long by 3 in. high by 3¾ in. wide, and complete with batteries weighing only 4 lb. 8 oz. It embodies a shallow lid, which, when opened by means of its push-button, automatically connects the batteries to the valve circuit, thereby switching the receiver on. Conversely, when the lid is closed, the set is automatically switched off. There is thus no chance of the batteries becoming run down through the receiver being put away with the batteries switched on.

Valve Complement

The valves used in the set are four in number and are as follows: Oscillator-mixer 1R5, I.F. amplifier 1T4, detector, A.V.C. and first audio stage 1S5, output stage 3S4.

Batteries

The H.T. battery is a 67.5-volt Type 467, while the filament battery is a 1.5-volt cell, Type 950. The battery life on normal intermittent operation should be approximately five hours for the filament battery and 60 hours for the H.T. battery.

Wave Range

The frequency coverage is 550 to 1500 kc/sec.

Power Output

The power output fed to a 2½ dia. permanent magnet speaker is 80 milliwatts.

Aerial

A loop aerial is used, this being built into the lid so that when the batteries are switched on by the lid being opened, the aerial swings away from the main body of the receiver and is in the best position for the picking up of signals without interference from the metal-work of the receiver itself.

Further information on this receiver may be obtained by writing to H.M.V. (N.Z.), Ltd., 118-120 Wakefield Street, Wellington.

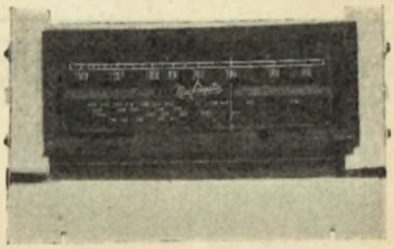
INDUCTANCE SPECIALISTS' TRANSFORMERS

TYPE 242 (Interstage) and **252** (Diode) Midget I.F. Transformers have been available on the New Zealand market since 14th November. These transformers measure only $^{25}/_{32}$" sq. x 2", and due to special construction give results comparable with full size transformers.

TYPE 150B and 160B are diamond wave, Litz wound loops for **Personal Portables.** They measure 2¼" and 3½" dia. respectively.

These are available now from Inductance Specialists, 202 Thorndon Quay, Wellington.

"MICROMATIC" BROADCAST SLIDE RULE DIAL



A new "Micromatic" Broadcast Slide Rule Dial is now available having an attractive glass edge lit scale, spin tuner, separate pointer rail, and calibrated for Plessey Type "E" gangs. The overall dimensions are 8½" x 5". The length of the scale is 5¾". The list price is 28/6.

These are available now from "Fears," 31 Willis St., Wellington.

OUR GOSSIP COLUMN

A change of plans is announced by Ian Hansen, late of Beacon Radio Ltd. Following the news that he would be going to England to take up a British Council bursary, he received the offer of a position with Amalgamated Wireles (A/sia) Ltd., and left on the 4th November for Sydney. He will be employed in the Valve Application Laboratory, under Mr. Langford-Smith. Although Ian has passed up the opportunity to study in England, he feels that his new appointment will have many compensating advantages.

* * *

George Wooller has returned from a business trip to Australia, and recently has been attending the Manufacturers' Federation Conference in Wellington.

* * *

Mr. H. M. Beecham, late Manager of the London Electric Clock Co., Ltd., has joined Westonhouse Radio Ltd. as Sales Manager.

* * *

Don Whisker, who until recently was with Kemp-Goodin, being well known not only in the Carterton district but also in a much wider sphere, has now joined the Sales Staff of Messrs. G. A. Wooller & Co., Ltd., his particular appointment being to assist clients of his new firm with the merchandising of Wooller lines. The special experience and ability Don has acquired in 25 years' work in radio in inspecting, servicing, and retailing are decided assets for competitive selling. Don was one of the original founders of the now defunct Electronics Institute in Christchurch. Outside of radio, Don's chief interests lie in bowling and amateur theatricals.

* * *

Mr. P. D. (Phil) England, Branch Manager at Wanganui for the National Electrical and Engineering Co., Ltd., has just been re-elected President of the Wanganui Branch of the Automobile Association, in which office he has served for many years. A great worker for "safety first" and good roads, Phil, who is an expert driver with a wide knowledge of roadways in the Wanganui and Taranaki districts, renders a great service to the cause of motoring. He is also a popular figure in Taranaki with the Radio and Electrical fraternity.

* * *

The announced retirement of Mr. A. D. Baggs, M.I.E.E., as Deputy Chief Engineer of the Post and Telegraph Department, recalls many interesting events connected with Radio development in which Mr. Baggs took a prominent part. He helped pioneer short-wave radio reception in the Dominion, and arranged the first radio-telephone broadcast from New Zealand following the Napier earthquake in 1931. When the Duke of Gloucester visited New Zealand in 1934, it was Mr. Baggs who was responsible for and actually made the arrangements which enabled the Duke to speak to the King in London by radio-telephone from Government House, Wellington. The valuable services rendered by Mr. Baggs to the Post and Telegraph Department have contributed much to the advancement of radio application in that Department.

* * *

Labour week-end was a good one for Hori Alston and Norm Swann, whose colt, Grand Scott, running up to top form, won two races at Greymouth. We understand that Norm is also the proud possessor of the famous "Highland Fling."

* * *

Of recent weeks, Walter Green has been covering the country pretty well, which is a good sign of complete recovery in health after his sojourn in hospital a few months ago. Recently, he has been in Auckland in connection with Pye Radio and Telephone equipment, travelling there by Luxury Bus and being quite impressed with our latest methods of transport to and from the Queen City.

* * *

A "FELLOW"

We know Allan Webster (Associated Radio Co., Wellington) as a good "jack of all trades" but we have only just appreciated how enthusiastic he is about horticulture. As a fitting record for Allan's contribution to the improvement of the landscape, he has just been awarded a Fellowship of the Royal N.Z. Institute

(Concluded on page 48.)

TRADE WINDS

The idea behind the New Zealand Radio Manufacturers' Federation's "Radio in Every Room" Campaign is an admirable one, as was the timing of it to coincide with the silver jubilee of radio broadcasting in New Zealand.

Most dealers seem to have viewed the campaign with favour, as evinced by the large number in Wellington and Auckland alone that are displaying (as we write it is still November) the special advertising material issued by the Federation. It is encouraging to see the results of the Federation's labours in this respect, and all concerned are to be heartily congratulated on the showing that is being put up.

Many dealers may not realize, however, that the essence of an advertising campaign is that it *is* a campaign. That is to say, it cannot be expected to produce miraculous results over-night, and in order to be as effective as possible, it needs to be carried on for an adequate length of time. Because the campaign has been specially arranged for the Jubilee Month of November, that is not to say that the Federation expects or desires the effort put into this nation-wide sales drive to cease abruptly after the 30th November, 1948. Far from it. Most retailers have no doubt realized this for themselves, and have made plans to continue the good work for some time to come, for it will be a long time yet before the market is saturated if the campaign finds favour with the public—as it should do. Many others will probably have wondered whether to expend their campaign effort in November only, and to these we would strongly recommend an extension of at least a month, but preferably for three months. It is only in this way that the sterling work put in by the Federation on behalf of the industry as a whole can bear its best fruit, and it is to everyone's advantage to do so.

* * *

Autocrat Radio Ltd. announce an expansion of activities as the result of a continued demand for their product. Extra space has been secured in Victoria Street, enabling additional staff to be employed. The office of this firm, however, remains at the old address in Victoria Street West.

* * *

It looks as though Radio and Electrical Services Ltd., Auckland, will commence the New Year with a "new look." This live ex-servicemen's firm has been up against it for space ever since it began business. A visit to Gundry Street in Newton recently found the staff busy moving into new premises which are being modernized and renovated. This change of address does not extend to the office which will remain as before in Wright's Building, Fort Street.

* * *

"CASH FOR NASH" SALE

The Lamphouse staged their Annual Sale during November under the title *"We want 'CASH FOR NASH'"* as a follow-up to their last year's sale, *"Money for Walter."* The caption was given plenty of advertising, and judging by the amount of traffic passing through their store, we would say it was a real success.

* * *

CATALOGUES

Rola Company (Aust.) Pty. Ltd. (Swan Electric Co., Ltd.) now has available a fully illustrated 20-page catalogue featuring technical data on Speakers, Transformer Coils, and Resistor and Condenser Coils.

"Rola Loud-speaker Repair Guide" is the title of that Company's technical bulletin for May, 1948, supplies of which are just to hand.

Both the above leaflets deserve room in everyone's radio service depot.

OBITUARY

MR. FRANK S. TAYLOR

Frank S. Taylor.

It is with deep regret that we record the death of Mr. Frank S. Taylor, a prominent figure for many years in the radio and electrical industry. Mr. Taylor was General Manager of the National Electrical and Engineering Co., Ltd., Wellington, joining that firm in 1921, and prior to coming to Wellington he was Manager of the Auckland branch. Mr. Taylor's interest in the electrical industry was full and varied, and his death will be keenly felt. He was the immediate past-president of the New Zealand Electrical Federation, and was past-chairman of the New Zealand Pottery and Ceramics Association.

Mr. Taylor was a veteran of the 1914–18 war in which he served with the Machine-gunners. He had a host of friends throughout New Zealand, being prominent in cricketing circles, and only a few years ago, when on a business trip to Australia, he returned with a cup won for the best performance at a radio trade friendly match. A member of the Wellesley and Central Clubs, Wellington, the Commercial Travellers' and Warehousemen's Association, Mr. Taylor was also an enthusiastic golfer.

He is survived by a widow, a son, and a daughter.

* * *

MR. E. H. McINNES

We regret to record the recent passing on of Mr. E. H. McInnes, late Resident Director for New Zealand of Standard Telephones and Cables Pty. Ltd. Mr. McInnes first served his company in Australia in the installation branch, being Manager of Melbourne branch, where he installed the first automatic telephone system. He came to New Zealand in 1914 as Resident Engineer and installed the first automatic telephone system in New Zealand at Masterton. He was appointed Manager of S.T.C. (N.Z.) in 1927 and subsequently was made a Director of the Australasian company. Held in very high esteem by all members of his staff, Mr. McInnes was of an unassuming character and most approachable from lowest to highest grades of employees.

PREDICTIONS FOR THE WORKING OF LONG-RANGE RADIO CIRCUITS ON AMATEUR FREQUENCIES

JANUARY, 1949

These frequencies are based on world charts of Maximum Usable Frequencies, prepared and issued by the Australian Radio Propagation Committee and supplied to *Radio and Electronics* by courtesy of this body and the New Zealand Department of Scientific and Industrial Research.

Contrary to normal commercial practice in the use of ionospheric predictions, the times given are derived from the Maximum Usable Frequencies, directly, and not from Optimum Working Frequencies, which are 15 per cent. lower.

The circuits are considered workable (a) if the band in question is below the M.U.F. at the time considered, and (b) if the said band is not lower than 65 per cent. of the M.U.F. If (b) is not satisfied, communication is unlikely, not because the frequency is not reflected by the ionosphere, but because the power available to amateurs is too low to overcome absorption in the ionosphere under these conditions.

Where the word "doubtful" appears in the tables, it indicates that between the times so labelled, the band is a little higher than the M.U.F. There is thus a possibility of effective communication on days when the actual M.U.F. is only slightly higher than that predicted.

All circuits have been assumed to start in Wellington. This creates the possibility of some slight error for other starting points, but this is of minor importance only, and does not justify the multiplication of the work involved.

ENGLAND

Wellington to Liverpool:

	N.Z.D.S.T.
(*a*) North Route:	
14 mc/sec.	1330 — 1830 1930 — 0630
30 mc/sec.	Nil.
(*b*) South Route:	
14 mc/sec.	1900 — 0930
30 mc/sec.	Nil.

U.S.A.

Wellington to New York:	
14 mc/sec.	0030 — 1430
30 mc/sec.	0700 — 1130
Wellington to New Orleans:	
14 mc/sec.	0100 — 2230
30 mc/sec.	0700 — 1330
Wellington to Washington:	
14 mc/sec.	0400 — 1800
30 mc/sec.	0700 — 1430
Wellington to San Diego:	
14 mc/sec.	0230 — 0030
30 mc/sec.	0700 — 1500

CANAL ZONE AND SOUTH AMERICA

Wellington to Panama:	
14 mc/sec.	24 hrs.
30 mc/sec.	0930 — 1630
Wellington to Pernambuco:	
14 mc/sec.	24 hrs.
30 mc/sec.	Nil.
Wellington to Buenos Aires:	
14 mc/sec.	24 hrs.
30 mc/sec.	Nil.

AFRICA

Wellington to Dakar:	
(*a*) South Route:	
14 mc/sec.	24 hrs.
30 mc/sec.	Nil.
(*b*) North Route:	
14 mc/sec.	1930 — 1030
30 mc/sec.	Nil.
Wellington to Capetown:	
14 mc/sec.	24 hrs.
30 mc/sec.	Nil.
Wellington to Aden:	
14 mc/sec.	0730 — 0600
30 mc/sec.	Nil.

INDIA

Wellington to Karachi:	
14 mc/sec.	24 hrs.
30 mc/sec.	1400 — 1700
Wellington to Colombo:	
14 mc/sec.	24 hrs.
30 mc/sec.	Nil.
Wellington to Calcutta:	
14 mc/sec.	24 hrs.
30 mc/sec.	1230 — 1800

ASIA

Wellington to Hong Kong:	
14 mc/sec.	0900 — 0730
30 mc/sec.	1130 — 1830
Wellington to Singapore:	
14 mc/sec.	24 hrs.
30 mc/sec.	1230 — 1800

SHORT-WAVE ENTHUSIASTS PLEASE NOTE!

Commencing in the next issue of *Radio and Electronics* we present the description and full constructional details of a high-performance receiver covering the range 3 to 30 mc/sec. We have called this set the "Junior Communications Receiver," because it has been specially designed for those without vast technical resources in the way of instrument and test equipment. In spite of this, it possesses good signal-to-noise ratio, high overall sensitivity, extreme selectivity, and has provision for calibrated spread on any desired bands. A novel, but extremely simple and easily constructed system is employed to give this last feature. By means of a double-conversion circuit, all the above features are obtainable without the use of a tuned R.F. stage, which is rendered unnecessary (*a*) by the use of a triode first mixer, and (*b*) by the use of a high first I.F.

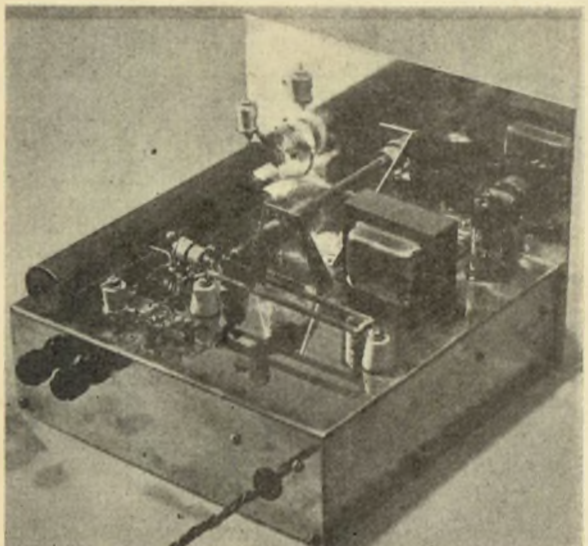
The performance of the set is made independent of the exact coil specifications by using separate tuning for the oscillator and signal input circuits and plug-in coils. These two features are not ideal, by any means, but are simply the price paid for outstanding performance *combined with* ease of duplication, even by a relatively inexperienced constructor.

The PHILIPS Experimenter

An Advertisement of Philips Electrical Industries of New Zealand.

No. 14: A RECEIVER FOR THE 165–170 mc/sec. AMATEUR BAND

Since the V.H.F. bands at 166 and 120 mc/sec. were allocated, the amount of work done by amateurs on them has been very slight indeed. This state of affairs is much to be deplored, from several points of view. In the first place, a great deal (though admittedly not all) local "nattering" could be done just as effectively on V.H.F. as on 80 metres, thereby relieving a good deal of congestion on this much-overworked band. Secondly, while 80 is, and probably always will be, the cradle of new-born amateur transmitters, the technique there is so standardized that there is very little new ground to break, especially in these enlightened times, and once the budding 'phone man has initiated himself into the



mysteries of 'phone transmitters generally, there is little on the technical side that he can do on 80 apart from building rigs different from the one he already has, and which, if properly built, will work just as well, but no better than the first, if that was properly built, too. Thus, for those without a high-frequency permit, the two bands mentioned are the logical place for the experimentally-minded amateur to look to for interesting new techniques.

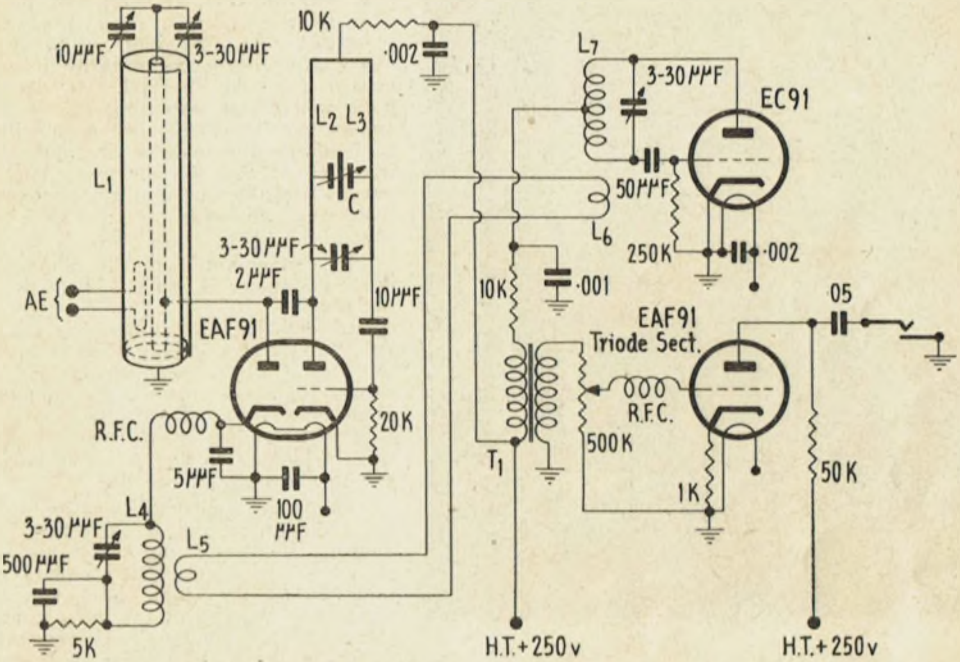
There may be a reason for the apparent lack of interest in the V.H.F. bands, in the comparatively smaller amount of published information on how to build equipment for them, but even here the amount of information available should be sufficient to enable many amateurs to get a start. However, this article may help to add to the range of 166 mc/sec. equipment that can be made quite easily by any amateur, and which will give excellent performance.

MODE OF OPERATION

The simplest type of receiver to use at very high frequencies is, of course, the super-regenerative. It is very easy to get going, has extremely high sensitivity, and the great advantage of broad bandwidth. This lack of selectivity is of great assistance where the transmitters to be received are self-excited and therefore subject to a certain degree of frequency modulation. The besetting sin, however, of the super-regenerative receiver is the fact that it radiates at the frequency of the signal being received. This would indeed be true were it not for the fact that additional circuits enable a super-regenerative circuit to be used and its advantages to be gained without the creation of interference by radiation. One way of doing this, and the most obvious method perhaps, is to add a tuned radio-frequency amplifier stage ahead of the super-regenerative detector. However, this scheme is not as easy to put into practice as it is to suggest, on account of the limitations of valves at very high frequencies where useful R.F. amplification is somewhat difficult to achieve. It is possible to construct excellent super-heterodyne receivers for V.H.F., but these have to contain many stages of high-frequency I.F. amplification in order to arrive at a satisfactory sensitivity, and are therefore quite expensive in valves and components. Another way out of the difficulty, however, has been used in the design of the present receiver. It may be termed a super-regenerative super-heterodyne. This is somewhat of a mouthful, but means simply that an oscillator and mixer circuit is used to heterodyne the incoming signal to an intermediate frequency, whereupon the sensitivity of the super-regenerative receiver is made use of by omitting all intermediate amplification stages and feeding the I.F. directly into the super-regenerative second detector. With the addition of the audio stage, we have a three-valve receiver with sufficient sensitivity for almost any purpose. This line-up makes the best possible use, both of the superheterodyne mixer and of the super-regenerative detector. Since the signal frequency is so high, any superhet. built to receive it must use a high I.F., for, if it does not, the image response will be very poor. Since the super-regenerative detector functions better the higher the frequency to which it is tuned, these two facts fit together very nicely, as exemplified in the present design. The I.F. has been made 60 mc/sec., and this is the frequency at which the super-regenerative detector works. The input circuit of the mixer is tuned to signal frequency, and therefore does not allow any 60 mc/sec. signal from the super-regenerative detector to be radiated by the aerial.

CIRCUIT DETAILS

The oscillator mixer uses an EAF91. This valve is one of the miniature E90 series, and has a diode and a triode in the same envelope, with separate cathodes. The diode is used as the mixer and the triode, of course, as the oscillator. The latter uses an open wire line in place of a lumped inductance, and this is tuned by two condensers. One, a 3-30 μμf. Philips trimmer is used for band-setting, and the other is a midget three-plate butterfly condenser, home-made, which is used for bandspread. Oscillator voltage is injected directly on to the diode mixer through a 2 $\mu\mu$f. condenser made from a twisted hook-up wire. The signal input circuit consists of a slotted concentric line tuned by a bandspread and band-setting condenser, and signal is coupled to the diode plate by direct connection from a tap on the inner conductor of the line. The aerial is coupled into the line circuit by means of a single turn loop, which is introduced through the slot and which allows a balanced or unbalanced aerial circuit to be used with the receiver. The I.F. is drawn from the mixer circuit by placing the tuned circuit containing



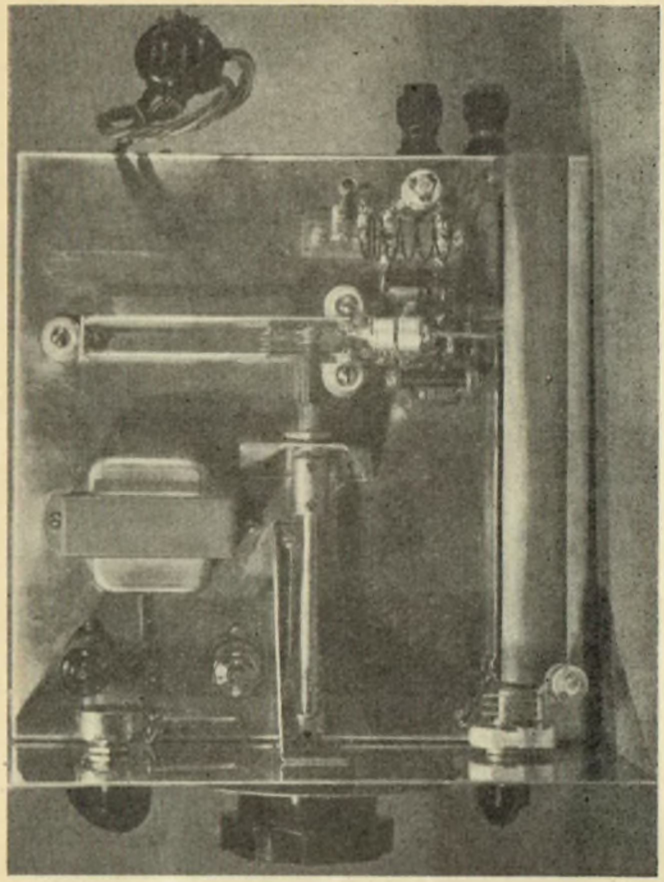
L_4 directly in the cathode lead. Above this is a signal frequency filter consisting of the 5 $\mu\mu$f. condenser and R.F.C., while between the I.F. tuned circuit and ground is a carbon load resistor of 5k. by-passed by a 500 $\mu\mu$f. condenser for both signal and I.F. The super-regenerative detector can be regarded as a completely separate unit, since it has its own tuned circuit using L_7 and is coupled to the mixer I.F. circuit by means of a twisted pair and two links, L_5 and L_6. It is thus possible to build the super-regenerative second detector and audio amplifier first, and to have these working properly before any attempt is made on the oscillator-mixer section. The second detector uses an EC91. This is a high mutual conductance triode, also in the miniature series, and designed primarily as a grounded grid amplifier. However, it makes an excellent V.H.F. oscillator, and for this reason, a very good super-regenerative detector also. It uses the same circuit as the R.F. oscillator, except for the fact that it has a lumped inductance instead of a tuned line. No difficulty will be experienced in getting it to oscillate properly or in getting it to super-regenerate. The value of grid leak is not at all critical, and should not cause trouble, but if super-regenerative action does not occur, it is a simple matter to try different values of grid leaks. An important point in connection with the detector is the filter consisting of the 10k. resistor and the .001 μf. condenser connected in the plate lead between L_7 and the primary of the audio transformer. If this filter is not present, the super-regenerative action will not take place. Similarly, if the leads are not short enough, or, through a fault, if the condenser should not have a sufficiently large value, the circuit still will not super-regenerate.

CONSTRUCTION OF THE RECEIVER

In a receiver of this nature the electrical stability is more than usually bound up with the mechanical rigidity of the construction. For this reason, it is recommended that the type of construction, and the lay-out shown in the photographs, is followed strictly. If any modifications are made, care must be taken to see that the structure, particularly that part of it connected with the local oscillator, is as rigid as possible. It is false economy to use anything but very firm supports for the oscillator open-wire line, so that midget stand-off insulators are really essential. As can be seen, the oscillator line is supported on three of these, one at the shorting bar end and one each for the open ends which are connected to the valve pins.

The concentric input line is supported by three bolts which have had their heads cut off and are sweated into holes in the outer conductor. The bolts pass through holes in the chassis, and when screwed down firmly earth the outer conductor at three points and also form useful bracing for the chassis.

Also of importance are the two brackets mounted above the chassis, (1) for supporting the tuning shaft, and (2) for adding rigidity to the front panel. The bearings for the tuning shaft are made from ¼ in. bushes taken from the old potentiometers. The rotor of the tuning condenser is so light that a third support on the other side of the line is unnecessary. In order to prevent back-to-front movement of the tuning shaft and therefore of the condensing rotor, a collar is used at each end of the shaft between the brackets.



The two 60 mc/sec. tuned circuits are mounted on strips of perspex 2¼ in. long, ¾ in. wide, and ⅛ in. thick, for support, and connection to the circuit; the coils are soldered to double-ended lugs, which are riveted to the strip. These lugs also support the Philips trimmers used for tuning the windings, and for supporting the coupling links.

LINE DIMENSIONS

The oscillator line is made from ¼ in. copper rod, 3¾ in. long, and spaced ½ in. between centres. The two stand-off insulators near the valve socket are so placed that the distance from their lugs to the plate pins on the socket is ⅜ in. The Philips trimmer used for band-setting is mounted directly on the end of the line which terminates exactly at the solder-lugs on the stand-off insulators. The midget ceramic grid condenser cannot be seen in the photograph, but the ⅜ in. mentioned above allows room for it.

The bandspread tuning condenser is made as follows: The two stators are made from 18-gauge copper sheet and measure ¾ in. x ½ in. They are soldered to the inside surface of the line, which gives them a spacing of approximately 5/16 in. The two rotor plates are semi-circular in shape except for the lugs by which they are mounted. The semi-circle is ½ in. in radius, and the lugs are ¼ in. in diameter. They project from the straight edge of the rotor so that the centre of the shaft is 5/16 in. from one end of this edge and ⅛ in. vertically above it. The two rotor plates are spaced by a small distance piece ⅛ in. deep, and are fixed to the end of a short perspex rod ¼ in. in diameter and 1½ in. long. The distance piece must be of metal so as to connect the two rotor plates in parallel.

The concentric input line is made from copper tubing, ¾ in. in outside diameter, with a 1/16 in. wall. The inner conductor is made from ¼ in. O.D. copper tubing or rod, and is fixed in place by making it a driving fit into a hole in the shorting plug. Both pieces of tube are 7 in. long, so that, allowing for the ½ in. thickness of the shorting plug, the effective line length is 6½ in. The plug can easily be filed to shape after being cut roughly from ½ in.-thick copper bar with a hack-saw. Using a thick plug enables an insulating spacer at the open end of the line to be dispensed with. In order to facilitate the making of connections to the inner conductor, the outer is slotted throughout its length. The slot is approximately ⅜ in. wide, and can easily be cut with a small hand-saw.

The connection from the diode plate to the inner conductor is made 1⅞ in. from the shorting plug.

Although the circuit diagram does not show this, the aerial coupling loop is introduced via the slot. For the sake of clarity, the drawing shows the loop connections coming out at a point opposite the slot. The loop is 2 in. long, ¼ in. wide, and is made from 16-gauge copper wire, which is insulated with spaghetti so as not to short-circuit the line.

At the open end of the line are soldered both the bandspread and band-setting tuning condensers, the line being positioned so that the stator of the bandspread condenser, which is mounted on the front panel, can be soldered directly to the end of the inner conductor. The rotor of this condenser is connected to the outer conductor by a short piece of 16-gauge copper wire, making the grounding independent of the chassis.

COIL DATA

The following table gives details of L_4 to L_7 inclusive:—

- L_4 ...... 5 turns, 20-gauge en. ⅜ in. diam. spaced to occupy 1 in.
- L_5 ...... 2 turns, same wire, same diameter, ⅛ in. between turns, and ⅛ in. from L_4.
- L_6 ...... 1 turn, same wire, same diameter, ⅛ in. from L_7.
- L_7 ...... 6 turns, same wire, same diameter, spaced to occupy ⅞ in.

R.F. CHOKES

The two chokes connected in the mixer cathode and audio grid circuits are identical and consist of 12turns of 20-gauge en. wire, inside diameter ¼ in., winding length ⅞ in.

The oscillator grid choke is wound with 30-gauge en. wire on a former ¼ in. inside diameter, and enough turns are put on to occupy ⅞ in. when close wound.

(To be concluded.)

RADIO HERE AND THERE

IMPORTANT DEVELOPMENT IN BRITISH TELEVISION

A major advance in British television is foreshadowed by the appearance of a new camera, fifty times more sensitive than the ordinary type of apparatus.

Known as C.P.S. Emitron, this all-British invention can transmit satisfactory pictures with normal lighting, such as is required for reading or writing. These pictures are claimed to be fairly free from fading effects.

Emitron, thanks to its greatly increased sensitivity, will enable a considerable saving to be made in the electric power needed to illuminate indoor scenes. Outdoor broadcasts will be possible until dusk—indeed, in the case of prolonged events poor light will henceforth stop play before the end.

Another considerable advantage of the Emitron camera will be better pictures, since even with quite moderate lighting, the lens aperture can be stepped down to such an extent that great "depressions of focus" can be obtained in the picture.

(The manufacturers are Electric and Musical Instruments, of Blythe Road, Hayes, Middlesex.)

* * *

TWO-WAY RADIO HELPS HYDRO PLANT ALONG

The increasing importance of the use of radio communication in traffic control was admirably demonstrated recently when the second stator unit for Bunnythorpe sub-station was transported by road from Wellington to Paekakariki.

Three traffic officers equipped with two-way radio sets patrolled the entire route, one travelling approximately half a mile ahead of the slowly moving convoy, the second a similar distance behind, whilst the third, on a motor-cycle, travelled between the first two to ensure the safe conduct of motorists past the equipment at dangerous sections of the road, according to advice received from either or both of the other officers. All three officers were not only in constant communication with each other, but also with their district office in Wellington. This ensured the taking of prompt and appropriate action according to the exact nature of the report supplied by the traffic officers.

* * *

FACSIMILE AND WEATHER

To improve the collection and dissemination of weather information and to extend its scope, the Air Weather Service of the United States Air Force recently inaugurated a plan whereby weather charts for all of North America and the adjacent ocean areas are prepared at a central point and distributed by a facsimile process to all Air Force fields in the continental United States. Times Facsimile Corporation type TXC equipment is used for the transmission and reception of these maps.

The weather map facilities of the U.S.A.F. consist of several separate networks which connect nearly 100 Air Force fields throughout the entire United States. The network can be interconnected so that one sending station may transmit to all receiving stations. Primary sending stations are located at the Weather Bureau Building, Washington, D.C., and at the Air Force Weather Central in Virginia. Secondary transmitting stations, at which more detailed weather information is plotted and analysed for transmission within their own regional territories, are located in Long Island, Georgia, Texas, Oklahoma, and California.

Approximately 15,000 miles of circuits are employed in furnishing the facsimile network, and, in its entirety, this system represents the largest of its kind ever attempted. The interconnecting circuits provided by the Bell Systems are high-quality telephone type facilities.

Once the basic weather information has been plotted and analysed in chart form, the facsimile method permits the transmission of the completed chart to all points in about 20 minutes. This provides the forecasters at individual Air Weather Service Stations with comprehensive data from which local and route forecasts can be developed without loss of time and without detailed clerical operations on their part.

Hitherto, the transmission of weather information to the forecasters at all domestic Air Force fields had been limited to the use of private line teletypewriter networks of the Air Force and the Department of Commerce, using a system of coding the locations of isobars as passing so many miles east or west of certain fixed reference points. While it did transmit complete data, this method used excessive amounts of teletypewriter circuit time and required personnel at each air base to decode and redraw a rough copy of the weather map.

Based on successful experience with facsimile operations under war-time conditions, the Air Force was confident that a similar arrangement, operating full time, would make it possible to provide each air base with comprehensive weather information much more quickly and with fewer personnel than the older method of weather map preparation.

GOSSIP

(Continued from page 41.)

of Horticulture. From now on, we shall expect to see his signature concluding with the letters F.R.I.H.N.Z. His early activities in horticulture were confined to improving his section around the home, but as his enthusiasm grew he extended his hobby to a week-end place at Otaki, where he has 1½ acres. There, he is working on a long-term plan of landscape lay-out, specializing in flowering shrubs and roses. Incidentally, in New Zealand the fellowship of the Society is limited to 500.

PANORAMIC ADAPTOR

(Continued from page 8.)

collecting parts for the circuit, the complete diagram of the unit proper is given in this instalment. The supply arrangements for the built-in cathode-ray tube will be given in Part 2 of the article, which is to appear in next month's instalment. The circuit given here is all that is needed if the adaptor is to feed its output to an external cathode-ray tube.

(To be continued.)

USE OF RESISTORS TO EXTEND METER RANGES

(Continued from page 27.)

shunt equals 1/n of the total resistance. In Fig. 8 the sum of all resistances remains the same for all ranges, so the values A–B, A–C, etc., are easily found. As an example, suppose the meter had a resistance of 80 ohms and a range of .5 ma. It is desired to obtain ranges of 1, 5, 10, 25, 50, and 100 ma. The total values of the tapped resistor is now taken as 120 ohms, making with the 80 ohms meter resistance a total of 200 ohms.

For a range of 1 ma., $n = 2$, so the shunt should be 100 ohms. This gives us the value of the tapped resistance in Fig. 9. The range of 5 ma. makes $n = 10$, so the shunt should be 20 ohms. For 10 ma., the shunt is 10 ohms, for 25 ma., 4 ohms, 50 ma., 2 ohms, and for 100 ma., 1 ohm. This gives us the solution for the complete circuit. All resistance values are standard, no special shunts required.

BEGINNERS' COURSE

(Continued from page 39.)

properly, even so. For instance, it would be a waste of time and money to provide insulated lugs for the secondary leads from T_1, when these leads have to go to the volume control anyway, but if it were not possible to put the control close enough for the leads provided to reach, then it would be much better construction to provide such lugs, rather than solder on extra lengths of lead, and wind the joints round with tape.

If the amplifier has been built according to the circuit, there is no reason in the world why it should not work at the first time of switching on. However, for safety's sake, it is necessary to check the wiring very carefully, before connecting the batteries, to see that no mistakes have been made. When this has been done, the "A" and "C" bateries should be connected up. The "A" wiring has been tested before, so that all that needs to be done is to see that the "C" and "B" batteries have not accidentally been cross-connected so as to get across the filaments. With "A" and "C" batteries connected, the "B" lead can be gingerly tapped on to the battery, with the "A" switched on. If all is well, a loud click should be heard from the speaker. If there is no sound, the connections must be carefully re-checked. The "B" can then be permanently connected, and the amplifier put into use, as described above.

(To be continued.)


HERE'S A Pointer
YES! Summer-time is 'portable' time. Naturally this means extra demand for "Eveready" and "Minimax" Radio Batteries. Make sure you carry ample stocks . . . display them prominently on your counter and in your windows.
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