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2-8 PABS (also available as KIT, see below).
Is a 2-way speaker system consisting of 2 speakers and crossover network. Max. Power Input: 8 Watts. Frequency Range: 50-18000 c.p.s. in 16 litres (0.57 cu. ft.) cabinet. Speakers: Woofers B 65 W. Tweeter MT 25 HFC. Crossover Frequency: 4000 c.p.s. Dimensions (inside) for 16 litres cabinet: Approximately 13\(\frac{1}{16}\) x 9\(\frac{3}{4}\) x 6\(\frac{1}{2}\)in. (395 x 245 x 167 mm). Specify grey or golden coloured plastic fabric grille.

2-10 PABS (not available as KIT).
Is a 2-way speaker system consisting of 2 speakers and crossover network. Max. Power Input: 10 Watts. Frequency Range: 50-18000 c.p.s. in 6.5 litres (0.23 cu. ft.) cabinet. Speakers: Woofers O 525 WL. Tweeter MT 20 HFC. Crossover Frequency: 3500 c.p.s. Dimensions (inside) for 6.5 litres cabinet: Approximately 8\(\frac{1}{2}\) x 6\(\frac{1}{2}\) x 1\(\frac{1}{4}\)in. (210 x 158 x 41 mm). Dark coloured plastic fabric grille.

2-15 PABS (also available as KIT, see below).
Is a 3-way speaker system consisting of 3 speakers and crossover network. Max. Power Input: 15 Watts. Frequency Range: 45-18000 c.p.s. in 30 litres (1.06 cu. ft.) cabinet. Speakers: Woofers P 525 W, Mid Range GT 50 MRC. Tweeter MT 20 HFC. Crossover Frequencies: 750 and 4000 c.p.s. Dimensions (inside) for 30 litres cabinet: Approximately 20\(\frac{1}{4}\) x 8\(\frac{1}{4}\) x 10\(\frac{3}{4}\)in. (515 x 218 x 270 mm). Specify grey or golden coloured plastic fabric grille.

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2-10 COMPACT SYSTEM
Is a 2-way speaker system in cabinet with dark coloured plastic fabric grille. Combines one special woofer (9\(\frac{1}{8}\)in.), one closed-back tweeter (9\(\frac{1}{8}\)in.) and a crossover network. Crossover Frequency: 3500 c.p.s. Frequency Range: 50-18000 c.p.s. Power Capacity: 10 Watts. Cabinet Size: 19\(\frac{1}{8}\) x 9\(\frac{1}{4}\) x 10\(\frac{1}{2}\)in. (500 x 250 x 276 mm).

2-10A MEDIUM SIZE SYSTEM
Is a 2-way speaker system in cabinet with brown coloured plastic fabric grille. Combines one special woofer (9\(\frac{1}{8}\)in.), one closed-back tweeter (9\(\frac{1}{8}\)in.) and a crossover network. Crossover Frequency: 3500 c.p.s. Frequency Range: 40-18000 c.p.s. Power Capacity: 10 Watts. Cabinet Size: 19\(\frac{1}{8}\) x 9\(\frac{1}{4}\) x 10\(\frac{1}{2}\)in. (500 x 250 x 276 mm).

4-30 MEDIUM SIZE SYSTEM
Is a 3-way speaker system in cabinet with brown coloured plastic fabric grille. Combines one special woofer (9\(\frac{1}{8}\)in.), one special mid range (5 x 7\(\frac{1}{2}\)in., elliptical), two closed-back tweeters (2\(\frac{3}{8}\)in.) and a crossover network. Crossover Frequencies: 500 and 3500 c.p.s. Frequency Range: 30-18000 c.p.s. Power Capacity: 30 Watts. Cabinet Size: 25\(\frac{3}{4}\) x 14\(\frac{1}{2}\) x 11\(\frac{1}{2}\)in. (655 x 380 x 300 mm).

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TOPIC OF THE MONTH

QRS!

THE quickness of the hand deceives the eye, sometimes — and if that hand grasps a morse key it sometimes appears to deceive the ear, too. That is, if we correctly understand the latest piece of petty niggling by the GPO.

The Radio Services Department of that august body has lately been mailing letters of complaint to licensed amateurs who are sending their callsigns faster than the specified 12 w.p.m. (it used to be 20 w.p.m.). Why it should suddenly become necessary to throw the book at operators is beyond understanding, unless the GPO monitors have so declined that they can only copy dead slow morse. It comes to something when the professionals ask the amateurs to slow down!

We would suggest that the GPO tries listening on the bands during one of the major DX contests, where a complete “QSO” flashes by in about ten seconds flat. A contestant dawdling at 12 w.p.m. would consider himself fortunate if he made any contacts at all!

But if the GPO really want to transform the amateur licence into a kind of Radio Highway Code, why stop at tut-tutting about c.w. operators exceeding the speed limit? How about some new rules such as — “Do not overtake a DX signal when he is in QSO”, “Do not park your carrier on a crowded band”, “Keep to the right lane” (for the v.f.o.-swishers), and some new (key) hand signals: QQQU (“I expect to drift upband — please follow my chirp”), QQOH (“Halt! When I asked what the weather was like, I didn’t want a Met. report”), QQOD (“Danger! I’m operating mobile on a camel with no rear lights”) QQOB (“Help! — my Super-Duper All-Band DX Ranger has gone berserk. Send breakdown van”).

Of course to be really effective, we should have an itinerant band of inspectors armed with breathalyzers — “This man was found drunk in charge of his log-book” — and traffic wardens to stop the parking of S9 signals on restricted frequencies.

Perhaps, however, it would be better for the GPO to run a course of Morse tuition. Or to transfer their attack on the a.m. and s.s.b. boys — many of whom we suspect of speaking faster than 12 words per minute!

W. N. STEVENS — Editor.

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APRIL ISSUE WILL BE PUBLISHED ON MARCH 8th
Cray Valley celebrates its twenty-first

Here we can see Arthur O. Milne, G2MI, president; Stan Coursey, G3JJC, chairman; Alan Swindon, G3ANK; Deryck Buckley, G3VLX, secretary; W. (Bill) Jardine, G2AQB; Norman Kemsley, G3WJK and T. I. Lundergaard, G3GJW.

The Cray Valley Radio Society was founded in 1946 and has therefore attained its majority—signified, naturally enough, by the addition of a morse key to the masthead of QUA, the Society's newsletter.

The occasion was marked by a special meeting in December last when the high spot of the evening was cutting the cake by G2MI, the Society's president. The birthday cake was home-baked by the XYL of the secretary G3VLX and expertly iced by his 15-year-old son. The cake decoration was a miniature replica of G2MI's h.f. beam.

There were two short talks by members. G3VLX (licensed in 1966) spoke on "My first 12 months" on the air and gave the newcomer's impression of Amateur Radio. Although so far confined to Top Band he recounted some interesting experiences and some amusing stories. G3ANK then outlined the earlier days of the Society and showed documents and cuttings from the days when many materials and foods were rationed.

The Society began as the Cray Valley Transmitting Club with members, as now, drawn from an area in North-west Kent comprising Eltham, Sidcup, Bromley, Orpington and the Crays. For the first five years interest in the club was so strong among local amateurs that it was possible to insist upon holding a licence as a condition of membership but later wider views prevailed and short wave listeners were admitted—today they are positively welcomed!

The Society's station—G3RCV—was on the air at the 21st meeting and several locals were worked on 4 metres. The rig (home-brew) was kindly supplied and operated by one of the members. G3TAA.

Start of VHF radio service from BBC's Ballachulish relay station

The v.h.f. radio service from the BBC's relay station to serve Ballachulish, Argyllshire, started on 6 January, on the following frequencies: Radio 2 (Light programme) 88.1 Mc/s, Radio 3 (Third Network) 90.3 Mc/s, Radio 4 (Scottish Home Service) 92.5 Mc/s.

RADIO 2 TRANSMITTERS IN SCOTLAND

Following the start of Radio 1 on 247 metres (1214 kc/s), the wavelength previously used to supplement Radio 2, the BBC, has been investigating means of helping listeners in parts of Scotland who are having difficulty in receiving Radio 2 on 1500 metres long-wave and who do not have receivers for receiving this programme on v.h.f.

The shortage of wavelengths in the medium-wave band presents a serious problem but tests have shown that some local reinforcement of the Radio 2 service is possible by making use of the International Common Wavelength of 202 metres (1484 kc/s).

Following the Postmaster-General's approval announced recently, low-power relay stations operating on 202 metres were brought into service in Glasgow on Wednesday, 20 December, and in Edinburgh on Thursday, 21 December.

The power of stations using the International Common Wavelength (202m) is restricted by international regulations so that the effective range of the stations is only a few miles. The range is further limited at night-time by interference from other European broadcasting stations, some 150 of which share this wavelength. The Glasgow and Edinburgh Radio 2 relay stations on 202 metres however, provide an alternative means of receiving Radio 2 in these two cities.

A PORTABLE DISCOTHEQUE

A new package deal in high fidelity discotheque equipment is now on sale to disc jockeys and users of professional record playing equipment.

The Rush D.J. is a suitcase size twin-turntable record playing console, complete with its own 30 watts solid state amplifier and control unit. Also included are a pre-fade listen switch for left- and right-hand channels feeding head-phones for cueing-in each disc; separate volume controls for left- and right-hand grams; separate bass and treble controls for gram channels. Mike input with its own volume, bass and treble controls. Foot-operated mikes on/off switch with music level reduction. Two Garrard SP25 Mk. II 4-speed single players are employed with turnover heads fitted with double L.P. stylus instead of normal L.P./78 stylus.

It is built into a leatherette covered case, which measures only 12in. high, 19in. deep by 36in. wide and weighs approximately 40 lb. It has a removable lid and is finished with anodised brass trims and locks.

Versions giving 60, 90, or 120 watts RMS output are also available at extra cost.

Further details regarding marketing, distribution, etc., may be obtained from Keith Pittman Limited, 42/44 Hanway Street, London, W.1.
SERT MEETINGS THIS MONTH

The Society of Electronic and Radio Technicians announce that their meetings for February are as follows:

HORNCHURCH. Tuesday, 20th February. 7.00 p.m. at Havering Technical College, 42 Ardleigh Green Road, Hornchurch, Essex. Automatic Landing Systems: F. J. Sullings (B.O.A.C.).

CHESTERFIELD. Monday, 5th February. 6.30 p.m. at Chesterfield College of Technology, Infirmary Road, Chesterfield. U.H.F. Reception: B. M. Goodwin (A.B. Metal Products).

NEWCASTLE-UPON-TYNE. Wednesday, 7th February. 7.15 p.m. at Charles Trelveylan Technical College, Maple Terrace, Newcastle-upon-Tyne. Interference: T. Boast (G.P.O.).

STOKE ON TRENT. Friday, 16th February. 7.30 p.m. at Room C7, North Staffs College of Technology, College Road, Stoke on Trent. Sony Video Tape Recorders.

OLDHAM. Thursday, 8th February. 8.00 p.m. at Oldham Technical College, Oldham, Lancs. Stereo Broadcasting: (B.B.C.).

LINCOLN. Tuesday, 6th February. 7.30 p.m. at Lincoln Technical College, Cathedral Street, Lincoln. U.H.F. Reception: B. M. Goodwin (A.B. Metal Products.)

GREENOCK. Friday, 2nd February. 7.30 p.m. at Watt Memorial College, Greenock, Renfrewshire. Colour Television: J. McMaster.

EDINBURGH. Friday, 23rd February. 7.30 p.m. at Room B44, Napier Technical College, Colinton Road, Edinburgh. Colour Television: J. C. Allen (Napier Technical College).

CARDIFF. Friday, 9th February. 7.30 p.m. at Llandaff Technical College, Western Avenue, Cardiff. Field Effect Transistors: E. F. Munroe (Texas Instruments).

LEWIS RADIO'S NEW RANGE

Lewis Radio, 100 Chase Side, Southgate, London, N.14, announce that the range of equipment they advertised in the February issue of "Practical Wireless" is now exhausted. The equipment advertised in this issue, however, is current and if readers require full details, they should contact Lewis Radio at the abovementioned address.

NEW SPEAKER FROM ROGERS

The "Standard" Speaker System introduced last year with the Ravensbourne Stereo Amplifier has now been joined by a "Compact" version employing the same basic design principles but using an 8in. main drive unit instead of the 12in. unit found in the "Standard" model.

The "Compact" has a frequency response of 50-14,000c/s, an impedance matching of 8-16Ω, power capacity of 10-15W and overall dimensions of 22 x 11½ x 8-in. (see photograph).

The "Compact" model costs £25 with £4 13s. 10d. purchase tax.

Rogers Developments (Electronics) Ltd., Rodevo Works, 4/14 Barmeaston Road, Catford, London S.E.6.

DE-SOLDERING KIT

This new De-Soldering Kit from Antex contains a footpump with patented moulded cylinder and a synthetic cup washer. Lubrication and condensation problems are eliminated, weight is reduced to 3 lb. and exceptionally high pressure is obtained immediately on starting the stroke. The Model ESS De-Soldering Tool is now obtainable for 12, 24, 50, 110, 220 or 240 volts. This model can also be supplied on request with the smaller bit (2-4mm. -3/32in.) normally fitted to the smaller model GSS. The net trade price of £4 19s. 6d. for the complete outfit remains unaltered.

NORTHERN RADIO SOCIETIES' CONVENTION

The Northern Radio Societies' Association will again be holding their Annual Convention in the Kent Suite, at the Belle Vue Zoological and Exhibition Gardens, Manchester, on Sunday May 19th, 1968.

As readers may know, the Association comprises a number of radio societies from the North of England, who will be exhibiting, along with a number of commercial enterprises, at the Convention. The Convention will consist of a number of active displays and items of topical interest.

"LEKTROKIT" CHASSIS PLATES USED IN EXAMS

More than 170 students successfully passed their finals in the first national examinations in electronics servicing held by the Radio Trades Examination Board this year.

In conjunction with the City and Guilds Institute, the R.T.E.B. final radio and television servicing and the final electronics servicing certificates are achieved after five years' part time study. These certificates ensure that successful candidates are competent to maintain on the one hand, domestic radio and television equipment and, on the other, "professional" and industrial electronic equipment.

The Final Electronic Servicing Certificate examination consisted of two 3-hour written papers, one 2-hour fault diagnosis paper and a 2-hour practical test. For the practical exam (see illustration) students were required to construct and test a transistorised multivibrator circuit and Lektrokit No. 4 chassis plates, made by A.P.T. Electronic Industries Ltd. were chosen by the Board for this.
THE RHODIAN TAPE RECORDER

JULIAN ANDERSON

THE Rhodian tape recorder is the result of much trial and experiment using different decks and choices of amplifier. The aim was to achieve the best possible results using the minimum of components. Obviously in any design of this sort a compromise has to be reached between quality on the one hand and simplicity on the other, and the final design, although not claimed to be hi-fi, has a quality which matches or betters most of the popular range of tape recorders on the market. The total cost in parts, including cabinet, tape deck and speaker was under £12.

To the beginner to construction or to the occasional dabbler a tape recorder circuit may seem way beyond their capacity; the complicated-looking circuitry, the warnings of careful component placing and a fearsome looking “function switch” immediately seem beyond them. Actually in operation a tape recorder amplifier is less complicated than a superhet radio or a push-pull amplifier. If the circuit is shorn of its switches etc. and only the functional components are shown it looks like Fig. 1 on record and as in Fig. 2 on playback.

Basically on record the signals from the microphone are amplified by three triodes and fed via a high-value resistor to the record head. This resistor is needed because the record head is an impedance and has a higher resistance at the higher frequencies. By having a resistance in series the current flowing will depend on the total resistance and not only on that of the head. This means that roughly the same current will flow through the head whatever the frequency.

Since on record the tape will need to be wiped clean a form of erase is necessary. This is provided by the pentode valve, arranged as an oscillator, the secondary of the oscillator coil feeding the erase head. The only complicated part which needs brief explanation is the recording bias. This consists of a tiny part of the high frequency erase current fed via a capacitor to the record head along with the signal. There is no reason why this should be fully understood by the constructor; adequate explanations have been given in previous issues of this magazine. Basically it is necessary because of the nonlinear characteristic of the recording tape, the high frequency bias signal overcoming this nonlinearity. It is absolutely necessary in the recording process although it involves only a small capacitor.

On playback the circuit is far simpler. Those who have made a valve amplifier will see that it is completely straightforward apart from the high gain involved.

On record one must have some method of seeing how much signal is being fed to the tape. If too little is fed to it the playback will be noisy, if too much heavy distortion will result. In the final circuit the record-level indicator also serves to show if the recorder is on playback or record.

Fig. 1: Effective circuit on record.

Fig. 2: Effective circuit on playback.
The complete circuit, shown in Fig. 3, is not very original. When the minimum number of components are used similarity between designs is bound to result. It is not dissimilar to many commercial designs available, but unlike these it uses readily available components which are completely standard, and also keeps the number of switchings to the minimum (four). The amplifier is even built on a standard chassis size available from advertisers in this magazine.

The recorder is built around the BSR TD2 deck which is available for about £5 10s. There is no reason why other decks should not be used, and the amplifier will need no amendments for any deck using a high-impedance record/playback head and a low-impedance erase head (most decks use this arrangement).

It was decided at the start to use a home-made cabinet. The disadvantage with most of the ones on sale is that, while very attractive, they are designed around a specially made chassis. The author's cabinet cost 10s, and was completed in under two hours. It is a very simple one and no doubt readers who are more accomplished at carpentry than the author would be able to improve on it.

It was decided to mount the loudspeaker forward facing. The simplicity of the deck and the amplifier may limit fidelity, but there is no reason to limit this further by using a tiny speaker tucked away on the side. The author's final design incorporated an 8 x 5 inch speaker. Another decision was to use a single chassis, with no flying leads, the only interconnecting leads going to the deck, and also for the amplifier to be capable of being worked upon while in the cabinet, thus making testing very much easier.

Amplifier switching is one of the features of a tape recorder, and on the deck of the BSR TD2 this is on the left. The deck is not normally supplied with a wafer, but this can be readily obtained. By using the switch provided, accidental erasure is impossible and allows the less technical members of the family to use the machine. The amplifier is sited on the left of the deck so that the interconnecting leads can be kept short.

General layout is more important in a recorder than on most equipment because of the high gains and high impedances involved. For those wishing to use a different layout the following should be observed: (1) Keep the low-signal and high-signal sections well apart. (2) Keep the mains transformer well away from the tape heads. (3) Screen wires liberally and especially all those carrying signal to the deck.

**Basic design**

As the main features of the recorder are cost and simplicity, the valves chosen were an ECC83 (a high-gain double triode) and an ECL82 (a triode pentode). Together these give more than adequate gain and a final output of about 21/2W. A contact-cooled metal rectifier was chosen since it is smaller than its valve counterpart and needs no heater current. A full-wave rectifier was chosen since a ripple of 100c/s is easier to smooth.

The magic eye chosen was a DM70. This is really intended for battery operation, but has the advantages that it uses little heater or h.t. current, and more important it is small and easily mounted. In the earlier stages of development the author used an EM81, but without special escutcheons it is very hard to mount it attractively.

Under no circumstances should a tape recorder have a live chassis. This is acceptable in a radio or TV set where all metal parts can be shielded, but on a tape recorder the deck and even the microphone can be live and only those with a death wish should avoid using a mains isolating transformer.

The BSR deck has no motor switch, and for those wishing to use the amplifier other than for the tape recorder a switch is included. This can also be used as a kind of pause control. The author uses his a lot when medium wave DXing and it is very useful to be able to start and stop the machine by just throwing a switch.

**Circuit description**

On record, the microphone signal is switched to the grid of V1a by S1a. This is the first part of the ECC83 and as mentioned is a high-gain amplifier. It
is arranged for very high input impedance and is especially good for use with crystal microphones, giving a good bass response. The signal then passes via a frequency-discriminating network (C4, R4) giving a treble boost to the signal (treble boost is needed on record to overcome head and tape losses). If a high signal source is used this is fed into the radio/gram input socket just before the network, the first stage being automatically shorted at the microphone socket.

The signal is further amplified by V1b. No cathode bypass capacitor is used since adequate gain is available and thus a measure of negative feedback can be introduced to improve linearity. The signal from this stage is controlled by the record-level control, VR1, and is then further amplified by V2a, finally being applied via R23 to the record head, the other side of which is connected to earth by S1b. The signal for the magic-eye record-level indicator is tapped off via R12, rectified by the OA81, smoothed and fed to the grid of the DM70 (V3). As mentioned earlier, the DM70 is intended for operation with an h.t. of about 50V and its anode is thus fed from a potential divider (R16 and R17). The low heater current required is achieved by the inclusion of R15 in the heater circuit.

V2b is arranged as an oscillator on record. The anode receives h.t. via S1d, rectifier SR1, the oscillator coil L1 and the output transformer T1. Part of the signal from the oscillator coil is fed back to the grid via C10. The frequency of oscillation is determined by C11 and should be in the order of 60 kc/s. The secondary of the oscillator coil is connected directly to the erase head. (If a high-impedance erase head is to be used the signal should be taken via an 0.05 µF capacitor from the anode side of the coil.) It will be noticed that the output transformer T1 is connected throughout, but the high impedance of its primary blocks the passage of oscillations thus making it inoperative on record, the high frequency signals being bypassed through C12. The tone control operates on the negative feedback circuit from the secondary of the output transformer and is thus also inoperative during record.

Bias is fed to the record head via C19 from the effective anode of V2b. It should be noted that there is 250V across this through the record head and if it is shorted for even a millisecond unpleasant things may happen to the head (the author was not willing to find out exactly what!). The power supply is standard, being smoothed by R21, C15 and C16. Adequate decoupling between stages is used, being provided by R9, R14, C3 and C6.

On playback the output from the record/playback head is switched to the grid of V1a by S1a, the other side of the head being switched to earth by S1b. The amplifier output is switched to the grid of V2b by S1c and h.t. is switched directly to the top of the output transformer by S1d.

In this condition the amplifier acts as follows. The playback head (which is the same as the record head on this and most decks) is paralleled with a 100kΩ resistor (R24). This lowers the input impedance of the first stage. The signal is amplified as before, still receiving treble boost. A low-level output suitable for a feed to another tape recorder or amplifier is taken from the anode of the next stage. This time the record-level control becomes the volume control, and the output from V2a is this time fed via
C13 acts as a tiny h.t. reservoir and, when the record/playback switch is altered, it will allow oscillations to die away rather than cut off thus preventing the head from becoming magnetised. (A magnetised head leads to noisy playback.)

C12, which on record bypassed the output transformer for oscillation, now acts as a treble cut to neutralise the unwanted top boost given earlier in the circuit. C10 now goes from V2b control grid to effective a.c. earth (the h.t. line) and cuts the top further. These two capacitors give the top cut necessary to equalise the signal on playback. The output transformer is now in use and negative feedback is applied to the cathode of V2a. The arrangement used gives a wide range of control from very mellow to very bright and has been found to be very satisfactory in this and other circuits.

TO BE CONTINUED

Modification to the GENERAL PURPOSE P.S.U.

(December 1967, page 570)

In order to eliminate the risk of an electric shock when this device has been overloaded (or short-circuited) the following modification must be carried out.

In Fig. 1 the common connection of C5, RL1, and R1 is removed completely from the earth connection (heavy black line) and wired directly to the centre tap (marked O) of the h.t. secondary of the mains transformer T1, as shown below. The existing connection from this point to earth is removed.

The negative sides of capacitors C1 and C2 are still returned to the earth connection (heavy black line), and the negative bus-bar connected to output terminal 3 may now be joined directly to earth.

This simple modification ensures that the chassis is always at earth potential, even during overloads.

It must also be stressed that, during an overload, when the relay is energised, high voltages still exist in the circuit and the device must be disconnected from the mains supply in order that servicing, etc., may be carried out on it.

F.M. DISTORTION

I have recently purchased an a.m./f.m. stereo radio chassis incorporating a Gorier tuning heart. Sound on f.m., however, is accompanied by a definite distortion which cannot be tuned out.

I have replaced the ECC85, also provided a loft aerial with 300Ω twin feeder but this has made no improvement. Before I adjust any trimmers or screws (there appears to be one beneath and three on top) could you advise how this distortion may be removed.—D. Spencer (Oldbury, Birmingham).

It is doubtful (though possible) that the distortion you mention is caused by incorrect alignment of the tuner unit in your f.m. radio. It is more likely that the trouble is due to incorrect alignment of the f.m. i.f. transformers, especially the one feeding the f.m. detector. We therefore suggest that you realign the f.m. i.f. circuits; alternatively, ask a local service engineer to do it for you. We advise you not to tamper with the tuner unit until all other possibilities have been eliminated. Before realigning, however, check the aerial orientation since the distortion could be caused by multipath reception.

LONG MIC LEAD

I wish to use a long microphone lead (about 25 yards) with my tape recorder. I have made several experiments with different types of microphone but find in all cases that the quality is poor and is accompanied by loud hum.—H. Wilson (Birmingham).

It is not possible to use a long lead on your microphone unless you add a preamplifier between the microphone and the long lead. The preamp would be arranged to have a low output impedance (by the use of a cathode follower valve stage, or an emitter follower transistor stage).

OHMS LAW

I have a three-transistor i.f. amplifier designed to work from a 9V supply. My supply voltage is 12V. Could you state what value of resistance I should use to drop the 3V and where in the unit it should be connected?—R. Riddle (Edinburgh, 11).

In order to calculate what value of resistance you need to feed your i.f. amplifier, you will need to measure the current it takes when connected to the correct 9V supply. Suppose that the current is 1 milliamps. Then, the value of the necessary resistance (in ohms) is given by dividing 3,000 by the current I. Thus, if the current was 6 milliamps, a resistor of 500Ω would be needed.

LEAGUE OR CLUB

We apologise for the error under the heading “Short Wave Club” published last month. The correct address of the International Short Wave Club is 100 Adams Gardens Estate, London, S.E.16 and the Secretary is Arthur E. Bear. The address we gave last month is that of the International Short Wave League. Will all concerned kindly accept our apologies for any inconvenience this may have caused.
Last month we discovered how to reclaim faulty or dud transistors, for use as diodes or zener diodes. Now let us look at a few of the many circuits in which we can use the reclaimed junctions.

Power supplies are perhaps the most important application for our reclaimed zener diodes. By using the test set described last month, we can measure the zener voltage and dynamic resistance ($R_d$). We can see that the voltage change with current is small, which indicates that it would be useful as a reference voltage in power supplies, or as a means of obtaining low voltage supply lines.

Figure 3 illustrates a method of providing a low voltage line from an existing power supply. This is often useful for supplying add-on units such as tuners, preamps, mixers etc., where only a low power and additional smoothing are required. It is also useful when we are experimenting with low voltage circuits where the only supply is in an existing equipment.

We can design the low voltage rail by first selecting a reclaimed zener diode of the correct voltage and then calculating $R$ from the following equation:

$$R = \frac{V_{IN} - V_z}{I_{LM} + I_z}$$

where $V_{IN}$ is the existing voltage
$V_z$ is the zener voltage measured on the test set
$I_{LM}$ is the maximum current from the low voltage line
$I_z$ is the minimum current for zener stability (1-5mA).

In order not to destroy the zener diode under open-circuit conditions, we must limit the zener power [$V_z(I_{LM} + I_z)$] to less than 200mW for a small transistor. Similarly the power rating of the resistor is $V_{IN}^2/R$ for short-circuit conditions. Thus we have designed a low voltage rail for our tuner or pre-amp., which will not be damaged by open or short circuits. The voltage versus current for the supply is given by Fig. 4 and is virtually constant, as the output resistance is $R_z$ (zener dynamic resistance) up to a maximum current of $I_{LM}$. For greater currents the zener has no effect, as all the current has been diverted from it, to the load. Commonly, a small transistor yields a 200mW zener diode which will deliver 30mA at 6V, or 20mA at 9V.

One of the advantages of this method is that additional smoothing is achieved since any ripple on $V_{IN}$ is reduced by $R$ and $C$ in parallel with $R_z$. This is especially useful for tuners and pre-amps. However, its limitation is that for high voltage zeners, say 20V, the maximum current for a small zener is approximately 10mA. In this case, however, we can use the circuit of Fig. 5.

The maximum current is again determined by the power of the zener, thus for a 10V difference between the input and output voltages, the maximum current is 20mA.

The output voltage is given by $V_{OUT} = V_{IN} - V_z$ and $R$ is given by $R = \frac{V_{OUT}}{I_z}$.

In this case the power in the zener diode for an open-circuit is small ($V_zI_z$), whilst a short-circuit would destroy the zener. The voltage-current characteristic is shown in Fig. 6. The disadvantages are that ripple on $V_{IN}$ is transferred directly to the low voltage rail and the output resistance is the sum of the source resistance and $R_z$.

Stabilisation and Rectification

Where an increased power is required the stabiliser circuit of Fig. 7 may be designed. The design follows that of Fig. 3 except that the maximum load current is $hFE I_{LM}$ (or $z' I_{LM}$) or the maximum transistor current, whichever is the lower. The output voltage is $(V_z - V_{BE})$ where $V_{BE}$ is 0.7V for silicon and 0.3V for germanium. The power rating of Vrl is $[(V_{IN} - V_{OUT}) hFE I_{LM}]$ and the transistor will generally require a heat sink. As $hFE$ is rarely less than 10 the current output for a 6V zener would be at least 300mA.

Reclaimed collector-base junctions, particularly of power transistors, are useful as rectifiers. The circuit of Fig. 8 shows a 6V 20mA supply for a tuner or pre-amp. using a spare 6-3V winding on a valve equipment. Here four reclaimed diodes and a 6V zener are used.

Reclaimed diodes may be used for temperature compensation. Silicon junctions have a negative temperature co-efficient and the voltage decreases by 2-4mV per °C. Now a 6-8V zener diode has a similar positive temperature co-efficient. Hence a forward biased diode in series with a 6-8V zener would give almost zero drift with temperature and an output voltage of $(V_z + 0.7)V_z$ whilst maintaining the low output impedance.

Fig. 3 (left): Zener power line.
Fig. 4 (right): Output voltage characteristic.
For zeners below 6.2V this cannot be used, since they have negative co-efficients. Above 7.2V more than one diode can be used for compensation.

Where the voltage in a circuit must not exceed a certain value, then a reclaimed transistor used as a zener diode may be used for protection. Thus a second zener diode of slightly higher voltage may be placed across the primary zener diode to give protection should the primary zener diode fail.

Similarly they may be used back to back across a high impedance path transformer, as in Fig. 9, to clip a signal. The maximum peak-to-peak signal would then be limited to \(2(V_z + 0.7)V\). This cannot be used for power transformers since the current is not limited.

A power supply protection circuit using a thyristor is shown in Fig. 10. Here, if the voltage exceeds approximately \((V_z + 1)\) volts, the thyristor will fire and blow the fuse. Thus expensive circuitry may be saved, and since the overload current of a small thyristor is greater than 15A, this can be used on high current supply lines.

Where a moving coil meter is used as a universal meter, the movement may be protected by silicon diodes across the meter as shown in Fig. 11. Provided the product \(I_aR_m\) is less than 250mV the diodes will have a negligible effect on the readings and yet prevent damage through overload.

For example, if the product \(I_aR_m\) is 200mV then the diodes will conduct for approximately 600mV and the overload current is limited to three times the normal current. As a meter movement is usually capable of this value of overload no damage will be sustained.

Pulse and gate circuits

High-speed diodes are often used in pulse circuits and the reclaimed junctions of high-frequency transistors are very suitable. Figure 12 illustrates a differentiating trigger circuit used for triggering bistables, monostables, etc. Figure 13 illustrates a peak detection circuit. This form of circuit is used at the detector stage of radios for which purpose the reclaimed diodes are very suitable.

Logic gate circuits have a very large number of applications though they are used only rarely in experimental equipment. The circuit in Fig. 14 is a gate circuit and operates as follows. Ignoring R1 to R3 at present, if A OR B OR C is connected to the positive supply, then Vr1 will conduct heavily and the relay will operate. This then is an OR gate and can be used for a number of applications, such as safety or alarm circuits. One example is in a tape-recorder. If A is made to be positive when there is no tape and B when the bias is absent and C when the level is too high, then the relay could operate an alarm light which indicated a fault, if any of these conditions were present.

If R1, R2, R3 are connected to A, B and C respectively, then the circuit would behave as follows. Only when A AND B AND C were connected to OV would the relay switch off. This then is the AND gate condi-

---continued on page 866---
WHILST the Clubman Mk I performs satisfactorily and is ideal for the beginner, it must, due to its simplicity, be somewhat limited in its selectivity and sensitivity. To improve the selectivity it is necessary to increase the number of tuned circuits in the i.f. amplifier. This normally requires extra i.f. transformers and the addition of an extra transistor i.f. amplifier stage. This incidentally also improves the sensitivity. With higher sensitivity it becomes more difficult to use a reflex circuit without encountering instability and so this feature has to be abandoned.

In the Clubman Mk II receiver, the existing Veroboard panel containing the reflex i.f., demodulator and a.f. stages is replaced by a new Veroboard panel comprising a conventional two stage i.f. amplifier using AF117 transistors and having automatic volume control, a demodulator stage and two a.f. stages. The biasing and gain control of the a.f. stages is similar to those used in the Clubman Mk I but with the i.f. components omitted. A new feature is the inclusion of a beat frequency oscillator for c.w. and s.s.b. reception. This is housed in a small screening box to prevent unwanted radiations to the earlier stages of the receiver.

The circuit of the Mk II version is shown in Fig. 19. The original frequency changer stage remains unchanged and the operation of this circuit has been described previously.

I.F. Amplifier Stages

Intermediate frequency signals (470kc/s) at the collector of Tr1 are accepted by the i.f. transformer if.t.1 and passed to the base of Tr4. D.C. biasing of Tr4 base is provided by the potential divider R12 and R13. The emitter stabilising resistor is R15. Decoupling for the base circuit is provided by C13, for the emitter by C14 and for the collector circuit by C12. Amplified i.f. signals appearing at the collector of Tr4 are accepted by i.f.t.2 and passed to
the base of TR5. Base biasing for TR5 is provided by R16 and R17 and the emitter stabilising resistor is R18. Decoupling for the base circuit is provided by C15 and for the emitter by C16. Amplified i.f. signals at TR5 collector are accepted by i.f.t.l. which also contains the demodulator diode circuit. In the presence of a signal a positive voltage is developed across the diode load resistor R19. The d.c. component of this signal is used for a.v.c. purposes and superimposed on this voltage is the a.f. signal which is passed to the a.f. stages via R20.

The positive a.v.c. voltage present across R19 is passed through S2 and R13 to the base of TR4, reducing the current through TR4 and thus reducing the gain of this stage. Filtering of this voltage is provided by R13 and C13. There is a limit to the amount of control which can be obtained by this method and so an additional method of gain control is employed. This is effected by D3 and R11. For small input signals, little or no positive voltage appears at the bottom end of R13 and the d.c. through TR4 causes a voltage drop across R14. The voltage at the bottom end of R14 being approximately ~6–5 volts. The voltage at the collector of TR1 is approximately ~7 volts and it will be seen that the voltage across D3 results in it being reverse biased and having negligible effect on the operation of i.f.t.l. If, however, a strong signal is being received, the positive a.v.c. voltage appearing at R13 will cause the current through TR4 and R14 to decrease. The reduced voltage drop across R14 results in an increase in the voltage at the junction of R11 and C12. When this voltage becomes more negative than that at the collector of TR1, D3 becomes conductive and connects the damping resistor R11 across the primary of i.f.t.l., thus reducing the gain of this stage. C12 provides a low impedance path for i.f. signals through D3 and R11 to chassis.

The a.v.c. switch S2 is provided to disconnect the a.v.c. voltage so that the i.f. stages may operate at fixed gain for c.w. and s.s.b. reception.

The operation of the a.v.c. stages has been described previously and is similar to those in the Clubman Mk I but with the i.f. components omitted.

**Beat Frequency Oscillator**

A separate b.f.o. coil is not available in the range of Weymouth i.f. transformers used, so a final i.f. transformer type T41/3T is employed as a b.f.o. coil, the secondary winding being unused.

The b.f.o. is a Hartley circuit which operates at a nominal frequency of 470kc/s. VC3 provides a tuning range of about ±5kc/s. Tr6 operates in common base mode with the tuned circuit in the collector, feedback is taken from a tapping on the coil to the emitter via C21. Base biasing for Tr6 is provided by R21 and R22, the emitter stabilising resistor is R23. The base decoupling capacitor is C20 and decoupling for the collector circuit is provided by C19 and R24.

The i.f. output from the emitter is coupled to the demodulator circuit by C17. S3 is the b.f.o. switch and it controls the d.c. supply to the b.f.o. circuit.

**Construction**

The Mk II i.f. and a.f. panel consists of Vero-board with a 0.2 x 0.2in. hole matrix, size 5½ x 2½in. The mounting positions for the various components and the drifts to remove the copper strip are shown in Fig. 23. The hints given previously to assist in marking out and working on the Vero-board panel are even more important with this more complicated layout if errors are to be avoided.

The i.f. transformers do not fit exactly into the Vero-board drillings and it is necessary to elongate the holes and open them out slightly to suit the soldering spills on the i.f. transformers. This can conveniently be done using a mouse tail file or Abrad-file, working downwards with the copper strip side of the panel uppermost so as not to tear off the copper strip. The transformer i.f.t.l. used in the Mk I version can be reused. Some difficulty may be experienced in removing this transformer from the Vero-board panel if a desoldering tool is not available. A useful alternative method is to clamp the old panel in a vice and whilst heating one tag with a soldering iron, brush away molten solder using a stiff-bristled brush. A cut down suede brush with metal bristles is ideal. This process is repeated.
for each tag and the transformer may then be extracted from the panel. Avoid excess heat for long periods as this may damage the transformer internally. The i.f. transformers are colour coded at one end and the position of this coloured dot is shown in Fig. 23. Make sure that the transformers are orientated correctly. The i.f. cans have two earthing tags, the one at the end with the colour code is cut short and the other tag is connected to the Veroboard as shown.

The b.f.o. unit consists of a small Veroboard panel, complete with the circuit components, which is mounted in a small aluminium box along with the b.f.o. tuning capacitor VC3. The Veroboard panel is fastened into the box by two 6BA screws and nuts and is spaced away from the side by two full nuts which are run on to the screws before the panel is fitted. The tuning capacitor VC3 is fastened through the 3/4 in. diameter hole at the end of the b.f.o. box. One fitting nut is used to lock the tuning capacitor in position and the protruding spindle bush is passed through the front panel hole and a further nut fitted on from the front of the panel. This nut, when tightened, locks the complete b.f.o. unit to the front panel.

![Fig. 21 (upper)](image1)

![Fig. 22 (lower)](image2)

**Components list**

**Resistors:**
- R1 10kΩ
- R2 2.7kΩ
- R3 see text on Mk1 receiver
- R4 1kΩ
- R5 1.2kΩ
- R6 8.2kΩ
- R7 5.6kΩ
- R8 100kΩ
- R9 1.5kΩ
- R10 470kΩ
- R11 680kΩ
- R12 56kΩ

**Capacitors:**
- C1 0.01 µF 20V disc ceramic
- C2 0.002 µF Hi-K ceramic
- C3 0.01 µF 20V disc ceramic
- C4 1.100pF (1,000 and 100pF in parallel) mica
- C8 8 µF 15V electrolytic
- R15 25 µF 15V electrolytic
- C10 0.1 µF 20V disc ceramic
- C11 0.22 µF 20V disc ceramic
- C12 8 µF 15V electrolytic
- C13 8 µF 15V electrolytic
- C14 0.1 µF 20V disc ceramic
- C15 0.047 µF 20V disc ceramic
- C16 25pF ceramic
- C17 25pF ceramic
- C18 8 µF 15V electrolytic
- C19 0.01 µF 20V disc ceramic
- C20 0.01 µF 20V disc ceramic
- C21 0.01 µF 20V disc ceramic
- TC1 3-30pF concentric trimmers
- TC2 3-30pF concentric trimmers
- VC1/VC2 365pF 2 gang type 0-2 Jackson Bros.
- VC3 25pF C804 Jackson Bros.

**Semiconductors:**
- Tr1 OC170
- Tr2 OC45
- Tr3 OC81
- Tr4 AF117
- Tr5 AF117
- Tr6 OC45
- D3 OA79

**Miscellaneous:**
- IFT1 470kc/s double tuned T41/1E Weymouth
- IFT2 470kc/s double tuned T41/2E Weymouth
- IFT3 470kc/s single tuned T41/3T Weymouth
- BFO Coil 470kc/s single tuned T41/3T Weymouth
- L1, L2, L3, aerial coil 3T Blue Denco
- L4, L5, L6, Oscillator Coil 3T Red Denco
- S1, 2, 3 miniature slide switch
- Slow motion drive, Jackson Bros.
- Knobs VR1 5kΩ VR2 250Ω
- Valveholders, terminals, solder tags, battery connectors, nuts and screws etc.
- Cabinet and chassis, H. L. Smith & Co.
- Used in Clubman Mk I.

The wiring and drilling of the Veroboard panel is shown in Fig. 24 and the construction of the b.f.o. box in Fig. 25.

A screened cable passes through a 3/4 in. diameter hole in the box and carries the b.f.o. signal to the connection point on the i.f./a.f. panel.
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The lid of the b.f.o. box has the flange removed at one corner as shown in Fig. 25, to clear the edge of the chassis. A hole is drilled in the lid to allow access to the tuning core of the b.f.o. coil when the lid is in place. The completed i.f. and a.f. panel is mounted in position shown in Fig. 21, by using two small right-angle brackets. Details of these are given in Fig. 20. The position of the b.f.o. box is also shown in Fig. 21 and to facilitate the mounting of the b.f.o. box, the b.f.o. switch and the a.v.c. switch, it is necessary to provide extra holes in the front panel as detailed in Fig. 22.

The i.f./a.f. panel and the b.f.o. unit are then wired to the various controls and other parts of the chassis, keeping the wiring tidy and close to the chassis wherever possible. After a check of all components, connections and wiring, the receiver is ready for testing.

Alignment

A signal generator with facilities for internal amplitude modulation is required and alignment may be carried out, in the usual way, as follows.

1—Set the receiver controls as given below:

<table>
<thead>
<tr>
<th>Control</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>ON/OFF</td>
<td>ON</td>
</tr>
<tr>
<td>B.F.O.</td>
<td>OFF</td>
</tr>
<tr>
<td>A.V.C.</td>
<td>OFF</td>
</tr>
<tr>
<td>TUNING</td>
<td>1.5Mc/s</td>
</tr>
<tr>
<td>A.F. GAIN</td>
<td>max</td>
</tr>
<tr>
<td>R.F. GAIN</td>
<td>max</td>
</tr>
</tbody>
</table>

2—Set the signal generator to 470kc/s with the modulation “on”.

3—Inject the signal between chassis and Tr5 base. The connection to the base should be via a suitable (0.01µF) coupling capacitor.

---continued on page 858
So the bargain turns out to be a flop, and the dealer's five-minute job will make him a loss unless he has the sense to swallow his chagrin and hand it regretfully back to the owner. Then, bang goes another reputation! "He couldn't do a straightforward repair," howls the disappointed customer.

Rubbing salt into the wound, the ubiquitous "chap round the corner" gets the thing going after a fashion. It is too often overlooked that he gives no sort of guarantee, may have "fiddled" the equipment, and can charge peanuts because of his minimal overheads and the fact that he does it out of a genuine interest, not costing his hours as he would have to in a commercial business.

Does that sound like sour grapes? Henry is a practising serviceman—has been for what seems a chunk off eternity—and feels pretty strongly about business ethics. He knows, as do most responsible dealers and service managers, that time is the biggest cost factor of all. Some jobs are inevitably timewasters. Experience provides the best short-cuts, and experience should be paid for. More important, the finished job should be up to some sort of reliable standard—even if the original specification cannot be attained. Henry and his mates are putting their stamp of approval on the repair; sticking their necks out.

This was rubbed in lately when a reader blew up about the refusal of a service agent for a well-known manufacturer to put his ageing tape recorder back to rights. "Use your influence to shake up the manufacturers," he told the Editor, "all it wants is a spring."

Further investigation showed that the agents had not refused service, but had advised him it would hardly be economical. In view of the age of the machine, and their experience of the prevalence of certain faults, plus the time it would take to check the relays, switches and solenoid-operated mechanism to obviate future breakdowns, they had to estimate a sum that was certainly more than the trade-in value!

Experienced readers would order the missing part and tackle the job themselves.

The alternative—have the job done properly, up to some stated level of reliability, with a guarantee of the work done, and be prepared to pay for the repair.

As a footnote—not every "simple" job is quite so straightforward as it seems. Just this week we had a tiny transistor radio handed to us with the laconic note on the worksheet: "Change batteries." First reaction was: "Why didn't the customer change them himself?"

This became obvious when we tried to take off the battery compartment cover. It was glued tight with a horrible chemical mess of burst cells that had spread all over the printed circuit and even jammed the wave-change switch. It took three and a half hours to clean out that set, trace the short-circuit in the output stage, change the transistor and its emitter resistor and finally—fit new batteries.

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MAINS TRANSFORMERS

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"EVEREST" 1-1. 5/8. 5/8.

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"EVEREST" 1-1. 5/8. 5/8.

"EVEREST" 1-1. 5/8. 5/8.
This v.f.o. is intended for use with the "Miniature Phone Transmitter" described last month but could be employed to drive other transmitters. The v.f.o. is constructed in an aluminium case matching the transmitter described.

The circuit (Fig. 1) is capable of very good results. Changes in the inter-electrode capacity in the valve due to heating etc., are largely swamped by C2 and C3. The oscillator circuitry is effectively isolated from the output (anode) circuit, thus changes in loading and the effects of modulation are minimised. The h.t. supply is stabilised by V2, the anode jumper connection being used so that the unit will not function if the regulator is removed.

Coverage

On 3.5Mc/s the v.f.o. covers 1.75—1.9Mc/s, the first stage of the transmitter acting as a doubler. The coverage may be adjusted to 1.8—2.0Mc/s for topband only, or 1.75—2.0Mc/s for two-band working.

Coil L1 has an inductance of 75µH and consists of 95 turns of 34s.w.g. enamelled wire close wound.

**Fig. 1:** Circuit diagram of the two-band v.f.o. If the transmitter is to work on topband only, then L2 is not required and may be replaced by a 22kΩ resistor.

![Circuit diagram of the two-band v.f.o.](image)

**Fig. 2:** Layout of the main components above the chassis.

Coil L1 is fitted to the chassis with its securing clip. It is broadly resonant at the middle of the 80 metre band. No slow motion drive is used on VC1 as this was felt unnecessary, however there is sufficient room to fit one if desired. It is advisable to punch a hole in the bottom of the case directly opposite TC1.

The power supply and output connections terminate at one small tagstrip. A suitable multi-pin plug might prove preferable.

Apply power to the unit, or plug the v.f.o. into the companion transmitter and switch to Net. The
original crystal oscillator will now act as a doubler and output will be heard between 3-5 and 4-0Mc/s.

For 80 metre operation only, put VCI at half-mesh and adjust TC1 until the doubler output is heard on 3-65Mc/s. For top band only, adjust TC1 for output on 19M/ce with VCI at half-mesh. For two-band working, adjust coverage to 1-75-20Mc/s.

To adjust L2, tune to about the centre of the band (say 3-65Mc/s) and rotate the core for maximum grid current in the 5763, as explained last month for testing the crystal oscillator. Grid current should be approximately 3mA falling slightly at band edges. The unit should now be calibrated and a suitable dial provided and marked accordingly.

Capacitor VC1 is a standard value which results in a little unused rotation. For 80 metre use only, it might be preferred to spread the scale. This can be achieved by removing a plate or two from the back of the capacitor, but band edges should be reached before the capacitor is completely open or closed.

If the original transmitter is used for 160 metre operation only, then L2 is not required in the v.f.o. and may be replaced with a 22kΩ resistor. The 5763 grid current should run at 2-3mA with all stages working straight through on 160.

<table>
<thead>
<tr>
<th>Resistors:</th>
<th>Capacitors:</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1 68kΩ</td>
<td>C1 56pF 1% s.m.</td>
</tr>
<tr>
<td>R2 47kΩ</td>
<td>C2 1,000pF 1% s.m.</td>
</tr>
<tr>
<td>R3 2-2kΩ</td>
<td>C3 1,000pF 1% s.m.</td>
</tr>
<tr>
<td>R4 10kΩ 10watt</td>
<td>C4 0.01µF 250V</td>
</tr>
<tr>
<td>C5 0.05µF 250V</td>
<td>C6 100pF s.m.</td>
</tr>
</tbody>
</table>

Inductors:
- L1 see text
- L2 QHFS (Osmor) TC1 25pF variable
- L3 R.F.C.

Valves:
- V1 EF91
- V2 OA2

Miscellaneous:
Universal chassis 5 x 6 x 3in. for case, and universal chassis runner 7 x 3 both from Home Radio, Mitcham; two B7G valve holders, one skirted; one B7G valve can; knob; dial; wire; etc.

THE MW COLUMN

CONSIDERING the period of the sunspot cycle, conditions have been, very good, particularly with regard to East Coast North Americans and these have been coming through from at least 2230 and have also been well received in the period around dawn, together with various Latin Americans.

My own log this month includes: VOCM St. Johns (590kc/s), WNBC New York (660), WABC New York (770), XEW Mexico City (very good on 900 at 0500), PRF4 Radio Journal do Brasil (good at 2205 on 940), CHER Sydney (0455), WFCF Chicago (very good at 0105 on 1000), WHN New York (also regular, on 1050), HJCT La Voz de Costa, Borarruquilla (very good at 0500 on 1190), Radio Puerto Cabezus (good at 0125 on 1290), WCAU Philadelphia (1210), WINZ Miami (940), WBT Charlotte (1110, regular), WZOK Jacksonville (fair on 1320), WLCP St. Petersburg (fair on 1380), WSCS Charleston (very good on 1390), WOND Pleasantville (1400), WPOP Hartford (very good on 1410), WENE Endicott (fair on 1430), WOKO Albany (1460), WSAR Fall River (1480), WCKY Cincinnati (fair on 1530), WQXR (regular on 1560), WSB Atlanta (good on 750), WJR Detroit (poor at 0300 on 760), CFDR Dartmouth (790), WHDH (good at 2350 on 850), WCBS (good at 2350 on 880), WBAL Baltimore (regular on 1090), YVQZ Radio Tiempo (fair on 1200), WWL New Orleans (good on 870).

Others heard here recently are: Surinam on 725; Georgetown, Guyana (760); HJED Cali (820); CX16 Radio Carve, Uruguay (850); YVRQ Radio Aeropuerto (910); Anhwei, China (heard evenings on 940); a tentative KOMO Seattle (fair but QRM from XEYO and WCFL, 1000); WQQT Radio Carupano (very good, 1110); St. Pierre et Miquelon (good on 1075).

Here are a few new ones to look for. Emisorra Official, Angola, has been heard testing on 1088, which with the 1367 channel should now be operating with 100kW. The Broadcasting Corporation of Biafra is now using 620 and 953; Radio Biafra is on 1320 and 1397. Kinshasa, Congo, has been testing on 836 with 5kW.

There is a new station in Madeira (Emisora Nacional) using 1kW. It signs off at 2300, on 1331kcs. Radio El Alm, Spanish Sahara, now seems to have moved from around 656 (variable) to 998. A new station in Saudi Arabia was scheduled to go into operation at the end of last year using 1250kW; this would be the most powerful station in Europe. Near East and Africa. Has anyone heard it? Addis Ababa, heard here last season on 840 is reported to have moved to 855. Anyone heard it?

The early hours of the morning should now be producing good signals from India. When looking for these note that several new ones are now reported to be in use: Aijul (920), Colombo (1010), Gulbarga (1110), Agartala (1270), Bhagulpur (1470), Mathura (1530) Hyderabad B (1060), Udaipur (1170). Although most are low powered you never know. We also hear that 100kW stations are planned for Bombay and Calcutta.

ALISTAIR WOODLAND

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YOU WILL HAVE IF YOU MAKE THE
P.E. FLUORESCENT CAMPING LIGHT

Ideal for tents, boats, caravans and any situation where there is no A.C. mains supply.
Will run from small batteries.

Practical Electronics out February 14th
ADAPTABLE LOW COST hi-fi SYSTEM

W. CAMERON

USING TWO OF THE CHANNELS DESCRIBED LAST MONTH TO GIVE A HIGH POWER STEREO AMPLIFIER

TWO of the high power circuits described last month can be combined to give a stereo unit, using ganged controls for the volume and tone control functions and adding a balance control.

Earth returns in the stereo unit obviously become of greater importance and Fig. 14 shows the system adopted to avoid troubles associated with feedback caused by high currents in the chassis. Not shown are the earth returns from the volume controls; these are taken to the earth line in the respective driver amplifiers.

The fuses in each of the supply leads must be of the ordinary quick-blow type and not anti-surge fuses, which apart from their undesirable (as far as transistors are concerned) delay have sufficient resistance to cause noticeable distortion and inter-modulation.

SELECTOR SWITCH

Figure 15a shows the switching arrangement when stereo is required only on gram. Figure 15b gives an idea of the wiring between the "phono" type input sockets, switch and balance control. Mono recordings can of course be used with this arrangement, and the inclusion of a stereo-mono switch is not necessary.

Figure 16 shows the arrangement when either stereo or mono is required on all inputs. A slide or toggle switch should be mounted adjacent and wired to the balance control to effect stereo-mono changeover.

The inputs as shown have series resistors which are suitable for, on gram, pickups with an output of 100 to 250mV/cm/S (the actual maximum r.m.s. output is several times this value) and, on radio, 100mV nominal. With higher outputs the resistor values should be increased proportionally. The auxiliary input is suitable for direct connection to a dynamic microphone or other device with an impedance of up to 30kΩ and output of 10 to 30mV. For higher impedances or outputs a series resistor must be included as discussed previously.

The wafer switch used for the selector is a Radiospares four-pole three-way one. Only two sections are used so some of the spare sections can be linked together to provide an anchor for the earthed braided outers of the screened leads.

BALANCE CONTROL

The balance control is simple and effective. It serves, with the series resistors, as a potential divider. Moving the slider toward the right-hand channel reduces the gain of that channel whilst the

![Fig. 14: Simplified schematic of wiring system used to avoid troublesome earth loops. No earth returns are made to chassis other than at the input. The most important return is from the speakers; this is taken direct.](image-url)
gain of the left-hand channel increases, and vice versa. Note that the slider earth connection is made via the screened leads and not to chassis.

**ANCILLARY EQUIPMENT**

An amplifier, however good, will not make good deficiencies in the signal source or speaker systems. For best results it is recommended that the speakers should have a flux density of not less than 10,000 gauss and a minimum frequency response of 50c/s to 15kc/s.

The gram input is designed for a medium output crystal or ceramic pickup cartridge. One which gives excellent results is the Sonotone type 9TA/HC. It is particularly suitable with the popular Garrard 3000 changer. The radio input should be from a v.h.f./f.m. tuner.

**CHASSIS**

The complete amplifier chassis was made from a single piece of 18s.w.g. aluminium, size 12 x 13in., bent into a U section to provide a chassis 12 x 7 x 3in. This will accommodate all the parts for either a single mono amplifier or a complete integrated stereo unit. These notes will deal with the stereo arrangement, but obviously apply also to the mono version. Most constructors concerned only with mono at this stage will no doubt wish to add the second channel later.

The chassis size allows for a mains transformer of the clamp construction type, with fixing centres of up to 3jln. The group panels on which the driver amplifiers have been constructed are each secured with two 6BA bolts, a couple of 6BA nuts on each serving as distance pieces to hold the boards clear of the chassis.

**MOUNTING POWER TRANSISTORS**

The power transistors are insulated from the chassis with the special bushes and mica insulators made for this purpose. A mica insulator is used as a template for marking the positions of the holes. Before mounting the transistors, it is essential that no burrs remain, as these will puncture the mica and render the insulation useless. It is good policy to rub down and polish the chassis area where the holes have been drilled prior to mounting the transistors, and finally to check the insulation with an ohmmeter.

A short piece of sleeving is pushed over the base and emitter connectors to prevent accidental short circuits to chassis. The transistors are spaced so that the securing 6BA bolts will also accommodate a length of Radiospares tag strip. The connections so made provide the collector connection to each transistor. The remaining tags serve to mount bias components etc. The edges of the mica insulators are trimmed slightly so that they do not overlap, and thereby allow close thermal contact with the chassis.

**CONSTRUCTIONAL NOTES**

Moulded feet are screwed to each corner of the chassis base. These apart from their normal function also serve to give clearance for the output transistors mounted under the chassis, and provide the necessary ventilation.

The twin fuse-holder can be cemented to the top of the mains transformer if this has a flat surface, or else bolted to a strip of aluminium held under the clamp holding the smoothing capacitors, taking care that no sharp edges are left to cut through the insulating sleeve on the capacitors.

Most mains transformers are rated to give their specified voltage at maximum current, and with

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**Fig. 15:**
(a) Input switching when stereo is required only on gram. (b) Wiring to the switch and balance control. The braided outer of the screened leads may be soldered to unused switch tags linked together.

**Fig. 16:**
Switching arrangement when mono or stereo selection is required on all inputs.
some transformers the voltage output under quiescent conditions may be unduly high. This tendency can be curbed if necessary by connecting a thermistor, type CZ1 or CZ6, in series with the mains input.

MODIFICATION

It has been found that with some makes of capacitor used in position C3a (25 µF) some low frequency instability may be present. This problem can be overcome by using a 100 µF capacitor in this position instead.

DETERMINING OUTPUT POWER

From an audio amplifier the power output is \( V^2 / R \) where \( V \) is the r.m.s output volts and \( R \) is the load impedance. Thus if an a.c. voltmeter is connected across the terminals of a 1Ω load and indicates an output of 4V, then the power output would be \( 4^2/16 \) or 1 watt.

Although an a.c. voltmeter can be used to check power output in this way it is not a reliable method of checking maximum sine wave output as will be seen.

The output from push-pull transistor amplifiers, whether using complementary pairs or matched pairs in transformerless output circuits, can be explained from the circuits in Fig. 17. When the transistor Tr1 is conducting, its resistance is lowered and the voltage at the centre point (the junction of the emitter resistors R1 and R2) will rise towards h.t. negative. Similarly when the lower transistor Tr2 is conducting, its resistance is lowered and the voltage at the centre point will fall towards the positive rail.

So it will be seen that the voltage at the centre point can move between negative and positive to a degree depending on how hard the appropriate transistor is conducting (Fig. 18a). If it were possible for the output transistors to swing the full h.t. then the output in the case of 12V h.t. would be 6V (peak) \( \times 0.707 \) = 4.242V r.m.s. (Fig. 18a). However, the resistance of the transistors and their emitter resistors represent loss (Fig. 18c).

In a high efficiency output stage this loss should be small, and for a quick calculation of power output, it can be taken that the r.m.s. volts out is about one-third of the h.t. Hence from a 12V supply the r.m.s. out will be about 4V. Therefore the power developed in a 1Ω load will be near enough \( V^2 / R \) or \( 4^2/16 \) = 1 watt. Into 1Ω it would be \( 4^2/4 \) or 4 watts, but it should be remembered that because of the higher current requirements imposed by a lower impedance load, the voltage losses will be greater, and therefore the available r.m.s. out will be less. Typically the power output into 4Ω would be expected to be in the order of 3 watts but this really would depend on the type of output transistors used and also the method and amount of audio drive into them. One could not expect low power transistors as used in the small basic amplifier described earlier to feed into speaker loads of 3 or 4Ω. They would simply blow up!

R.M.S. MEASUREMENTS

It is difficult to measure the maximum r.m.s. voltage output accurately with an a.c. voltmeter, unless the output waveform is also monitored on an oscilloscope, as only then is it possible to see when peak clipping commences (when the amplifier is driven beyond the capabilities of the h.t. supply voltage). The true maximum power output is the maximum sine wave output. When peak clipping commences, the r.m.s. output voltage will rise, and will continue to rise as the clipping becomes more severe. Thus the r.m.s. out will be much greater than peak \( \times 0.707 \) and may be as much as peak \( \times 0.9 \) (Fig. 18b). So it is apparent that the maximum output is much greater than the maximum sine wave output.

CLIPPING

One may have concluded from this that an amplifier delivering speech or music at an average level near maximum output must be making excursions into the clipping region on peaks. This is true and is permissible. A small amount of clipping does not cause objectionable distortion, particularly when the peaks of signal are of short duration as occurs in speech and music. Summing up, an a.c. voltmeter will give a reasonable if not always accurate indication of power output. When used with an oscilloscope it will give a very accurate indication as the commencement of peak clipping is observed.

The other method, of taking the r.m.s. out to be one-third of the h.t. supply, is useful for checking claims made concerning power output from amplifiers of this type.
A TRIPLE FUNCTION T

THIS unit was designed to be a completely portable testing device, suitable for rapidly locating faults in a wide variety of radio and electronic equipment. Being self-powered it is ideal for servicing transistored equipment and, above all, it is inexpensive and quite easy to construct. The unit can be built for just under £3 although many of the components may be found in the spares box. The specifications on the unit are as follows:

Voltage ranges: 0—15; 0—60; 0—150; 0—1,500.
Current ranges: 0—600µA; 0—15mA; 0—150mA.
Resistance range: 0—500kΩ.

Signal Injector: Square wave generator at approximately 2kc/s with harmonics into the i.f./r.f. region.

Transistor Tester: Suitable for p-n-p types. Will measure the leakage Ico and the approximate gain of the device under test.

CIRCUIT DESCRIPTION

The circuit of Fig. 1 consists of a simple multimeter combined with a signal injector and transistor tester. The multimeter and transistor tester are built around the well-known Ex-19 set 500µA meter movement which is available from many of the advertisers in this magazine for only a few shillings. This meter has two scales marked 0—15 volts and 0—600 volts respectively, making it ideal for this unit. Shunts are switched in series with the meter for voltage ranges and in parallel with the meter for current ranges, this is done by the six-way two-pole selector switch Si. All shunts should be 5% high stability types although 10% types may be used if an ohmmeter is available to check their accuracy. The internal resistance of the meter used in the prototype was 500Ω, if a different meter is used this may be different. The important point is to ensure that the total resistance of R1 plus the internal resistance is 2kΩ. The resistance range (0—500kΩ) uses an internal 9 volt battery which is also utilised by the transistor tester and signal injector.

The transistor tester, which is an integral part of the unit, is a modified ohmmeter circuit. The circuit in a more conventional form is shown in

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**Fig. 1 (Above):** Complete circuit of the tester.
**Fig. 2 (Below—left):** Conventional circuitry of a transistor tester.
**Fig. 3 (Below—right):** Wiring diagram of the selector switch.

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**Fig. 4: Layout of the main components and wiring diagram of the front panel.**
CONSTRUCTION

The prototype was constructed in a ready-made cabinet although a suitable one could be made from plywood. The outside dimensions are $6\frac{1}{4} \times 4\frac{1}{2} \times 2\frac{3}{4}$ in., this being about the smallest size that would allow easy wiring and fitting.

The selector switch S1 should be wired up first as outlined in Fig. 3, this can then be assembled into the cabinet together with all of the switches and sockets. Layout is not critical but it is advisable to keep the leads as short as possible and Fig. 4 will show how the front panel should be arranged. The meter may have a bracket or flange on it, alternatively a simple bracket may be made from hardboard as shown in Fig. 5. Insulated wander plug sockets are mounted on the front panel, the wires and components may be soldered directly to these so that no tag strips are necessary.

The signal injector is constructed on a piece of Veroboard which is then secured into the cabinet with a small metal bracket. The wiring of this board is straightforward and is shown in Fig. 6. When all of the other wiring has been completed, the Veroboard may be fastened in the cabinet and connected to the rest of the unit. A suitable bracket for mounting the board can be made from an old capacitor clip by bending it to form a right-angle, this should be secured with a nut and bolt to the bottom of the cabinet.

Fig. 5: Simple bracket for mounting the meter.

Fig. 6: Wiring diagram of the Veroboard and associated components.
The battery used is a 9 volt PP3 type and if no clips are available a substitute can be obtained by carefully dissecting a used PP3 battery. It will be found that the terminals can be removed quite easily without damaging the plastic that they are mounted on, and they will connect directly to another battery. Care should be taken to ensure that the correct polarity is observed when wiring the battery. The battery itself may be secured in the cabinet with judiciously placed blocks of wood, alternatively the outer part of a standard matchbox will hold it in place.

When the unit has been completed it should be thoroughly tested by making every conceivable measurement with it. If necessary the accuracy may be compared with a standard multimeter.

**VOLTS/mA**

To measure volts and milliamps, probes should be inserted into sockets marked — and +/C. The selector switch is then adjusted to the required range (always working from the high ranges down to the low ones) and the value read off on the appropriate meter scale, the other controls should have no effect on these measurements. All of the voltage ranges are d.c. and to measure high voltages up to 1,500 volts the positive probe should be plugged into the appropriate socket and the selector switch set to the 150 volt range.

**RESISTANCE**

To measure Ohms the selector switch should be turned to the 600μA range and probes inserted in the Ω/E and +/C sockets. With the probes touching, the meter is adjusted to give full-scale deflection with the potentiometer. Since the meter is not calibrated directly in Ohms, if quantitative measurements are to be made, the meter reading (0-15 volt scale) is noted and the value of the resistance under test read off from the scale of Fig. 7.

**TRANSISTOR TESTS**

To test p-n-p transistors, three probes should be inserted in the sockets marked +/C, B, and Ω/E; these connect to the collector, base and emitter of the transistor respectively. The selector switch should then be set to 600μA and the potentiometer turned fully clockwise, the leakage Ico should now be indicated (0—600μA scale) and for a general purpose p-n-p transistor this should not be greater than 200μA at 20deg.C.

**GAIN**

To measure gain, the press-button marked GAIN is depressed (S2) and the increase in meter reading noted. This increase divided by 10 gives an approximate value for the current gain α. The value of α cannot be determined accurately by this method as it is not necessarily a constant under these circumstances. It may be necessary, when the leakage has been found, to turn the potentiometer slightly anticlockwise before the gain is found.

**SIGNAL INJECTOR**

The signal injector is used as follows. The probe illustrated in Fig. 8 is inserted into the output socket and the injector switched on by the toggle switch. The wander lead is clipped to the + battery line of transistorised equipment or the chassis (— line of valve equipment) then in the case of, for example, a radio, the probe is applied to the slider of the volume control preceded to full volume and with the set switched on. The output amplitude of the injector can be varied by adjusting the potentiometer. If a note is heard in the headphone or speaker then the fault in the receiver lies in the r.f. or i.f. stages.

If no note is heard then the fault lies in the a.f. stages, i.e. between the loudspeaker and volume control. If, for example, the latter fault existed then the probe should then be applied to the output transformer secondary and primary windings, base of output transistors and so on, working back from the loudspeaker to volume control. The injection should proceed until a point is found where the signal is not heard when the probe is applied. The fault then lies between the point found and the one previously checked when the signal was heard.

**FURTHER TESTS**

A similar procedure should be followed if the fault lies in the r.f. or i.f. stages, starting by injecting the signal at the diode, then the bases of the i.f. transistors and so on back to the aerial. It should be pointed out that a transistor may for some reason lose its gain but still pass a signal. This method of fault finding would not reveal this fault, which, fortunately, is seldom encountered.

A good test in transistorised equipment is to measure the voltage across the emitter resistor of each transistor (if there are any!). The voltages measured should be within 10% of the values given in the service sheet or manual. If this is not the case there is most likely a fault in that particular stage.

For those who wish to make the Ohms range calibration accurately the following should help. If M is the meter reading (0—15), then resistance R under test is given by: R = 225/M—15, answer in kΩ. For example, when M = 7.5, R = 225/7.5—15 = 15kΩ.

**CONCLUSION**

In conclusion, while the test unit may be used confidently for most routine checks its limitations should be realised and should not be used too ambitiously. It should be used with care when dealing with valve equipment and the signal injector should not be used to fault-find in the a.c./d.c. type of radio or television receivers.
LETTERS...

Please play the game chaps

Thank you very much for publishing my letter regarding the disposal of back numbers of P.W. I received more than 50 requests for these and had cleared them all within about a week.

One feature stands out, however. I received about a dozen requests for copies as gifts, and without exception none of these were accompanied by a stamped addressed envelope. It cost me several shillings to reply to these. Could you please ask your readers to observe this elementary courtesy?—R. J. Morris (Melton Mowbray, Leicestershire).

[We must emphasise that if readers do write to people who offer issues or information, they must enclose a s.a.e. We make this ruling ourselves with our Query Service. No s.a.e. or Query Coupon, and no reply!—Editor.]

Instant Silence

Instant silence is the greatest unsatisfied need of the age in which we live. Any manufacturer who produced a comfortable headset which would completely shut out sounds of conversation or other noises, when not in use for wireless reception, I think has a ready-made national market.

I have been looking, without success, for an Army No. 19 Set headset for five years, so that I can use it as an aid to concentration in chess matches.

The instant silence set would also be useful in parks or on long-distance trains, to shut out the sounds of “yappers”, when one just wants to think or relax.


No auto transformer

In the “Your Questions Answered” section of PRACTICAL WIRELESS you advised Mr. J. Macfarlane to use an auto transformer to drop 220V to 110V at 75 watts. A much cheaper and just as reliable way is to use a 75 watt bulb in series with the iron. I have been using this system for some time now and I have found it completely satisfactory.

—A. Jefford (Devon).

Radio Alarm

The idea that Mr. H. S. Barker mentions in his letter on page 690 of the January 1968 issue, is in fact, in use by most electricity boards (in the South at least) in the control of “off peak loads”, “night metering”, some “street lighting”, etc, etc, and this idea is used in the time switches used to control above. This allows for correct time to be maintained even during a supply failure up to about 30 hours; on resumption of supply, spring reserve will be left fully wound. The saving in man hours to reset clocks is obvious when you realise the many, many thousands in use.

So, Mr. Barker, do not think your idea outdated because even now an experimental 2-dial and 3-dial meter to register units on selected dials Low High Normal at Low High Normal prices per unit during selected periods is in fact controlled by a similar time switch.

The idea of course is to try and shift peak use from peak periods by offering cheaper electricity at selected times.—H. A. Blunden (Guildford).

Any old gear?

The Peterborough Amateur Radio Society, of which I am Hon. Secretary, will be holding an exhibition of “Wireless in the Twenties” at their Mobile Rally at Peterborough on August Bank Holiday.

If any reader has a very old wireless set, ancient valve, or old radio book or magazine, would they please drop me a line? Thank you.

Later, it is hoped to form a Radio Museum and so keep this ancient equipment for the benefit of future generations.—Douglas Byrne, G5KPO (Jersey House, Eye, nr. Peterborough, Northants.).

Electronic metronome

With reference to the Electronic Metronome, August 1967 issue, I would like to point out that the correct value for R3 is 100 ohms and not 100kΩ as the circuit diagram indicates.—A. Jay (Limerick, Eire).

Not always true

One of your correspondents has said, referring to Mail Order, “you get what you pay for” but I am afraid this is not always the case.

An interesting article on a crystal calibrator set me off and as the source of the crystals was mentioned I wrote asking for the price of certain crystals together with sockets and after 10 days received just a price list and an order form.

I ordered two crystal units and sockets to match, the price list did not make clear the price of sockets so I included 1s. 3d. for each. I may add that there is a handling charge of 2s. 6d. for each order.

Almost by return I received the crystals but no sockets. There was a delivery note but no mention as to why the sockets were not sent.

I immediately wrote pointing out that I had ordered and paid for two sockets and 11 days later received a short note saying “with reference to sockets recently ordered—credit note enclosed”; a credit note for 1s. 3d. was enclosed—note 1s. 3d. not 2s. 6d.

If they could not supply sockets they should have said so in the first place and I contend that they should refund the amount paid and not send credit notes.

I suppose I shall have to think myself lucky that the item in question was only shillings and not pounds.—R. Haworth (Manchester, 21).

A simpler method

With reference to the letter from Mr. J. Macfarlane in “Your Questions Answered” in the January 1968 issue, I would like to point out that it is not necessary for him to purchase an auto-transformer for his soldering iron. A BY100 or equivalent in series with either mains lead would be equally effective and certainly cheaper and more compact. It is of course essential that the diode be insulated in order to avoid contact by the operator. Polarity is of no importance.

—M. Francis (Cheltenham).
Undoubtedly more and more amateur constructors are now using semiconductors in preference to valves. This being the case, there must be many who have complete sets of coils which have, in the past, been used with valve circuits but which now seem likely to be relegated to the darkest corners of the junk box.

Some time ago, a general coverage multi-waveband shortwave receiver using semiconductors was decided upon by the writer, but the expense of purchasing a set of brand new coils as well as a set of i.f. transformers and the like led to this idea for a project being temporarily shelved.

Recently, however, a number of experimental circuits were made up to see if it would be at all practicable for coils designed and intended for valve circuits to achieve any measure of success when utilised in semiconductor circuitry. The main problem appeared to be one of matching impedances, since a coil possessing a particular inductance would not alter its value merely because a semiconductor was used in place of a valve. The basic consideration boiled down to matching a high impedance tuned circuit meant for valves, to a low impedance input required by a transistor.

Circuitry

Figure 1a shows the generally accepted method of matching the low impedance base input of the transistor to the high impedance presented by the tuned circuit. The coil L1 is the aerial coupling coil, while L2 together with the tuning capacitor forms the first selective circuit in the receiver. Coil L3 is a low impedance winding inductively coupled to the other two, which will pass on the signal to the base of the transistor. In Fig. 1b this latter low impedance winding is not required because the high impedance of the tuned circuit can be fed directly to the high impedance input of the valve.

The first logical method of adaptation appeared to be the addition of a third low impedance winding to each coil in order to feed the base. However, when it was realised that a four-waveband superhet receiver complete with r.f. stage contains a minimum of twelve coils, it became apparent that the whole procedure would be both tedious and time-consuming, not to mention the physical difficulties of the correct degree of coupling, etc.

Impedance Matching

Recalling the early days of semiconductors when there were very few associated coils and other suitable components available to the home constructor, the problem of matching the base input impedance to the input circuit was very often overcome by using a capacitive tap. This method is depicted in Fig. 1c, where the two capacitors, C1 and C2, form the tap. By altering the respective values of these two capacitors, it is possible to alter the impedance “seen” at the tapping point. By making their values low (low in pF’s), we can avoid their affecting the tuning of the parallel circuit formed by L2 and the variable capacitor. Although the two capacitors are in parallel with the tuned circuit, they will not detune it to any great degree. This is because (a) although capacitances in parallel add, thus the capacitance of C1 and C2 will add to the value of the tuning capacitor, (b) the two capacitors (C1/C2) are themselves in series and thus their effective capacitance is less than the value of the smaller of the two. Thus by keeping these two capacitors to the low value, the capacitance added to the circuit will be very slight and can be offset by slight adjustment of the core in the tuning coil.

Applications

The initial circuit used to experiment along these lines is shown in Fig. 2. This is a straightforward t.r.f. type of circuit without the complication of frills and gimmicks. The transistor, Tr1, functions as a tuned r.f. amplifier with an inductive collector load L3. Coil L4 is the secondary winding on this load and feeds the amplified r.f. signal to the diode, the audio being developed across the resistor R4 and fed for subsequent a.f. amplification via capacitor C8. The capacitive tap for base matching is formed by C1 and C2. For the OC170 the values shown proved optimum. The coils in this circuit are the Wearite PA2 for L1/L2, and PHF2 for L3/L4. Considering the simplicity of the circuit, selectivity was reasonably good.

The Superhet

Encouraged by the results obtained from Fig. 2, a superhet mixer was built along the lines indicated in Fig. 3. The coils in this instance were the well-known Denco types, range three being chosen because this embraces the two lower amateur bands plus trawlers etc.

The white coded coil was used in the oscillator position, and the i.f. output at 1.6Mc/s was then fed from the 1.6Mc/s i.f.t.l., into a domestic superhet tuned to the highest frequency of the medium waveband. After aligning in the usual manner this single transistor converter gave a very lively account of itself, therefore, the next step was to precede this mixer by a transistor r.f. amplifier.

The final circuit of this two-stage converter is shown in Fig. 4. When it was aligned and fed into the superhet already referred to, the unit performed extremely well and fully justified the effort in making it.

Certainly if a receiver using semiconductor circuitry is to be built from scratch, the proper transistor coils should be obtained.

Note. The capacitors shown in dotted lines should be omitted from the circuit. These capacitors form standard circuitry but must not be used in these circuits as they will upset the tuning.
Rubber sleeve

Fig. 1a: Method of matching the base of a transistor.

Fig. 1b: Tuned circuit connected in valve circuitry.

Fig. 1c: Using a capacitive tap for matching.

Fig. 2: A simple t.r.f. circuit.

Fig. 3: Mixer stage using valve-type coils.

Fig. 4: Two-stage converter using valve-type coils, and capacitive taps for matching.
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FROM this issue on in the Broadcast Band column we will take a look at propagation conditions in the different broadcast bands.

During the winter months here in the northern hemisphere as the days are shorter the ionosphere will not reflect the higher frequencies of 25, 21, 17 and 15 Mc/s the greater part of evenings here in Europe. 25 Mc/s is dead by 1700 GMT, 21 Mc/s by 1830 GMT, 17 Mc/s by 2030 GMT and 15 Mc/s by 2200 GMT. But some nights these bands stay open later, this is due to a sunspot disturbance, and the next day the band will be disturbed and close a lot earlier than usual. Also, during the winter evenings there is a greater “skip” distance, signals from the UK transmitted on 6 Mc/s will bounce right into Central Europe, whereas in the summer 6 Mc/s would reach Holland on the first hop.

In February as the days lengthen in the northern hemisphere the higher frequency bands will stay “open” later in the evenings, and the “skip” in Europe will start a little later in the evening. So again reception of Holland on 6 Mc/s will be possible in the early evening and Switzerland will give steadier, stronger signals on 6 Mc/s.

On the 2nd and 3rd March operating schedules of most overseas broadcasting shortwave stations will change over to spring in the northern hemisphere and autumn in the southern hemisphere schedules. So most of the information in this column will be liable to change on that weekend. But in the April issue we will list as many of the new schedules as possible. Also, note that on 18th February Great Britain goes on to British Standard Time so please add 1 hour to all times shown. Now on to this month’s DX-tips.

AFRICA


Rwanda: Deutsche Welle Relay station at Kingali is now on the following schedule: 0300–0330, 0345–0530 GMT on 9,565; 0545–0745 on 11,905; 1045–1145 on 11,785; 1200–1400 on 17,765; 1415–1445 on 15,245; 1500–1730 on 9,735; 1745–2015 on 17,765; and 2030–2235 on 15,380.

South Africa: Radio R.S.A. now transmits its English service to the UK and Eire from 1900 to 1950 GMT on 17,790 and 11,875. The North American transmissions are now as follows: 2362–0020 17,805. 15,220; 0026–0220 15,220, 11,875; 0226–0320 11,875 9,705.

ASIA

Afghanistan: Now transmits to Europe in German and English from 1730–1830 on 25mb, has been heard on 11,770, but is trying to find a clear channel in the 25mb, heard regularly on 9,545.

Israel: Kol Israel transmits two English programmes daily 2015–2030 on 9,725 and 9,625 to Europe, 9,009 to S. Africa, 2115–2130 to Europe on 9,725, 9,625 and 9,009.

Philippines: The only transmission beamed to Europe from Far East Broadcasting Co., Manila, is the Russian programme from 1615 to 1730 and English closing announcements 1730–1738, beamed to Europe on 11,850 and 9,545, to Eastern Siberia on 11,890 and to Asian USSR on 7,230 and 6,030; 11,850 does not start, until 1631.

AUSTRALASIA


Radio New Zealand transmits as follows: to Pacific Islands in English 1700–1945 11,780, 9,520; 2000–0545 15,110. 0600–0800 also in Samoan, Rarotongan and Niuean as well as English on 11,780, 9,520. English weekdays 0800–0845 11,780, 9,520. English Sundays 0800–0845 11,780. To Australia in English 2000–0545 17,770; 0900–1145 11,705, 9,520. To Antarctica in English (Sundays only) 0815–0845 9,520.

NORTH AMERICA

Radio Canada, Montreal has made some changes to its evening services to Africa and Europe now as follows: 1832–1958 English and French to Africa 17,820, 15,320, 11,720; 2001–2150 French and English to Europe 15,320, 11,720, 9,610.

EUROPE

Monaco: Trans-World Radio, Monte Carlo English transmission on Sunday afternoons is now on 7,230 from 1515 to 1630. On Saturdays from 0710–0725 there is the DX-special on 7,295.

We would like to thank the Sweden Calling DX’ers Bulletin for information supplied.
ABOVE DX station WB1IA, W1WQC, YU2RC, 9H1R, SL3ZZN, SM4CTF, UA2WJ, WA4ZE, W3OV, DJ3WI, DJ6WX, DL5CG, R.S.G.B. KIYIW, eighty. says with b.f.o. and weeks in the month, Zambia will plenty of things like ZS, transmitting from topband when WOYOP, YO3AID, and CN8FW. Yet and producing some very good contacts so it could well be a bumper year for all r.f.-loving hounds.

The six bands from 1.8—30Mc/s are going through a bit of a patchy period at present, especially the three h.f. segments. This explains why one person will listen and hear nothing, while another s.w.l. with roughly the same gear will hear half the world.

G. Haslip (no address on the letter—probably working portable in Hyde Park), has a 3-valve t.r.f. and heard these on ten metres a.m.—UA2KAA, UC2AOL, UC2DZ, UP2NX, UD5DUD, W3IAC, W2YOP, Y03AID, and CN8FW. Yet the other day when I listened for a spell on ten I didn’t hear a thing.

Chris Kirby (Oxon), says that nothing much on topband seems to arrive at his QTH, he reckons the best band this month is eighty where he logged VQ9JW and weirdy—6E1AEP. By the way, Zambia has decided to issue 913 call signs.

Rummaging around in my personal postbag this month, the following dispatches were received.

BELOW 7Mc/s

J. Bradley (Co. Donegal), R1224A, 50ft. end fed, has been listening on eighty metres for about six weeks in the Emerald Isle. On s.s.b. after 2200hrs he logged—CN8AW, CT1QO, LA3XI, ON4UN, OZ6PG, PAOQDTT, SM7ABO, SP6AAT, SP8AVB, TF5TP, UP2OV, UR2IV, VE1AOZ, VE1WA, VE2TJ, W1FRR, W1WQC, W2GO, YU2RAZ, ZB2BC. A point to remember when listening on eighty is that the American stations are licensed to transmit from 3.5 to 40Mc/s whereas the British amateur is limited to 3.5 to 38Mc/s.

D. M. Clark (Bucks.), P.W. progressive superhet with b.f.o. and S-meter, 60ft. end fed running NW/SE says that twenty is very present at hand. He heard things like ZS, VE, 8R, PZ, 5Z4 and one he queries—7P8AR. Mr. Clark sent in a model log for eighty. Among those listed on s.s.b. were—D5LMA, K1YW, LA3ZH, OES3BW, OI1AF, OK1BY, OZ1BQ, PA0GHB, SL3ZV, VE1IE, V01FX, WI1MM/P, W1ZF8, W2FZJ, YU2N6J, ZA2MJC.

D. V. Godaby (Leics.), HA700, 140ft. tapped at 44ft. (VS1A) or multi-band Windom aerial (see R.S.G.B. handbook), logged these on 80 s.s.b.—DJ3VI, DJ6WX, D5SCG, DU1AS (Philippine Islands), F9DH, I1BLU, K1YW, K1BCK, K23Y/P, LA3XI, ON4XJ, OZ9FJ, PA0HPR, SL3Z2N, SM4CTF, UA2WJ, WA4ZE, W3OV, WB1IA, W1WQC, YU2RC, 9H1R, 9J2BC.

Sad to say nobody reported hearing the famous DX station G3JDG on topband this month. It’s no good, I’ll just have to use an aerial like the rest.

ABOVE 7Mc/s

David Henry apologizes for not having had much time to listen because of end-of-term exams, and then proceeds to send a list of the most gorgeous DX including all those I didn’t hear. David lays in wait for the DX with a HA500 receiver and then harpoons it as it passes with a 7ft. copper rod at thirty feet. He hopes Santa will bring a Joystick, but meanwhile the 7ft. rod managed to skewer—CR6IV, DU1TFH, HK4BFQ, HR1JAP, JT1KAA (Mongolia), KG6AQG (Guam), KG6SA (Saipan), OA4CV, P9JCT (Curaçao), PZ1CI, RU2BA, TY2KG, VP1LL (British Honduras), VP2AA (Antigua), VP2LA (St. Lucia), VP5DJ, VP6TBZ (Saunders Island in the Falkland group), VP8IE (South Georgia), VP8UI (Austral Island), VP8JD (Signy Island in the South Orkneys), Y18BW, ZD8RH, 9X5PB, 9Y14A. All this gang on twenty metres s.s.b. Notice all the VP8 call signs. I mentioned the activity in the VP8’s last month.

G. Richards (Isle of Wight), five-valve domestic receiver, bent long wire (80ft.), draped his ears on the fifteen metres band to detect this bunch on a.m. phone—CT1JN, CT1IVA, DK1PG, EA4IA, ET2FJ, G3CJX, G3UXM, H1AMS, H5RO, K1GUP, K2UTC, K4GLY, K5PMZ, LA7KK, OE3MJW, OH3LS, OZ5ND, SM3AT, SP0PZM, UA2KUP, U2A5H, VE1GD, VE3UKL, W1RF, W2CDY/P1 (on s.s.b.), W3BV, WA4PDY, WA4GU, Y02BV, YU2EQ, YU10W, which is pretty good for an ordinary domestic receiver. Quick—into the living room and fire-up the gramophone.

N. Edwards (Southampton—SO1 2HNO) (Funny callsign!), is fourteen years old (congratulations Sir!) and is a member of the Southampton Radio Society. His “tools of the trade” are an 840C receiver and a 100ft. V aerial running East/West. Alone in the ten-metre wilderness, Nicholas observed a.m. coming from—IT1SMSO, K4ZYY, SM3DMM, UA11B, UA3JQC, UA3KHD, UA3MRH, UB5CDV, UB5DUS, UB5FGC, UC2APW, UL7AWD, UP2YNC, UV3ABA, UV3ABW, VE1AOG.

LEG PULLING

A word about sending in logs for those uninitiated and just “dunno”. First and foremost—only genuine logs please. Some of the lists I get, if genuine, would quality for the eighth wonder of the world. As an example, a recent log of quite fantastic DX was received from a listener who claimed that he was right—ten metres was really humming. His receiver (he claimed) was a one transistor (admitted he did claim to have regeneration) followed by a three-transistor amplifier. The bit that hurt was that the line-up was an OC45 into three OC81’s. Just for the record, the OC45 has an f₁ of 6Mc/s, so on ten metres the set amounted to a crystal detector and an a.f. amplifier. So please slaves—only what you hear and not a grand pulling of “3JDG’s hoof.

CONTESTS

Examination of my little black book shows four contests coming up soon. These are—February 11th, First 70Mc/s contest; 17—18th, First 18Mc/s contest (c.w.). Early March contests include—March 2nd—3rd, RTTY contest for the teleprinter enthusiasts; 3rd—4th, Third 14Mc/s contest.

Deadline for logs this month is the 20th.
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THE power supply is provided by two 6V batteries arranged in series. Since the equipment was designed for 9V operation a potentiometer VR8 is inserted in series with the supply and can therefore be used to set the supply voltage. It has the disadvantage that VR8 is in series with the intrinsic impedance of the power supply with the result that a path exists for unwanted signals to flow between the oscillator and the frequency meter. Normally, with both units working, if S3 is switched to EXT with no input, the meter should not read if S4 is turned to Monitor (Set) Freq. Due to the high impedance however sufficient oscillator voltage is passed to the frequency meter via the power supply to make the meter respond to the internal oscillator irrespective of the position of S3. Decoupling both sections by high value electrolytics C11 C22 cures this effect, and the use of a two pole switch for S3 is desirable.

CONSTRUCTION

With solid state equipment the use of some form of circuit board is almost mandatory. Consequently a means was sought which would be reasonably inexpensive and easy to fabricate, and capable of easy modification, if this became necessary. Such a means is provided by turret tags which are inserted into holes drilled in a suitable piece of bakelite or paxolin and then riveted over.

The boards on which the oscillator and frequency meter are constructed are of ¼ in. paxolin and measure 8 x 3in. Figures 7 and 8 show the wired and assembled circuit boards. The thermistor which is comparatively fragile, should be fitted with a piece of felt between them) by means of an elastic band passing through two small holes drilled in the paxolin in either side of the transistor and then tied together on the reverse side of the board. All interconnecting wiring on each panel is carried out on its reverse side.

PRELIMINARY TESTING

Upon completing the circuit boards, it is advisable to establish if they are functioning correctly before wiring them together on the front panel, as mistakes or faulty components can be located and rectified more easily at this stage. Flying leads should be soldered to the respective tags of VR1 a, b and the other ends soldered to the appropriate points on the tag board. Any pair of capacitors out of C1—C4 and C5—C8 should be wired into circuit and leads should be soldered to connect VR2 and VR3 to their respective points on the circuit board and after a final check to ensure that everything is correctly connected. The power supplies can be applied with VR8 set to maximum resistance. This acts in the manner of a safety device by limiting the maximum current the circuit can draw in the event of a fault being present. An oscilloscope or high resistance headphones connected between C13 and chassis (+ve side of the supply) will indicate the presence or absence of oscillations. VR2 should vary the output between zero and maximum, determined by the setting of VR3, which affects the amplitude and waveform of the output signal. The maximum output is in the region of 1.500mV (1-5V) and when the signal is reduced to 1,000mV it should be free from all apparent distortion. This concludes the preliminary tests on the oscillator panel.

The frequency meter is checked by soldering into the circuit the differentiating capacitor (C18—C21) corresponding to the frequency range of the oscillator panel. C14 should be connected to the junction of C9 and R9 and one
of the pre-set potentiometers VR4 to VR7 should be temporarily connected into circuit. The oscillator frequency is next determined by comparing it to the 50c/s a.c. mains supply by means of Lissajous figures and the pre-set pot is adjusted to make the meter read this frequency. The scale linearity can be checked by adjusting the oscillator frequency and seeing if the meter readings correspond. Any deviation can be corrected by altering R34 though this should not normally prove necessary. Although leads terminated in crocodile clips such as used by the author are very convenient it is probably safer to solder all flying leads into circuit.

Once it has been established that both units are functioning correctly they can be bolted on to the front panel and the remainder of the wiring completed.

COMPONENTS

The working voltages of all capacitors with the exception of C14, need not exceed 15V and in fact one capacitor will have to be limited to 6V working if it is to be incorporated on the circuit board. This is C9 (500µF) which is on the bulky side even at 6V. C14 which may be connected to varying voltages of differing polarities should preferably be a reversible electrolytic with a working voltage at least equal to, and preferably higher than, the highest voltage it is likely to encounter. Unfortunately paper capacitors of equivalent capacity are almost always on the large side and it may prove easier to use two 16µF electrolytics back to back in place of C14.

It may prove desirable to include a series isolating capacitor between the output socket and S4 if the oscillator is to be fed into a point of high d.c. potential, as for example, the anode of a valve. Without such a capacitor, the attenuator resistors could suffer damage. Due to the low characteristic impedance of the attenuator, such a capacitor would have to be made as high in capacity as possible, in order to minimise low frequency losses. Again, the working voltage must be adequate.

Although a two gang 10kΩ wirewound potentiometer was used as the fine frequency control in the experimental stages of the prototype, it was found to suffer from two major disadvantages which made it desirable to replace it with the component specified. A wirewound potentiometer can be regarded as being composed of a large number of individual resistors in series, with its wiper corresponding to the wiper of a multi-way rotary switch. Whilst this may not prove to be a disadvantage in some applications it has the disadvantage, in the present application, of causing the frequency to alter in small increments instead of smoothly, making the selection of a precise frequency often difficult if not altogether impossible.

The second disadvantage is that being wirewound it possesses a certain amount of self-inductance

![Fig. 8: Wiring details of the frequency meter panel](image)
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Fig. 9: Dimensions and details of the drilling for the front panel of the unit, viewed from the front.

Fig. 10: Sketch showing the wiring of components mounted on the inside of the front panel. All other wiring is contained in the two circuit boards of Figs. 7 and 8.
which becomes noticeable at the higher frequencies by causing the output voltage to fall well below its mid band (1kc/s) level. The reason for this is not hard to find if we remember that one section of the potentiometer is in series with the oscillation producing positive feedback, with the result that its inductive reactance increases with increasing frequency and thereby reduces the feedback, which in turn reduces the output voltage. Although the thermistor can compensate for this to a certain extent, it is unable to restore the output to its 1kc/s level. The measured drop (using the wirewound potentiometer was 4dB at 150kc/s relative to the 1kc level (measured across VR2).

Where resistor leads are short, it is advisable to use a heat shunt to avoid excessive overheating which often causes an appreciable resistance change.

The meter is the most expensive single item and it is desirable to acquire the best available, consistent with one's individual means, since the performance of the equipment as a whole is greatly dependent upon it. Apart from the desired sensitivity, it should have a clear open scale calibrated from 0—10 or 0—20. Some meters are calibrated expressly for use in a particular position and for use on a ferrous or non-ferrous panel. Any departure from the maker's recommendation can therefore lead to inaccurate meter readings.

The transistors used are freely available and cheaply available. The use of alternative transistors has not been investigated.

THE CLUBMAN

4—With a suitable insulated trimming tool, adjust the tuning core of i.f.t.3 for maximum audio output, reducing the output from the signal generator as necessary, to avoid overloading the a.f. stages.
5—Disconnect the signal generator and connect to Tr4 base and chassis.
6—Adjust the primary and secondary cores of i.f.t.2 for maximum output, reducing the signal generator output as necessary.
7—Disconnect the signal generator and connect to Tr1 base and chassis.
8—Adjust the primary and secondary cores of i.f.t.1 for maximum output.
9—With the signal generator still connected to Tr1 base, repeat the adjustments 4, 6, and 8.

This completes the i.f. alignment.
10—With the signal generator connected as in 9, switch the signal generator modulation “off”.
11—Switch the receiver b.f.o. “on”.
12—Adjust the b.f.o. tuning capacitor VC3 to half capacitance (90deg. from fully meshed).
13—Adjust the tuning core of the b.f.o. coil until the b.f.o. is heard to zero-beat with the 470kc/s signal from the signal generator.
14—Check that rotating the b.f.o. tuning control VC3 produces a beat note of approximately equal frequency at maximum and minimum capacitance. This completes the b.f.o. adjustment.

The r.f. alignment is identical to that previously described for the Clubman Mk I.

The performance of the receiver when fully aligned is as follows:

Sensitivity 1.8Mc/s 5µV 50Mc/s 3µV

We come now to the only component that may prove difficult to obtain, at least in provincial areas. The author, who ordered his thermistor through his local dealer, had to wait for some eight weeks even though he was told he could have a gross in a week!

The range switch (S1) is the only switch that is in any way critical, that used by the author had two three-pole four-way wafers, of which only two poles on each wafer are actually used. The two wafers should be as far apart as practicable, the wafer nearest the front panel being used for switching the frequency meter, and the other wafer used to switch the audio oscillator. The wiring to the switch should be kept short and direct. No interaction was noticed on the prototype between the two wafers and their associated wiring, but should it occur an aluminium screen, made as large as practicable and inserted between the two wafers should cure the trouble.

S2 and S4 are of the wavechange variety, S2 being a single-pole three-way switch and S4 a three-pole four-way switch. A two-pole three-way switch was used for S2 because it happened to be handy and the spare tags used to anchor R18 and D1 D2.

S3 is a miniature two-pole two-way slide switch and can if desired be replaced by a two-pole two-way rotary switch. The meter short-circuiting facility should not be omitted whatever changes are made to the rest of the switching.

next month—Calibration

(For 50µW output, 6dB s/n ratio, input signal modulated 30% at 400c/s)
Selectivity 3dB down 3kc/s
20dB down 10kc/s

The controls of the Clubman Mk II are self-explanatory but the following points should be borne in mind.

1—For the reception of a.m. signals the a.v.c. is normally switched on. To obtain best results from the a.v.c. system, the r.f. gain should be set at maximum unless noticeable overloading occurs from very strong signals.
2—For the reception of c.w. signals, the a.v.c. should be switched off and the c.w. signal tuned in. The b.f.o. should be switched on and the b.f.o. tuning adjusted to give a suitable beat note. The r.f. gain should be adjusted to avoid overloading of the i.f. stages to give the cleanest signal with respect to any interference that may be present.
3—For the reception of s.s.b. signals the r.f. gain should first be set to minimum and the a.f. gain to maximum. Increase the r.f. gain slightly and carefully adjust the s.s.b. signal. Switch the b.f.o. on and carefully adjust the b.f.o. tuning control until the s.s.b. signal is resolved. Slight adjustment of the r.f. gain may now improve the results. It is important to keep the a.f. gain near maximum and the r.f. gain at the minimum level for satisfactory results.

References

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**P.W. DATA RULE**

**PART 5**

In this final article concerning the Data Rule (still available at 5s. from the Blueprint Department), some practical applications will be considered.

**CONSTANT-CURRENT GENERATOR DESIGN**

The generator that will be developed is intended for driving only low impedance loads, loads which will not develop more than about 3V. It is ideally suited for driving emitter-base currents, in, for example, a transistor tester, and the value of constant-current can be programmed by switch positions. The useful range of the circuit is about 0.5µA to 50mA.

Figure 1 shows the basic circuit in which Tr1 and Tr2 form a long-tailed pair, the base of Tr1 being held constant at a set voltage. The emitter-base voltage of the transistors can be regarded as a constant, therefore the emitter of Tr1 must also be held constant. The emitter of Tr1 is linked to the emitter of Tr2, since they both draw their emitter currents through the same emitter load. Since Tr1 base is clamped, also effectively clamping its emitter, Tr2 emitter is also clamped, and an identical emitter-base voltage to Tr1 means that Tr2 base will be clamped at the same voltage as Tr1 base.

The emitter resistor Tr3 is thus totally influenced, in terms of current, by this clamping, since a constant voltage is maintained across this resistor. Because there is constant voltage across the resistor, there will be constant current driven through the Tr3 emitter. The BC109 is a very high gain device, and thus we can assume that the collector current is virtually all of the emitter current, and thus, in effect, constant current, programmed by the Tr3 emitter resistor, is driven through the collector load.

To allow accurate programming, since \( I = \frac{V}{R} \), the voltage to be presented at Tr2 base should be adjusted in order that a preferred resistor value will provide the required constant-current/s. The circuit will be designed to produce currents of 1µA, 10µA, 100µA, 1mA and 10mA. As seen from the Preferred Resistors Table on the Data Rule, 6.8 is a preferred value. Since we want multiples of ten in terms of constant current, then the values of current can be produced by 6.8V across different resistors with multiples of 6.8Ω. Thus we must design for 6.8V at Tr1 base. The transistors in this circuit are all silicon, giving \( V_{BE} \)'s of about 0.5V, therefore the voltage across R4 must equal \( V_A - V_{BE} \) of Tr1, i.e., 6.8V - 0.5V = 6.3V. As shown on the figure, we shall drive the transistors with 1mA emitter current apiece, therefore the current through R4 will be the sum of the two, namely 2mA, and therefore:

\[
R_4 = \frac{6.3V}{2mA}
\]

Adjust the rule slider to give 6.3V in scale R opposite the coloured "V" mark on the central window. Read off the value of R4 in scale U opposite 2mA in scale V, i.e., 3.15kΩ. Refer to the Preferred Resistors Table on the other side of the rule, and see that the nearest preferred value is 3kΩ, and therefore R4 = 3kΩ.

Now consider the bias chain for Tr1, and the zener diode, D1. Bearing in mind the possible spread of zener voltage, \( V_z \), R2 must be capable of adjusting to 6.8V. Consider the spec. for the OAZ203 zener diode given in the table on the following page.

If we run this diode at \( I_z = 1mA \), the maximum \( V_z \) closely approaches the required 6.8V, but cannot exceed it. Now in the minimum case, \( V_z = 5.8V \), R2 must drop at least 6.8 - 5.8 = 1.0V. Since the zener current is 1mA, therefore \( R_{2min} = \frac{1V}{1mA} \). The answer to this is obviously 1kΩ, however the rule could be employed as a further illustration. Set scale R to 1V, and read 1kΩ adjacent to 1mA in scale V. Thus, since this happens to be a preferred value for potentiometers, usually found to follow multiples of 1, 2 and 5, we shall make R2 a 1kΩ pot.

Now R1 has to drop the remaining voltage in the chain, which can be line voltage minus 1V across the pot, with a further 5.8V in the worst case, giving 5.2V.
Now if $V_z$ is its max., the voltage to be dropped by $R_1$ reduces to 4.4V and the two resistance values could then be usefully computed. Set 5-2V on scale R and read the resistance 5.2kΩ opposite 1mA in scale V. Set 4.4V on scale R and read the resistance 4.4kΩ opposite 1mA in scale V. Thus the resistor $R_1$ may be between 4.4kΩ and 5.2kΩ. Bearing in mind, from the data, that a slight increase in current will not greatly affect $V_z$, we will prefer a lower biased resistor, therefore, looking at the resistor chart, 4.7kΩ is seen to be a likely value, and we will therefore make $R_1 = 4.7kΩ$.

For correct design, we should look at the curves for the BC107 transistor before selecting the collector resistances, however, assuming this is not available, we shall assume the typical value of $V_{ee} = 3V$, giving adequate collector bias, and still leaving a reasonable bias across $R_3$ and $R_5$. The long-tailed pair will be made symmetrical, therefore $R_3 = R_5$. If 6-3V are dropped across $R_4$, and a further 3V across the transistor, the collector resistors must drop 12 = 6.3 - 3 = 2.7V. Remember that the 2mA in the common emitter load is now divided equally between $T_r1$ and $T_r2$, therefore we feed 2.7V and 1mA into the Data Rule. Select 2.7V on scale R and read off 2.7kΩ opposite 1mA in scale V. Note that the design of this circuit has led to a multiple of 10 making calculations easy, but the rule would be far more appreciated in cases where such manageable values are not attained. From the table, it is seen that 2.7kΩ is a preferred value, thus $R_3 = R_5 = 2.7kΩ$.

Switch position 1 programmes the load current for 1mA, and bearing in mind the clamped 6.8V across which ever of $R_6 - R_{10}$ is selected by $S_1$, then the rule will give $R_6$ if we calculate 6.8V and 1μA. Set the voltage in the middle window, and read 6.8kΩ opposite 1mA, since 1μA is not on the scale. Now, 1μA = 1mA x 10⁻³, therefore $R_6 = 6.8kΩ x 10³$, i.e., 6.8MΩ.

The other resistors selected by $S_1$ may be similarly found, and we already know that for 1mA, switch position 4, that $R_9 = 6.8kΩ$. By inspection, however, it will be seen that since, from switch position 1, the current increases in factors of 10, the programming resistance will reduce by factors of 10, giving the following values of all components:

<table>
<thead>
<tr>
<th>$I_z$ mA</th>
<th>min.</th>
<th>typ.</th>
<th>max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1</td>
<td>5.0</td>
<td>5.6</td>
<td>6.4</td>
</tr>
<tr>
<td>1.0</td>
<td>5.8</td>
<td>6.2</td>
<td>6.6</td>
</tr>
<tr>
<td>5.0</td>
<td>6.1</td>
<td>6.3</td>
<td>6.8</td>
</tr>
</tbody>
</table>

The table shows the specifications for the OAZ203 zener diode referred to in the text.

across $R_4$, and a further 3V across the transistor, the collector resistors must drop 12 = 6.3 - 3 = 2.7V. Remember that the 2mA in the common emitter load is now divided equally between $T_r1$ and $T_r2$, therefore we feed 2.7V and 1mA into the Data Rule. Select 2.7V on scale R and read off 2.7kΩ opposite 1mA in scale V. Note that the design of this circuit has led to a multiple of 10 making calculations easy, but the rule would be far more appreciated in cases where such manageable values are not attained. From the table, it is seen that 2.7kΩ is a preferred value, thus $R_3 = R_5 = 2.7kΩ$.

Switch position 1 programmes the load current for 1mA, and bearing in mind the clamped 6.8V across which ever of $R_6 - R_{10}$ is selected by $S_1$, then the rule will give $R_6$ if we calculate 6.8V and 1μA. Set the voltage in the middle window, and read 6.8kΩ opposite 1mA, since 1μA is not on the scale. Now, 1μA = 1mA x 10⁻³, therefore $R_6 = 6.8kΩ x 10³$, i.e., 6.8MΩ.

The other resistors selected by $S_1$ may be similarly found, and we already know that for 1mA, switch position 4, that $R_9 = 6.8kΩ$. By inspection, however, it will be seen that since, from switch position 1, the current increases in factors of 10, the programming resistance will reduce by factors of 10, giving the following values of all components:

<table>
<thead>
<tr>
<th>$R_1$</th>
<th>$R_7$</th>
<th>$R_8$</th>
<th>$R_9$</th>
<th>$R_{10}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.7kΩ</td>
<td>680kΩ</td>
<td>68kΩ</td>
<td>6.8kΩ</td>
<td>680Ω</td>
</tr>
<tr>
<td>1kΩ</td>
<td>68kΩ</td>
<td>68kΩ</td>
<td>6.8kΩ</td>
<td>680Ω</td>
</tr>
<tr>
<td>3kΩ</td>
<td>6.8MΩ</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.8MΩ</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Circuitry Note: $R_2$ is preset, and in the practical circuit, put a 10mA f.s.d. meter in as a load, and adjust $R_2$ for exactly 10mA with $S_1$ in position 5.

The circuit can be adapted to provide reliable low-level current for testing silicon planar transistors for gain at low levels, the circuit providing the programmed base-current drive. It can work down as low as 30nA programmed current, if a fourth transistor, another BC109, is added in Darlington configuration with $T_r3$.

It is best to set the pre-set at a higher current, since as the programmed current reduces, and with it the output transistor's gain, the base current in this transistor assumes greater importance. In extreme cases, such as 30mA, it may be advisable, if the means to check the current is available, to adjust the programming resistor to allow for this reduction in collector current due to base current. With a Darlington configuration, currents above 100nA should give good accuracy, the accuracy being set almost solely by the tolerance of the programming resistors.

Finally, check on the power ratings of resistors necessary. Our highest current is 10mA through $R_{10}$, therefore set the $I_{max}$ arrow in the central window opposite 10mA in scale O. It will be seen that the resistance value of 10, 680Ω, is way off the power scale, this resistance value in scale O seen to be less than 0.1W on scale N. Thus even a 1W rating resistor will suffice. Move the slider to read 1mA in scale Q, and $R_9$, 6.8kΩ, is again low. It will be seen that as we go down the switch positions, although we move one cycle higher on the resistance scale, we also move one larger division in the reduction of current scale, therefore 1W is satisfactory for $R_6$-10. Set to 2mA, and look for 3kΩ in scale O for $R_4$ power dissipation. Again power is negligible. Similar checks on all other resistances show the same result: negligible power dissipation, and 1W resistor ratings adequate throughout.

**MULTIVIBRATOR DESIGN**

Figure 2 shows the familiar multivibrator design, and space will not be taken up here on explanations of how this functions, since this has been explained a number of times previously in this magazine. We shall simply consider the circuit design. The period of time that each of the two sections of the circuit is on is given approximately by $t = 0.7CR$. A much more involved calculation is required to get a truly accurate answer, however 0.7CR is a reasonable approximation in practice, and will suffice for most applications. The CR terms refer to coupled base resistances and capacitances.

If the CR product is unequal for the two sides of the circuit, unequal switching times will occur, and this is quite acceptable if desired. We shall design for a symmetrical case, however.

Let us assume that a reasonably slow frequency is required, say 500c/s. The reciprocal of this gives the period of the waveform, and this can be worked out easily mentally, but by the rule, place 500 in scale L opposite the 1 of scale M, and read the significant figures of the reciprocal opposite the mark above, in scale Y, namely 2,00, and correcting for the true decimal place, this is 0.002 sec. This represents the full cycle, but to consider one transistor's function only, its period will be 0.001 sec.

We will firstly select a suitable value of base resistance, work out the appropriate capacitance, then take the nearest preferred capacitance value, working back to then modify the base resistance, since it is easier to alter the resistor than capacitor by a small amount to adjust to the required frequency.

Assuming $I_a = 1mA$ in the first instance and that the OC71 has an $h_{fe}$ of around 40 then $I_a = 10⁻²$ - 0.3mA. This can be evaluated as a reciprocal on the ZL scales as 1/40mA, and is seen to give, when correcting the point by inspection, 25μA. Since germanium transistors are being used, in comparison with line voltage, $V_EB$ can be neglected, and line voltage and the
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calculated base current are fed into the scales on the rule to evaluate the resistances R2 and R3.

Set 6V in scale R, and read off the resistance 2.4 kΩ opposite 2.5 mA in scale V, since 25 μA is off scale. 2.5 mA = 25 μA x 10^3 therefore R = 2.4 kΩ x 10^3 which is 240 kΩ. Thus: 1 x 10^-3 sec = 0.7 x C x 240 x 10^3 i.e.,

C = \frac{0.7 x 240 x 10^3}{1 x 10^{-3}} = 7.0 x 240.

Place the 7 in scale L opposite the 1 of scale M and read off the significant figures 143 as the reciprocal. It is now only necessary to divide this by 240. Place the 1 - 43 of scale M adjacent to the 2 - 40 of scale L to divide by 240 and read off 594 in scale M opposite the 10 of scale L. To place the decimal point do a rough calculation. In the denominator the 0 - 7 reduces the 240, and since we are rounding number off, we shall thus reduce this to 200, approaching the 70.6 value of 240 that is required anyway. This gives: \frac{0.2 x 10^3}{1 x 10^{-9}} = \frac{1 x 10^{-9}}{0.2} = 5 x 10^{-9}, or 5,000 pF. Thus the true answer is seen to be 5,940 pF. The nearest capacitor to this easily available is probably 5,000 pF, therefore, assuming this, we shall now check the frequency that this would give, to see if this is acceptable without further modification: \frac{0.7 x 5 x 10^{-9} x 240 x 10^3}{3.5 x 240 x 10^{-8}} = 1.43 (mentally readjusting).

Multiply this out with the L and M scales, giving 840 x 10^4, or 2 x 840 x 10^4 the full period, giving 1.68 x 10^4. Take the reciprocal of this from L and Z scales, giving 598 c/s. Now, bearing in mind that the formula used is only an approximation, this may be considered close enough. We can check the percentage error, assuming the formula accurate, by placing 5 (representing 500 c/s) opposite the component tolerance central mark, adjacent to the Z scale. From this we see that 598 c/s represent nearly a 20% error, and we may wish to make this closer to 500 c/s. To do this, take the previously used formula, but instead of C being the unknown, make R the unknown, putting C in as 5,000 pF. This gives: \frac{1 x 10^{-3}}{0.7 x 5 x 10^{-9} x R} = \frac{1 x 10^{-9}}{0.7 x 5 x 10^{-9}} = \frac{1 x 10^{-9}}{0.7 x 5 x 10^{-9}}

thus R = \frac{0.7 x 5 x 10^{-9}}{1 x 10^{-9}} = \frac{0.7 x 5}{10^9} = 5 x 10^{-9}.

Determine the reciprocal of 3.5, and correct, giving 0.286 x 10^6 or 286 kΩ, as opposed to the original 240 kΩ. Refer to the preferred resistor chart, and it is seen that 270 kΩ is the nearest preferred value. Now if this is worked out for frequency, i.e., for 270 kΩ and 5,000 pF, the frequency is seen to be 529 c/s. By checking with the component tolerance scale again, this is now found to be between 5 and 10%. To get even closer than this it would be necessary to use parallel resistors for the base resistance, and since the formula is only an approximation, this is pointless. Thus we shall use R2 = R3 = 270 kΩ.

Now, I_b must be determined for the transistors, by setting 6V in scale R, and reading off 2.23 mA opposite 2.7 kΩ in scale U. Since 270 kΩ = 2.7 kΩ x 10^3, the base current is 2.23 mA x 10^{-3} = 22.3 μA. The collector current will thus be 22.3 x 40 μA, which, multiplied on L and M scales, gives 0.892 mA. Again, curves for the OC71 should then be consulted, but allowing, say, 4V across the transistor, this leaves 2V to drop across the collector loads. Select 4V in scale R and read off 448 kΩ in scale R against 8.92 mA in scale V. Now this is one cycle too far to the right, so it is seen at once that the true value is 4.48 kΩ. Looking at the preferred resistance value chart it is seen that 4.3 kΩ is the nearest suitable value. Thus, R1 = R4 = 4.3 kΩ. Thus, the calculated components for an approximate frequency of oscillation of 500 c/s are: R1, R4 = 4.3 kΩ; C1, C2 = 5,000 pF; R2, R3 = 270 kΩ.

The output may be taken from either collector through a capacitor, shown in the figure taken from Tr2. This capacitance should present low impedance to 500 c/s, and should really consider the following circuit impedance, but generally speaking, since the capacitive reactance, \( X_c = \frac{1}{2\pi fC} \) we can select a suitable capacitor from this, giving a low value \( X_c \), say 100 Ω for example. This value can be very loose indeed, in terms of accuracy, and hence \( \pi \) may be taken as 3 without any qualms. Thus the formula \( X_c = \frac{1}{2\pi fC} \) is quite adequate, and \( C = \frac{1}{2\pi f X_c} \) where the reciprocal of 6 has been worked out from the rule. Take 0.167 as 0.17, and divide by 100, the reactance, giving 1.7 x 10^{-3}. Now divide by 10 for the frequency, 500, and obtain the significant figures of 340. 0.2 A rough calculation is: \( \frac{1}{2\pi f X_c} = 0.02 \times 100 = 2 \mu F \) and thus the true value is 3.4 μF. Increasing the capacitance decreases \( X_c \), therefore the most convenient capacitor above 3.4 μF would be very suitable, say 4 or 8 μF, the value for C3.

**AMPLIFIER STAGE CALCULATIONS**

Figure 3 shows a typical amplifier stage, grounded or common-emitter. We shall not design the stage, but use the stage as shown to do a couple of calculations. Let us find the input impedance of the stage. \( R_{in} = \frac{R1}{R2 + R1} \). If the transistor is germanium, then \( V_{be} \) is approximately 0.15 V, therefore the voltage with respect to earth, must be \( \pi - 1.15 \). To calculate \( R \), then, the base current of the transistor must be known. The 1V across the emitter resistor, apart from indicating the base potential, also enables us to calculate emitter current. In scale R, 1V gives us 1 mA opposite 1 kΩ in scale U. Since \( I_e \) is approximately the same as \( I_b \), take the base current as: \( \frac{1}{6} \) from the L and M scales, or by reciprocal, the L and Z scales, this is found to give 16.7 μA. Now, \( R_1 = \frac{V_b}{I_b} = \frac{1.15}{16.7 \times 10^{-3}} \). Set 1.15 V in scale R and read 690 Ω opposite 1.67 mA. Since 16.7 μA = 1.67 mA x 10^3, therefore \( R_2 = 690 x 10^3 \), i.e., 69 kΩ. Thus, input resistance is 69 kΩ in parallel with 39 kΩ in parallel with 5.6 kΩ, and is, of course, less than the lowest of these, 5.6 kΩ.

Now there are two possible approaches on the rule to evaluating this, one, and that which will be considered first, considerably more cunning than the more conventional way, and giving a good approximation to the answer. The first method makes use of the parallel resistors chart. Let us consider the 69 kΩ resistance in parallel with 39 kΩ. Looking at the chart for the higher value, 69 kΩ, we see the 68 the closest to the required 69. Below this the other required significant figures, 39, are seen. Trace the 69 and the 39 lines back until they intersect, and this is seen to occur at about 25 on the right-hand scale. This represents 25 kΩ.

Note. When using this method, take care that when one of the numbers is multiplied by some factor \( 10^n \) to give the particular resistance, the other resistance must also be multiplied by the same factor, for a true reading, i.e., in the previous example, both 69 and 39 are \( x 10^4 \) in terms of absolute resistance. In this case
you could not go wrong, but if the line for 390 had been shown, this intersecting 68, for example, would have given a wrong answer.

We must now consider 25kΩ in parallel with the remaining resistance 5-6kΩ. We must, to use the provided values, modify the 25kΩ to 22kΩ, and employing the factor x 10^4, 220 then represents 22kΩ, and 5-6kΩ is represented by 56. These intersect at 45, giving the value for R_1 approximately equal to 4-5kΩ.

The more conventional method is to apply the formula: \[ R_T = \frac{R_a \times R_b}{R_a + R_b} \]
Thus, considering 39kΩ in parallel with 5-6kΩ, we have: \[ \frac{39k \times 5-6k}{44k} = 4-9kΩ \].

Then we consider 49kΩ in parallel with 69kΩ, giving: \[ \frac{49k \times 69k}{73-9k} = 5-8kΩ \] where L and M scales are used to evaluate these expressions. Thus, with the approximate chart method, as can be confirmed from the tolerance scale, the approximation of 4-5kΩ is less than -2% error of the more accurate calculation giving 4-5kΩ.

Finally, let us select a suitable value for C1, assuming that the lowest frequency of operation of the amplifier is 100c/s. C1 should be made to have a reactance of about 1/10 the value of the resistor it decouples, to give good dynamic gain at low frequency. As frequency increases, the reactance decreases, and thus we need only worry about the low frequencies with the decoupling capacitor. Its object is to, relative to R4, provide an a.c. short-circuit to earth. Thus Xc should be about 100Ω maximum at 100c/s. Again there is no reason why we should not round off π to 3, hence, to obtain C, we obtain the following: \[ C = \frac{6 \times 100 \times 100}{1} \].

It is seen that the reciprocal of 6 gives us at once the significant figures required, and this is found to be, from the rule, 1-67. Now, a rough calculation gives us:

\[ 60 \times 10^8 = 10\mu F. \]

Thus 16.7µF is seen to be the actual value, and the nearest higher capacitance will be taken, namely either 20 or 25µF. A 16µF capacitor is available, if the physical dimensions of the larger capacitor are too great, and this is just acceptable, however better to reduce the reactance even further if possible, hence going to a higher capacitance.

In this article the rule has been shown in some of its uses. The circuit designer and constructor should find the rule of great use, and it is hoped that the information provided in this series will enable anyone to use the rule to its fullest.

**RECLAIMING FAULTY TRANSISTORS**

—continued from page 825

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- Detailed specifications available

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**Silicon Rectifiers**

- High-quality rectifiers
- Suitable for various applications
- Detailed specifications available

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**Avalanche Silicon Rectifiers**

- High-quality avalanche rectifiers
- Suitable for various applications
- Detailed specifications available

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**Thyristors**

- High-quality thyristors
- Suitable for various applications
- Detailed specifications available

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**Dry Reed Inserts**

- High-quality dry reed inserts
- Suitable for various applications
- Detailed specifications available

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**Moving Coil Meters**

- High-quality moving coil meters
- Suitable for various applications
- Detailed specifications available

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**P.W. Clubman**

- High-quality products
- Includes various accessories
- Suitable for various applications
- Detailed specifications available
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The Strand Amplifier  
The PW Signal Generator  
The Berkeley Loudspeaker Enclosure  
The Luxembourg Tuner  
The PW Troubadour  
The PW Everest Tuner  
The PW Britannic Two  
The PW Mercury Six  
Beginner's Short Wave Two  
S.W. Listener's Guide  
PW "Sixteen" Multirange Meter  
Test Meter Applications Chart  
The Celeste 7-transistor Portable Radio  
The Spinette Record Player  
Transistor Radio Mains Unit  
7 Mc/s Transceiver  
The Citizen (December 1961)  
The Mini-amp (November 1961)  
The Beginner's Short Wave Superhet (Dec. 1964)  
The Empire 7 Three-band Receiver (May 1965)  
Electronic Hawaiian Guitar (June 1965)  
Progressive SW Superhet (February 1966)  
Beginner's 5-Band Receiver  
Home Intercom Unit  

**PRACTICAL WIRELESS**

**query service**

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The PW Query Service is designed primarily to answer queries on articles published in the magazine and to deal with problems which cannot easily be solved by reference to standard text books. In order to prevent unnecessary disappointment, prospective users of the service should note that:

(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.

(d) We regret we are unable to answer technical queries over the telephone.

(e) It helps us if queries are clear and concise.

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