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<tr>
<th>M.E.T.E.R.S.</th>
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<th>Type</th>
<th>Fitting</th>
<th>Price</th>
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<tbody>
<tr>
<td>250 microamp</td>
<td>D.C.</td>
<td>2 in.</td>
<td>M.C.</td>
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<td>500</td>
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<tr>
<td>1 m.A.</td>
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<tr>
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<td>400 m.A.</td>
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<td>500 m.A.</td>
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<tr>
<td>1/2 amp.</td>
<td>D.C.</td>
<td>2 in.</td>
<td>Thermo</td>
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<tr>
<td>1 amp.</td>
<td>D.C.</td>
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<td>Thermo</td>
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<tr>
<td>3 amp.</td>
<td>D.C.</td>
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<td>7/6</td>
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<tr>
<td>5 amp.</td>
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<td>Thermo</td>
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<td>6 amp.</td>
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<tr>
<td>20 amp.</td>
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<td>50 amperes</td>
<td>D.C.</td>
<td>2 in.</td>
<td>Thermo</td>
<td>13/6</td>
</tr>
<tr>
<td>10 volt</td>
<td>D.C.</td>
<td>2 in.</td>
<td>M.C.</td>
<td>8/6</td>
</tr>
<tr>
<td>15 volt</td>
<td>D.C.</td>
<td>2 in.</td>
<td>M.C.</td>
<td>8/6</td>
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<tr>
<td>10-15 volt</td>
<td>D.C.</td>
<td>2 in.</td>
<td>F.R.</td>
<td>8/6</td>
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</tbody>
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F.Sq. — Flash Square. F.R. — Flash Round.

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NOTICES

The EDITOR invites original contributions on construction of radio subjects. All material used will be paid for. Articles should preferably be typewritten, and photographs should be clear and sharp. Diagrams need not be large or perfectly drawn, as our draughtmen will redraw in most cases, but all relevant information should be included.

All MSS must be accompanied by a stamped addressed envelope for reply or return. Each item must bear the sender's name and address.

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

ALL CORRESPONDENCE should be addressed to THE RADIO CONSTRUCTOR, 57 Maida Vale, London W.9 Telephone CUN. 6515.
suitable charging voltage for the capacitor. Whilst deaf-aid batteries, for instance, appear to present the most obvious solution, they suffer from the disadvantage that a complete battery may be rendered useless by a single defective cell, and that the process of connecting the requisite number of units in series is rather tedious. Vibrator packs, on the other hand, may tend to be unreliable. This month’s circuit offers a suggested method of overcoming these difficulties. Although the circuit is intended ostensibly for use with the Mazda FA8 photo-flash tube and the T.C.C. SCE60FE capacitor, this application is meant to be illustrative only. The principle used may be applied to any other type of discharge circuit where relatively high voltages are needed.

The circuit is shown in the accompanying diagram. It will be seen that three SCE60FE capacitors (C1, C2 and C3), are used, these being connected, via switch S1, to the charging battery. This battery may consist of two conventional 67½ volt portable radio batteries connected in series to give a voltage of 135. When switch S1 is set to the “Charge” position the three capacitors are connected, via R1, R2 and R3, to the battery, and become charged, consequently, to the battery voltage. When S1 is set to “Operate,” the capacitors are connected in series, across the flash tube; offering therefore a

---

**SUGGESTED CIRCUITS FOR THE EXPERIMENTER**

The circuit presented in this series have been designed by G. A. French specially for the enthusiast who needs only the circuit and essential relevant data.

**No. 41. A Portable Low Voltage Electronic Flash**

As is well known, the respective sciences of photography and electronics are closely allied, the techniques of one often being called upon to facilitate progress in the other. This is especially true of recent developments in capacitor flash tubes, the operation and functioning of which are almost purely electronic.

Capacitor flash tubes consist essentially of three-electrode devices designed to take the place of conventional battery-operated photo-flash bulbs. The electrode assembly of a flash tube consists of an anode, a cathode, and a trigger element. The flash tube is prepared for operation by charging a capacitor connected across its anode and cathode. To initiate the flash, a voltage pulse is then applied between trigger electrode and cathode, causing the tube to conduct and discharge the capacitor. The trigger voltage is usually derived from a suddenly-excited inductor. The outstanding advantage of the electronic flash tube is that it is capable of being used over and over again; whilst the conventional bulb may be used only once, after which it has to be discarded.

**Energy**

Owing to the transient nature of its working, it is most convenient to consider the light output of the flash tube in terms of the energy supplied to it during the flash period by the capacitor. The units used are Joules, (one Amp flowing through one Ohm in one second equals one Joule), and may be found from the following expression:

\[
\text{Energy (Joules)} = \frac{\text{Capacitance} \times \text{Voltage}^2}{2}
\]

To give an illustration of what is required in practice, a design appearing in Amateur Photographer for April 1953 utilised a circuit arrangement capable of offering 25 joules. Modern low-voltage flash tubes work from capacitors charged to voltages around 350, and such voltages are often obtained, as in the Amateur Photographer design, from a number of deaf-aid batteries connected in series. Deaf-aid batteries appear to be used, also, in some commercial designs. Otherwise, however, it is more usual to have the capacitors charged by means of a vibrator pack.

The capacitors used for flash tube operation have relatively large values of capacitance, and electrolytic components intended especially for this type of work have been developed by T.C.C. As an example of the values usually used, the Amateur Photographer design incorporated three 120μF capacitors connected in parallel and charged to 360V. The normal radio electrolytic capacitor, incidentally, is unsuitable for this class of work.

**Power Supplies**

It will be appreciated, from what has been mentioned above, that one of the greatest difficulties in designing portable photo-flash gear lies in the provision of a connecting battery. This battery may consist of two conventional 67½ volt portable radio batteries connected in series to give a voltage of 135. When switch S1 is set to the “Charge” position the three capacitors are connected, via R1, R2 and R3, to the battery, and become charged, consequently, to the battery voltage. When S1 is set to “Operate,” the capacitors are connected in series, across the flash tube; offering therefore a
Radio Component Show

There will be 130 exhibitors in the 11th British Radio Component Show to be held at Grosvenor House, London, from April 6th to 8th, 1954. This is more than ever before and includes six firms who have not previously taken part in this exhibition. This annual private exhibition — compact, bright and generally acknowledged to be of real value to the technical visitor — is organised as usual by the Radio and Electronic Component Manufacturers’ Federation (22 Surrey Street, Strand, London, W.C.2) from whom invitations may be obtained. It crowds into the space of a few thousand feet in a comfortable hotel a representative display of an industry which employs 40,000 people and turns out nearly 1,000,000,000 components, valves and accessories a year.

The exhibits comprise British-made components for the radio, electronic and telecommunication industries, as well as gramophone components, valves and test gear. While several manufacturers will not announce their new products until the opening day, it is possible to give some idea of the scope of the exhibits and trend of development. As might be expected, there will be a good many exhibits catering for the development of television all over the world and its expansion in England to the higher frequencies. Several manufacturers will show multi-channel tuners for TV receivers, there will be valves for the new British TV frequencies and cathode ray tubes with improved focusing units. Some new instruments for television servicing will be shown and there will also be camera cables and television aerials for Continental as well as home use.

Resistors, capacitors and other components will be shown in their new ranges, meeting still more stringent tests of efficiency under the most severe conditions of temperature and humidity, and there will be new applications of some of the latest plastics and other materials. Several firms will show tape recorders this year. Gramophone components, including a new ceramic pick-up, will be well featured, and there will also be new microphones and loud speakers. Printed circuits will also be seen.

502 THE RADIO CONSTRUCTOR

voltage of 405 at an effective capacitance of 300µF. This is sufficient to give a discharge of nearly 25 joules. The flash is initiated in the normal fashion by closing S2, S2 may, of course, be the synchronous flash contacts of a camera.

There are several points of interest in the circuit. Firstly, it will be noted that three resistors, R1, R2 and R3, are used in series with the individual capacitors, instead of having a single resistor serving all three. This has been done to obviate arcing at the switch contacts when S1 is returned to the “Charge” position. The arcing could be caused if the three capacitors were connected directly in parallel whilst the charged capacitors are charged. It is disconnected in the “Operate” position.

Values for the resistors R1, R2 and R3 are not given, as these depend upon the type of capacitor and battery used. The manufacturer's advice should be sought on this point.

Advantages

The advantages of the circuit are obvious, and consist mainly of the convenience of using a low and dependable charging voltage.

There is also a disadvantage. This is given by the fact that it is necessary to operate S1 before the flash tube can be used. The writer has conferred with several professional photographers on this point, however, and has been assured that, in practice, this point will not entail a great deal of inconvenience.

In YOUR WORKSHOP

In which J. R. D. discusses problems and Points of Interest connected with the workshop side of our Hobby based on Letters from Readers and his own experience.

My remarks the other day concerning the operation of radio and TV equipment from low voltage DC supplies has prompted yet another spate of letters from interested country-dwelling readers. These readers, living in districts not yet supplied by the normal electric mains, have shown the traditional ingenuity of the amateur in overcoming their difficulties; and their letters make extremely interesting reading. They also convey a great deal of information which I am happy to pass on to other readers.

Vibrator Supplies

Several of my correspondents state that they are using Power Units type 173 for HT. These, together with series heater arrangements, are similar to the circuits mentioned by N. V. Dinsdale in the previous article. Others obtain HT from American 28V input, 200V 60mA output, dynamos of the “Command” type. The PU173 appears to be most popular, however, as it gives less interference.

On the other hand, F. W. Street of Southport is definitely “again” vibrator packs since one of his broke down during his local club’s Field Day after only eight hours running. Fortunately, he says, a permanent magnet motor-generator was available and this, hastily pressed into service, saved the day. In preparation for the following year’s Field Day, Mr. Street got ready a “Command” dynamotor. This gave 24 hours’ continual service despite the fact that for the last ten hours it had a 75% overload due to a transistor fault.

On this second occasion the receiver was supplied separately by an inverter with a 250V 50 cycle output. This inverter similarly gave trouble-free performance, but it took a heavy input current.

Another reader, W. A. Smith of Skerton, Lancs., has also written to me on this subject. As an example of what can be achieved with low-voltage supplies, he describes the installation he has fitted in a friend’s house. This installation is, I think, the most comprehensive of its type I have ever heard of.

It all started off when Mr. Smith’s friend moved into his new, mains-less house; and it was decided to use a temporary 12V system, whose wiring could be connected to the mains as soon as it arrived in the district. Lighting would then be provided by what Mr. Smith refers to, rather intriguingly, as “bus” bulbs.

However, the 12V system was soon changed to 24V; and it was planned to overcome the charging problem by obtaining a shore-boat or similar petrol-set generator.

Mr. Smith noticed, fortunately, that there was always a breeze blowing in the locality and so he decided instead to try a wind-charger. This he obtained from Lucas, who also supplied a propeller and charging board.

The wind-driven generator proved to be an unqualified success. It was mounted on an old Austin front wheel axle and brake drum; this being fitted, in its turn, on top of an ex-G.P.O. 3a-foot telephone pole. The generator worked perfectly, a light breeze being sufficient to generate 5A, a normal wind up to 15A, and a gale 20A plus. (Mr. Smith’s charging ammeter limits at 20A, and I understand that the end-stop is by normally worn away 0).

Since the acquisition of the wind-driven generator guaranteed plenty of charging current, Mr. Smith next proceeded to look for ways and means of using it up. As a start, an electric razor was re-conditioned by the
The radio chassis proper of this radiogram was soon modified to series-parallel heaters and a synchronous motor HT, and gave no trouble at all. Mr. Smith then tackled the motor itself. This he fed from a 250V AC motor-generator. He claims that this arrangement was much more perfect than being forced from flaw, flutter, or any other defect. An interesting point, this, for others similarly placed.

The original chassis came the vacuum cleaner! This now also works from the 24V supply, the higher voltage being given by a motor-generator mounted on wheels and rolled from room to room as required.

This motor generator is heavily overloaded and has to be switched off every quarter of an hour to cool off. The chassis came next. This was an AC/DC model, and best results were given by driving an old DC 220V motor from a 24V generator. The motor now acts as a generator and the generator as a motor. Consumption at 24V is 9A and the picture is perfect.

"I know what you're thinking," comments Mr. Smith at this point in his letter, "poor old generator on top of the pole! Well, it's driven for over a year now and hasn't given one moment's trouble.

Mr. Smith's friend, incidentally, has no intention of going over to the mains supply, even when it does arrive. As he says, "I'm getting a summation for now." I would certainly concur with that!

The Magic Box

A friend of mine recently had a rather annoying experience. Calling at an acquaintance's house one evening, he arrived in the middle of a TV programme. Such is the custom of the land these days that he had, perforce, to sit with the family until the end of the programme before anything approaching conversation could be embarked upon.

Whilst watching the programme, my friend noticed that the frame-held was just "on the edge." Every now and then the picture rolled up. No one, however, seemed to be very bothered by this, and far as my friend could make out, it was considered to be quite a commonplace phenomenon. Being a technical type, my friend offered to readjust the frame-held. His offer was greeted with a suspicious assent and so he re-adjusted the set, which then settled down to correct working again.

Now, here is the rub of this little story. A week or so after his visit to the house the set stopped working and was packed off to the local shop. The fault was the line output valve, and the repair bill came to the price of the new valve plus the service fee. Reasonable enough, one would think. But no. My friend was not only blamed for the whole business; it was even suggested that he should fork out the money for the repair as well! The argument was that the set had never given any trouble till he started "moving around at the back," and he was perfectly to blame from now on.

I know that this sounds a tall story, but it is quite true. And it only proves the moral that the simplest thing to do is to grip and bear an acquaintance's picture, until one is actually asked if one can improve it. However, most families with TV sets have an accredited knob-adjuster within their own domestic circle, and so the case mentioned above does not arise. It is interesting, incidentally, how many instances one hears of these little things that can be control slightly off-set to prevent "that line effect." There is, surely, food for thought there.

Whilst on the subject of the results shown on the TV screen, it is also surprising to note how common line transformer ringing is, especially when a picture shows up, of course, as a vertical bar down the left-hand side of the picture and is caused mainly by ringing of the EHT overload after the line filter. Many efficiency circuits "squash out" the ring voltages, as it were, so that when ringing occurs it is not usually very noticeable. However, some commercial sets have quite noticeable line rings; and it is difficult to offer advice on methods of curing them, as so much depends on the individual circuit.

TV in Small Stages

Quite a few people have written to me recently saying that the only thing that prevents them from launching forth on wide-angle television is that they don't want to stand the initial charge of the large picture tube required. Many of these readers have nine or twelve inch tubes already on hand. I can assure these constructors that the wide-angle components specified for the Magna-View, etc., can be very easily connected to scan a nine or twelve inch tube, and supply also the reduced EHT required. So a complete wide-angle TV set around any nine or twelve inch tube he may already have, changing over to the larger tube when felt prepared to do so.

The alterations to the scanning circuits consist mainly of reducing the line output HT rail voltage, and specific values and voltages to be obtained from the manufacturers concerned.

Beginning In Radio

I had a letter passed on to me by the Editor the other day which, whilst at first glance being something that is easy to answer, has, in actual fact, given rise to considerable thought.

Here is the letter:

"Dear Sir,

I've just finished with the Army, and I would like to start up radio construction in my spare time as a hobby, but I've never had any previous knowledge whatsoever. I was wondering if you could possibly tell me the name of some books dealing with radio principles and theory that I could get, and the best way to set about it.

I'll be very thankful if you can oblige me.

There. It is a simple question which demands a simple answer. But is it so simple? To start off, let us take the question of books in its literal sense. There are, however, so many books dealing with radio principles and theory that it is difficult quite to know what to exclude. Some books are excellent. Scroggie's Foundations of Wireless is, for instance, about the best in its particular sphere. Another, taken quite at random, is the A.R.R.L. Handbook. This can also be of considerable value, even if the reader has no intention of becoming a ham. But these are only two publications in a very considerable field.

When magazines are concerned, the choice in Great Britain is rather limited for the beginner; and, of course, I can't say too much on this subject for the obvious reason of not having written for a magazine myself. However, I can at least say that The Radio Constructor has created a reputation for articles which are factual and reliable.

The trouble in this instance is that I am not at all certain that every beginner really wants literature which gives him a lot of theory only. Wouldn't it be better, perhaps, if he were to start off by actually building himself a set, and let the theory, or at least, the more complicated theory, come afterwards? I am convinced that a high percentage of the people who devote much of their time to radio these days, whether as a profession or as a hobby, commenced by making their own gear; and learned their theory "the hard way," by the actual process of getting that gear to work. After all, as said and done, a radio chassis is little more than a circuit diagram in three-dimensional form; and if one has cured a case of, say, AM distortion by replacing a leaky coupling condenser, surely this is a simple piece of theory learned in a way which will be remembered always.

I often think that it was all a lot simpler for the beginner in the times before the war. In those days all that was needed to get going was a two-volt accumulator, an HT battery, a pair of phones, and one or two simple valves. With these components it was easy enough to knock up a one or two valve receiver; whereupon one had then gained the experience and confidence necessary to carry on to more ambitious gear.

The days of the 2-volt valve are gone completely now, of course. The beginner, instead of relying on his accumulator and HT battery for power, now has to think in terms of mains transformers and rectifiers. Which are, admittedly, a little more difficult to construct from scratch.

I advise the reader whose letter prompted these paragraphs not to worry too much about the more complicated theory, at any rate. I suggest that he starts by making himself a simple set and getting it to go.

Several small and easy-to-build sets have been described recently in this magazine and there are quite a few more "on the stocks" scheduled for future issues. The Rubicon to be crossed by the beginner is that of building the initial job. After that, there will be no holding him back!

"Calling all Guards..."
FRINGE AREA TELEVISION

By J. GLAZER

Part 4  THE POWER SUPPLY

As the sound, vision, and timebase units were built separately and work independently of each other, it was decided to construct the power unit in two separate parts; one feeding the sync and timebases, the other feeding the sound and vision units. Consequently the two power units are constructed on identical chassis, as the power required for driving the units is divided almost equally between them. Separate power units make adjustments to the individual units comparatively easy, as only one unit need be on at a time.

The requirements of the timebase power unit are 140mA max. HT current and, under 4 Amps heater current, while those of the sound/vision power unit are 130mA max., and a little under 5 Amps heater current. The full-wave rectification is carried out by a 5U4G in both power units, the smoothing for the vision unit being a little more elaborate than the rest. The EL33 output valve is located on the sound/vision power unit and is furnished with a grid stopper and a tone correction capacitor. This valve drives a ten inch speaker of 10Ω impedance, the matching ratio being 25:1.

One end of the 6.3V heater windings on both chassis is earthed, and a fuse is located in each HT negative line for safety measures against HT short circuits. The CRT bias is found for safety on the timebase power unit; any failure in the bias due to the failure of HT volts will be counteracted by the failure of the line timebase, and therefore the EHT. The CRT cathode has a minimum bias resistance of 10kΩ which is decoupled by a 0.5μF capacitor. The heater winding for the CRT is on the timebase power unit transformer, and the on/off switch for both power units is combined with the volume control.

Construction

Both power unit chassis are the same size and are made of heavy gauge aluminium, 15" long by 6" wide and 3" deep. The mains transformers are sunk into the chassis and the rectifier valves are mounted close to them. The rest of the components are dispersed along the chassis, depending on the types and sizes used.

The CRT is mounted on a standard CRT carrier, which are fairly easy to obtain. All

COMPONENT LIST

<table>
<thead>
<tr>
<th>Component</th>
<th>Value</th>
</tr>
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<tbody>
<tr>
<td>Sound/Vision Power Unit</td>
<td></td>
</tr>
<tr>
<td>R1</td>
<td>100Ω</td>
</tr>
<tr>
<td>R2</td>
<td>0.5MΩ</td>
</tr>
<tr>
<td>R3</td>
<td>150Ω</td>
</tr>
<tr>
<td>C1</td>
<td>16μF, 500V wkg. electrolytic</td>
</tr>
<tr>
<td>C2</td>
<td>32μF, 450V wkg. electrolytic</td>
</tr>
<tr>
<td>C3</td>
<td>32μF, 350V wkg. electrolytic</td>
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<tr>
<td>C4</td>
<td>25μF, 25V wkg. electrolytic</td>
</tr>
<tr>
<td>C5</td>
<td>0.01μF, 330V wkg.</td>
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<td>V1</td>
<td>5U4G</td>
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<td>V2</td>
<td>EL33</td>
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<td>F1</td>
<td>2A cartridge fuse</td>
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<tr>
<td>F2</td>
<td>500mA cartridge fuse</td>
</tr>
<tr>
<td>CH1</td>
<td>5H, 150mA</td>
</tr>
<tr>
<td>CH2</td>
<td>10H, 100mA</td>
</tr>
<tr>
<td>S1</td>
<td>ON/OFF switch on volume control</td>
</tr>
<tr>
<td>T1</td>
<td>MAINS TRANSFORMER. Primary: 200-250V. Secondaries; 300-0-300V, 150mA; 6.3V, 5A; 5.0V, 3A.</td>
</tr>
<tr>
<td>T2</td>
<td>Sound output transformer</td>
</tr>
<tr>
<td>Sync/Timebase Power Unit</td>
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<tr>
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<td>0.5MΩ</td>
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<tr>
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<td>10kΩ</td>
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<tr>
<td>R6</td>
<td>7.25kΩ, 1 watt</td>
</tr>
<tr>
<td>R8</td>
<td>20kΩ, wirewound variable (brilliance).</td>
</tr>
<tr>
<td>C6</td>
<td>0.5μF, 250V wkg.</td>
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<td>C7</td>
<td>32μF, 450V wkg., electrolytic</td>
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<td>C8</td>
<td>32μF, 500V wkg., electrolytic</td>
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<tr>
<td>V3</td>
<td>5U4G</td>
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<tr>
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<td>5H, 150mA</td>
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<td>F3</td>
<td>500mA cartridge fuse</td>
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<td>2A cartridge fuse</td>
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<td>T3</td>
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The QRP Society

SINCE ITS INCEPTION NEARLY five years ago, the QRP Research Society has progressively expanded, both in its membership and activities. Its functions now being much more comprehensive than when the title was originally conceived, the word "Research" is to be deleted and the Society will in future be known as The QRP Society. This will avoid any possible misunderstanding, for while appropriate importance will continue to be given to research, as hitherto, this no longer constitutes the sole aim of the Society, and the development of this branch will be left in the hands of those existing or future members whose knowledge and technical ability are best suited for the purpose.

The Society is now entirely flexible in that it can offer something of advantage to all, even to the beginner in wireless, for such a recruit will be placed "under the wing" of an experienced member. There is a new section which serves the large number of SWL's who find that the simple TRF receiver continues to give satisfaction, especially where sensitivity and ease of construction are of importance.

To interest the two-metre and seventy-centimetre man, there is the VHF section.

The brilliance, contrast, and volume controls are mounted in an escutcheon in the side of the cabinet, on an oblong piece of bakelite. Long leads can be used on the brilliance control for an auxiliary armchair control. The writer used a permanent magnet focusing unit, but an electro-magnetic coil can be used, though it will be an extra load on the power unit.

Finally, if you have any VR65's upon the shelf, don't leave them there; throw them in the dustbin. (So much for the writer's opinions on this current-absorbing valve).
functions by these new tubes and obtain identical results.

However, by utilising the improved design features of the 5B254M, one can obtain improved results and efficiency — particularly at the higher frequencies. Some may be puzzled to observe that the base connections of the 5B254M show no less than three cathode connections and two connections to the control grid. This is not for the purpose of filling up spare pins, but has a definite reason. The object is to overcome the deleterious effects of the inductance of the cathode and grid leads. In this tube, the grid and cathode leads are in fact very short, so that inductance effects are already less than in the conventional 807 construction. However, the use of multiple connections enables even these small inductance effects to be further reduced. Take the case, for example of the anode and screen grid bypassed to the same cathode connection. The inductance of the common section of cathode lead inside the valve base acts as an unwanted coupling between the two circuits. However, by bypassing to separate cathode leads, each bypass path has its own separate circuit right up to the cathode. Similarly, two grid connections are very useful to enable a neutralising circuit to be used independently of the signal circuit drive applied to the other grid. To make this quite clear, Fig. 2 shows how the anode and screen circuits may be separately bypassed. Fig. 3 shows how neutralising can be effected by using the two grid connections. If neutralising is not used, the two grid connections should be paralleled, so that RF drive power has the lowest impedance path possible.

In all other respects, the tube can be treated precisely as an 807, and the maximum grid drive should not exceed 5 mA as with the normal 807. In fact, the 5B254M is excellent as a Zero Bias Class B tube, giving 120 Watts of audio with 750 volts on the anode. Definitely a valve worth trying!

**Fig. 2. The multiple cathode connections enable the screen bypass (C₂) and the anode bypass (C₁) to be made to the cathode independently, thus eliminating "common lead" inductance effects. Stability and efficiency are thus greatly assisted.**

**Fig. 3. The double grid connection comes in useful if neutralising is required. If unneutralised, the two grid connections should be paralleled.**

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**SEMI-CONDUCTOR DEVICES**

**CRYSTAL DIODES, TRANSISTORS AND THEIR APPLICATIONS**

A N EARLIER ARTICLE* gave a résumé of devices available or being developed in this very interesting new field. This part concerns itself with practical information about their use, particular attention being paid to the newer devices whose special advantages and limitations are not at all well known to the majority of amateurs.

Power Rectifiers

The plate or disc type copper oxide and selenium rectifiers are so well known that they will only be touched upon briefly. In general they are more expensive than valves, but being simpler and longer lived they are well worth using. Their practical advantage is that they need no separate winding or dropping resistance to supply a filament or heater. Even in half-wave circuits this is important, impedance valves, but there is one operational point that does need watching, and that is keeping down the temperature. Metal rectifiers always pass more reverse current when the temperature rises and this, of course, generates more heat which in its turn increases the reverse current, so that the device can 'run away' and destroy itself. It is therefore necessary, especially when using these rectifiers near the limit of their range in compact equipment, to allow good ventilation.

A recent addition to the range of power rectifiers is the germanium junction type. This packs an amazing power handling capacity and excellent regulation into a minute space.

Crystal Diodes

Before taking individual applications, a few general points should be mentioned as a guide to their use. Their good points are their tiny size, low capacitance and lack of a heater. Their main limitations are their

* Semi-Conductor Devices, September 1953.
relatively low back resistance and voltage handling capability. Crystals are graded into types which differ in these characteristics and, therefore, a suitable type can be selected for any particular circuit. Incidentally, most of the crystals being sold as ‘surplus’ are rejects from all other grades and cannot, therefore, be expected to give satisfactory results in circuits demanding high back resistance or high back voltage.

One of the simplest applications of crystal diodes is to make an up-to-date version of the old-fashioned crystal set. Such a set makes a useful standby for emergencies, and children love listening to programmes in bed with headphones. Many circuit variations are possible but the general rules are—

1. The maximum loudness of the signal is governed by the goodness of the aerial used.
2. This maximum may have to be reduced by selective consideration.

If there is no difficulty in separating stations in your locality with a single tuned circuit, then more elaborate arrangements will give no advantage and merely lose strength. If, however, selectivity is a problem, then careful design is needed to obtain it without throwing away too much power.

The true experimenter’s set would include large coils with many taps so that every coupling could be adjusted for optimum results. It is certainly very constructive to make up a set of this type, putting a micro-ammeter in the crystal circuit to be able to see immediately the effect of circuit variations. Practical variations can be made giving individual improvements too small to be noticed by the relatively insensitive ear, but which add up to a decided audible difference. Single circuit and double circuit arrangements are shown in Fig. 2 (a) and (b). For the coils 60 turns of 20 swg wire are wound on 3" formers, and taps are taken out every 5 turns. Stranded wire would be better, but there is some difficulty in taking off tappings. The optimum tapping for feeding the crystal will usually be found somewhere near the half-way point, and is not very critical.

The position of the aerial tap will depend mainly on the length of the aerial, and to some extent on whether it is indoors or slung up well away from buildings. In the double circuit version the top coupling capacitor will control the compromise between selectivity and strength. A further variation which is worth trying when the aerial is large, is to place the tuning capacitor in series with the aerial and tuning coil.

Two final points. A good earth connection makes a lot of difference, and best results will be obtained with high resistance headphones.

The use of low resistance phones will lose a good deal of signal strength unless a matching transformer is used. By replacing the headphones with a 47kΩ resistor, the crystal set can be used as a convenient feed-in unit for a high quality amplifier. It should be remembered, however, that even a crystal can introduce harmonic distortion unless supplied with a reasonably large signal, so this arrangement should only be used for a strong local station.

Probably the commonest TV application of germanium diodes is as vision detector, where they have advantages over thermionic diodes. The circuit can be orthodox, but the lower capacitance of the crystal allows a few more turns to be added to the final coil and also helps the higher video frequencies to be maintained. It can be wired in the circuit in a very small space, and if placed in the final I.F. can it helps prevent the feedback of harmonics to the earlier stages.

Another convenient use is as sound detector and limiter. A typical circuit is given in Fig. 2. Very effective clearing up of ignition noise is given by this circuit, which is very easy to incorporate in an existing set.

Although germanium crystals are recommended as spot limiters their use needs certain precautions. If used on the output side of the video stage they have to withstand quite a high voltage amounting to the full peak-to-peak swing of the signal (vision plus sync pulses). Many crystals will do this quite comfortably, since several types are rated at 75 volts and many of them are, in fact, quite happy at 100 volts. These ratings, however, are at 20°C. and do not hold good at higher temperatures. The crystal should, therefore, be placed in a cool part of the set, where it is usually easier in home constructed gear than in a commercial job where the smallest possible cabinet is used and temperatures sometimes rise to surprising figures.

A few miscellaneous applications will be touched on without going into much detail, and they may possibly suggest others on the same lines. A signal tracer of extreme simplicity can be made with nothing other than a crystal and a pair of high resistance phones connected in series. This must be restricted in its use to cases where it can be connected directly across a tuned circuit with the coil providing the necessary DC return path. For more universal use the more complicated circuit shown in Fig. 4 may be used. This can be applied to any point at which there is a signal, but it is a little more trouble to make up in a convenient form.

A crystal in series with a DC meter enables it to be used on AC up to high frequencies. Calibration will vary somewhat from one crystal to another, but this can be carried out against any AC meter at 50 cycles and can then be taken as accurate over the whole of the video range, and sufficiently accurate for most purposes up to several megacycles. It will give readings even above 100 megacycles, but they will need correction.

Although not intended to be power rectifiers, crystals are sometimes convenient for providing a small amount of current at moderate voltages. For instance, for bias supplies or for small pieces of equipment such as oscillators or valve voltmeters. If the safe PIV of the better varieties is taken as 60V, then generally speaking 20V RMS is the maximum voltage that should be rectified.

Crystals can, of course, be used in series to handle higher voltages. Where a small voltage is wanted from a high voltage supply a resistance can be used to reduce the value, but this will not reduce the back voltage when the crystal is not conducting. A second
crystal connected as in Fig. 5 will remove this reverse voltage satisfactorily. This would make a convenient source of negative bias for output valves and avoid the subtraction from available HT caused by auto-bias.

Transistors
This section is included in the hope that some transistors will be available on the amateur market by the time these notes appear in print. Point contact types will be dealt with mainly, since junction types appear to be further off.

First, a few words about their characteristics and how they affect circuits. For the purpose of comparison the emitter of a transistor can be compared to the grid of a valve, the base to the cathode and the collector to the anode. This comparison should not be pushed too far, but it is convenient up to a point. Now for the differences. The collector must be fed from a positive supply instead of a positive, and the emitter instead of a positive voltage bias has a positive current bias. The input impedance is only a few hundred ohms, whilst the output impedance is about 20,000 ohms. This low input impedance means that for LF coupling step-down transformers are used—they step up the current and the transistor is a current operated device, so this does not sacrifice gain. For HF the best arrangement is a tap on the coil.

The circuit shown in Fig. 6 uses one transistor with an HT supply of 6-9 volts. Since some transistors are not so efficient in the MW band, it is suggested that in the first place the long wave Light Programme should be tried. This circuit will get Drintwhit at good phone strength almost anywhere in the British Isles on a small indoor aerial. The capacitor C2 gives reaction. No separate winding is needed.

To give LS results, this should be followed by an HF stage, and a suitable circuit is given in Fig. 7. Note that a separate bias supply is used. To get sufficient output power the HT has been raised to 16 volts. For additional sensitivity an HF stage can easily be added, and a circuit is given in Fig. 8. Reflex circuits are doubtless possible but should not be attempted until experience has been gained with straight circuits.

More than one LF stage is not advisable, because point contact transistors are rather noisy in the LF region—this is a reason for hoping that junction types which are better from this viewpoint, will soon be available.

The type of circuit used with junction transistors is shown in Fig. 9. It will be seen that the base is used for input instead of the emitter, thus raising the input impedance, and no separate bias supply is needed. This type of circuit cannot easily be used with point contact types because of instability.

Point contact transistors make excellent low power oscillators, and all that is necessary is to put the tuned circuit in series with the base electrode. A typical LF oscillator is shown in Fig. 10. The tuned circuit consists of an output transformer primary tuned by a 0.1µF capacitor. The secondary can be used to feed the oscillation to an amplifier under test or a bridge. The same type of circuit can also be used for HF and makes a useful test oscillator.

Commencing next issue...

CONVERSION OF THE 182 UNIT TO A 'SCOPE

APRIL 1954
GROUNDING GRID INTERSTAGE COUPLING AT VHF

By H. E. SMITH, G6UH

These notes are primarily intended to assist the novice to obtain maximum results from a 145 Mc/s Pre-amplifier. Some of the points dealt with may also be utilised with advantage in the construction of TV Pre-amplifiers.

The Grounded Grid Pre-amplifier using EC91 valves has been almost exclusively adopted throughout the country for 145 Mc/s operation, and in many instances as a TV pre-amp. The low noise figure of this valve makes it eminently suitable for VHF use.

While the stage gain from a single EC91 is little better than 5 dB, its usefulness lies in the fact that, apart from the low noise, matching from low impedance feeders ceases to become a problem. Because of the somewhat low amplification from a single stage, it is usually necessary to use two stages in order to secure adequate gain. The important point about using two stages is the method used to couple the anode of the first valve to the cathode of the second.

The Grounded Grid stage has a low impedance input characteristic, and a high impedance output. A glance at Fig. 1 will show that the circuit is impracticable as it stands because of the terrific impedance mismatch between the anode of V1 and cathode of V2. The modified circuit in Fig. 2 (as specified in some American Handbooks as late as 1953) does little to improve the matching, and there is still a high impedance existing at the connection to the isolating capacitor "C".

The generally accepted method of obtaining a fair degree of matching is to use a capacitive potentialmeter as shown in Fig. 3, TC being a 3-30pF trimmer and C a 20pF fixed capacitor. This method does provide reasonable matching, but as the output voltage is "pointed down," only about one third of the available signal is passed to the cathode of V2, and this much gain is lost. Fig. 3A is almost identical to Fig. 3, but will give a better performance if the position of the cathode tap is adjusted with care on weak signals.

A circuit which will provide maximum stage gain with excellent matching is given in Fig. 4. On test, this arrangement has given an improvement of at least 4 dB in signal level over Figs. 3 and 3A, with no increase in the noise level.

Choke...19 inches of 30 DSC close wound on a 1MΩ ceramic resistor.

L1...6 turns of 16 swg tinned copper wire on a 1/2" former, each turn spaced 1/8. This coil is tuned to resonance (145 Mc/s) with a brass plunger.

L2...4 turns of 16 swg on same sized former with similar spacing between turns, tuned with a 1/4" iron plunger.

The link coil consists of 2 complete turns on a former approximately 3" in diameter, i.e., just large enough to slide over L1. The ends of the link coil are soldered to a short length of flexible 50 ohm feeder (about 6 inches will do). Fig. 4A shows the assembly of the two coils, and the link.

The tuning procedure is as follows:—

Trim L1 to resonance on a signal with the link coil "sitting" on the earthed end of L1. Adjust TC1 for maximum signal. With the aid of an insulated rod, push the link up the coil slightly, at the same time retrimming with the brass plunger. When the peak signal level has been obtained, secure the link to L1 with durofix.

Note. Do not attempt to make these adjustments on noise alone. The correct trimming point for maximum signal is not that which produces the highest hiss level.

Coupling Grounded Grids to Neutralised Triode

The circuit given in Fig. 5 shows a 6AK5 triode-connected, preceded by a Grounded Grid stage. Here we have the reverse effect in impedance matching, as the impedance of the Grounded Grid output is lower than the input to the 6AK5. Transformation is effected by tapping the output of V1 down the grid coil of V2.

FIG. 1. Tw. grounded grid stages, badly mismatched

FIG. 2. Typical American method of coupling. This system is as badly mismatched as Fig. 1.

FIG. 3. Reducing 'C' to 10pF and adding 'TC'

(3-30pF trimmer) forms a capacitive pot and allows for correct impedance match. Main drawback is that use is only made of about 1/2 of signal voltage

FIG. 3A. Modified arrangement of Fig. 3. Somewhat better performance. Position of cathode tap is fairly critical for best signal/noise ratio and gain

FIG. 4. A circuit which will ensure maximum transfer from anode of V1 to cathode of V2. At least 4dB improvement in gain over Fig. 3, with no increase in noise figure

FIG. 4A. Pictorial representation of L1 & L2 with coupling link
This is a highly effective circuit, and it is recommended where something "a little better than usual" is required.

Chokes... As per Fig. 4.
TCl... 30pF variable air spaced trimmer (both sides “hot” to RF).
L1... 4 turns of 16 swg on 3" former, each turn spaced 1 1/4". Tuned with a dust iron plunger. (Tap 1 turn from grid end).
The neutralising circuit L2/TC2 consists of 7 turns of 16 swg on a similar former, spacing the same, but with no plunger, and a 25pF air spaced trimmer with both ends well insulated from earth, as per TC1.
L3... same as L1.

Tuning procedure:—Adjust L1 trimmer, on a signal, for peak response. Adjust L3 trimmer for maximum signal. Carefully trim TC2 for minimum noise. (This is best observed by watching an output meter fitted to the L8 terminals of the main Rx).

Comparisons
Some figures obtained with the various circuits mentioned above may be of interest.

Gain:
Fig. 3, 14 dB.
Fig. 3A, 14 dB.
Fig. 4, 18 dB.

Noise:
Fig. 5, 20 dB.
Fig. 3, 6 dB.
Fig. 3A, 5.5 dB.
Fig. 4, 4.8 dB.
Fig. 5, 5 dB.

The main conclusions to be drawn from these notes are—
(a) That the interstage coupling method has a direct influence on the overall noise figure of the pre-amplifier.
(b) That both the noise figure and the gain may be improved by paying special attention to the interstage impedance matching. Whether the 2 dB increase in gain of Fig. 5 over Fig. 4 is worth while, considering the 0.2 dB worsening of the noise figure, is a matter for debate and conjecture. Experience has shown that a noise figure of 5 dB or less is a sign of an efficient converter, so we give our vote to Fig. 5.

(Opposite page)

OSCILOSCOPE TRACES
By A.B.

Figures A, B, and C show the waveforms encountered in half-wave rectifier circuits:

No. 8: THE HALF-WAVE RECTIFIER

Waveforms encountered in half-wave rectifier circuits differ considerably from those experienced in the full-wave case.

Choke input will produce waveform A when the oscilloscope is connected to point I. Inserting C2 into the circuit will modify the trace to that shown at B. Except that the frequency in this case is 50 c/s, there is a strong similarity between this wave form and that obtained for a full-wave circuit.

Trace C is the result of the connection of the oscilloscope to point I, removing L1, C1, and C2 and substituting a resistive load.

When carrying out these checks, care should be taken to ensure that the amplifier input coupling capacitor is of a sufficiently high voltage rating to withstand the applied DC.

The Editor invites . . .
articles of a practical nature from readers.

He is particularly interested in contributions dealing with Radio Control and Test Equipment, although other subjects are, of course, always of interest.

Articles should preferably be typewritten, but in any case should be double-spaced. Drawings should be clear, but need not be elaborately finished. Photographs should either be large (half-plate), or the negatives available for enlarging by us.

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ECONOMICAL PERSONAL RECEIVER

By S. A. MONEY

The usual requirements of a personal or bedside radio are that it should receive the Home and Light programmes at a reasonable volume, and should not be too expensive. It is completely unnecessary to use a superhet for this class of receiver. The receiver to be described is perhaps the most economical that can be built for a similar performance.

Two valves are used, a 6CH6 video pentode acting as detector and output stage and a 6X4 as full-wave rectifier. The 6CH6 has a slope of 11mA/V, and is quite capable of delivering 1 watt of audio on local stations. This was found to be ample volume for a bedside radio.

Various aerials were tried with the receiver. A good outdoor aerial gave the best results, whilst quite good signals were obtained on a picture rail aerial. It was found that the indoor aerial gave better selectivity at the expense of some volume. If an outdoor aerial is used, it may be necessary to tap down the coil in order to get sufficient selectivity. A good earth should be used if possible, since it increases the sensitivity of the receiver.

A 6" PM speaker was used and matched to 5,000Ω. The RF choke between the anode and the speaker transformer and the 0.001 µF condenser to earth were included to remove hand-capacity effects around the speaker.

Reaction was applied to increase the sensitivity and selectivity of the circuit. The 10kΩ potentiometer between anode and reaction coil serves to give smoother reaction. Some adjustment will be required here, since the value of resistance required depends on the aerial loading. Reducing the resistance will give fiercer reaction.

The 6X4 is used in a normal full-wave power supply and gives 200-250 volts HT. It will be found that the receiver works quite well on 200V HT.

6CH6 and 6X4 valves are readily available at about 7/6 each on the surplus market. The rest of the components are easily obtainable and the total cost is very moderate.

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THE RADIO CONSTRUCTOR

A SINE-WAVE AND SQUARE-WAVE GENERATOR

Covering 17 c/s—175 kc/s

By R. A. SEAL

Perhaps one of the most essential requirements for the seriously minded engineer interested in the design of equipment covering the audio and video range of frequencies is the signal generator.

In the past there have been a number of articles in the technical press discussing the merits and demerits of known circuitry with a view to designing a generator involving as little constructional work as possible. Whilst the majority of these are often adequate for a number of purposes, they do not as individual instruments cover a wide enough range for the average designer.

There are, of course, limits as to what can be achieved with average workshop facilities, and this had to be borne in mind when considering the design of a suitable instrument.

Fig. 1. Front view of the completed instrument

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Another factor which seriously influences any design is that of component cost and availability, thus any circuit that calls for specialist components is usually of no use to the majority of constructors. Taking all these points into consideration the following broad specification was laid down as a guide to the final design.

Before deciding upon the form of circuitry to be used, it is first necessary to lay down a broad specification and then endeavour to meet this specification in the final instrument. There are perhaps two ways of obtaining suitable frequency coverage for the testing of both audio and video amplifiers. The first is to have a straightforward sine-wave oscillator covering approximately 20 c/s to 3 Mc/s, and the second to have a sine-wave and square-wave generator covering 30 c/s to 200 kc/s. With a time of rise on the square-wave better than 0.1 microsecond. After careful consideration it was decided to adopt the latter method, using a low distortion sine-wave oscillator feeding two independent output channels. After having decided on the method to be adopted, the following broad specification was laid down as a guide to the final design.

**Fig. 2. Rear view**

Frequency Range — 20 c/s-200 kc/s.
Sine-Wave output — Max. 1V into 600 ohms.
Distortion — Max. 1% at 1,000 c/s.
Calibrated attenuator in either millivolts or dB.
Square-wave rise time on highest frequency better than 0.1 microsecond.
Square-wave output 10 volts approximately.

The first essential problem was the choice of oscillator, and after a careful study of all the known types it was decided to use a Wein bridge with two stage amplifier. The use of a Wein bridge involves as the main frequency control two ganged variable elements, either C or R. For stability and low hum level it is usually found preferable to use two potentiometers as the variable elements, as it is possible to keep the impedance in the grid circuit very much lower.

However, for smoothness of control there is no doubt that a variable capacitor is the answer. It was decided to see whether a suitable variable capacitor was available, and finally a Polar type, four-ganged unit with ceramic spindle was chosen. The unit selected had four sections of 532pF each, which when connected in pairs gave two sections of 1,064pF each. A small variable air-spaced trimmer is connected across the top section to balance out the stray capacities to earth. The effect of this trimmer is more important if it is necessary to use a variable capacitor without a ceramic spindle, as then the whole of the rotor sections and the metal frame are at VI grid potential, and there exists a very high stray capacity to chassis.

In view of the high impedance of the grid circuit on the lower frequency range, it is necessary to use a bandswitch incorporating ceramic wafers to avoid leakage. It is also most important that the tuning capacitor be well screened to avoid hum pick up. Any screening employed must be well spaced from the capacitor, to avoid as much as possible high stray capacities which will upset the bridge balance and restrict the upper frequency limit of each band.

The resistors used in the bridge circuit are of the High Stability type with tolerances of ±1%. It is preferable for these to be in matched pairs, although not essential if the 1% tolerances are strictly adhered to.

Automatic amplitude control of the oscillator is accomplished by the use of a Thermistor. This has proved by far the most satisfactory method of amplitude control, and dispenses with the necessity for using complicated feedback circuits and the use of special lamps. The VR150/30 stabiliser keeps the HT+ potential to the oscillator constant, and greatly improves stability. Full theoretical details of Wein bridge oscillators can be found in most

**Fig. 3. Underneath of chassis**
### Components List

#### Resistors

<table>
<thead>
<tr>
<th>Design</th>
<th>Value</th>
<th>Tolerance</th>
<th>Watts Rating</th>
<th>Type</th>
<th>Remarks</th>
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These resistors should preferably be matched in pairs and be within 1% of the nominal value.

#### Capacitors—continued

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#### Capacitors

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<th>Value</th>
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</thead>
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<td>V4/2 6SN7, Meter Valve.</td>
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<tr>
<td>V2</td>
<td>6AJ7, Oscillator</td>
<td>V6 U52 or SU4G, Rectifier.</td>
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<tr>
<td>V3</td>
<td>VR150/30, Stabiliser</td>
<td>V7 7FS, Squarer.</td>
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</tr>
<tr>
<td>V4/1</td>
<td>6SN7, Cathode Follower</td>
<td>V8 Z77, Clipper.</td>
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</tr>
<tr>
<td>V5</td>
<td>6SN7, Sine Output Cathode Follower</td>
<td>V9 Z77, Clipper.</td>
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<tr>
<td>V10</td>
<td>7FS, Square-wave Output Cathode Follower</td>
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</tbody>
</table>

The output from the oscillator section is taken via the "Sine/Square" switch on position 1 to the "set level" control and thence via an isolating cathode follower.

**Valves**

- **V4/2** 6SN7, Meter Valve.
- **V6** U52 or SU4G, Rectifier.
- **V7** 7FS, Squarer.
- **V8** Z77, Clipper.
- **V9** Z77, Clipper.

**Standard reference books,** so it is not proposed to deal with them in this article. The output from the oscillator section is taken via the "Sine/Square" switch on position 1 to the "set level" control and thence via an isolating cathode follower. **Values**

- **V4/1 to the voltage dividing network.** This consists of a special stepped potentialmeter VR2 with 20 steps of 5,000 ohms each, making a total of 100kΩ, fed into a four-position multiplier section. The potential dividers are calibrated in millivolts, but if

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desired a dB scale giving dB loss on 1 volt RMS can be included. A line is taken from the top of the potentiometer to the meter valve, which is set to give a convenient arbitrary figure with one volt across the output (loaded with 600 ohms). If required, the meter can be marked X1 or X2 thus doubling the effective output voltage.

To maintain the accuracy of voltage calibration over the entire frequency range it is essential that all circuitry following the potential divider should have a flat frequency response within ±0.5 dB over the whole range covered by the oscillator, and to this end stray capacities must be kept to a minimum. The method of placing the attenuator system at this point rather than in the actual 600 ohms line was to avoid the use of expensive constant impedance attenuator units.

The output stage comprises a 6SN7 with both sections in parallel. This in conjunction with the 1,000 ohm cathode load resistor gives sufficient amplitude linearity over the whole range of input voltages to enable the accuracy of calibration to be maintained over practically the complete frequency range covered by the instrument. As the output stage is required to have a flat frequency response from 50 c/s-200 k/c/s, the use of a cathode follower transformer becomes impracticable and an alternative output circuit had to be used. The use of a CR output circuit feeding into 600 ohms presents quite a number of compromise had to be made. As a result, a small error of voltage calibration is noticeable at frequencies below 50 c/s due to the increase in resistance of both C11 and C12. The change in C11 is somewhat compensated by VR3, which should be used at no load as a variable as possible. In practice this works out at around 1,200-1,500 ohms. The error can, of course, be further reduced by increasing the value of C11 and C12.

Square waves are obtained by amplifying and shaping the output from the sine-wave oscillator section.

The sine-waves are taken via position 2 on switch 82/1 and are fed into a 7FP8 square. The mark space ratio of the square-wave is mainly governed by the amplitude of the sine-wave fed into V7, and the value of the cathode load resistor R31. To obtain a steep leading edge on the wave shape it is advisable to leave the input at maximum and adjust R31 to obtain the optimum frequency response. The overall mark space ratio of interest, it is possible to produce pulse outputs by adjusting L1 to a much higher value. L1 is normally adjusted to give the optimum resonant frequency response. L1 and L9 are two over-driven clipper stages which have the effect of progressively improving the time of rise. Both stages are shunt compensated by means of L2 and L3, and adjustment of these components should give optimum compensation on the highest frequency range.

The output stage of the clipper stages is fed to a cathode follower V10. It was not possible to feed the square-waves through the attenuator and associated circuits on the sine-wave channel, and this would have degraded the square-wave to such an extent as to make it unsuitable for video testing. If difficulty is experienced in obtaining 7FP8 type valves, it is possible to replace them by valves type 6J6, although the slightly lower gain of the 6J6 would slightly degrade the square-wave. It is pointed out that whereas the 7FP8 was a "Loclal" base, the 6J6 uses the 87G base. If different attenuator ratios are required for the square-wave output, the values of R38-43 can be modified, but in no instance should their total value exceed 500 ohms. A useful accessory to the square-wave generator is a termination unit and this can either be built into the instrument or used separately. In the writer's case, a small unit was made up in a screening case - see Fig. 4. This is invaluable, as it includes an accurate 600 ohm load for the sine-wave section and a straight-through condition for use with the square-wave section.

The unit incorporates a rotary switch and necessary components. It is fitted with plugs and leads suitable for connection to either sine-wave or square-wave outlets.

The power supply for the unit is fairly conventional, except that it employs a two-section filter, with main, supporting 6J6 type valves, at least 132µF. This is necessary to preserve a reasonably flat top to the low frequency square-waves. Of course, a great improvement could be obtained by fitting a regulated power supply, but this makes the unit too large and reduces its portability.

The actual construction of the unit is quite straightforward, as will be seen from the illustrations. Fig. 1 shows the layout of the front panel, and it will be seen that it is possible to obtain a symmetrical layout with convenient grouping of the controls. The dial markings can be marked or type-written on piece of paper inserted under the bezel of the cabinet. The front panel is preferably made of a dural-sheet and the entire instrument housed in a wooden case of modern design with suitable ventilation. Fig. 2 shows the chassis layout. On the left can be seen the two oscillator valves, and next to them the four-gang capacitors for tuning. On the side of the condenser can be seen the small sub-chassis which is mounted on the square-wave. It is essential to build up this section in this fashion so that cro file screens can be fitted underneath across the valve bases. This prevents any trace of HF instability which might otherwise occur if the stages were mounted unscreened on the main chassis.

If there is any trace of hum in the output it is advisable to fit a fully screened mains transformer or, alternatively, to fit a copper screening ring round the existing transformer.

The underchassis view given in Fig. 3 shows the layout of the instrument. The components are, in the main, supported on ceramic stand-off lugs, although this is not strictly necessary except for the resistors R1, R2, R7 and R8, in the oscillator circuit. In the bottom left-hand corner can be seen VR3, which is adjusted by means of a screwdriver inserted through a hole in the wooden cabinet.

It is advisable to use first-class components throughout, and to pay special attention to coupling capacitors, especially C18, 19 and 20. Any doubtful components should be checked before use, and all capacitors "meggered" to their full working voltage. This is very important if old or government surplus components are being used.

The Thermistor is mounted in a small rubber grommet, supported on a stand-off tag, and this method has proved entirely satisfactory.

The instrument was subjected to a number of stringent tests, and in the main came well within the original broad specification. The actual measured figures were as follows:

- Frequency coverage 17c/s-175 k/c/s
- Distortion, Sine-Wave, 0.5% max. at 1 k/c/s
- Time of rise on Square-Wave -0.055 microseconds
- Oscillator amplitude stability, ±2 dB over whole range.

Although it was found that the oscillator did not quite reach the desired upper limit, it is hoped, by reducing still further the stray capacities in V1 grid circuit, that a satisfactory conclusion will be reached.

In view of the fact that ranges 1-3 in one decade, one scale will suffice for these three ranges, but it is preferable to include a second individual calibrated scale to cover range four. There are a number of ways of carrying out frequency calibration, and perhaps the simplest is to provide a simple oscillator with only rough calibration and an oscilloscope. Calibration can now be carried out using lissajous figures and starting with the 50 c/s mains supply. By switching from the oscillator to the other the signal generator can be accurately calibrated over its entire range.

Termination Unit

In position 1 the output is straight through. In position 2, a 600Ω 1/2 load is connected by the yaxley switch in parallel with the output. In position 3, the 600Ω is in parallel, and a 0.5µF is connected in series with the output, on the output side of the switch after the 600Ω resistor.

The ranges covered were as follows:

- Range 1. 17 c/s-200 c/s
- Range 2. 170 c/s-2 k/c/s
- Range 3. 17 k/c/s-20 k/c/s
- Range 4. 17 k/c/s-175 k/c/s
Radio Miscellany

Radio amateurs in the United States can look back with pride on a long and hard-won service in which their equipment and operating skill have enabled them to maintain a network of communication in times of emergency. Happily, in this country we rarely suffer from hurricanes, earthquakes, dam-breakdowns, widespread flooding, forest fires or blizzards. In such emergencies American amateurs have often been the sole means of keeping communications open.

On a few odd occasions British amateurs have been able to step into the breach in minor incidents, but in the past there has always been an obstinate complacency when any attempt has been made to organise a network capable of coping with any large-scale disaster. Nor have the R.S.G.B. given solid support to such a plan, and in the past a few of its leading members have officially played it down. They even suggested the "G.P.O. would not permit it" or "the need was too rare to justify it," and one even said "it couldn't be done."

After the East coast floods of Jan./Feb., 1953, Dr. Arthur Gee, G2UK, campaigned for an emergency network on a national scale. Rather belatedly the R.S.G.B. also took action, and things very quickly got humung. The G.P.O. raised no difficulties and numerous civic authorities, including the Police, asked for cooperation. As a result, the Radio Amateurs Emergency Network has been formed, and many hundreds of amateurs are now operating on standby in readiness to help. While we all fervently hope there will be no occasion for them to have to go into action other than for practice, it will at least serve as a valuable insurance policy and stimulate interest in QRP and portable design. The resourceful enthusiast who can go on the air some clever-looking rig, or even do it in readiness to help. While the G.P.O. would not permit it" or "the need was too rare to justify it," and one even said "it couldn't be done."

VHF

Discussing lines of action with some of the members of the R.A.E.N., I found they were virtually unanimous in the choice of 144 Mc/s as the most suitable eventual band. Some groups will, of course, be on the lower frequencies, at least to start with.

The 2-metre band has a charm of its own. It gives a consistent 30-mile upwards ground wave, free from noise, clear of jamming, and almost predictable DX possibilities. There is also plenty of room for dozens of stations to be operating at the same time within close range without mutual interference, and large scale exercises can be carried out without the slightest interference with TV viewers. Its only drawback is the scarcity of valve types which perform with reasonable efficiency above 50 Mc/s. The position is still worse with battery types, but one or two amateurs, particularly GM6LS, have proved what can be done with a half-watt walkie-talkie.

Even the old-timers coming to 2-metres discover that it means virtually acquiring a new technique — I know I did — but with a little patience and a few specialised oddments, results soon begin to come.

Amongst ourselves, we agreed that in the past interest in VHF had always been patchy, and many of those who have successfully operated on 6 metres deserted it after a year or so. I was rather surprised at the unanimity of the reasons given for this.

The approach to VHF by the radio press has been fairly active. One quarter of our members has been particularly guilty in encouraging a spurious, highly competitive spirit, with "Ladders", certificate collecting, and "stations-worked" mania. To make matters worse, even the Bulletin thoughtfully copied this silly business and one magazine worked itself into a frenzied headline about signalling munitions from the moon, which turned out to be nothing more than an All-Tools-Day joke. No wonder 2-metres has come to have a reputation of being friendly, quiet and least Ham-spirited of all the amateur bands.

One no would deny competition and DX-chasing is great fun in its proper place, but it is not the be-all and end-all of the hobby.

Even the columns of those magazines which have been most guilty of provoking this situation, frequently quote their readers as continuing to work "you-once-to-add another-to-my-list" attitude and bewail the lack of activity and spasmodic interest.

Happily, 2-metre interests are still growing along nicely with those who are not made miserable and dissatisfied because there are no new counties to be worked. Nor can serious interest be sustained by pretending to start all over again and counting only counties worked since last Michaelmas.

I am fully aware that I am liable to incur unpopular quibbles by quoting extracts from this discussion, but to any of the V.H.F. fraternity who would disagree with us I would say, prove those who hold these views wrong by trying your bit with the R.A.E.N. V.H.F. with battery gear and a dipole on your back, is quite a different affair from using a super-comfort, multi-element arrays and electric mains.

The Punishment Fit the Crime

Most readers will have seen the newspaper account of a loudspeaker enthusiast who was fined a couple of pounds and had his receiver confiscated. The right of the G.P.O. to apply to have the receiver impounded was not, until it was exercised on this occasion, generally realised. As a form of punishment it obviously varies in its deterrent effect. There is a world of difference between losing a 100-guinea radiogram and being relieved of a box of old junk you'd have to pay anyone else to take away.

When I heard the incident discussed by a couple of listeners, one brightly suggested getting a friendly neighbour to run in an extension speaker. To do this, of course, also requires a licence. The bright boys who make a living by devising regulations are quite sure to have prepared for a thing like that. Those who remember me telling the story of the start of relayed radio could tell you that at one time it was actually forbidden! At least, the bright boys found it was when they carefully checked over the regulations they had drafted.

Occasionally we get queries from readers about the licence position of portable recruiting, distributed to their cycles and cars. The licence for a fixed address also covers the use of a portable set, not only by the licensee but also by any member of his household. A receiver which is fitted in a vehicle is not considered to be portable in the sense that it is a "portable receiver," and therefore an additional licence must be taken out.

Larger Than Life

Recently I commented on the small amount of steam radio listening I have done in recent years, to my surprise one or two of my indignant letters arrived from the anti-T.V. types. One even suggested sarcastically that this column should be re-named TV Miscellany and confined itself to comments on the other stupid clods, like myself, who have no soul for serious music.

Funny, that! When I weigh in with strong opinions on controversial issues, no one says a dicky bird — as the Cockneys have it — but after an innocent remark like that, two or three something letters turn up.

I can at least console myself with the thought that I have almost secretly suspected these "quality merchants" are often queer birds. Not that I have any right to say these particular correspondents are — but you never know. They might be, and I have met some of them. In fact, you don't meet them. They meet you, and before you know quite what is happening they get a judo-like grip of your arm and you are yanked to hear their latest secret amplifier. They then carefully position you in front of a loudspeaker dressed up like the back of a racehorse (and of course are also the highly esteemed) and you are literally blown backwards by an avalanche of sound which hurls out of the open window.

Apart from the nervous feeling you get from seeing all the ornaments on the mantel-piece dancing about crazily, there is something terrifying about reproduction that is nearly three times as loud as the original. That little demonstration is merely to let you know that the amplifier is capable of giving enough uncontrolled output to fill the Albert Hall, but even a life-size Symphony Orchestra is too much for a drawing room.

You utter a few words of gratitude to most providence that he doesn't live nearer to you, and you no longer wonder why he is hardly on speaking terms with his wife.

Gramophonomaniac

It is baffling how these hi-fi types manage to get their wives to consent to their keeping enormous labyrinth speakers and acoustic chambers in the drawing room. It can only

Centre Tap talks about

R.A.E.N. V.H.F. G.P.O. Hi-Fi

The Radio Constructor

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be that these chaps are determined characters who secretly believe their poor wives are putting on an act when they shut themselves up in the airing cupboard as soon as the pile of gramophone records is produced. Even there they know no safety. Torrents of undistorted power pour in under the door.

Concert Hall volume isn’t the only thing they have to endure. The drawing room furniture is dwarfed by gigantic oven-like speaker cabinets which are tightly packed with bags of sand and solid concrete blocks.

In the corner of the room stands the control panel, with so many knobs and dials that it begins to look like the cabin of a space-ship. Thus the treble, middle and bass can be cut, lifted or boosted as required and the needle hissed amplified or suppressed to taste. Usually the record is all over long before the hi-fi fiend has obtained what he considers to be the right balance. That, however, is only a detail—it’s the quality that matters.

Maybe these vitriolic correspondents are not really like that, but as I have already hinted, I’ve got my suspicions—

(Well, well! — Ed.)

Those Close-ups

Referring to my recent hints on taking close-up photographs of gear and gadgets, a reader reminds me I did not mention the use of extension tubes. Actually this was no oversight, but as so few cameras have a readily detachable lens, I thought it hardly worth while.

He also sent specimens of some remarkably fine large-as-life photographs of rare, or unusual, stamps—not being a philatelist I cannot be sure which—using this method.

The idea of extension tubes is an easy approach for those who possess cameras which have an easily removable lens mount. The extension ring simulates the idea of the extending bellows, and the depth of the ring (for those good at latte-work) can well be ascertained by the method I formerly suggested.

Can Anyone Help?


Dear Sir, I would be extremely grateful if you would spare me some space to enquire whether anyone would be willing to sell, lend or exchange information on the W.S.38 and 21 sets. If possible, I should like circuits and component values, if not manuals.
—N. W. Bean, Ellesmere College, Salop.

Dear Sir, Can anyone help me with the loan of the circuit of the Homelab Signal Generator, 100 kc./s-130 Mc./s. The one I have is one of the type first introduced by the makers about three years ago.—L. Lynch, 37 Poplar Avenue, King’s Farm, Gravesend, Kent.

Dear Sir, I have a Radiovision V55R receiver for which I would very much like service data—I wrote Radiovision of Leicester and reply was “completely out of stock for V55R.” I particularly wish to know the identity of the trammers, and any alignment data.—O. Adams, 18 South Parade, Whitby Bay, Northumberland.

Dear Sir, In the October 1953 issue, Mr. David Millard of Tipton, Staffs, asked for information re the 666H Triplett Test Set. FSD is 400µA, meter resistance 250Ω. If anyone has any further information about this Test Set, i.e. wiring diagrams and component values, I should be very much obliged.—B. Whatmore, 37 The Woodlands, High Road, Finchley, London, N.12.

Dear Sir, Will you please assist me by asking in your columns for circuit diagrams on sale or loan of the American receiver models RU-19 and RU-16.—S. Bradley, 55 Wood Lane, Newsome, Huddersfield, Yorks.

Electronic Selectivity Filter

By F. A. BALDWIN, A.M.I.P.R.E.

In which the author describes two methods of constructing an “Electronic Crystal Filter” using the Mallard ECC-10 double triode, together with standard components currently available on the market.

For those who are in possession of a communications receiver, either of the home-built, commercial, or surplus varieties, which are not fitted with a crystal filter, the latter item must seem a most desirable addition to the circuit. The advantages and effectiveness of a good crystal filter are well known and will not be discussed here.

Unfortunately for the home constructor, there are many difficulties to the fitting of such a filter, even if one has access to reliable matching IF transformers, and this, together with the cost of a crystal unit, tends to make the project somewhat fearsome—from many points of view. There is, however, a way out of the foregoing objections by the method about to be described, and the average enthusiast may construct and fit an “electronic crystal filter” which has all the properties of a good crystal.

This unit is relatively cheap—many of the components would already be to hand; easy to construct—taking a couple of hours and expensive test equipment. Apart from the constructional and lining up troubles which one must inevitably encounter, there is the very real problem of obtaining suitable

Showing construction of version “B”

and expensive test equipment. Apart from the constructional and lining up troubles which one must inevitably encounter, there is the very real problem of obtaining suitable

only; simple to fit; easy to align; and it may on completion be used either as an internal unit or as an outboard addition to the receiver. A further advantage is that the

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completed unit, once aligned, is very much easier to operate than the normal type of crystal filter, where operation of the phasing condenser will alter the shape of the band-pass curve. With the electronic type of filter, operation is much easier—the accept and reject positions being selected by means of a Yaxley type switch.

Circuit Operation

The high selectivity is obtained from Q multiplication derived from the positive feedback employed. There is, of course, nothing new in this idea; most of our readers have used it in RF and IF feedback circuits for years, but the difference here is that the unit is much more efficient than the normal methods and is a completely separate circuit. A tuned circuit with a multiplication factor of 20 to 40 applied, results in a Q as high as a good crystal filter. Off resonance, the impedance of the tuned circuit shown in Fig. 1, when connected to the existing receiver IF strip, is low and therefore attenuates IF signals; the opposite effect, however, takes place when the tuned circuit is at resonance. By virtue of the very high impedance achieved when resonant, a very highly peaked IF band-pass results; see Fig. 2. The actual resonant frequency of the tuned circuit effectively determines the position of the peak within the IF band. After adjustment of the circuit (described later), this position is controlled by the operation of C5, which may be brought out to the front panel. The phase shift at resonance is zero.

Having briefly described the operation of the "accept" circuit, the "reject" circuit probably requires some explanation. Here, negative feedback is used to control the anode resistance of VIA and this, a Mullard ECC40, has a high anode resistance compared to the impedance of the IF circuit. The multiplier VIB controls the negative feedback of VIA. With the multiplier at resonance, phase shift through VIB is at zero and therefore a high negative feedback results in VIA. The resulting low anode resistance of VIA effectively attenuates the IF signals. At non-resonance, the negative feedback lessens, thereby raising the anode resistance so that IF signals pass through the IF circuit with practically no attenuation. The sharp "reject" position curve is shown in Fig. 3.

Circuit (Version "A")

This is shown in Fig. 1, where it will be seen that VIA is the negative feedback amplifier and VIB the multiplier which, in conjunction with VIA, produces the IF "reject" condition. The Yaxley type switch selects the "accept", "reject" or "off" positions, and in this latter condition, the original IF band-pass shape is unchanged, (see Fig. 2). The cathode variable resistors R4 and R5 control the positive feedback of VIB, and should be of the wire-wound type. The variable condensers C6 and C7 are of the type normally used for reaction control (mica dielectric) and these are so adjusted that constant feedback throughout the range of C5 is achieved. The cathode resistor of VIA (R2), together with the associated condenser (C3), effectively ensures that VIA has a high anode resistance.

The special inductor made to the writer's specification by the Teletron Co.—see advertisement pages. This coil, Type B38, is small, compact and highly efficient. The RF choke is also important, and has also been made for us by the same company.

Connection to the receiver IF strip is made via C1, which may be connected to the grid or anode of the first IF stage. The prototype was connected to the anode but, whichever is preferred, some adjustment of the appropriate receiver IF core will be required when the filter is in the "off" position, in order to allow for the capacitance of the connecting wire. This would be particularly important where the unit is operated as an outboard accessory, in which case the connection should be via a short length of co-ax cable in order to avoid stray coupling. When used as an integral part of the receiver, the filter should be mounted as near to the appropriate IF stage as possible, with the switch and C5 brought to the front panel via extension spindles.

All condensers, except of course the variables, and C3 should be of the mica type, and all resistors should be close tolerance types of ½ watt rating, except R2 and R6 which are of 1 watt rating.
Operation

The operation of the “electronic crystal filter” will be found to be much simpler than that of a normal type of crystal filter, where the phasing control must be altered to find either the “accept” or “reject” notches. Here, these are automatically selected by means of the switch, and judicious use of C5 will allow the operator complete control of the ‘IF band-pass and therefore the signal desired. With a phone station, an interfering adjacent heterodyne will completely disappear when the “reject” position is selected. On CW the unwanted station is rejected and the wanted signal accepted, without changing the pitch, simply by varying C5.

The circuit (Fig. 1), is intended for an IF of 465 kc/s only (plus or minus the usual variation); for other IF’s the coil L1 and associated components would, of course, have different values from those shown. In conclusion the writer wishes to state that no claims to originality are made with respect to this circuit; the basic idea is not new, but readers wishing to consider the selectivity of their receiver could do no better than to construct this cheap and efficient “electronic crystal filter.”

Version “B”

This version is that seen in the illustrations included with this article, version “A”, of course, being the prototype. The circuit is substantially the same as that for the previous version except that the condensers C5, 6, and 7 have been replaced with a bank of three 100pF trimmer type condensers seen mounted at one end of the small sub-chassis. This method has several advantages over the previous model in that (a) only one panel control is necessary, thus saving all-important panel space, (b) a considerable saving is made in cost and (c) greater ease of operation results.

Dealing with the latter advantage, the operator simply switches to the “Accept” position for maximum selectivity, which can be pre-adjusted to the centre of the IF band-pass. Unlike the conventional crystal filter, there are no phasing difficulties, and whereas in the prototype the operation of C5 was required, this also has been eliminated. One now has minimum selectivity (Off), maximum (Select) and the “Reject” positions.

This latter version is, however, slightly more difficult to align unless one has access to test equipment, although it is not impossible to do so provided a certain amount of time and patience are expended.

As a final note, the writer would express the belief that this little unit will largely revolutionise amateur home-built equipment, for it has all the advantages and more — of the standard crystal filter, it is simpler to operate, easy to construct both in time and cost, and is just the thing for that new communications receiver which you wish to experiment with.

Club News

NORWOOD AND DISTRICT GROUP—R.S.G.B.

At the Annual General Meeting of the Group, reports were given by the T.R. and other members of the Group, a point of note being that the average attendance had increased from 17 to 23 at each meeting. For his outstanding work in connection with R.N.F.D., the “1952 Committee Trophy” was awarded to Ron Reed, G2OX. Morse classes have now been arranged in the Area, and enquiries from interested persons should be directed to Don Hill, 9 Addington Grove, S.E.26.

Arrangements for the 1954 R.N.F.D. are well under way and it is expected that two stations will again be competing.

The April meeting is on 17th April, 1954, at 7.30 p.m. in Windermere House, Westow Street, Crystal Palace, and all members are invited to a “Ragchew”.

CLIFTON AMATEUR RADIO SOCIETY

Attendance remains at a high level and we have been pleased to welcome several new members during the past 6 weeks. Meetings continue to be held every Friday at 7.30 p.m. at the clubrooms, 223 New Cross Road, S.E.14.

It is hoped to run a series of DF events again this summer, when members will compete for the DF shield, and an evening will shortly be devoted to a talk, with hints and tips, by last year’s winner. Transmitting and Listening contests continue to be popular, and the next is scheduled to be held in April.

DERBY AND DISTRICT AMATEUR RADIO SOCIETY

Officers elected at the Annual General Meeting were:—Chairman, Mr. C. M. Swift (G3HUK); Hon. Sec., Mr. G. T. Bethwaite (G3HPL); Hon. Treasurer, Mr. W. R. Chaffs (G2DLL); Hon. Contest Secretary, Mr. F. Clay (G3JBI); Committee Members, A. McCall (G4CH); F. clay (G3JBI); B. J. Brown (G3FPH); A. C. Rodger (G3HJH) and T. Darr (G3FFG).

The Chairman remarked on the recent success of the Local Top Band Contest organised by Mr. F. Clay. This contest, which this year has been extended to all bands, was a great success, a financial profit of £75. The present figure of 72 fully paid members was the highest on record. The Society’s President, A. G. G. Melville, F.R.C.S., presided, and in thanking the Committee for their past work, regretted that it was necessary to cease publication of the Society’s Magazine in favour of the new-looker. Incorporation of the title (Derby Wireless Club 1914), (the first Wireless Club in the World) in the Society’s name was discussed, and it was reported that necessary steps to proceed with this title change will be taken.

Hon. Sec., F. G. Ward (G2CVV), 5 Uplands Avenue, Littleover, Derby.

LANCASTER AND DISTRICT AMATEUR RADIO SOCIETY

It has been decided to give support to the Radio Amateurs Emergency Network organised by the R.S.G.B. and it is hoped that some practical work will be undertaken in the near future.

Hon. Sec., A. G. Ellersin, (GJEJ), 10 Seymour Avenue, Heysham, Lancashire.

TORBAY AMATEUR RADIO SOCIETY

G2GK has been appointed local ECO of the R.S.G.B. Emergency Network.

The Annual General Meeting, accompanied by the customary Jamb Sales, will be held on the 17th April at the Y.M.C.A., Torquay.

Meetings are held on 3rd Saturday each month at 7.30 p.m., at the Y.M.C.A., Caen Road, Torquay.

Hon. Sec., L. H. Webber, (G3GDW), 43 Lime Tree Walk, Newton Abbot, Devon.

SOUTHEND AND DISTRICT RADIO SOCIETY

The meeting looked for the 19th March is rather special because we shall welcome again one of the T.R’s of the United Kingdom, Mr. G. T. Bethwaite (G3HPL), for D/F Fane, whose promised talk on “Radio Control of Models,” with the accent on CONTROL, is anticipated with considerable interest — which is just the case you are urged to bring your friends. We hope to see you all there.

Meetings are held at the Officers Club, officers Club, Goring-by-Sea, each first Monday at 8.15 p.m.

Hon. Sec., J. H. Barrance, 49 Swamp Road, Southend-on-Sea, Essex.
Let's Get Started

II: VOLTS, AMPS or OHMS?

By A. BLACKBURN

EVER SINCE MAN DISCOVERED HOW TO CONVERT and develop nature to his own advantage, he has had to devise some means of measuring the property with which he is dealing. And he found it necessary, as he progressed, to standardize his measurements with some common guide, in order that following generations could continue research on the same basic assumptions. A typical example is, of course, the foot and span.

However, the greater the accuracy required, the less crude the instrument of measuring becomes. A foot that varied in length would obviously affect the ultimate results more or less according to the limits of accuracy specified. The situation eventually arises when the development of the measuring instruments becomes as important as the equipment to be measured.

The science of radio is now sufficiently advanced to offer the engineer a range of apparatus specifically designed to provide him with all the information he normally wants of the quantities with which he is dealing, e.g., voltage, current and resistance. How and when this apparatus is used is the subject of this month's article.

Meters

Current and voltage are usually measured by means of pointer instruments, of which there are many types, each having a specific purpose. Of these, the one most commonly used is the moving coil type, since it has an excellent sensitivity in addition to low power consumption from the circuit under test.

Ordinary moving coil meters are available in sensitivities down to 5μA, full scale deflection. The less robust and more expensive galvanometer form of this instrument is capable of even greater sensitivity, but is not normally to be found outside the laboratory.

Range

Further on it will be explained why it is that the more sensitive a meter is, the less power it will take from the circuit under test. Why, in other words, the circuit is less affected.

Generally speaking, a sensitivity of 1mA FSD is common in radio work, since it combines the highest sensitivity with the lowest cost—a consideration not lightly to be dismissed by the amateur! As a general rule, the cost of the instrument increases with the sensitivity.

But, you will ask, how do you set about measuring currents in excess of 1mA? Since it is quite likely that currents up to 1Amp may be encountered, are we to assume that it is essential to have a number of instruments in order to cover this range? This would appear to be the answer, were it not for a simple device which has been developed to enable the same meter to be used for reading currents well in excess of its own full scale deflection value.

In Fig. 1 we have a 1mA meter connected in the anode circuit of a valve. The current flowing through the valve is 10mA. As a result the meter is hopelessly overloaded, and the needle will be somewhere off the scale—probably bent around the stop! The solution to this overloading lies in including the resistor R in parallel with the meter. Its value must be such, in relation to the resistance of the meter, that 9mA flows through it, leaving only 1mA to flow through the meter itself.

This can be more clearly explained in mathematical terms. Suppose the meter resistance is 1000Ω, and we want only 1mA to flow through it. Then the voltage developed across it must be:

\[ E = 1 \times R = 0.001 \times 100 = 1 \text{ Volts} \]

However, the same voltage must be developed across R, through which we want 9mA to flow. The value of R must therefore be:

\[ R = \frac{E}{I} = \frac{0.001 \times 100}{0.009} = \frac{1}{11.1} \text{Ω} \]

As the meter will be reading full scale for 10mA instead of 1mA, we can say that we have reduced its sensitivity to a tenth or, alternatively, increased its range ten times.

We can, by this method, provide the meter movement with a number of additional ranges by switching a corresponding number of resistors, of suitably chosen values, in parallel with the meter.

The expression normally used for calculating the value of the shunt resistor R is:

\[ R = \frac{I_{\text{shunt}} \times R_{\text{meter}}}{I_{\text{shunt}} - I_{\text{meter}}} \]

where \( I_{\text{shunt}} \) = FSD of meter

\( I_{\text{meter}} \) = current to be measured

\( R_{\text{meter}} \) = resistance of meter.

If \( I_{\text{shunt}} = 1 \text{mA}, I_{\text{meter}} = 10 \text{mA}, \) and \( R_{\text{meter}} = 100 \text{Ω} \) as before, then

\[ R = \frac{0.001 \times 100}{1 - 0.001} = \frac{0.01}{0.999} = 0.0101 \text{Ω} \]

Universal Shunt

Fig. 2a shows a meter with switched shunts to produce a number of ranges. The disadvantages with this method is that the switch contact resistance is in series with the shunt resistor. For the higher current ranges the shunt resistor may have a value of 0.1Ω. If the switch contacts also have a resistance of 0.1Ω, the total shunt resistance becomes 0.2Ω, which would cause an appreciable error in reading.

To overcome this problem, a method of connecting the shunt so that the switch is outside the meter and shunt circuit is shown in Fig. 2b. This is known as the universal shunt.

The current to be measured is connected between the positive and negative terminals. As in the previous case, a definite fraction of the current flows through the meter, but since no switch contacts are inserted in the meter and shunt circuits, the likelihood of dirty or faulty contacts affecting accuracy is greatly reduced.

The maximum permissible voltage drop V across the meter must be decided before going ahead with the design of the shunt. A normal value is 0.1 volts. \( R_s \) may therefore be calculated from the current to be measured.
measured, I, and the voltage, V, and expressed as:

\[
V = \frac{I}{R_1}
\]

Placing a resistor in parallel would not help at all because, although the total current drawn from the battery would increase, the same current would flow through the meter, since there would be no change in the voltage applied. It therefore becomes necessary to attenuate the voltage applied to the meter, because we have already found that 0.1 Volts across the meter produces full scale deflection.

Instead, we will try a resistor in series with the meter, as shown in Fig. 3.

We can express the voltage developed across the meter as:

\[
V_m = \frac{R_m}{R + R_m} \times V,
\]

and

\[
V_m = \text{Im} \times R_m.
\]

Therefore

\[
\text{Im} \times R_m = \frac{R_m}{R + R_m} \times V.
\]

Since we know V, the voltage to be measured, and we know Im and Rm, we can evaluate R by rearranging the above expression to read:

\[
R = \frac{\text{Im} \times R_m}{V - \text{Im} \times R_m}.
\]

From this we can give a value to R: reading 1 Volt full scale,

\[
1 - 0.001 \times 100 = 990 \Omega.
\]

or, reading 10 Volts full scale,

\[
10 - 0.001 \times 1000 = \text{approx. } 990 \Omega.
\]

Owing to the almost negligible effect that 0.001 x 100 has upon the final result in the last calculation, we ignore this particular term, and are left with a simplified version of the original expression:

\[
R = \frac{\text{Im} \times R_m}{V - \text{Im} \times R_m}.
\]

This applies only when the voltage to be measured is considerably larger than the voltage which, applied directly across the meter, would produce full scale deflection.

The sensitivity of voltmeters is very often expressed in ohms per volt. Thus our 1mA meter has a sensitivity of 1000Ω/volt. To read 10 Volts therefore, we have to introduce, in series with the meter, a resistance of 10 x 1000 = 10kΩ — which, of course, agrees with the answer we have already obtained by calculation.

Errors

There is no infallible system of measurement. Even the most costly and complex are known to have a percentage of error, however small. But much can be done to reduce the margin of error, the necessary precautions taken being dependent upon the accuracy ultimately required of the instrument. It is therefore important to know the magnitude of error present in the instrument, since this can then be taken into consideration when making measurements. The seriousness of the error is then greatly diminished.

When measuring current the meter is, of course, connected in series with the circuit. But the following example indicates how the resistance of the meter (and shunts, if any) may alter the value of current flowing.

A 10 volt battery connected to a resistance of 10Ω would have to supply a current of 1 Amp. If a meter having a resistance of 20Ω were connected in series with the resistor, the current flowing would be modified to approximately 0.8 Amps, which is the value the instrument would indicate. 0.8 Amps is the correct value only while the meter is in circuit.

Admittedly, this is an exaggerated case, because meter resistances are usually of the order of 0.1Ω for such currents, but it serves to illustrate my point.

Voltage measurements often produce serious errors. Fig. 4 shows a voltmeter connected between the anode of a valve and earth. Suppose the true anode voltage was 100V, the load 100kΩ, and the meter the same one that we have used before. The meter resistance at 100V will be 10kΩ, for full scale deflection on 100 volts. If the current through the valve and anode load is 1mA without the meter connected, it will be 2mA with the meter connected. The voltage drop across the anode load would be 0.001 x 100,000 = 100 volts. When the meter is connected, 2mA will flow through the load resistor and the voltage drop will be 0.002 x 100,000 = 200 volts. In practice, of course, the valve anode voltage would have been modified to such an extent that it would draw a different current when the meter was in circuit. In spite of this, however, the fact remains that a considerable error will result if a meter is connected in a high impedance circuit, such as that shown in Fig. 4.

If the meter has a sensitivity of 20,000Ω/volt, it will have a resistance of 2MΩ on the 100 volt range, and will only draw 50μA for full scale deflection. The current drawn through the anode load in Fig. 4 would not be modified to any great extent, and the reading error would be less. For this reason it is an advantage to use the highest sensitivity meter available.

AC and DC

The meters so far described will only measure DC. With the moving coil type of movement a rectifier is necessary to convert the applied AC into DC. The circuit normally used is a bridge connected rectifier, shown in Fig. 5. The multiplying resistors for various voltage ranges are inserted between the input terminals and the rectifier system. The value of these resistors is 1.11 times lower than those used for DC voltage measurements.

The reason for this is tied up with the conversion of AC mean voltages to RMS. The meter deflection is proportional to the mean value of the applied voltage, but the quantity normally required is RMS. As the RMS value is 1.11 times the mean value, the series resistor has a value 1.11 i.e. 0.909, times the value calculated for reading the same DC voltages.

Current measurements on AC are made by connecting the points A and B in Fig. 5 in series with the circuit under test, just as for DC. However, the range of the instrument cannot be extended merely by shunting the meter. Such a practice introduces errors of a very large order.

Instead, a 'current transformer' is incorporated in the circuit. The primary is connected in series with the apparatus under
that the principle involved is a reversal of that used for measuring voltage. In this case we have a known voltage, \( V \), and the current flowing through the meter is a measure of the resistance.

The disadvantage of this system is the non-linearity of the scale; that is to say, a given change in \( R \) does not produce the same change in position of the needle at all points on the scale. It is also to its disadvantage that the zero ohms point is at the opposite end of the scale to the zero volts and current points.

The ballast resistor \( R \) is necessary because, for zero reading on the meter, the test terminals A and B are connected together. \( R \) may be calculated from the meter current and the battery voltage \( V \), but remember that this point on the scale represents full scale deflection on the meter. For half scale reading, therefore, since the current will be halved, \( R \) will be equal to \( R_1 \).

The problem now arises that, as the battery runs down through use, the reading will no longer be zero when the test points are connected together, and inaccuracy of readings will result. The resistor \( R_z \) is added to overcome this danger. \( R_z \) is connected in shunt with the meter and is adjusted so that the current through the meter is modified.

Resistance

There are undoubtedly many techniques employed to measure resistance, all of which have much to recommend them. The direct reading type of instrument, to which this month we shall confine our interest, consists basically of a battery, with the unknown resistor and the meter in series, as illustrated in Fig. 6. You will notice

Continental Holiday

Arrangements are being made by G6MN and G2DUV for a fortnight’s Continental Holiday commencing 24th July.

Amateurs, XVLs and YLs who would like to join the party, can obtain further particulars from Eric Martin G6MN, Castlemount, Workop.

Those interested are asked to write as early as possible to enable the organisers to secure the most advantageous party-travel and hotel rates.

A CRYSTAL FEEDER UNIT

By JAMES S. KENDALL, ASSOC. BRIT. I.R.E., M.I.R.E.

It has for many years been agreed that the best form of detection and the one with the lowest noise level, is the crystal detector. For years the crystal was a troublesome thing that required adjusting just as the programme started and one just could not find the spot!! With the late war came the development of the germanium crystal, one of the latest of which is the Mullard OA50. This is, in the writer’s opinion, one of the best detectors on the market. Not only is it very good but the price, considering it will last indefinitely, is very low.

Having decided on the detector, next came the consideration of coils, which had to be of high “Q”. Several types were tried, selective. The output of the feeder unit was, with a good earth and under 20 feet of aerial, found to give enough power to drive an amplifier.

The first tuned circuit is tapped to allow the aerial to be fed into it via a 50pF condenser. The coupling between the two tuned circuits is done by link coupling, that is by joining the two reaction windings in such a way that the current induced in one coil induces a current in the second coil. The voltage across the second coil is again magnified by the “Q” of the coil. Here the average crystal set builder goes wrong, by connecting the ‘phones from the top of the coil, thereby damping it and reducing the overall circuit “Q”.

but, as bandpass tuning had been decided upon, most were unsuitable. Eventually the Laboratory was sent samples of Dual-Range High-Gain coils, manufactured by Radio Experimental Products of Coventry. These have two windings, one (tapped in two places) for the tuned winding, and the other designed for a reaction winding. These coils were tested and found to be very

THE RADIO CONSTRUCTOR

APRIL 1954
The writer finds the use of a woodwork marking gauge invaluable for such marking out, as it is so quick and easy to set. The terminals, jack and switch holes were each made 1" in from both the sides and the ends, this giving a symmetrical layout. The drilling for the coils and the variable condenser depend on the latter component; the writer used the same fixing holes for both the tuning condenser and one side of the coils. The position of the hole for the other mounting screw for the coil was marked and drilled.

![Diagram](image-url)

**FIG. 2**

The actual sizes of the holes for the terminals (or sockets if used) will depend on the type and make chosen by the constructor; the same applies to the switch and the jack.

The coils should be mounted with at least 1" between them or interaction with each other, with resulting loss of gain, or selectivity, will be apparent! This also applies to the mounting of the coils, which should not be too close to the edges of the chassis.

The wiring of the unit is simple, the coil tags being of good quality and exceptionally easy to solder. The connecting wire should be thick and tinned: 18 swg was used in the prototype. Large Bellini-Lee terminals were used in the original, but are a little expensive; a good socket on the other hand, is the OZ type made by the same firm. The earth terminal was anchored direct to the chassis. The jack used was a Bulgin J6, which has the metal sleeve direct to the chassis. If a jack of the insulated type or earth terminal of the insulated type is used, it must be joined to the chassis by means of an earth tag.

The connections are:—Aerial terminal to Yellow of the first coil via the 500pF condenser; Blue tag to one of the tags of the switch of Black of the first coil to the Black of the second, then to the switch and finally to the chassis.

The two Blue wires are each taken to one section of the tuning condenser. The Red and Purple tags are joined to the corresponding tags on the other coil by a piece of twisted wire. Lastly, the OA50 diode is wired in, this having been left till last so that the risk of damage during wiring is lessened.

To align the unit, tune to a station on the medium wave band, then turn the trimmers until maximum audio gain is achieved. Tuning on long waves is fairly broad. If a really good finish is required, one of the modern dial drives such as the J.B. Squareplane would be ideal. It gives just that extra finish to the appearance.

If the unit is to be used with head-phones, high impedance types should be used. On the other hand, if it is required as a tuner unit for an amplifier, then it is advisable to join a 1MΩ resistor across the output jack in case the input to the amplifier is via a condenser.

**Components Required**

- Two R.E.P. Dual-Range High-Gain Coils
- One Two-gang 500pF Tuning Condenser, with trimmers, Kendal and Mousley
- One OA50 Crystal diode, Mullard Ltd.
- One Bulgin J6 Jack
- One Bulgin P38 Plug
- One Two-pole Toggle Switch
- Two Terminals, 500pF Mica Condenser
- One Piece aluminium sheet, 4" × 8", about 16 swg.

**THE RADIO CONSTRUCTOR**

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**TRADE NEWS**

**FRETSAW SET IS LATEST ADDITION TO WOLF**

**CUTLER'S EQUIPMENT**

**HANDYMEN, model makers and radio enthusiasts will be interested in the latest addition to the Wolf Cub range of home constructor equipment—a Fretsaw attachment for use with the Wolf Cub Drill.**

The new Fretsaw is of sturdy construction, possesses an operating speed of 2,000 strokes per minute and a throat depth of 8" enabling work to be cut to centre of 16" circle. Cutting capacity in wood is 1" thick or 3/4" in non-ferrous metal. Blades of special design and special steel exclusive to Wolf are employed. Ample power for prolonged usage is provided by the Cub Drill, the drive being delivered by an eccentric arbor fitted into the Drill Chuck, through an ingenious rocker arm mechanism, thence to the saw blade by means of two pure nylon belts, which are claimed to last indefinitely.

Blade changing and tensioning is instantly and easily effected, and the work table of pressed steel measuring 8" square is mounted on a machined platform. An adjustable guard and workholder is mounted on the top arm of the Fretsaw frame. This holds work down when cutting and protects the moving saw blade from breakage. Apart from occasional lubrication, no maintenance attention is necessary.

The Fretsaw No. 8 set is supplied complete with 12 high speed blades for wood, plastics, etc., and 12 for non-ferrous metals, and is low priced at £3 15s 0d.

For those wishing to obtain the complete Fretsaw equipment, a Fretsaw Kit which includes Cub Drives, Bench Clamp and Pillar can be bought at a cost of £10 15s 0d. This latest addition to the Cub range now brings within reach of the handyman the means for drilling, sawing, polishing, wood turning, bench drilling, bench sawing, fretsawing, etc.

Starting with the Cub Drill, the necessary conversion sets for covering this extremely wide range of activities can be purchased in easy stages. The new Fretsaw equipment is now available from all leading tool merchants, and all who are interested are invited to apply for full descriptive literature to Wolf Electric Tools Ltd., Hangar Lane, London, W.5.

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- **FM-10V-01** Crystal microphone input to junction transistor, Inductance 60 henrys at no DC. Ratio 10 to 1.

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| 662G | 6 | 625T | 6 | 575 | 6 | 575X | 6 | 1450 | 6
| 661G | 6 | 625T | 6 | 575 | 6 | 575X | 6 | 1450 | 6
| 660G | 6 | 625T | 6 | 575 | 6 | 575X | 6 | 1450 | 6
| 659G | 6 | 625T | 6 | 575 | 6 | 575X | 6 | 1450 | 6
| 658G | 6 | 625T | 6 | 575 | 6 | 575X | 6 | 1450 | 6
| 657G | 6 | 625T | 6 | 575 | 6 | 575X | 6 | 1450 | 6
| 656G | 6 | 625T | 6 | 575 | 6 | 575X | 6 | 1450 | 6
| 655G | 6 | 625T | 6 | 575 | 6 | 575X | 6 | 1450 | 6
| 654G | 6 | 625T | 6 | 575 | 6 | 575X | 6 | 1450 | 6
| 653G | 6 | 625T | 6 | 575 | 6 | 575X | 6 | 1450 | 6
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