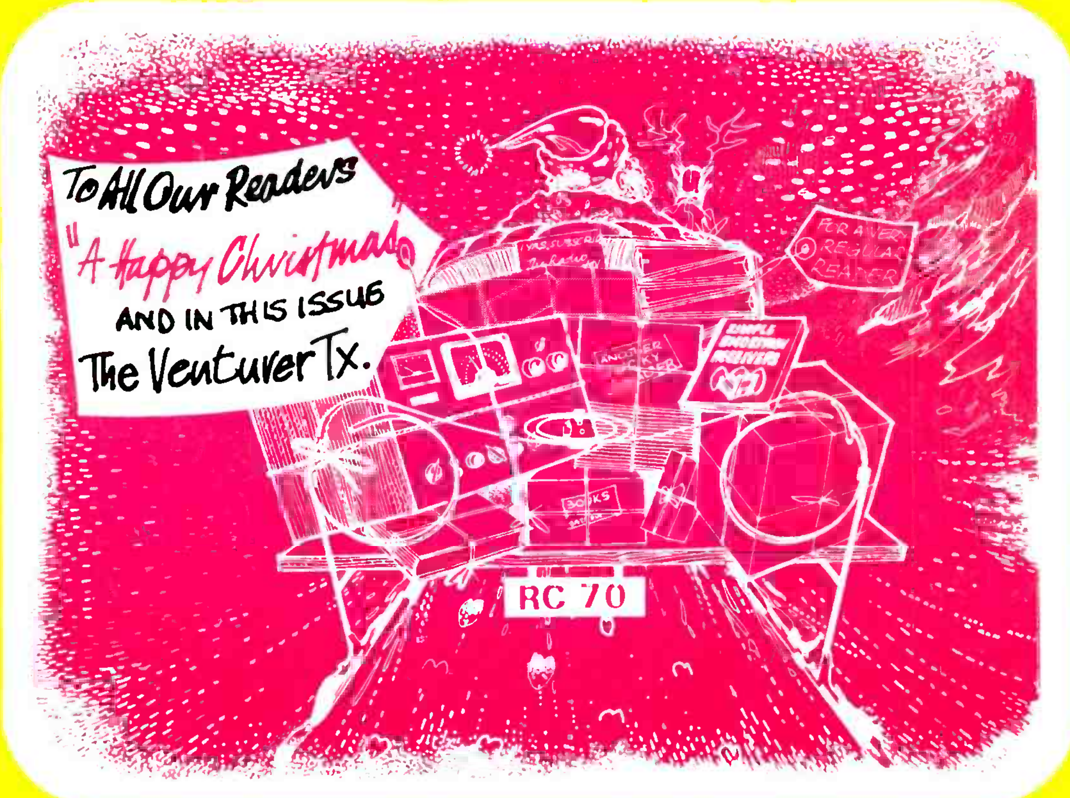
THE

# RADIO CONSTRUCTOR

Vol. 24 No. 5 DECEMBER 1970 3/6

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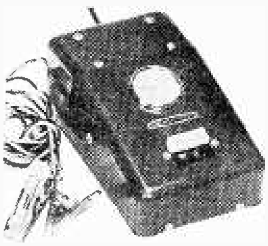
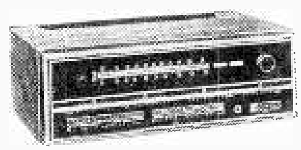
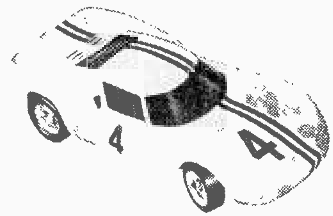


CONSUMER



HI-FI & AUDIO



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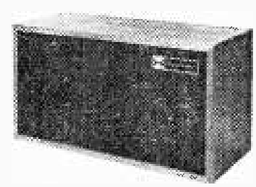

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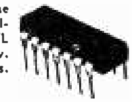

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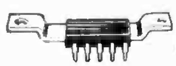

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# frequency divider signal generator

by

**A. KYPRIOTIS**

**This crystal controlled signal generator has the unusual feature of offering outputs at submultiples of crystal frequency. In the prototype outputs are provided at 200kHz, 100kHz and 50kHz, and the basic scheme can be adapted for other frequencies, if desired. Because its construction may entail the experimental determination of some of the component values, this project is intended for the more experienced constructor rather than the beginner**

CARRYING OUT EXPERIMENTS SOME TIME AGO IN THE v.l.f. region, the author urgently needed a signal generator supplying at least three standard frequencies, namely 200, 100 and 50kHz. These had to be available as pure sine waves of known and controllable output amplitude.

The idea of buying a signal generator was out of the question because the price of commercial instruments offering the required performance was too high. In consequence, it was decided to make the signal generator. This article describes the result of such an effort.

The writer's instrument is somewhat specialised but the basic principle can be employed for more general use by extending its frequency range downwards, and this can be done quite easily by the more experienced constructor. The prototype is used in conjunction with a frequency meter for measurements of transistor oscillator stability.

**EDITOR'S NOTE**

The author of this article is not resident in the U.K. and, in consequence, does not have access to components available on the British home-constructor market. Because of this, the i.f. transformers employed in the tuned circuits in the prototype may have slightly different inductance values from those obtainable in the U.K., whereupon it may be necessary to experimentally adjust the values of C1, C2, C4, C5, C7 and C8. An oscilloscope is required for setting up the circuit, and this will assist in the selection of the tuning capacitors just mentioned, if alternative values should be required.

For exact operation on 200kHz the crystal should be series resonant at this frequency. The 200kHz parallel resonant crystals normally available will result in a frequency slightly removed from 200kHz.

## CIRCUIT DESCRIPTION

The circuit of the instrument is shown in the accompanying diagram. It consists of a 200kHz crystal oscillator followed by two locked oscillators, an untuned amplifier, an emitter follower and a simple metering and attenuator system. The output of each oscillator can be independently selected by switch S1. The selected output is then fed to the amplifier and finally passed through the matching emitter follower stage to the metering and attenuator system.

The first stage, incorporating TR1, is the crystal oscillator. In the original model a 200kHz U.S. Army crystal (DC–9) was employed because this was the only one available. Unfortunately this crystal presented a high dynamic resistance which made the design of a transistor oscillator stage rather difficult. The problem was however, solved by using a selected high gain transistor especially for this stage. With normally available crystals of low dynamic resistance the stage should be easily started and maintained in a stable oscillation condition. Of course it is possible for an alternative crystal to overdrive the stage, with the result that a distorted output appears. Generally the feedback must be adjusted so that it is just sufficient to start and maintain oscillation (class A operation) in order to have the needed pure sine wave output.

This adjustment can be made by changing the ratio of the tuning capacitors C1 and C2, or by inserting a low-value variable carbon resistor in series with the crystal. One way of checking the amount of feedback is to measure the voltage between the base and the negative supply rail with a valve voltmeter. If the voltage falls by 0.3 to 0.6 volt when the crystal is plugged in, the circuit is working in class A and is not being overdriven. However, the best, and most definite, method of checking for correct oscillator running conditions is to check its output with an oscilloscope. An oscilloscope is required, in any case, for setting up the divider stages. The output of the crystal oscillator, at about 1 volt peak-to-peak, is used to lock the second stage at 100kHz. It also feeds the untuned amplifier, TR4, when switch S1 is at the 200kHz position. Oscillator output amplitude to the switch is adjusted by means of R4.

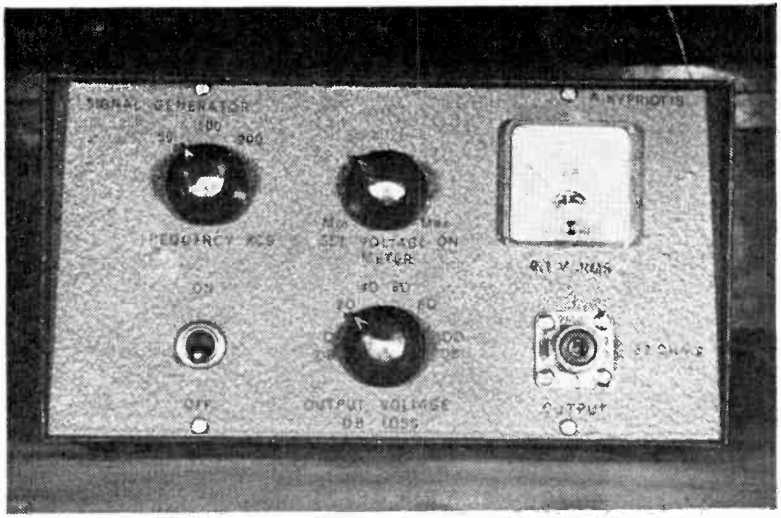
The second stage, incorporating TR2, is an LC oscillator which, when it runs free, oscillates near 100kHz. A 10kΩ damping resistor, R9, across the tuned circuit is used to broaden the response curve of this circuit in order to ensure reliable locking, should the oscillation frequency shift. Potentiometer R10 controls the output to S1 when this switch selects 100kHz.

The third stage is the same as the second but works at 50kHz and is driven by the second.

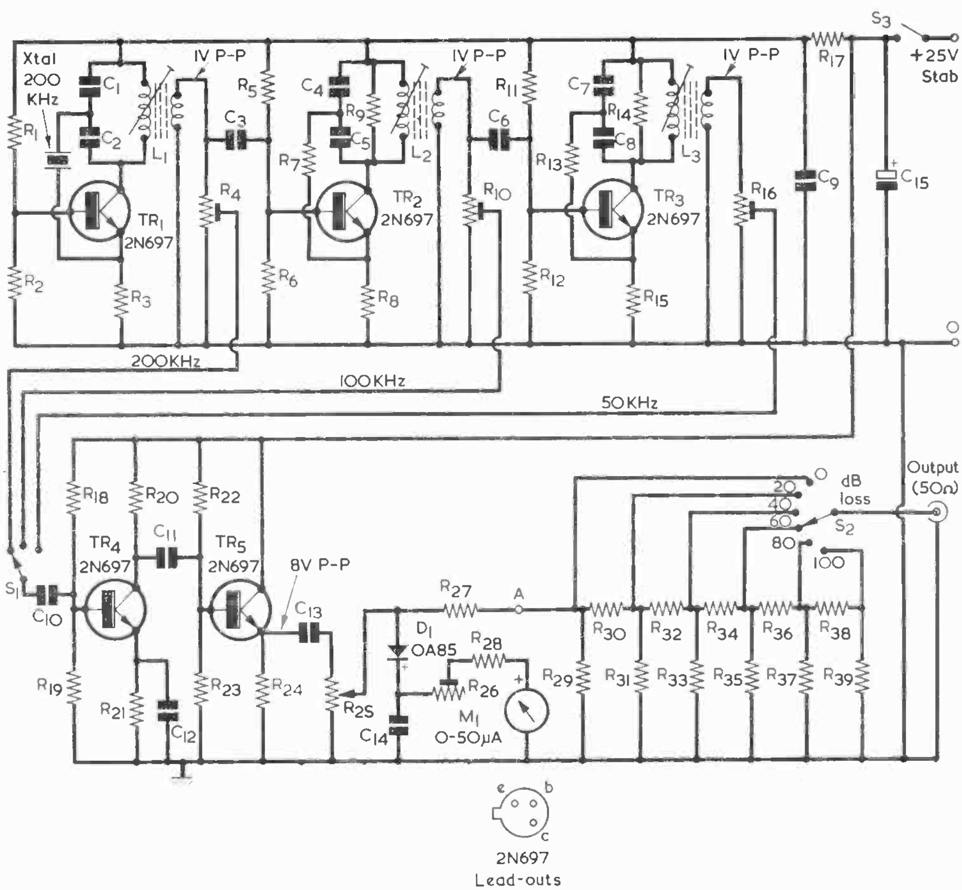
The particular frequencies employed were chosen to suit the writer's requirements. It is very easy to modify these frequencies by designing oscillators which work at other submultiples, up to the fifth. Higher ratios are possible but not recommended. More divider stages can also be added if this is desired.

## UNTUNED AMPLIFIER

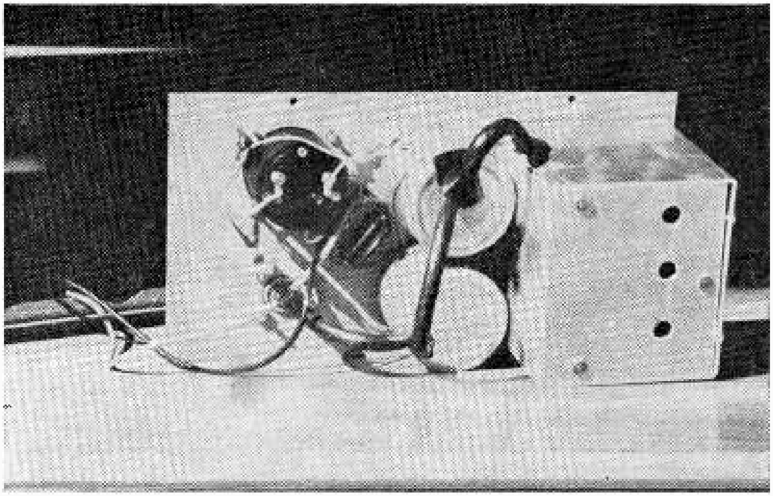
The untuned amplifier, TR4, is fed by one of the




*Front view of the prototype unit. S1 is at the top left, R25 is at top centre and S2 is at bottom centre*




*The complete circuit of the frequency divider signal generator*



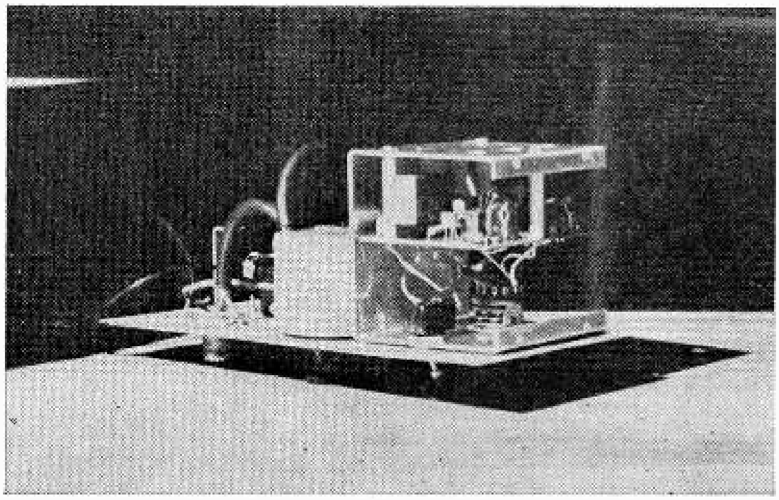
*The rear of the front panel. The large screening cover encloses the transistor circuitry*

three oscillators by means of switch S1. The three potentiometers, R4, R10 and R16, are adjusted so that the output of the untuned amplifier is about 8 volts peak-to-peak (2.8 volts r.m.s.) undistorted sine wave. The emitter follower stage is used as a matching device between amplifier and attenuator.

The attenuator is a simple ladder type designed for 50Ω output impedance. It gives a maximum of 100dB loss in 20dB steps through switch S2, each 20dB step corresponding to a voltage ratio of 10:1. The values shown for R29 to R38 inclusive are calculated to suit the attenuator output impedance. If a high degree of attenuation accuracy is required, these resistors may be selected or made up from series-parallel combinations of suitable close tolerance components. For lower levels of attenuation accuracy the 495Ω values could be replaced by 2% 500Ω resistors, and the 60Ω values by 2% 62Ω or 56Ω resistors.

A peak reading voltmeter is used at the input of the attenuator, but is calibrated in r.m.s. because the signal is always sinusoidal. It is set up by R26 for full-scale deflection when the output control, R25, has been adjusted for 0.1 volt r.m.s. at point A. Under these conditions the total resistance given by the series combination of R26, R28 and the meter should be 70kΩ, and this fact may assist constructors who would find difficulty in measuring the voltage at A. Indeed, some constructors may find it more convenient to employ, at the outset, a fixed resistor in place of R26 and R28 which brings the total resistance up to 70kΩ. The correct voltage will then be automatically given at A when the meter reads full-scale deflection.

The method of construction is left to the reader, but that employed by the writer will be of interest. The parts were fitted in a metal cabinet measuring 9 by 5½ by 5½in. All components were mounted on the rear of the front metal panel, the circuit being divided into three main sections. Each section is screened from the others by aluminium boxes. The main section comprises all the transistor circuitry up



*View illustrating construction inside the main screening cover. Components, including the preset potentiometers, are mounted on a printed circuit board*

## COMPONENTS

*Resistors*
(R29–R38 inclusive – see text. All other fixed values $\frac{1}{4}$ watt 10% unless otherwise stated).

| | |
|---|---|
| R1 | 18kΩ |
| R2 | 10kΩ |
| R3 | 4.7kΩ |
| R4 | 10kΩ preset potentiometer, skeleton |
| R5 | 33kΩ |
| R6 | 10kΩ |
| R7 | 120Ω |
| R8 | 4.7kΩ |
| R9 | 10kΩ |
| R10 | 10kΩ preset potentiometer, skeleton |
| R11 | 33kΩ |
| R12 | 10kΩ |
| R13 | 82Ω |
| R14 | 10kΩ |
| R15 | 4.7kΩ |
| R16 | 10kΩ preset potentiometer, skeleton |
| R17 | 470Ω |
| R18 | 100kΩ |
| R19 | 10kΩ |
| R20 | 4.7kΩ |
| R21 | 470Ω |
| R22 | 10kΩ |
| R23 | 10kΩ |
| R24 | 1.5kΩ |
| R25 | 2kΩ potentiometer, linear |
| R26 | 100kΩ preset potentiometer, skeleton (see text) |
| R27 | 1.5kΩ 2% |
| R28 | 22kΩ (see text) |
| R29 | 60Ω |
| R30 | 495Ω |
| R31 | 60Ω |
| R32 | 495Ω |
| R33 | 60Ω |
| R34 | 495Ω |
| R35 | 60Ω |
| R36 | 495Ω |
| R37 | 60Ω |
| R38 | 495Ω |
| R39 | 56Ω |

*Capacitors*

| | |
|---|---|
| C1 | 2,200pF silver mica |
| C2 | 1,200pF silver mica |
| C3 | 0.1μF paper |
| C4 | 0.018μF paper |
| C5 | 3,300pF silver mica |
| C6 | 0.1μF paper |
| C7 | 0.068μF paper |
| C8 | 0.012μF paper or silver mica |
| C9 | 0.1μF paper |
| C10 | 0.1μF paper |
| C11 | 0.1μF paper |
| C12 | 0.1μF paper |
| C13 | 0.1μF paper |
| C14 | 0.1μF paper |
| C15 | 10μF electrolytic, 30V wkg. |

*Semiconductors*
TR1 – TR5 2N697
D1 OA85

*Switches*
S1 1-pole, 3-way, rotary
S2 1-pole, 6-way, rotary
S3 s.p.s.t., toggle

*Coils*
L1 – L3 455kHz transistor i.f. transformers (see text)

*Meter*
M1 0–50μA moving-coil meter

*Crystal*
200kHz crystal – see text (Henry's Radio)

*Miscellaneous*
Crystal holder
3 pointer knobs
Coaxial output socket
Material for case, screens, etc.

to the output from TR5. The second section is the metering system (with the meter and R28 outside the screen) whilst the third is the attenuator. These last two sections were screened in discarded photographic film cans. Coupling from section to section is carried out by means of coaxial cable.

The tuning coils were small Japanese 455kHz i.f. transformers (yellow) having a tuned winding and a separate coupling winding. Connections are made to the outside ends of the tuned windings.

## ADJUSTMENT

An oscilloscope is needed for adjustment. Connect it to the output of the crystal oscillator stage and turn the core of the coil whilst watching the screen for maximum undistorted output (about 1 volt peak-to-peak).

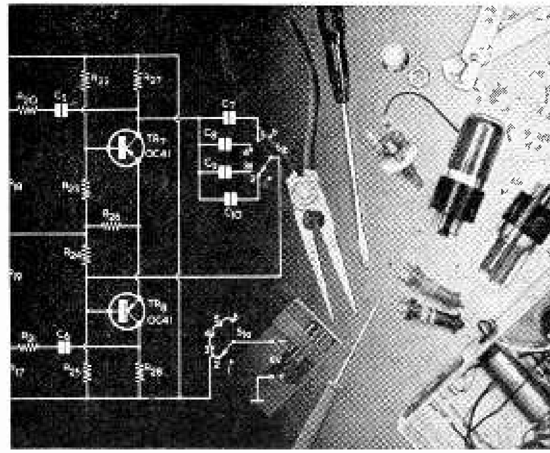
The locking of the two oscillators is then carried out in the following manner. Connect the oscilloscope to the output of the second oscillator and turn the core of its coil to one end of its range. Set up the oscilloscope sweep so that some six to eight cycles appear on the screen. Next, turn the core slowly and watch the pattern moving. When the pattern suddenly stops moving make a note of core position. Continue to turn the core slowly to find how far it can go before the pattern starts moving again. Finally, set the core to the middle of the range in which the pattern does not move. Repeat the same procedure for the third oscillator. Check the output of the oscillators for one volt peak-to-peak undistorted sine wave. If necessary, obtain this by varying the value of R7 or R13, as applicable.

Next, adjust R4, R9 and R16 for each frequency to give eight volts peak-to-peak undistorted at the emitter of the emitter follower stage.

Finally, set up the meter circuit by adjusting R26 for full-scale deflection when the output control, R25, is adjusted for 0.1 volt r.m.s. (0.28 volt peak-to-peak) at point A. This last step is not necessary if R26 and R28 have been replaced by the fixed resistor mentioned earlier. ■

# Experimenter's Power Supply

by G. A. FRENCH



A MAINS POWER SUPPLY UNIT having a variable voltage output is always a useful aid to the constructor who experiments with transistor circuits. A newly assembled experimental circuit may be quickly connected to such a supply unit, the latter being set to provide zero voltage output. After switching on, the output voltage from the supply unit can then be gradually increased until it reaches the final working level required. Should there be any faults or wiring errors in the transistor circuit being checked, these will then become evident at a reduced voltage with a consequent lessening of the risk of damage.

Designs for stabilised power supplies with variable voltage output have appeared in the technical press from time to time, but these tend to employ complex circuits and offer a performance which is considerably in excess of what is required for much experimental work. In consequence, there is a need for a simple, inexpensive and robust power supply that offers a variable voltage output with good regulation. Stabilisation against changes in mains supply voltage are not really needed in a power supply of this nature.

The supply unit which forms the subject of this month's 'Suggested Circuit' article falls into the category just outlined. It employs standard components in a circuit whose functioning is easy to understand, and it offers an output voltage ranging from zero to greater than 13 volts at currents up to a nominal maximum of 200mA. In practice, the supply can provide output currents of up to 500mA or more, but this is only because, in the interests of good regulation, components that are capable of handling currents well in excess of the 200mA figure just mentioned have been incorporated.

## CIRCUIT DESIGN

The circuit of the power supply appears in the accompanying diagram. The a.c. mains is applied, via on-off switch S1, to the primary of transformer T1. This component would normally be employed as a heater transformer and its secondary offers 12.6 volts with a current capability of 1 amp or more. It is assumed in consequence that secondary winding resistance plus reflected primary resistance is low.

The transformer secondary couples to the bridge rectifier given by D1 to D4. Silicon diodes type BY100 are employed here, this type being specified because of its high surge current rating. Although the BY100 is normally employed as a high voltage rectifier it functions equally well at the lower voltages encountered here. If desired, it would be quite in order to employ low voltage silicon rectifiers of equal surge ratings in place of the BY100's specified. However, there is no particular advantage in using such alternative rectifiers because the

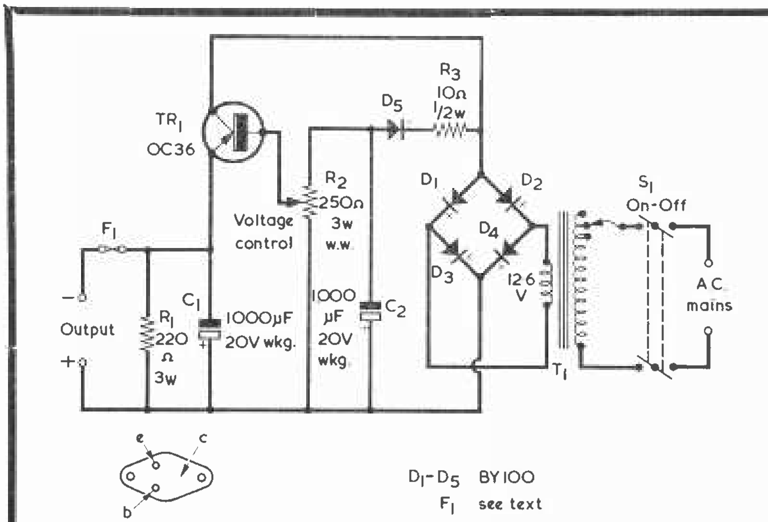



*Fig. 1. The circuit of the power supply. Output is continuously variable from zero to more than 13.5 volts, the recommended maximum output current being 200mA*

BY100 is widely available at low cost and the alternatives would provide no significant improvement in performance.

The rectified negative voltage from the bridge rectifier is passed via limiter resistor R3 to diode D5, and thence to potentiometer R2 and capacitor C2. The slider of R2 taps off the reference potential which controls the output voltage of the power supply. The assumption has already been made that internal resistance in the mains transformer is low. If the further assumption that forward resistance in diodes D1 to D4 is similarly low is next made, it can be expected that the rectified half-cycles passed to diode D5 will exhibit little change in voltage amplitude despite changes in the current drawn from the bridge rectifier via the output terminals of the supply unit. The reference voltage provided by R2 should, as a result, remain virtually unaltered for all current demands from the power supply within the specified range. In company with D1 to D4, and for the same reasons, diode D5 is a BY100.

The negative voltage from the bridge rectifier is also applied to the collector of TR1, an OC36. This functions as an emitter follower, the potential on its emitter being about 0.1 to 0.2 volt positive of the reference voltage on its base which is provided by the slider of R2. The emitter couples to resistor R1 and capacitor C1, and via fuse F1 to the negative output terminal. Resistor R1 acts as a bleed, ensuring that C1 discharges quickly, to provide a lower output voltage, whenever the slider of R2 is moved towards the positive end of its track. R1 also serves to draw a standing current through TR1, with the result that the base-emitter voltage drop is maintained at nearly the same figure for output currents at zero and at 200mA.

Summing up circuit operation so far, it may be stated that transformer T1 and bridge rectifier D1 to D4 provide rectified half-cycles whose amplitude is assumed to be nearly constant for all currents drawn from the power supply output. This nearly constant amplitude is employed to provide, via D5, a controllable variable reference voltage from R2. The reference voltage is applied to the base of TR1, with the result that output voltage can be directly controlled by adjustment of this potentiometer.

## FURTHER DETAILS

Some further details which have not been covered in the description of circuit operation just given may next be discussed.

Capacitor C1 functions as a reservoir capacitor. When the slider of R2 is near the negative end of its track, TR1 passes current on the uppermost tips of the half-cycles from the bridge rectifier, as shown in Fig. 2(a). On the other hand, when the slider of R2 is near the positive end of its track the transistor becomes conductive at a much earlier part of each half-cycle, so that the voltage on its emitter has the waveform shown in Fig. 2(b). It will be evident that voltage regulation will be better with the waveform of Fig 2(b) than with that of Fig. 2(a), because in Fig. 2(b) C1 receives a charge for a greater part of the cycle. This point is, in fact, borne out in practice, and regulation becomes poorer as output voltage increases.

It may be noted, in passing, that the voltage on the collector of TR1 does not actually consist of a series of full half-cycles from the bridge rectifier. This is due to the fact that, when TR1 collector potential is about 0.1 volt positive of that on its base, the diode given by the collector-base junction becomes conductive. Thus, the diodes in the bridge rectifier do not conduct when their rectified output would otherwise be more than 0.1 volt positive of the potential tapped off by the slider of R2. This is a matter of academic interest only, since the reference voltage across R2, given via D5 which conducts on half-cycle peaks, is not significantly affected. Nevertheless, it is worthwhile drawing attention to the existence of the effect.

It is necessary to include the fifth diode, D5, to provide a reference voltage, because it serves to isolate capacitor C2 from the output circuitry of the power supply. If D5 were short-circuited, C2 would function as a reservoir capacitor for the bridge rectifier and the voltage across its plates would decrease as output current increased.

A relatively large standing current, of about 75mA, flows in R2. This current is much larger than the base current likely to be drawn by TR1 at high output currents, with the result that the voltage tapped off by the slider of R2 will not undergo

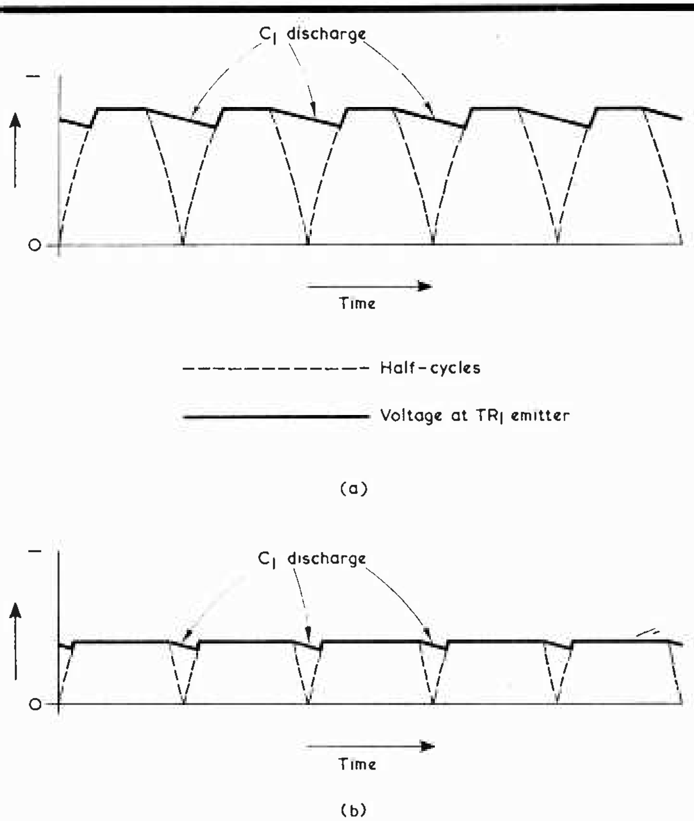



*Fig. 2. Illustrating the voltage waveform at the emitter of TR1 when R2 is adjusted for (a) a high output voltage and (b) a low output voltage. The half-cycle sections are included to demonstrate the formation of the waveform, although (as is explained in the text) they do not appear as such in the power supply itself*

any significant alteration with varying load current.

An OC36 is specified for TR1 as it has a high maximum reverse emitter-base voltage rating. It is possible for about 13 to 14 volts to be applied across the emitter-base junction with reverse polarity if the slider of R2 is very quickly turned from the negative to the positive end of its track. Also, if high values of capacitance are connected across the output terminals a similar reverse voltage can appear if, with R2 slider at the top of its track, the power supply is switched off. The OC36 can comfortably withstand the reverse base-emitter voltages which result from these occurrences.

The transistor dissipates nearly 3 watts when an output current of 200mA is drawn at a low output voltage. In consequence, it should be mounted on a heat sink. The finned heat sink type H10, available from Henry's Radio and having nominal dimensions of 4½ by 2 by 1in., will be adequate, as will any other sink of similar dimensions.

Since C1 functions as a reservoir capacitor, a small ripple voltage will be present across its plates, this increasing as output current increases. If desired, the supply may be constructed with two sets of output terminals, as in Fig. 3. Here, Output No. 1 is the same as that provided by the circuit of Fig. 1. Output No. 2 is a smoothed output, being taken by way of the l.f. choke and capacitor C3. An extra fuse is also fitted. The l.f. choke should be rated for 200mA operation and it requires a low resistance. A suitable component is the Type FM580, also available from Henry's Radio. This has an inductance of 0.3 henry at 200mA and a winding resistance of 3Ω only.

It will be noted that, whereas a resistor, R3, is included to limit switch-on surges in the circuit around D5, there is no limiter resistor in the circuit between the bridge rectifier and C1. Limiting here is provided by TR1, which must always insert an effective resistance between its collector and emitter. As an additional precaution, the types specified for TR1 and D1 to D4 are purposely selected for their ability to pass high surge currents.

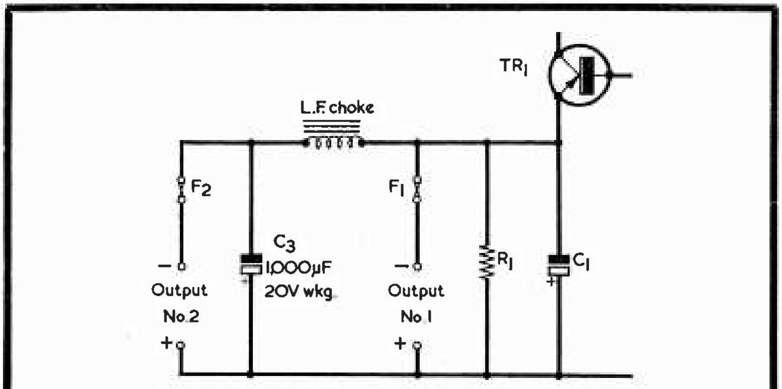


*Fig. 3. A second, smoothed, output may be added, if desired*

**TABLE**

| *Output Voltage at zero current* | *Output Voltage at 100mA* | *Output Voltage at 200mA* | *Regulation Resistance* |
|---|---|---|---|
| 2V | 1.9V | 1.8V | 1.Ω |
| 4V | 3.85V | 3.8V | 1.Ω |
| 6V | 5.8V | 5.7V | 1.5Ω |
| 8V | 7.75V | 7.6V | 2Ω |
| 10V | 9.75V | 9.5V | 2.5Ω |
| 12V | 11.6V | 11.3V | 3.5Ω |
| 13.6V | 13.2V | 12.8V | 4Ω |

## COMPONENTS

Fuse F1 of Fig. 1 is optional, and can be omitted if it is felt that adequate safety for experimentl projects is given by the fact that output voltage can always be initially raised from zero by adjusting R2. If a fuse is fitted it may be rated either at 250mA or at 500mA, according to the preference of the constructor. The 250mA type may tend to blow occasionally if output currents around the maximum figure of 200mA are drawn for long periods of time. The current available from the supply is well in excess of that needed to blow a 500mA fuse, should this be fitted. These same remarks apply to both F1 and F2 if the second output shown in Fig. 3 is added.

Potentiometer R2 is mounted on the front panel of the supply unit. It may be fitted with a pointer and scale, the latter being calibrated in terms of output voltage, as determined by a voltmeter connected across the output terminals after the unit has been completed. The calibration will be sufficiently accurate for most requirements.

The mains transformer in Fig. 1 is shown as having a secondary voltage of 12.6, this being obtained in practice by connecting two 6.3 volt heater secondaries in series. A suitable transformer is available under Cat. No. TH5C from Home Radio. This is a Radiospares 'Hygrade' component and has two secondaries, each offering 6.3 volts at 1.8 amps. However, any mains transformer whose secondary or secondaries can provide 12 to 14 volts at currents of 1 amp or more will be satisfactory. So also would a valve receiver mains transformer having the requisite heater secondaries. In this case no connections would be made to the h.t. secondary.

## PROTOTYPE PERFORMANCE

In the prototype circuit, a valve receiver transformer was employed to provide the 12.6 volts, this having two heater secondaries rated at 6.3 volts 2 amps. The maximum d.c. output voltage from the power supply, when using this transformer, was 13.6 volts.

As was mentioned earlier, the design of the supply is based on the assumptions that there is low internal resistance in the mains transformer, and that forward resistance in D1 to D4 is similarly low. These assumptions appeared to be reasonably well justified by the practical performance of the unit, regulation resistance at the output of the Fig. 1 circuit ranging from 1Ω at 2 volts output to 4Ω at the maximum of 13.6 volts output. ('Regulation resistance' is the internal source resistance of the power supply.) The increase in regulation resistance with increase in output voltage is due to the consequent reduction in charging time for C1 throughout each half-cycle, as exemplified in Figs. 2(a) and (b).

The accompanying Table shows measured output voltages, as obtained across R1 with the prototype.

The regulation resistance values are calculated by taking the voltage drop from zero output current to 200mA output current and then dividing it by 0.2. This follows the Ohm's Law equation $R = E/I$, the 0.2 term representing 0.2 amp (i.e. 200mA). It is felt that, bearing in mind the considerable simplicity of the power supply circuit, these regulation resistance figures represent a performance that is more than adequate for most of the experimental work likely to be undertaken by constructors. ■

## NEW MODULAR MICROWAVE INTEGRATED CIRCUITS

**The new EMI-Varian range of modular microwave integrated circuits (microstrip) provides systems designers and research workers with a powerful design and development technique.**

**The range offers a system for breadboarding integrated circuits operating at microwave frequencies. This is achieved by isolating various circuit functions into modules which are designed to be readily interconnected.**

**The system also provides for the custom re-engineering of such a breadboarded circuit to produce a smaller number of more complex units. This creates cost and space advantages especially when production runs are involved.**

**All the units are produced by modern vacuum-deposition techniques, leading to rugged construction and repeatable performance. The units available from established designs include passive components such as filters, switches and aerials and also active circuits such as mixers, amplifiers, doppler generators and transmitter/receiver units.**

**The techniques are also applicable to custom-engineered circuits to meet individual customer requirements.**

**The circuits are described in a new leaflet available from EMI-Varian Limited.**

# CURRENT TRENDS

## BSR McDONALD MP60 TURNTABLE

The McDonald single player deck MP60 has been designed to appeal to audio enthusiasts building their own installation; it is marketed by a new consumer division of BSR (McDonald division) formed especially for this purpose.

The complete McDonald range includes four decks: the McDonald 310, 510, 610 and the first-ever single player from BSR – the MP60.

The McDonald MP60 deck, reviewed here, incorporates a number of features aimed at refining the range in line with the needs of hi-fi enthusiasts.

A study of the Instruction Manual provided with the unit showed that it was concisely and clearly written, outlining the correct procedure for obtaining the best possible results. One point could, however, be included. Once electrical and electronic connections have been made, it is imperative that the turntable is level, a spirit-level being used for this purpose. It is quite useless to balance a cartridge weighing three grams if the turntable itself is not level.

After a long period of use, no heat problems were experienced and the strobe striations (speed test disc) were constant and accurate, possibly due to the small drive wheel ratio. Obviously the motor was achieving its correct torque, thus obviating variations.

One most pleasant discovery was the fact that there was a complete absence of rumble – even with full bass. Some considerable thought was plainly given to the diversities one must expect nowadays.

The new look square arm features a slide-in cartridge carrier allowing for quick and easy maintenance.

Viscous cueing ensures that the pick-up arm descends ultra slowly precisely when and where it is directed.

The vernier type balance of the pick-up arm incorporates modified ball race bearings enabling the arm to track – at exceptionally light stylus pressures and allow freedom of movement, at the same time giving a high degree of stability. This is a marked improvement on the usually rather coarse system generally employed, and suggests that expensive pick-ups could be employed.

The underside mechanism is exceptionally free of projections and some plinth manufacturers may consider an arrangement with those producing the now popular modular amplifiers. A compact suite could then be offered – always an attraction to the long-suffering lady of the house.

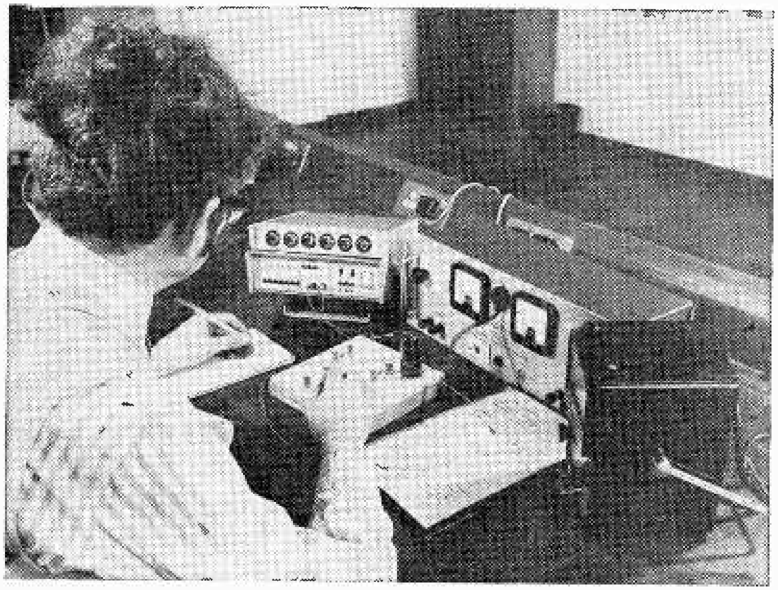
BSR Ltd. are offering the MP60 as rather a unique deal. For the first time, a turntable manufacturer is offering a unit in this price category fitted on a plinth, complete with mains lead, phono lead and amplifier earth lead. A dust cover is also fitted so that the consumer can purchase the unit, ready wired, in one box over the counter – thus saving assembly work at home.

No doubt the McDonald BRS turntables will be in great demand, and deservedly so.

Recommended retail price: £15 (plinth and cover extra). ■

*The MP60 deck which embodies the highest standards of precision, quality reproduction and operating convenience. The unit is equipped with a high precision, low mass square section pick-up arm, counterbalance arm, calibrated stylus pressure control adjustable for perfect tracking, heavy balanced large turntable, bias compensator, simple to operate controls, anti-skate device and viscous cue-pause lever*

# NEWS . . . AND .



*Using a six-digit Dawe Digital Frequency Meter, Counter and Timer Type 3001A in the electronics laboratory at South Birmingham Technical College to examine the performance of a multivibrator*

**Dawe Instruments Ltd., the wellknown manufacturers of instruments used in the electronic and ultrasonic industries, recently celebrated the 25th anniversary of their establishment.**

**Their growth is quite a business romance, starting in a wooden hut in Amersham, Buckinghamshire and now occupying extensive modern premises in Acton, West London.**

**They have substantial financial backing as a member of the Simms group of companies, but trading decisions are those of its own management, thus the company has the flexibility and financial resources to obtain the maximum benefit from the technical advances of recent years in electronics and ultrasonics.**

**From the beginning Dawe were active in the ultrasonics field and during their existence they have become a leader in this sphere as ultrasonics became an industry within the electronics industry.**

**A speciality has always been electronic measuring instruments and we show in our illustration a Digital Frequency Meter in use at the South Birmingham Technical College.**

**It will be interesting to watch the progress of this enterprising company as it goes into the next quarter of a century.**

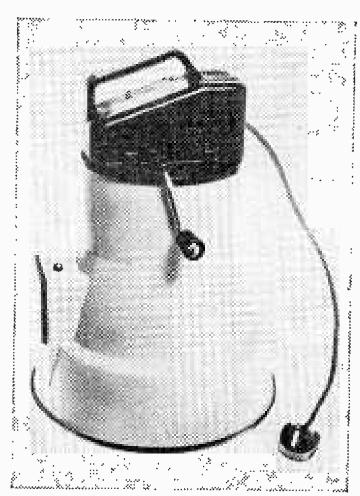
**We wish all our readers a very Happy Christmas and a Prosperous New Year—Editor**

## LIGHTWEIGHT CABLE DISPENSER

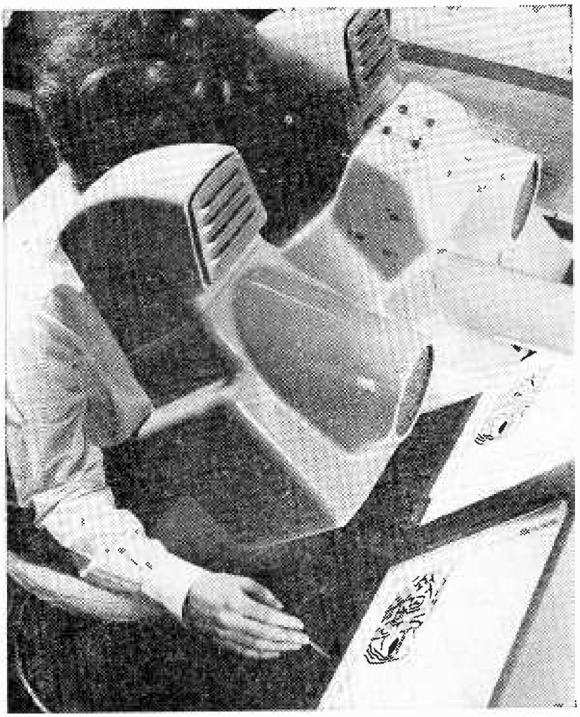
A new, lightweight mains extension cable dispenser is announced by V. L. Martin & Co. Ltd., Witley Works, Witley Gardens, Southall, Middlesex, manufacturers of the well-known 'Marcaddy' range of cable reels

Designated the 'Cablesafe', this compact dispenser is fully portable, weighing only 4 lb., and incorporates a 13A outlet socket (adaptable for use abroad), a neon indicator and a geared winding handle. It is capable of accepting 100/120 ft. (30/37 m.) of 13A round core cable, which automatically feeds out as the unit is transported. Re-winding of the cable proves a quick and simple operation. Due to the unique, cone-shaped construction (British and foreign patents pending) of the 'Cablesafe', upon rotating the winding handle, the cable feeds back and, by sheer gravitation, self-coils to the shape of the housing. The handle is geared for a complete rewind and an added advantage is provided in that the extension socket does not revolve, obviating the necessity for mains disconnection when reeling and unreeling, thus enabling a constant circuit to be maintained at all times.

Safety has played an important part in the design of the 'Cablesafe'. Fully insulated, being constructed throughout of tough, moulded polypropylene, attractively contoured and finished in orange and black, the only metal part is the wind handle shaft.



# . . . COMMENT



*A Palmer Aero technician uses the comparascope to detect possible missing holes. Using a master board, to her left, she compares it with an unchecked board. Any missing holes will flash on the viewer of the machine*

'Palmaboard', a series of partly processed standard printed circuit boards, which can be tailor-made to to individual designs, being indispensable to the small processor, captive laboratory and consumer alike, has been introduced by the Printed Circuits Division of Palmer Aero Products Limited at Camberley, Surrey.

Individual designs are applied to the partly finished board to coincide with in-built contacts and a hole matrix system. Boards can be brought to completion in the minimum of time, making a very attractive proposition in terms of reduced delivery times, and effect a substantial reduction in cost due to standardisation and the instant readiness from stock.

## LST ELECTRONIC COMPONENTS LTD.

**LST Electronic Components Ltd. have recently announced their appointment as sole U.K. Distributor for The International Rectifier "Semiconductor Centre" range of products.**

**LST Electronic Components Ltd. wish to appoint a number of new "Semiconductor Centre" stockists throughout the country, and traders interested are asked to apply on Company headed stationery for trade prices, etc., to the company at 7 Coptfold Road, Brentwood, Essex.**

**A new Hobbies Manual describing circuitry and applications for the "Semiconductor Centre" range will shortly be available to the amateur enthusiast via their local Semiconductor Centres.**

## COLOUR TV PROSPECTS

"Everywhere, the signs are that in the television field, it is coming to be accepted that the real future of television is colour television. Monochrome may remain for some purposes and, in some countries, the only viable and economical way of providing a public service – for many emerging countries it would be foolish to encourage them to run before walking. But for Europe and North America and Japan, and before too long Australia and South Africa and some other countries, I am sure that in their hearts television engineers have virtually abandoned monochrome and think firmly in terms of colour. We must encourage the programme people to press on with colour, not only for entertainment but for the educational and other purposes. For, as engineers, we now know from our own experience how much colour enhances the enjoyment of entertainment programmes, heightens the impact of news and documentary programmes and how vitally important it can be for educational and training purposes."

"Already, this country has accepted colour, even if many viewers are not yet able to accept the economics of colour. A recent 'Which' report shows that less than one in 20 colour viewers are at all disatisfied with colour. Indeed, three-quarters expressed themselves as 'very satisfied' with the quality and realism of the colour picture, and the few complaints made were mainly directed towards colour films made initially for presentation in the cinema rather than for television itself."

Extract from the Introductory Session Address at the International Broadcasting Convention given by F. H. Steele, Director of Engineering Independent Television Authority.

# THYRISTOR OVERLOAD TRIP

by

P. MEREDITH

**This simple protection circuit can be preset to trip reliably at any overload current from 75 to 200mA and at supply potentials of 6 to 15 volts**

THE OVERLOAD TRIP SHOWN IN FIG. 1 WAS DEVISED to prevent excessive current flow in experimental transistor circuits. It may be inserted between any source of d.c. power, either a mains unit or a battery, and the equipment being supplied. The supply voltage may be between 6 and 15 volts and the circuit can be set up to trip at any current between 75 and 200mA. When the trip current is exceeded the power to the supplied equipment is cut off and can only be restored by switching off the associated mains power unit and switching it on again, or by disconnecting and reconnecting the battery. Should the overload still be present the circuit will then trip once more. The circuit also trips instantaneously if a short-circuit is placed across the output terminals. The only disadvantage with the circuit is that it causes about 0.75 volt to be dropped when the current drawn approaches the overload figure. However, this does not affect the writer's requirements, as all his experimental work is concerned with receiver and small amplifier designs, with which a highly stabilised supply voltage is not necessary.

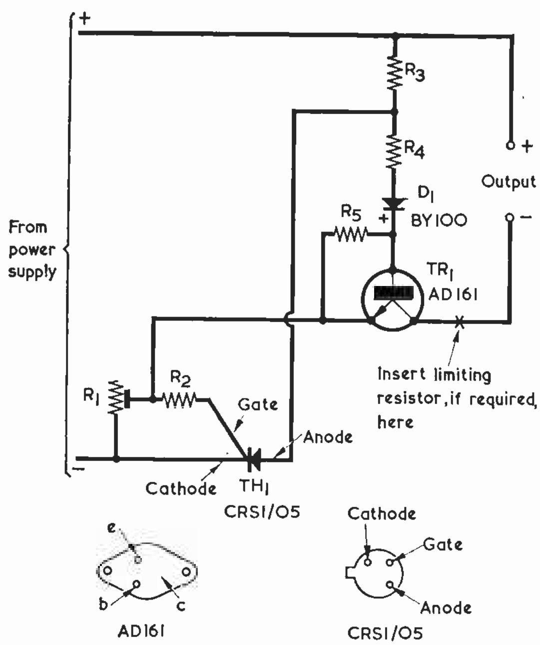



*Fig. 1. The circuit of the overload trip*

## CIRCUIT OPERATION

To understand circuit operation, assume that the overload trip is connected to its source of d.c. power and that a load consisting of a variable resistor is connected to its output terminals. Initially, this variable resistor is adjusted so that it draws a current that is lower than the trip value.

Talking in terms of electron current (from negative to positive), current flows from the negative input terminal through R1 and transistor TR1 to the negative output terminal. Transistor TR1 is kept fully conductive by the base current which is passed by D1, R4 and R3. The result is that a small voltage is dropped across TR1 and resistor R1.

The assumed variable resistor load is next adjusted so that it draws a continually increasing current. As this current approaches trip level, the voltage across R1 increases to a value which allows current to flow through the cathode and gate of thyristor TH1 and through R2. When the trip level is reached the gate current is sufficiently high to fire the thyristor, and it suddenly becomes conductive. The junction of R3 and R4 then takes up a voltage which is slightly positive of the negative input terminal and transistor TR1 cuts off, isolating the load from the supply. Once it has fired, TH1 remains conductive, and the circuit can only be brought back to its original state by removing the power supply voltage from the input terminals and then reapplying it.

It should be noted that a small current is drawn from the supply, through R3 and the thyristor, after tripping.

## COMPONENTS

*Resistors*

(All fixed values ¼ watt 10% unless otherwise stated)

| | |
|---|---|
| R1 | 25Ω preset potentiometer, wirewound, 1 watt |
| R2 | 30Ω |
| R3 | 1kΩ ½ watt |
| R4 | 1kΩ |
| R5 | 470Ω |

*Semiconductors*

| | |
|---|---|
| TR1 | AD161 |
| TH1 | CRS1/05 |
| D1 | BY100 (see text) |

## COMPONENTS

The trip current at which the circuit isolates the source of power from the equipment being supplied is adjustable by means of R1. To set up this resistor, a load drawing the trip current is connected to the output terminals in series with a current-reading meter, and R1 is adjusted from the position in which it inserts zero resistance to that at which the circuit trips. With the writer's version of the circuit this occurs when R1 is set up to drop about 0.7 volt.

Diode D1 is included to ensure that TR1 becomes fully cut-off after tripping. The anode of the thyristor then drops to about 0.6 volt relative to its cathode and, without D1 in circuit, the transistor would still pass a small base current and would not be completely cut off. Resistor R5 provides the requisite d.c. path between base and emitter of the transistor after the circuit has tripped and keeps emitter-collector leakage current at a low level.

The transistor specified was chosen because it is capable of passing collector currents up to 3 amps and is not thereby liable to be damaged by the very short pulse of current than can flow when a direct short-circuit is placed across the output terminals. It is, however, necessary to limit the instantaneous short-circuit current to the 3 amp figure, and this may be done in the following manner. First calculate the resistance which causes 3 amps to flow at the supply voltage chosen. If, for instance, this is 15 volts then the value of limiting resistance required, from Ohm's Law, is 5Ω. Next, measure the resistance inserted by R1 after it has been adjusted. If this resistance is equal to or greater than the required limiting resistance, R1 provides all the limiting that is needed and no further action is required. If R1 is lower than the required value and the accompanying power supply has a large-value electrolytic capacitor across its output terminals (or otherwise presents a very low internal impedance) insert resistance between the collector of TR1 and the negative output terminal, at the point marked with a cross, to make up the overall resistance to the desired figure. In the example just given the limiting resistance required was 5Ω. If it is found that R1 inserts 3.5Ω, then a 1.5Ω resistor should be inserted at the point marked with a cross.

This extra limiting may only be required if the input voltage and trip current are inside the shaded area shown in Fig. 2. If the source of power is a dry battery, an extra limiting resistor will not be required. Because of the limiting provided by R1, take care not to allow any accidental output short-circuits to occur before it has been adjusted to its final setting.

R2 also provides limiting, and ensures that the gate current of the thyristor cannot exceed 600mA, which is the maximum figure specified for the type employed.

Transistor TR1 dissipates negligible power as it is either fully conductive or cut-off. It does not need to be mounted on a heat sink. The voltage dropped across its emitter and collector when it is conductive is negligibly low.

Diode D1 is shown as a BY100 in the circuit diagram and Components List, but any other silicon diode could be employed instead. A BY100 was used in the author's version since he has fairly large stocks of this type on hand.

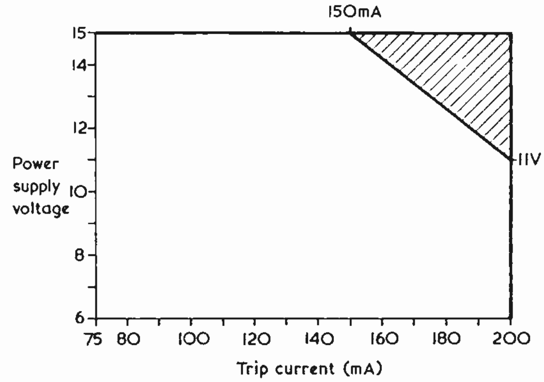



*Fig. 2. The shaded area indicates the power supply voltages and trip currents which may require the fitting of an extra limiter resistor, as described in the text*

A figure of 200mA is specified as the maximum trip current for the circuit because of the necessity of avoiding unduly large series resistance for short-circuit current limiting. The minimum figure of 75mA was decided upon because it was found, with the prototype, that thyristor operation became a little erratic at trip currents of around 40mA or less, and it was considered advisable to specify a minimum figure that was well in the reliable current range. ■

## VIDOR BATTERY IN NEW CONTAINER

**The Vidor V.18 6-volt battery, made by Crompton Parkinson Ltd., a Hawker Siddeley Electric company, is now being marketed in a container made of high impact polystyrene. It is the first time that a battery of this type has been available in the United Kingdom in a plastic container.**

**The battery, which is designed for roadside warning lamps, security and built-in fire alarm systems, ordinary lanterns and hand lamps, has a recommended retail price of 6s. 6d.**

**The new type of container has many advantages over the metalclad and cardboard-wrapped versions. These include:**

**a) Protection of the battery in wet conditions. No moisture can seep through and the battery case is rust-proof.**

**b) If misuse or short-circuiting causes leakage, this is contained within the cell as long as the battery is mounted and used in the appliance in an upright position.**

**c) The appliance is not endangered by leakage from the cells should the battery be left on accidentally for long periods.**

**d) It has a high resistance to impact and will not crack or break when dropped.**

**e) The lid of the plastic container is so constructed that it is virtually impossible for the spring contacts to touch one another and cause short-circuiting.**

**Size of the container is $2\frac{5}{8}$ inches square, $4\frac{1}{2}$ inches high including terminals.**

# The 'Miniflex' Mark III Medium-Long Wave Tuner

by

SIR DOUGLAS HALL, K.C.M.G., M.A.(Oxon)

**Using hardly a handful of components, this development from the author's original 'Miniflex' design provides continuous tuning over medium and long waves. Particularly ingenious are the methods employed for obtaining regeneration and waveband switching**

THE AUTHOR INTRODUCED HIS Miniflex circuit to readers in the June 1968 copy of *The Radio Constructor*, and in the following month a developed version was published using silicon transistors and making provision for reception of Radio 2 on 1,500 metres. The circuit was also used in the 'Kangaroo Radiogram' in the issue for August 1969.

The present design is in the form of a tuning head and involves further development which allows the whole of the long wave band to be covered. It also gives improved reception at the low wavelength end of the medium wave band. The tuner is very suitable for use with the author's 'Sliding Challenger' amplifier, which was described in the issue for August 1970.

## CIRCUIT DESIGN

In the design which forms the subject of the present article, it is important that the specified transistor should be used. (The transistor type SF115 is available from Amatronix, Ltd.) Also, the special selenium rectifier quoted for D1 is essential for best results. The circuit will not give satisfactory results with the more usual germanium or silicon diodes. It is also important that VR1 should give zero resistance when the slider is fully anti-clockwise looking at the spindle, as in this position it functions as a wave change - switch. Most components will prove satisfactory.

Let us examine Fig. 1 and assume that VR1 is turned fully anticlockwise so that L2 is short-circuited. L1, the medium wave coil, will then be tuned by VC1 and signals will be applied to TR1 functioning as a common collector amplifier with a high input impedance and an output impedance of the order of 1kΩ. This output is fed to the base of TR2 which, as a common emitter amplifier, will offer a good match. The amplified output appears across the choke L3 and is rectified by D1 which also acts as an audio frequency load and as a bias resistor for the base of TR1. TR1 now functions as a common collector audio frequency amplifier coupled to a second similar stage in the form of TR2. In fact, at audio frequencies TR1 and TR2 form a super-alpha pair and the output, across VR2, is at a very low impedence of about 50Ω. A small part of the radio frequency signal will pass across D1, and C1 provides a capacitance tap into the tuned circuit so that regeneration in the Colpitts mode is obtained.

Regeneration is controlled by VR2. As the slider moves downwards, as seen in Fig. 1, part of the emitter load for TR2 has no r.f. bypass capacitance across it, and negative feedback is consequently introduced into the functioning, at r.f., of this transistor. Further negative feedback takes place by way of R1 and C2. VR2 also functions as an audio frequency volume control, feeding the audio signal to the small winding (i.e. the winding with the lower number of turns) of T1. This method of combined regeneration and volume control is more satisfactory than that employed in earlier Miniflex circuits,

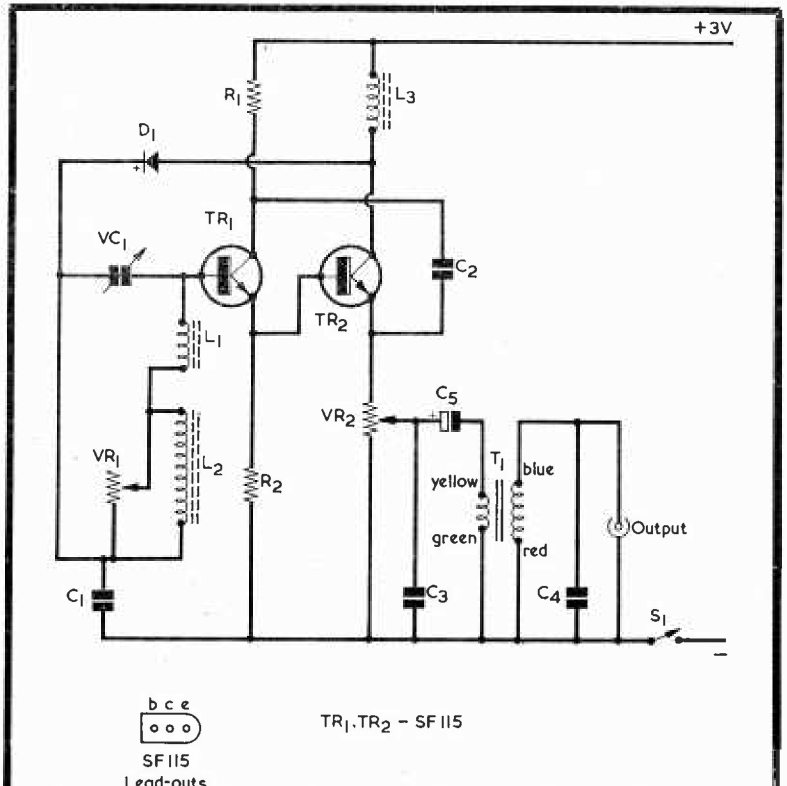



*Fig. 1. Circuit diagram of the 'Miniflex' Mk. III tuner. Note the small quantity of components required*

which used a potentiometer between TR1 and TR2. T1 gives an impedance step-up of 1 : 20 so that the load across the large winding is about 1kΩ. T1 also provides a step-up of voltage of 4½ times.

Although regeneration is looked after by C1 for wavelengths up to about 350 metres, the rest of the medium wave band and the whole of the long wave band require a little extra coupling for oscillation to prove available. It is necessary, therefore, for L3 to be orientated correctly with respect to L1 and L2.

As soon as the slider of VR1 is moved away from the zero resistance position L2 becomes alive, and reception on the long wave band takes place. For this purpose VR2 is turned to maximum and VR1 is used as a reaction-cum-volume control. As the resistance across L2 increases so also does the tendency to oscillate. In other words, VR2 is the volume control for the medium wave band, and VR1 for the long wave band. VR1 provides wave change switching as well. VR2 can also be used as a volume control on the long wave band, but it is convenient to leave it at maximum and use VR1 only.

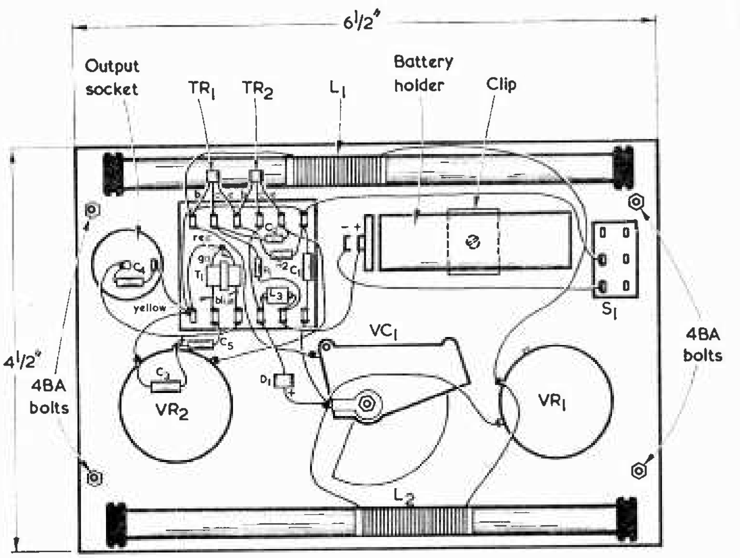



*Fig. 2. The layout and wiring of the tuner should follow that shown here*

## COMPONENTS

*Resistors*
- R1 470Ω, ½ watt 10%
- R2 5.6kΩ, ½ watt 10%
- VR1 250kΩ potentiometer, linear
- VR2 100Ω potentiometer, wirewound

*Capacitors*
- C1 3,000pF
- C2 1,000pF
- C3 0.1μF
- C4 0.1μF
- C5 100μF electrolytic, 2.5V wkg.
- VC1 300pF variable, solid dielectric, Dilecon (Jackson Brothers)

*Inductors*
- L1 See text
- L2 See text
- L3 2.5mH choke, type CH1 (Repanco)
- T1 Interstage transformer, type TT49 (Repanco)

*Semiconductors*
- TR1, TR2, SF115
- D1 M3 diode. (Available as 'half-wave meter rectifier' from Henry's Radio, or under Cat. No. MR50 from Home Radio)

*Switch*
- S1 Slide switch

*Battery*
- 2 cells type U7 (Ever Ready)

*Battery Holder*
- Holder type BH2 (Amatronix)

*Miscellaneous*
- 3 knobs
- 6-way groupboard, Radiospares miniature, Cat. No. BTS13 (Home Radio)
- 2 Ferrite rods, 6in. x ⅜in.
- Phono socket
- Plywood, grommets, etc.

## CONSTRUCTION

The layout is shown in Fig. 2 and should be followed closely, especially as regards the positions of the two ferrite rod assemblies and L3. L1 consists of 65 turns of 32 s.w.g. enamelled wire, close-wound on a paper sleeve which is free to slide on the rod. L2 has 300 turns of similar wire pile-wound to a length of about 1 in. This is also on a paper sleeve, free to slide on its rod. All components are mounted on a piece of plywood measuring 6½ in. by 4½ in., most of the small components being soldered to a 6-way miniature Radiospares tagboard. Each ferrite rod is tied to the panel by thread (not wire) passing through appropriate holes and round rubber grommets tightly fitted to the ends of the rods. A metal clip is made to hold the battery holder in position. This stands on one of its sides.

## SETTING UP

Before setting up commences, it will be found convenient to pass four 1¼in. 4BA bolts through the panel, in the positions shown in Fig. 2, these being tightened by appropriate nuts. The lengths of the bolts are on the same side as the components, and they enable the panel to stand unaided while testing is being carried out.

To set up, a suitable amplifier should be plugged in with an input impedance of the order of 1kΩ to 5kΩ. Alternatively a 1kΩ magnetic ear plug may be used, though this will not provide very loud signals. Turn VR1 to zero resistance and set VC1 with its vanes fully enmeshed. Advance VR2 clockwise to a point very near to maximum and slide L1 on its rod until oscillation is heard in the form of a hiss. If oscillation cannot be obtained, reverse the connections to the two leads of L1. If necessary, L3 may be twisted on its leads one way or the other for best results. It will need to have its axis approximately parallel to the axis of L1. Having found oscillation with the vanes of VC1 fully enmeshed, make sure that oscillation can still be obtained as the vanes are opened. The object of the adjustment of L1, and possibly L3, is to find positions which result in oscillation being available at all settings of VC1 with VR2 as near maximum as possible.

Next, advance VR1, turn VR2 to maximum and slide L2 on its rod to such a position that oscillation can be obtained for all settings of VC1. If necessary, reverse the connections to the leads of L2. It may well happen that for best results VR1 will not be more than about half-way towards maximum before oscillation starts for some settings of VC1.

Backing down VR1 does not reduce audio frequency amplification, as occurs when VR2 is backed down on the medium wave band. Nevertheless, as VR1 damps the long wave band tuned circuit it is as well to find a position for L2 which allows VR1 to be advanced as far as possible before oscillation starts. This is also advisable in the interest of having a useful portion of the travel of VR1 available for volume control purposes. Also, if oscillation starts with unnecessarily little resistance in circuit it may be accompanied by backlash.

prove necessary to obtain adequate volume from the tuner. This applies particularly to transformerless types which are often very insensitive. No extra stage is needed when the tuner is plugged into the 'Sliding Challenger' nor should this be necessary with most Class B amplifiers using four transistors.

After initial setting up, constructors will no doubt wish to make a

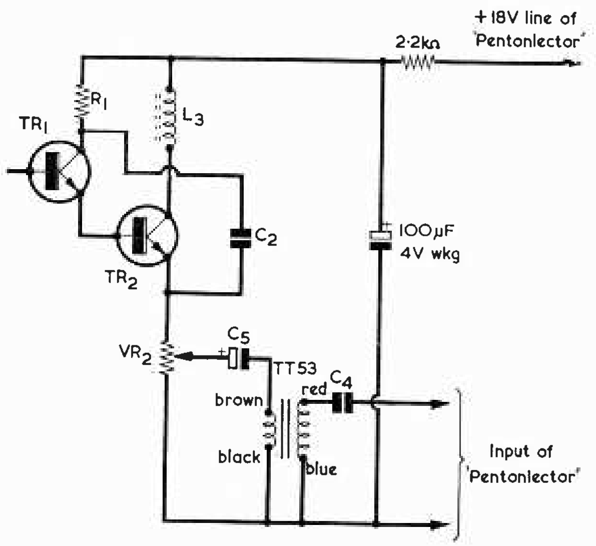



*Fig. 3. An alternative output circuit, suitable for high input impedance amplifiers including, in particular, the author's 'Pentonlector' design*

## PERFORMANCE

When used in conjunction with the 'Sliding Challenger' amplifier, the prototype of the tuner receives a large number of stations at excellent strength on both wavebands. Powerful local stations may cause some spread – the circuit is not quite as selective as the author's 'Spontaflex S.A.' designs – but in many cases the directional properties of the ferrite rod assemblies can be used to remove interference. For maximum selectivity the reaction control of the tuner should be advanced as far as possible, volume being reduced as necessary by means of the volume control in the amplifier. The further the reaction control is advanced, the greater is the ratio between the signal strength of the wanted signal and that of the interfering signal.

The two transistors will pass about 7 to 8mA from a new battery, most of this current being passed by TR2. On no account should more than three volts be used as a power supply. The amplifier will, of course, use its own battery.

With some 3-transistor Class B amplifiers a pre-amplifier stage will

small case to protect the components. The control side of the panel can be covered with a white card on which wavelengths are calibrated – plenty of stations will be received to make this easy – and a neat finish is given by covering this, in its turn, with a sheet of Perspex, drilled for the controls and output socket. It was not found essential to employ a slow-motion drive. Nevertheless, a fairly large tuning knob is recommended as tuning is pretty sharp, particularly around 200 metres.

## HIGH IMPEDANCE OUTPUT

Some readers may wish to modify the output for coupling to a high input impedance amplifier, using a valve or f.e.t. at the input. In this case the TT49 transformer specified in the Components List should be replaced by a Repanco TT53, the red, brown, black and blue leads of the TT53 taking the places of the blue, yellow, green and red leads of the TT49 respectively. See Fig. 3. The lead from the centre contact of the output socket to the tagboard is removed, and the end of C4 shown connected to the outside contact of the output socket is taken instead to the tag to which the red lead of the TT53 transformer is connected. C4 now becomes a coupling capacitor instead of a bypass capacitor. The author has tried this arrangement with his 'Pentonlector' amplifier, as modified in the 'Kangaroo Radiogram', with very pleasing results.

In this case, the tuner's battery is dispensed with and its 3 volt power supply is taken from the positive 18 volts line of the amplifier through a 2.2kΩ resistor, a decoupling electrolytic capacitor of 100μF, 4V working, being shunted across the positive and negative lines of the tuner. ■

# AUTOMATIC METER READING BY COMPUTER

**A computer could read your electric, water or gas meter automatically through your telephone line without ringing the phone or perceptibly tying up the line.**

**In use, an attendant at the utility company establishes a connection between the utility company's computer and special equipment in the telephone company central office. The computer calls the subscriber's phone number, and telephone equipment connects the call to the meter on the subscriber's telephone line.**

**To keep the phone from ringing, this connection is made using different electrical currents and circuits than those normally used. An encoder and a modulator attached to the meter convert mechanical dial readings into electrical pulses or tones which are transmitted, through a coupler and telephone lines, back to the utility's information collection centre. There, a data communications terminal, which controls the entire process, receives the meter signals and directs them to the computer. The utility's data processor then handles the information for record and billing purposes.**

**The full procedure, from connection to recording, takes only a few seconds – about the time it takes to read this sentence aloud. The automatic part of the process involving the subscriber's line is so fast that someone starting to make a call would be unaware that a reading had just been taken. The automatic system will not interrupt a call in progress.**

# S.E. Asian Quest (2)

★ BURMA ★ PHILIPPINES

★ INDONESIA ★ VIETNAM

By nature, the broadcast bands listener does not tend to have a parochial mind but casts his mental gaze, as it were, around the world about him sitting at his receiver controls, he tunes in to events, news and opinions, coming from all parts of this terrestrial sphere. At this time of year the attention of the Dx'er is focussed upon Asia, this being the 'season' for the best chances of short wave reception from that part of the planet Earth.

Asia, with its teeming millions of human beings, has many broadcasting stations operating on the short wave spectrum and, in the main, these are difficult to receive in the United Kingdom.

Apt to be mostly low powered and catering for local consumption, S.E. Asian transmitters are swamped on the higher frequency bands by other transmissions from countries located nearer the islands in which we live. The experienced Dx'er therefore tends to migrate to the low frequency bands in an effort to log some of the less powerful Asian stations.

On the low frequency bands (60 metres, 4750 to 5060kHz; 75 metres, 3900 to 4000kHz and 90 metres, 3200 to 3400 kHz) providing propagation conditions are favourable, the Dx'er is left with the problem of interference (QRM) from utility transmissions – mainly in the form of morse (CW) and teletype signals. However, this is less of a hazard than a powerful semi-local transmission completely blanketing the wanted signal – which is a common occurrence on the higher frequency bands.

Utility services interference is apt to be spasmodic, one moment the QRM is right on top of the desired signal and a few moments later, if you are lucky, the interfering transmission has vanished – its message completed. At other times the utility station continues its transmission – blissfully unaware of its Dx'er-thwarting tactics !

On other occasions, unfortunately few and far between, when conditions are just right for Asian Dx reception, the skip distance is such that many of the interfering signals are not heard in the U.K. It is on these occasions that the Dx'er enters into his logbook some positive results of his S.E. Asian quest.

## BURMA

The Union of Burma is a republic having an area of 261,000 square miles and a population of around 20,000,000. The capital is Rangoon, the religion Hinayana Buddhism. Burma is bordered by the Bay of Bengal, East Pakistan and India on the West, Tibet on the North and China, Laos and Thailand on the East. The densely populated valley of the Irrawaddy river is surrounded by mountains extending from the East Himalayas.

Broadcasting in Burma is controlled by the Burma Broadcasting Service, Prome Road, Kamayut P.O., Rangoon. This organisation has several transmitters operating on the short waves and these are listed in Table VI.

**TABLE VI**

| *Freq.* | *Stn.* | *Power* | *Remarks* |
|---|---|---|---|
| 4725kHz | XZK2 | Rangoon 50kW | Burmese 1100–1445GMT |
| 5040kHz | XZK42 | Rangoon 50kW | English 1430–1600GMT |
| 6035kHz | XZK3 | Rangoon 50kW | English 0130–0230GMT |
| 7120kHz | ZXK4 | Rangoon 50kW | English 0700–0730GMT |

The station announcement in English is – "This is the Burma Broadcasting Service" and the interval signal is Burmese orchestral music.

Burma is rather difficult to receive; probably the best chance for beginners would be on the two lower frequency channels of 4725 and 5040kHz. On the latter frequency, the Dx'er has to cope with interference from Tbilisi (USSR) which occupies the same channel. Nevertheless, Rangoon was reported by several Dx'ers last year on both these channels.

## INDONESIA

An island republic having an area of 574,000 square miles and a population of about 95,200,000, Indonesia is comprised of something like 3,000 islands in the Malay Archipelago. The capital is Djakarta and the principal island groups are the Sunda Islands (including Java, Sumatra and Borneo); Lesser Sundas (including Bali, and part of Timor); the Moluccas; the Riouw Archipelago; and West New Guinea (West Irian).

Because of its island configuration, Indonesia has a relatively large number of short wave transmitters in S.E. Asian terms. Most of these transmitters are low powered and are, generally speaking, unlikely to be heard in the U.K., therefore they are not mentioned here.

In Table VII are listed the Foreign Service frequencies of Radio Republic Indonesia (RRI).

The English Service from Djakarta, directed to Europe, is from 1900 to 2000GMT on 9580 and 11715kHz, with news at 1902GMT.

On the lower frequency bands, Indonesian stations have quite often been reported by Dx'ers. The reception of any RRI station on these bands (60, 75 and 90 metres) is a feat of real operating ability. Some of those reported last year were – 4855kHz YDK Palembang at 1445GMT; 4927kHz Djambi closing at 1600GMT; 5030kHz Medan at 1530GMT; 5045kHz Djakarta at 1545 and 5086kHz Nusantara Tiga closing at 1600GMT. The writer has found that the 4927kHz channel offers a good chance of Indonesian reception.

Most of these low frequency Indonesian stations close down at 1600GMT, although some variations do occur on occasions. At sign-off, local identification is made and the transmission ends with a most haunting tune rendered on a Hawaiian guitar. Once heard, this soft plaintive melody will not easily be forgotten.

**TABLE VII**

| *Freq.* | *Stn.* | *Power* |
|---|---|---|
| 6105kHz | Djakarta | 100kW |
| 9580kHz | Djakarta | 50kW |
| 11710kHz | Djakarta | 50kW |
| 11715kHz | Djakarta | 100kW |
| 11770kHz | Djakarta | 20kW |
| 11795kHz | Djakarta | 100kW |

### PHILIPPINES

A group of some 7,000 islands and rocks in the Malay Archipelago constitute the Republic of the Philippines. With an area of some 114,830 square miles and a population of 27,500,000, the capital is Quezon City – near Manila on the island of Luzon. Only about 400 of the islands are permanently inhabited.

There are several broadcasting organisations with short wave transmitters in the Philippines, including the Voice of America network at Poro.

In Table VIII are listed some of the stations with a power of 50kW or more which may, given the right conditions be heard in the United Kingdom.

**TABLE VIII**

| *Freq.* | *Stn.* | | *Power* | *Schedule GMT* |
|---|---|---|---|---|
| 6120 | DZF4 | Manila | 50kW | 2145–2245 |
| 6170 | DUH2 | Manila | 50kW | 2100–1600 |
| 7225 | DZ19 | Manila | 50kW | 2130–2315, 1345–1800 |
| 9505 | DZH7 | Manila | 50kW | 2215–2345, 1100–1400 |
| 11830 | | Manila | 100kW | 0530–0630, 1100–1430 |
| 11855 | DZH8 | Manila | 100kW | 2130–2325, 1030–1245 |
| 11890 | DZE9 | Manila | 100kW | 0845–1030 |
| 11920 | DZF2 | Manila | 100kW | 2130–2330, 0945–1615 |
| 11950 | | Manila | 100kW | 2100–2300, 0300–0400 |
| 15170 | | Manila | 100kW | 0530–0630, 1100–1430 |
| 15440 | DZF8 | Manila | 100kW | 2325–0500, 1245–1630 |

The transmitters on 11830 and 15170kHz are those of Radio Veritas, reported by many listeners. Radio Veritas is operated by the Philippine Radio Educational and Information Centre.

The complete list of stations is a long one and cannot, for reasons of space allocation, be completely included here. For the beginner, the writer recommends listening for Radio Veritas on the channels mentioned above.

### VIETNAM

This former State is now divided into two countries as a result of the Geneva Conference of 1954. In the North is North Vietnam with its capital at Hanoi whilst, in the South, is South Vietnam with a capital at Saigon.

Vietnam as a whole was formed from the mainly Annamese populated areas of Indo-China: Tonkin, Annam and Cochin China. It has forested plateaus and mountains, with the Red river delta in the North and the Mekong river delta in the South.

The Republic of Vietnam, in the South, has an area of 66,350 square miles and a population of about 14,054,000, includes Cochin China and most of Annam and is bordered by Laos and Cambodia on the West and the South China Sea on the East and South.

The Democratic Republic of Vietnam, in the North, has an area of 60,900 square miles and a population of 16,000,000, includes Tonkin and North Annam and is bordered by Laos on the West; China on the North; and the Gulf of Tonkin on the East. It has most of Vietnam's mineral resources, especially coal.

*South Vietnam*

The short wave outlets of this country are listed in Table IX, from which it will be noted that the best chance of hearing S.Vietnam would be on either 6165 or 9620kHz.

**TABLE IX**

| *Freq.* | *Stn.* | *Power* |
|---|---|---|
| 6165kHz | Saigon | 20/200kW |
| 7175kHz | Saigon | 10kW |
| 7245kHz | Saigon | 20kW |
| 9620kHz | Saigon | 20/200kW |
| 11950kHz | Saigon | 20kW |

Of the channels listed, all have a 24-hour schedule except 7245kHz which is in operation for the Forces from 2200 to 1600GMT.

Reception of Saigon is no easy matter; the SWL press has not reported Radio Vietnam for some time. All of the programmes are in Vietnamese; there is no English Service on the short waves. The address is R.Vietnam, 3 Phan-dinh-Phung Str, Saigon.

*North Vietnam*

This country devotes more of its resources to short wave broadcasting than does the Southern Republic, it therefore being a relatively easy matter to log N.Vietnam. The easiest channel for beginners is that of 15018kHz at 2000GMT when full station identification is made at the commencement of the English programme.

Table X gives the current list of published short wave outlets.

The station announcement in English is "This is the Voice of Vietnam broadcasting from Hanoi, capital of the Democratic Republic of Vietnam". The address for reports is – Voice of Vietnam, 58 Quan-Su Street, Hanoi.

Table X should not, however, be taken literally

**TABLE X**

| Freq. | Stn. | Power |
|---|---|---|
| 4684kHz | Hanoi | Not listed but probably 150–250kW |
| 5985kHz | Hanoi | ditto |
| 7360kHz | Hanoi | ditto |
| 7416kHz | Hanoi | ditto |
| 9760kHz | Hanoi | ditto |
| 9840kHz | Hanoi | ditto |
| 10224kHz | Hanoi | ditto |
| 15018kHz | Hanoi | ditto |

as Hanoi has been heard on other additional frequencies both by the writer and many other Dx'ers, including the 4823kHz channel as early as 1410GMT during the winter season. ■

*(To be concluded)*

# GALLIUM ARSENIDE F.E.T.

by

J. B. DANCE, M.Sc.

**As this short note makes evident, semiconductor operation is not entirely confined to devices based on germanium or silicon**

Almost all of the early transistors were germanium devices, but now high performance silicon devices have tended to displace them for most purposes. Although many other semiconductor materials are available for use in devices such as infra-red detectors, etc., few successful transistors have been made, even in research laboratories, with materials other than germanium or silicon.

It is therefore particularly interesting to note that the Plessey Microelectronics Company have recently introduced an N-channel gallium arsenide field effect transistor which is ideally suited for low noise u.h.f. amplifier applications. It has an operating frequency of up to 1.5GHz (= 1,500MHz) and a cut-off frequency of up to 4GHz. This device provides a common source power gain of not less than 10dB at 1GHz with matched input and output circuits, a drain to source potential of 5V and a zero gate to source bias. The noise figure is about 4dB at 2.2GHz for a source resistance of 100 to 200 ohms.

The device is coded GAT. 1 (i.e. Gallium Arsenide Transistor 1) and is available in a TO–18 case with four leads, one of which is connected to the can. ■

# NOW HEAR THESE

*Times = GMT* *Frequencies = kHz*

● **SAUDI ARABIA**

The Broadcasting Service of the Kingdom of Saudi Arabia can be heard on **11855** (50kW) from 1950 to 2000 in English.

● **NATIONALIST CHINA**

The Voice of Free China, Taipeh, Taiwan, beams to Western Europe and Africa from 1800 on **17720** (50kW).

● **HONDURAS REPUBLIC**

HRVC Tegucigalpa has been heard with good signals on **4820** (5kW) at 0505 sign off. Announces as "La Voz Evangelica".

● **SINGAPORE**

Radio Singapura has been heard at good strength on **11940** (50kW) with English request programme for S. E. Asia at 0905. Also logged on **5052** (10kW) with news in English at 1530.

● **COSTA RICA**

Radio Reloj, San Jose, has moved from **4690** to **6005** (1kW). Schedule is from 1200 to 0600.

**ECUADOR**

HCJB, Voice of the Andes, has replaced **15425** with **15300** for the evening broadcast to Europe.

● **VENEZUALA**

Several new short wave stations are now in operation from this country. **4820** Radio Cristal, Barquisimeto; **5960** (1kW) YVZN Radio San Cristobal; Radio Cristal, **5980**; **5990** (1kW) YVTX Radio Machiques; **6020** (1kW) YVWK La Voz de Anaco, Anaco; **6030** (1kW) YVMN Esc. Radiofonicas. Caracas; **6050** YVTH Radio Metrapolitana, Baruta; **6080** (1kW) YVQX Radio Zaraza, Zaraza; **6090** (1kW), YVPK Radio Difusora La Pasqua; **6140** (1kW) YVZS Radio Terepaima, Cabudare; and **6160** (1kW) YVMU Canasma, Ciudad Guayana.

● **UGANDA**

Kampala can be heard on **4976** (3/8kW) at 2215 with a programme of European music and announcements in English.

● **INDIA**

Hyderabad is to be heard on **4800** (10kW) at 1530 with a musical programme. Local weather forecast at 1538.

VUM Madras **4920** (10kW) has been logged several times around 1530 on this channel.

VUB Bombay **4840** (10kW) may be heard with a local dialect programme around 1515.

● **N. VIETNAM**

For those wishing to log this country, try **4864** at around 2000 when it may be heard with a programme in Vietnamese. The channel is subject to CW QRM at times.

*Acknowledgements – Our Listening Post and SCDX*

# Weather-vane Repeater

by

C. DICKSON

**This article describes an unusual method of employing dry reed switches. Although intended here for indication of wind direction, the basic principle can be adapted for other applications where it is desired to monitor the orientation of objects**

MEMBERS OF THE YACHTING FRATERNITY TEND TO follow their pursuit with as much zest as does the more dedicated electronics enthusiast. An acquaintance of the writer is particularly keen on the sport and spends every possible moment that he can on the water.

Recently, he asked the writer whether it would be possible to rig up a weather-vane repeater unit that would display, within the house, the direction of the wind outside. The display would be provided by a number of bulbs arranged radially around the points of the compass, as shown in Fig. 1. Readers who have seen repeaters of this nature in weather stations, air-traffic control towers and similar places, will know the sort of thing the writer's friend had in mind.

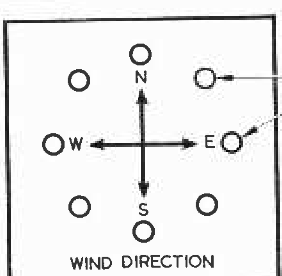



*Fig. 1. The front panel of a wind direction repeater. Individual bulbs light up to indicate the orientation of an external weather-vane*

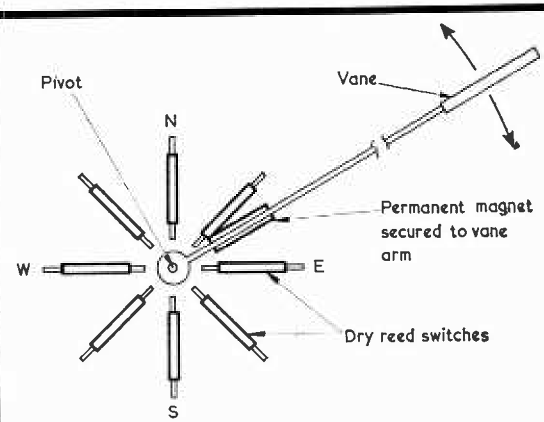



*Fig. 2. The basic method of controlling the repeater lamps by the weather-vane*

Suppressing the notion that his friend was intending to fit out his cosy semi-detached with enough nautical equipment to enable him to sail it down the High Street from the comfort of his living-room, the writer agreed to see what he could provide.

## CONTACT OPERATION

It was obvious that the wind direction indicating device, when completed, would consist of an external weather-vane coupled to the display unit by suitable wiring. Also that, as the weather-vane rotated on its pivot, it would cause contacts to close according to its position, these contacts causing the appropriate bulb or bulbs in the display unit to light up. What was not so obvious was the actual form these contacts would take.

The idea of coupling the weather-vane to a series of radially disposed springy brass contacts was almost immediately dismissed. Such contacts, particularly if of the home-constructed variety, would become corroded by the weather in no time at all. Besides, it would be very difficult to make up suitable contacts which would not apply excessive braking friction to the weather-vane as it rotated. A second idea consisted of coupling the weather-vane to a 12-way Yaxley rotary switch with the indent spring ball removed, so that the switch spindle rotated relatively freely. But this idea was also rejected. Contact life could still be short because of the corrosive action of the weather. Further, the centre insulated discs of rotary switches have a nasty habit of swelling and consequently jamming under conditions of excessive damp.

It was then that the author had his moment of revelation, and he conceived the idea which is shown in basic form in Fig. 2. In this diagram a permanent bar magnet is fitted to the underside of the arm which carries the weather-vane. Distributed radially on a plane just below that traversed by the magnet are eight dry reed switches, spaced out at 45° intervals. As is well known, the contacts of a dry reed switch close when a bar magnet is brought close to the body of the switch. In the scheme shown in Fig. 2 the permanent magnet would cause the contacts of the nearest switch or switches to close and these would then activate the corresponding bulbs in the display

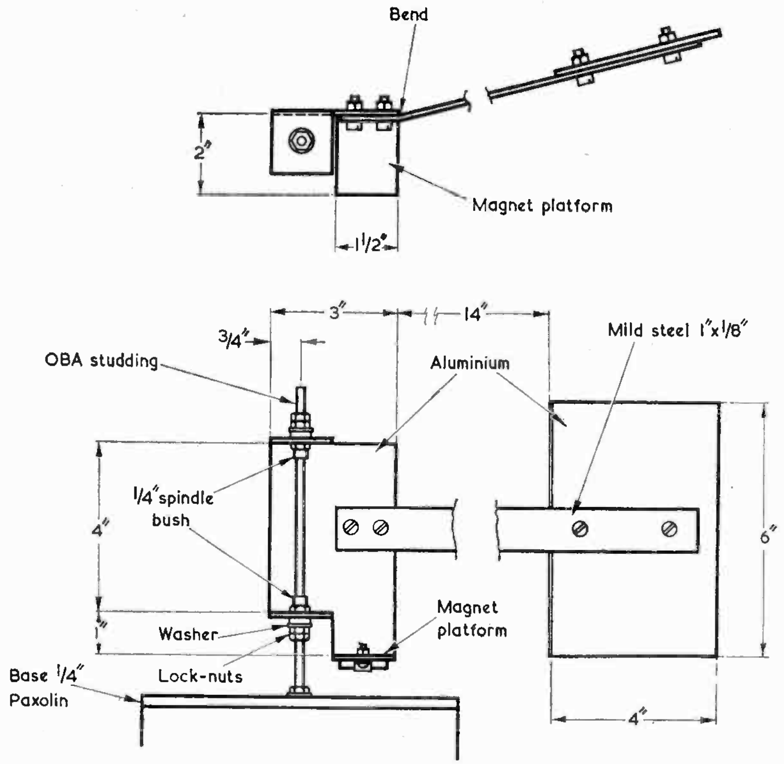



*Fig. 3. Top and side views of the prototype weather-vane assembly constructed by the author*

unit. The advantages offered by this approach are two-fold. First, there would be no braking friction on the rotation of the weather-vane whatsoever, since the magnet would not be in physical contact with the dry reed switches it passed over. Also, any magnetic attraction between the magnet and the nearest switch would be far too small to cause any unwanted deflection of the weather-vane. Second, the contacts of dry reed switches are sealed inside glass envelopes and cannot possibly be affected by the weather.

## PRACTICAL APPROACH

The next job was to try out the idea of Fig. 2 in practice, and this resulted in the construction of the prototype weather-vane assembly shown in Fig. 3. The pivot is a length of OBA studding, on which an aluminium bracket rotates. The bracket is made from 12 s.w.g. aluminium sheet and is fitted with two brass ¼ in. radio component spindle bushes at the ends where it passes over the studding. A pair of lock-nuts at the bottom allow the height of the bracket to be adjusted, whilst a second pair of lock-nuts at the top prevent the whole thing from taking off during storms and gales. Since, in addition to its tenacity, molybdenum disulphide is the slipperiest stuff known to mankind, a molybdenum disulphide based grease was applied to the studding at the places where the two spindle bushes bear against it.

The mild steel bar which holds the weather-vane is bent so that a line drawn along the horizontal width of the vane passes through the centre of the studding. The vane is also made of 12 s.w.g. aluminium sheet. The bracket which fits over the studding is bent to provide a platform for the magnets (the reason why more than one magnet is required will be explained shortly). These mount underneath the platform by means of aluminium clamps.

The base on which the studding is mounted is ¼ in. Paxolin and the eight dry reed switches are clamped underneath its surface so that they are spaced out in

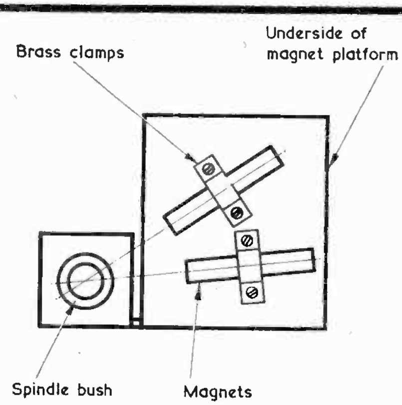



*Fig. 4. When two magnets are required, they should be mounted radially as shown here*

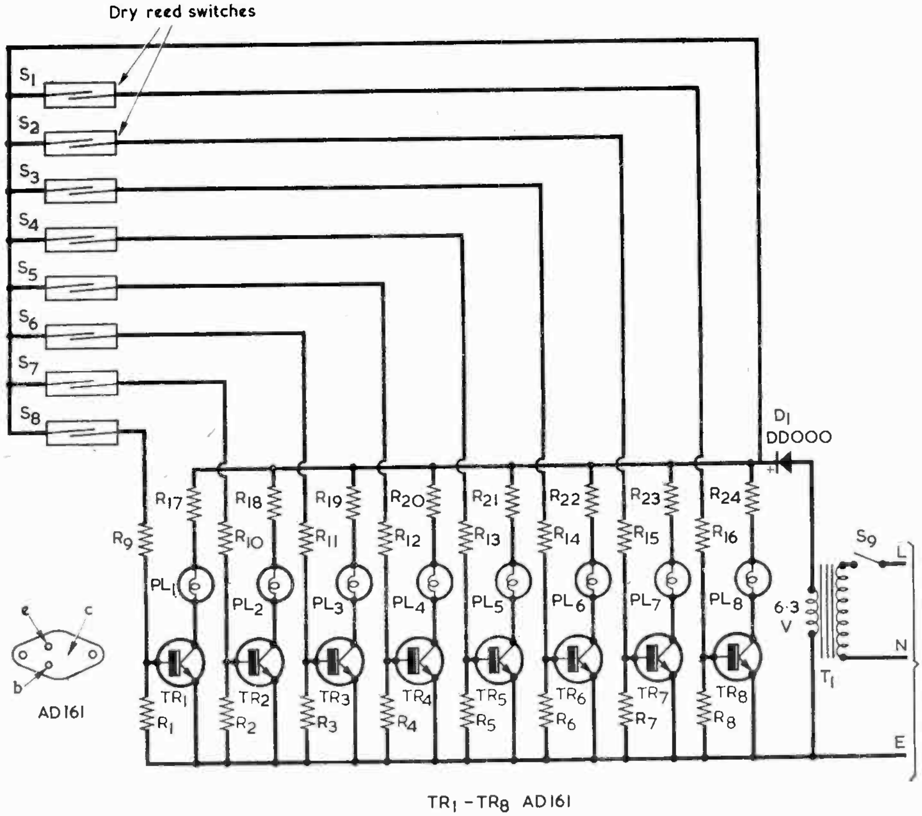



*Fig. 5. Each dry reed switch illuminates the corresponding lamp in the display unit by way of a small power transistor*

the same way as in Fig. 2, with their centres lying on a circle of about 2 in. radius centred on the spindle. The switches are secured by small aluminium clamps which are, in turn, held by countersunk 6BA bolts and nuts. The holes in the Paxolin for these bolts are countersunk to ensure that the bolt heads lie flush. This is a desirable feature because the magnets need to approach the top surface of the Paxolin fairly closely. A small piece of p.v.c. sheet should be inserted between each clamp and the body of the dry reed switch it secures to avoid putting excessive strain on the glass.

The writer will be the first to admit that the design of Fig. 3 is of a somewhat flimsy nature. It is intended, at some future date, to modify it by fitting a spindle whose diameter is about ½ in., and which will in consequence be considerably stronger than the OBA studding shown. To maintain the ability to adjust height, the new pivot will probably be ½ in. Whitworth studding, or similar. Readers who have metalworking facilities at home can, no doubt, incorporate other changes which will increase the mechanical strength of the vane assembly. Another possible improvement would be the use of Formica instead of Paxolin for the base. However, avoid using the heat-resistant grade of Formica, as this has a thin shim of metal incorporated into the laminate.

The underside of the base needs to be protected by providing a water-tight box, wires being taken from the reed switches inside this box to the display unit in the house. Nine wires are needed. One wire connects to one terminal of all the reed switches. The other eight wires connect to the remaining terminals of the switches.

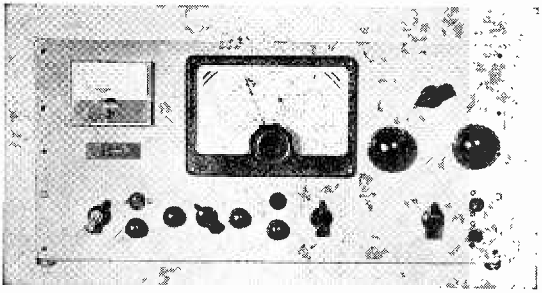
## MAGNET ADJUSTMENT

The basic scheme of Fig. 2 looks ideal in theory, but in practice things don't work out quite as easily. The reader making up the weather-vane unit must definitely be prepared to carry out some experiments with magnet positioning to obtain best results.

If the constructor is lucky, he will find that a single magnet, as in Fig. 2, is all that is required. If the magnet is sufficiently strong it will cause the two nearest reed switches to close when it is positioned mid-way between them. The display will then always have either one bulb illuminated or two, allowing a good indication of wind direction to be provided. The overlap effect as the magnet passes from one reed switch to the next is essential. If, with the magnet mid-way between two reed switches, neither of these is closed, the whole set-up is useless because no bulbs at all are illuminated in the display.

It is worth trying the device with a single magnet

*(Continued on page 300)*



# THE 'VE TRANS

J. BRC

**This comprehensive c.w./a.m. desi inclusive and incorporates switch It must not, of course, be opera licence. Final constructional deta procedure will be given in the c**

THE WRITER OPERATES S.S.B./C.W./A.M. ON BANDS 160 metres to 432MHz, but decided to make a simple effective a.m./c.w. transmitter for stand-by operation. The outcome is detailed here and will be found a valuable asset as either stand-by or even as main transmitter. Even in these days of s.s.b. as a means of communication, it will be of great interest to Old Timer and newly licensed amateur alike. The set-up is simple and there are no wide-band couplers. Each stage has a job to do and does it efficiently. The components are easily available and the valves are readily obtained.

In the prototype a pair of TT11 (VT501 or CV1501) valves are used in parallel in the p.a. stage. These valves are cheap and the writer paid 1s. 6d. each for his. Very infrequently used now, the TT11 is a very efficient little valve (it is octal based), and will work well up to 60MHz. The writer has seen them in a commercial military set working up to 144MHz. The exciter section has plenty of drive available, so even a 6146 or TT21 could be used for p.a. However, the writer would point out that these are expensive and cannot be abused as can the inexpensive TT11, and so they are considered more of a 'luxury'.

## CIRCUIT DETAILS

As is shown in Fig. 1, a 6CH6 was chosen as a v.f.o. Efficient even at low voltage, the output is excellent. The driver is a 5763 and its anode is tuned from the front panel by VC2, which is designated the 'Peak Control'. This resonates the anode circuitry, ensuring maximum p.a. grid drive. The main drive control, VR1, is also adjustable from the front panel, and it varies the screen-grid voltage of the driver. It gives a good, even, control.

The p.a. illustrated in Fig. 2, incorporates a pair of TT11 valves arranged to give legal power on 160 metres, plus an increased power on other bands.

Clamper control is introduced into the p.a. stage so that, in the case of loss of drive the clamper valve, a 6AQ5, holds the p.a. to a low anode current. Hence it is possible to key a previous stage and the p.a. will be held in 'open key'. The clamper circuitry also includes a very little used idea, this being front panel control, by VR2, of power. This control allows the p.a. output to be within the legal limit of 10 watts when on 160 metres. The p.a. can be loaded up to 40 to 50mA and, after loading efficiently, the power can then be reduced by VR2. So, on 160 metres the transmitter can run legal power, and on the other bands run up to some 25 watts. Many commercial transmitters alter the h.t. feed to the p.a. screen-grid or even the complete exciter to bring the power down to 10 watts on 160 metres. The writer feels that this alters the impedance of the p.a., and that the idea used here is better and more efficient in terms of r.f.

The speech amplifier (see Fig. 3) uses a 12AX7/ ECC83 as microphone amplifier, followed by 12AU7/

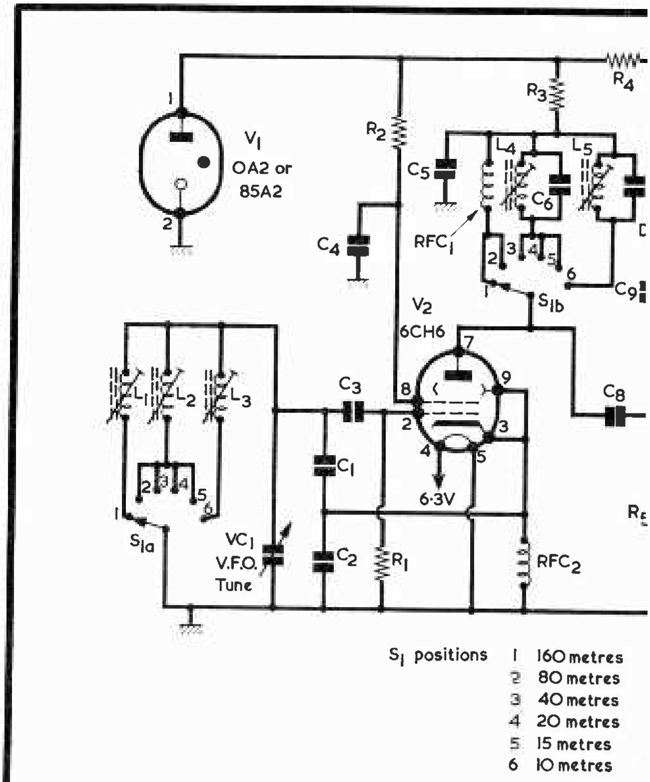



*Fig. 1. The v.f.o. and driver s*

# NTURER'
# MITTER

y
N, G3LPB

**covers all bands from 10 to 160 metres band change and p.a. drive peaking. without the appropriate Post Office and a description of the setting-up luding article in next month's issue**

Cover Feature

ECC82 as amplifier and phase inverter. This drives a pair of EL84's in push-pull. These are capable of giving well in excess of 10 watts, so there is plenty of power for anode and screen-grid modulation of the p.a. stage.

### R.F. SECTION

On 160 metres the v.f.o. grid tunes over 1.8 to 2MHz, whilst on 80 metres the v.f.o. grid tunes over 3.5 to 3.8MHz, another coil being switched in.

On 40 metres the v.f.o. grid tunes over 3.5 to 3.8MHz, its anode being switched to a coil peaked mid-band at 7MHz. Hence, doubling takes place in this stage.

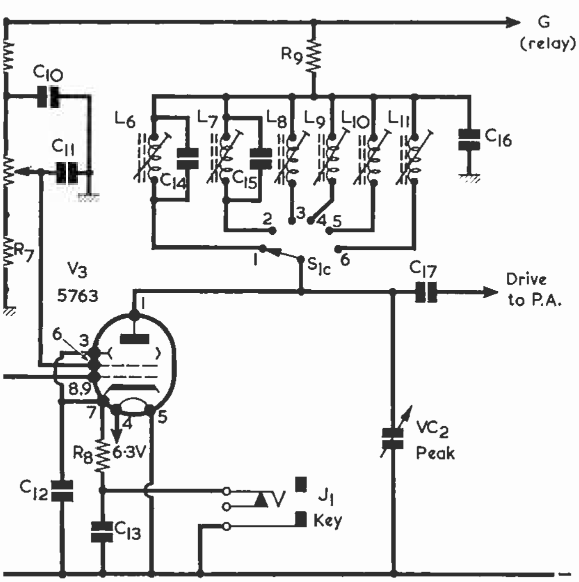
On 20 metres the same happens again, and the driver stage also doubles, giving 14MHz.

On 15 metres, the driver triples to 21MHz.

On 10 metres the v.f.o. grid runs at 7MHz, its anode doubles to 14MHz, and the driver doubles to 28MHz.

On 160 and 80 metres the anode load of the v.f.o. is aperiodic and consists of an r.f. choke. This point is detailed in the accompanying Table.

With these arrangements there is plenty of drive on all bands. The driver anode coil can always be peaked from the front panel so there are no harmonics here nor wide-band couplers to cause trouble.




'es of the 'Venturer' transmitter

### METER SWITCHING

The meter switching circuit is shown in Fig. 4, this interconnecting with Figs. 2 and 3 at the points with corresponding letters. The shunts shown in Figs. 2 and 3 can be either purchased or made. The series resistor in Fig. 4 has a value which causes the meter to read 500 volts f.s.d. No precise data on the shunts can be given as the range of meters available is too numerous. As a guide, the shunt required for 100mA f.s.d. is one-nineteenth of meter resistance, that for 30mA is one-fifth of meter resistance, and that for 10mA is equal to meter resistance.

Provision is made for metering the following quantities.

1. P.A. grid current.
2. P.A. screen-grid current.
3. P.A. current. This is obtained from a cathode connection, so the meter really reads anode current plus screen-grid current. The true anode current is the current indicated minus screen-grid current.
4. R.F. output. The meter really offers an indication that the r.f. is getting out, but the transmitter could be tuned using this indication.
5. Modulator current.
6. H.T. voltage to the p.a.

### TRANSMIT/RECEIVE RELAY

Fig. 5 shows the transmit/receive relay together with the main control switch. The relay energises on 'Transmit'.

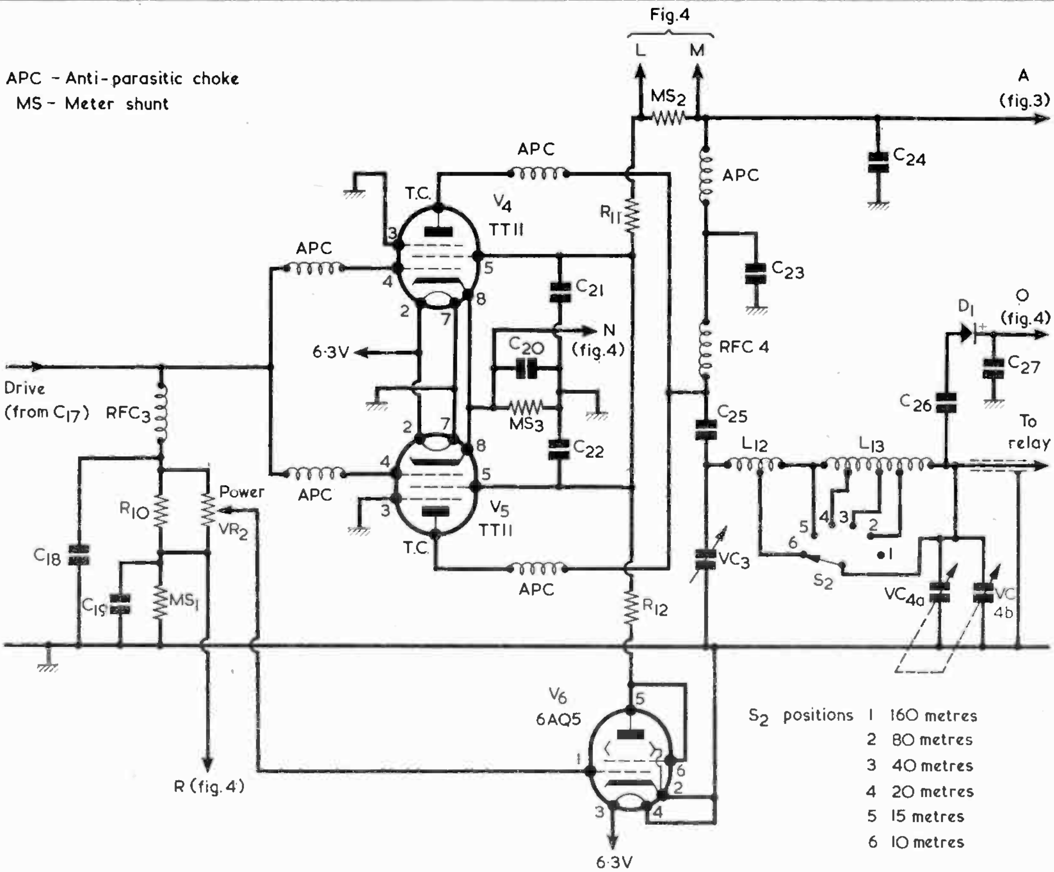
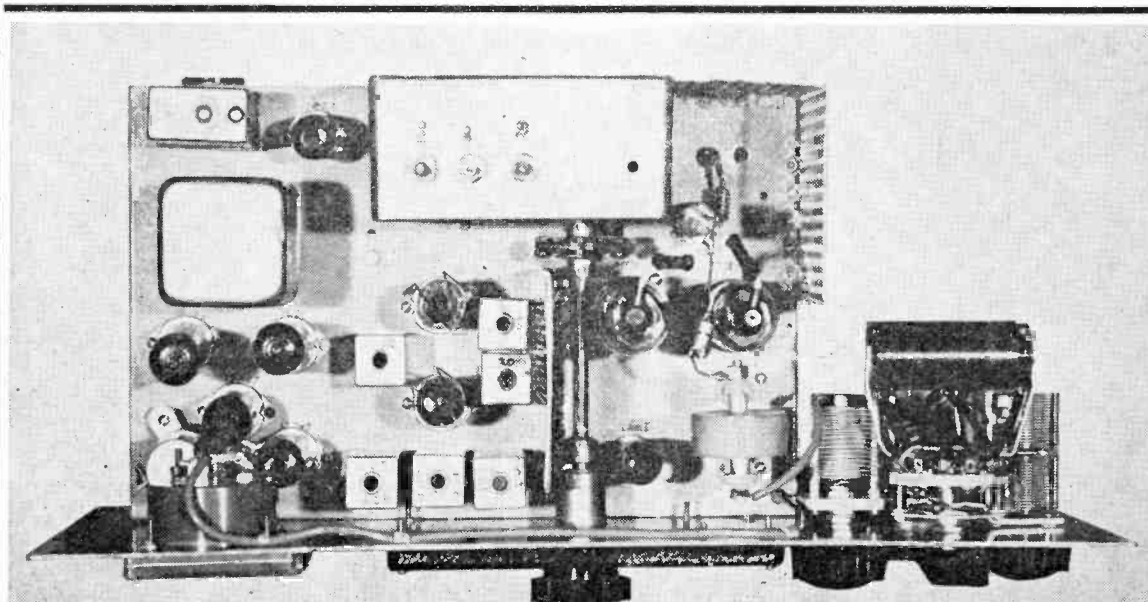



*Fig. 2. The p.a. stage and output circuit. V6 is a clamper valve and reduces p.a. current in the absence of drive*



*Top view of the transmitter. The chassis is filled comfortably without cramping at any point*
*(Photographs, G. Cooper, G3VJB)*

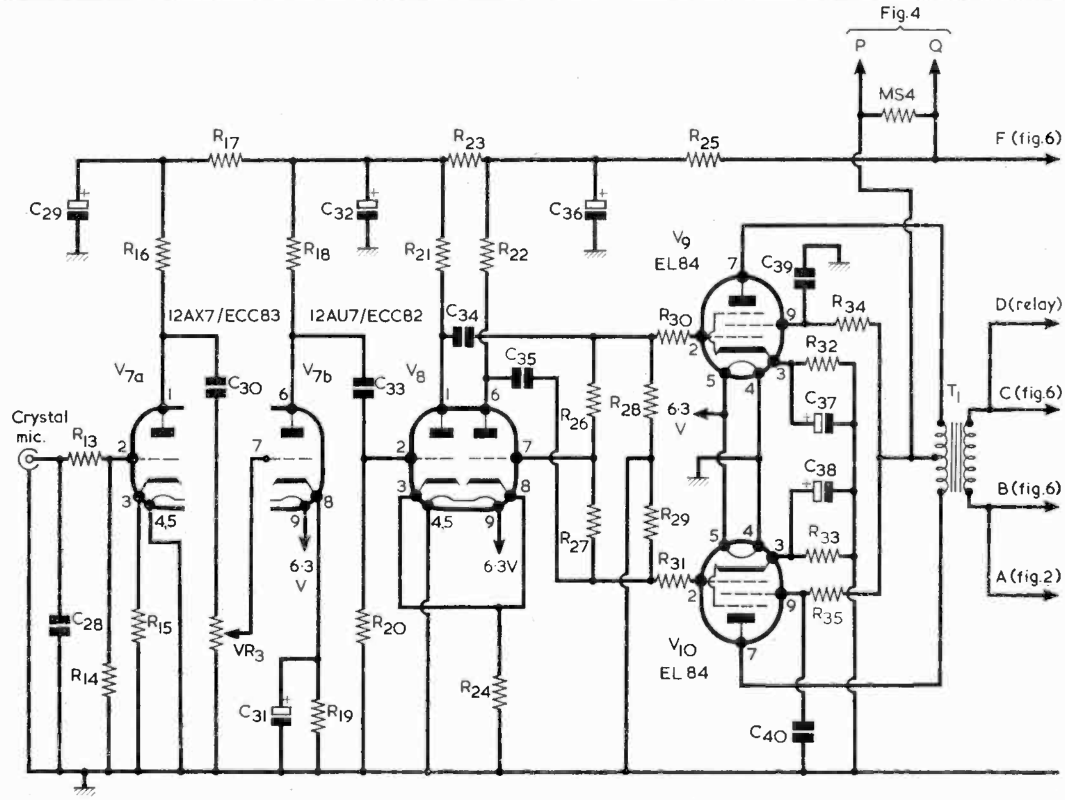
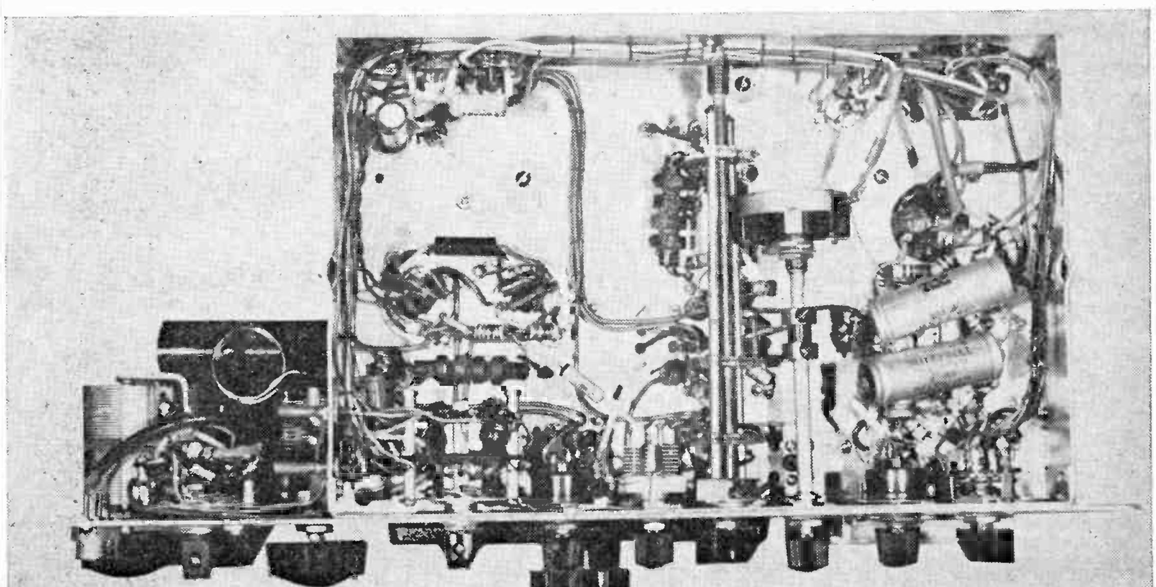



*Fig. 3. The modulator amplifier*



*Underneath the chassis. Note the 3-section band switch and the drive control potentiometer alongside*

**TABLE**

*Transmitter Frequencies*

| *Band* | *V.F.O. grid* | *V.F.O. anode* | *V.F.O. anode coil* | *Driver anode* | *Driver anode coil* | *P.A. coil* |
|---|---|---|---|---|---|---|
| 1.8 – 2MHz | 1.8 – 2MHz | Aperiodic | RFC1 | 1.8 – 2MHz | L6 | 160 metres |
| 3.5 – 3.8MHz | 3.5 – 3.8MHz | Aperiodic | RFC1 | 3.5 – 3.8MHz | L7 | 80 meters |
| 7MHz | 3.5 – 3.8MHz | 7MHz | L4 | 7MHz | L8 | 40 metres |
| 14MHz | 3.5 – 3.8MHz | 7MHz | L4 | 14MHz | L9 | 20 metres |
| 21MHz | 3.5 – 3.8MHz | 7MHz | L4 | 21MHz | L10 | 15 metres |
| 28MHz | 7 – 7.4MHz | 14MHz | L5 | 28MHz | L11 | 10 metres |

When the switch is on 'Stand-by' there is no circuit to the relay coil, and the h.t. supply in the receiver is broken. Putting the switch to 'Receive' completes the h.t. circuit to the receiver which then becomes operable. Also, the receiver has an aerial input via the de-energised contacts of the relay. Putting the switch to 'Transmit' causes the relay to energise. One of its contacts changes the aerial to the p.a. pi output circuit whilst further contacts complete the h.t. supply to the v.f.o. and driver stages. The h.t. supply for the modulator passes to another switch which will be discussed shortly.

The relay may be any reliable type, such as P.O. 3000, energising at around 12 volts. This voltage can be obtained from a low voltage supply, whose design is left to the constructor. A suggested supply is given in Part 2.

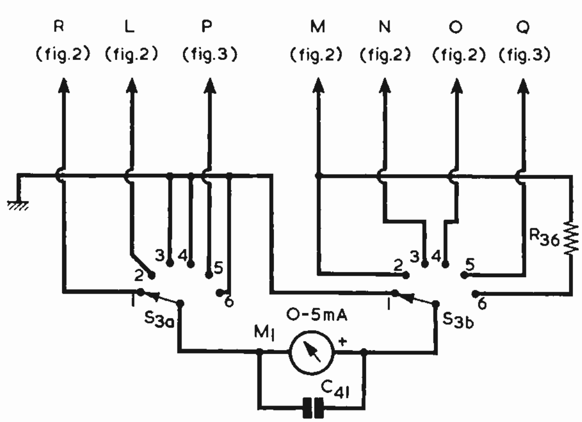
Fig. 6 shows the Function Switch, which offers 'Net', 'C.W.', 'Stand-by', and 'A.M.'. On 'Net' the right-hand pole allows h.t. to be applied to the b.f.o. and driver, regardless of the condition of the transmit/receiver relay. When set to 'A.M.' the centre pole allows the h.t. supply from the relay contacts to be fed to the modulator. The left-hand section of the switch causes the modulation transformer secondary to be short-circuited on 'Net', 'C.W.' and 'Stand-by'.

If desired, a press-to-talk switch may be added to the relay circuit of Fig. 5. In one version of the transmitter, this switch was incorporated into the microphone. Operation in this manner still causes the receiver to be muted during transmission.

It will be seen that the switch of Fig. 6 controls functions as indicated, and that it also allows netting to take place when the main transmitter switch is at 'Receive'. Incidentally, the 'Stand-by' position of the main switch allows the operator to kill both transmitter and receiver during any shack 'internal interruption'.

## COIL DATA

The v.f.o. grid coils may be wound on Denco polystyrene formers with 0.375in. diameter, each being




$S_3$ positions
1 P.A. grid current (f.s.d. = 10mA)
2 P.A. screen-grid current (f.s.d. = 30mA)
3 P.A. cathode current (f.s.d. = 100mA)
4 R.F. output
5 Modulator current (f.s.d. = 100mA)
6 P.A. H.T. voltage (f.s.d. = 500V)

*Fig. 4. Meter switching circuit*

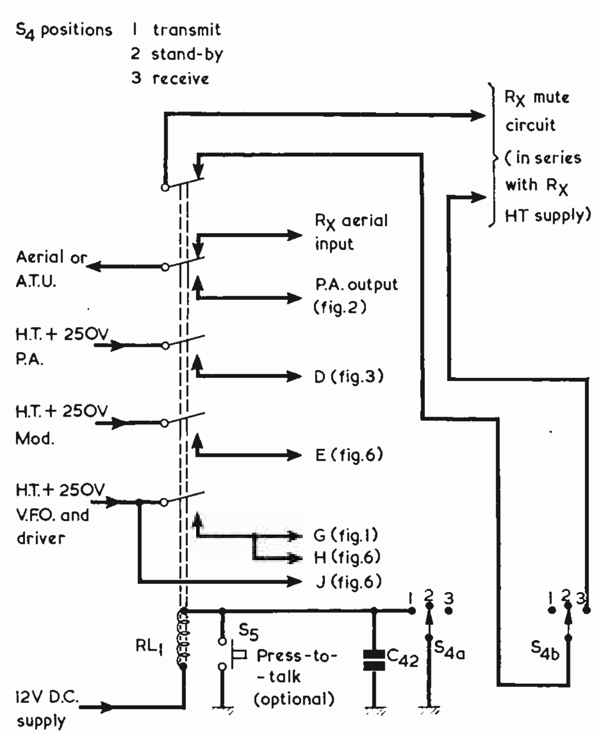



*Fig. 5. The main switch and transmit/receive relay*

## COMPONENTS

*Resistors*
(All fixed values ½ watt 10%. R4 may require adjustment for correct voltage regulation).

| | | | |
|---|---|---|---|
| R1 | 100kΩ | | |
| R2 | 4.7kΩ | | |
| R3 | 1kΩ | | |
| R4 | 6kΩ 2 watts (OA2) or 11kΩ 4 watts (85A2) | | |
| R5 | 47kΩ | R21 | 220kΩ 5% |
| R6 | 4.7kΩ | R22 | 220kΩ 5% |
| R7 | 4.7kΩ | R23 | 10kΩ |
| R8 | 68Ω | R24 | 1.5kΩ |
| R9 | 1kΩ | R25 | 68kΩ |
| R10 | 15kΩ 2 watts | R26 | 1MΩ 5% |
| R11 | 30kΩ 3 watts | R27 | 1MΩ 5% |
| R12 | 47Ω | R28 | 820kΩ 5% |
| R13 | 10kΩ | R29 | 820kΩ 5% |
| R14 | 2.2MΩ | R30 | 4.7kΩ |
| R15 | 2.2kΩ | R31 | 4.7kΩ |
| R16 | 220kΩ | R32 | 470Ω 5% 1 watt |
| R17 | 150kΩ | R33 | 470Ω 5% 1 watt |
| R18 | 100kΩ | R34 | 100Ω |
| R19 | 3.3kΩ | R35 | 100Ω |
| R20 | 1MΩ | R36 | 100kΩ 2% 5 watts |

MS1 Meter shunt (10mA f.s.d.)
MS2 Meter shunt (30mA f.s.d.)
MS3 Meter shunt (100mA f.s.d.)
MS4 Meter shunt (100mA f.s.d.)
VR1 50kΩ potentiometer, 3 watts, wire-wound
VR2 100kΩ potentiometer, linear
VR3 500kΩ potentiometer, log

*Diode*
D1 OA81

*Switches*
(Details concerning S1 will be given in Part 2).
S1(a)(b)(c) 3-pole 6-way rotary
S2 1-pole 6-way rotary, ceramic
S3(a)(b) 2-pole 6-way rotary, break-before-make contacts
S4(a)(b) 2-pole 3-way rotary
S5 s.p.s.t. push-button (optional)
S6 3-pole 4-way rotary, break-before-make contacts

*Meter*
M1 0–5mA moving-coil meter

*Relay*
RL1 12-volt relay, 3 make contact sets, 1 break contact set, 1 changeover contact set

*Jack*
J1 closed circuit jack

*Miscellaneous*
Slow-motion dial and drive
Knobs, as required
2 coaxial sockets
Power socket
Microphone socket
2 octal valveholders
6 B9A valveholders
2 B7G valveholders
Material for chassis, panel, etc.

*Capacitors*
C1 1,000pF silver mica 2%
C2 1,000pF silver mica 2%
C3 100pF silver mica
C4 1,000pF disc ceramic
C5 1,000pF disc ceramic
C6 50pF silver mica
C7 50pF silver mica
C8 100pF silver mica
C9 1,000pF disc ceramic
C10 1,000pF disc ceramic
C11 1,000pF disc ceramic
C12 1,000pF disc ceramic
C13 0.01µF disc ceramic
C14 150pF silver mica
C15 150pF silver mica
C16 1,000pF disc ceramic
C17 100pF silver mica
C18 1,000pF disc ceramic
C19 1,000pF disc ceramic
C20 1,000pF disc ceramic
C21 1,000pF disc ceramic
C22 1,000pF disc ceramic
C23 1,000pF disc ceramic
C24 1,000pF disc ceramic
C25 0.005µF mica 1,000V wkg.
C26 8.2pF ceramic
C27 1,000pF disc ceramic
C28 50pF silver mica or ceramic
C29 16µF electrolytic 350V wkg.
C30 1,000pF paper or plastic foil
C31 50µF electrolytic 6V wkg.
C32 16µF electrolytic 350V wkg.
C33 1,000pF paper or plastic foil
C34 0.005µF paper or plastic foil
C35 0.005µF paper or plastic foil
C36 16µF electrolytic 350V wkg.
C37 200µF electrolytic 25V wkg.
C38 200µF electrolytic 25V wkg.
C39 1,000pF disc ceramic
C40 1,000pF disc ceramic
C41 1,000pF disc ceramic
C42 0.5µF paper or plastic foil
VC1 75pF variable
VC2 50pF variable
VC3 150pF variable
VC4(a)(b) 500 +500pF 2-gang, broadcast receiver type

*Inductors*
(See text for details of all r.f. inductors)
T1 Modulation transformer: ex-SCR 522, Woden UMO or equivalent

*Valves*
V1 OA2 or 85A2 (see text)
V2 6CH6
V3 5763
V4 TT11 (VT501, CV1501)
V5 TT11 (VT501, CV1501)
V6 6AQ5
V7 12AX7/ECC83
V8 12AU7/ECC82
V9 EL84
V10 EL84

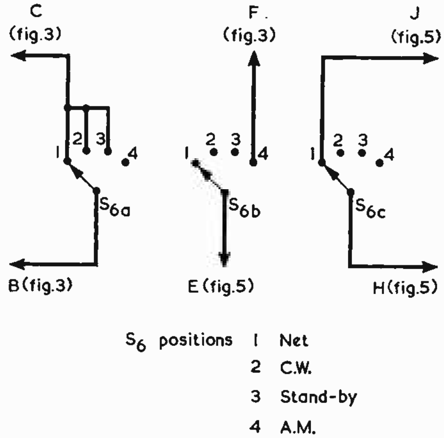



*Fig. 6. Connections to the function switch*

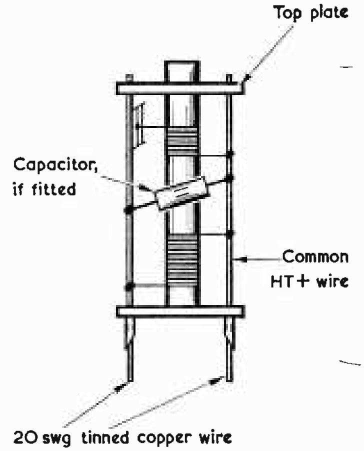



*Fig. 8. Coils L6 to L11 are wound in the manner shown here, in which two coils are fitted on a single former*

fitted with an iron-dust core. They are mounted by their fixing nuts inside the v.f.o. box at the rear of the transmitter.

L1, which covers 1.8 to 2MHz, has 40 turns close-wound of 36 s.w.g. enamelled wire. L2, for 3.5 to 3.8MHz, has 20 turns close-wound of 24 s.w.g. enamelled wire. L3, which tunes over 7 to approximately 7.4MHz, has 15 turns close-wound of 26 s.w.g. enamelled wire.

The actual frequency coverages obtained may vary a little from the figures just given according to the manner in which the coils are wound, but it should, in most cases, be possible to bring them to the right frequencies by means of the cores. If frequency is still too high add a small-value silver mica-capacitor across the coil to provide correction. If the frequency is too low remove a turn or two, as required.

RFC1 and RFC3 are normal r.f. chokes. They are the air-cored types wound with a number of pies, and not the ferrite cored variety. They require an inductance of 2.5 or 2.6mH. The Denco type RFC9A, or similar, will be satisfactory.

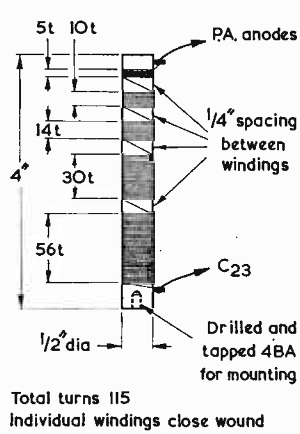



*Fig. 7. Winding details for RFC4. The prototype used a solid former. If a tubular former is employed an alternative means of mounting it vertically to the chassis must be provided*

RFC2 is a made-up component and is mounted in a can alongside the v.f.o. valve. Take any small valve type 465kHz i.f. transformer, remove the cores and both the internal capacitors, then remove one winding with the aid of a razor blade. The remaining winding forms the choke.

RFC4 is wound on a 4in. coil former having a diameter of ½in, as shown in Fig. 7. The winding wire is 26 s.w.g. enamelled. When completed, the windings are painted with Denco 'Denfix' polystyrene solution.

L4 and L5 are wound on Denco formers Ref. 5000A/4PL fitted with top plates Ref. 5001 and cans Ref. 1. Both have iron-dust cores. Vertical 20 s.w.g. tinned copper wires pass through the bottom lugs up to the top plate in the same manner as for the coils (L6 to L11) shown in Fig. 8. L4 (7MHz) has 30 turns close-wound of 28 s.w.g. enamelled copper wire, with a 50pF silver-mica capacitor in parallel. L5 (14MHz) has 15 turns close-wound of 28 s.w.g. enamelled copper, and also has a 50pF silver-mica capacitor in parallel.

L6 to L11 are wound on Denco 5000B/4PL formers, with top plates Ref. 5001 and cans Ref. 3, as in Fig. 8, L6 and L8 are wound on one former, L9 and L10 on another, and L7 and L11 on the third. Since both coils in a can share a common h.t. connection, their inside ends may both be terminated at a single upright 20 s.w.g. tinned copper wire. Two cores are fitted to each former.

L6 (160 metres when peaked) has 150 turns close-wound of 36 s.w.g. enamelled wire, plus a 150pF silver-mica capacitor in parallel. L7 (80 metres when peaked) has 40 turns close-wound of 28 s.w.g. enamelled wire, plus a 150pF silver-mica capacitor in parallel. L8 to L11 do not have parallel capacitors. L8 (40 metres when peaked) has 30 turns close-wound of 28 s.w.g. enamelled wire. L9 (20 metres when peaked) has 15 turns close-wound of the same wire; L10 (15 metres when peaked) has 11 turns close-wound of the same wire; and L11 (10 metres when peaked) has 8 turns of the same wire. All coils

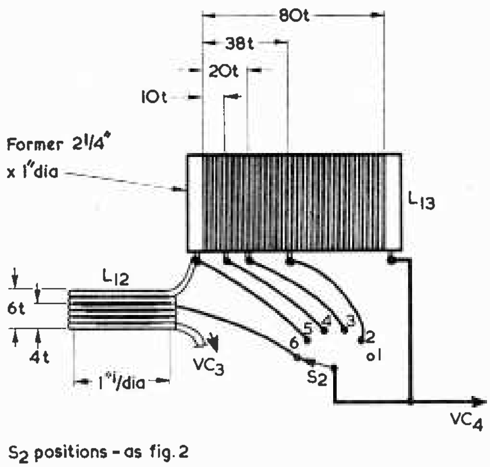



*Fig. 9. Illustrating the manner in which the output coils, L12 and L13, are wound*

are painted with 'Denfix' after winding.

The p.a. coil consists of L12 and L13, as shown in Fig. 9. L12 consists of 6 turns of 12 s.w.g. wire, tapped at 4 turns. It is self-supporting and has an i.d. of 1in. L13 consists of 80 turns of 26 s.w.g. enamelled wire close-wound on a 1in. former, as shown. Taps are made at 10 turns, 20 turns and 38 turns.

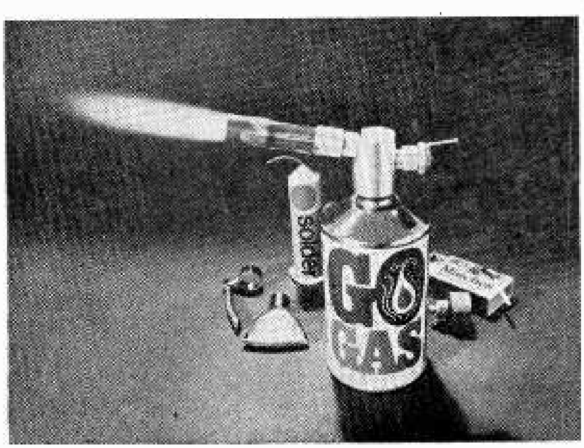
There are five anti-parasitic chokes in the grid and anode circuits of the p.a. valves. Each consists of 6 turns of 20 s.w.g. enamelled wire wound over a ½ watt 47Ω resistor.

(To be concluded)

## NEW TILLEY 'GO-TORCH'

**A new product from The Tilley Lamp Company is a useful butane gas blow-lamp complete with paint stripper and soldering bit attachment operating on a Tilley 'Go-Gas' 6 oz. disposable cartridge.**

**Made from high quality chrome-plated steel, brass and aluminium, the 'Go-Torch' will appeal to home decorators, radio, electronic, car and boat enthusiasts and do-it-yourself handymen. Cost – £2–19–6d including general purpose burner, soldering bit attachment and flame spreader for paint stripping.**




# CURRENT SCHEDULES

*Times = GMT* *Frequencies = kHz*

**★ NETHERLANDS**

The English broadcasts to Europe from 1830 to 1950 is now on **6020** (10kW) and to Africa on **9715** (100kW), **11730** (100kW), **15220** (100kW) and **21570** (100kW). The English broadcasts to Europe from 2000 to 2120 is now heard via Bonaire (Netherlands Antilles) on **15390**.

**★ USA**

WNYW Radio New York has replaced the **15415** channel with that of **15440** (100kW) for the transmission from 1800 to 2230. That from 2230 to 2400 can now be heard on **11870** (100kW) instead of **11805**.

**★ LEBANON**

Radio Lebanon, Beirut, broadcasts to Africa, in English, at 1830 on **15380** (100kW), Arabic at 1900 and French from 2000 to 2030. To South America on **17715** in Portuguese at 2300, Arabic at 2330 and Spanish from 0030 to 0100. To North America on **11890** (100kW) in French at 0130, Arabic at 0200, English at 0230, Arabic at 0300 for the West Coast of North America, and Spanish from 0300 to 0330.

**★ MOZAMBIQUE**

Radio Clube de Mozambique, Beira, radiates the B Programme on **3265** (25kW) from 1630 to 0400. The A Programme is on **3210** (25kW) from 1630 to 2210. The **3218** (0.25kW) channel is that of Quelimane from 1600 to 2000.

**★ TANZANIA**

Radio Tanzania, Dar-es-Salaam, is using a new transmitter on the new channel of **6105** from 0330 to 0500 for the English service, the **4785** channel being in parallel.

**★ PAKISTAN**

The station at Multan has been heard with test transmissions in Urdu on **9870** from 1414 to 1600 and also at 0700.

**★ CANADA**

The Afro-European Service of Radio Canada is now as follows – from 0710 to 0745, in English, on **5990, 9625, 11925, 15390** and **17820.** The South Pacific Service is from 0825 to 0935, in English, on **5970** and **9630**. The N. American and Antilles Service is from 1217 to 1313, in English, on **9625** and **11720.** The European Service is from 0558 to 0630, for Canadian Forces, on **5990** and **9625**. From 1055 to 1215, for Canadian Forces, on **15325** and **17820.** From 1217 to 1313, in English, on **15325**. The evening transmission to Europe, in English, is from 2115 to 2152 on **9610, 11720** and **15325.**

**★ SWITZERLAND**

Programmes are broadcast in English on **3985, 6165** and **9535** as follows – Daily from 0900 to 0930; 0845 to 0915; 1100 to 1130; 1315 to 1345; 1515 to 1545 and from 1745 to 1815.

**★ SWEDEN**

Radio Sweden now has a daily transmission in English and Swedish to Australia and New Zealand from 0515 to 0615, on **11895** in parallel with **17840,** directed to S. Asian countries.

*Acknowledgements to our own Listening Post and SCDX.* ■

## WEATHER-VANE REPEATER

*(Continued from page 291)*

at first, even if this does not turn out to be successful. Should the single magnet not work, try two magnets 'in parallel', as it were, as shown in Fig. 4. The magnets should be mounted radially, as indicated, and like poles should be alongside each other. Initially, try the magnets positioned close together on the underside of the magnet platform. If this is unsuccessful spread their composite field out a little more by spacing them slightly further apart. In extreme cases it may even be necessary to use three magnets. Adjustment of the height of the magnets above the reed switches should also be carried out as required. The magnets are offset from the direction to the vane at the end of the mild steel bar, this being taken up by similarly offsetting the dry reed switches with respect to the points of the compass.

Unfortunately, it is by no means easy to be precise about magnet requirements, as there are quite wide tolerances both on magnet strength and on minimum field strength needed to operate the reed switches. It should also be remembered that a reed switch releases at a lower magnetic field strength than that at which it closes. The writer obtained his reed switches from a surplus supplier but they are readily available from regular mail-order houses. A sensitive reed switch is listed in the Home Radio catalogue under Cat. No. WS120. This is the Radiospares switch type 6RSR and Radiospares literature quotes operating distance between this relay, and the magnet listed by Home Radio under Cat. No. WS123, as 11 to 23 mm. (0.43 to 0.9 in.). Release distance is quoted as 24 to 37mm. (0.94 to 1.4 in.). The corresponding operate and release distance figures when the reed switch is used with the magnet listed by Home Radio under Cat. No. WS124 (that with which it is normally intended to be used) are 5 to 13 mm. (0.2 to 0.5 in.) and 11 to 20 mm. (0.42 to 0.78 in.) respectively. Incidentally, these Radiospares parts *have* to be ordered through a retail source; Radiospares do not deal direct with home-constructors.

### ELECTRONICS

Dry reed switches are not capable of switching, at d.c., currents suitable for operating any but very low consumption bulbs. In any case, it is desirable to have them switch relatively low currents in the interests of long contact life. In consequence, each of the reed switches in the weather-vane unit lights up its appropriate bulb by way of a transistor.

As the writer's friend was paying for the components, and since money is no object with these yachting types anyway, it was decided to resist the temptation to use low-cost surplus transistors and to employ brand-new devices operated well within their maximum ratings instead. The author felt that the resultant long-term reliability with such transistors would be well worth the extra cash outlay involved.

The electronic circuit for the weather-vane repeater is given in Fig. 5. In this diagram, S1 to S8 are the dry reed switches in the outside weather-vane unit. All the rest of the components in the diagram are in the display unit, being connected to the switches via the nine wires shown. Power is obtained from the half-wave rectifier D1, there being no necessity for a reservoir capacitor or for smoothing.

In Fig. 5, all transistors coupling to dry reed switches with open contacts are held cut off by the base resistor, R1 to R8, as applicable. When a reed switch closes it causes positive half-cycles to be passed, via the appropriate resistor R9 to R16, to the corresponding transistor base. The transistor is thereby turned on, and the bulb in its collector circuit becomes illuminated.

The bulbs PL1 to PL8 are cheap 2.5 volt flash-lamp types. Transformer T1 is a standard 6.3 volt heater transformer. The transistors are all n.p.n. power devices type AD161. Since they are either cut-off, or fully bottomed for most of the time, they dissipate only a small amount of power and do not need to be mounted on heat sinks.

Take care to ensure that a reliable connection to a mains earth is made, as illustrated in Fig. 5. This ensures that only very low voltages with respect to earth can appear on the external wiring.

Resistors R1 to R16 are given relatively low values in order to guard against false operation due to leakage between wire terminations at the weather-vane unit. However, the constructor should, at the outset, aim at preventing such leakage occurring by making sure that the housing for the reed switches is fully water-tight. One good thing about doing jobs for yachting enthusiasts is that they always seem to have stacks of paint available to enable weather-proofing of this nature to be carried out! ■

### COMPONENTS

*Resistors*
(All resistors 10%)

| | |
|---|---|
| R1 – R8 | 470Ω ¼ watt |
| R9 – R16 | 330Ω ¼ watt |
| R17 – R24 | 10Ω 1 watt |

*Semiconductors*

| | |
|---|---|
| TR1 – TR8 | AD161 |
| D1 | DD000 |

*Transformer*
T1 Heater transformer, secondary 6.3 volt, 1 amp or greater

*Switches*

| | |
|---|---|
| S1 – S8 | Dry reed switches (see text) |
| S9 | s.p.s.t. on-off, toggle |

*Lamps*

| | |
|---|---|
| PL1 – PL8 | 2.5 volt flash-lamp bulbs |

*Magnets*
2 magnets, or as required (see text)

*Miscellaneous*
8 bulb-holders
Materials for weather-vane and display units
Interconnecting wire

## HIGH ACCURACY THERMOSTAT

Due to lack of space, this article has been held over and will now appear in our next issue – due to be published on 1st January.

# CHRISTMAS CAROLS

Continuing the saga of the three financial wizards about which I wrote in the last issue, the near-twelve year olds aspiring to gather 'wireless' parts with which to construct a 3-valve receiver, ruefully assessed the 'shack' funds. It didn't take long – the contents were so sparse that Old Mother Hubbard's cupboard looked like Aladdin's cave in comparison! However, our schoolboy enthusiasm for 'wireless' knew no bounds, after all, bounds were there simply to be broken. Those hopefully imposed by a well-meaning headmaster on a sweetshop trading in opposition to the school tuckshop was assailed with great gusto and for a very good reason – the owner purveyed the most delectable ½d. toffee apples in the district! Brandished as a law-breaking trophy, they also represented authority outwitted!

The much wanted Burndept dial would cost money and with our funds in their usual parlous state something had to be done. Reluctantly turning our thoughts from the delicious sticky toffee apples to the more desirable dial, we hopefully set out on a Christmas Carolling expedition to redress the void exhibited by our cash tin. The depleted treasury just had to be replenished.

Singing with all our might 'Hark the Herald Angels Sing' and 'Once in Royal David's City' in what we fondly imagined was a tuneful rendering, our raucous youthful warblings evoked a hurried interest by the now long-suffering householders whose only thought was to gain some respite either by (a) hastily parting with a penny or (b) parting with some invective – not all of it flattering!

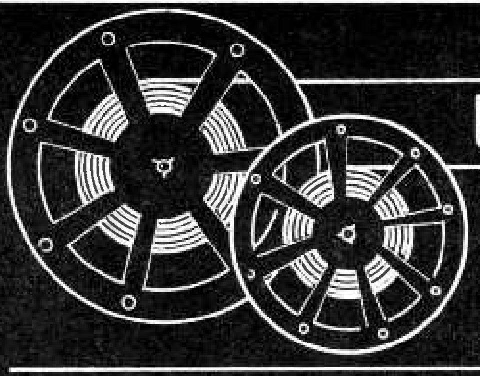
One such carolling performance I recall, was at the house of an elderly gentleman who, after we had gone through our entire repertoire of both carols and had ended with the final flourish of "Merry Christmas Sir," had the colossal effrontery to ask for our begging licence. Needless to say, we came away empty-handed and that worthy was ever after darkly referred to as "that old skinflint"!

We did not, I regret to say, achieve financial success – we had it seems been beaten to the draw by other schoolboy groups also having rival designs on the collected swag. In course of time sufficient wealth was amassed and exchanged for the dial but by then we were again engaged in other schemes that would, we hopefully thought, extract the necessary coinage from some of the local populace. At that juncture of time we were in dire need of a Graham Farish choke and that most necessary of all items – a 120 volt 'high tension' battery.

Nothing daunted we struggled on. The only thing we had plenty of, apart from youthful enthusiasm, was a supply of wooden boxes from which we made shelving, furniture of sorts and that most necessary component – the breadboard base on which the receiver was to be constructed.

The financial affairs of many young 'wireless' enthusiasts in those days beggars description – and that is the only way to describe it!

C.W.



# UNDERSTANDING TAPE RECORDING

*by W. G. Morley*

**In this concluding article in our short series on the subject of tape recording, our contributor deals with the main features of recorders incorporating transistors**

IN LAST MONTH'S ISSUE WE commenced by discussing superimposition, then carried on to switched equalisation filter circuits, which provide different recorder amplifier frequency responses for different tape speeds. We next dealt with half track and quarter track recording, after which we ended by discussing head azimuth and height adjustments.

We now carry on to an examination of tape recorders incorporating transistors.

## TRANSISTOR CIRCUITS

All the basic processes occurring in valve tape recorders appear in transistor tape recorders. However, whilst valve recorders of the more inexpensive domestic type tend to employ the 'standardised' amplifier stage layout which incorporates the ECC83 and ECL86, transistor tape recorders show no trend towards a similarly 'standardised' design. Indeed, there is a marked variance between the design approaches of different manufacturers, and this appears, even, in successive models by the same manufacturer. Many of the variations are due to the continuing evolution of the transistor itself. A typical example here is given by the introduction of silicon transistors in place of the older germanium types. Silicon transistors offer higher gain at a lower noise level, and allow the use of fewer amplifier stages. Another factor is that design economics do not dictate that the minimum number of transistors should be employed in a particular circuit as stringently as they prescribe that the minimum number of valves should be used. Transistors are cheaper than valves, and low-cost recorders may incorporate a relatively large number of them.

It is doubtful, also, whether transistor tape recorders will, in future, tend towards 'standardisation' in the same way that valve recorders have done. It is more probable that integrated circuits will become incorporated into tape recorders before any trend towards such 'standardisation' becomes noticeable.

The variance in transistor tape recorder designs does not alter the fact that their basic make-up is similar to that of the valve recorder. In common with valve recorders, a single amplifier is normally used both for record and for playback, and the switched equalisation filter circuits are much the same as those employed with valves. Another similarity is that a number of transistor tape recorders switch the a.f. output stage to function as an erase oscillator during recording.

We shall examine typical transistor circuits in this article, and it will be helpful to bear in mind that transistors are low impedance devices. In consequence of this, capacitance values in all signal circuits are higher, and resistance values are lower, than are those encountered in valve circuits. Also, in a battery or mains/battery transistor tape recorder the supply potential is limited to that of the battery it-

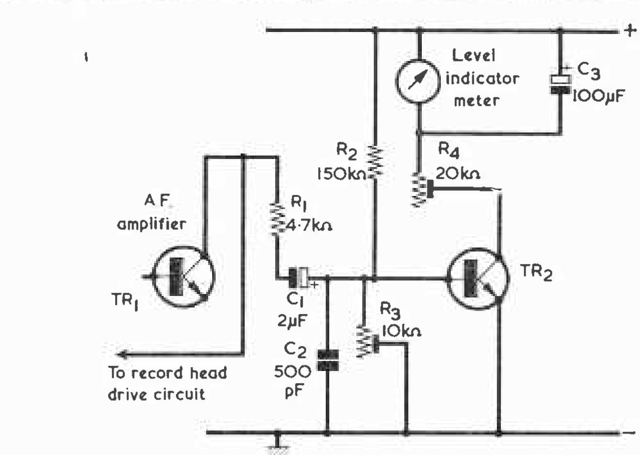



*Fig. 1. A typical level indicator meter circuit. Component values given here and in succeeding diagrams are representative of current practice*

self. In mains-driven transistor tape recorders the supply voltage situation is alleviated somewhat, since the d.c. supply (obtained after a mains transformer and rectifier circuit) is generally of the order of 20 to 30 volts. These relatively low voltages preclude the use of an electron beam tube level indicator, and it is general practice to employ a meter to monitor recording level. Low supply voltages can also affect the design of the 'constant current' record head circuit, and we shall first turn our attention to these two sections of the tape recorder.

## RECORDING LEVEL METER

A recording level meter circuit, representative of those encountered in transistor tape recorders, is shown in Fig. 1. In this diagram an a.f. signal from the collector of transistor TR1, which also feeds the record head circuit, is applied via R1 and C1 to the base of transistor TR2. Resistor R1 and capacitor C2 decouple the bias signal applied to the record head, and prevent it reaching the base of TR2. The meter in TR2 collector circuit has a movement which causes f.s.d. to occur at the left-hand end of its scale rather than at the right-hand end, as is usual with conventional instruments. When no current passes through the meter, its needle rests at the right-hand end of the scale. In the absence of signal, TR2 collector current causes the meter to take up its f.s.d. indication. When an a.f. signal is applied to the base, the base-emitter junction rectifies, causing the base to go negative according to the amplitude of the signal. The negative base bias results in reduced collector current, whereupon the meter needle moves to the right. The two preset variable resistors, R3 and R4, are set up such that the meter needle is at the left-hand end of its scale in the absence of signal and is about three-quarters of the way towards the right-hand end (at a point suitably marked on the scale) when the a.f. signal is at the maximum recording level for the recorder. Capacitor C3 discharges into the meter at a quicker rate than it charges via R4, with the result that the meter is quicker to respond to increases in a.f. signal level than to decreases. C3 also bypasses any a.f. currents that would otherwise flow through the meter, and prevents needle vibration with low frequency signals.

Other transistor record level meter circuits are similar to that of Fig. 1, with the exception that the meter may alternatively be in the emitter circuit of the transistor rather than in the collector circuit.

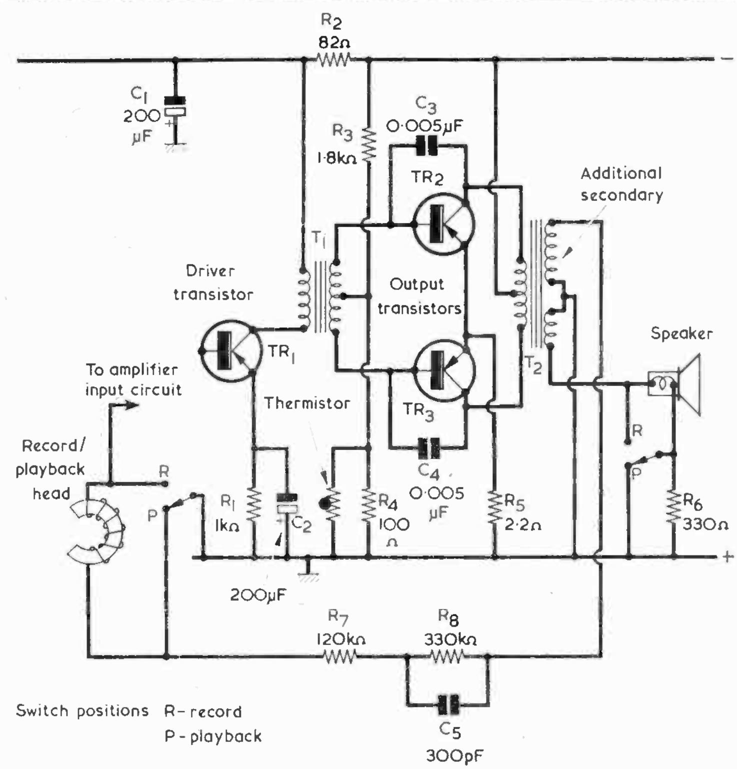
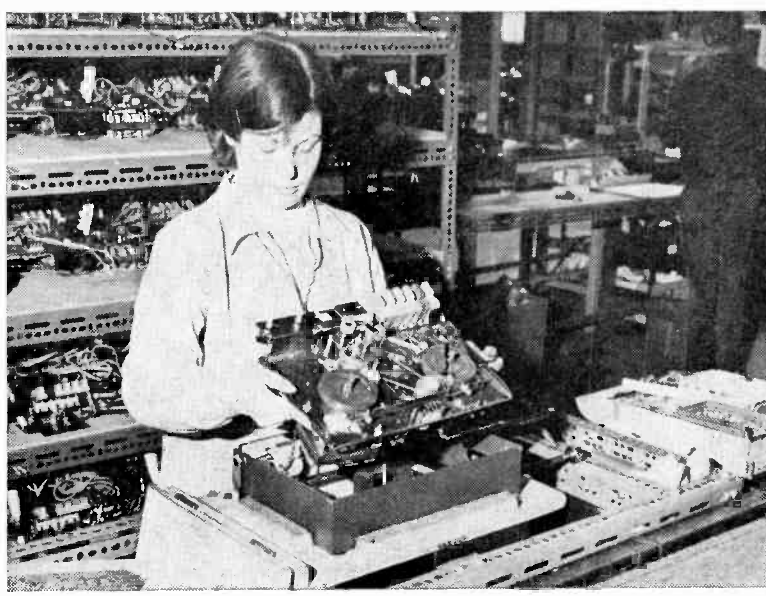



*Fig. 2. 'Constant current' drive circuit for a battery or mains/ battery transistor recorder*

## 'CONSTANT CURRENT' CIRCUITS

As we have seen earlier it is desirable to provide a 'constant current' drive for the record head to ensure that current flow in its coil is kept nearly constant at all audio frequencies. With valve tape recorders this requirement is met by



*A final step in the manufacture of a British Radio Corporation tape recorder. The machine, mechanically and electrically completed, is fitted into its cabinet* inserting a high-value resistor in series with the head, the value of the resistor being well in excess of the difference between head impedances at the maximum and minimum recording frequencies. It is necessary for the drive to the series resistor to have a high voltage amplitude, but this is an easy matter to arrange with valve circuits operating with h.t. potentials of the order of 200 volts or more. The required drive can be readily taken from the anode of a voltage amplifier valve.

With battery or mains/battery transistor recorders it is difficult to obtain a suitable drive amplitude from the collector of a transistor since, with a normal collector load, the drive voltage is limited by the supply potential. One solution consists of making the collector load an a.f. choke, and of feeding the record head from the collector by way of a coupling capacitor. Since the reactance of the choke increases with frequency, the a.f. output voltage at the transistor collector similarly increases with frequency, thereby ensuring that an approximation to 'constant current' in the record head takes place. This scheme was discussed in the first article of this series, published in the May issue.

An alternative approach, and one that is commonly encountered in battery and mains/battery transistor recorders, is illustrated in Fig. 2. When the two switches in this diagram are in the 'Playback' position TR2 and TR3 form a conventional Class B output stage, feeding the speaker in normal fashion by way of output transformer T2. Setting the switches to 'Record' disconnects the speaker and couples in the record/playback head. The a.f. amplifier stages which precede the driver transistor now amplify the signal to be recorded and apply it to TR1. TR1, TR2 and TR3 provide further amplification, causing the signal to appear at the primary of transformer T2. This transformer has an additional secondary having a relatively large number of turns, and the a.f. voltage across this additional secondary is applied, via the 'constant current' resistors R8 and R7, to the record head. The voltage step-up provided by the additional secondary produces an a.f signal having a voltage well in excess of battery voltage and the 'constant current' resistors can have values that are of the same order as are encountered in valve recorders. Capacitor C5, connected across R8, is included to provide a small amount of treble boost.

Mains-driven tape recorders have d.c. supply potentials which enable a satisfactory performance to be achieved, without step-up transformers, with 'constant current' re-

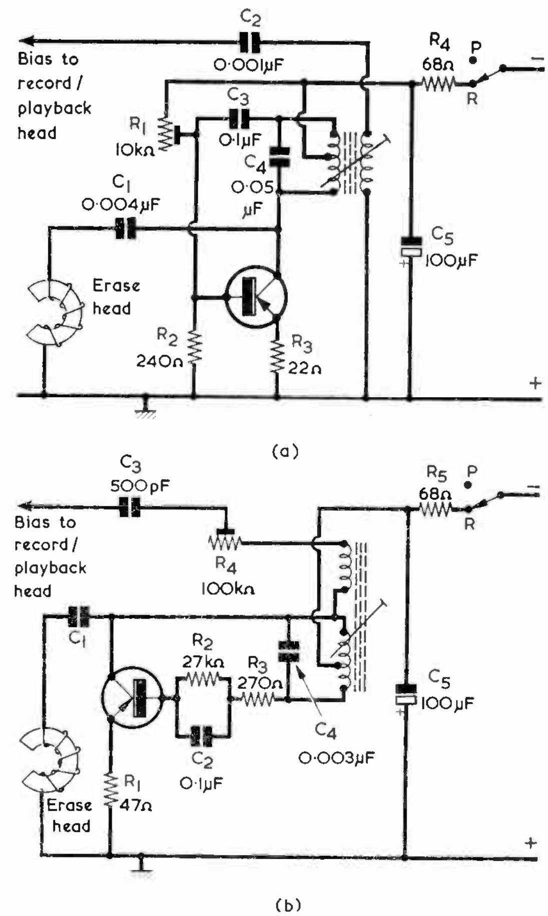



*Fig. 3(a). Design detail of single transistor erase oscillators varies widely according to make and model. A representative circuit is shown here*
*(b). Another basic single transistor erase oscillator circuit*

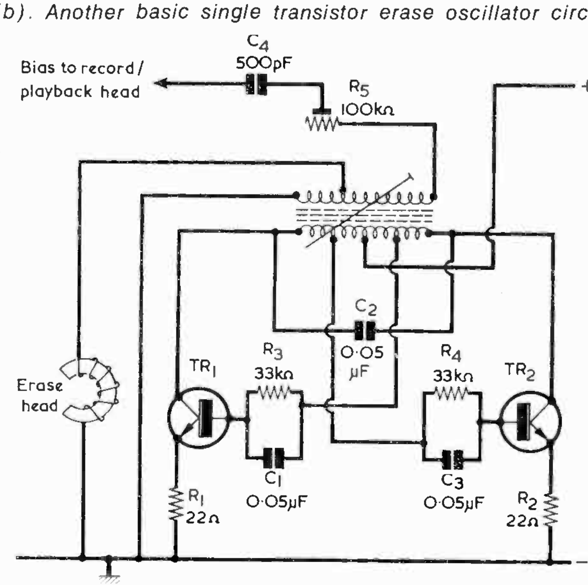



*Fig. 4. A push-pull erase oscillator circuit*

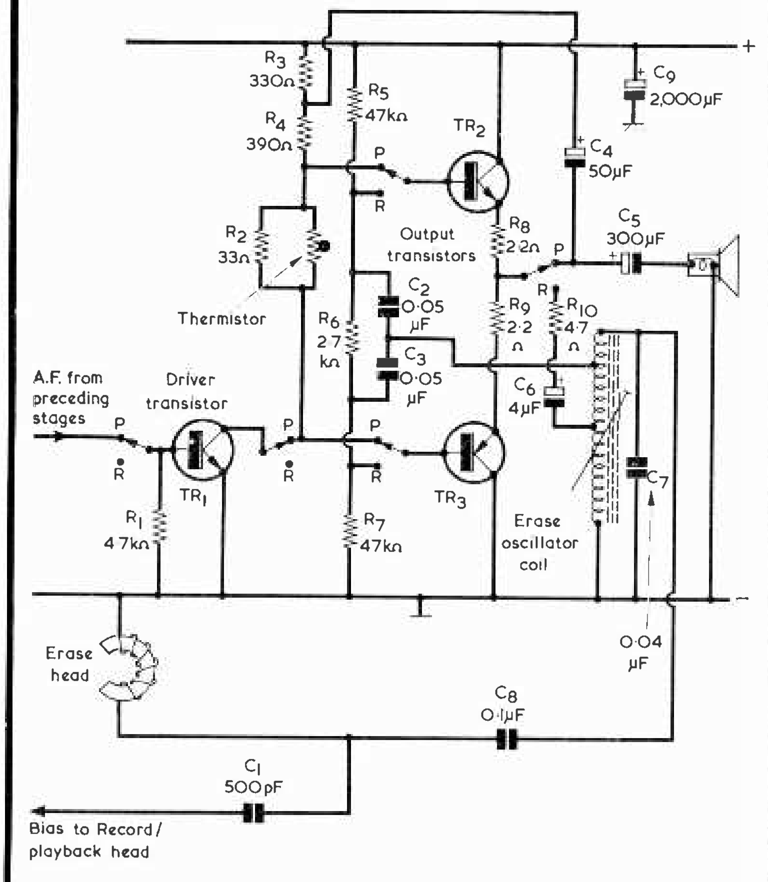
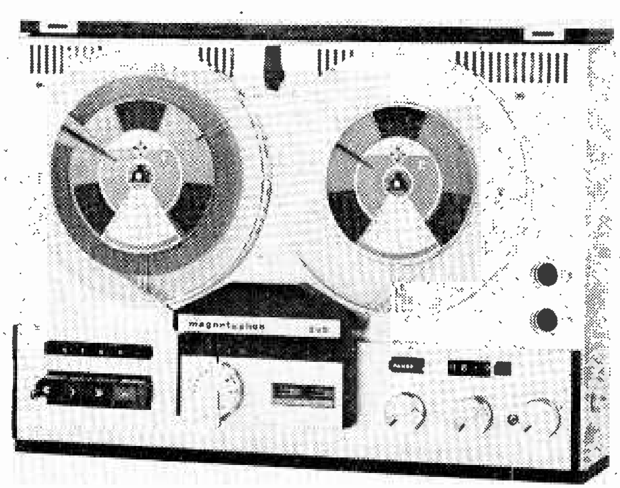



Fig. 5. In this circuit the a.f. output stage functions as an erase oscillator on 'Record'



Top view of the Telefunken "Magnetophon 205". This is a quarter track stereo machine having tape speeds of 1⅞, 3¾ and 7½ i.p.s. It can be operated vertically as well as horizontally

sistors of the order of 10kΩ, these functioning in combination with low impedance record/playback heads. Similar circuits, with 'constant current' resistors as low as 6kΩ to 7kΩ are employed on some low-cost battery machines. However, some of these recorders incorporate equalisation filters offering a response which compensates for the fact that true 'constant current' recording does not take place.

## ERASE OSCILLATORS

Rather a wide range of erase oscillator circuits are to be found in transistor tape recorders. A representative single transistor erase oscillator is shown in Fig. 3(a). This employs a Hartley configuration with an earthy tap into the collector coil, which is tuned by C4. The tuned coil couples to the erase head via C1. A secondary winding having considerably more turns than the tuned winding provides a bias voltage, this being passed to the record-playback head by way of C2. As was discussed in the article in this series which appeared in the October issue, it is often desirable to have the bias frequency available at a high voltage level so that the capacitor coupling it to the record/playback head may have a relatively low value. This is achieved in Fig. 3(a) by the secondary winding, which steps up the bias signal voltage generated in the tuned winding. Variable resistor R1 is adjusted for the desired erase and bias levels.

Another typical single transistor oscillator circuit is shown in Fig. 3(b). This is basically the same as that of Fig. 3(a), similarly employing a Hartley configuration. A further winding coupling to the tuned winding allows a bias signal at relatively high voltage to be applied, via a series capacitor and preset variable resistor to the record/playback head.

The circuits of Figs. 3(a) and (b) are illustrative of what is to be expected in battery or mains/battery recorders. The oscillators are turned on by a section of the record/playback switch, which completes the supply when set to 'Record'. Both circuits employ a power transistor of the type used in a.f. output stages.

Mains-driven transistor recorders may incorporate similar single transistor oscillators. Since these recorders have a higher supply voltage, step-up windings are not always added to the tuned coil to provide a high voltage bias signal. The bias signal is then taken from the non-earthy end of the tuned coil.

A push-pull transistor erase oscillator is illustrated in Fig. 4. With this circuit the erase head is fed directly from part of the secondary winding, whilst the whole of the secondary winding provides a high voltage bias signal for the record/playback head circuit. Push-pull oscillators, such as that of Fig. 4, are employed in mains-driven transistor recorders.

In company with valve recorders, some of the more inexpensive transistor tape recorders have switching circuits which cause the a.f. output stage to function as an erase oscillator when recording. One approach here consists of switching in an erase oscillator coil when the machine is set to 'Record'. The switching circuit achieves the same result as occurs in valve recorders where the valve output stage is similarly switched to function as an erase oscillator. The valve switching circuit was discussed in the September issue. A transistor version is shown in Fig. 5.

When, in this diagram, all the switches are in the 'Playback' position, a.f. is fed to TR1, which drives the output transistors, TR2 and TR3, in normal manner. TR2 and TR3 form a complementary output pair, the junction of their emitters coupling to the speaker via C5. Putting the switches to 'Record' disconnects the driver transistor and causes the bases of TR2 and TR3 to couple into the bias network given by R5, R6 and R7. TR2 and TR3 now operate as emitter followers in Class A. Their bases couple to the upper tap in the oscillator coil and their emitters to the lower tap. The coil is tuned by C7 and couples via C8 to the erase head.

The circuit oscillates because the emitters of TR2 and TR3 are in phase with their bases. Looking at Fig. 5, the actual mode of oscillation may be difficult to visualise, whereupon it will be helpful to examine an equivalent circuit using a single transistor, as shown in Fig. 6(a). This diagram omits capacitors and assumes that the positive supply rail is at chassis potential, as in fact it is for erase frequency due to the presence of the usual high-value capacitor across the supply rails. If the tuned circuit is turned upside-down we get the circuit given in Fig. 6(b). If next, as in Fig. 6(c), we transfer the chassis connection from the collector to the emitter of the transistor, the oscillator takes up the familiar Hartley configuration. Thus, the oscillator circuit of Fig. 5 is basically a Hartley type with the earthy connection taken to the collector instead of, as in the oscillators of Figs. 3(a) and (b), to the emitter.

An elegant alternative circuit, originally developed by Mullard Limited, operates on the same principle but uses the erase head itself as the tuned coil. It employs a switching circuit around the output transistors similar to that of Fig. 5. On 'Record', however, the output transistor emitters and bases connect to the junctions of three capacitors in series, as shown in Fig. 7, instead of to taps in a coil. As in Fig. 5, the emitters connect to the tap in the tuned circuit that is nearer chassis (and, hence, as demonstrated in Fig. 6, nearer the collector) and oscillation takes place in similar manner. If the tuned circuit connections in Fig. 7 are brought down to basic form, as were those of Fig. 5, the circuit can be shown to have the Colpitts configuration. The resonant frequency of the tuned circuit in Fig. 7 is given by the capacitance offered by the three series capacitors in parallel with the inductance of the erase head winding.

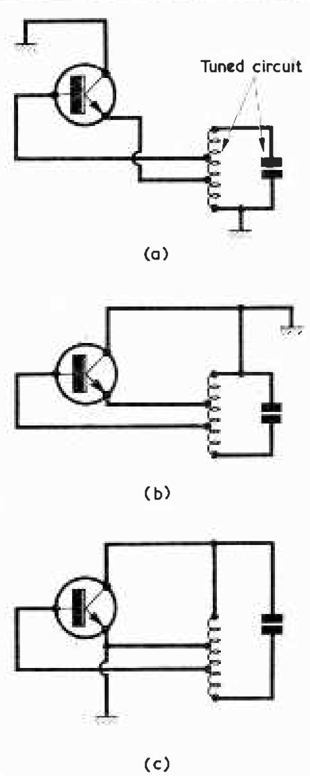



*Fig. 6(a). Equivalent circuit for the erase oscillator of Fig. 5 (b). The circuit with the tuned coil and capacitor inverted (c). Taking the earthy connection to the emitter instead of to the collector reveals the familiar Hartley oscillator*

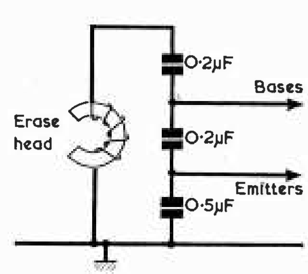



*Fig. 7. An alternative version of the circuit of Fig. 5, in which the erase head provides the tuned circuit inductance for the erase oscillator*

## EQUALISING CIRCUITS

In valve designs it is common practice to obtain the record and playback equalisation responses by inserting suitable negative feedback frequency selective filters between the anode of a voltage amplifier valve and the cathode of the preceding valve. A similar approach is employed in many transistor tape recorders, in which the filters appear between the collector of one a.f. amplifier transistor and the emitter of the preceding transistor. A typical instance, for a single speed machine, is given in Fig. 8. The filter components are C2, C3 and R4 to R7, and the filters function in the same manner as the valve equivalents discussed in the September issue. The only major difference is that capacitance values are higher and resistance values lower, due to the lower impedances at which transistors work.

The position along the amplifier chain at which the two transistors of Fig. 8 may appear depends upon the overall design of the recorder amplifier. In some designs the first transistor in Fig. 8 may be the input transistor for the recorder, whilst in others it may be the second transistor in the amplifier. Machines with more than one speed will have switched filter circuits of the same basic type as were described last month.

## GENERAL POINTS

As may be gathered from the details just given, transistor tape recorder amplifiers do not differ basically from valve recorder amplifiers, although individual details may vary considerably between one machine and the next. With recorders in the domestic category a single amplifier employing, in general, two to four transistors, is common to both the record and playback functions. The subsequent output stage consists of a driver transistor and two output transistors in Class B. As we have just seen, in some designs the output stage also enter the recording chain, whilst in others it is switched to function as erase oscillator. A third alternative, not yet mentioned,

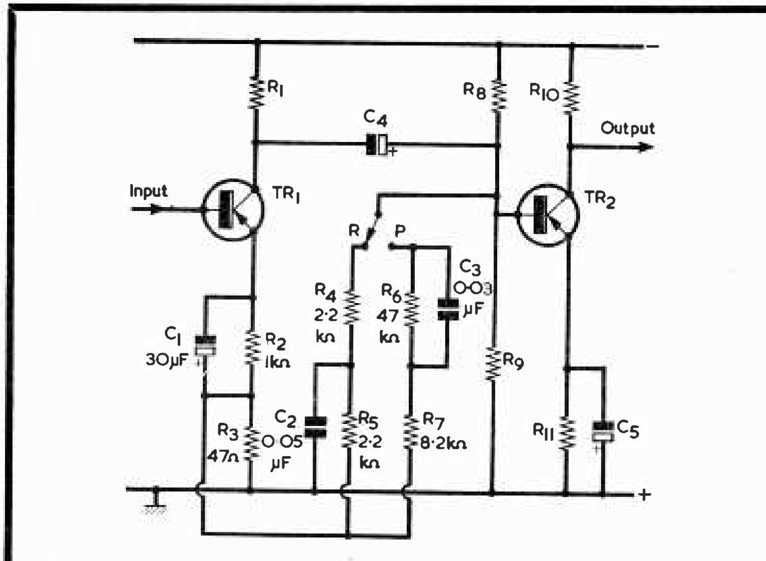



*Fig. 8. A typical equalisation switching circuit for a single-speed recorder. Components outside the filter circuit have standard values*

is that the output stage may be left in circuit and employed for monitoring the input signal during recording.

## RECORDING TAPE

Before concluding this series, a few notes on recording tape will be given.

The tape base may consist of one of three plastic materials, these being cellulose acetate, p.v.c. or polyester. The last two were introduced later than cellulose acetate, and are employed in most modern tapes. The magnetic coating consists of minute particles of ferric oxide dispersed within a binder.

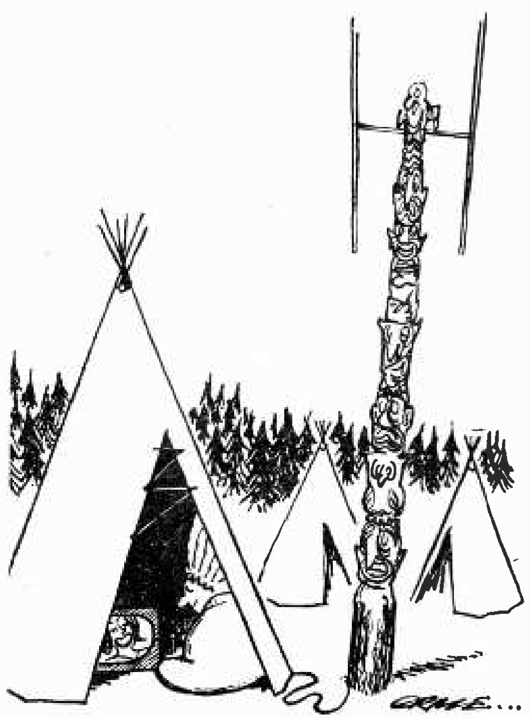
Tape is available in a number of thicknesses, these being classified as Standard Play, Long Play, Double Play and Triple Play. Double Play tape is approximately half as thick as Standard Play, whilst Triple Play tape has about one-third the thickness of Standard Play tape. Thus, it is possible to accommodate twice as much Double Play, and three times as much Triple Play, as Standard Play on a given spool.

The thinner tapes are usually preferred for quarter track recording, because their thinness causes them to be more supple, whereupon they can be held against the small quarter track record head gap more readily. A wide range of spool diameters is available, the most popular sizes being 3in., 4in., 4¼in., 5in., 5¾in. and 7in.

The playing time for a tape is given by the expression $T = \frac{FN}{5S}$ where T is in minutes, F is the length of tape in feet, N is the number of tracks and S is tape speed in inches per second.

## NEW SERIES

The series on 'Understanding Tape Recording' is now concluded. A further series, following the same 'Understanding' style, is scheduled to commence in March and details on this will be given in the February issue.



## RADIO AMATEUR INVALID BEDFAST CLUB

**It will be readily understood what a valuable hobby Amateur Radio is for invalids, disabled persons and the blind. It is one sphere in which they can be on complete equality with their fellow men, no distinction or concessions are made, or asked for. It was to encourage and help each other that this Club was founded in 1954 by a handful of invalids, and the membership has now grown to over 300 with a further 350 supporters and representatives who visit the members in their particular area to keep their equipment in working order and to assist in any way necessary. A monthly newsletter is circulated and there are weekly get togethers on 80 metres to exchange news and views and give pleasure to the listener who has not passed the necessary examinations to enable him to transmit. The Club also helps those who wish to obtain their transmitting licences with text books, and the use of braille books and tape-recording lessons. All the work in this is done by members, as is the recording of morse code on tape and the reading of the newsletter for blind members. The Club depends entirely on voluntary subscriptions and help, and as illness and disability know no barriers, it is classless and non-denominational. There are members in many countries and the exchange of letters and tapes does much to increase the 'family' atmosphere which is so important. —*Radial.***

# In your Workshop

**As usual, Christmas finds Dick and Smithy working furiously to clear an excessively large number of faulty radio and television sets. But they are fortunate this year and are able not only to repair all receivers by a reasonable hour but also to examine the intricacies of a transistor complementary pair a.f. amplifier that is very popular with set manufacturers**

"HALLO. WHAT'S THIS?"

Smithy grunted the question to himself as his car turned the corner leading to the Workshop. It was the morning of Christmas Eve, and he had purposely started out from home early to make sure of clearing up all his outstanding work. The habitual phenomenon of the season had once more taken place, and he and Dick had been labouring mightily over the last week at an exceptionally large number of TV and radio receivers which had mysteriously chosen to break down just before Christmas, and which all had to be fixed in time for the Day.

But, early as Smithy was, someone had preceded him. The Workshop, ablaze with light streaming from its windows, stood out like a beacon in the surrounding gloom.

## EMBELLISHMENTS

The bewildered Serviceman parked his car then walked the few yards to the door of the Workshop. He opened it and peered inside.

"Well," said a voice proudly, "what do you think of it?"

Smithy's eyes blinked as they became accustomed to the brightness of the Workshop lighting. Bemusedly, he looked around him.

The Workshop had been transformed. Two long brilliantly coloured paper chains were suspended diagonally across it, each passing from one corner to the corner opposite. A large red balloon marked their point of intersection, where they were raised to the ceiling so that they formed four gracefully dependent arcs. More embellishments were to be seen at the spares cupboard, where a veritable carillon of paper bells descended down both sides. At the windows, small pieces of cotton wool had been stuck in neat rows to the glass, giving the appearance of geometrically precise flurries of snow. Further paper chains were festooned along the wall surfaces, with more balloons at the points where they were suspended. The ricketty table near the sink on which were ranged the culinary effects of the Workshop had its legs covered in alternate stripes of green, orange and purple crepe paper, and the same colour scheme had been applied to the legs of both Dick's and Smithy's benches. Indeed, it was at that moment that Smithy's assistant, with a flourish, pushed in the last drawing-pin securing the paper at Smithy's bench. After this, Dick stood up and surveyed his handiwork with great satisfaction.

"Looks all right, doesn't it? he remarked.

"Er, yes," replied Smithy, a little uncertainly. "I suppose it does."

"Brightens the place up no end."

"Oh, definitely."

Gradually regaining his normal composure, Smithy took off his overcoat and hung it up behind the door, taking care not to disturb a cylindrical yellow balloon that hovered dangerously near its upper end. He donned his overall jacket.

"Well," he said briskly, "I *did* make a point of coming in early to clear up all the extra work, so I suppose I'd better get started on it right now."

"Fair enough," replied Dick. "I'll get stuck in, too. I've finished all the decorating."

Breathing a silent sigh of relief at this news, Smithy walked over to the 'For Repair' rack to pick up his first set for the day. Dick followed shortly afterwards and the multi-coloured Workshop was soon the scene of concentrated and dedicated activity. As time passed the pace became swifter, until Dick and Smithy were working like men possessed. The number of repaired sets rose slowly but steadily. Suddenly, Dick and Smithy found themselves both walking together to the 'For Repair' rack and reaching out in unison to pick up the same small transistor receiver. They looked at each other in wonderment, then turned back to the rack. That transistor radio was the only set left for repair.

"Gosh," said Dick in awestruck tones, "don't say we've actually cleared them all out!"

"We must have done," said Smithy.

He glanced at his watch.

"What's more," he resumed, "we've done the whole lot during the morning. It's only quarter to one now."

"Is it? Well then, all I can say is that either, unbeknown to ourselves, we've become super-skilled in our jobs, or the sets we've been working on today have all been easy ones."

"Seeing that it's Christmas," grinned Smithy, "I'll plump for your first explanation. Anyway, thank goodness we can ease off now. You see about making some tea, Dick, and I'll get started on this last little radio that's left."

## COMPLEMENTARY OUTPUT STAGE

Dick walked over to the now gaily coloured table alongside the sink, filled the kettle and placed it on the electric ring. He then returned to Smithy's bench and watched the Serviceman as he experimentally adjusted the controls of the receiver. The sound from its speaker appeared to be badly distorted.

"This," announced Smithy, "should be a pretty easy one. I'll tune in a station and let you hear how it sounds, first at a low volume level and then at a high level."

Dick listened attentively as Smithy adjusted the volume control. At the low volume setting the sound from the radio was pleasant and acceptable, having the usual quality to be expected from a small transistor receiver. As Smithy increased the volume level the sound commenced to become harsh and distorted, the distortion increasing severely as volume level became greater. Smithy turned the volume control fully back, thereby switching off the set.

"The r.f. and i.f. sections of this receiver appear to be O.K.," he remarked cheerfully. "It looks as though we've just got a straightforward snag in the a.f. department."

"Here, hang on a minute," protested Dick. "You haven't even taken the back off that set yet, but you're already stating that whole sections of it are working properly."

"With good reason, too," retorted Smithy. "Here, let me show you."

The Serviceman switched the set on again with the volume control at a low level. He swung the tuning dial from one end to the other. The set was switched to the medium wave band, and some seven or eight stations were audible, all at more or less the same strength. Smithy switched the receiver to the long wave band, and tuned in the B.B.C. Radio 2 transmission on 1,500 metres. This also was reproduced at a similar level.

"Well," said Dick suspiciously, "what does that tell you?"

"It tells me," replied Smithy, "that there is enough i.f. getting to the diode detector to provide an adequate a.g.c. voltage. If there weren't, the set would either be obviously insensitive, or the local station or stations would come in at reasonable volume and the rest would be much weaker. The fact that the stations were all reproduced at about the same level indicates that the r.f. and i.f. stages are capable of producing an adequate a.g.c. voltage, and so they *must* be working at least reasonably well. Also, the set has the selectivity you expect from a receiver of this class, so all the i.f. tuned circuits are operating correctly. Having a quick run round the dial is, of course, a routine initial check which you should carry out with any a.m. radio set. It only takes a jiffy to do, but it can tell you a great deal about the condition of the receiver. Anyway, I'll satisfy you now by taking the back off."

Smithy removed the back of the receiver and carried out a visual check of its internal components.

"There's nothing obviously wrong," he pronounced. "No loose wires, connections adrift or anything like that. Let's check the battery voltage."

Smithy switched on the receiver and applied the prods of his testmeter to its internal PP9 battery.

"There's a full 9 volts there," remarked Dick, who had been watching the meter scale.

"Fair enough," grunted Smithy. "I might as well check battery current whilst I'm at it."

He switched his testmeter to read 100mA f.s.d., removed one of the

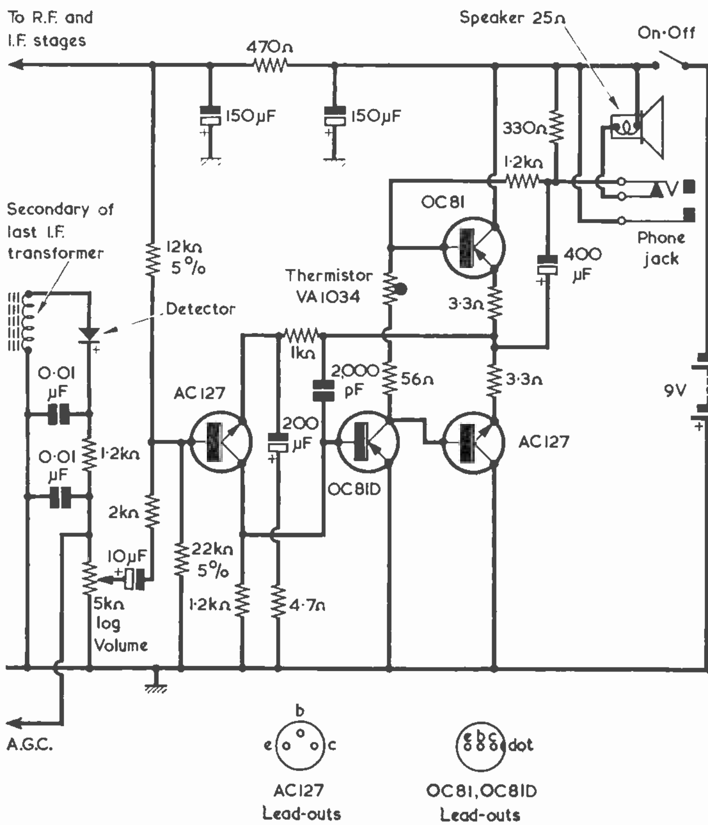



*Fig. 1. The a.f. amplifier and output stages of the transistor radio serviced by Smithy. Nominal output power is 250mW. This basic circuit is employed in many transistor receivers*

battery connectors and inserted the meter in series.

"The quiescent current," announced Dick from his station at the meter, "is about 7 or 8mA, which is pretty well what's to be expected. Try turning the wick up a bit, Smithy."

Smithy tuned in a station and adjusted the volume control. The receiver output increased in level, accompanied by its attendant distortion.

"The current," stated Dick, "is now hopping up to the 20 to 30mA mark on sound peaks."

"Right," pronounced Smithy. "Then the audio signal is getting to the Class B output stage. We'd better start being a bit technical now, Dick, so would you please get out the service sheet for this set?"

Dick walked over to the filing cabinet and, after a little searching, extracted the service manual in question. Returning, he opened it at the circuit diagram and laid it out on Smithy's bench. The latter, who had replaced the battery clip that had been disconnected for the current test, indicated the detector and a.f. amplifier section of the circuit. (Fig. 1).

"This is where the trouble will be," he stated assuredly. "Since the distortion only appears above a certain volume level it's pretty likely that the output stage is clipping."

"Clipping?"

"Clipping," repeated Smithy. "This set uses a complementary output stage and, for correct operation, the junction of the two output transistor emitters should be at approximately half the potential of the battery above chassis under quiescent conditions. This means that the potential at the junction of the two emitters can then swing both positive and negative by about the same voltage before clipping occurs. Incidentally, so far as this particular circuit is concerned, when I refer to the junction of the two emitters I really mean the junction of the two 3.3Ω resistors in series with those emitters. These resistors can be ignored in the present discussion."

"I'm not entirely clear," confessed Dick, "what exactly you mean by clipping."

Smithy took a pen from his pocket and sketched out a waveform on the margin of the service sheet.

"Now here," he remarked, "is what happens when the output transistor emitters are at the correct half-battery potential. They can, under this condition, swing positive and negative up to nearly half-battery potential on either side of zero without any distortion being introduced at all. (Fig. 2(a)). If the audio input to the output stage increases further, the negative and positive peaks at the emitters flatten off, because there isn't enough supply voltage to take them further. (Fig. 2(b)). That flattening off is known as 'clipping'. When the clipping is symmetrical on positive and negative peaks the output stage is working properly and it's possible

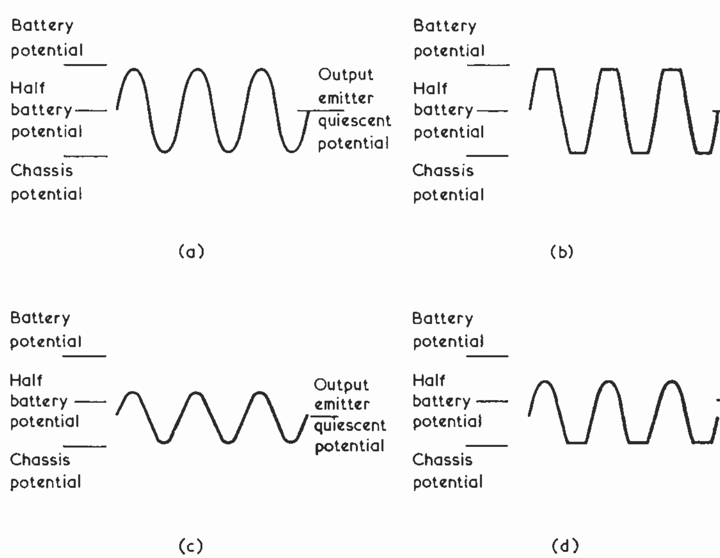



*Fig. 2(a). The a.f. voltage output of a correctly set up complementary output stage*
*(b). Increasing the output causes symmetrical clipping*
*(c). An incorrectly set up output stage can still handle low level signals without distortion*
*(d). If the signal at (c) is increased in amplitude, asymmetric clipping occurs*

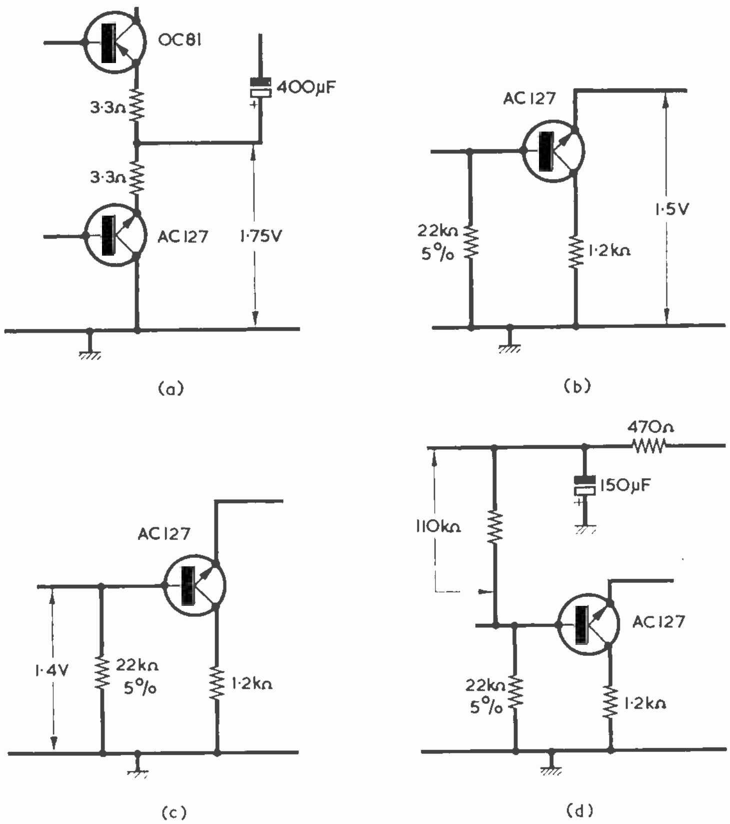



*Fig. 3. Testmeter readings obtained with the circuit of Fig. 1. Output emitter voltage is shown at (a), and emitter and base voltages for the first AC127 in (b) and (c). The resistance reading in (d) located the faulty component*

to get the maximum power from it of which it is capable before clipping, and hence distortion, takes place."

Smithy scribbled a further waveform on the margin of the service sheet. (Fig. 2(c)).

"This," he stated, " is what happens when, due to a fault condition or maladjustment, the output emitters are not at half-battery potential under quiescent conditions. I've shown their quiescent potential here as being displaced towards the supply rail which connects to chassis. The output stage can still handle low level signals without distortion, but clipping then starts as soon as the signal amplitude increases above that low level." (Fig. 2(d)).

"Oh, I see," said Dick brightly. "With a bit of luck it will be that quiescent voltage that's wrong with this set, then."

"I hope so," replied Smithy. "Seeing that it's Christmas Eve, we could do with a nice easy job to finish off with. Let's have a dig with the testmeter."

## FAULT LOCATION

Smithy switched the receiver on again, set his testmeter to a low volts range, clipped its positive test lead to the receiver metalwork and, after having identified the point in the circuit board where the two 3.3Ω output emitter resistors connected together, applied the negative meter prod to their junction. The testmeter indicated a potential of 1.75 volts. (Fig. 3(a)).

"Blimey, Smithy," said Dick, impressed. "You've found the fault first go! The bottom output transistor must be partly short-circuit or something like that."

"I very much doubt it," returned Smithy. "What you have to remember is that the d.c. potentials in complementary output stages of the type we have here depend upon the balance of components further back in the amplifier. Let's see what we've got on the emitter of the first AC127, the one which immediately follows the detector diode. Ah, here it is!"

Smithy applied his test prods

carefully. (Fig. 3(b)).

"It's 1.5 volts this time," announced Dick, looking at the testmeter needle. "Just a wee bit less than the previous reading."

"Good show," said Smithy. "I'll try the base of that AC127 next."

"The voltage now," called out Dick, "is just a bit lower again. About 1.4 volts, I'd say." (Fig. 3(c)).

"Right," said Smithy, switching off the receiver and disconnecting the positive test clip from its chassis. "A simple resistance reading is called for next, I think."

He switched his testmeter to an ohms range, zeroed its needle, then applied the test prods to the upper base bias resistor for the AC127. The meter indicated 110kΩ. (Fig. 3(d)).

"That's it, then," he remarked, pleased. "That resistor I've just checked is *supposed* to be 12kΩ, but it's giving me a resistance reading that's a darned sight higher than that. We want a new 12kΩ 5% resistor here, Dick. The existing one's gone high."

"Okeydoke," said Dick, as he walked over to the spares cupboard. "Can I solder it in, Smithy? I'm getting a bit fed up with just standing here watching."

"As you like," replied Smithy. "Unless we're unlucky, that replacement resistor should clear up this fault, whereupon we're completely finished for the day."

At that instant the Workshop kettle produced an ear-splitting whistle and Smithy rose from his stool and walked over to make the tea. He returned with a cup for Dick and with his own tin mug full to the brim, then settled down alongside his assistant who was now busily soldering in the new resistor.

"By the way," said Dick. "I thought that it wasn't always advisable to check the value of a resistor when it's in circuit in a transistor radio. Aren't you liable to get false readings due to transistor junctions acting as diodes and causing other resistors to be effectively in parallel with the one you're checking?"

"That *can* happen," agreed Smithy. "When you're checking a resistor in a transistor circuit you should apply the testmeter prods to it one way round and then the other way round. If one reading is higher than the other it's the one that's more likely to be an accurate measure of the actual resistance. This is because any transistor junction which is acting as a diode and introducing extra resistance in parallel to give a false low reading will be non-conductive when the higher reading is obtained. Even then, though, you've got to be a wee bit careful, especially if the resistor connects between two separate transistors. In our case, fortunately, we got a reading which was *higher* than the nominal resistance of the resistor, so the resistor itself was obviously faulty."

Dick placed Smithy's soldering iron back on its rest.

"All done," he announced. "One new resistor soldered in!"

"Switch it on, then," replied Smithy. "We'll see how that set plays now."

Dick turned on the receiver and advanced its volume control. The previous distortion at high volume level was completely absent. Smithy leaned forward, turned the volume down and switched his testmeter back to the low volts range again. Once more he checked between chassis and the junction of the two 3.3Ω output emitter resistors.

The testmeter indicated 4.6 volts.

## OUTPUT STAGE OPERATION

"Excellent," pronounced Smithy, rubbing his hands together. "Well, that's got our last pre-Christmas job buttoned up."

He gazed happily around the garishly decorated Workshop.

"I'm beginning," he continued exultantly, "to feel quite festive already. Just imagine – no more radio or TV to think about right up to the end of the Christmas holiday!"

"D'you know, Smithy," said Dick, breaking into Smithy's paean of joy at his release from matters electronic. "There's something in this circuit that's puzzling me."

Smithy's smile of pleasure ceased abruptly.

"I should have known," he commented bitterly, "that I'd have no escape, with *your* enquiring mind around the place. Okay then, tell me what it is that's puzzling you."

"It's the 200μF capacitor and 4.7Ω resistor in series," replied Dick promptly. "The components that connect from the emitter of the first AC127 down to the chassis line. I can't quite see what they're there for."

"That 200μF electrolytic," replied Smithy shortly, "is a d.c. blocking capacitor. And the resistor is a negative feedback limiter."

"A negative feedback limiter?" repeated Dick incredulously. "When it connects to chassis?"

"Dear, oh dear," sighed Smithy. "It's impossible to give you any further gen on those two components without going into the business of explaining how the whole amplifier works. So I suppose I'll have to do just that. Well now, let's start at the beginning. As you can see, the a.f. input from the volume control, which forms the diode detector load, passes to the base of the first AC127. Right?"

"Right."

"Good," said Smithy. "I'm glad you're not lost up to now. As you continue along the circuit you'll notice that the collector of the first AC127 drives the base of the OC81D. If, for the time being, you forget about the resistor and the thermistor between the two output transistor bases, you can see that the collector of the OC81D connects directly to the bases of those two output transistors. These transistors are nothing other than simple common-or-garden emitter followers. When the OC81D collector goes negative during negative half-cycles of a.f. so also do the base and emitter of the OC81. The AC127 at the bottom is then cut off. On the other hand, when the collector of the OC81D goes positive during positive half-cycles, so also do the base and emitter of the AC127. This time it's the OC81 that's cut off. What you've got, in consequence, is a basic transistor Class B arrangement, with one transistor handling negative half-cycles and the other transistor handling positive half-cycles."

"I see," said Dick, frowning at the circuit diagram. "I suppose the resistor and thermistor in series between the two output transistor bases will be the usual components you get in transistor output circuits. You know, the ones which allow the transistors to be slightly conductive under quiescent conditions."

"That's right," confirmed Smithy. "The output transistors need to pass a small current under quiescent conditions so that the change-over from one output transistor to the other on alternate half-cycles is smooth and doesn't introduce distortion. They provide the normal forward bias found in all Class B transistor output circuits. The next point to notice is that the two output emitters couple to the speaker via a 400μF electrolytic."

"There's a 1.2kΩ resistor coupled to that speaker as well," observed Dick. "Its other end goes to the base of the OC81."

"That resistor," stated Smithy, "is the collector load for the OC81D. Since the resistor is connected to the speaker, its speaker end goes positive and negative in sympathy with the a.f. voltage on the collector of the OC81D, so that there's virtually a constant voltage across it all the time. This is a useful feature because on large negative excursions it allows an adequate base current to flow into the OC81."

"Why, so it does," said Dick. "Gosh, Smithy, there are quite a lot of crafty ideas in this circuit, aren't there?"

"It *is* an ingenious arrangement," agreed Smithy. "Let's look next at those two 3.3Ω resistors in the output emitter circuit. These are usually referred to as emitter stabilising resistors. Alternatively, you can look upon them as current limiters which prevent the output transistors from passing excessively high currents. They function in conjunction with the resistance between the bases provided by the thermistor and the 56Ω resistor."

"What about that 200μF electrolytic and 4.7Ω resistor in series I asked you about at the beginning?"

## NEGATIVE FEEDBACK

"I'll be getting to them shortly," promised Smithy. "But, before I do, take a look at the 1kΩ resistor coupling the junction of the two 3.3Ω resistors back to the emitter of the first AC127. One of the functions of this resistor is to allow the d.c. operating conditions to be stabilised. As we've just seen, it's necessary for the junction of the output emitters to be at half-battery voltage. Now, the potential at that junction is controlled by the potential on the base of the first AC127. Indeed, you've already seen how the output emitter potential drops when, due to a fault condition, the potential at the base of the first AC127 drops. In our circuit that base potential is controlled by the 12kΩ resistor which we replaced, and by the 22kΩ resistor below. The base potential, in its turn, controls the potential of the AC127 emitter. If, for any reason, the emitter of the first AC127 tends to go positive so also, by an amplified amount, does the collector. This causes a further-amplified excursion, but in the negative direction, at the collector of the OC81D, with a similar excursion at the output transistor emitters. Thus, the original positive change at the emitter of the first AC127 becomes cancelled out by an amplified negative excursion fed back to it via the 1kΩ resistor. The circuit similarly stabilises itself against negative changes at the emitter of the first AC127."

Smithy paused and drank deeply from his mug.

"As you can see, then, that 1kΩ resistor provides negative feedback at d.c. and stabilises the whole circuit so far as d.c. potentials are concerned. It also provides negative feedback at a.f. but, if the 1kΩ resistor were left in circuit on its own, the a.f. feedback would be so high that the circuit wouldn't give any useful amplification. That's where the 200μF electrolytic and 4.7Ω resistor you've been nagging me about come in. At a.f. these form what is effectively a potential divider with the 1kΩ resistor in the upper part and the 4.7Ω resistor below (Fig. 4), so that a.f. negative feedback, whilst still present, is considerably reduced. To be pedantic, it would be more correct to explain this process by saying that the 4.7Ω resistor passes feedback current which would otherwise flow in the emitter of the first AC127, because

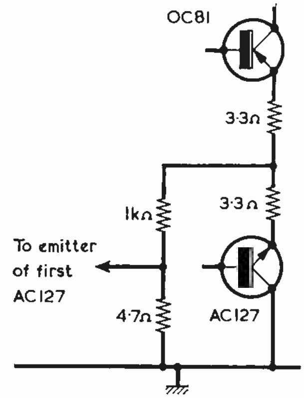



*Fig. 4. At audio frequencies, negative feedback to the emitter of the first AC127 is effectively applied in the manner shown here*

the effect is more in the nature of a current operation than a voltage operation. But the potential divider concept should enable you to initially grasp the idea more easily."

"Yes, it does help," agreed Dick. "You seem to have almost completely cleared up this circuit for me, Smithy. There's just a couple more questions I've got to put to you."

"Fire away!"

"What's that 2,000pF capacitor between the output emitters and the base of the OC81D for?"

"It provides top cut," explained Smithy. "Or, to use the more posh expression, 'tone correction'. The output emitters and the base of the OC81D are out of phase, and so the capacitor is in a frequency-selective negative feedback loop. It feeds back more signal at the higher frequencies, where its reactance is lower."

"Well, that's simple enough," remarked Dick. "Finally, what about that 330Ω resistor across the speaker?"

"That resistor is not just across the speaker," Smithy corrected him. "It's connected across the speaker and the closed-circuit phone jack that's in series with the speaker. Its purpose is to prevent excessively high a.f. voltages appearing at the output emitters if someone should plug in high resistance phones and then turn the wick up. You wouldn't need the resistor if the phone jack was omitted and the speaker connected directly to the 400μF electrolytic."

## HOME CONSTRUCTOR VERSION

"Well, it's certainly a jolly useful audio amplifier circuit," remarked Dick.

"What I find mildly surprising is that you, as a service engineer, carry on as though you've never seen it before," stated Smithy. "It's an extremely popular circuit amongst set-makers and you'll find it used in a large number of portable transistor radios, as well as in more powerful mains-driven sets *and* car radios. Naturally, the transistors in these other applications are types chosen to suit the power output required. Also, different manufacturers use different makes of transistor and they play about with component values and minor circuit details as well. I should mention that there's a less frequently employed version which still has the complementary output transistors

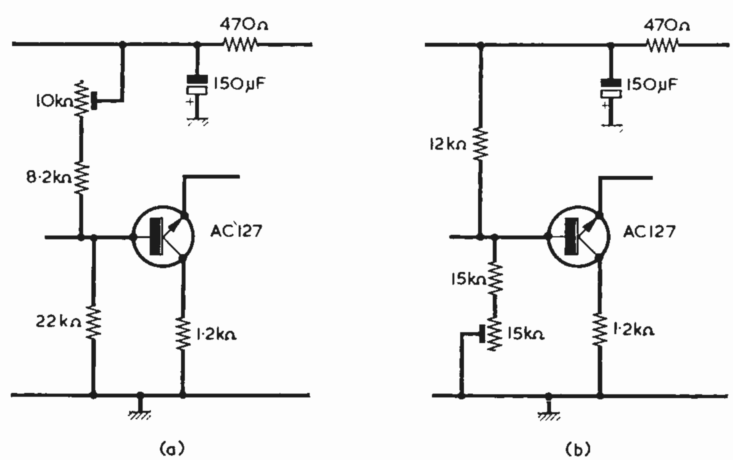



*Fig. 5. If the circuit of Fig. 1 were used for a home-constructor project, it would be advisable to have the base bias for the first AC127 adjustable, using either the method of (a) or that of (b). All fixed resistors may be 10% tolerance*

but which has feedback coupled back to the base of the driver transistor. With our circuit the driver is the OC81D. In the alternative circuit the first transistor is then just an ordinary a.f. amplifier and doesn't enter the feedback loop. Returning to the circuit in this service manual, I must point out that this has no adjustment for quiescent d.c. output potential. Such an adjustment is provided in a large proportion of sets using the circuit, and is given by replacing one or other of the base bias resistors for the first transistor by a preset potentiometer and smaller fixed series resistor. (Fig. 5). The preset pot is then adjusted to give half-battery voltage at the junction of the output emitters. If you were thinking of making up an amplifier like this as an amateur project, I'd definitely advise the inclusion of a preset pot for adjusting the d.c. potentials in the circuit. It would be difficult to guarantee that these would be correct using fixed resistors under home-constructor conditions. Also, you could replace the resistor and thermistor in series across the output bases with a 200Ω preset pot (Fig. 6), this being set up to give a current in the output transistors of some 5mA or so under quiescent conditions."

"What about matching the output transistors?"

"The beauty of this circuit," said Smithy in reply, "is that the output transistors don't have to be closely matched. That's because they both act simply as emitter followers. If you're unlucky enough to use two badly matched transistors, you can still guard against distortion by increasing their quiescent current a bit."

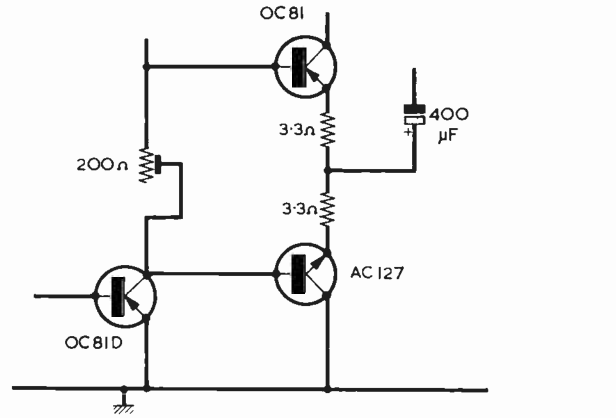



*Fig. 6. The thermistor and 56Ω resistor of Fig. 1 can be replaced by a preset potentiometer*

## A TOUCH OF CHEER

"It's certainly an interesting circuit," said Dick. "Thank you very much, Smithy, for giving me all the gen on it."

Smithy looked suspiciously at his assistant.

"You're getting very polite all of a sudden, aren't you?"

"That's because," replied Dick, "today is Christmas Eve and this is the Season of Goodwill to all men, mate."

"Well," chuckled Smithy, "I must admit that I'm beginning to feel all festive again myself now. Any more technical questions?"

"None at all."

"Hooray."

The Serviceman, freed at last from his technical responsibilities, gazed around the Workshop with eyes that were more ready to appreciate Dick's early-morning endeavours.

"You must," commented the Serviceman, "have put quite a lot of work into putting up those decorations."

Dick looked lovingly at the fruits of his labour.

"The worst part," he replied, "was blowing up those flaming balloons. It nearly creased me, mustering up all that puff first thing in the morning."

Smithy turned a further approving glance at the decorations, then stooped down and rummaged mysteriously in the cupboard under his bench. He straightened up, and there was the cheerful tinkle of bottle and glass.

"I think," he remarked as he carefully filled two glasses, "that a little something to celebrate the coming of Christmas and the end of work is now called for. Here you are, Dick my boy, and let me wish you a very Merry Christmas to go with it as well."

"Thanks, Smithy," said Dick warmly, as he sipped at his glass, "and the same to you."

"Thank you," replied Smithy. "Well now, let's be upstanding for our special annual toast."

The pair stood and held up their glasses.

"Let us," announced Smithy, "wish a really Happy Christmas to all the readers who've put up with our antics during this last twelve months. A truly Merry Christmas to you all."

They both drank deeply.

"And," added Dick. "Let us end, as we have done on so many previous Christmasses, by saying 'God Bless Us, Every One!'."

# INDEX

## RADIO CONSTRUCTOR'S DATA SHEETS

# Radio Topics

## By Recorder

### SLANT POLARIZATION

IT IS INTERESTING TO NOTE THAT the aerial polarization of B.B.C. Radio Manchester on 95.1MHz is neither horizontal nor vertical. Instead, it's slant.

This type of polarization, with the electric field at 45° to the horizontal and perpendicular to the direction of propagation, is used to improve reception with car radios and portable receivers when these are near the limit of the service area. The B.B.C. points out that, except at unfavourable receiving sites, it is unnecessary and inadvisable to adjust existing horizontal aerials as the resulting improvement in reception will be less significant than occurs with car and portable radios. If an adjustment *is* made, the correct slant position is obtained by turning the receiving aerial 45° from the horizontal, clockwise when looking towards the transmitter.

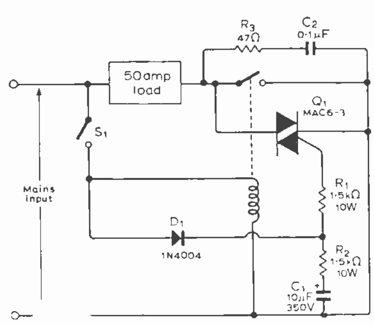
### TRIAC SWITCHING

Relays, contactors and circuit breakers can be adapted to switch alternating load currents up to ten times the rated breaking current by the addition of a simple triac circuit which has been devised by Motorola Semiconductors Limited, of York House, Empire Way, Wembley, Middlesex. The reason for this increase in switching capacity is the elimination of arcing between contacts on breaking and during contact bounce on closure.

A triac is particularly suitable for this type of application as it can conduct on both positive and negative half-cycles of an alternating voltage. As many readers will already know, it consists of two thyristors housed in a single case, connected internally, with the anode of each connected to the cathode of the other, and possessing a single gate.

As can be seen from the circuit in the accompanying diagram, a Motorola triac type MAC6–3 is connected in parallel with the relay contacts. Basically, it operates to short-circuit the contacts for a limited duration while the contacts are opening or closing so that, in fact, they make or break the circuit under no-load conditions. As the triac conducts for limited periods only it can operate, like the relay, on currents much higher than the normal rated current. In the circuit shown, a relay rated at 5 amps and a triac rated at 8 amps are used to switch a 50 amp load.

The circuit works in the following manner. When switch S1 is closed to energise the relay coil, there is a delay lasting about 15 millisec. between the coil energisation and the closing of the contacts. If the switch is closed during the positive half-cycle of the mains input, the gate of the triac draws current via resistor R1 and diode D1, triggering the triac into conduction so that it carries the full load current. This occurs during the delay between coil energisation and contact closure, the turn-on time of the triac being only 1 microsec. from the instant that the gate voltage reaches a typical value of 0.9 volt. At the same time, capacitor C1 charges via R2 so that, when the following negative half-cycle of the incoming supply starts, there is sufficient charge in C1 to enable a triggering voltage to be appplied to the gate and maintain conduction. Without the voltage from C1 the triac would otherwise cut off as the mains voltage passed through zero.




*A triac circuit, developed by Motorola Semiconductors, which is capable of increasing the a.c. switching capacity of a relay by up to ten times*

When the relay contacts eventually close, they short-circuit the triac, which then ceases to conduct as its anode-to-cathode voltage falls to zero. Should the contacts bounce, the triac, which is still fed with a triggering voltage because of the charge in C1, resumes conduction within 1 microsec. of the contacts parting. Thus, arcing across the contacts during bouncing is eliminated.

If S1 is closed during a negative half-cycle, the circuit merely waits for the next positive half-cycle and then commences operation. With 50Hz mains, the maximum time that could elapse before the triac is triggered is 10 millisec., which is short enough to ensure that the triac conducts before the contacts close.

Triacs can be triggered by a negative gate voltage as well as by a positive gate voltage, but as more power is required for negative than for positive triggering, the circuit has been designed to obviate the need for a negative gate voltage.

A similar delay to that which occurs on contact closure takes place between the times that the coil is de-energised and the contacts open. When S1 is opened, C1 continues to discharge via R1, R2 and the gate of the triac, keeping it in the triggered condition. The result is that as soon as the relay contacts open the triac conducts, shunting the full load current which would otherwise cause an arc across the opening contacts. The capacitor continues to discharge via the triac, which maintains conduction for several further mains input cycles until the instant when the mains supply passes through zero after the gate voltage has fallen below the triggering level.

Capacitor C2 and resistor R3 are connected across the triac to lengthen the rise time of any voltage transients or surges introduced by external equipment or by an inductive load. Too high a rate of change of voltage can trigger the triac spuriously or even damage it.

### RECORDER WITH DOLBY SYSTEM

The accompanying photograph illustrates the new Kellar DTA50 stereo amplifier and stereo cassette recorder, which is designed to offer high fidelity recording and playback using cassette loading. Up to now, cassette recorders have not, perhaps, received the same acclaim from the serious high fidelity enthusiast as have the more conventional spool machines, but the manufacturers of the DTA50 state that the major shortcoming – high background noise level at low tape speeds – has now been overcome by the incorporation of a Dolby 'B' Noise Reduction System.

Briefly, the Dolby system works by boosting the strength of the input signal during recording whenever this falls below a predetermined level, thereby increasing the signal-to-noise ratio on the tape. On playback the system reverses this process by lowering the boosted passages to their correct level. Thus, background hiss on the quieter sections of a recording is considerably reduced.

Other features of the Kellar DTA50 are high frequency recording bias (105kHz) to prevent interference with f.m. broadcast pilot tones, a magnetic head with 1 micron gap, all silicon circuitry, four-track stereo and two-track mono recording and playback, a response from 20Hz to 15kHz, and 25 watts continuous power output per channel. The retail price is £150 including Purchase Tax, and the manufacturer is Kellar Electronics Ltd., Maryland Works, London E.15.

### AUTOMATIC COLOUR CAMERA

The first fully automatic colour television camera in the world is now in production by Marconi Communication Systems Limited, Marconi House, Chelmsford, Essex. This, the Marconi Mark VIII camera, incorporates a miniaturised computer built into the camera and motor-driven potentiometers to carry out all the routine alignment and colour balancing adjustments required at the beginning of each operational day. These, and subsequent adjustments during programme time, are performed completely automatically, thus freeing the camera operator from lengthy manual setting up procedures and, also, allowing him to pay fuller attention to the production of artistically satisfying pictures.

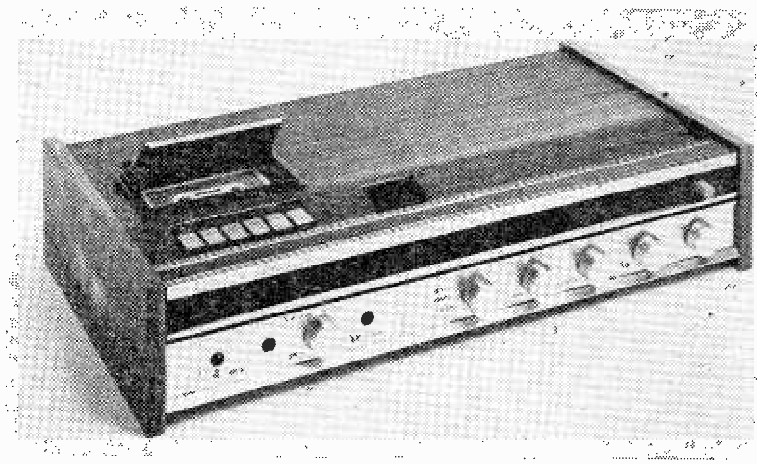
The registration and lining up sequence is initiated by pressing a single button on the camera control unit or control panel. When this is done a test slide in the optical system of the camera is brought into operation by the movement of a motor-driven shutter which incorporates a mirror. The image of the test slide is reflected into the light-splitting optical system and so into the three tubes employed in the camera.

The computer first adjusts the gains of the red and blue channels to correspond with the signals from the green tube. A focus rocking voltage is then applied to each tube, and the tube alignment currents are adjusted in sequence to produce the minimum displacement at the centre of the picture. The computer then examines the picture at a number of points to detect any relative displacement of the red and blue signals with respect to the green. Adjustments are made to the width, height, rotation, skew, horizontal and vertical centring and horizontal linearity to eliminate any discrepancies in the geometry of the three pictures.

All adjustments are made through tiny motor-driven potentiometers. Each of these is fitted with a thumb wheel in order that manual adjustments can be made for test purposes, or in an emergency. At the same time, the motor-driven controls represent mechanical information stores which cannot drift.

A further feature of the Mark VIII camera is that it provides a continuous check on the registration of the three tubes while the camera is in operation. The signals on the three colour channels are examined continually for transitions in the picture waveform. If an error is detected a correction is applied to the appropriate tube deflection circuit.

One of the major problems with previous three-tube colour cameras has been the very much greater degree of lag in the red and blue tubes, which has tended to produce colour distortion in the smear behind a moving object. A white object can produce a multi-coloured smear as it moves rapidly across the screen. This rather startling defect has been overcome in the Mark VIII by using differential image sizes on the three tubes to increase the relative brightness of the red and blue images. Lag is inversely proportional to image brightness, and in this way it has been possible to balance the lag in all three tubes. Smearing from fast-moving objects is therefore the same colour as the object itself, and is far less noticeable.



*The Kellar DTA50 stereo amplifier and stereo cassette recorder, which incorporates the Dolby 'B' Noise Reduction System. The finish is teak with solid teak sides, and brushed aluminium fascia*

The complete sequence of automatic operations takes approximately three minutes in the worst case of misalignment, but will probably be well under a minute in normal day-to-day usage.

Another button initiates an automatic colour balancing sequence. It is only necessary for the camera to be pointed at a white object, which should occupy at least 10% of the picture area in roughly the centre of the picture. The iris is automatically set to give a predetermined peak green reference voltage, and the red and blue channels are then adjusted to match this level. The complete operation takes as little as ten seconds, and can even be carried out during a transmission, at a moment when the camera is not 'on the air'.

Apart from its automatic features the new Marconi camera has high sensitivity. It is capable of offering usable pictures at the incredibly low illumination level of 5ft.-candles. ■

## NEW HALF-WIDTH CASES FROM VERO

**A new half panel width version of their very popular 'Series D' Cases has just been introduced by Vero Electronics Ltd., of Chandler's Ford, Hampshire. These cases are designed with the same well known slim line style of the larger model. On this range, the front aperture is 9.5in. wide and internal depth 10.5in. There are four panel sizes ranging from 3.5in. to 8.75in. in steps of 1.75in. The styling of these cases results in the overall height and width being kept to only 0.75in. more than the front panel size. They are available with or without handles, but are supplied with a tilt foot as standard.**

# LATE NEWS

*Times = GMT* *Frequencies = kHz*

## ★ AMATEUR BANDS

● **NICARAGUA**
YN1CW has been heard on **7035** at 0320 using the c.w. mode.

● **FRENCH SAHARA**
7XØRW was recently logged, at 0325, on **7010** c.w.

● **CUBA**
CO3VM is often to be heard around **14080** using c.w. during early morning sessions.

● **WEST PAKISTAN**
AP2KS reported on **14182** s.s.b. at 1730 and on **14200** s.s.b. at 2100.

● **FIJI**
VR2CC heard on **14132** s.s.b. at 0730.

● **PARAGUAY**
ZP5CE heard on **14180** s.s.b. at 0735 busily working into Europe.

● **SAUDI ARABIA**
7Z3AB heard on **14262** s.s.b. at 2025, on **21083** c.w. at 1432 and on **21294** s.s.b. at 0852.

● **SAO TOME**
CR5SP heard on 14175 s.s.b. at 0600 Sundays, on **21176** s.s.b. at 1417, on **21198** s.s.b. at 1730, on **21250** s.s.b. at 1539 and 1723 and is often QRV weekends on **21250/350** s.s.b. from 1700 to 2000.

● **SUDAN**
ST2SA heard on **14205** a.m. at 1840 and on 21033 c.w. at 1615.

## ★ BROADCAST BANDS

● **ANGOLA**
Radio Ecclesia is now on the air 24 hours a day on **7215** (10kW).

● **CLANDESTINE**
The Voice of Free Serbia has been heard on **11700** and **11910** from 2330 to 0020.

● **GABON**
La Voix de la Renovation has been noted with a new regional programme from Libreville on the new channel of **9555** at 0630.

● **DOMINICAN REPUBLIC**
HIMA Radio Cristal, Santa Domingo, has been logged on **5010** (lkW) from 0530 to 0533 with full identification and closing down with National Anthem.

● **MOZAMBIQUE**
Radio Clube de Mozambique, Lourenco Marques, now uses **3210** (25kW) for the 'A' (Portuguese) programme from 1630 to 2210.

● **NIGERIA**
The Nigerian Broadcasting Corporation is now operating new stations at Calabar on **6145** (10kW) and at Maiduguri on **6140** (10kW). Both schedules from 0430 to 2305.

● **CHINA**
The People's Liberation Army transmitter at Fukien has been logged with a talk in Chinese vernacular at 2000 on **3400**.

*Acknowledgements – Our listening Post, ISWL and SCDX.* ■

## BADX

**BADX – the British Association of DXers issued their first DX News Letter ('Bandspread') on 29th of October.**

**Devoted to Broadcast bands listening, BADX is a new concept in the short wave club world. Membership is limited to 50 and is by invitation only. Members *must* be active and experienced Dxers and report results obtained on a regular basis. Inactive membership is *not* required.**

**'Bandspread' is issued fortnightly throughout the year except July and August when it will appear monthly. Sent via first class post, it specialises in up-to-the-minute DX news only.**

**The first issue contained all 'hard' news and reflected the current Dx scene admirably.**

# LAST LOOK ROUND

### UNIDENTIFIED

From time to time unidentified stations appear on the Broadcast bands and cause even experienced Dxers some bewilderment. A lot of fun may be had by trying to identify such transmissions.

Currently there are several U's – as they are termed – on the air; here are three –

**4815kHz** R. Pakistan or Azad Kashmir? Asiatic type music from 1600 to past 1800. Frequency subject to some variation.

**4887.5kHz** Latin American station closing at 0300 with recording of church or monastic choir. No National Anthem. Not YVKB on **4890**.

**5045kHz** Not Bissau or Lomé. Uses both the Portuguese and French languages. Suspected to be located in Africa – Angola? Try around 2000.

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*(Continued on page 321)*

## SMALL ADVERTISEMENTS

*(Continued from page 319)*

**JOIN THE INTERNATIONAL S.W. LEAGUE.** Free services to members including Q.S.L. Bureau, Amateur and Broadcast Translation, Technical and Identification Dept.—both Broadcast and Fixed Stations, DX Certificates, contests and activities for the SWL and transmitting members. Monthly magazine, *Monitor*, containing articles of general interest to Broadcast and Amateur SWLs, Transmitter Section had League affairs, etc. League supplies such as badges, headed notepaper and envelopes, QSL cards, etc., are available at reasonable cost. Send for League particulars. Membership including monthly magazine, etc., 35s. per annum. Secretary ISWL, 1 Grove Road, Lydney. Glos., GL15 5JE.

**WANTED:** Books, brochures, pamphlets, etc. re FAX. Any information of interest. G2UK, "East Keal", Romany Road, Oulton Broad, Suffolk.

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**"MEDIUM WAVE NEWS"** Monthly during Dx season —Details from: K. Brownless, 7 The Avenue, Clifton, York.

**IF YOU HAVE ENJOYED A HOLIDAY** on the Norfolk Broads, why not help to preserve these beautiful waterways. Join the Broads Society and play your part in determining Broadlands future. Further details from:—The Hon. Membership Secretary, The Broads Society, "Icknield", Hilly Plantation, Thorpe St. Andrew, Norwich, NOR 85S

**WANTED:** Ex-Govt. R208. Good condition. State price. S. Giess, 2 Brompton Close, Lytham St. Annes, Lancs.

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**WORLD DX CLUB** covers all aspects of SWLing on Amateur and Broadcast Bands through its monthly bulletin *"Contact"*. Membership costs 27/6d. a year. Enquiries to Secretary, WDXC, 11 Wesley Grove, Portsmouth, Hants., PO3 5ER.

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*(Continued on page 323)*

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*(Continued from page 321)*

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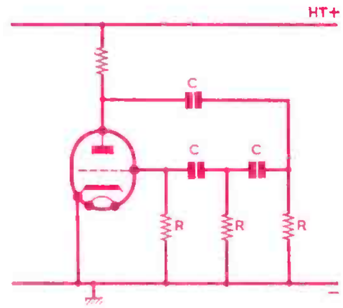
**PANEL-SIGNS TRANSFERS.** We have a limited supply of sheets of Frequencies expressed in cycles per second. Price 1/- per two sheets plus 4d. postage. Data Publications Ltd., 57 Maida Vale, London W9 1SN.

# CONSTRUCTOR'S DATA SHEET

**45**

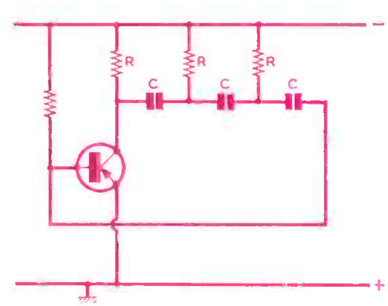
## R.C. SINE WAVE OSCILLATORS

The resistance-capacitance oscillators shown produce an undistorted sine wave when valve or transistor gain is just sufficient to maintain oscillation. The phase shift oscillators of (a) and (b) have networks which produce a phase shift of 180°. Note that the anode resistor in (a) and the base resistor in (b) are outside the network; the variation in (b) is due to the low base impedance of the transistor. Neither (a) nor (b) will oscillate if voltage gain is less than 29. In (c) and (d) oscillation occurs at the frequency where phase shift is zero. The circuit in (d) shows the Wien Bridge oscillator; in this, R3 and R4 have values which slightly unbalance the bridge. In all equations F is in Herz, C in farads and R in ohms.



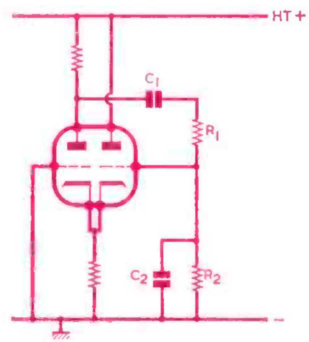

$$f_o = \frac{1}{2\pi CR\sqrt{6}}$$

(a)

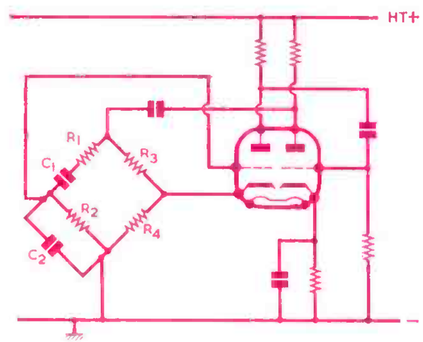



$$f_o = \frac{1}{2\pi CR\sqrt{6}}$$

(b)




$$f_o = \frac{1}{2\pi\sqrt{C_1C_2R_1R_2}}$$




$$f_o = \frac{1}{2\pi\sqrt{C_1C_2R_1R_2}}$$

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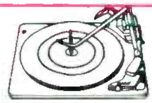

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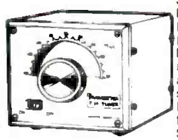

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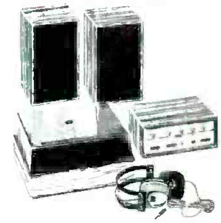

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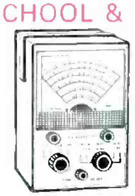

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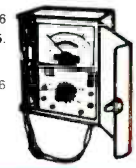

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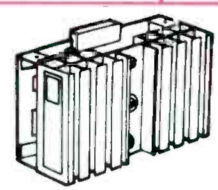

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