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IF we had a flag, it would now be at half mast. For the radio and television industry has stood by and doomed to oblivion the 1965 Radio Show, a venture that was hardly allowed to get off the ground.

Since the 1920's the Radio Show has flourished until in recent years it began to flounder, and both public attendance and stand bookings began to decline. No single factor can be pinpointed for the reasons are several, complex and partly intangible.

However, the snowball effect of company mergers progressively reduced the number of potential exhibitors. The increasing cost of buying stand space and of fitting and manning exhibits, also took its toll, and then the broadcasting authorities made less spectacular provision for entertaining the public.

But the death knell for the old-type Radio Show clearly rang out when major exhibitors began staging their own independent trade-only splinter shows. Now this year with most of the big boys opting out, the 1965 Show had little chance.

Whatever the success of these private ventures, however, we do not think they are in the industry's long-term interest. The public may often prove tiresome and exhausting at exhibitions but these are the people who buy the products and keep the manufacturers in business.

Other major industries manufacturing highly competitive consumer goods continue to run successful exhibitions catering for trade and public. The radio industry is the odd man out—and surely it cannot afford to be so insular. Let it have the foresight to organise something worthwhile for 1966.

The Radio Show is dead! Long live the Radio Show!

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All correspondence intended for the Editor should be addressed to: The Editor, "Practical Wireless", George Newnes Ltd., Tower House, Southampton Street, London, W.C.2. Phone: TEMple Bar 4363. Telegrams: Newnes Rand London. Subscription rates, including postage: 20s. per year to any part of the world. © George Newnes Ltd., 1965. Copyright in all drawings, photographs and articles published in "Practical Wireless" is specifically reserved throughout the countries signatory to the Berne Convention and the U.S.A. Reproductions or imitations of any of these are therefore expressly forbidden. THE SEPTEMBER ISSUE WILL BE PUBLISHED ON AUGUST 5TH.
Can Anyone Help

Please can anyone help me? I need a small internal switch for a wireless set issued by R.A.P. Ltd., London, 7634. Apart from this component the set appears to be in good condition. R.A.P. appear to have discontinued this model.

W. M. Stanley.
17 Denton Road,
Wokingham,
Berkshire.

C.W. Standards

As an ex-W.T. operator of 20 years' standing I find after months of listening on the amateur bands that the standard of British operators (c.w.) is fast deteriorating compared with other countries. Many of them seem barely able to work at 10 w.p.m.

At a recent R.A.E. examination centre I met a few of the old ex-Service operators who are all eager to do a spot of operating. These men are excellent operators and quite good mechanics, capable of building their own transmitting and receiving equipment. But these men failed the R.A.E. simply because they were unable to memorise a few formulae. Several lads of about 16, however, passed the test, yet they had not a clue how to operate. Consequently they turn to phone working—too scared to work c.w.

If this state of affairs continues there will be very few British operators working on c.w. in a few years' time.

F. Taylor.
Plymouth,
Devon.

Octal Valves Again!

I disagree with R. A. Packer's comments on I.O. valves (May issue). Manufacturers are all for miniaturisation, as we all know, but need constructors follow blindly along the same path? While I.O. valves are obtainable I consider that the saving in odd shillings far outweighs the sacrifice of that inch or so of not so valuable space.

J. Huet.
Canvey Island,
Essex.

404 LOUDSPEAKERS IN WEMBLEY P.A. SYSTEM

The largest public address system in Britain is that of the Wembley Stadium where no less than 404 loudspeakers are installed. Sixty of these are mounted on baffle boards and the remainder in 86 column enclosures.

The p.a. system was recently installed by Rediffusion technicians in time for the F.A. Cup Final in May, but only after they had solved the formidable problem of the Stadium's acoustics which, when it is empty are very different from when it is packed to capacity.

NEW COMPUTER FOR THE MIDLANDS

Businessmen in and around Birmingham requiring computer services can now make use of a new Honeywell 200 machine recently installed by Midlands Computing Centre Ltd.

The new British-made computer is expected to find ready acceptance by Midland-based firms too small to buy their own computer, yet large enough to warrant the analysis of production, sales and costs which modern equipment can provide.

LOW-COST PORTABLE MADE IN BRITAIN

This portable receiver is British made and inexpensive. In fact, according to the makers, Philips Electrical Limited, it is the lowest-priced British-made portable radio ever.

Known as the "Popmaster", it has been introduced to combat the ever-growing imports of Hong Kong-manufactured portables into the UK and will sell at £7 19s. 6d.

Each set carries a six months guarantee covering spares and labour and also a world-wide service guarantee valid for any service department of Philips companies throughout the world.

The "Popmaster" covers long and medium wavebands and measures just over 5½in. x 3½in. x 1½in. The 6-transistor circuit is powered by four U7 batteries housed in a sealed compartment in the base of the cabinet. Also contained in the base is a fitted earpiece attachment.
OXFORD MOBILE RALLY

On July 11th the Oxford and District Radio Society will hold its tenth anniversary mobile rally. The organisation of this event has been in conjunction with the RSGB.

Talk-in stations on 160m, 80m, 4m and 2m will be operating at the venue in the grounds of the College of Technology, Headington, Oxford. Attractions planned for the day include morris dancing, films, demonstrations, competitions, etc.

TRANSCEIVERS FOR NEW POLICE SQUAD

Radio communications is playing a big part in London’s new 100-strong police patrol group, which began operations recently. The group has been formed to counteract sudden outbreaks of crime by saturating trouble spots with uniformed police.

Contact between the group’s vehicles and Scotland Yard and the P.C.s on foot, is by v.h.f. radio’ each constable in the group carrying a light-weight transceiver.

There are just two women P.C.s in the group; one of them is seen here using one of the fully-portable transceivers.

THE '65 SHOW CANCELLED

The ’65 Show—this year’s planned successor to the National Televison and Radio Show—is off due to lack of support.

The organisers of the Show—Industrial and Trade Fairs Ltd.—announced the complete cancellation of the venture after many of the largest companies in the British radio industry had decided not to take part. The commercial TV companies also dropped out.

The exhibition was to have taken on a new appearance this year, with all parts of the radio, television and home entertainment industry represented. This year too, overseas participation was expected for the first time.

GPO TO HAVE SEVEN COMPUTERS

The first of seven English-Electric LEO 326 computers ordered by the GPO has been installed at Charles House, Kensington, London, where it succeeds a LEO 3 machine which has been operating for nearly a year. The work of producing six million telephone bills a year, calculating repayments of National Savings Certificates, preparing experimental route schedules for mail vans and analysing stores and equipment, which the old machine handled, will be carried on by the LEO 326 at much faster speeds and still provide extra computer time for further developments.

A second LEO 326 computer will be installed at Charles House later this year and another two will go to the POs Savings Department at Lytham St. Annes, Lancashire.

When all seven are installed and operating, the GPO will be the largest commercial computer use in Europe.

more News and Comment on page 330

Bottling Acid

SURELY Mr. Ian Gregory (News and Comment, June, 1965) is a little antiquated in his choice of containers for hydrofluoric acid. In this day and age a polythene bottle would probably be cheaper and more easily obtainable than one of wax or gutta-percha and equally effective.

I. M. Hutchings.

Rugby, Warwickshire.

Correspondents

I AM 27 years of age and studying radio and television servicing with a correspondence school. I would like to correspond with radio and television service men anywhere in the world.

Ernest Tchakanga.

P.O. Box 357, Mufulira, Zambia, Cent. Africa.

I WOULD like to correspond with anyone in South Africa who is interested in radio and motor yachts. I am 14 years old.

Ian Thornton.

13 Adshead Close, Poundswick, Manchester 23, Lancs.

I AM a regular subscriber to Practical Wireless. In addition to being interested in electronics I am a philatelist and would like to correspond with people in England willing to exchange Indian stamps and first-day covers for miniature electronic components not available here.

G. H. D’Cruz.

Sugar Factory, Shimoga, South India.

The Solo Organ

I HAVE located a small error in the transistor solo organ article (April issue, page 1163). The wire from top right-hand tuning resistance tag should go to the lower arm of VR2 and not to the middle arm as shown.

G. W. Hardy.

Poole, Dorset.
THIS is a receiver circuit using the minimum of components, driving a hearing aid type earpiece, and having as its power supply a solar cell. It requires no external aerial or earth. The final circuit was developed from the somewhat standard receiver circuit of Fig. 1, and it is advisable to build this one up first to test reception conditions in your area. If you have already experimented with one and two transistor circuits of the regenerative and reflex types and you know that you are in a good reception area then the final version may be constructed immediately. Otherwise build up the circuit of Fig. 1, e.g., in a “bread-board” arrangement. This circuit should easily, without external aerial or earth, drive the earpiece on most m.w. stations — the local Home (and possibly Light) should be loud and continentals should be fair. If these conditions are fulfilled then the final Mark 3 version is assured of some success. However, some areas of the country, especially those in deep valleys or below high cliffs, provide very low signal levels (and even a standard six transistor superhet has difficulty in these areas) in which case the circuit of Fig. 1 will receive little if anything and the light powered circuit even less. Thus the disappointment of building something doomed from the start to failure is avoided (and the expense of the solar cell is saved).

Tr1 can be any standard r.f. type for this circuit (in fact a number of accepted “low frequency” transistors will function here, e.g., odd specimens of OC71, XB103, and even an occasional “red spot” — however the recommended r.f. types are necessary for the final circuit) and examples tested were: OC44, XA112, OC171, AF114. Slight variation of R1 may be necessary but the results of this reflected-regenerative should be good. The coil may need a few turns adding or removing to cover the entire m.w. depending on the characteristics of the components used. It was considered initially that this type of circuit, providing maximum gain at both r.f. and a.f. with separate detection by diodes, would be the most efficient for a light powered receiver.

Then came the choice of a solar cell. Data was obtained from Ferranti Ltd. (Gem Mill, Chadderton, Oldham, Lancs.) and it became obvious that no single cell had been designed solely as a power supply for an application like this, however it appeared that most could provide sufficient current in average light conditions, all of them appearing to produce a voltage which remained constant at about 0.5V. The type finally chosen was of large (comparatively speaking) surface area: 0.75in. x 0.45in. (19cm. x 1.2cm.), designed for both high and low light levels — type MS2A and appears as in Fig. 2.

The current provided by the cell depends on the light intensity, from zero in darkness to about 20mA in bright sunlight on open circuit. Thus the receiver had to be capable of operating from these power conditions. The voltage supply for the design of Fig. 1 was thus reduced to a single dry cell, i.e. 1.5V, and R1 was likewise reduced to approx. 150kΩ in order to keep the same current — of the order of 1mA — flowing in the transistor. Suitable adjustment of TC1 and VR1 then resulted in a fairly similar performance, at slightly reduced volume, to that of the 9V circuit. At this stage the solar cell was substituted for the dry cell, giving

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**SOLAR-POWERED POCKET RECEIVER**

by C. J. Walton

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[Diagram of the circuit of a simple one-transistor reflex receiver which formed the basis of the final design. The coil is wound on a 2in. length of 34in. diameter ferrite rod using 34s, w.g. d.c.c. wire.]
the Mark 1 version of Fig. 3. At this stage it was found that the alloy junction type transistors were not as effective as the alloy diffused types at these low power levels. However the alloy diffused types—OC171, AF114, and a micro alloy type: MAT 121, were all operating quite well. Volume was down from the 1.5V circuit but in my area (Sowerby Bridge near Halifax, in the West Riding of Yorkshire) the Home and Light came through quite well.

With the receiver not tuned to a station as the cell was turned towards a window or other light source, a hissing could be heard in the earpiece signifying that current was flowing in the circuit (and in strong sunlight the hiss was louder than with the 1.5V cell in circuit). Stations became audible just before the hiss commenced, became louder as more light was allowed to fall on the cell, and finally regeneration in the form of whistling was heard. Keeping the light intensity constant and varying R1 the graph of Fig. 4 was obtained. No quantitative measurements were possible, but it can be seen that for regeneration to occur under fairly bright conditions, the optimum value for R1 should be between 10kΩ and 150kΩ approx. A value of 47kΩ was therefore chosen.

Regeneration was, however, difficult to control, occurring either at one end of the band or the other and was very critical, no matter what adjustment was made to TC1 and VR1 the circuit tended to "plop" in and out of oscillation. To try and alter this unsatisfactory situation and as a further experiment, it was decided to operate the circuit as a regenerative detector, i.e. C2, D1, D2 were removed. The results of this were interesting. Output volume was reduced slightly but regeneration was more easily controllable, far less feedback being required to achieve the same effect. In fact the 30pF trimmer used for TC1 had a too high value even at minimum capacitance (approx. 3pF). VR1 and TC1 were thus removed and a length of insulated (plastic coated) wire was connected to point X and another to point Y (see Fig. 3) and these were twisted together to act as a fine trimmer. This is a very sensitive type of control, the value changing at each twist by only a very small amount.

Finally the effect of removing the r.f. choke (i.e. allowing the earpiece to act as its own choke) was tried. Again there was a reduction in volume but this time regeneration was much easier to control and extended more evenly over the entire band with medium light intensity, tailing off at the low frequency end as the light was reduced. This was the final Mark 3 version shown in Fig. 5. Note that only use 8 components altogether. Omitting R1 resulted in very weak reception of the Home Service and nothing else.

**Details of Components Used in Final Receiver**

Transistors tested included OC171, AF114 (this was the actual transistor used when built into a case) and MAT121. VC1, miniature solid dielectric 300pF tuner.

A small, clear plastic case available from dealers (for from T.S.L., Hudson House, 63 Goldhawk Road, W.12) at 1s., size 2-2in. x 1-4in. x 0-9in. The 2in. length of ferrite rod used as aerial would just fit into the case.

The earpiece used in all the versions is an Ardente ER550. Any good quality magnetic (not crystal) earpiece would be suitable provided its impedance is > 1kΩ. The chassis is a small piece of perforated eyelet board (cut from a 4in. x 2in. piece) which is available, including eyelets, from...
as well as Athlone (Eire) and the northern Caroline. At night some form of artificial light must be used. Any operated from the mains are found to produce an annoying buzz of "mains hum" either at one end of the band or at various points along it as the cell is moved to and from the light source. An ordinary torch is much better, whilst a fluorescent light is useless, producing a continuous buzz. It was found that the set will operate, if held close enough, from a cigarette lighter or even a match. Note that as with all ferrite rod aerials the set is very directional and sometimes a

continued on page 338

Fig. 5: The final circuit of the receiver.

Right: The finished receiver mounted in its plastic case.

Home Radio (Mitcham), Ltd., 187 London Road, Mitcham, Surrey. The ferrite rod is wound with 32s.w.g. enamelled or silk covered wire. Other details are given in Fig. 6. The layout of the finished receiver is given in Fig. 6. The cell was stuck with Sellotape to the inside of the case (loss of light through absorption in the plastic is negligible) and its leads sleeved. If an opaque or coloured case is used the cell obviously will have to be stuck on the outside. Feedback was set for dull daylight and if the light intensity should become too high, i.e. a lot of whistling occurring, then the set must be turned away from the light to reduce current rather than changing the feedback.

Fig. 6: These two views of the completed receiver show clearly the construction and wiring.

Further Details of Operation

The circuit does cover the entire m.w. band but obviously local conditions will determine exactly what the performance will be. In Leeds the Home, Light and Third are all at reasonable volume and in the evening the heterodyning whistles of most of the Continentals are heard. Careful tuning in quiet surroundings has brought in Luxembourg, A.F.N. and Berlin
Tape		Tape	
Tape Terminology	Tape

Part One

NOWADAYS every branch of art and science carries around with it an enveloping cloak of jargon. Although this may be understood by the coterie of enthusiasts many of the terms are quite incomprehensible to the outsider.

Not least among the "specialist fields" is the art (or science, if you insist) of tape recording. Most readers of this magazine are quite aware of the general idea of tape recording and can interpret most of the terms in everyday use. But now and again the need arises to interpret most of the terms of tape recording and can understand just what those impressive specifications mean.

We want to know what a "drop-out" is and how it is caused, not merely be told it exists. More important, when weighing up a possible bargain we want to know just what those terms mean.

The following notes are compiled, more or less alphabetically, to clear up a few of these vague definitions. This is not a complete glossary of tape terms—which would insult the average readers' intelligence—but an illustrated description of some of the special aspects of tape recording.

AUTOMATIC RECORDING LEVEL

The principle of automatic gain control for radio and television is well known. In tape recording there are special difficulties and special circuits. A portion of the amplified signal is sampled, amplified and fed back as bias to a controlled stage whose gain varies with the applied voltage.

The difficulty lies in the long time constant needed with audio frequency signals. The sampling circuit must react quickly to a loud sound, apply the bias and then retain a comparative level of sounds for a reasonable period.

It is hoped to devote more space to a detailed description of how this is done in a future number of Practical Wireless.

AUTOMATIC STOP

A method of halting the tape transport system when (a) the tape breaks or (b) metal foil leader tape, usually at the end of the reel, completes a relay circuit.

The actual method of stopping the spools varies from the simple interrupter switch in the motor supply to relay-operated solenoid which disengages the head and capstan pressure system, applies the brakes and neutralises the mechanism. Fig. 1 shows typical systems.

AZIMUTH ADJUSTMENT

Setting of record, playback and erase heads to bring the gap into the right position at 90° to the tape length.

Correct positioning is important to allow tapes to be played on different machines and to ensure maximum gain and frequency response. Incorrect azimuth setting of the record/playback head causes loss of high frequencies (see Fig. 2).

Normal method of azimuth adjustment is to replay a pre-recorded signal of constant level (see Test Tape) and adjust the playback head for maximum response.
BALANCED INPUT AND OUTPUT

Method of connecting items of equipment by transformer coupling with centre-tapped windings which may be earthed.

Hum and noise are cancelled out to a greater extent by this method and longer leads can thus be used. Normally two-cored screened cable is employed and matching is at low impedance.

BANDWIDTH

In hi-fi work this normally refers to the frequency range covered by the amplifying equipment which is between two extremes that occur where the output is 3dB below that of a standard reference frequency. (Usual reference for this purpose is 1kc/s.)

Bias voltage depends upon the head and tape characteristics and is usually adjustable by a preset control for optimum conditions. Normal adjustment is a little beyond that which produces the maximum output, i.e. over the peak of the curve (see Fig. 3b).

CAPSTAN

Normal method of driving the tape to attain constant speed is by pressing it against a revolving spindle called the capstan. The capstan may be mounted on a flywheel and driven by coupling belts or intermediate wheels from the motor.

The flywheel tends to "iron out" minor speed variations due to its inertia. On some single-motor machines the capstan and flywheel are integral with the motor.

Method of keeping the tape in constant contact with the capstan is by applying a spring-loaded pressure roller or pinch wheel.

CASSETTE

An enclosed spool of tape, usually adapted for automatic loading, either in a complete magazine or as a replacement for a single spool with a free end of tape fed to the take-up spool.

An endless cassette contains a long loop of tape which is wound off the outside and back on the inside of the spool for continuous playing.

C.C.I.R.

See Standards.

Fig. 2: Off-set guides (a) or head (b) cause h.f. loss.

Fig. 3(a): Signal imposed on bias waveform prevents distortion due to "kink" in magnetisation curve. Optimum bias setting (b) is at value which produces a 3dB drop in output beyond peak.

Where the two limit frequencies only are quoted the above standard is understood. (See also Frequency Response.)

BIAS

The non-linear characteristics of the recording medium are overcome by imposing the audio signal on a high-frequency bias before applying the combined waveform to the recording head (see Fig. 3a).

The frequency of the bias should be as high as possible, allowing for heating losses in the head windings. Normally the bias frequency is about four or five times that of the highest frequency to be recorded; 45 to 70kc/s is the range used in domestic tape recorders.

A bias frequency that is too low will cause shrillness of reproduction of heavily modulated signals.

CHANNEL

In stereo reproduction, one amplifier chain.

CHANNEL SEPARATION

The degree of interference between channels must be reduced below 30dB for stereo systems. Parallel track systems require more stringent separation, greater than 50dB.

CROSSTALK

The above interference is known as crosstalk and may be specified at certain frequencies. It is more noticeable at higher frequencies. Overall separation at all frequencies for tape recording systems should be better than 40dB.
CROSSTRAK
A method of mixing the output from one track with the input to another by which a composite signal can be built up without the need for 'super-imposition'. Modern tape recorders may incorporate this under the specified terms multiply or sound-on-sound.

CUEING
Marking of particular places on the tape, visually or aurally. Special controls for 'inching' may be fitted to aid cueing.

DEFLUXING OR DEGAUSSING
Heads and ferrous metal parts such as supports and guides tend to build up a residual magnetism during use. This causes noisy reproduction when it affects the modulated tape. Method of removing this residual magnetism is to apply a strong and varying field with a deflexer and gradually remove this source so that the normal 'random' disposition of magnetic "domains" in the metallic parts is resumed.

The construction of a deflexer is generally based on a solenoid with a projecting pole, shaped to be inserted in the tape path mechanism. Regular defluxing should be carried out to reduce background noise. A pronounced hiss is the usual indication of head magnetisation.

Degaussing of the record/play head can be effected by gradually removing the bias voltage. One method is to switch to "Record" and interrupt the mains supply, allowing oscillations to die away. Repeated several times this can keep a recording head degaussed but will not demagnetise other ferrous parts.

DISTORTION
The difference in waveform between input and output of the amplifier as a whole. This is mainly harmonic distortion and may be expressed as a percentage at a specified frequency at full modulation. (e.g. less than 5%, at 1kc/s, third harmonic distortion at full modulation, may be stated as $\leq 5\%$.)

The signal-to-noise figure may also be stated as that obtained for a certain distortion factor (see Signal-to-Noise).

DOUBLE GAP
Method of achieving more complete erasure by applying an erase field at two successive places along the tape path. Dimensions are such that the delay from first to second gap is a few milliseconds.

DROP-OUT
Short-term loss of signal which may be caused by discrepancies in tape coating or uneven tracking of tape.

DUOPLAY
Name given to the system of feeding two outputs from a tape recorder into a single channel amplifying system.

DYNAMIC RANGE
The separation, expressed in decibels, between the smallest and the greatest signals the system can handle with specified minimum distortion. The limits are imposed by the loudest sounds received at the input having to be recorded without over-modulating, while the quietest sounds are still above the noise level and the balance between is in proportion.

For a domestic machine the dynamic range may be between 40 and 60dB. In practical terms this means that a 1kc/s signal has a ratio of 10,000 or 1,000,000 to 1. Although the actual dynamic range of a full orchestra may be as much as 70dB the above range is adequate owing to the non-linear relationship between loudness and sound power.

DYNAMIC MICROPHONE
See Moving Coil Microphone.

DUBBING
A term used, mainly in editing, to denote the combining of two or more sound sources into a single recording. Also, in ciné work, the adding of a soundtrack to the film.

ECHO
A signal delay produced by feeding back a replayed signal into the recording channel. The time of delay is determined by the physical separation of the heads and tape speed and may be doubled on two-channel machines by using the second channel as an intermediate stage.

An echo chamber can be either a device similar to the above, to produce the echo effect, or an acoustic method of achieving the same end. Note that echo alone is not effective without reverberation for realistic simulation of original sounds.

EDITING
Altering of the signal by cutting and interposing programme material. This can be done physically (see Splicing) or by a form of dubbing, using two machines with the first playing back the original programme, the second recording such parts as are required to be used, and halted meanwhile, or with interposed material recorded during the same operation.

ELECTROSTATIC MICROPHONE OR LOUDSPEAKER
A device which depends on capacitor action for its operation. Fig. 4a shows examples.

Basically a diaphragm is held between perforated plates and charged by an external voltage. Sound signals cause vibration and a change in capacity in the former case and in the latter case set up vibrations of the diaphragm to produce the aural output.

The electrostatic loudspeaker is particularly suited to high-frequency reproduction and is often used as a " tweeter ".

EQUALISATION
Compensation for the rising frequency response of the tape system and for high-frequency loss which occurs in the playback head. Circuits in the playback amplifier "shape" the response to a
Equalisation standards were revised a year ago and it will be noted that there are three distinct sets of standards, the CCIR, DIN and NARTB. The previous standard, generally accepted, for 33in./sec. tape speed was 200 microseconds, now revised to the DIN standard of 140 microseconds, with a turnover frequency at the point where the reactance of the capacitative arm of the attenuator equals the resistance of 1.3 kc/s and a low-frequency roll-off of 3.180 microseconds (at 30c/s).

Fig. 5 shows typical equalisation curves. Low-frequency roll-off is generally recognised nowadays as machines in the domestic class rarely reproduce frequencies below this point.

Replaying tapes recorded to one standard on a machine equalised to another will require some modification to the amplifier response to achieve a "level" output. Thus American tapes, recorded to NARTB standards, replayed on European machines, equalised to CCIR standards, will tend to sound over-brilliant and with some bass accentuation.

Conversely CCIR recorded tapes replayed on machines with NARTB standards, having bass and treble cut to compensate for the recording pre-emphasis, will tend to sound weak in both treble and bass.

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**Table 1. Equalisation Standards**

<table>
<thead>
<tr>
<th>Time Constant (micro-secs.)</th>
<th>Speeds (in./sec.)</th>
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<tbody>
<tr>
<td></td>
<td>15</td>
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<tr>
<td>CCIR</td>
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<tr>
<td>DIN</td>
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**Fig. 5:** Recording and playback curves, showing effect of h.f. loss in recording which must be compensated by a boost during playback. At higher speed the loss is less, 6dB octave curve is ideal response.

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**ERASE**

One virtue of the tape recording medium is the possibility of "cleaning off" a tape for re-use. This is termed "erasure" and consists of destroying the pattern of magnetism on the tape and reverting to the normal random disposition of magnetic domains.

Erasure is effected by the application of a strong and varying field as the tape passes a point prior to the recording head.

The method of applying erasure may be by passing the tape across a permanent magnet, or magnets, or by applying the field from the gap of a d.c. or a.c. energised head. The last-mentioned is preferable, as d.c. or permanent magnet erasure tends to build up a unidirectional magnetism, resulting in a hiss.

The waveform should be symmetrical, and is often derived from the common oscillator used to provide the bias waveform.

Bulk erasure is a method of removing the modulation from a tape in one action by inserting the complete spool in a strong field. Special apparatus for this purpose has been developed and is widely used. The applied a.c. field is made to diminish regularly, to prevent residual magnetism leaving a high background level.

**PART TWO NEXT MONTH**
3 BAND TRANSMITTER
by G30GR

The 6146 will take an input of up to 60W and the transmitter described here covers the 80, 40 and 20m bands. The building cost is not very great and can be further reduced by simplifications described later if required. The transmitter itself is crystal controlled but it can readily be used with a v.f.o.

Fig. 1. The transmitter circuit complete except for the power supply.
Fig. 1 shows the transmitter circuit. A 6C6H6 is used as an oscillator (V1) which gives high harmonic output when wanted, so that 3.5 Mc/s crystals may be used for the 80, 40 and 20m bands. Some 160m hand crystals are also satisfactory, especially for 80m.

L1 is the oscillator anode coil switched to cover the 80, 40 and 20m bands and tuned by the 100pF variable capacitor VC1, which also allows grid drive to be adjusted to obtain suitable grid current. It was found that more than sufficient grid current was available on all bands, so this capacitor is normally tuned somewhat off the resonant point. This has no effect on oscillator frequency.

The 6L46 (V2) runs with about 2mA to 2.5mA grid current, providing about 45-50V bias developed across the 22kΩ grid resistor R4. This valve has three cathode and beam plate pins each grounded for r.f. by a 2000pF capacitor to chassis (C10-12). For c.w. operation the key plug is inserted in closed-circuit jack J1, the cathodes of both stages being keyed. For 'phone transmission the plug is withdrawn or the key shorted.

L2 is the pi tank coil for three-band coverage and this can work directly into many aerials. L5 is an anti-parasitic choke. Anode current is checked with the anode meter M2. For a 600V h.t. supply the anode current of the 6L46 is listed as 112mA, providing an input of 67W. It is, however, probably as well to restrict the anode current to 100mA. This would give an input of 60W at 600V or 50W at 500V and so on. Good results have been obtained with a 275V h.t. supply or input of 27.5W.

In order to avoid the necessity of providing a large modulator, screen grid modulation is used. A single 6BW6 (V4 in the circuit diagram) will easily supply enough audio power for this type of modulation, excess being dissipated in the 4.7kΩ resistor R15.

When using 'phone it is necessary to reduce the power amplifier (6146) input to about one-half that which can be run on c.w. This is a general rule with screen grid modulated systems. The transmitter thus has an input of up to about 30W on 'phone for average work and 60W on c.w., which is adequate for much DX working.

The modulator section is very straightforward and has enough gain for a crystal microphone of reasonable output. Component values have been chosen to give some treble and bass cut.

Full control switching is furnished by a four-pole, five-way switch S1, the positions of which are shown in Fig. 1. Each "standby" position switches off all circuits but leaves the heaters running. These positions are used while receiving. The second standby position is merely to allow the operator to switch from C.W. to Standby without passing through the 'phone and net positions.

With the switch at "net" h.t. is applied to the oscillator only, allowing tuning up for grid current and netting the receiver on the transmitter frequency. (With a v.f.o. this allows the v.f.o. to be tuned to the receiver frequency also.)

With the switch set for "phone" the modulator is brought into use and h.t. applied to the p.a. anode. Choke modulation of the screen grid is by the 6BW6, with the d.c. potential derived from the modulator high-tension supply.

When the switch is in the "c.w." position the V2 screen grid is supplied from the high-voltage supply through a dropping resistor chosen to allow full input. This resistor can usually be 27kΩ but is selected as described later.

Metering

As grid and anode currents are very important in setting up, two meters are included. A single meter with grid/anode switching is sometimes employed but the use of separate meters avoids the need for repeated switching from grid to anode circuits and avoids errors such as looking for anode current while the single meter is switched to read grid current.

Two "surplus" meters were used and suitable thermo-couple meters can be purchased at very low cost. When the thermo-couple is removed these instruments usually have a full-scale reading of about 2mA to 5mA. They are thus readily shunted to allow suitable scales to be drawn. The latter can be on thin card cemented to the old dial.

For grid current a 5mA meter is suitable. The one used was 2mA full scale, shunted for 4mA full scale. For anode a 100mA, 150mA or 200mA instrument is suitable or a smaller meter shunted to 150mA or 200mA full scale.

Fig. 2: Winding details of the oscillator anode coil, L1.

Oscillator Stage VI

The oscillator anode coil L1 is shown in Fig. 2 and is wound with 26swg enamelled wire on a paxolin or similar former 1in. in diameter and 2½in. long. A space of about ½in. is left between each section. All turns are in the same direction.

Ends A and D are anchored by passing them through holes. Taps B and C are made by barting and twisting the wire and soldering the loop. Switching is so arranged that ten turns are in circuit for 20m. 24 turns for 40m and the whole 59 turns for 80m.
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P.A. Tank Coil L2

This is wound on an insulated tube 3¾in. long and 1¼in. diameter as shown in Fig. 3. Beginning about ½in. from one end, the 18 s.w.g. wire is anchored in hole A and ten turns are wound at eight turns per inch. The wire is secured at B. A further ten turns are then wound and a small loop made at C. After 14 more turns the wire is fixed at D.

The aluminium bracket shown in Fig. 3 holds the coil to the switch. It is cut and bent as shown and fitted to the coil with 6BA bolts, S3 already being in the central hole. Stout connections are then soldered to S3. They are as short as possible. S3 has two three-way sets of contacts and they are used in parallel.

The completed tank coil assembly can be attached to the panel by the securing nut of S3 and short connections taken from A to VC1 and D to VC3.

Fig. 4: Above chassis layout where most of the larger components are mounted.
Above Chassis

The chassis measures about 10 x 7 x 2\text{in.}, and the layout is shown in Fig. 4. The crystal holder can be for \( \frac{1}{8}\text{in.} \) or \( \frac{1}{4}\text{in.} \) spacing crystals or both. Valveholders can be located from the dimensions given.

VC2 must have wide spacing to avoid sparking over; a spacing of 0\text{in.} between plates is more than adequate for 600V. For 40 and 20m 100pF will suffice but 150pF is required for 80m and 200pF would be better.

VC3 is a receiver type capacitor and should have a total of at least 1,000pF (two-gang 500pF with sections in parallel). For low impedance aerials on 80m 1,500pF is better (three-gang capacitor) but 1,000pF is easily sufficient for the 20 and 40m bands.

Both capacitors are bolted to the chassis and short earth returns provided for their rotor contacts. A small plate carrying a coaxial socket is bolted to the frame of VC3 and allows a coaxial feeder from an aerial to be plugged in. The socket outer sleeve is common to the chassis. This socket is not placed on the rear of the chassis as complete segregation of the p.a. anode and aerial circuit from other wiring would then be difficult.

The front panel measures 101 x 74in. It can be of hardboard or aluminium. Holes are required for the meters, capacitors and S3. S1, S2 and VC1 hold the panel to the chassis. L4 and C15 are wired together and to VC2 (Fig. 4). The assembled tank coil unit can then be fixed by S3 and a short lead taken from A on the coil to VC2 fixed plates. D on the coil is connected to the fixed plates of VC3. L4 is a 2.5mH r.f. choke rated at 1.50mA d.c.

The anti-parasitic choke L5 consists of five turns of 20 s.w.g. wire with an outside diameter of \( \frac{1}{8}\text{in.} \) and a total length of \( \frac{1}{4}\text{in.} \). When the choke is made R5 is placed inside it and connected to choke and anode cap with the shortest possible leads.

Twin twisted leads from the anode current meter pass through a hole nearly under S3 to C9 and the switch. The grid meter is connected from chassis to C8 as in Fig. 4. The lead from L4 goes through the chassis to C9, which is immediately below.

S3 control knob should have band positions marked. It is convenient to use 0-100 or similar dials for p.a. anode tuning and aerial loading (VC2 and VC3) but control knobs without dials are also perfectly satisfactory. Screening cans should be provided for the 12AT7 and 6CH6.

Underside of Chassis

Positions of components and leads are shown in Fig. 5 and the transmitter may conveniently be
wired in stages. For r.f. circuits 18 or 20 s.w.g. wire is used. Heater and h.t. wiring should run against the chassis and be adequately insulated. It will be helpful to use sleeving or insulated wire of several colours, especially to identify meter, h.t. and switch circuits.

**6CH6 Oscillator**

Coil L1 is left until wiring is otherwise finished here. C4 and C6 are disc ceramic capacitors. L3 and R3 are anchored to an insulated tag near the crystal holder. Points MC are tags bolted to the chassis in the usual way.

Connections to C7 and C3 should be as short as possible. L1 is held with a bracket bolted about 1 in. from the lower edge of the chassis and 2 in. from the panel.

The oscillator may be tested, if desired, by applying 6-3V a.c. to the heaters and about 250V d.c. to point X (see Fig. 1). With valve and crystal in, current should drop to about 20mA as oscillation commences. The carrier may be detected with a receiver or a tuned wavemeter with bulb indicator will glow if near L1, with S2 and VC1 adjusted for each band.

**Power Amplifier**

C10, C11, C12 and C13 are disc capacitors connected with very short leads. R4 is clear of the chassis and anchored at a tag providing the grid meter negative connecting point. C8 is a disc capacitor. The meter leads run against the chassis and anode meter leads are clear of the grid meter connections and pass through a separate hole near the function switch S1.

When no plug is inserted in the key jack, L3 and the p.a. cathode circuit are returned to chassis by closing of the jack contacts. Efficient grounding for r.f. by C10, C11 and C12, as shown, is necessary to avoid unwanted oscillation.

**Double Triode**

C17 and C19 should be mica or of equal quality as any slight leakage will upset bias on the second triode section (V3B) or on the 6BW6 (V4). C18 is displaced in Fig. 5 to show connections but lies over R16.

The microphone has the usual screened lead terminating in a coaxial plug. The inexpensive type of general purpose crystal mike should be satisfactory. It may be necessary to keep the microphone and its lead reasonably clear of the aerial.

**6BW6 Output**

The 6BW6 audio output stage or modulator V4 is very straightforward. For the anode choke L6, a speaker output transformer is most suitable. The type intended for a mains pentode, rated at 60mA or more and probably with a ratio of about 40:1, is ideal. The secondary is not used.

The optimum load of the 6BW6 is about 5kΩ, but the modulating impedance of the screen grid is much higher and not uniform throughout the audio cycle. As more power is available than required a 4-7kΩ resistor R15 is thus added to supply a stable load. The 6BW6 anode connection runs near the back of chassis and tag strip, clear of r.f. circuits, as in Fig. 5.

The modulator may be tested, if required, by temporarily connecting a loudspeaker to the transformer secondary. R15 may be disconnected.

Speech should be clear and distinct. The microphone must be well away from the loudspeaker to avoid feedback howling.

**Function Switch S1**

This is four-pole, five-way, but no circuits have to be completed at either extreme position. Two two-pole, four-way wafers were actually used, assembled on a cut-down spindle from an old switch, and with a stop removed so that a second "off" position was obtained.

Fig. 6 shows the wiring for a new switch, consisting of two wafers, each having two-poles with five-ways. Lengths of coloured flex or other insulated wire can be soldered on before mounting the switch in the chassis.

Switching can be checked without supplies and valves. High tension should reach the 6CH6 anode (pin 7) in all but "standby" positions. With the switch at "phone" h.t.+1 should be connected to pin 8 of the 6BW6 holder and through R17 to pin 3 of the 6146 holder. H.T.+2 also goes to 6146 anode. When the switch is at "c.w." h.t.+2 remains connected to the 6146 anode but pin 3 is now fed through R7 from h.t.+2. In no circumstances must switching be such that screen grid voltage is present on the 6146 when the anode voltage is absent.

**Power Supplies**

The heaters require 3-2A at 6-3V, so a 3½A or 4A secondary will do well. For h.t.+1 a 250V receiver type power pack is ideal. A supply of about 220V to 270V at 60mA is sufficient.

The voltage applied at h.t.+2 depends on the
power supplies which may be available and the input wanted. It is a good plan to make an initial test or tuning up with reduced voltage, such as can be obtained from a 250V supply, or by joining h.t.+2 to h.t.+1.

About 100mA at 450V to 600V falls easily within the rating of a transformer of moderate size and a suitable power supply is shown in Fig. 7. R7 controls the screen grid voltage when working on c.w. and it may be reduced to 10kΩ or less for a 300V supply. The screen voltage of V2 should not exceed 250V or 400V with key open. A screen voltage of about 150V is generally suitable for c.w. current, being about 10mA. Screen dissipation (volts x current) should not exceed 3W.

If there is any doubt the best solution is to begin with a high-value screen grid resistor and reduce this after checking the screen grid voltage and current with a meter. For a phone the screen voltage is much lower as this is necessary for correct modulation.

**Tuning Up**

First tests should be made with the switch at "Net". A 3.5Mc/s band crystal can be inserted and adequate grid current should be found on each band by adjusting VC1. Grid current should not be allowed to exceed 3.5mA and should generally be between 2mA and 2.5mA. S2 is always switched to the band upon which output is wanted, so that the final amplifier is not used as a doubler.

A 7Mc/s band crystal is useful to check 14Mc/s tuning to make sure the third harmonic of 3.5Mc/s (10.5Mc/s) is not selected by VC1 in error. Or a bulb indicator meter or receiver can be used. The 14Mc/s band should peak up with VC1 nearly open.

An initial test can be made with power delivered into a 60W household lamp connected to the aerial socket and chassis by a few feet of twin flex. With S2 and S3 at 80 close VC2 and VC3 and tune for grid current at "Net". The function switch is then turned to "Phone" and VC2 is immediately adjusted to find the dip in anode current as shown by the anode meter. The current is increased by opening VC3 and retuning with VC2. VC2 is always tuned for minimum anode current, corresponding to maximum r.f. output.

Grid current is readjusted if necessary by VC1. When the p.a. has been tuned to resonance the switch can be turned to "c.w." if wanted (key closed). As loading progresses in the way described the lamp will light with increasing brilliance. For c.w. the anode current may run up to 100mA.

Loading the transmitter into an aerial follows the same method. A coaxial-fed dipole can be fed directly from the transmitter. Various end-fed aerials can also be used in this way with a good earth to transmitter chassis. For resonant end-fed aerials some type of aerial tuner placed between aerial and transmitter will be almost essential.

**Crystal Frequencies**

Crystals with fundamental and harmonics falling within the band limits may be used on all three bands but some crystal frequencies will not supply harmonics within the bands. For 7Mc/s and 14Mc/s, 7Mc/s crystals may be used, while 3.5Mc/s crystals will do for 3.5, 7 and 14Mc/s. Any 1.75 to 19Mc/s crystals will do for 3.5-38Mc/s also.

"Phone Loading"

For best speech quality with screen grid modulation the p.a. must be heavily loaded. To accomplish this the screen voltage of V2 is kept low by R17 and loading with the pi-tank is continued until the dip in anode current on rotating VC2 has become small. An input of about

—continued on page 321
One station getting its schedule out well in advance is Radio Moscow. Until the end of August English for Europe is aired at 0700—0730 on 11,830/9,710/9,600/9,480/7,240; 1200—1300 on 15,490/11,930/11,830/11,700/9,780; 1900—1930 on 9,710/9,480/7,340/6,050/1,320; 2000—2030 on 9,710/9,480/7,160/7,340/6,050/1,380; 2100—2200 on 9,710/7,340/7,260/6,050/1,490/2200—2330 on 9,710/7,340/6,050/1,490/1,380/1,320. In September/October the following changes are made: 0700—0730, 11,830 dropped: 1900—1930, 2000—2030, 7,280/6,170 replace 9,710/9,480; 2100—2230, 7,280 replaces 9,710.

Frequencies used for several English transmissions were changed by Radio Prague for its summer schedule. Changes are: 0100—0155, 0330—0425 on 5,930/7,120/7,345/9,795/11,900; 0300—0355 on 15,285/15,448/17,825; 0800—0855 on 6,055/9,503/15,235/15,285/21,450. On its QSL, says D. Hill, date, time and metre band are given.

T. Robinson, Liverpool, reports that Radio Nederland (P.O.B. 222, Hilversum) has a DX programme at 1600 on Fridays and a request programme on Saturdays. In London 15,425 gives better reception than 11,730 for the 2100—2150 English transmission but suffers from severe interference from A.F.R.T.S. New York on 15,430.

A. Waddelow, Norwich, has heard the Bonaire relay with Dutch at 2100 on 15,290 giving SINPO 33433. He reports full verification details from Radio Denmark (Radio House, Copenhagen V), Radio Andorra (Roc des Anelletes, Andorra La-Vielle, Andorra—return postage required), Radio Berlin International (Berlin-Oberschoneide, Nalepastrasse 18-50, German Democratic Republic), and Radio Belgrade.

The 1315—1400 English transmission to South-East Asia from Emissoja Nacional de Radiodifusao (Rua Sao Marcel, L.A, Lisbon) is now on 21,495/17,895. The BBC now has an English transmission to East Africa from 1800—1830 on 15,420.

D. Hill mentions two English transmissions from Radio Bucharest (P.O.B. 111, Bucharest) from 1930—2030 on 9,570/9,510/7,225 and 2230—2300 on 7,195/6,190.

Middle Eastern stations reported this month are Radio Ankara, Kol Israel (Broadcasting House, Jerusalem, Israel), Radio Baghdad (Salihiya, Baghdad), Radio Iran (Ministry of Information, Meydan Ark, Teheran), and Saudi Arabian Broadcasting (Ministry of Information, Airport Road, Jeddah). Paul Harris, Elgin, says that English from Kol Israel is now from 2045—2115 on 9,009/9,625/9,725. Ankara now has English at 1930—1945 and German at 1800—1815 on 15,160. A. Waddelow reports English on this frequency at 2200—2230 (SINPO 44444).

E. Conduit, Wolverhampton, has had a QSL with date and frequency only from Saudi Arabia and with frequency only from Baghdad. Although W. Smith had a yellow card giving date and frequency from Baghdad, Alex Bushby, Glasgow, reports a letter giving no details from Iran.

Two African stations, Radio Information de la Republique Democratique du Congo (B.P. 3171, Leopoldville) and the Nigerian Broadcasting Corporation (Broadcasting House, Lagos) are reported by R. Howard, Stockport. The former he has heard between 2030—2200 on 11,795. Nigeria was logged in English between 2130—2205 on 11,900/15,255.

Cairo Radio (U.A.R. Broadcasting and TV, Maspero) has changed the language segments for its transmissions on 17,920 to East and Central Africa. They are now Nianga 1545, Shona 1615, Somali 1645 and English 1745—2030.

According to Paul Harris, Radiodiffusion Televison, Ivorienne (B.P. 2261, Abidjan, Ivory Coast), has replaced its International Network frequency of 11,820 by 6,015. He has heard this frequency at 2200—2400 and presumes it carries the 1830—1900 English transmissions on weekdays.

A. Wildsmith, Manchester, advises those who have written to Radio Ghana (Broadcasting House, P.O. Box 1633, Accra) and have not received a reply not to despair. He has just received a verification after five months.

Conflicting reports on the QSL of All India Radio (P.O. Box 500, New Delhi) from E. Conduit and D. Hill. The former’s card had the date only, whilst the latter’s had all details.

Finally three reports on Radio Pyongyang (Pyongyang, North Korea). Paul Harris has heard English at 1800—1900 on 10,380 and 1900—2000 on 6,540/7,370 with 7,580 being announced as well. According to announcements, he says, other transmissions are 1000—1100, 7,580; 1100—1200, 9,750; 2400—0100, 17,520; 0300—0400, 9,570. M. Clark, Cheltenham, has heard the station on 6,500 at 1900 when it says it is using 7,389/7,595/8,333/10,381. A transmission from 1000—1200 on 6,061/7,353 was also announced.
The Amateur Bands—by David Gibson G3JDG

ONCE more unto the h.f. bands, dear friends, and verily DX shall be thine. Unbelievers should listen on 20m, where thousands of stations from almost everywhere are battling it out.

It is fair to reckon that all those not on 20 are on 15 and this band seems more consistent these days. It stays open for longer and although there is often some QSB it's on the up and up, certainly as regards reliability.

Poor old 10? Not any more—half Europe gets on at the weekends and the African continent shows itself, too. Those with directional antennas on this band should have very full logs.

TWENTY

Let's start with a bang. Here is the pick of the log from BRS26813, of Cheltenham, who uses an S640 and HRO5T with a 90ft longwire. All c.w.: AC4H (Tibet), CN8MH, CR4AE, 4BC: EL2AEG, 2AM: ET3GO, 3USA: DJ1OR (Philippines), FG7XS (Guadeloupe), FM7WH (Martinique), HI4ARM, HK3RO, HP1BR, HZ3TYQ (Saudi Arabia), JA1BZR, IFHK, IDU, IZZ, 7AB, 7ARZ: JT1AG, HK6DSW, FLK, JI, TD, WU; KM6DJ, KP4ARS, LA4EI/P (Jan Meyer Island), LU2DAW, 8EE: OA4EM, OY7ML (Faroes), PY1BTX, 2ON: PJ1CZ, SU1IM, UL4PY, UN1BR, V2C0, VK2EO, 200: VOZNA, VP5BH/AI, 9EP: VS7GW, 2L1: WS1UW/VPR, 6INX: XI6EIO, YV1AD, 4MC, SAAQ, 5ACP, 5BH1: ZD8BC, ZB8TT, ZP5LS, ZS6AJO, 4U1ITU, 4X4HK, MZ, QA: 5A3TT, 5Z4AQ, 6YSMJ, XG: 7X2ARA, 7X3CT, 912GJ.

Which station has that if it emits r.f. then it can be found on 14Mc/s and BRS26813 will hear it! Well done, Bob—when do you sleep?

Norman Ponsford (Devon) found these on his t.r.f. CR45 with 60ft longwire, all on a.m.: HB9VW, K3NHJ, K2YLM, OE3CL, PY7GV, SVOWBB, WA4110, 4X4FA, S2AQR, S2AAQ. Langham (Somerset) got these on a domestic receiver and 75ft longwire: 11UG, L1ZKBD, PA0PAN, U9AKCF, U05KBR, UY6BC, 4X40S, all a.m.

Messrs. McWhirter and Weare are the ops at Derby School Signals Platoon and pulled in these on an R107 with 200ft longwire: K2ZKR/P, SP4AUQ, U2AKBD, VE4SA, W2RKV, WHCPC (all on a.m.), ET3USA, UAI1KBD, UA9MX, UN1BR, UW3FV(? on c.w.

FIFTEEN

Stephen Beale (London), using the P.W. t.r.f. (May, 1964) and a 66ft longwire, got these on a.m.: CR6BY, EA8ER, LA4EI, SV1DL, ZC4MO, 4X4OR, 5A1TK, 5A5TE, 5N2KOB, 9G1MR, 912DT, 9L1WV, 9Q5DL, 9X5RZ.

D. F. Carrington (Derby) pulled in on his HE30 and 68ft longwire with 14ft vertical whip at far end: CT3AQ (Madeira). EL5CG, EA6GL, PY1NBA, PY1AGP, SVOWWO, W9ACU, ZC4KW, 4X4OR, 5A1TK, 9X5WTB and 9Q5's DL, US, AWB, RB, AQ and AD.

Mike Silverstein (London), CR100 and 132ft longwire, hooked. CR6BY, CR7FR, H18BGA, JAI4TN, KZ5BE, OA4OS, PY1BYS, VP4LE, VS9ANR, ZE7JR, 9X5RZ.

TEN

Back in circulation! Why, we have even been getting logs!

George Owen (Bristol), using a five-valve t.r.f. and vertical joystick, leads the field with CE4FB, CR4AO, BC: CT1CN, MZ, ILX, IOF, LIM; EA3PA, EL2L, F2SI, HB9FMA, 11SO, BIW, 11YJ, MTO, FA1, WRR: KC4CKC, OK1ABN, ZD8JC, ZE1JJ, 5A4HR, 5Z4AA, 9Q5AA.

THE L.F. BANDS

Only the real stalwarts stick at it. On 7Mc/s Bob Garvy (Gloucester) had these on his HRO and 90ft longwire, all on c.w.: DJ3ZXA, EI1TF, OK4ADX, PY7AOD, SM7ACR, UA1KAL, VP2LZ, ZS6DF.

On 3-5Mc/s A. Rolfe (Halstead) got DJ8RS, DL2UZ, DL6VU, F2WWW, F3ZK, PA0PAL, SM3YF/MM using an R109 and 12ft whip. And an unsigned log from Preston mentions DJ6OT, DL6ME, EI4R, GC2AZ, OZ1HI, SM7WW, VE11E.

Top hand almost abandoned and the only letter we had was from W. Smith (Staffs) with a large list of G stations heard.

IN GENERAL

The coat-hanger and cuff-link gang are still at it! BRS26325 (Dundee) used a fireguard on 21Mc/s for 5A1TK, CT1JJ, 9M4LP, EA8EH. M. Carter (North Wales) used a ground-floor window frame into an HRO for 14Mc/s s.s.b.: EP2DS, KH6BK, KR6AAC, MP4BCC, OD5BZ, HU6N, HB0AFM, HL9PK, KP4CL, VE6TP, W6VPY, W7MKI, ZS6XB, 5N2AAC, 9M2SR. Anybody thought of the little strip of metal foil around cellophane wrapped cigarettes? (Watch it, they resonate at 947Mc/s!)

ZB1 (Malta) is now 9H1 for sure. The Western Carolines and Kure Islands are on and the calls on to listen for KC6 and KH6 respectively, 4U1TU is the headquarters station of the International A.R.C. located in Geneva. Others rumoured to be squiritting r.f. about are South Georgia VP8, Christmas Island and Cocos Keeling both VK9, ZD8 on Ascension Island. Crete SVOWGG high end of 20 on s.s.b., Willie Island VK4 and Samoa KS6. For Top-band addicts there is a beacon on 1.801Mc/s in South Africa signing ZE1AZD, reports very much appreciated.

What a lot of field days, British, American and now Korean. The Korean effort will be July 3rd-4th on 80, 40, 20 and 15m. Callsigns to listen for are HM and HL. Other activities on in July are: 4th: 144Mc/s portable contests; 11th, three mobile rallies, tenth anniversary rally. South Shields rally and Torbay mobile rally; 17th-18th, 1.296Mc/s tests (you've just got time to wind a set of coils); 25th, 70Mc/s portable contest and Cornish mobile rally. August 1st, SLADE D/F qualifying event. Good hunting and don't forget to drop me a line on what's coming in at your QTH.

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The lists of parts for constructional articles are those found satisfactory in the prototypes and available at the time of publication. Many queries which the editor receives show that many beginners regard a published list of parts as being strictly binding down to the last detail.

Whilst this may be true for special projects a considerable latitude normally exists and the informed constructor can use his discretion regarding substitution of components already in his possession or more readily available.

It is the aim of this article to help readers in making on-the-spot substitute decisions if a dealer does not happen to have the exact item desired in stock. The information given will also serve many other useful practical purposes, such as the selection of modern replacements for defective components in obsolete equipment, or just to make better use of items available in the junkbox instead of making new purchases.

Resistor and Capacitor Values

A frequent type of enquiry concerns apparently strange component values, such as "a capacitor of 0.056 µF." Whilst the familiar sequence of preferred values is quite commonplace for resistors, it is less familiar in Britain for capacitors. However, our example of a 0.056 µF capacitor simply bears the same relation to a more familiar 0.05 µF capacitor as does a 56kΩ resistor to an older-type 50kΩ resistor. Such values are mutually interchangeable unless very critical conditions are involved and which the author of an article would point out. Unless otherwise stated, the constructor may assume that a ±20% tolerance is implied for resistor and capacitor component values. This obviously permits mutual interchange of a 0.05 µ F capacitor with a 0.047 µF or 0.056 µF preferred-value capacitor. (The 0.05 µF ±20% could, of course, be anything between 0.04-0.06 µ F.)

If a preferred-value component is outside the tolerance of a near old-type component, one should select a parallel combination of two standard value capacitors or resistor and capacitor component values. Thus, given ±20% tolerance, the correct substitute for a 0.68 µF capacitor is a parallel combination of a 0.5 µF and a 0.2 µF.

Similarly a 50kΩ resistor can generally replace a 47kΩ or 56kΩ resistor, but a 68kΩ resistor requires either a 75kΩ resistor as substitute, or various combinations of two resistors, such as a 50kΩ and a 20kΩ component in series, or two 150kΩ resistors in parallel. Note that the individual wattage ratings of series or parallel combinations of two resistors can be halved only if the individual values are equal or very nearly equal.

In cases where resistor or capacitor substitutions of the kind discussed above lead to a residual discrepancy close to the tolerance limit, e.g. when substituting a 10kΩ resistor for a 12kΩ resistor, it is advisable to measure the actual values. Judicious selection can often lead to a closer approach to the specified value and will avoid additive tolerance errors greater than the tolerance limit. However, a large number of experimental circuits remain uncritical even under the latter circumstances.

The important thing to remember is that, generally speaking, any value within the tolerance of the specified value will be acceptable.

Critical Capacitor and Resistor Values

Resistor values are frequently more critical when they constitute parts of bleeder networks which determine the operating point of a valve or transistor, or when they are parts of calibrated shunts, multipliers, attenuators or other measuring circuits.

Fig. 1: Series and parallel combinations of resistors and capacitors
Capacitor values are critical in tuned r.f. and i.f. circuits and in oscillator padding positions. Even then, substitutions of combinations of two or even more components in series or parallel to make up the exact specified value are generally permissible. Note that capacitors in parallel and resistors in series are added whereas capacitors in series and resistors in parallel are equal to the reciprocal of the sum of the individual reciprocals, see Fig. 1.

ELECTROLYTICS

It is normally permissible to substitute non-electrolytic capacitors of the same value for specified electrolytes, if space permits, but electrolytic capacitors cannot be substituted for paper or foil capacitors when insulation and capacitance stability are important factors.

Thus it is usually unsatisfactory to substitute an electrolytic for a paper or metallised foil component in an anode-grid coupling circuit since leakage of the electrolytic would lead to an intolerable displacement of the operating point of the subsequent stage. Very large metallised foil capacitors in long-period high-impedance timing circuits (minutes or hours) cannot be replaced by electrolytics. However, low-impedance transistorised timing equipment does often use low-voltage electrolytics. The accuracy of such circuits, or at least their long-term stability, nevertheless tends to be inferior.

Electrolytic capacitors are relatively coarse, inaccurate components whose capacitance and insulation may vary greatly during the useful lifetime and according to the length of resting time without applied voltage. Thus even if an electrolytic capacitor is found to function satisfactorily in a critical circuit position at some particular time, that circuit cannot in general be relied upon to function satisfactorily with it at all subsequent times. In valve circuits, electrolytics should normally be confined to smoothing and decoupling functions.

Electrolytics are more widely usable in transistorised circuitry because impedances are generally lower, so that insulation deficiencies are less important. Therefore any slight leakage of electrolytic coupling capacitors leads to much smaller relative displacements of the transistor operating points than in the case of valve circuits.

RF CAPACITORS

It may be unsatisfactory to substitute paper capacitors for ceramic or mica capacitors in r.f. circuits when the operating frequencies are high, although this may not matter so much in long- and medium-wave circuits. On the other hand, ceramic or mica capacitors of adequate voltage rating may be substituted for specified paper ones.

In most r.f. applications it is immaterial whether ceramic or mica types are used. Modern ceramic materials have a greater capacitance in a smaller space, but their voltage ratings are often more limited. Paper capacitors generally have a lower capacitance stability, so that even if they work in local oscillator circuits they should nevertheless be avoided in these stages, otherwise trouble is likely to be encountered with drift. Mica or ceramic components of good basic stability are most desirable, especially for v.h.f. circuits.

Where an author specifies strange combinations of odd-value capacitors with exact details of manufacturer and type number, and with two or more such capacitors connected in parallel at each position, the intention is to achieve mutual cancellation of the individual temperature coefficients. In such cases it is not possible to make straightforward substitutions of other capacitors without impairing the frequency stability of the circuit.

Forbidden resistor substitutions can arise in circuits where the stray inductance of the resistors plays a significant role. This often means that wirewound resistors cannot be used in place of specified carbon resistors in such circuits as the signal amplifiers of oscilloscopes and wideband a.c. valve voltmeters, or in the video stages of television equipment. However, in these same types of equipment wire wound resistors with a definite inductance used as frequency-correcting peaking inductance may sometimes be found.

If such resistors fail and have to be replaced, simple substitution of a carbon resistor or an arbitrary-inductance wire wound resistor of the same wattage and resistance value may lead to unsatisfactory performance of the equipment (generally reduced bandwidth at the high-frequency end).

POWER SUPPLIES

Due to the lack of standardisation in mains transformers, difficulty in obtaining the exact one specified in an article is a common problem.

Other power supply problems concern rectifier substitutions, in particular the conditions under which valve, metal and silicon rectifiers may or may not be mutually substituted. Finally, readers often query possible interchanges of halfwave, fullwave and bridge rectifier circuits if a specified rectifier arrangement is not available.

There are standard rules of substitution which can be applied to most power supply problems.

MAINS TRANSFORMER SUBSTITUTION

Space permitting, it is always possible to use separate heater transformers, either to cater for all heater requirements independently, or to augment the heater supplies available on the transformer which also carries the h.t. winding. If more than one transformer is used, all primaries should be connected in parallel, but never connect secondaries of physically or electrically different transformers in parallel. Series connections of secondaries are always permissible for any combination of transformers, within the insulation ratings, e.g. to obtain higher heater voltages.

If it is possible to obtain a transformer with all the required windings as far as voltages are concerned, but the current ratings are too low, then it is always permissible to wire two such identical transformers in parallel.

All primary and secondary connections should be respectively connected in parallel. The current
rating of each composite winding is then twice that of a single transformer. It must be stressed that such connections are possible only for truly identical transformers.

If, for example, an h.t. current rating of 150mA is specified, there is no objection to using a transformer with a somewhat higher rating, e.g. a 200mA or even 250mA. However, overloading of h.t. windings in the other direction should be avoided, since it leads to severe overheating. Thus if 150mA h.t. rating is required but only a 100mA transformer type is available, two such identical transformers will have to be connected in parallel.

Fig. 2 shows such a transformer substitution. In the example, a 250-0-250V 200mA transformer with two separate 6.3V 2.5A heater windings has been specified (Fig. 2a). This may be replaced by two smaller transformers, each having a simple 250V 100mA winding for halfwave rectification and a single 6.3V 2.5A heater winding.

Provided that the two transformers are fully identical, there is no objection to feeding the two sections of a full-wave rectifier circuit from separate transformers in the manner shown, and the current rating of each transformer need only be one half of the required rectified h.t. current.

But there is one rather important reservation. The two separate windings must be of a type specifically intended for halfwave rectification at their full rated current output. Halfwave rectification always passes a d.c. current component through the secondary winding of a transformer, which magnetises the core and lowers the primary inductance. The primary inductive current therefore increases and the transformer gets much hotter than it would otherwise do.

There is no net d.c. magnetisation of the core when the type of halfwave rectification shown in Fig. 2a is employed, with both rectifiers fed from the conventional centre-tapped h.t. winding on a single transformer.

If the two transformers of Fig. 2b are not designed for halfwave rectification, it is better to change the rectifier arrangement too, using a single transformer with a simple h.t. winding (now rated for the full required h.t. current) feeding a bridge rectifier as shown in Fig. 3.

Provided that the transformer voltages are the same and the rectifier classes of Fig. 2a and Fig. 3 are the same (e.g. in both cases contact-cooled selenium rectifiers, or all silicon diodes), the respective circuits are generally completely interchangeable, whichever one an author should happen to specify.

Fig. 2a: Normal full-wave rectifier circuit.

Fig. 2b: Full-wave rectifier circuit with two half-wave transformers.

Fig. 3: Bridge h.t. rectifier circuit with simple transformer winding.

PROBLEMS WITH HEATER WINDINGS

Unless two or more transformers are absolutely identical, heater windings should not be connected in parallel, but any form of series connection for obtaining higher voltages is permissible. It is inadvisable to connect two heater windings on the same transformer in parallel, even if the current ratings are identical.

If two or more heater windings are required to meet the demands of all valves in a piece of equipment, it is generally best to "common" one side of each winding to chassis and to connect

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Fig. 4: Surge voltages in electrolytics C1, C2, C3 (see text).

respective groups of valve heaters independently to the other ends. In most cases the specified heater requirements may be redistributed in any manner within reason.

If rectification of the output from a heater winding is required, keep to fullwave or bridge rectification unless the current drain on the d.c. side is only a small fraction of the a.c. current rating. Otherwise d.c. magnetisation of the transformer core can lead to severe overheating and possible burnout.

Whereas h.t. windings may be fairly generously overrated, e.g. there is little objection to loading a 200mA winding with no more than 50mA actual h.t. current drain, such severe underloading is undesirable on heater windings since it can lead to unduly high heater voltages which would endanger valves.

Check with a multimeter and if necessary insert a low-value series resistor (e.g. a coiled length of stout resistance wire determined by experiment or calculation). Adjust for correct voltage reading at heater pins of valves. Alternatively, connect the primary to a higher voltage tap than the prevailing mains voltage. Slight resulting loss of h.t. output voltage is generally tolerable.

**RECTIFIER SUBSTITUTIONS**

There is little to choose between conventional metal rectifiers, contact-cooled ("flat") selenium rectifiers and silicon rectifiers as far as normal performance in h.t. circuits is concerned, although the efficiency improves in the order given and the heat dissipations and physical sizes decrease accordingly.

The modern silicon h.t. rectifier is undoubtedly the best component in the semiconductor class of h.t. rectifiers and it can serve as a versatile substitute in most cases where specified metal rectifiers or contact cooled rectifiers are unavailable. Contact cooled selenium rectifiers use a coding such as, for example,

E250 C50= Halfwave (E),
250V a.c. input, d.c. current
(C) 50mA

B450 C200= Bridge (B),
450V a.c. input, d.c. current
(C) 200mA.

Whilst the first example is very common, the second example and similar types often specified for high-power electronic or amplifier designs may be difficult to obtain. Four simple 250V a.c. input silicon h.t. rectifiers connected in a bridge circuit represent a perfect substitute for a B450 C200 and are always easy to obtain.

It is fairly general to use the ubiquitous silicon mains rectifier if any other specified semiconductor rectifier is unobtainable. If the a.c. input does not exceed 250V for non-bridge circuits or 450V for bridge circuits, use a single silicon mains rectifier for each diode section of the substituted rectifier. Otherwise use two silicon rectifiers in series for each diode section if the a.c. input voltage lies between 250V and 500V for non-bridge circuits or between 450V and 900V for bridge circuits.

The silicon mains rectifier has the further advantage that it is generally equally suitable for rectifying low voltages, e.g. heater voltages, although cheaper types with lower inverse voltage ratings are available.

**VALVE RECTIFIERS**

Whilst it is generally possible to substitute a valve rectifier for a semiconductor h.t. rectifier, if one is willing to go to the trouble of introducing a rectifier heater supply, the converse is not necessarily true. Equipment for which a valve rectifier is specified may well be damaged if a metal rectifier is substituted without due consideration.

Consider the circuit Fig. 4, in which a full-wave valve rectifier circuit feeds a two-stage audio amplifier. If V1 is indirectly heated as shown (e.g. type EZ80), it will not pass any current into the reservoir capacitor C1 until the audio output valve V2b has also warmed up and is able to draw full h.t. output current from C2. The voltage developed across C1 and C2 thus does not rise much above the r.m.s. (a.c.) input voltage from the transformer if the loading is correct.

If a semiconductor rectifier is now substituted for V1, the h.t. voltage builds up immediately across C1 and C2 at switch-on, but there is no output current drain until V2 has warmed up.

The voltage build-up across C1 and C2 will thus initially rise to the peak a.c. input voltage, which is about 1.4 times the r.m.s. input voltage. Electrolytics of correspondingly higher voltage
ratings are then required for C1 and C2.

If the valve rectifier is directly heated (e.g., type 5Y3G), it will deliver h.t. voltage before many of the other valves in the equipment have fully warmed up and are able to draw full h.t. current. The initial h.t. voltage excess will then be less than in the case of semiconductor rectifier circuits, and certainly of shorter duration, but it will often still be significant. Thus beware even of substituting a directly heated rectifier valve for a specified indirectly heated one.

Note that some indirectly heated rectifier valves, e.g., the EZ80, will tolerate the full h.t. output voltage between cathode and heater, so that the rectifier heater may be connected in parallel with the heaters of the other valves, with one side connected to chassis. Other rectifier valves, and of course all directly heated types, will not tolerate this and require a separate rectifier heater winding floating at h.t. voltage on the mains transformer.

If the transformer h.t. winding delivers 250V a.c. or less to the rectifier, a common figure for small amplifiers and receivers, standard 350/380V electrolytics will always be satisfactory for any type of rectifier, whether valve or semiconductor, since this voltage rating withstands the maximum peak voltage which could arise under such conditions. In such equipment there is generally no objection to straightforward substitution of a metal rectifier for a specified valve rectifier.

3 BAND TRANSMITTER

—continued from page 314

50mA should be suitable. If loading is too small speech quality will deteriorate. Excessive loading will reduce r.f. output.

When working with the full anode voltage the p.a. should always be tuned up initially on phone, even when c.w. is required, as this helps keep off-tune anode current down. The p.a. stage must not be left operating off tune or without grid current.

V.F.O.

The voltage stabilised v.f.o. originally described for the 160/80m phone transmitter is satisfactory*. This v.f.o. operates on 1.75Mc/s. The 160m anode coil is replaced by a slug-tuned coil broadly resonant in the 80m band. Tuning may be done by observing grid current, then leaving the coil alone.

It is necessary to short L3 and C1 may be disconnected. Drive to the 6CH6 is on 3.5Mc/s. for all bands. Any other ordinary v.f.o. is likely to be satisfactory.

Simplifications

If 'phone working only is wanted, R3, C5, C10, C11 and C12 may be omitted, the cathode circuit going directly to chassis. R7 is not wanted, nor the "c.w." switch position. For c.w. only the whole modulator and associated circuits can be omitted. It is also possible to use an 807 as the p.a. with useful results and this type of valve is very inexpensive.

* PRACTICAL WIRELESS, March, 1965.
TWO-BAND DIPOLES

CONFIGURATED COAX-FED AERIALS

by F. G. Rayer

A HALF-WAVE dipole, centre fed with a coaxial or twin line, is one of the simplest aerials which can be used successfully without trouble. Most ready-made, kit and home-built transmitters have a pi-output circuit which allows the transmitter to be loaded directly into a 75Ω or similar coaxial line. This method of working is accordingly very convenient.

An ordinary dipole of this type has two disadvantages which sometimes prevent its use. First it needs to be of particular length and enough space may not be available. Secondly the aerial is generally suitable for one band only, which rather limits operating unless another aerial is also available. Both these difficulties can be overcome to a useful extent.

Dipole Length

Requirements for a single band dipole can best be noted first. An aerial of this kind is shown in Fig. 1. The total length is a half-wave at the operating frequency. This can be found from:

Length in feet = \( \frac{468}{\text{Mc/s}} \)

It is usual to cut the aerial for about the middle of the band so that actual coverage includes most of the band. On this basis typical lengths are:

- 80 metre band ... 128ft.
- 40 " " ... 66ft. 4in.
- 20 " " ... 33ft.
- 15 " " ... 22ft.
- 10 " " ... 16ft. 3in.

If particular interest lies at the c.w. end of a band, or any other frequency, length can be adjusted to suit.

A 75Ω coaxial feeder is generally used and can be of any length. It may run against roof, walls or elsewhere and is thus easily brought back to the transmitter.

Practical Construction

A suitable method of making the aerial is shown in Fig. 2. A ceramic dipole "T" piece is most convenient at the middle and the overall length is measured as indicated. Hard-drawn 14s.w.g. wire is most suitable but 7/26 aerial wire is lighter and cheaper. The 14s.w.g. wire can be tightly twisted at insulators but the 7/26 needs knotting, soldering or binding.

The coaxial cable outer braiding is separated with a pointed tool and twisted into a pigtail. This is soldered to one aerial wire. The inner lead is soldered to the other wire. Tape holds the feeder to the "T" piece. If moisture enters the coaxial cable this will upset working. Some spacing material can be melted with the soldering iron to seal the end. Or a sealing compound can be used. Ribbed insulators are generally used. For supporting, polythene line is excellent.

If the aerial is not too long, and supports are rigid, the wire can be drawn taut from the ends. But if the aerial is long (say for 80m) an additional pole or other support at or near the centre is useful to help take the weight of the coaxial cable. The latter should run away at right-angles from the aerial.
Two-band Aerial

Distribution of current in the aerial is as shown in Fig. 1 and current is large and impedance low at the centre. This is why the 75Ω feeder is satisfactory.

On any even multiple a high-impedance point will be found near the centre, so the 75Ω feeder is then unsuitable. But on odd harmonics an uneven number of half-waves exist on the aerial, so that the centre is again low impedance. This is shown for three half-waves in Fig. 3.

As a result, a 7Mc/s dipole can be used on 21Mc/s. The actual calculated length for three half-waves is:

\[
\text{Length in feet} = \frac{492 \times 2 \times 95}{\text{Mc/s}}
\]

It will be found that three half-waves for the 21Mc/s band result in an aerial of about 68ft. Despite this quite good results can be obtained. No other amateur bands can be covered with a single wire in this way.

Fig. 4: This dipole arrangement will work for any two chosen bands.

Double Dipole

A dipole for any two chosen bands can be made as in Fig. 4. Length L1 is for the lower frequency band and L2 is for the chosen higher band. One half of L1 is high impedance at even harmonics, so has little effect on the band covered by L2.

In an aerial of this kind made for 3.5Mc/s (80m) and 14Mc/s (20m) bands it was found convenient to suspend the smaller dipole by 6in. ceramic spreaders as used for open-wire lines. L1 was 120ft and L2 33ft. Three spreaders were used each side the centre "T" piece.

On the first day of testing this two-band dipole the best signal report received was strength 8 to 9 from K4QVK, using 120W a.m. Subsequent results in general seemed about the same as those from a single band dipole cut for 20m. On 80m no change in signal strength compared with an 80m dipole could be found.

From these results it appears that the system is completely practical, though it is clear that the aerial is not one offering any gain in signal strength but merely allowing immediate operating on either of two bands.

It is apparent that if L1 or L2 is operated in the way described for Fig. 3 three-band working is possible. That is, coverage is given for 7Mc/s, 21Mc/s and one other band.

Bent Dipoles

Since the aerial has to be a half-wave this may require a clear span greater than available. This can often be overcome by using some other configuration for the dipole.

Tests show that the conventional arrangement of elements in line can be varied considerably without much loss of efficiency. A dipole with its two wires at about right angles has almost no directivity. Lengthy tests with such an aerial showed no obvious loss at all, compared with the straight dipole. The apex and feeder were supported at the house.

Experiments were made by letting several feet at one end of the horizontal wires drop vertically. This further reduces the space needed, and seems to have little effect on radiation.

It may also be possible to have one half of the aerial in a roof or attic space, with the other half suspended over a short garden. Sloping dipoles were also tried, the angle being from about 30° from vertical to 45°, so that 15m and 20m band aerials could run from a single pole down to an anchor point a few feet from the ground. These all gave good results.

Length Adjustment

When making tests with practical dipoles which were in part near earth or walls, etc., it became apparent that the theoretical length as calculated in the way described was not always best. As a result, it was found that some aerials would load the transmitter in a satisfactory manner near the low-frequency end of the band, but not near the HF end.

This is cured, if necessary, by pruning the outer ends of the aerial. With a 80m aerial, there will probably be no harm in cutting off 2ft. at each end to begin. But with the higher frequency bands, pruning should be correspondingly less, say about 2 per cent of the total, at a time.
FOUR circuits are described, starting with a simple design using the photocell in series with a relay and supply and concluding with a more advanced device using two cells and a transistor logic circuit.

There are several different types of device which are called collectively "photocells". This article is concerned only with one type: the photoconductive cell, which is compact, fairly cheap and suitable for most switching applications. The photoconductive cell is essentially a resistance which changes its value according to the intensity of the light falling on it. Cells are available which give a very large change of resistance with light intensity; a typical change might be from 10MΩ to 300Ω when the cell is exposed to bright, unfocused daylight after being in complete darkness. From this it can be seen that a simple switching circuit need be no more complicated than that shown in Fig. 1.

![Fig. 1: A simple switching circuit employing a photocell.](image)

With the values given the current in the relay when the cell is illuminated will be a little more than 10mA and this should be sufficient to operate many surplus relays.

The values are given simply as an example and are not critical. For instance, the supply voltage could easily be increased to 12V if required. The range over which the supply voltage and relay resistance can be changed is limited by three considerations:

1. The current required in the relay for it to operate. This is determined by the mechanical construction of the relay and will fix an upper limit to the relay resistance for any given supply voltage.

2. The maximum voltage which the cell can sustain across it. If the voltage across the cell exceeds a certain value it will "break down" and become permanently damaged. This maximum permissible voltage is usually about 100V or above.

3. The power dissipated in the cell. This is measured in the normal way by the product of the voltage dropped across the cell and the current flowing through it. Photoconductive cells are not usually capable of dissipating much power and this places an upper limit to supply voltages and a lower limit to relay resistance. The maximum power which a cell can dissipate varies according to the type. For the Mullard ORP12 (which is the cell for which Fig. 1 was designed) the value is 200mW. The circuit must be designed so that this value is not exceeded for any intensity of illumination. The cell is not necessarily dissipating the most power when it is fully illuminated and the current is at a maximum, nor when it is in the dark and the voltage across it is at a maximum. The most power is dissipated when the current flowing is half the value it would have if the cell were short-circuited and the relay placed straight across the supply.

Suppose a circuit is required to operate a 1,000Ω relay which needs 20mA to actuate it. Assuming a maximum cell resistance when illuminated of 200Ω then:

Supply voltage = 20 × (1,000 + 200) = 24V.
Dissipation in cell = 80mW at 20mA current and = 144mW at 12mA (with relay alone I = 24mA). Since these values are within the maximum ratings for the cell (ORP12) the circuit will be satisfactory.

The photoconductive cell is not sensitive to the polarity of any voltage across it. Consequently in the simple circuit of Fig. 1 it is not necessary to use a d.c. supply; a.c. is equally satisfactory. It should, however, be remembered that the values given for a.c. voltages are usually r.m.s.; it is important to consider whether the peak supply voltage (r.m.s. × √2) is going to cause the cell to exceed its maximum voltage rating.

If it is desired to make the sensitivity of the circuit adjustable a variable resistance can be put in series with the other components. As the relay is held on when the cell is illuminated it is best to use a relay with changeover contacts, so that the circuit is suitable for such applications as automatic garage door opening by the headlights as well as detecting intruders or counting people passing through doorways.
The circuit of Fig. 1, whilst it has the merit of being extremely simple and compact, nevertheless has some disadvantages. If the cell is used so that it is normally illuminated the relay will be held on all the time and battery drain will be high. Also the power limitations of the cell mean that relays requiring currents above 30mA or so cannot be used.

**CIRCUIT ONE**

Fig. 2 shows a circuit which overcomes these disadvantages and uses an OC83 transistor as a current switch operated by the cell. In this circuit the photocell forms part of a potential divider to which the base of the transistor is tapped. When the cell is illuminated the transistor will be cut off and the total battery drain will be substantially equal to the current flowing in the potential divider. This is less than 2mA and so photocells with a low power rating can be used provided they give a suitable change in resistance.

The magnitude of the collector current is determined by the supply voltage, the relay resistance, the current gain of the transistor ($\alpha$) and the base current. With the values given in the figure and assuming $\alpha=90$ we have:

$$I_C = \alpha \times I_B, \quad I_B = 1.5 \text{mA} \text{ approximately.}$$

$$\therefore \quad I_C = 90 \times 1.5 = 135 \text{mA.}$$

However, since the maximum voltage across the relay is 7.5V and it has a resistance of 60Ω the current is limited to $7.5/60 = 125 \text{mA}$. Any relay that will operate at this current or below will do and the coil resistance need not be exactly 60Ω. If a relay with a different coil resistance is used the 4.7kΩ resistor should be changed accordingly to give a suitable base current. The OC83 can carry a maximum collector current of 500mA but for power dissipation reasons it is necessary to limit the current to a maximum value of considerably less. Currents up to about 200mA should be O.K. The OA81 diode is placed across the relay to short-circuit any induced e.m.f. set up across the relay windings when the transistor switches off. If the diode were not present any induced e.m.f. due to the relay inductance would give rise to a large voltage across the transistor at a time when it is still conducting quite heavily. In other words, the transistor would be called upon to dissipate too much power.

**CIRCUIT TWO**

Fig. 3 shows a circuit with variable sensitivity using a 100Ω 20mA relay. The circuit can be adjusted to respond to any desired intensity of light above a certain minimum. It will work equally well with a bright focused beam and with the light from a 60mA pea bulb underrun at 40mA from a supply chopped at 10c/s. The circuit has been run under these latter conditions for five hours in daylight with the cell unshielded and placed a few centimetres from the flashing bulb. The relay oscillated in sympathy with the light for the whole period in spite of the changing ambient light level. Since the transistor was continually being switched on and off during this time this trial serves as a good test of power stability. The transistor did not heat up at all.

There is much scope for experiment in the circuits of Figs. 2 and 3. Almost any relay to hand may be tried (with due attention to the power handling capacity of the OC83) and the potential divider adjusted to suit any special requirement. Additional sensitivity to dim light may be achieved by connecting point A to a third supply line, positive with respect to the OV line. (+4±1.5V, OV and -7.5V supplies can readily be obtained from a 9V grid bias battery). Different types of screening, lattice windows and coloured filters can also be tried. Photoconductive cells will respond to most of the visible spectrum and...
Fig. 4: An arrangement for a device to determine the direction of a body passing two cells.

Fig. 5: A practical circuit for the arrangement of Fig. 4.

also to infra-red rays which cannot be seen by the human eye. This is useful for burglar alarms.

CIRCUIT THREE

Fig. 4 is a schematic diagram of a device which uses two parallel beams of light across an entrance with two cells and is capable of determining the direction in which any body interrupting the beams is going. Suppose something is travelling through the beams in the direction of the arrow and that we call the output of the cells "0" when they are illuminated and "1" when the beam is interrupted. The pulse generator in this circuit is a device that only emits a short output pulse when its input goes 1/0. The gate has output 0 only when both its inputs are 1. Fig. 5 is the practical circuit and 1 indicates a potential of OV and 0 a potential of -7.5V when related to this circuit.

Beam A will be blocked first and the output of cell A (Tr3) goes 0/1. The output of gate A is unchanged, since its other input (from P.G.B.) is at 0. The pulse generator A is unaffected since it does not respond to 0/1 voltage steps, but only to negative going steps (1/0). Then beam B is broken and cell B (Tr1) goes 0/1. Gate B is not affected since its other input (from P.G.A., Tr4) is still 0. P.G.B. is unaffected. A little later the body moves out of beam A and cell A (Tr3) goes 1/0. Gate A does not respond since its other input (from P.G.B.) is at 0. P.G.A. (Tr4) now produces a short pulse 0/1/0. Since beam B is still blocked, one i/p to gate B (Tr2) is already at 1 and the gate therefore gives a short output pulse 1/0/1 as P.G.A. goes 0/1/0. When the body moves out of beam B, P.G.B. gives a short pulse, but as cell A (Tr3) is at 0 gate A is unaffected.

As the circuit (Fig. 4) is symmetrical gate A will produce a pulse when something passes through the beams in the opposite direction. If a body only passes through one beam, or is too thin to interrupt both beams simultaneously, the device gives no output. This may be used to discriminate between persons and arms where it is necessary to prevent people from interfering with a counter by moving their arms through the beams or between pedestrians and vehicles. If it is required to detect objects moving in one direction only, half of the circuit can be removed (i.e. to detect objects moving in the direction of the arrow P.G.B. and gate A can be discarded). Fig. 5 gives the circuit of such a unidirectional device; for bidirectional detection Tr3 and Tr4 should be duplicated with associated components.

The width of the output pulse is determined by the time constant CR and will be less than 1mS with the values given. Such a short pulse cannot be detected on a meter and, unless the device is feeding into further electronic equipment, it is necessary to connect the output to some prolonging circuit such as a monostable. In the case of a unidirectional circuit and if the operation initiated

---continued on page 338---
THE design to be described is essentially a simple inexpensive fixed-tuned Light Programme receiver which is fitted into an extension speaker cabinet. By a system of simple switching either the programme on your main receiver, or on this receiver may be selected at the extension position. Construction is simple and there are no problems of alignment or stability: the less experienced constructor may therefore attempt it with confidence.

Circuit Description

Fig. 1 shows the circuit of the prototype. The ferrite rod aerial fitted with a long wave coil L, is fixed-tuned by C1 to 200kc/s. V1, an EF91 high gain r.f. pentode, is a most versatile and inexpensive valve. The arrangement of V1 is conventional, and the stage gain is high and selectivity ample for reception at 200kc/s.

Further r.f. amplification is provided by a second EF91, V2. It must be explained at this stage, that the prototype unit is in service in a locality where the Light Programme is not very well received. In many areas V2 and its associated components will not be required and the amplified signal from V1 may be passed through capacitor C4, direct to the diode detector D1. With only one r.f. stage, the decoupling components R2 and C2 can also be dispensed with. These modifications simplify the receiver considerably. As a guide, the single stage version worked very well in the North-west London area but V2 had to be added for satisfactory results in South-west England.

A GEX34, crystal diode, is used as a detector, and the rectified signal passes via the filter network C7, R8 and C8, and thence to the volume control VR1.

A.F. amplification and output are provided by an ECL82 triode-pentode. Bias for the triode section is obtained through the 10MΩ grid resistor R9, and the cathode can therefore be returned direct to chassis. R10 is the anode load resistor, and C10 couples the audio signal to the grid of the pentode section. R11 and C11 are audio decoupling components. The usual biasing components are included in the pentode cathode circuit, while in the anode circuit, a filter network, comprising R14 and C13 give tone correction. The optimum load for the ECL82 is 9,000Ω and the output transformer should therefore have ratio of about 55:1 for a 3Ω speaker or 25:1 if the speaker is of 15Ω impedance. There will be a voltage drop across the primary winding of the output transformer and resistor R13 ensures that the voltage at the screen grid shall not exceed that at the anode.

Power Supply

The total h.t. current requirement with two r.f. stages is 60mA at 230V, while the valve heaters need 2A at 6.3V. This is provided by a miniature

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Fig. 1: The Light Programme receiving circuit.
mains transformer and a 6X4 valve rectifier. Any other arrangement which provides these currents and voltages will be quite suitable, however, if half-wave rectification is used, it will be necessary to double the value of the reservoir capacitor C15. Smoothing is provided by resistor R16 and capacitor C14. Depending on whether there are one or two r.f. stages and upon the transformer-rectifier combination employed, the value of R16 may need alteration to bring the h.t. line voltage within the range 230—250V. A 6.3V 0.3A pilot light is fitted in any convenient position on the front of the speaker cabinet.

Connection to Main Receiver

Switches S1 a, b, c and d, are the poles of a 4-pole, 3-way switch. This is arranged so that, from a central OFF position, rotation in one direction connects the speaker to the main receiver and in the other, to the internal receiver, at the same time switching the power supply as necessary. Switch S1b introduces a dummy resistive load at the positions where the speaker is not connected to the main receiver, so that the loading of the main output stage will not be upset by operations at the extension. If the extension speaker is of 155Ω impedance, the value of R17 should be increased to

**Components List**

**Resistors:**

<table>
<thead>
<tr>
<th>Resistor</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>150Ω</td>
</tr>
<tr>
<td>R2 (marked 🆗)</td>
<td>1kΩ</td>
</tr>
<tr>
<td>R3 (marked 🆗)</td>
<td>47kΩ</td>
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<tr>
<td>R4 (marked 🆗)</td>
<td>1kΩ</td>
</tr>
<tr>
<td>R5 (marked 🆗)</td>
<td>47kΩ</td>
</tr>
<tr>
<td>R6 (marked 🆗)</td>
<td>150Ω</td>
</tr>
<tr>
<td>R7 (marked 🆗)</td>
<td>47kΩ</td>
</tr>
<tr>
<td>R8 (marked 🆗)</td>
<td>10MΩ</td>
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<tr>
<td>R9 (marked 🆗)</td>
<td>6800Ω</td>
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<tr>
<td>R10</td>
<td>220kΩ</td>
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<tr>
<td>R11</td>
<td>22kΩ</td>
</tr>
<tr>
<td>R12</td>
<td>470kΩ</td>
</tr>
<tr>
<td>R13</td>
<td>2.2kΩ</td>
</tr>
<tr>
<td>R14</td>
<td>4.7kΩ</td>
</tr>
<tr>
<td>R15</td>
<td>680Ω</td>
</tr>
<tr>
<td>R16</td>
<td>1kΩ</td>
</tr>
<tr>
<td>R17 (marked 🆗)</td>
<td>1kΩ</td>
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<tr>
<td>R18 (marked 🆗)</td>
<td>22kΩ</td>
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<tr>
<td>R19 (marked 🆗)</td>
<td>47kΩ</td>
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<td>R20 (marked 🆗)</td>
<td>4.7kΩ</td>
</tr>
<tr>
<td>R21 (marked 🆗)</td>
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<td>R22 (marked 🆗)</td>
<td>68kΩ</td>
</tr>
<tr>
<td>R23 (marked 🆗)</td>
<td>82kΩ</td>
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<tr>
<td>All 10% 1W carbon, unless otherwise stated</td>
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</table>

**Capacitors:**

<table>
<thead>
<tr>
<th>Capacitor</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1 (marked 🆗)</td>
<td>330pF silver mica 350V</td>
</tr>
<tr>
<td>C2</td>
<td>0.01µF paper 350V</td>
</tr>
<tr>
<td>C3 (marked 🆗)</td>
<td>0.01µF paper 350V</td>
</tr>
<tr>
<td>C4 (marked 🆗)</td>
<td>330pF silver mica or ceramic 350V</td>
</tr>
<tr>
<td>C5</td>
<td>0.01µF paper 350V</td>
</tr>
<tr>
<td>C6 (marked 🆗)</td>
<td>330pF ceramic 350V</td>
</tr>
<tr>
<td>C7</td>
<td>330pF ceramic 350V</td>
</tr>
<tr>
<td>C8 (marked 🆗)</td>
<td>330pF ceramic 350V</td>
</tr>
<tr>
<td>C9 (marked 🆗)</td>
<td>0.01µF paper 350V</td>
</tr>
<tr>
<td>C10</td>
<td>0.01µF ceramic 350V</td>
</tr>
<tr>
<td>C11</td>
<td>8µF electrolytic 350V</td>
</tr>
<tr>
<td>C12</td>
<td>25µF electrolytic 25V</td>
</tr>
<tr>
<td>C13 (marked 🆗)</td>
<td>0.01µF paper 350V</td>
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<tr>
<td>C14 (marked 🆗)</td>
<td>32µF electrolytic 350V</td>
</tr>
<tr>
<td>C15 (marked 🆗)</td>
<td>8µF electrolytic 350V</td>
</tr>
</tbody>
</table>

**Inductors:**

<table>
<thead>
<tr>
<th>Inductor</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1 (marked 🆗)</td>
<td>Dual-wave ferrite rod aerial (Denco FRA2)</td>
</tr>
<tr>
<td>RFC1 (marked 🆗)</td>
<td>R.F. choke (Denco RFC7A)</td>
</tr>
<tr>
<td>T1 (marked 🆗)</td>
<td>Output transformer. 55:1 ratio for 3Ω speaker; 25:1 ratio for 15Ω speaker</td>
</tr>
<tr>
<td>T2 (marked 🆗)</td>
<td>Mains transformer. Secondaries: 250-0-250V, 60mA; 6-3V, 2A</td>
</tr>
</tbody>
</table>

**Valves:**

<table>
<thead>
<tr>
<th>Valve</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>V1</td>
<td>EF91</td>
</tr>
<tr>
<td>V2</td>
<td>EF91</td>
</tr>
<tr>
<td>V3</td>
<td>ECL8</td>
</tr>
</tbody>
</table>

**Miscellaneous:**

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SI (marked 🆗)</td>
<td>4-pole, 3-way rotary switch</td>
</tr>
<tr>
<td>DI (marked 🆗)</td>
<td>GEX-34 or similar diode</td>
</tr>
<tr>
<td>LP1 (marked 🆗)</td>
<td>6-3V, 0.3A pilot lamp</td>
</tr>
</tbody>
</table>

Three B7G and one B9A valvholders. Lampholder. Tinned copper wire, sleeving, grommets, etc.

*These components are not required if there is to be only one r.f. stage.*
about 22Ω. The connection to the extension line is made by way of a non-reversible plug and socket as shown in Fig. 2, the "earthy" side of the line being taken to the larger of the plug pins.

**Construction**

This is not at all critical and the size and shape of the chassis can be varied to suit the cabinet into which it is to be fitted. For the prototype, an 8in. speaker in a cabinet 12 x 12in. offered a narrow space at the bottom and a chassis 10 x 3 x 14in. of 18swg. sheet aluminium was used. Because of the proximity of the aerial, V1 and V2 must be screened and RFC1 must also be enclosed in a screening can. A satisfactory mounting for the aerial can be made from sheet aluminium, cut to shape shown in Fig. 3 and bolted to the rear chassis runner. Fit rubber grommets into the two 5in. holes and pass the aerial rod through them as shown in the illustration.

Fig. 2: A suggested addition to the chassis for mounting the ferrite rod aerial.

Fig. 3 shows all the wiring and the approximate positions of the components on the chassis. Tinned copper wire of 22swg. covered with sleeving, is suitable for all the wiring. Work can proceed in any desired order, but it is convenient to deal with the power, output and a.f. stages first and to fit the aerial last, one lead from L1 being earthed at a convenient point above chassis. The ratings for resistors and capacitors are given in the components list. No special components are required but it is convenient to use a disc ceramic for C10.

**Testing and Alignment**

When all the wiring is complete, check with a meter between CI5 and chassis to see that there are no shorts in the h.t. circuits. Now connect the power supply and after allowing a minute or so for warming up, advance the volume control and slide L1 along the ferrite rod until the programme is heard. Accurate tuning is obtained by connecting a high resistance voltmeter, positive to chassis, across VR1 and adjusting the position of L1 carefully for maximum indication. Alternatively, the adjustment can be done by ear at very low volume. When the best position for L1 has been found, fix it in position with a little beeswax.
WONDERFUL RESPONSE

You will, I am sure, be pleased to know that my letter, printed in the May issue of Practical Wireless, has more than served its purpose.

I have received a complete set of transformers from a student in Bridlington and a set of slugs from a Londoner. I also received a rather bald request for “the h.f. coil” with no mention of slugs at all! Even then I would have replied, of course, if he had had the goodness to include a s.a.e.

Perhaps the most pleasant result of your publication was a brief note asking me if I was a person the writer knew years ago in... I am indeed, so you have found an old friend for me!

Again many thanks and my best wishes for the continued success of P.W.

G. H. Scholey, G3CDR
Dartford, Kent.

LIKE PRACTICAL TELEVISION

I am a keen reader of Practical Wireless and Practical Television. I think that they are both excellent magazines but I would like to see a Test Case relating to radio in Practical Wireless. I would also like to see a monthly section on Servicing Radio Receivers similar to Servicing Television Receivers in Practical Television.

Wm. G. Hall
Billingham, Co. Durham.

I would be interested to hear what other readers may have to say on the above subject.—Editor.

COMPETENT CONSTRUCTORS

With reference to Mr. R. A. Packer’s letter (News and Comment, May issue). In my view, a competent constructor is one who makes the best possible use of components he already has in stock. Or to put it another way, no sensible person would go and buy a new Mini if there was a perfectly good and reliable large car of somewhat older vintage already in the garage.

H. T. Kitchen
Nuneaton, Warwicks.

SEMICONDUCTOR SUPERMARKET

For the first time in the UK, semiconductor components will soon be available on a self-service basis in a number of centres throughout the country.

Pre-packaged components complete with technical data and information booklets will be displayed in selected retail shops where constructors will be able to help themselves to a range of solar cells, transistors, rectifier diodes, zener diodes, silicon controlled rectifiers, selenium photocells, etc.

The manufacturers of all the products are International Rectifier of Oxted, Surrey, and the first semi-conductor centre opened at Stern-Clyne Ltd. in Holloway Road, London, during May.

All these components have guaranteed performance figures and in the case of such items as transistors, hundreds of American and European equivalents are listed in accompanying literature.

HONG KONG IMPORTS BRITISH RESISTORS

A British electronics firm—Morganite Resistors—is exporting a quarter of a million resistors to Hong Kong every week. According to a recent announcement this is because Japan—a major component supplier to the Hong Kong radio industry—cannot make resistors of the same accuracy within the price range, with a tolerance of better than 10%.

The resistors are mainly used in low-cost transistor receivers.

MINIATURE 18W SOLDERING IRON

This new 18W miniature soldering iron—model “G”—_was announced recently by Antex Limited of Grosvenor House, Croydon.

As in all Antex irons, the heat-source of this model is placed inside the actual bit, which is split to prevent “freezing” to the iron. Extra heat storage capacity is achieved with this particular iron in the heavy shank of all the bits designed to fit it. In fact there is a range of four bits (from 3/8 in. to 2 in.) available for the model “G”.

Complete with bit the iron weighs between two and three ounces (according to the bit used) and costs 32s. 6d.

RADIO TELEPHONES FOR TANKER FLEET

The installation of a v.h.f. a.m./f.m. radiotelephone in the S.S. British Holly this year brings the number of Redifon v.h.f. equipments now in use aboard B.P.’s fleet of tankers up to one hundred. A similar installation was also made in the 100,000 ton British Admiral—the largest tanker ever built in Europe.

Redifon supply two types of v.h.f. radiotelephone—the GR.286 Mk.2 and the GR.289 Mk.2—for use in vessels of all classes. The GR.286 Mk.2 provides complete coverage of all allocated f.m. channels in the International Maritime band of 156–162Mc/s.

The GR.289 Mk.2 radiotelephone provides 11 f.m. channels and covers international distress and safety, inter-ship, port control and radar advice services while also providing public correspondence and private band ship-to-shore channels.
COMMENT

IMPROVED WIRE STRIPPERS

A wire stripper and cutter, more sophisticated than previous models, has been introduced by Multicore Solders Limited (Maylands Avenue, Hemel Hempstead, Herts.).

The tool is in the form of a pair of pliers and is shown in the photograph above. A rotating gauge on the side selects the depth to which the stripper blades cut for any Standard Wire Gauge between 12 and 26, while the blades will also be cut through any wire or flex if required. The price is £5.6d.

ELECTRICAL ENGINEERS EXHIBITION 1966

Over 30,000 sq. ft. of extra floor space will be available to exhibitors at next year’s Electrical Engineers Exhibition. Already the dates for the Exhibition, to be held once again at Earls Court, London, have been fixed as 23rd to 30th March. Increased overseas participation is expected at the larger show.

RADIO/TV LICENCES TOP 13½ MILLION

The total number of combined sound and television receiving licences in the UK now stands at over 13½ million. The actual figures for April just issued, show an increase during the month of 42,722 to 13,295,767.

The number of sound only licences continues to decrease, the April total being 2,788,405, including 630,191 for sets in cars.

TELEGRAMS VIA EARLY BIRD

During June American telegraph companies and selected customers in Great Britain exchanged pictures and data, telex calls and public telegraph messages via the Early Bird satellite. (Before this Early Bird had been used to relay trans-Atlantic television exchanges.

The telegraph messages transmitted, were ones selected at random from normal “traffic”, and were transmitted both by trans-Atlantic cable and by the satellite. Recipients of these received two copies of the telegrams, one clearly marked “Via Early Bird”.

BECAUSE OF THE LARGE NUMBER OF OUTSTANDING “SELL OR LOAN” REQUESTS NOW HELD BY US, WE REGRET THAT FOR THE NEXT FEW MONTHS WE WILL NOT BE ABLE TO ACCEPT ANY LETTERS ON THIS COLUMN.

Sir, I would be grateful if any reader could sell or loan me . . .

- circuit diagram and/or any information regarding the Holland-made radio Type KYS84E “INR 3731” I do not know the brand but there is a symbol showing an orchestra conductor on the cabinet. As soon as I have time, I’ll get a look at it. - G. Braddock, 36 Yard’s Road, Cleethorpes, Lincs.

- modification details (2m) for 19 “L” set. - H. Dresner, Paul’s Hill, Leigh, Nr. Tonbridge, Kent


- a circuit diagram and/or information about the valves used in the “Packard” A00914 four valve superhet m.r. receiver. - E. Jones, 13 Cunie Way, Meadowbridge, Cape, South Africa.

- information on the connections to, or any other data on, the c.r.t. type CV1526. - A. F. Young, 26 Church Road, Kearsley, Bolton, Lancashire.

- the details for a s.s.b. adaptor and a circuit diagram and data of a 60W v.d.o. type transmitter and modulator.

- also, could the reader who very kindly lent me the manual for 3X26 please let me have his address? - S. L. Anand, 107 T.I. Quarters, Kalianpour, Kanpur U.P.


- any information on the crystal controlled oscillator section of the Elco v.h.f. receiver unit AP61357—6124, No. 1597, including the type and frequency of crystal required. - F. Neeson, 34 Bangor Road, Hoywood, Co. Down, N. Ireland.

- circuit diagram and information re Hallicrafters Communications Receiver model 540, frequency range 550kc to 44Mc. - Ainal Ratanagye, Royal Ceylon Air Force, China Bay, Ceylon.

- any information at all on unit R-3/ARR-2X and/or indicator unit type Z6. - D. Bartle, Runnymede. 35 Oaklands Avenue, West Hartlepool


- the handbook for the R220. - J. Freer, 83 West End, Kirkbymoor, York. U. K. - the handbook for the Glove Scout model 65, by World Radio. Also information as to where a stockist for this company exists in Britain. - Denis McCann, 96 Chelmsford, Cowie, Stirlingshire, Scotland.


- the circuit and servicing manual of the Walter Metropolitan tape recorder. - 13 Grange Avenue, Leicester Forest East, Leicester.

- any information on the army set No. 19. - B. Kitcher, 11 Scarborough Road, Blackburn, Lancashire.
10. CRYSTAL OSCILLATORS; FREQUENCY MULTIPLIERS; POWER AMPLIFIERS; TRANSMITTER KEYING; AMPLITUDE MODULATING A TRANSMITTER

10.1 R.F. Oscillator Stability

VARIOUS oscillator circuits were dealt with in a previous article (R.A.E., May, 1965, P.W.) and in each case the frequency of oscillation was determined by an inductance/capacitance combination forming a tuned circuit. (Types of oscillators mentioned included the Tuned Anode-tuned Grid (T.A.T.G.), Colpitts and Hartley.)

In any of these circuits a change in the value of any component in the tuned circuit will result in a change in frequency of the oscillator. For example, if the oscillator valve generates sufficient heat to slightly alter the size of the inductance a gradual frequency drift will occur. Changes in voltages applied to the valve electrodes may also cause frequency changes as different voltages will cause different amounts of heat to be generated. Mechanical vibrations in an oscillator may also cause frequency changes—and can even modulate the oscillator frequency.

An extremely stable oscillator can, however, be constructed which does not use the familiar inductance/capacitance in the grid circuit but instead uses a quartz crystal.

10.2 Crystal Controlled Oscillators

The frequency of an oscillator can be maintained at a constant level by using a quartz crystal as the tuned circuit. The crystal is resonant at a particular fixed frequency and this is determined almost completely by the dimensions of the crystal. In fact the thickness of the crystal is the main controlling factor. In order to make a quartz crystal oscillate, however, feedback from the anode to the grid must be facilitated in much the same way as in other types of oscillator mentioned.

When a crystal oscillator is operating, a small current passes through the crystal, this being determined primarily by the amount of feedback applied. If this current becomes too large, heating of the crystal will occur and slight frequency changes will result. It is important to use as low a crystal current as possible—consistent with easily maintained oscillation.

It can be seen that the power output of a crystal controlled oscillator should preferably be kept low and in this respect it is inferior to the inductance/capacitance controlled oscillator.

10.3 Typical Crystal Controlled Oscillator Circuits

In Fig. 88 is shown a very simple crystal controlled oscillator circuit—this is, in fact, a Pierce oscillator.

In Fig. 88 the amount of feedback is controlled by the ratio of the values of C1 and C2. If the circuit is studied carefully it can be seen that C1 is in parallel with the anode/cathode interelectrode capacitance of the valve and that C2 is in parallel with the grid/cathode interelectrode capacitance of the valve. In order to obtain feedback the interelectrode capacitances of the valve are effectively increased. R is a grid leak and may have a value of 20-100,000Ω. R.F.C. is a radio frequency choke and this prevents r.f. power from the oscillator being dissipated in the power supply or from being passed to another circuit through the power supply circuits.

Shown in Fig. 89 is an oscillator circuit which is basically the same as the tuned anode-tuned grid oscillator dealt with previously. In this case the inductance/capacitance in the grid circuit has simply been replaced by a quartz crystal.

Fig. 89: A grid plate crystal controlled oscillator.

10.4 Frequency Multiplier Circuits

Up to quite recently crystals were only reliable up to a frequency of about 20-30 Mc/s, crystals for higher frequencies being very thin and able to operate at very low powers only. Therefore it was found to be comparatively easy to multiply the frequency of operation of a crystal. Frequency
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multipliers are also of use to enable a single crystal of, say, 3-5Mc/s to be used to obtain output frequencies of 3-5, 7 and 14Mc/s, etc.

In a simple form a frequency multiplier could be as represented in Fig. 90. The tuned circuit in the grid of the valve is resonant at the same frequency as the crystal oscillator and the tuned circuit in the anode may be resonant at two, three, four or five times this frequency. The power output from a frequency multiplier can never be as great as when the stage is used as a straight amplifier. Consequently the greater the number of times the frequency is multiplied the less the power output from the multiplier. Bearing this in mind it is not general to use frequency multipliers which multiply the frequency more than five times.

A simpler frequency multiplier does not use a tuned circuit in the grid but is connected directly to the oscillator anode. This circuit is shown in Fig. 91.

Fig. 90: A frequency multiplier circuit.

10.5 R.F. Power Amplifier Circuits

In order to radiate considerable power from a transmitter the signal generated by the oscillator has to be amplified to a very great extent. The function of a power amplifier is, as mentioned, to generate high r.f. powers, but it must also be efficient in respect that harmonic radiation is low. In order to minimise harmonic radiation the Q of the tuned circuits used in a Power Amplifier (p.a.) is made very high.

A simple p.a. is shown in Fig. 92 and L2 may be connected to the aerial or to the next amplifier stage. The load resistance at which the valve operates must be matched to the transmission cable which carries the power to the aerial. For example, the transmission line or feeder may be of, say, 3000 impedance and, as the p.a. load resistance is usually much higher, L1—L2 constitute a step-down matching transformer.

Fig. 92: The circuit of a simple r.f. power amplifier.

In Fig. 92 the r.f.c. is to prevent the power from the driver stage being dissipated in the low impedance bias supply. R.F. power amplifiers are generally operated under Class C or AB conditions. Output circuits will be dealt with further when aerials are discussed.

10.6 Keying a Transmitter

In order to radiate carrier wave (c.w.) signals, using the Morse Code, the output of the transmitter must be reduced to zero after each "dot" and "dash". This is simply a way of saying that in fact the transmitter must be switched on and off in order to radiate the desired signal. This is usually accomplished by using a key. In the interests of safety it is desirable to key the transmitter at a point where high voltages are not present. The key is often placed in the cathode circuit of a crystal controlled oscillator or in the cathode circuit of a buffer amplifier (a buffer amplifier is an amplifier which is used to isolate an oscillator from any higher power amplifier which may follow and it usually operates at the same frequency as the oscillator). In a v.f.o. (variable frequency oscillator) it would be
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preferable to key the buffer amplifier rather than the oscillator in order to ensure that the signal does not become "chirpy". A chirpy note results when the keying of the transmitter either directly or indirectly alters the frequency of the oscillator.

When the transmitter key is closed a spark may result; this will generate an r.f. signal but this will only be heard in the immediate vicinity of the transmitter.

When key clicks can be detected on a receiver many miles away they are formed in a different way. When the transmitter is keyed and the carrier wave is interrupted almost instantaneously a key click will result. In order to eliminate the key click the components in the keying circuit must be arranged so that the carrier wave is not interrupted instantaneously but fairly gradually. (The time taken for the signal to reach its peak value is, of course, only measurable in microseconds—μs.)

A simple keying circuit which could be used in the cathode circuit of a buffer amplifier is shown in Fig. 93. The radio frequency choke and the capacitor act as a filter to eliminate r.f. clicks.

10.6 Amplitude Modulating Transmitter

Modulation is the superimposing of one type of signal on another, in fact in the cases to be discussed it is the superimposing of an a.f. signal on an r.f. signal. If a carrier modulation is used in a circuit the modulated wave will be of the type shown in Fig. 93. The line AB on Fig. 95 represents the mean value of the modulating signal and the ratio of x to y enables the percentage modulation to be calculated, i.e. percentage modulation

\[
x = \frac{x}{y} \times 100\%
\]

Obviously if x equals y the modulation must be 100%. A carrier modulated to 100% is shown in Fig. 96.

If modulation exceeds 100%, distortion will occur as the signal envelope is no longer the same shape as the modulating signal.

When a carrier is modulated the signal which is transmitted does in fact consist of three components, a carrier, an upper sideband and a lower sideband. If a carrier of 100kc/s is modulated by an a.f. signal of 10kc/s the transmitted signal would consist of three components—100kc/s (the carrier), 100kc/s±10kc/s (the upper sideband) and 100kc/s−10kc/ (the lower sideband). The modulating signal is carried by the sidebands.

10.7 Anode Modulating a Transmitter

A very common method of amplitude modulating a transmitter is anode modulation. The output from an audio amplifier (class A or B and generally push-pull) is passed, via a modulation transformer, to the anode voltage supply of the r.f. power amplifier valve. The modulation of the r.f. amplifier will be 100% when the output of the audio amplifier is such that the voltage appearing at the r.f. amplifier anode varies between 0 and 200% of its d.c. operating voltage.

In order to obtain 100% modulation the same wave audio power output from the modulator
must be at least half of the d.c. power input to the r.f. amplifier.

Readers are advised to study also control grid modulation, screen grid modulation and cathode modulation.

SOLAR-POWERED POCKET RECEIVER

—continued from page 302

compromise between the signal direction and the light direction has to be made.

The total cost of the final receiver was about £3, but this may be reduced considerably by using an International Rectifier B2M solar cell, price 15s.

The effect of adding a second transistor was negligible but further experiments may prove fruitful. The final circuit appears so simple that to many it would appear inconceivable that it works, yet it does. Surely in this circuit the transistor is operating to its capabilities (as they should in all circuits). The field of light operated transistor circuits appears to be almost untouched by experimenters, both amateur and professional (what about Sinclair Radionics Ltd. and others?). The writer would be very interested in receiving details of similar experiments carried out by readers.

PHOTOCELL CIRCUITS

—continued from page 326

by the device has a definite ending (e.g. garage door opening, gate opening, etc.) the output from the gate can be made to set a bistable which controls the opening motor. A limit switch can then be used to reset the bistable when the doors have opened.

No particular transistor is specified for the bulk of the circuit as almost any type will do except surface barrier types.

Fig. 6 shows a suitable relay drive circuit which may be tacked on to any bistable or monostable designed for these supply voltages and with a collector resistance of around 1.5kΩ.

For simple on/off applications the photocell should be mounted in a lightproof box painted matt black inside. A simple lens system using two converging lenses with the cell and lamp filament at the focus will do. The cell lens should be shielded by a tube painted matt black inside.

That light can only enter from sources along the axis of the tube.

The constructor who has some old glass encapsulated transistors which are lightproofed with black paint might like to try making his own photocell by scraping off the paint. The paint can easily be scraped off with a penknife and should be removed from the rounded top end and for about 2mm down the side. The capsule will be filled with blue, white, greyish or transparent grease. Obviously the transparent grease types are best and the blue and white types are no good at all; it is best to repaint them for future use. The scraped transistor will function as a photoconductive cell (emitter +ve) with the base open circuit, but for best results try a resistance between base and emitter. The value will be between 5 and 100kΩ and can be found experimentally. Photocells made in this way will not be as sensitive as proper ones but can be made to work perfectly well by the use of a suitable transistor-amplifier stage.

Fig. 98: A typical superhet circuit which would fulfil the requirements of last month's question. It should be remembered however that there could be many variations to this circuit and therefore many correct solutions.

Question.—Draw diagrams of the type shown in Figs. 95, 96 and 97 to show a carrier wave modulated to—

(a) 50%—let x be denoted by 50.
(b) 75%—
(c) 150%—

Last Month's Question.—A typical answer to this question is as shown in Fig. 98.

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P.W.8
The Radio and Electronic Component Show was held at Olympia from May 18th to 21st.

The old joke about disposable sets—you know, throw it away when the battery runs out—is coming uncomfortably close to reality.

Of the 300 firms exhibiting, more than twenty were making a thing of micro-miniaturisation. Despite the off-hand attitude of one demonstrator: “Needn’t bother us, old boy. Thing of the future, what?” I was impressed by the strides recently made by some of the firms we have always regarded as stick-in-the-mud reactionaries. Tiny switches, banks of printed-foil circuits, combination components, and everywhere that word Integration. If a circuit is not integrated nowadays, nobody wants to know.

The ultimate seems to be achieved when our old friends Mullard come up with a threestage amplifier about the size of a soldering joint. As one critic said: “What’s the point if the piece of equipment is smaller than the knob which is being used to control it?”

Whatever the PRO boys may tell you, quoting reliability, efficiency, weight-cost factor, serviceability, etc., it boils down to one essential: is the tiny fellow going to be cheaper to produce in quantity than the hand-assembled juggernaut it transplaces? And the answer appears to be Yes. Modern methods have found ways of whistling down capacitors and reducing resistors to strips of etching.

So far, the problem of reducing inductors physically has proved difficult, but the bright lads at Manchester University have been playing about with that one. They have already used computer control on a thin film micro-circuit to prove what can be packed into its 1 square millimetre area and come up with the amazing answer of 100 passive elements. That is equivalent, to save you reaching for the slide rule, to 70,000 per square inch. So, in the space taken up by that coil you can make up practically any R-C combination you wish to supersede it.

Certainly, the modules shown by Erie had quite a few identifiable bits packed into them, and the sub-miniature switches by Elcom and Arrow made one want to hide one’s clumsy fingers.

Who makes these things? we wanted to know. How the dicekens are they assembled? And the answer, as we might have expected, is that magic word “automation”. Cassandra Henry has already commented on the machine that is more reliable than the circuit designer. Here, at Olympia, we saw machines ten times more reliable at fault tracing than any engineer.

Elliott-Automation had an automatic circuit tester that monitors up to 1,000 contact points for continuity and insulation at a rate of ten tests a second. Faster than our apprentice as clocking-off time approaches.

More threatening still, from Solartron we hear of a machine which is programmed to allow the operator to carry out a sequence of tests, or make connections. But if he makes a wrong connection in the sequence, the machine prevents him from making the next move. I was afraid to ask how!

Flexible printed circuits—no, not those from certain portable radios which the makers really intended to be rigid—but genuinely flappable boards, copper-clad laminate that could be bent and shaped without cracks in the foil appearing. That’s another thing on the way—as Formica and Electroprints Ltd. showed us. This seems to promise much fun in the workshop.

Yet another aspect of the modern trend is the increasing use of “precious metals”. There are firms specialising in the plating of switch contacts with not only silver and platinum, but gold, rhodium and palladium.

With memories of the old days, when circuits were laboriously screwed together by hand, when scraping off a resistor was the accepted method of modification, when the nearest approach to integration were those horrible “blocks” of components covered with shiny black pitch, Henry is not at all sure whether he will be able to bring himself to throw away his radio each time the sun goes in and his solar cell runs down.
A DIRECTION FINDER for Small Craft
by F. C. Judd

PART TWO

FULL conctsrional details of this receiver were given in Part 1, together with calibration procedure and notes on the Radio Information Charts which are essential when using the long wave marine radiobeacons. This part deals with a suitable mounting for the receiver and gives further notes on calibration and testing, etc.

Receiver Mounting

The receiver is much easier to handle if it can be rotated through 360° by mounting it on a heavy base as shown in Fig. 8. The base could be made of wood, preferably loaded with brass or lead or, better still, made entirely of brass. A cast-iron base could also be used, in fact the one shown in the photograph in Part 1 is cast-iron. In this case, however, careful checks must be carried out to ensure that it does not interfere with the compass. A 360° protractor, obtainable from most large stationers, should be screwed to the top of the base, for this is most useful when working against the heading of a vessel or when there is no alteration in position, i.e. when the vessel is at anchor. A small pointer is attached to the bottom of the receiver case for use with the bearing scale.

The receiver could, of course, be permanently mounted in a vessel providing it (the receiver) can be rotated through 360°. In this case a compass need not be fixed to the receiver but the bearing scale would have to be used in conjunction with the compass on the vessel.

Calibration of the Tuning Dials

The tuning dials, which are small Data Panel Signs (100° type), require pointers which can be attached to the flanges of the Jackson epicyclic ball drives. These pointers can be cut from thin perspex or stout celluloid and shaped and drilled as in Fig. 9. The tuning control knobs can be left to the discretion of the constructor.

The actual calibration of the tuning dials has already been dealt with but as a further guide the diagram in Fig. 10 may prove useful. It is, however, very important that the exact tuning point of each radiobeacon group frequency is known. As it is difficult to mark the actual spot frequencies on the r.f./oscillator dial it is suggested that a separate calibration chart is compiled, this being mounted on stiff card and protected by a celluloid cover.

Fig. 9: Two of these perspex tuning dial pointers are required.

Testing the Receiver

Preliminary tests and approximate tuning, etc., can be carried out with a long aerial loosely coupled to the ferrite aerial coil via a small series capacitor. This will allow the radiobeacons to come in quite strongly, but as soon as initial alignment has been completed, close calibration, etc., should be carried out with the band switch in position 3 (d.f.) and any other aerial disconnected. Remember, you may not hear a particular radiobeacon if the ferrite aerial happens to be end on (in the null position) to that particular station. When listening for different stations in different
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groups, etc. It is essential to work with the Radio Information Charts, a compass and a protractor, so that whilst calibration is being carried out, maximum signals can be maintained with the ferrite aerial broadside to the station.

Use of the telescopic aerial will alter the tuning of the ferrite aerial slightly, but remember, this aerial is only an aid to finding weaker signals and must not be used when direction finding.

The final calibration of the aerials or the making of a calibration chart requires infinite patience, since it may be necessary to wait for each particular group to operate. It is, of course, only necessary to identify one station in a group working on a particular frequency and it does not follow that all the stations in a group will be heard. These stations use quite low power (10 to 20W) and a good deal depends on propagation conditions as to whether they will be received inland.

D.F. and Compass Checks

On no account should d.f. checks be carried out at night as errors may occur through so-called "night conditions" which cause the signals to arrive by different paths. When, and only when, you are satisfied with the calibration, d.f. and compass checks should the receiver be used under working conditions. On no account should one blindly rely on a radiobeacon d.f. receiver whether made commercially or home constructed. Radio direction finding is a navigation aid, not a method of navigation. Like other navigation aids, a d.f. receiver is used mainly to confirm position as otherwise plotted by compass and charts.

It is interesting to note that whilst we were carrying out d.f. checks with the d.f. receiver in the North Sea and in thick fog at that (see last month's cover), two other small cruisers hailed us to enquire as to where they were. They also requested direction to a particular position on the mainland. This information, confirmed also by our own d.f. fixes, depth finder readings and compass and chart navigation, we were able to give. To our great surprise, however, both cruiser skippers then admitted that neither had even a compass! We pointed into the fog and they went thataway!

The Radio Information Charts

Details of these charts were given earlier, and it must be emphasised that they are not suitable for navigation of any kind. The charts merely show the positions of the radiobeacons on a large scale. The exact position in latitude and longitude of all the radiobeacons is, however, given in the table printed on the charts. These should be used in conjunction with standard navigation charts. The Radio Information charts also give precise details of frequencies, groups and sequences as well as radiotelephone, British Coastal radio stations and Aircraft beacons. The latter can be received with the d.f. receiver but should be used with caution as most of them are inland which may result in serious bearing errors.

Finally, when using a d.f. receiver, it is necessary to be aware of the various reasons for bearing errors. These can be due to (a) night effects when signals arrive at the receiving aerial by two different propagation paths, (b) reflection from high land such as cliff faces, (c) reflection from other aerials or stay wires or even from metal structures on the vessel.

Errors in plotting can also occur, especially when converting magnetic to true bearing or vice versa and in taking into account the heading of the vessel which is usually from magnetic compass. Remember the d.f. aerial will indicate a true bearing and the difference between this and a magnetic compass reading is approximately seven degrees. Up to date navigation charts will show the exact deviation.

Radio on Yachts and Cruisers

The ordinary broadcast receiving licence authorises the reception of programmes sent only from authorised broadcasting stations for general reception. It does not permit the reception of messages from coast stations, ship stations, special service stations and radio navigation stations. If reception of messages etc., from these stations is desired (this includes marine radiobeacons) a special "ship" receiving licence is required. This does, however, cover broadcast station reception as well and can be obtained from the Radio Services Department, W.T.S., G.P.O., London, E.C.1. The licence costs £1 per year.
BOOKS REVIEWED


If you were asked to find the circuits of a 35Mc/s transistor transmitter, a Q-multiplier, a cathode modulator and an electronic T/R switch, it is highly probable that you would have to search through a number of books, and sort issues of magazines in order to find them.

Amateur Radio Circuits Book is a collection of some 150 circuits liable to prove useful to the average ham. Transmitters, front ends, oscillators, power supplies, noise limiters, and a host of other items. There are circuit diagrams only, for the person who needs just this and values.

At first sight this appears most excellent book, but a second more detailed reading brings disappointments. For although the drawings score full marks many details are omitted.

The first page depicts an A.T.U. We are shown how the coils are mounted, informed that the diameter should be 2½ and 3 inches and that 14s.w.g. is suitable. But not told how many turns, or even the inductance.

It is this lack of odd bits of information which spoils the ship. A 15W transistor transmitter has all the information except the transistor types. A d.c. amplifier has no transistor type or voltages specified for the two batteries. And so on.

The idea of having all those useful circuits together in one volume is excellent, but it is to be hoped that when second edition time comes around the editor will have filled in the few remaining details.—F.H.S.


Many books have been written about the uses and applications of the oscilloscope. It is a great pity that these are studied only by the committed reader, the experimenter, would-be constructor, student, etc. The man with his cobwebbed ‘scope, past its first intriguing fascination, hidden in a corner of his den, seldom finds the book to suit him. And the technician who brings his workshop instrument into occasional use often has no idea of its potentialities.

This book does much to remedy the defect. It first appeared in February, 1963, and has already in March, 1964, come out with a healthy reprint. Its virtue is the method of presentation, rather like an amplified operating manual. As such it should appeal both to the inquiring experimenter and the man at the service bench.

The first four chapters are descriptive. Chapter 1 discusses waveforms, laying the ground for later works. Chapters 2 and 3 cover the theory of the cathode ray tube and the principle of sweep systems. In Chapter 4 a more practical approach is introduced. Detailed descriptions of both general purpose and laboratory type oscilloscopes are given with 21 diagrams of the vital portions of circuitry.

From this point we enter the field of application. Chapter 5 is a long one, dealing with alignment. Although it is obvious that precise instructions cannot be given because of variations of circuit design a valiant attempt has been made to cover the many possibilities. Chapter 6, on Oscilloscope Techniques, underlines this practice and could profitably have been juxtaposed. There is much useful information in these 24 pages.

More applications are to be found in the next chapter, dealing with tests and measurements. Audio experimenters and students of electronics would find several points of interest; the “hook-up” details, so often ignored in more technical works, are meticulously outlined. Values of network components, too, are not ignored.

In the final chapter this is carried a step farther by what will be instruction in 16 useful experiments. The man who has ever had the “hook-up” diagram continued in this chapter but by the time this stage is reached the student should be able to cope.

Both as general reading and as a bench-side reference this book is to be recommended.—H.W.H.
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To fulfil these conditions the Moullin or anode-bend circuit was chosen. In this simple, well-known circuit a triode is biassed almost to cut-off, and if the $V_g-I_a$ characteristic of the valve is non-linear in this region, partial rectification takes place as shown in Fig. 1.

In particular, if the characteristic can be represented by the relation $I_a = aV_g^2 + bV_g + c$, where $a$, $b$, $c$ are constant for a particular value of the anode potential, then analysis shows that when the input e.m.f. to the grid is of the form $v = V_{pk} \sin \omega t$, the mean value of the increase in anode current is $\frac{a}{2} V_{pk}^2$, where $V_{pk}$ is the peak e.m.f. Hence a square-law scale can be produced. This means that true r.m.s. values can be read, independent of the input waveform.

CHOOSING A VALVE

The following valves were measured (all pentodes and tetrodes being connected as triodes) to determine the form of the $V_g-I_a$ curve when using 9 volts anode potential. IT4, EF91, 12AT7, 354, CK503AX. The 354 and CK503AX gave the most promising results when plotting $\frac{dI_a}{dV_g}$ against $V_g$, which should be a straight line if the $V_g-I_a$ curve is of the required form. The CK503AX is a miniature wire-ended output tetrode. It was decided to use the 354 (a battery powered output tetrode) since it is more readily obtainable. The 354 filament is tapped and, except where stated, half the filament is unused, the valve taking 50mA at 1-4V.

WORKING POINTS

The basic circuit, shown in Fig. 2, is self-explanatory. The potentiometer across the filament ensures that $V_b$ is the true bias on the grid.

It was stated above that the change of anode current, which will be called $\Delta I_a$, was equal to $-V_{pk}^2$, assuming parabolic $V_g-I_a$ characteristics.

In practice there is a best value of $V_b$ for a maximum $\Delta I_a$ as the graph of Fig. 3 shows. It was drawn using...
Fig. 3: Illustrating variation of sensitivity and linearity with bias (Vb).

**Fig. 4 (right):** The complete circuit. Backing-off current is taken from the heater supply cell.

The circuit of Fig. 2 with Vb variable and a source frequency of 50 c/s.

It can be seen from Fig. 3 that although the square-law is true approximately for a range of Vb, it is best when Vb = 1.5V or greater, but the sensitivity falls as Vb increases. A bias of −1.5V is a good compromise between sensitivity and linearity and is also the e.m.f. of a single dry cell. A mercury cell could be used with a little loss of linearity and negligible current is drawn.

It was found that if all the filament of the 3S4 was used i.e. 0.1A at 1.4V, then ΔIa for any given Vb was approximately doubled, but a greater non-square linearity was also incurred. Since the use of dry cells was contemplated the 50mA consumption will be used henceforth.

The complete circuit is shown in Fig. 4. The meter movement is backed off with an equal and opposite current to the standing anode current with no signal which was approximately 80μA.

The values of the resistors and capacitors are not at all critical. The following are the components used in the original:

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TAYLOR Model 197A £23. 10. 0 £44. 14. 6 12 of £18. 6. 6 £218. 0. 0

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August, 1965

200
100
0
Input resistance (MΩ)

0-71 Peak
0-5 RMS
14
10
2-2
1-5
Input EMF at 50c/s

Input impedance at 50c/s

Fig. 6 (left): Illustrating the variation of input resistance with input e.m.f.

Fig. 7: The input capacitance (dotted) in parallel with the potential divider arm.

R1 500 Ω wire-wound
R2 71 Ω wire-wound with filament on/off switch.
R3 100k Ω carbon
C1 0-1μF paper
C2 0-001μF ceramic
Meter 0-75μA, 715 Ω movement.
If a multi-range instrument is used for the detector it should be of roughly constant input resistance from one range to the next or the sensitivity, i.e. the slope of the Vpk² – ΔIab graph will vary.

SQUARE-LAW LINEARITY

The degree of square-law linearity and the effect of bias upon it is shown in Fig. 3. The effect of driving the grid positive is shown in Fig. 5. The grid is made positive when the peak input signal exceeds the standing bias. When the grid is positive, grid current flows, which is equivalent to saying that not all the electrons from the cathode reach the anode. Hence a lowering of anode current change and sensitivity as Fig. 5 shows. The over-all increase in anode current can be explained by the positive grid now attracting more electrons from the cathode than were formerly emitted. It can be seen that the square-law is not quite true for large input e.m.f. even when the grid is negative.

INPUT IMPEDANCE

If the input of the voltmeter can be assumed to consist of an input resistance R in parallel with an input capacitance C then simple measurements can be made, to arrive at an estimate of R if C is known (or vice-versa). If ΔIab is the current change when the voltmeter is fed from a low impedance source, and ΔIac is the reading when the voltmeter grid is connected to the same source by a high resistance R1 ohms, then it can be shown that:

\[ R = \frac{R_1}{\sqrt{(n-1)^2 + n^2R_1^2C^2}} \]

where R and C are defined above, ω is the angular source frequency and \( n^2 = \frac{ΔI_{ac}}{ΔI_{ab}} \).

C includes the capacitance of the wiring in the grid circuit and between the grid and other electrodes. An average value is about 15pF. A graph of input resistance R with input e.m.f. is shown in Fig. 6, in which C=15pF is assumed. The decrease of input resistance is due to the increasing number of electrons reaching the grid as it becomes more positive. The input resistance is however still greater than 30M Ω when the grid is being driven positive during part of the input cycle.

CALIBRATION

It should be stressed that permanent calibration of the instrument is not readily obtainable without voltage stabilisation of the supply power. The square law however is valid over a fairly wide range of battery ageing and for many purposes only the ratio of two e.m.f.'s need be known.

FREQUENCY RANGE

The original instrument was used at all frequencies between 25c/s and 25Mc/s; beyond these limits it was not tested. The Moulin instrument of the 'twenties was stated to be useful up to about 30Mc/s.

—continued on page 354
BRADFORD RADIO SOCIETY
Hon. Sec.: J. J. Hunt, G3SAO, 77 Brantwood Road, Bradford 9, Yorkshire.
Meetings are now held in the Bradford Technical College, and the call sign G3BNH has been issued for the Club station, G3OTO.

There was an "inquest" on the N.F.D. on 22nd June.

COVENTRY AMATEUR RADIO SOCIETY
Hon. Sec.: A. A. Wilkes, G3PPQ, 141 Overslade Crescent, Coundon, Coventry.
The Society will be taking part in the N.F.D. event again after an interval of many years.

DERBY AND DISTRICT AMATEUR RADIO SOCIETY
Hon. Sec.: F. C. Ward, G2CVV, 5 Uplands Avenue, Littleover, Derby.

Raymond F. Street gave a lecture entitled "Introductory to Colour Television" on 23rd June, and on the 30th G. D. Kelsey, B.Sc., discussed the problems of Efficient and its Treatment.

On 13th—14th July, the "Breakfast and Pong" weekend event was held, and on 17th July there will be a Garden Party and Exhibition at Heanor Aldecar Secondary School.

HALIFAX AND DISTRICT AMATEUR RADIO SOCIETY
Hon. Sec.: J. Ingham, G3RMQ, Lambert House, Greetland, Halifax, Yorkshire.
On 27th July, G. Drake, G3SIG, will talk on Transmitters, and on 24th August, there will be a lecture by F. Nicholls, G3MAX and a visit from the Huddersfield Radio Society.

HUDDERSFIELD AMATEUR RADIO SOCIETY
Hon. Sec.: R. Highton, 5 Brian Avenue, Dalton, Huddersfield, Yorkshire.
Recently the Society held a lecture and demonstration on Oscilloscopes. The Society operating QTH has proved very good with Q DX in mind, using a 250ft. dipole.

MID-WARWICKSHIRE AMATEUR RADIO SOCIETY
Hon. Sec.: H. C. Loxley, 5 Guy Street, Warwick.
There will be an open meeting on 12th July, when members will be able to discuss a range of subjects.

Meetings are now held on the top floor of 7 Regent Grove, Leamington Spa. These premises are well situated in the centre of the town, close to main bus routes and with ample car-parking accommodation.

NORTHERN HEIGHTS AMATEUR RADIO SOCIETY
Hon. Sec.: R. A. Robinson, G3MDW, Candy Cabin, Ogden, Halifax, Yorkshire.
Recent activities of the Club have been a recorded lecture by the late G3SU who was a founder-member, and the first of this year's demonstrations when the Club call sign was first used.

A novel innovation this year was a mobile car in the Warley Gala procession which was able to report back to the fixed station on the progress of the parade.

Some future events will include, on 21st July a Ragchew and on 4th August, a lecture on D.F. Equipment by G3LGN.

READING AMATEUR RADIO SOCIETY
Hon. Sec.: N. C. Taylor, G3TOQ, 83 Stoneham Close, Tilehurst, Reading, Berkshire.
The first Mobile Picnic of the season was held on 20th June, and a good time was had by all. Talk-in stations were operated by G3TOO on 2metres and G3EIA on 160 metres.

SALTASH AND DISTRICT AMATEUR RADIO CLUB
Hon. Sec.: D. Bowers, BRS 26760, 95 Grenfell Avenue, Saltash, Cornwall.
A "Mobile Rally" was held at Calstock on Whit Monday, 7th June, and on the 18th, there was a tape and slide lecture which was kindly loaned by Northern Heights A.R.S.

An R.S.G. Tape Lecture on Receivers was heard on 2nd July. There will be a Treasure Hunt on 16th July.

SOUTH BIRMINGHAM RADIO SOCIETY
Hon. Sec.: J. R. E. Bristow, 153 Castle Lane, Solihull.
On 17th June there was a demonstration and display of Heathkit Products and transmitters and test gear were on show for members to use.

SOUTHGATE, FINCHLEY AND DISTRICT GROUP OF THE R.S.G.B.
The May lecture was given by G3OLE, who spoke about his "hybrid" mobile transmitter. The next meeting will be on 8th July.

SOUTH SHIELDS AND DISTRICT AMATEUR RADIO CLUB
Hon. Sec.: D. Forster, G3KZZ, 41 Marlborough Street, South Shields.
The Club is making preparations for its 8th Mobile Rally which is to be held on Sunday, 11th July at the Bents Park Recreation Ground, Coast Road, South Shields.

Meetings are held weekly on Friday evenings at 7.30 p.m., in Trinity House Social Centre, Lartigue Lane, South Shields.

SPEN VALLEY AMATEUR RADIO SOCIETY
Hon. Sec.: N. Pride, 190 Raikes Lane, Birstall, Nr. Leeds.
On 24th June there was an Open and Final Meeting of the season. The A.G.M. of the New Session will be held on 8th July.

Meetings are held at 7.30 p.m. at Heckmondwike Grammar School.

WEST KENT AMATEUR RADIO SOCIETY
Hon. Sec.: H. F. Richards, 17 Reynolds Lane, Tunbridge Wells, Kent.
On 9th July, John Gould will give a talk entitled "Seventy C.M.S.," which is aimed at getting all the Club members on 430 M.C.S.

WIRRAL AMATEUR RADIO SOCIETY
Hon. Sec.: A. Seed, G3FOO, 31 Withert Avenue, Bebington, Wirral, Cheshire.
A Tape Lecture was given on 7th July. Meetings are held at Scout H.Q., Harding House, Park Road West, Cloughton, Birkenhead, at 7.45 p.m. on the first and third Wednesdays in each month.

A BASIC MOUILLIN VOLTMETER
—continued from previous page

CONSTRUCTION
No special construction is needed and the constructor may adopt any layout. The only wire that is at all critical is the grid lead. It should be short and well spaced from any other wires to minimise the input capacitance, and very well insulated. The input terminals should be well apart on a panel of insulating material and a ceramic valve-holder should be used. A high input resistance will not be obtained if the above is disregarded although of course the instrument will still work.

RANGE EXTENSION
Although a range of 0-1 to 1V peak is ample for radio-frequency measurements, i.e., measuring Q or self-capacitance of coils, an extension of range would make the instrument more versatile. It is however very difficult to do at high frequencies due to input capacitance. At low frequencies, when the reactance of the input capacitance is considerably less than the resistance of the potential divider in parallel with it, (see Fig. 7) it can be done.

The e.m.f. at the grid is then of the applied R + r e.m.f.
If a non-contributory source of e.m.f. is being used then the grid must be given a d.c. path to earth. This can be done with a high resistance, 5M ohms being a suitable value. The input resistance then drops to slightly below 5M omega, but which is high enough for most purposes.
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(a) We cannot undertake to design equipment or to supply wiring diagrams or circuits, to individual requirements.

(b) We cannot undertake to supply detailed information for converting war surplus equipment, or to supply circuitry.

(c) It is usually impossible to supply information on imported domestic equipment owing to the lack of details available.

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**QUERY COUPON**

This coupon is available until 5th August, 1965 and must accompany all queries in accordance with the rules of our Query Service.

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*PLEASE NOTE that we can supply no blueprints other than those shown in the above list. Nor are we able to supply service sheets for commercial radio, TV or audio equipment.*
**VHF FM TUNER TO BUILD**

- 5-transistors, 4-diodes.
- Printed circuit superhet.
- Tuning range 87 to 105 MHz.
- P.F. stage and double tuned I.F.'s. 9 volts 9 mA operated.
- All parts sold separately.
- Output up to 1 volt.
- Size: 4 x 3 x 2 1/2 in.

**TOTAL COST TO BUILD** £6.19.6

**M/W/LW POCKET SUPERHET RADIO TO BUILD**

- 6-transistor plus diode.
- Push-pull speaker output.
- Easy printed circuit.
- Slow geared tuning.
- Full MED and long waves.
- Moulded cabinet 5 x 3 x 1 1/2 in.

**TOTAL COST TO BUILD** 85/-

**TWO-WAVEBAND ALL TRANSISTOR CAR RADIO TO ASSEMBLE**

- Supplied as factory built assemblies—just interconnect.
- 6-transistor push-pull design—double tuned I.F.'s.
- Push-button wavechange—full tuning range.
- Size 7 x 4 x 2 in.—fits any car—chromed front dial.

**TOTAL COST TO BUILD** £3.19.6

**PUSH-BUTTON TRANSISTOR PORTABLE TO BUILD**

- 6-transistor superhet design.
- Easy to build printed circuit.
- Full ferrite aerials, and D.I.T.I.FS.
- Push-button wavechange.
- Full M.E.D./L.W. geared tuning.
- Attractive sturdy cabinet.

**TOTAL COST TO BUILD** £7.19.6

**VHF FM TUNER TO ASSEMBLE**

- Supplied as prebuilt and printed, units plus metalwork just interconnect.
- 88 to 108 MHz FM tuning.
- 100 mV to 1000Kohm output.
- 6-transistor printed circuit.

**TOTAL COST TO BUILD** £12.17.6

**10 WATT AND 20 WATT AMPLIFIERS**

**ALL TRANSISTOR PRE-BUILT AND TESTED UNITS**

- **POWER AMPLIFIERS**
  - 10 watts RMS music power output.
  - 10 watts peak.
  - Transistor designs.
  - 40 c/s to 20 Kc/s.
  - 100 mV sensitivity.
  - Unit 1. For 100 watts 8 ohm speakers, 40 volt supply.
  - Unit 2. For 3 to 5 ohms 24 volt.

**PRICE** £5.19.6 P.P. Unit 1 and 2

**SPECIAL PRICE** £5.10.0 P.P.

**PREAMPLIFIERS**—MONO AND STEREO VERSIONS.

- 8 inputs, 1/2 mV to 300 mV at 1K to 500 Kohm.
- Response 30 c/s to 20 Kc/s.

**PRICE** £10.19.6 P.P.

**LOW NOISE—LOW DISTORTION QUALITY DESIGNS**

- Enables complete Mono or Stereo equipment to be assembled at a fraction of the cost of a commercial comparable design.

**TOTAL AND FOUR TRACK PORTABLE TAPE RECORDERS TO ASSEMBLE**

- Prebuilt equipment—6 valves—Collaro studio decks—portable cabinets.
- Complete recording and playback.

**SPECIAL PRICE** 7/6 P.P.

**4 WATT AND 1/2 WATT PACKAGE AMPLIFIERS**

- 6-transistor push-pull printed circuit designs.
- Peak output 8 watts and 3 watt.
- Size only 2 1/2 x 2 x 1 1/4 in.
- 4 IF'S.
- For 3 to 5 ohm speakers.
- 7 mV into 1 Klimn, 40 c/s to 15 Kc/s.

**PRICES** £1 7/6 P.P.

Let us quote for Parts for your circuit. Send a list for quick reply.