

THE

RADIO CONSTRUCTOR

Vol 20 No 11

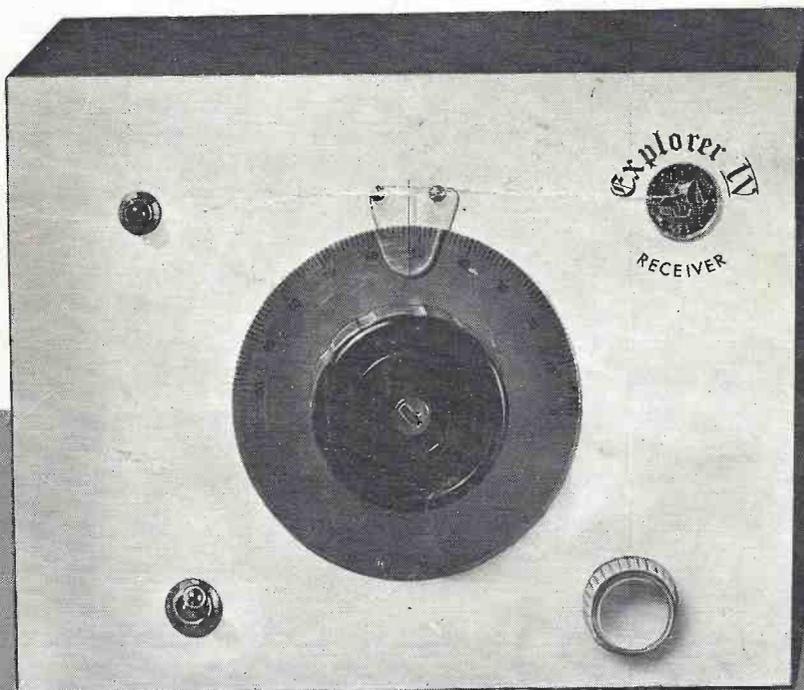
JUNE 1967

2/6

A DATA PUBLICATION

RADIO • TELEVISION
ELECTRONICS • AUDIO

1-Valve Beginner's Receiver



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First Class
Design
Easy to
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Bistable Circuit



4-Channel
Mixer/Pre-amplifier



Model Control
Transmitter



Car Turning
Indicator

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TELEVISION SETS, RECEIVERS AND TRANSMITTERS

Television Sets, Receivers and Short Wave Transmitters are expensive to acquire and you no doubt highly prize your installation. Apart from the value of your Set, you might be held responsible should injury be caused by a fault in the Set, or injury or damage by your Aerial collapsing.

A "Scottish" special policy for Television Sets, Receivers and Short Wave Transmitters provides the following cover:

- (a) Loss or damage to installation (including in the case of Television Sets the Cathode Ray Tube) by Fire, Explosion, Lightning, Theft or Accidental External Means at any private dwelling-house.
- (b) (i) Legal Liability for bodily injury to Third Parties or damage to their property arising out of the breakage or collapse of the Aerial Fittings or Mast, or through any defect in the Set. Indemnity £10,000 any one accident.
- (ii) Damage to your property or that of your landlord arising out of the breakage or collapse of the Aerial Fittings or Mast, but not exceeding £500.

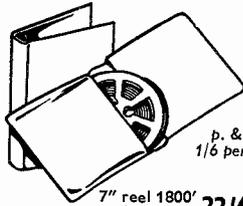
The cost of Cover (a) is 5/- a year for Sets worth £50 or less, and for Sets valued at more than £50 the cost is in proportion. Cover (b) (i) and (ii) costs only 2/6 a year if taken with Cover (a), or 5/- if taken alone.

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With each reel of this tape by an internationally famous manufacturer we give you a beautifully made wallet strongly made in simulated leather with space for a reel of tape each side. This is professional quality full frequency tape with metallised leader/stop foils. These library wallets solve once and for all the problems of storing tapes efficiently and tidily.

7" reel 1800' with wallet **22/6**
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WITH 4 VALVES, FRONT PANEL, WIRED & TESTED **£65.0**

OUTSTANDING T.R.S. VALUE—Absolutely complete mains powered amplifier for B.S.R. T.D.2 Deck. Supplied wired and tested. Facilities include mike/radio/P.U. inputs, playback switching, superimpose, magic eye, tone and volume controls, 3Ω outlet and monitoring. With front panel and knobs. **£65/-**. (P. & P. 5/-.)

Contemporary sized 2-tone cabinet to take above Size 14 x 13 1/2 x 7 1/2in. Detachable lid. **39/6** (P. & P. 7/6.)

T.R.S. Mullard Stereo 10-10

Valve amplifier by T.R.S. to exact Mullard spec. Complete with pre-amp and o/p transformers tapped for 3 and 15 Ω Bass, treble, volume, balance controls. Outlet for H.T. and L.T. for tuner. Switching for mono/stereo and speaker phasing. Shrouded pre-amp. Complete with plugs, sockets, escutcheon, knobs, etc.

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7 Valve AM/FM RG Chassis

A superbly powerful high performance instrument for the keenest enthusiasts. Provides tuning on long, medium and F.M. wavebands, 3 wave-band L/M/FM Permeability tuning on F.M. Large clear dia. A.V.C., good neg. feedback. Magic eye 3 w. output. A.C. 200/250 v. Circuit diagrams available.

Aligned, tested and ready for use (Carr. and ins. 7/6.) S.A.E. brings full details. **£13.19.6**

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- AUTOMOBILE
- AERONAUTICAL
- PLASTICS
- BUILDING
- DRAUGHTSMANSHIP
- B.S.C.
- CITY & GUILDS
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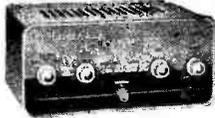


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S-33H**



**10W
POWER
AMP.
MA-12**



**GARRARD
PLAYER
AT-60**



**20+20W
STEREO
AMP.
AA-22U**

10W POWER AMPLIFIER. Model MA-12. 10W output, wide freq. range, low distortion. For use with control unit. Kit **£12.18.0** Assembled **£16.18.0**

STEREO CONTROL UNIT. Model USC-1. Ideal for use with the MA-12 power amplifiers. Push button selection, ganged controls, rumble and variable low-pass filters. Kit **£19.19.0** Assembled **£27.5.0**

DE LUXE STEREO AMPLIFIER. Model S-33H. 3+3 watt output with two-tone grey perspex panel, and higher sensitivity necessary to accept the Decca Deram pick-up. Kit **£15.17.6** Assembled **£21.7.6**

HI-FI STEREO AMPLIFIER. Model S-99. 9+9W output. Ganged controls. Stereo/Mono gram., radio and tape inputs. Push-button selection. Printed circuit construction. Kit **£28.9.6** Assembled **£38.9.6**

TRANSISTOR PA/GUITAR AMPLIFIER, PA-2. 20W amplifier. Four inputs. Variable tremolo. **New Low Price** Kit **£39.19.0** Assembled **£54.10.0**

50W VALVE PA/GUITAR AMP., PA-1. Kit **£54.15.0** Assembled **£74.0.0**

TRANSISTOR MIXER. Model TM-1. A must for the tape enthusiast. Four channels. Battery operated. Similar styling to Model AA-22U Amplifier. With cabinet. Kit **£11.16.6** Assembled **£16.17.6**

20+20W TRANSISTOR STEREO AMPLIFIER. Model AA-22U. Outstanding performance and appearance. Kit **£39.10.0** (less cabinet). Assembled **£57.10.0** Attractive walnut veneered cabinet **£2.5.0** extra.

GARRARD AUTO/RECORD PLAYER. Model AT-60. Garrard cartridge **£14.12.10** With Decca Deram pick-up **£19.7.4** incl. P.T. Many other Garrard models available, ask for Lists.

HI-FI MONO AMPLIFIER. Model MA-5. A general purpose 5W Amplifier, with inputs for Gram., Radio. Attractive modern styling. Kit **£11.9.6** Assembled **£15.15.0**



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INSTRUMENTS

3" LOW-PRICED SERVICE OSCILLOSCOPE. Model OS-2. Compact size 5" x 7 1/2" x 12" deep. Wt. only 9 1/2 lb. "Y" bandwidth 2 c/s-3 Mc/s ± 3dB. Sensitivity 100mV/cm. T/B 20 c/s-200 kc/s in four ranges, fitted mu-metal CRT Shield. Modern functional styling. Kit **£23.18.0** Assembled **£31.18.0**

5" GEN-PURPOSE OSCILLOSCOPE. Model 10-12U. An outstanding model with professional specification and styling. "Y" bandwidth 3 c/s-4.5 Mc/s ± 3dB. T/B 10 c/s-500 kc/s. Kit **£35.17.6** Assembled **£45.15.0**

DE LUXE LARGE-SCALE VALVE VOLT-METER. Model IM-13U. Circuit and specification based on the well-known model V-7A but with many worth-while refinements. 6" Ernest Turner meter. Unique gimbal bracket allows operation of instrument in many positions. Modern styling. Kit **£18.18.0** Assembled **£26.18.0**

AUDIO SIGNAL GENERATOR. Model AG-9U. 10 c/s to 100 kc/s, switch selected. Distortion less than 0.1%. 10V sine wave output metered in volts and dB's. Kit **£23.15.0** Assembled **£31.15.0**

VALVE VOLTMETER. Model V-7A. 7 voltage ranges d.c. volts to 1,500. A.c. to 1,500 r.m.s. and 4,000 peak to peak. Resistance 0.1 Ω to 1,000M Ω with internal battery. D.c. input resistance 11M Ω. dB measurement, has centre-zero scale. Complete with test prods, leads and standardising battery. Kit **£13.18.0** Assembled **£19.18.6**

MULTIMETER. Model MM-1U. Ranges 0-1.5V to 1,500V a.c. and d.c.; 150μA to 15A d.c.; 0.2 Ω to 20M Ω. 4 1/2" 50μA meter. Kit **£12.18.0** Assembled **£18.11.6**

R.F. SIGNAL GENERATOR. Model RF-1U. Up to 100 Mc/s fundamental and 200 Mc/s on harmonics. Up to 100mV output. Kit **£13.18.0** Assembled **£20.8.0**

SINE/SQUARE GENERATOR. Model IG-82U. Freq. range 20 c/s-1 Mc/s in 5 bands less than 0.5% sine wave dist. less than 0.15μ sec. sq. wave rise time. Kit **£25.15.0** Assembled **£37.15.0**

TRANSISTOR POWER SUPPLY. Model IP-20U. Up to 50V, 1.5A output. Ideal for Laboratory use. Compact size. Kit **£35.8.0** Assembled **£47.8.0**



OS-2



IM-13U



V-7A



MM-1U



IG-82U

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Will give you superb LW and MW entertainment wherever you drive. Tastefully styled to harmonise with any car colour scheme. Available for your convenience in two separate parts, RF Amp. Kit **£1.13.6** incl. P.T. IF/AF Amp. Kit **£11.3.6**

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TRANSISTOR RADIOS

"OXFORD" LUXURY PORTABLE. Model UXR-2. Specially designed for use as a domestic, car or personal portable receiver. Many features, including solid leather case. Kit **£14.18.0** incl. P.T.



UXR-2

TRANSISTOR PORTABLE. Model UXR-1. Pre-aligned I.F. transformers, printed circuit. Covers L.W. and M.W. Has 7" x 4" loudspeaker. Real hide case. Kit **£12.11.0** incl. P.T.



UXR-1

JUNIOR EXPERIMENTAL WORKSHOP Model EW-1. More than a toy! Will make over 20 exciting electronic devices, incl: Radios, Burglar Alarms, etc. 72 page Manual. The ideal present! Kit **£7.13.6** incl. P.T.

STEREO TRANSISTOR FM TUNER

(Mono version also available)
14 transistor, 5 diode circuit. Tuning range 88-108 Mc/s. Designed to match the AA-22U Amplifier. Available in separate units, can be built for a total price.

Kit (Stereo) **£24.18.0** incl. P.T.

Kit (Mono) **£20.19.0** incl. P.T.

Cabinet extra **£2.5.0**.



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TAPE AMPLIFIERS TAPE DECKS CONTROL UNITS



FM TUNER
FM-4U



STEREO DECODER
SD-1

HI-FI FM TUNER. Model FM-4U. Available in two units. R.F. tuning unit (£2.15.0 incl. P.T.) with I.F. output of 10.7 Mc/s, and I.F. amplifier unit, with power supply and valves (£13.13.0). May be used free standing or in a cabinet. Total Kit **£16.8.0**
(Multiplex adapter available, as extra.)

HI-FI AM/FM TUNER. Model AFM-1. Available in two units which, for your convenience, are sold separately. Tuning heart (AFM-T1—£4.13.6 incl. P.T.) and I.F. amplifier (AFM-A1—£22.11.6). Printed circuit board, 8 valves. Covers L.W., M.W., S.W., and F.M. Built-in power supply. Total Kit **£27.5.0**
(Multiplex adapter available, as extra.)

STEREO DECODER. Model SD-1. Converts FM Mono receivers to stereo at low-cost. Styled to match Heathkit models FM-4U and AFM-1 Tuners. Kit **£8.10.0** Assembled **£12.5.0**



TRUVOX DECK



AM/FM TUNER

MAGNAVOX "363" TAPE DECK. The finest buy in its price range. Operating speeds: 1½", 3½" and 7½" p.s. Two tracks, "wow" and "flutter" not greater than 0.15% at 7½" p.s. **£13.10.0**

TRUVOX D106 TAPE DECKS. High quality stereo/mono tape decks. D106, ½ track, **£39.15.0** D108, ¼ track, **£39.15.0**

TAPE RECORDING/PLAYBACK AMPLIFIER
Mono Model TA-IM kit **£19.18.0** Assembled **£28.18.0**
Stereo Model TA-IS kit **£25.10.0** Assembled **£35.18.0**

HI-FI CABINETS. A wide range available for example: Malvern Kit **£18.1.0** incl. P.T. Gloucester Kit **£18.10.0**

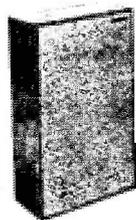
MONO CONTROL UNIT. Model UMC-1. Designed to work with the MA-12 or similar amplifier requiring 0.25V or less for full output. 5 inputs. Baxandall type controls. Kit **£9.2.6** Assembled **£14.2.6**

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SSU-1



Berkeley

SPEAKER SYSTEMS

HI-FI SPEAKER SYSTEM. Model SSU-1. Ducted-port bass reflex cabinet "in the white". Two speakers. Vertical or horizontal models with legs, Kit **£12.12.0**, without legs, Kit **£11.17.6** incl. P.T.

THE BERKELEY Slim-line SPEAKER SYSTEM, fully finished walnut veneered cabinet for faster construction. Special 12" bass unit and 4" mid/high frequency unit. Range 30-17,000 c/s. Size 26" x 17" x only 7¾" deep. Modern attractive styling. Excellent value.

Kit **£19.10.0** Assembled **£24.0.0**

COTSWOLD SPEAKER SYSTEMS. Outstanding performance for price.

MFS: Size 36" x 16½" x 14" deep.

Kit **£25.12.0** Assembled **£33.17.0**

STANDARD: Size 26" x 23" x 14½" deep.

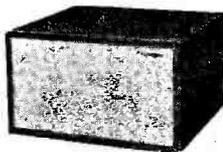
Kit **£25.12.0** Assembled **£33.17.0**

'AVON' Low-cost Mini Speaker System ... with Hi-Fi performance

6½" Bass speaker, 3½" enclosed treble unit, Inductor-capacitor cross-over network. Kit **£4.18.0** incl. P.T. Strongly constructed, fully-finished walnut veneered cabinet Kit **£8.18.0**. Compact size gives wide 50-19000 c/s range.

TOTAL PRICE:

Kit **£13.16.0** incl. P.T.



"AMATEUR" EQUIPMENT

THE "MOHICAN" GENERAL COVERAGE RECEIVER. Model GC-1U. With 4 piezo-electric transfilters, variable tuned B.F.O. and Zener diode stabiliser, this is an excellent fully transistorised general purpose receiver for Amateur and Short wave listeners. Printed circuits, telescopic aerial, tuning meter and large slide-rule dial. Kit **£37.17.6** Assembled **£45.17.6**

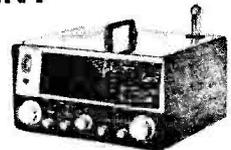
AMATEUR BANDS RECEIVER. Model RA-1. To cover all the Amateur Bands from 160-10 metres. Many special features, including: half-lattice crystal filter; 8 valves; signal strength "S" meter; tuned R.F. Amp. stage. Kit **£39.6.6** Assembled **£52.10.0**

160-10M TRANSMITTER. Model DX-100U. Careful design has achieved high performance and stability. Completely self-contained.

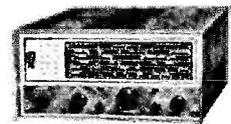
Kit **£81.10.0** Assembled **£106.15.0**

COMMUNICATIONS TYPE RECEIVER. Model RG-1. A high performance, low cost receiver for the discriminating listener. Frequency coverage: 600 kc/s-1.5 Mc/s and 1.7 Mc/s-32 Mc/s.

Kit **£39.16.0** Assembled **£53.0.0**



GC-1U



RG-1

Low-cost 3 + 3W Transistor Stereo Amplifier, TS-23



Incorporating all the essential features for good quality sound reproduction from record, radio and other sources. 16 Transistor, 4 diode circuit. Good frequency response 6 position selector switch. Modern slim line styling.

Kit (less cabinet) **£17.15.0**

Kit (with handsome finished cabinet) **£18.19.0**



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HI-FI AMPLIFIER
AND PRE-AMP

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- ★ 15 WATTS MUSIC POWER (30 WATTS PEAK)

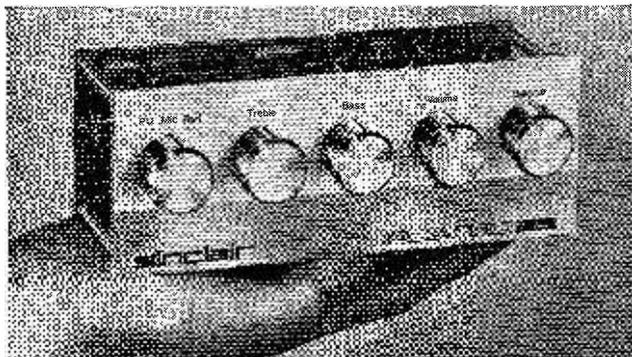
The embodiment of power efficiency and reliability. Nothing could be better than this fine amplifier for use with space-saving plinth-mounted motor and pick-up assemblies. Equally, the light weight of the Z.12 makes it the ideal guitar amplifier, particularly since it operates efficiently on any power supply between 6 and 20 V.D.C. The pre-amp of this 8-transistor masterpiece will accept the outputs of pick-up, radio and microphone, etc. Full details for matching control, and selector switching circuits are in the manual supplied with each unit. The Z.12 is now in use all over the world and is the accepted standard for all hi-fi needs.

- Frequency range — 15–50,000 c/s \pm 1dB
- Ideal for use with a 12V car battery
- Can be used with 15, 7½ and 3Ω speakers. Two 3Ω speakers can be used in parallel
- Size 3 x 1½ x 1¼in.
- Class B ultralinear output
- Input sensitivity—2mV into 2K ohms

Ready built, tested and guaranteed, with Z.12 manual of circuits

89'6

SINCLAIR PZ.3 Transistorised A.C. mains power supply unit for two Z.12s with Stereo 25. **79/6**



SINCLAIR MICRO FM

7 Transistor combined FM tuner-receiver

This unique, superbly engineered FM superhet is the only set in the world which can be used both as an FM tuner and an independent FM pocket receiver just whenever you wish.

Problems of alignment have been completely eliminated making the Micro-FM ready for use the moment you have built it. The pulse counting discriminator ensures best possible audio quality; sensitivity is such that the telescopic aerial included with the kit assures good reception in all but the very poorest reception areas. The Sinclair Micro-FM will give you all you want from a high quality FM unit. The case is elegantly styled in brushed and polished aluminium with spun aluminium slow motion tuning dial.

SIZE—less than 3 x 1½ x ¼"

Needs no alignment when built



Complete kit inc. aerial, case, earpiece and instructions.

£5.19.6

SINCLAIR STEREO 25

Pre-amp and control unit for use with two Z.12s or other stereo amp

THE SINCLAIR STEREO 25 has been designed specially to ensure the highest possible standards of reproduction when used with two Z.12s or any other first class-stereo power amplifier. The front panel of the Stereo 25 is in solid brushed and polished aluminium with beautifully styled solid aluminium control knobs. Mounting the unit is simple, and power is conveniently obtainable from the Sinclair PZ.3 which can also be used to supply two Z.12s to make a complete stereo assembly.

Performance figures obtained using Stereo 25, two Z.12s and a PZ.3.

- **INPUTS** for P.U., Radio and Mic.
- **FREQUENCY RESPONSE** (Mic. and Radio)—25 c/s to 30 kc/s \pm 1dB extending to 100 kc/s \pm 3dB.
- **EQUALISATION** Correct to within \pm 1dB on R1AA curve from 50 c/s to 20 kc/s.
- **CONTROLS** Volume, Treble, Bass, Volume, Input
- **SIZE** 6½ x 2½ x 2½", plus knobs.

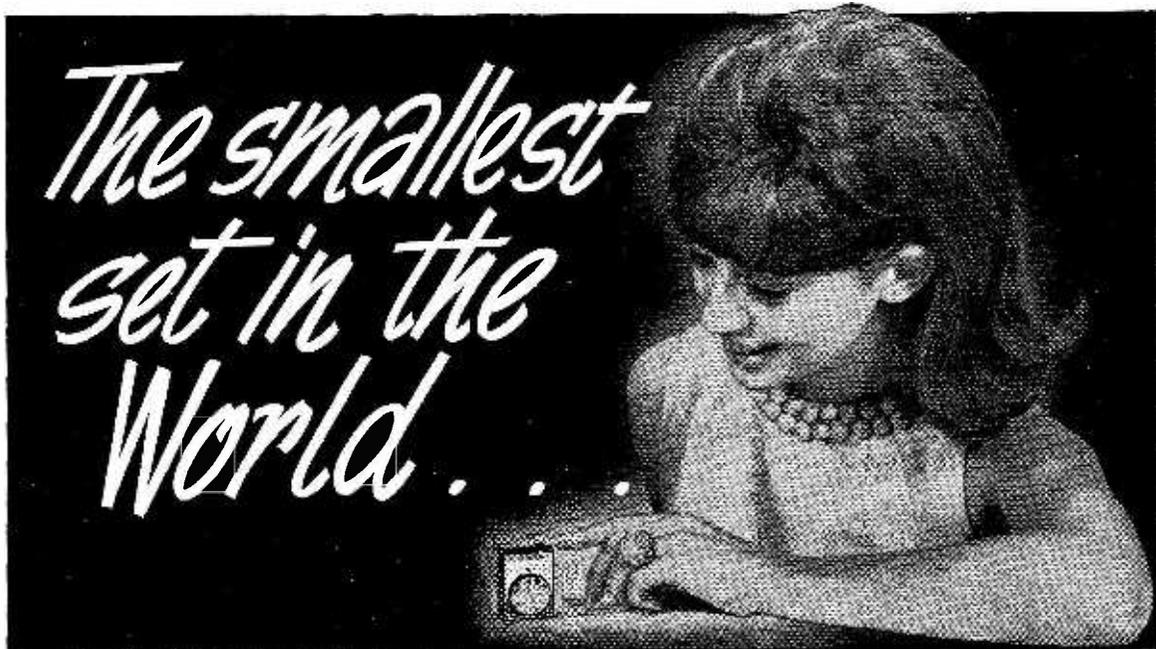
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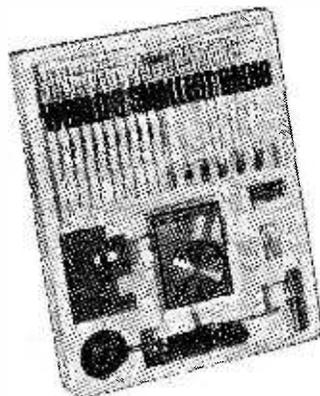
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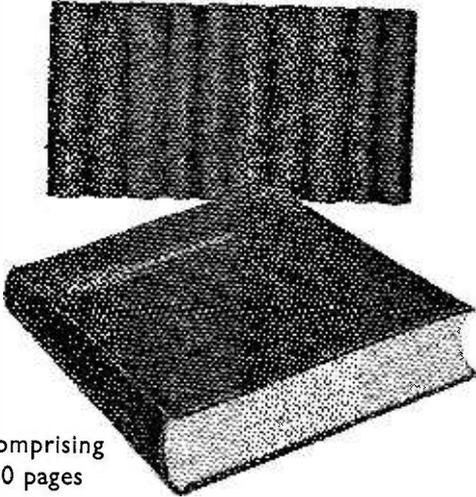
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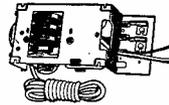
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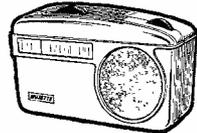
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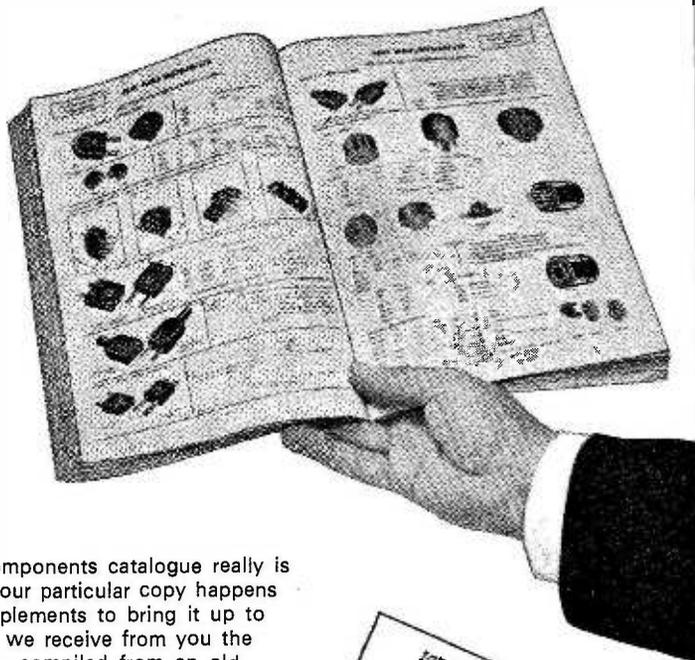
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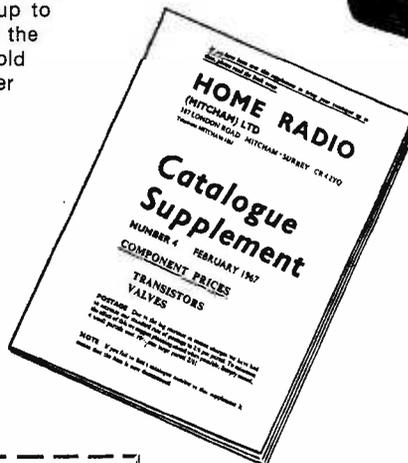
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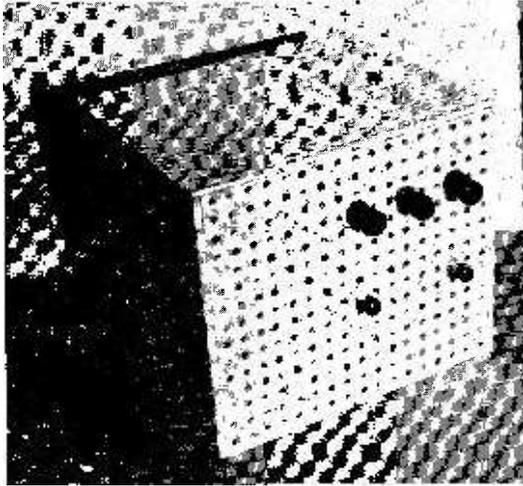
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MOST RECEIVERS, AMPLIFIERS AND MODULATORS, and amateur transmitting equipment require h.t. supplies in the range of about 250V 60mA up to about 1,000V 400mA. The practical circuits described here, which have been used by the writer, fall roughly within these limits. They can be used with confidence as they stand, or may be modified as explained to secure other outputs.

Capacitor or Choke Input

With a given transformer and rectifier, the d.c. output obtainable depends on whether the rectifier is used with capacitor or choke input. Fig. 1 illustrates this. In each case a 5U4G rectifier is employed with a 350-0-350V transformer.

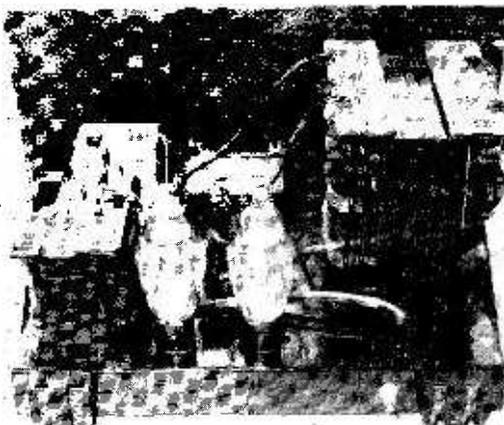
With capacitor input, the maximum current which can be drawn is 235mA at 320V. The output voltage is 350V at about 170mA. When less current is drawn, the voltage soars, being 400V at about 80mA and 450V at 25mA. With no current drawn, the supply rises to nearly 500V.

When using choke input, the change in output voltage is very much smaller. Maximum current

Power Supplies for Transmitters and Other Equipment

By F. G. Rayer, Assoc.I.E.R.E., G3GR

This article is devoted to practical power supplies, with the emphasis on supplies for amateur transmitters. The differences between capacitor and choke input filters are examined, and typical working circuits employed by the author are given for medium and high power equipment. It has to be emphasised that the power supplies described in this article offer high voltages at low impedance, and that all precautions against accidental shock must be rigorously observed



A 1,000 volt pack using two 866A's in the circuit of Fig. 8

is 270mA, output then being about 280V. If the current drawn falls to 80mA, the voltage rises only to around 300V, while at 25mA it is only about 310V.

It is thus clear that choke input is much more satisfactory when the load current is likely to vary considerably. This is so with transmitters where the h.t. circuit is interrupted for "stand-by" periods, and also Class B modulators or amplifiers, where the current required varies greatly with signal strength. Choke input is almost always used for transmitters and modulators of other than low power.

If a steady current is required, the capacitor input is suitable, and provides a higher voltage with the same transformer. So the capacitor input circuit is usually employed for receivers, audio amplifier stages working under Class A conditions, and sections of a transmitter which draw a fairly uniform current.

Capacitor Input Circuit

A capacitor input circuit supplying the output in Fig. 1 is shown in Fig. 2. If an output of about 250V is required, a 250-0-250V transformer can be employed. C_1 is generally $8\mu\text{F}$, $16\mu\text{F}$ or $32\mu\text{F}$, while C_2 is often $8\mu\text{F}$ or $16\mu\text{F}$. C_2 must not be larger than specified for the rectifier or the peak charging current may be too high.

With this circuit, the transformer h.t. secondary has a voltage rating similar to the voltage wanted at the normal load current. For a receiver or small amplifier, a 250-0-250V 60mA secondary is quite usual. For a small transmitter, 300-0-300V, 350-0-350V, or 400-0-400V, at some 100mA to 150mA, will generally be adequate. The current rating is the maximum which should be drawn by the load. It is in order to draw smaller currents, and a transformer of adequate rating is preferable to one which is rated only at the current required.

R_1 in Fig. 2 is a bleeder, which improves regulation and helps to prevent the voltage soaring when the load is removed. R_1 is generally omitted when a receiver or similar load is permanently connected. But if the h.t. circuit is opened, as occurs in many transmitters, R_1 is almost essential. For a bleeder current of about 25mA at 350V, R_1 can be $15\text{k}\Omega$ 15W. If the transformer, rectifier and choke are rated much higher than the current actually wanted, the bleeder can have a lower resistance, as this improves the stability of the output voltage.

Choke Input Circuit

A choke input circuit is shown in Fig. 3, and the output voltage remains almost constant over a wide range of currents, as illustrated in Fig. 1. R_1 is the bleeder, drawing about 25mA. C_1 can be very large. A circuit of this kind is normally used to supply the power amplifier and modulator of commercially made amateur transmitting equipment in the 50-150 watt range. Rectifier and transformer ratings are increased as needed.

When the required voltage is high, smoothing capacitors of adequate rating are difficult to obtain. This difficulty is overcome by using two capacitors in series, as shown by C_1 and C_2 in Fig. 4. Two 450V wkg. capacitors will be adequate for a supply of 600V or similar. The capacitors should be of the same make, type and capacitance. If they are metal cased, remember to insulate C_1 adequately.

R_1 and R_2 of Fig. 4 have equal values and also function as the bleeder. They are connected as shown to equalise the voltages across C_1 and C_2 . This circuit is found in nearly all medium and medium-high power amateur transmitters.

Occasionally, extra smoothing is added as shown in Fig. 5. This gives some of the advantages of separate power packs for modulator and p.a., without the need for separate rectifiers or transformers. The h.t.1 terminal serves the p.a., while the h.t.2 connection is taken to the push-pull modulator output stage. The capacitors C_1 to C_4 may each be $32\mu\text{F}$ or larger. Resistors R_1 to R_4 equalise the capacitor voltages, and form bleeders.

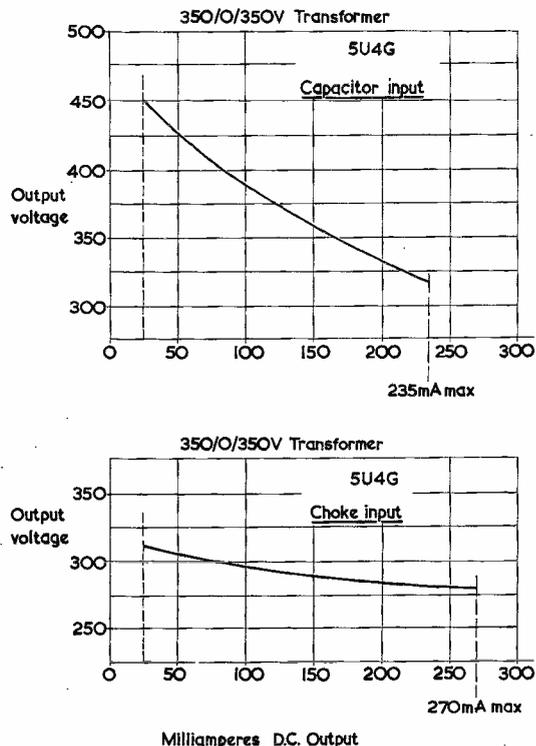


Fig. 1. A comparison of capacitor and choke inputs

They draw excess available current. For example, if the rectifier could supply 250mA, and about 175-200mA will be required by the transmitter, the bleeders may draw about 50mA.

Complete Power Pack

A circuit which will prove to be very satisfactory with a transmitter in the 45-60 watt range is shown

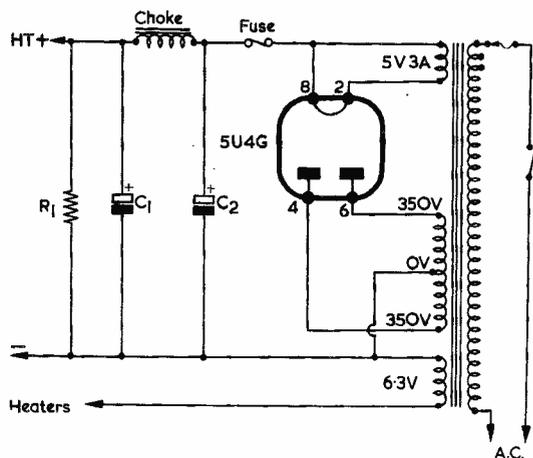


Fig. 2. The capacitor input circuit

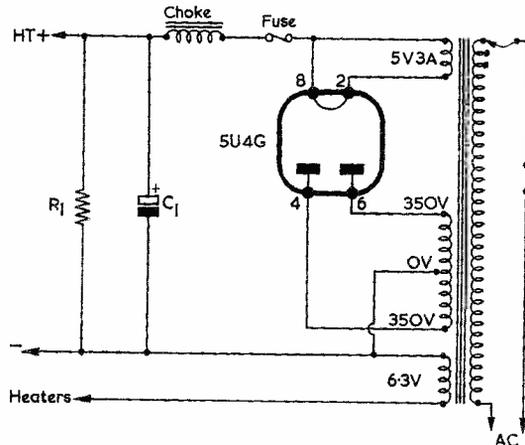


Fig. 3. The choke input circuit

in Fig. 6. It provides 150mA at 480V for the p.a., 40mA at 300V for buffer and driver stages, and 5mA 150V regulated for a v.f.o.

R_1 and R_2 form the high voltage bleeder. R_3 is the medium voltage bleeder. A tapped h.t. secondary supplies both 550V and 350V. The EZ81 does not require a separate heater winding. The 6.3V winding should be able to meet the current requirements of all heaters in the transmitter including that of the EZ81.

If necessary the stabilised output can be changed to 108V by fitting an OB2 regulator, and a VR105/30 is also suitable. The VR75/30 is suitable for 75V, and the VR150/30 for 150V. In each case adjust R_4 so that the regulator passes about 15mA to 20mA.

Mains transformers with tapped secondaries, of the type shown in Fig. 6, are normally available from suppliers of amateur transmitting equipment and usually have a single current rating for the entire h.t. secondary. The present circuit has been used by the writer for amateur transmitting work in which the peak demand from the secondary (including bleeder current) is 285mA. However, this current is only drawn on voice peaks, and an "intermittent amateur service" rating of 250mA has proved satisfactory in practice. If continual service at 285mA is envisaged, the secondary should be rated at 300mA.

A swinging choke is employed in the 480 volt output, this offering 10 henrys at 50mA and 2.5 henrys at 200mA.

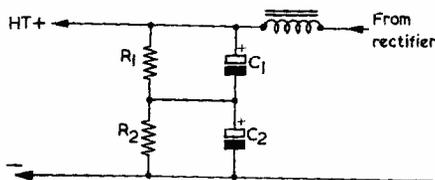


Fig. 4. Capacitors in series for high voltage working

Higher Voltages

For medium-high power transmitters, 5R4GY rectifiers are often used, and the circuit in Fig. 7 is popular. These valves may receive up to 1000V r.m.s. each anode, with choke input, a pair then supplying about 840V d.c. at 300mA. The circuit in Fig. 7 will supply the power requirements of p.a. and modulator for a 100-130 watt transmitter. It can be relied upon for long periods of regular use with a transmitter drawing about 200mA at 600V for the p.a. (120 watts input) and modulator requiring about 200mA on speech peaks.

In this circuit, T_1 supplies a medium voltage for buffer, driver, and early audio stages. The high voltage rectifiers are also run from a 5V winding on this transformer. S_1 is the main on/off switch. S_2 is left open until h.t. is wanted for the p.a. and push-pull modulator output stages. This method of cutting out the high voltage supply is very satisfactory.

High Power Supply

The circuit in Fig. 8 is among the largest likely to be needed for c.w. or phone, and can provide 1,000V at 450mA. R_1 is the usual bleeder. R_2 ,

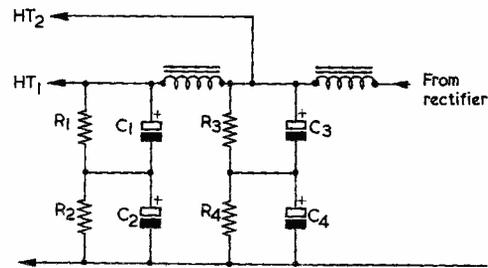


Fig. 5. A double smoothed output

R_3 and R_4 form a safety bleeder to discharge the capacitor. A separate heater transformer is used, and must have suitable insulation for the high voltages present. S_1 and S_2 operate as already described, so that no high potentials are present until S_2 is closed.

The 866A rectifiers are extremely rugged, but when first put into commission their heaters must be left on for 30 minutes, before h.t. is applied. Afterwards, the heaters should always have been on for at least 30 seconds before closing S_2 . The half-hour warming process should be repeated if the valves are removed or have been placed in other than an upright position.

This power pack has seen long use with an 813 p.a. running at 150mA 1,000V input (150 watts) and modulated by two DA41's drawing a peak current of nearly 200mA. In these circumstances, there is scarcely any drop in available h.t. voltage.

Fuses

It generally seems wise to include a fuse in the h.t. circuit, as this may save a rectifier. The fuse

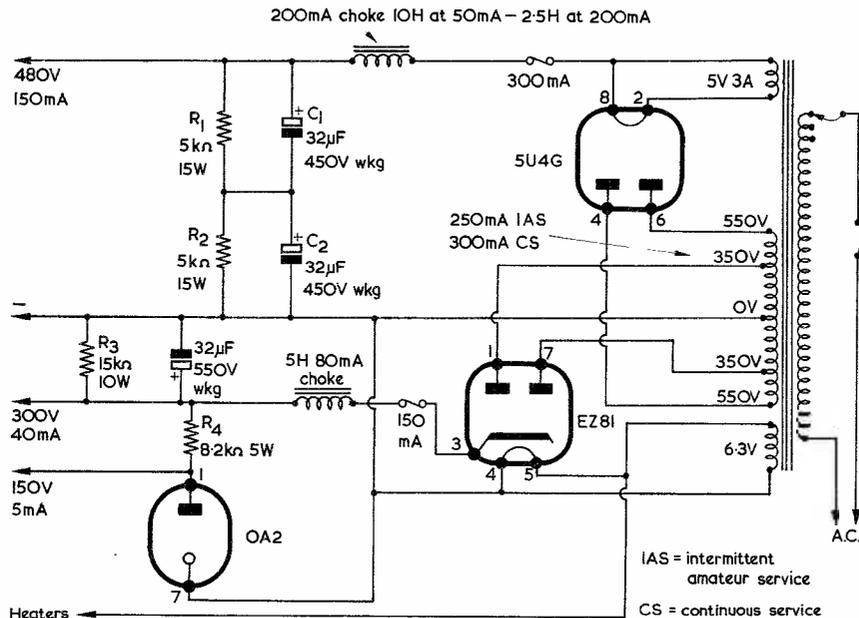


Fig. 6. A power pack having high, medium and stabilised outputs

rating should be as low as possible, for best protection, provided it does not fail in normal use. A fuse is sometimes included between the chassis (h.t. negative) and centre tap of the transformer winding.

Choke

The current rating of the choke should at least equal the current passing through it. For supplies in the 60–100mA range, and when some voltage drop is not important, a suitable choke is easily obtained. The voltage drop in the choke = $I \times R$. For example, if a 200Ω choke passes 100mA, the voltage lost is $200 \times 0.1 = 20V$.

For large currents, a robust choke having a low d.c. resistance is required. The usual circuit will need a 2 to 5 henry choke, this inductance being at the average rated current.

It will be noticed that any particular transformer allows a d.c. output of two different voltages, depending on whether choke or capacitor input is used. This fact is occasionally useful if an existing transformer provides too high a voltage with capacitor input.

Transformer

Transformers are obtainable in many ratings. The transformer needs to supply the required h.t. current at the wanted voltage, and will also usually provide a 6.3V heater supply for all heaters. The total needed can be found by adding the currents of all the 6.3V valves fitted in the equipment. Many rectifiers also need a separate heater winding, usually 5V 2A, 5V 3A or 5V 4A.

When capacitor input is used, peak rectifier current is limited by the d.c. resistance of the supply. That is, the resistance of the transformer windings. Generally, sufficient series resistance is present to avoid damage to the rectifier. But if a rectifier is employed with capacitor input and a transformer of heavy current rating, it may be necessary to check the supply resistance, to avoid damage to the rectifier. The effective resistance per anode is easily found.

It is :

$$R^2P + S,$$

where R is the ratio of one-half the total secondary to the primary, P is the primary resistance, and S is the resistance of one half of the total secondary.

Rectifier Table

The accompanying Table shows maximum ratings of rectifiers which will meet nearly all requirements. The r.m.s. figure is the maximum input voltage per anode. For example with a 6 x 4 the transformer should not supply more than 325–0–325V for capacitor input, or 450–0–450V for choke input.

The minimum supply resistance or impedance is per anode, and has been described. It is generally present in the transformer. If not, a resistor can be included in series with each anode to make up this figure.

The capacitance listed is the maximum for the reservoir capacitor (C_2 in Fig. 2). The remaining capacitor (C_1 , Fig. 2) may be of any value. With choke input, the capacitor may be of any value, but is generally large to secure adequate smoothing. The choke inductance is the minimum figure for

Rectifiers							
Capacitor Input					Choke Input		
	RMS	Supply impedance	Capacitor	Output	RMS	Choke	Output
6X4 6.3V 0.6A	325V	470Ω	16μF	70mA 310V	450V	6H	70mA 380V
5U4G 5V 3A	450V	145Ω	16μF	225mA 430V	550V	2H	225mA 460V
5R4GY 5V 2A	750V	505Ω	8μF	250mA 620V	1000V	5H	175mA 870V
866A 2.5V 5A	—	—	—	—	3500V	5H	250mA 2800V

the current stated, and this figure rises as current falls. In each case the output is the expected maximum voltage at the current shown.

All rectifiers can be used at lower voltages and currents, and some under-running is wise for long valve life. For higher currents, rectifiers may be

used in pairs, as in Fig. 7. The 866A is a half-wave type, so two must be used for full-wave rectification, as shown in Fig. 8.

Construction

Small power packs can be constructed on a 4-sided chassis with mains and h.t. circuits underneath, and a case is not essential. A small or medium power pack can be boxed in by cutting pegboard and bolting this to the chassis. The top corners are joined with small angle brackets, and top and bottom boxed in. Adequate ventilation is absolutely essential for medium and large power packs.

500mA choke 25H at 40mA - 5H at 500mA

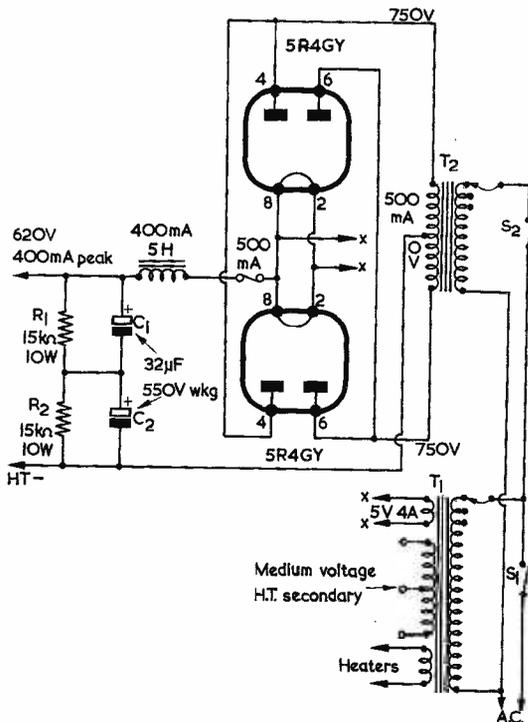


Fig. 7. A power supply for a 100 to 130 watt transmitter

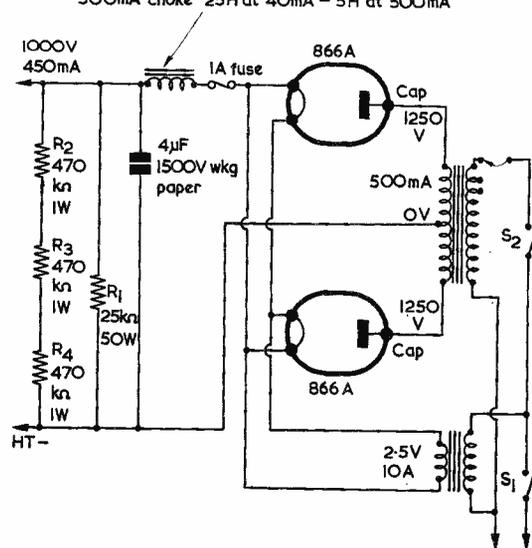


Fig. 8. A supply for high power transmitter and modulator

If the pack is for only one or two pieces of equipment, a multi-way socket can be fitted to it, and a lead from the equipment can have a matching plug. For varied experimental work, terminal connections may be preferred. Insulated safety type terminals are required for h.t. outputs.

For 500V or over, use best quality high voltage insulation on internal and external leads. This is very important with 750V, 1,000V, or higher potentials. Stout conductors, or two or more wires in parallel, must be used for high current filament or heater circuits, and it is wise to check the actual voltage appearing at the filament or heater of any rectifier, p.a. or modulator valve, not forgetting that directly heated rectifier filaments are common to h.t. positive.

For large power packs, construction must be rigid, no high voltage connections must be exposed, and the whole must be enclosed in a metal or other ventilated case. Any metal chassis or case must be earthed by using a 3-core flexible cord from a 3-pin plug.

Always remember that the voltages present in transmitting and other power equipment are dangerous. Apparatus must be constructed and used in such a way as to avoid any hazard for the operator or other persons. If h.t. circuits are to be investigated after switching off, always check that smoothing capacitors are discharged.



Computer-assisted Circuit Designs

Using a computer, a television-like display screen, and an electronic "pen" with which to draw images on the screen, American engineers are experimenting with a technique which reduces the time between a design idea and a finished scale drawing of a micro circuit.

This method has done away with many of the tedious steps associated with designing a circuit and creating an engineering drawing. Intermediate drawings, for example, which must be redrafted when the engineer modifies his design, can be eliminated.

Engineers using the display screen and light-sensitive pen can change their designs simply by manipulating the computer-generated images of transistors, diodes, resistors and other components.

When an engineer is satisfied with his design, a computer-controlled printer produces a precise, scale-drawn layout of the circuit. This hard-copy drawing—a finished version of the engineer's sketch on the screen—then is reduced photographically to make a printing mask for the new circuit. The mask could be used to fabricate the actual printed circuit.

The experiments are being carried out by IBM at East Fishkill, New York.

CAN ANYONE HELP ?

Requests for information are inserted in this feature free of charge, subject to space being available. Users of this service undertake to acknowledge all letters, etc., received and to reimburse all reasonable expenses incurred by correspondents. Circuits, manuals, service sheets, etc., lent by readers must be returned in good condition within a reasonable period of time

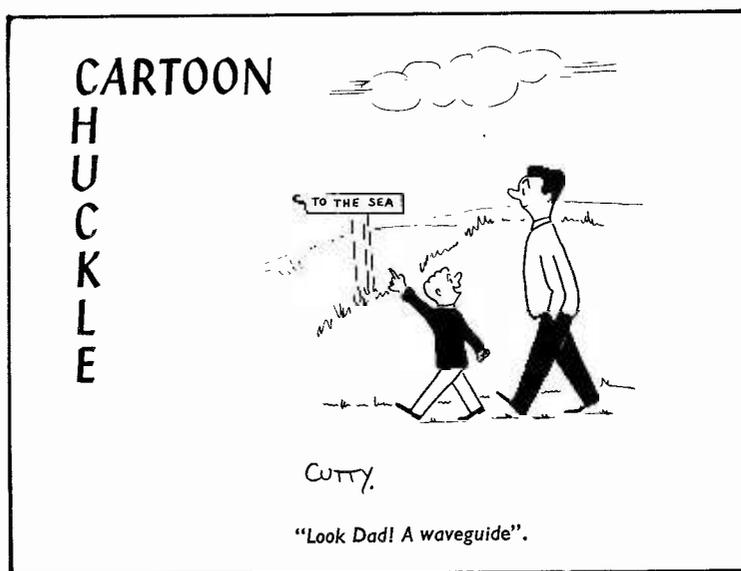
KB Super 8 Transistor Portable, Model VP21.—S. T. Vickery, 271 Shooters Hill Road, Blackheath, London, S.E.3—requires circuit diagram.

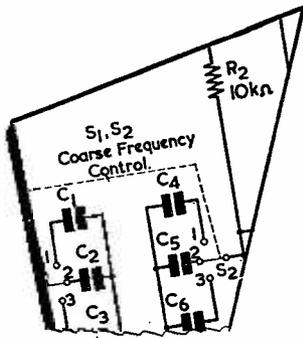
Wireless Set No. 46.—D. Smith, 8 Lilac Road, Golborne, Nr. Warrington, Lancs—manual or circuit diagram, willing to purchase.

Pam 25W Amplifier.—D. A. Graham, Lower House, South Muskham, Newark, Notts—would like to borrow or purchase circuit diagram or any information on this amplifier (type 501-B.E601BT).

AR77E Receiver.—A. Besford, 49 Blake Road, Gt. Yarmouth, Norfolk—wishes to borrow or purchase circuit or manual.

R1392 Receiver.—D. Ashcroft, 10 Foredown Road, Portslade, Sussex—conversion from crystal oscillator to normal tuning, details of modifications required.





SUGGESTED CIRCUIT No. 199

Neon Lamp Bistable Circuit

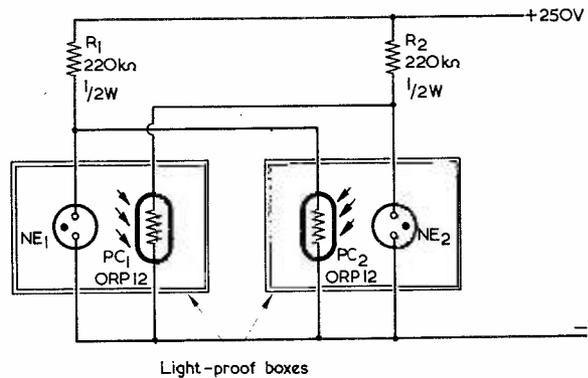
By G. A. FRENCH

IN THIS ARTICLE IN THE "SUGGESTED Circuit" series the writer introduces a novel and interesting bistable circuit which has a number of important advantages including, in particular, those of simplicity and low cost. This article is intended to deal with the basic bistable circuit in detail, after which a brief description will be given of a simple application in which it functions as an intermittent short-circuit tester, the latter forming the actual working "Suggested Circuit" for this month. The writer will employ the basic bistable circuit in a more sophisticated application in next month's article and readers may find it helpful to retain this issue of *The Radio Constructor*, as reference will be made next month to some of the points made in it. It is possible that the writer may employ the bistable circuit in one or two later articles, also.

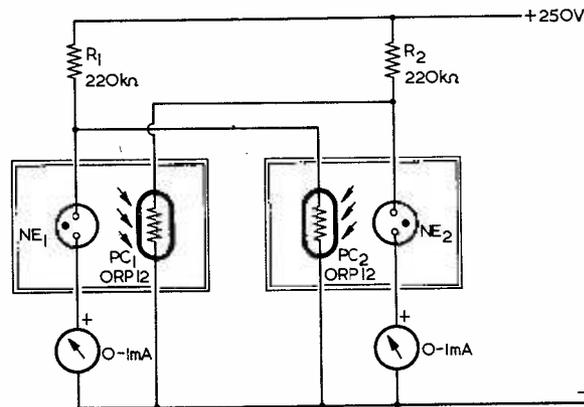
The Basic Circuit

The basic bistable circuit appears in Fig. 1 (a), and it will be seen that it comprises two neon bulbs, two photoconductive cells type ORP12, and two 220kΩ resistors. A power supply of some 250 volts d.c. is provided, from which the current drain is of the order of 2mA. Two light-proof boxes are required, neon bulb NE₁ and photoconductive cell PC₁ being fitted in one, and neon bulb NE₂ and photoconductive cell PC₂ being fitted in the other.

In the dark condition, an ORP12 photoconductive cell has a resistance of 10MΩ or more, this dropping to some 300 to 75Ω when it is fully illuminated. In the present circuit each photoconductive cell is spaced from its accompanying neon bulb in



(a)



(b)

Fig. 1 (a). The basic bistable circuit. Either NE₁ is alight with NE₂ extinguished, or NE₂ is alight with NE₁ extinguished
(b). For experimental work, it is helpful to insert a meter in series with each neon bulb to indicate whether it is alight or extinguished

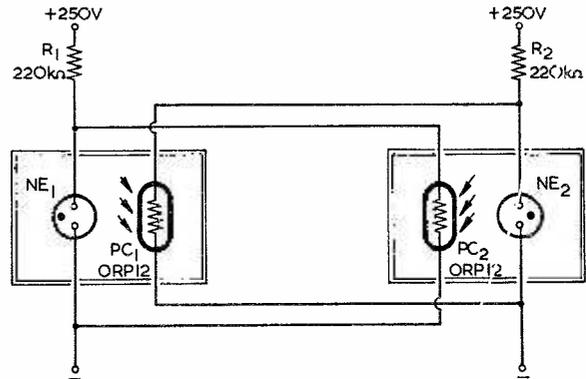
such a manner that, when the neon bulb is alight, the cell resistance drops to around 5 to 10k Ω . The neon bulbs employed are inexpensive wire-ended components, suitable types being the Hivac 16L or 34L available from Henry's Radio Ltd., or the bulb under Cat. No. PL32A from Home Radio (Mitcham) Ltd. These bulbs have striking and burning potentials of the order of 60 volts, and are intended to run from a 250 volt supply by way of a resistor of around 220k Ω , as occurs in Fig. 1 (a).

As soon as the 250 volt supply in Fig. 1 (a) is applied, either NE₁ or NE₂ ignites. If it is neon bulb NE₁ which ignites, PC₁ becomes illuminated and its resistance drops to some 5 to 10k Ω . This drop in resistance causes the voltage across NE₂ to be limited to some 11 volts or less, whereupon NE₂ fails to ignite. If now, neon bulb NE₁ is short-circuited it becomes extinguished, whereupon the resistance of PC₁ will at once commence to rise. When PC₁ offers a sufficiently high resistance the voltage across neon bulb NE₂ reaches striking level, whereupon neon bulb NE₂ lights up. In consequence, photoconductive cell PC₂ becomes illuminated, and its resistance drops to some 5 to 10k Ω . When the short-circuit across NE₁ is removed this neon remains extinguished, because the low resistance now offered by PC₂ limits the voltage across it to well below striking potential.

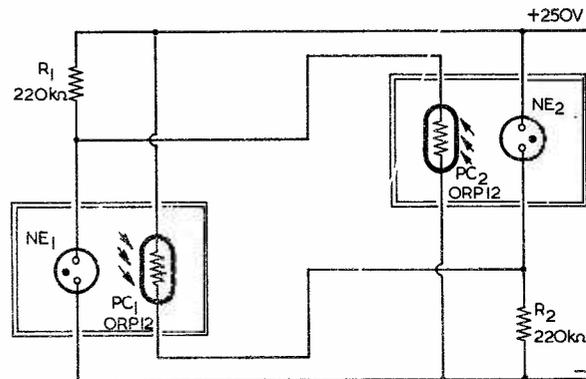
Thus, by short-circuiting neon bulb NE₁, we have caused neon bulb NE₂ to become illuminated, and to remain illuminated when the short-circuit is removed. To bring the circuit to its original state we must short-circuit NE₂. Following a similar course of events to that which occurred previously, NE₂ will then become extinguished, and neon bulb NE₁ will light up, remaining alight after the short-circuit has been taken from neon bulb NE₂.

The circuit of Fig. 1 (a) is, therefore, a bistable circuit, since it can only exist in one of two states. These are given by NE₁ alight and PC₁ at low resistance, or by NE₂ alight and PC₂ at low resistance.

Since it is impossible to see the condition of the neon bulbs in their light-proof boxes, readers wishing to experiment with the basic circuit should insert a milliammeter in series with each neon bulb, as shown in Fig. 1 (b). The meters will indicate a current of about 1mA when the associated neon is alight. For reasons which are explained shortly, care must be taken to ensure that the



(a)



(b)

Fig. 2 (a). The bistable will operate if the neon bulbs are run from separate power supplies

(b). Satisfactory operation will also be given if one neon bulb couples to the positive side of the supply and the other to the negative side

neon bulb circuits are not accidentally opened with the supply applied when the meters are brought into use. The short-circuit needed to actuate the changeover can be applied across a neon and its series meter.

A fascinating aspect of the bistable circuit of Fig. 1 (a) is its versatility with respect to supply arrangements, such versatility being due to the fact that the only coupling between one half of the circuit and the other is by means of neon bulb illumination of the associated photoconductive cell. In consequence, the circuit will operate if neon bulb NE₁ is supplied from one power supply, and neon bulb NE₂ from another separate supply, as is shown in Fig. 2 (a). To give an idea of the possibilities offered, the power supply for NE₁ could be obtained from a piece of equipment which is fully isolated from the mains and the power supply for NE₂ from a piece

of equipment whose chassis is "live" and is connected to one side of the mains. The unique feature given by the lack of electrical connection between the two halves of the circuit ensures that the circuit of Fig. 2 (a) maintains complete isolation between the two supplies.

Again, polarity is unimportant, and the two halves of the circuit could be connected up in the manner shown in Fig. 2 (b). In this diagram NE₁ connects to the negative side of the supply whilst NE₂ connects to the positive side of the supply.

We have seen that the circuit can be changed from one state to the other by short-circuiting, for a short period, the neon bulb which is alight. The circuit could similarly be changed from one state to the other by open-circuiting, for a short period, the supply to the neon bulb which is alight, in the manner illustrated in Fig. 3 (a). Open-circuiting the supply will cause the

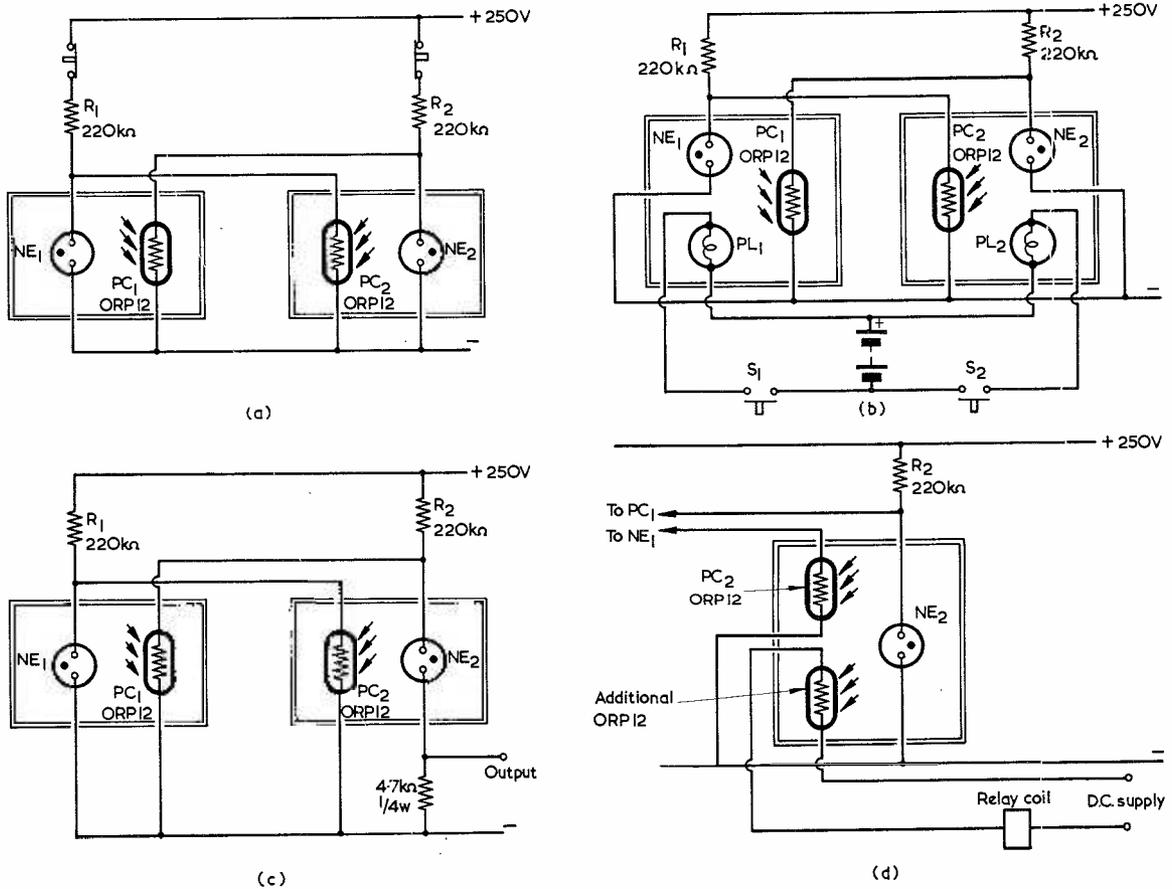


Fig. 3 (a). Using press-to-break push-buttons to instigate the changeover
 (b). Another method of causing changeover, in which small pilot lamps are introduced to the light-proof boxes
 (c). An output from the bistable may be obtained by inserting a $4.7k\Omega$ resistor in series with one of the neon bulbs
 (d). Inserting an additional ORP12 in one of the light-proof boxes enables a relay to be directly controlled by the bistable

neon bulb to extinguish and to remain extinguished after the supply has been re-applied. In this respect, it is most important to note that the circuit must *not* be actuated by making an open-circuit immediately adjacent to the neon bulb itself. Both neon bulbs must be *permanently* connected to their photoconductive cells (NE₁ to PC₂, and NE₂ to PC₁), as, otherwise, the photoconductive cell voltage can rise above its maximum rating of 110 volts (as specified by Mullard for the ORP12) and the cell will become damaged. This particular point must always be borne in mind during construction and experiment with the circuit. It is, of course, permissible to insert meters in series with the neon bulbs, as in Fig. 1 (b), but the constructor should always ensure

that no accidental open-circuit appears in the meter circuits.

An attractive method of actuating the circuit is shown in Fig. 3 (b). In this diagram a small pilot lamp is introduced to each light-proof box, being operated by way of a push-button from a separate supply, shown here as a battery. If neon bulb NE₁ is alight, push-button S₂ should be momentarily pressed. Pilot lamp PL₂ will then light, causing PC₂ to exhibit low resistance and NE₁ to extinguish. Neon bulb NE₂ then lights up, remaining illuminated after the push-button has been released. The circuit may be restored to its original state by momentarily pressing push-button S₁, whereupon NE₁ will light up and remain illuminated. As can be seen, there is complete electrical

isolation between the pilot lamp actuating circuit and the neon bistable. Alternatively, small neon bulbs, of the type already employed for NE₁ and NE₂, may be introduced into the light-proof boxes in place of the pilot lamps, circuit actuation being carried out, in the same manner, by causing these to be illuminated for a short period. The additional neon bulbs can, of course, be made to light up by high impedance low-current circuits, such as appear at the anodes of voltage amplifier valves and the like.

The basic bistable circuit may be used to control external high impedance circuits in a number of ways. A simple method consists of inserting a $4.7k\Omega$ $\frac{1}{4}$ watt resistor in series with the lower end of either or both neon bulbs, in the manner

shown in Fig. 3 (c). When the associated neon bulb is extinguished the output is zero volts whilst, when it is alight, the output is around 4.5 to 5 volts with a current availability of about 1mA. This is more than adequate to control an external valve circuit or two transistors in a "Super-Alpha" emitter-follower combination. The polarity of the output voltage can be either positive or negative according to the polarity of the supply for the bistable circuit. The extra 5 volts dropped across the series resistor does not cause the voltage rating to the photoconductive cell connected across it and the neon bulb to be exceeded.

Another method of using the bistable to control an external high-impedance circuit can be given by introducing a second photoconductive cell in either or both light-proof boxes. See Fig. 3 (d). As the writer demonstrated in "Suggested Circuits" in the December 1962 issue, an ORP12 illuminated by a neon bulb will actuate a relay directly. Since the December 1962 issue is now out of print, the writer may add briefly that the ORP12 in the earlier "Suggested Circuit" was connected directly in series with a 5kΩ relay which energised at 2mA, the relay and ORP12 being powered by a 24 volts d.c. supply. The 5kΩ relay used then is not currently shown in home-constructor retail lists, but the 3,800Ω relay now available from Home Radio (Mitcham) Ltd. under Cat. No. Z70D should cope equally well. The writer has not, incidentally, checked this last application for the bistable in practice.

Speed of Actuation

The basic circuit of Fig. 1 (a) and the alternative circuits shown in the subsequent diagrams illustrate the main advantages of the neon bistable circuit. These are its simplicity, its low cost, its versatility and the electrical isolation appearing between its two halves. The circuit has one important disadvantage, however, this being given by the sluggishness of resistance change in the photoconductive cells employed. An ORP12 does not change immediately from its high resistance to its low resistance condition when illuminated, nor does it change immediately from its low resistance to its high resistance condition when the illumination is cut off. If an ORP12 is connected in series with a 220kΩ resistor across a 250 volt supply, as shown in Fig. 4, some 60 volts will appear across it when it presents a resistance of 70kΩ.

A series 220kΩ resistor and a 250 volt supply are used in Fig. 1 (a) —in which the neon bulbs strike and become illuminated at about 60 volts—with the result that the changeover of the bistable circuit from one state to the other is controlled, firstly, by the time that the previously illuminated ORP12 takes to rise from less than 10kΩ up to 70kΩ and, secondly, by the time that the previously non-illuminated ORP12 takes to drop from 10MΩ or more to 70kΩ. Working from Mullard curves for the ORP12, by far the longer of these two periods is for the rise to 70kΩ, this being roughly 200mS. So it can be assumed that if, to take an example, the circuit is to be changed from one state to the other by short-circuiting one of the neon bulbs, the short-circuit has to be applied for at least one-fifth of a second.

In practice, the writer found that different photoconductive cells varied noticeably in this respect, although all caused the bistable to change states reliably when the short-circuit was applied for, at worst, nearly half a second or so. With some cells, noticeably quicker circuit operation was obtained. The ORP12 is used within its ratings for voltage and dissipation up to 50°C ambient temperature, and it was found that a Valvo LDR03 gave equivalent results. Incidentally, the lag in changeover causes no difficulties when actuation is carried out with pilot lamps, as in Fig. 3 (b), because even with momentary closing of the associated push-button the lighting and extinguishing period of the pilot lamp is greater than the delay in the photoconductive cells.

In the prototype circuit, the spacing between each neon bulb and ORP12 was 1in, as shown in Fig. 5. If a greater spacing is used, the illuminated resistance of the photoconductive cell will be higher than the 5 to 10kΩ given with the prototype circuit and changeover operation will be speeded up. Experimenters may care to try circuit operation with increased spacing. The writer felt, however, that the 1in spacing represented reasonably optimum conditions since it gave an illuminated resistance which was sufficiently below the 70kΩ changeover value to give reliable bistable working. It is important to ensure that the light-proof box for each neon bulb and photoconductive cell is really efficient, since the resistance of an ORP12 drops noticeably at quite low levels of ambient illumination.

A neon bulb is not an entirely

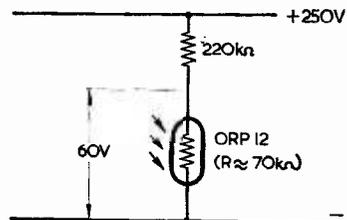


Fig. 4. Changeover occurs when the voltage across one of the photoconductive cells is approximately 60. (In practice, the photoconductive cell must always be shunted by a neon bulb)

positively acting on-off device, since it can glow at reduced brilliance under circuit conditions which just allow ionisation to occur. In consequence, it is feasible that the circuit of Fig. 1 (a) could offer a third stable condition, this being given by both neon bulbs just maintaining illumination, with corresponding intermediate resistances in the photoconductive cells. A number of attempts were made to make the circuit take up this third stable condition but it was found impossible to achieve; the circuit always falling into one or other of its two basic states. This practical experience confirms that the circuit is a true bistable.

Intermittent Short-Circuit Tester

Fig. 6 shows a simple example of the bistable circuit used for a practical application. The diagram illustrates a tester to indicate intermittent short-circuits (or intermittent leakage resistances below around 70kΩ) at a voltage of 60. The circuit to be checked is connected to the Test terminals whereupon, it exhibits a short-circuit for a sufficiently long period to trip the bistable, the 0-1mA meter in series with NE₂ indicates full-scale deflection, remaining in this state even when the short-circuit is removed. The device can be particularly useful for checking suspect lengths of cable (which can be manipulated to bring on the short-circuit), electric motors, and

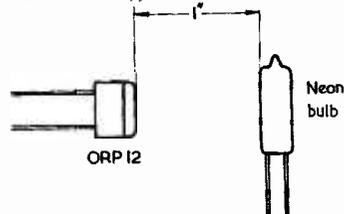


Fig. 5. Each neon bulb and its associated photoconductive cell are spaced by 1in in their light-proof box

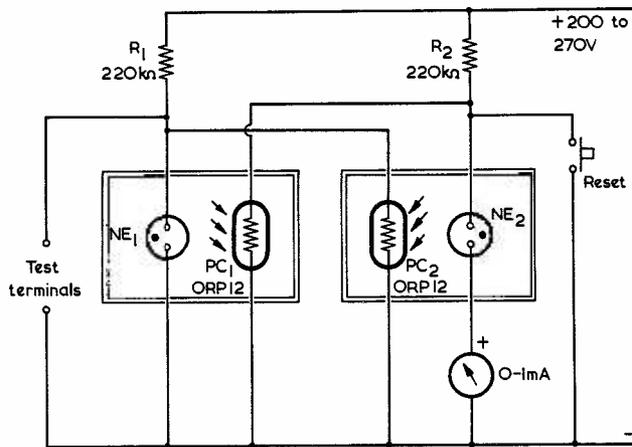


Fig. 6. A simple practical application for the bistable. An intermittent short-circuit across the Test Terminals will cause the meter to register, it remaining in this condition after the short-circuit has been removed

any other equipment in which an intermittent short-circuit may occur. It lends itself especially well to production-line testing, since its operation is very simple and reliable.

Power is first applied to the insulation tester circuit, whereupon either neon bulb NE₁ or NE₂ becomes illuminated. If neon bulb NE₂ becomes illuminated the meter will

register. The "Reset" button is then pressed to extinguish NE₂ and cause NE₁ to light up. Any subsequent short-circuit between the Test terminals will then extinguish NE₁, cause NE₂ to light up and the meter to register, the bistable remaining in this condition until the "Reset" button is pressed again.

The power supply voltage for Fig. 6 is not critical and may lie between some 200 to 270 volts with the component values shown. Current consumption is only of the order of 2mA. If the 0-1 milliammeter reads slightly in excess of f.s.d. when NE₂ lights up, it may be shunted with a suitable value of resistance to bring the needle on-scale.

During construction of the circuit of Fig. 6 (or any other of the bistable circuits shown this month) it must be remembered that the ORP12 photoconductive cell can be damaged by excess heat. Connections to the ORP12 should in consequence be made quickly using, preferably, a heat shunt on each lead-out during soldering.



Car Turning Indicator

by G. Ning

We have published several car flasher circuits in the past, these obtaining their switching cycle from a transistor multivibrator. In this article our contributor offers an ingenious alternative approach which uses a minimum of components. It has to be pointed out that, since the prototype employed a non-standard surplus relay, the constructor may need to experiment a little to obtain the required circuit operation at correct switching speed

THE WRITER HAS BEEN INTERESTED TO NOTE THE transistorised flashing indicator devices which have previously appeared in *The Radio Constructor*. Whilst these have proved very satisfactory he would now like to describe a cheaper and simpler circuit.

Flashing Unit

The circuit of the writer's flashing unit is shown in the accompanying diagram. In this, relay $\frac{RLA}{2}$ has two contact sets, of which A1 is normally closed and A2 is normally open.

When switch S₁ is in the central position there is no circuit from the negative terminal of the 12-volt battery back to chassis, and the device does not operate. On turning S₁ to position "L" a circuit is completed from the negative terminal of the battery through the winding of the relay, through R₁, through contacts A₁, through S₁, through the Left lamps, and then back to chassis. The current which flows in this circuit is too low to cause the lamps to illuminate, and it results in a continually increasing voltage appearing across the relay winding as capacitor C₁ charges.

After a period the voltage across the relay winding is sufficient to cause the relay to energise, whereupon contacts A1 open and contacts A2 close. The latter contacts cause the negative terminal of the battery to be applied directly to the lamps, which then light up.

Capacitor C_1 now discharges into the relay winding. After a period, the voltage across the relay winding is sufficiently low for the relay to de-energise. Contacts A2 open, extinguishing the lamps, restoring the original circuit and allowing C_1 to commence charging again. The cycle then repeats continuously.

It will be appreciated that the same effect will be given with the Right lamps if switch S_1 is turned to position "R".

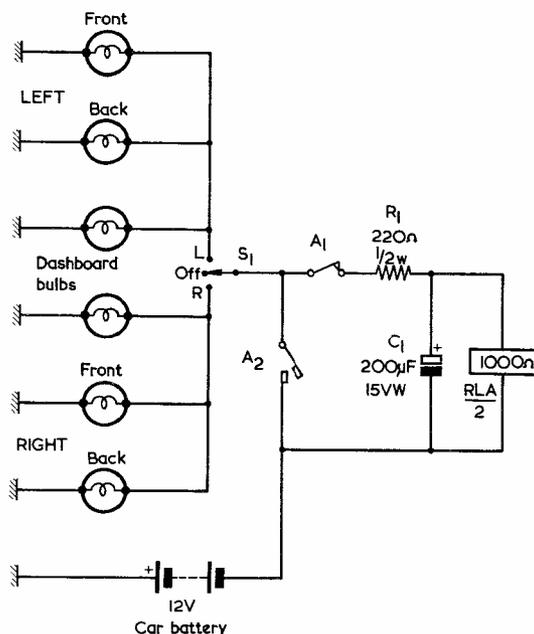
Components

As will be gathered, the circuit is very simple indeed, since it consists basically of a resistor, a capacitor and a relay only. The direction switch may be of the type normally fitted to cars as this circuit requires a single-pole switch only.

The relay used in the prototype was a Government surplus component which energised reliably at less than 12 volts. It had a coil resistance of $1,000\Omega$, together with a set of normally-closed contacts (A1) and a heavy-duty set of normally-open contacts (A2). The component values shown, and the relay used, provided a "blink" of slightly faster than one per second. The period in the cycle during which the relay is energised is mainly controlled by C_1 . Increasing or decreasing its value will increase or decrease the energised period respectively. Alteration in the value of R_1 will similarly affect the length of the period when the relay is de-energised.

Editor's Note

It should be noted that flashing indicators fitted to cars must provide not less than 60 or no more than 120 flashes per minute. The constructor should aim at making this circuit operate at a frequency approximately midway



Complete circuit of the flashing unit installation. With a negative earth the polarity of C_1 must be reversed

between these limits. There must be a visible (or audible) warning for the driver when the indicator is switched on, this being provided here by the dashboard bulbs in parallel with the Left and Right lamps, as shown in the circuit diagram.



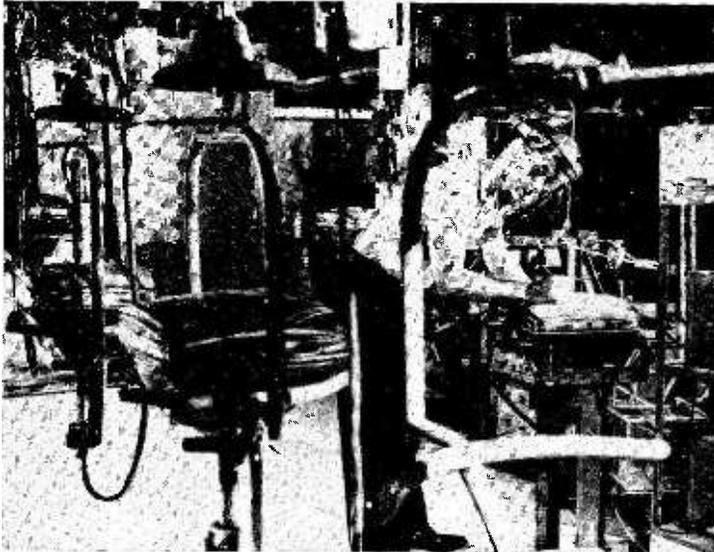
Educational TV for London Schools and Colleges

The first studio equipment for an Educational Television Service, covering 1,300 schools and colleges in Inner London, is currently being supplied by The Marconi Company. A Television Centre, initially with two studios, is being established at Laycock School in Islington by the Inner London Education Authority, the start of a scheme which will be the largest closed circuit system in the British Isles and one of the most advanced and ambitious in the world.

In the last few years, The Marconi Company has supplied equipment and undertaken installations in over thirty universities and colleges throughout the country. By 1971, it is estimated that in London alone over a million school children and students will be able to view transmissions derived from Marconi cameras and TV equipment.

The first part of the London scheme will be in operation shortly, although programmes will not be sent out before September 1968, when the first GPO cable links between the educational establishments and the studio centre will have been installed. The complete network of coaxial links, covering the whole of the Greater London area, will not be finished until 1970 when it is expected that about eight channels will be available, two of which will be reserved for BBC1 and ITV.

It is intended to staff the Television Centre with a permanent team of engineers and technicians. However, the production of programmes will be carried out by teachers who have received training in television techniques, and these first two studios will be used initially for giving practice and instruction to London teachers.



One stage in the manufacture of colour television tubes. This picture was taken at the RCA plant at Lancaster, Penn

Those Walkie-Talkie Sets

A session "window-shopping" in any of those areas famed for their radio stores, will surprise the serious radio enthusiast with the very large selection of imported walkie-talkies now being offered at prices which would suggest that their purchasers do not buy such equipment "just for fun"! At £20 to £30 a pair, those who buy them obviously intend using them!

Much has already been written about the interference these are causing to legitimate radio and TV equipment when used by unlicensed operators outside allocated frequencies, and our radio control model enthusiast friends are getting more than their fair share of trouble from this quarter. A little co-operation between the Board of Trade and the GPO some months ago, might well have saved the terrific effort which will now have to be made to clear up this muddle.

One of the reasons why dealers may have stocked up with this gear is the idea which has been gaining ground that a Citizen's Band is about to be allocated by the GPO. However, a note in the March issue of the RSGB Bulletin (p. 192) now leaves no doubt about this matter. The GPO "have officially denied that they are considering opening a "Citizens' Band in the United Kingdom . . . they claim that they are profiting by the experience of other countries such as the United States, who have allocated frequency space for this purpose 'but now regret it'."

The new Wireless Telegraphy Bill, however, offers some hope of stopping these illegal transmissions, with its powers to restrict the manufacture or importation of certain goods. This Bill has, as some readers will no doubt know, caused quite a flurry in some amateur radio circles, as in its draft stages it appeared to give authority for stopping the home construction of legitimate radio transmitting apparatus, but we are reliably informed that thanks to the vigilance of the Radio Society of Great Britain, changes in the final draft will remove any such fears.

Colour TV—American Experience—will we follow?

Suddenly, it seems, the world is clamouring for colour television.

In America, where the initial impact of colour on the home screen was scarcely impressive, colour TV has forged ahead to become a boom industry.

There is little doubt that the American success with colour TV in the past five years has stimulated other countries to speed up their plans.

Colour programmes began in the United States in December 1953. But for the next eight years colour television remained a novelty that interested engineers far more than the public.

By 1962, the pattern had changed. Sales began to rise, slowly at first, then more quickly. By the end of last year the accelerated demand had brought more than 10 million sets into use. And nearly half of them had been installed during 1966.

Towards the end of the year, sales of colour receivers outpaced those of black-and-white sets. During this year another five million colour sets are likely to be in use—if manufacturers can avoid bottlenecks in the production of picture tubes and other components.

What has caused this dramatic rise in the demand for colour?

One reason is that a great variety of colour broadcasts are offered by the big networks whose programmes are taken by local stations all over the United States. During the peak-viewing hours at night-time, all the programmes are in colour. One big network, NBC, transmits in colour day and night.

Another reason is that, as more sets are installed in homes, neighbours look in to see what colour is like. In many cases they decide to add the extra dimension of realism to their own viewing.

Cost is undoubtedly a factor, too. An American can buy a 19-inch colour set for as little as \$360 (£130) which makes colour a serious rival to black-and-white.

And the "compatible" system used means that colour transmissions can be received in black-and-white by non-colour sets, and programmes broadcast in black-and-white can be seen in monochrome on colour receivers.

COMMENT

Torrey Canyon Disaster

Radio Amateur Emergency Network in Action

It seems rather ironic that the best example of RAEN activity, since the inauguration of this Service in this country following the East Coast Floods in 1953, should occur around those coasts of England where a National Emergency would appear to be least likely to arise. So frequently, one hears the critics of RAEN say: "It could not possibly happen here"! One might be pardoned for thinking that the beaches of Cornwall were the least likely to be the stage for a National Emergency, but following the Torrey Canyon disaster, such was in fact to be the case, as all the world now knows.

The part played by RAEN and other radio amateurs in assisting the authorities with emergency communications in the affected areas has already been recounted in part in local press, radio and TV coverage, and the full story will no doubt appear in detail in the appropriate amateur radio journals. Suffice it to say that RAEN got its biggest chance to prove itself to be a reliable Public Service. The radio amateurs concerned rose to the occasion, proving beyond all doubt that RAEN is a very worthwhile project indeed and that its services may turn out to be of real value in the most unexpected emergencies.

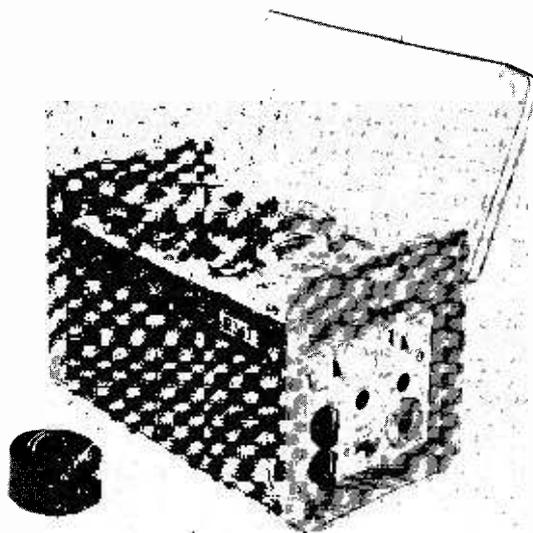
Quotes

● Shortwave broadcasts, whether they be in the service of an ideology, of a great community, or of a small dissident group, must sooner or later reveal their true identity to the alert listener. Their actual motivations are bound to become evident in the long run. Broadcasting to the world, day after day, no wolf may speak with the voice of a lamb and remain undiscovered.

From *Switzerland Calling*—the programme schedule of the European and Overseas Services of the Swiss Broadcasting Corporation.

● This column asked a bookshop if they had a copy of the White Paper on Broadcasting. Reply: "You mean 'Clean Up TV', don't you?"

From 'Compatible's' column in *The Association of Broadcasting Staff Bulletin*.



New Portable Professional Tape Recorder

The new L4 portable professional tape recorder is announced by EMI Electronics Limited. Weighing only 10½lb. with batteries, and less than a foot long, this new tape recorder has a versatility far beyond that of its predecessors.

L4's portability and simple operation make it ideally suitable for industrial noise measurement, medical research and a wide variety of uses in science and entertainment.

All Independent Television News camera crews are equipped with EMI L4 portable tape recorders with film sync facilities. The picture below shows the L4 being used by the ITN crew covering Sir Francis Chichester's voyage round Cape Horn in *Gypsy Moth IV*.

Photograph by courtesy of Independent Television News



Cheap Transistor Supply Circuit with Automatic Overload Protection

by T. B. Read M. A.(Oxon.) A.Inst.P.

A typical approach towards obtaining low voltage power supplies with automatic overload protection consists of providing a high rectified voltage and inserting a relatively high resistance between this voltage and a zener diode, across which the output voltage appears. The high series resistance limits the overload current. Our contributor employs the alternative device of inserting a high impedance before the mains isolating transformer, thereby enabling a small and inexpensive component to be employed. Some minor precautions need to be observed with this approach, but these will be readily appreciated and followed by the more experienced constructor

MAINS SUPPLIES RATHER THAN BATTERIES ARE favoured by the author for powering transistor circuits and the unit described in this article was the result of an attempt to make such supplies as cheaply as possible, and without the need for purchasing low voltage mains transformers. Whilst the original idea was to produce a compact unit which could be built into small transistor instruments, the excess current protection provided automatically by the circuit also makes it admirably suited as a general purpose supply for experimental circuits under test, and the component values listed in the diagram correspond to those used in such a unit constructed by the author to supply 0-10 volts at currents up to about 50mA.

Primary Current Limitation

The circuit is built around a small audio-frequency interstage coupling or similar type of transformer, a turns ratio of between 1 : 1 and about 4 : 1 being

suitable (the author has found timebase oscillator transformers from scrap television sets to be very satisfactory and is using one with a ratio of 3 : 2 in his general purpose unit). The current through the primary is limited by a series capacitor, which should be rated at 500 volts d.c. because of the dielectric stresses produced on 50 c/s mains operation and 0.5 μ F here will give an a.c. current of 40mA. A 6k Ω resistance would give approximately the same current, of course, if this is preferred, but the component rating and the ventilation would have to be adequate for the 10 watts it would dissipate. Depending on the type of transformer used its insulation might possibly be inadequate for 250 volts and so, for safety, it should be connected to the neutral side of the mains and the current limiting component to the line side; there will then be a comparatively small voltage between the two

(continued on page 667)

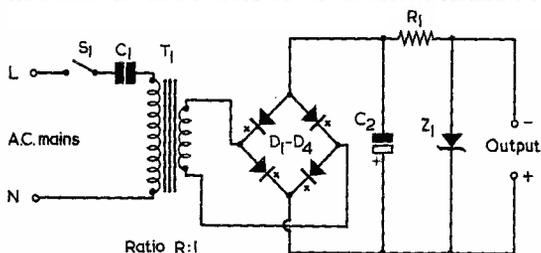


Fig. 1. The basic circuit of the power supply

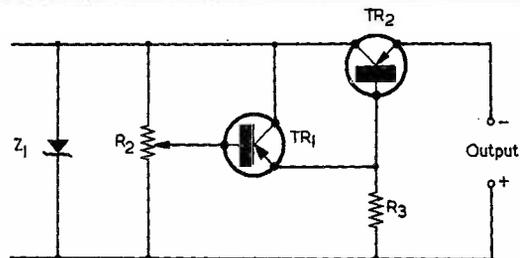


Fig. 2. If the components shown here are added after Z₁, a variable voltage output becomes available

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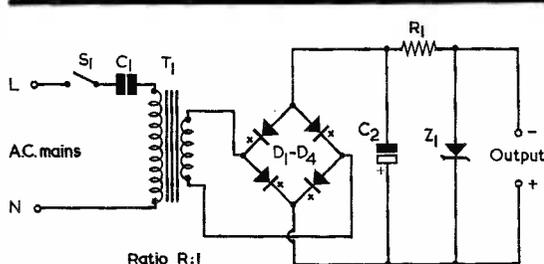


Fig. 1. The basic circuit of the power supply

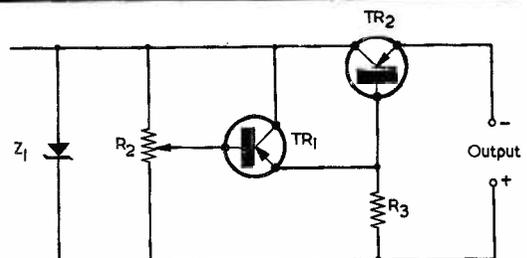
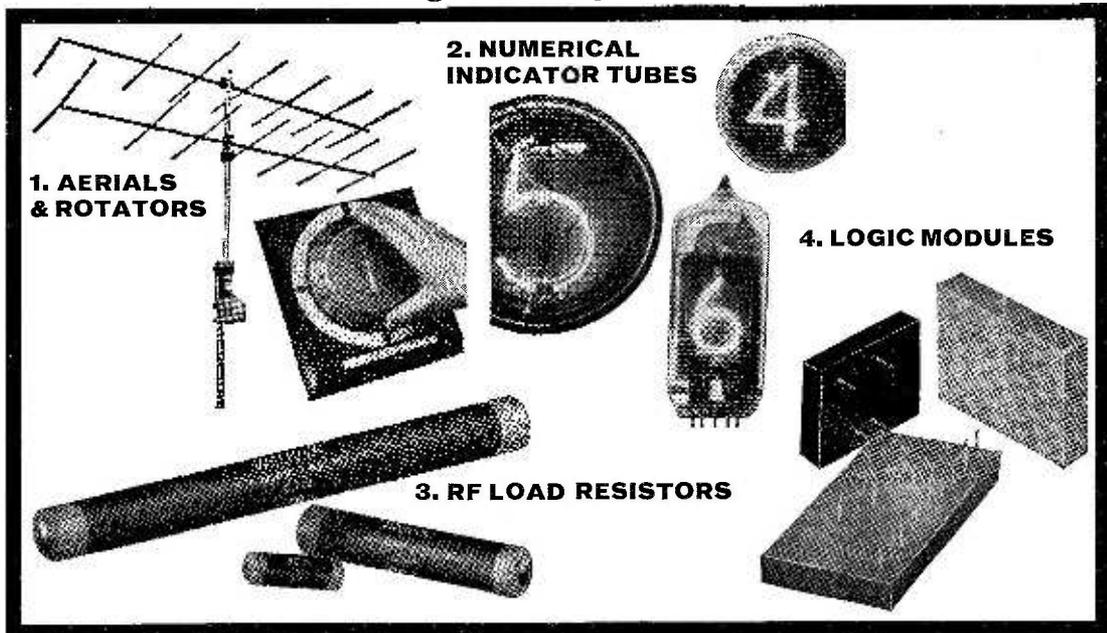


Fig. 2. If the components shown here are added after Z₁, a variable voltage output becomes available

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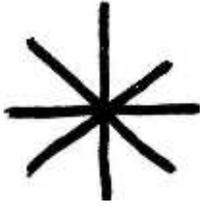
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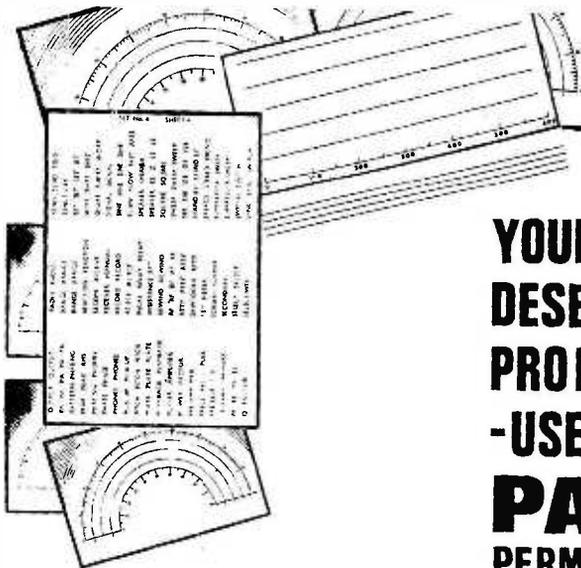
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Cheap Transistor Supply Circuit with Automatic Overload Protection

(continued from page 664)

windings even if one side of the d.c. output of the unit is earthed. The windings of most small transformers of the type described should withstand 40mA or so, but if higher current units are envisaged then it would be wise to first check the transformer for any signs of overheating.

With this circuit connection it is basically current rather than voltage which is transformed and the maximum current which can flow in the secondary, on short-circuiting this winding, is rather less than the turns ratio (R) times that in the primary (a step-down voltage transformer steps up the current). The voltage developed across the secondary depends markedly on the load impedance connected across it and can be quite high on open circuit; for low impedances the current flow is almost equal to the short-circuit value and the voltage is approximately proportional to the impedance. Such a supply, where the voltage rather than the current varies with the load, is not very useful as it stands, but it can be made to provide a constant voltage quite simply by means of a zener diode connected across the output, as shown in Fig. 1.

Rectification

Full-wave rather than half-wave rectification is much to be preferred since the latter will only supply half as much current for a given value of C_1 . However, if it is decided to use half-wave rectification, care must be taken to check that the diode has a sufficiently high p.i.v. rating to withstand the voltage developed across the transformer secondary under the open-circuit condition during each non-conducting half-cycle. For currents of 30 to 40mA signal diodes such as OA81's are quite satisfactory in bridge connection, whilst for rather higher currents any of the small silicon rectifiers widely advertised are suitable.

In a conventional voltage supply the resistor R_1 would be needed to limit the current through the zener but this is unnecessary with the present circuit and the purpose of the resistance here is merely to provide (together with the dynamic impedance of the zener) a filter for the residual 100 c/s ripple across C_2 . For the component values shown the ripple on the output is only a few millivolts and if a good quality zener diode is used then the output impedance of the supply should not exceed 5Ω or so for currents up to within a few milliamps of the short-circuit value.

If it is thought worth the extra cost the output

COMPONENTS

(Figs. 1 and 2)

N.B. See text for general details concerning components.

Resistors

- R_1 50 Ω , $\frac{1}{4}$ watt, 10%
- R_2 5k Ω potentiometer, linear track
- R_3 10k Ω , $\frac{1}{4}$ watt, 10%

Capacitors

- C_1 0.5 μ F, 500V wkg.
- C_2 100 μ F, electrolytic, 15V wkg.

Semiconductors

- D_1 - D_4 DD000 (Lucas)
- Z_1 10 volt, 1 watt zener diode
- TR_1 OC71 or equivalent
- TR_2 OC26 without heat sink

Transformer

- T_1 Small a.f. or similar transformer

Switch

- S_1 s.p.s.t. on-off switch

voltage can be made variable by the addition of the components shown in Fig. 2. These form a normal two-transistor emitter follower type of stabiliser circuit and whilst the author used an OC26, without any heat sink, for TR_2 because a spare one was available, any p.n.p. transistor capable of dissipating rather more than 0.5 watt will be suitable. The output impedance is increased slightly by these extra components, but should remain quite adequate for most purposes. The excess current protection still functions, of course, and so it is impossible to damage the series transistor by overloads.

Editor's Note

With reference to components, a 1.5 watt range of zener diodes is available from Henry's Radio, Ltd., this including a type ZL10 which is rated at 10 volts $\pm 5\%$. A ZL10 would be suitable for Z_1 .

For optimum safety the capacitor C_1 could be rated at 250 volts a.c. Silicon diodes such as the Lucas DD000 (p.i.v. = 50) would be adequate in the D_1 to D_4 positions. The OA81 has an average p.i.v. of 90 at 25°C and 75 at 75°C, with maximum average forward currents of 50 and 17mA respectively at these two temperatures.

The possibility of resonance in the primary LC circuit is negligible as, apart from the heavy damping provided by the secondary circuit, the primary would require an inductance of some 20H for resonance to occur at 50 c/s.



Electronic Organ Constructors Society

For interested readers, the name and address of the Hon. Secretary of this Society is as follows:
E. Kirk, Esq, 66 Arnold Crescent, Isleworth, Middlesex.

Car Voltage Regulators

by John G. Dew, B.Sc.

Many cars employ simple single contact voltage regulators, in which the contact short-circuits a resistor in series with the dynamo field winding. Our contributor describes his experiences in replacing this method of control by a transistorised system. It must be pointed out that the modifications described here should be looked upon as being experimental only, and that they should only be carried out by readers who are familiar with car electrical equipment and its functioning.

THIS ARTICLE OUTLINES THE THEORY OF THE voltage regulator, and describes the author's experience of two transistorised versions.

A car derives its immediate electrical power from a lead-acid battery, but to keep this battery charged a d.c. generator, driven by the engine, is used. However, the charging operation must be carefully controlled, as continuous charging would soon damage the battery.

The easiest way to control the charging is to connect, in parallel with the battery, a generator giving the same voltage as a fresh, newly-charged battery (see Fig. 1). Thus when the battery is discharged and its terminal voltage falls, a current flows into it from the generator.

This system has one difficult requirement—the generator voltage must be maintained constant within narrow limits. The output voltage of a shunt generator varies very much with speed (see Fig. 2) and so this characteristic must be modified to approximate to the ideal shown in Fig. 3.

The Mechanical Regulator

The majority of modern cars are fitted with a mechanical voltage regulator, as shown in Fig. 4. Here the field coil current is obtained from the generator output via a vibrating contact. The contact is biased by a voltage-sensing coil; as the generator output rises the contact stays open longer,

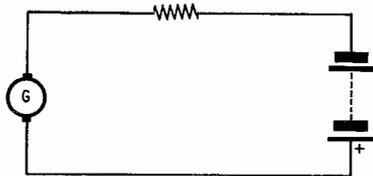


Fig. 1. Simple battery charging circuit

so reducing the output again. This system relies on vibrating mechanical contacts which can become unreliable and which require maintenance—obviously transistors are called for!

Transistorised Regulator

Fig. 5 shows the first design checked by the author. A portion of the generator voltage, "backed off" by zener diode D_1 , is applied to the first transistor TR_1 , which is directly coupled via an emitter follower to a power transistor, TR_3 . Any increase in supply voltage above a certain value causes a very rapid decrease in field coil current. A variation of about 100mV on the supply line is sufficient to switch TR_3 from "on" to "off", so the generator voltage must lie within 100mV of the value set by VR_1 .

This circuit, built as in the photographs, was used by the author on a car with a 6 volt system. Over a year of use, the following points were observed.

(a) The voltage was being controlled too closely. Use of the self-starter on a cold morning would cause the battery voltage to drop considerably, and very heavy currents would be drawn from the generator.

(b) There was no temperature compensation. Battery voltage rose with temperature, but the leakage current of TR_1 , together with the negative temperature coefficient of the zener diode, caused

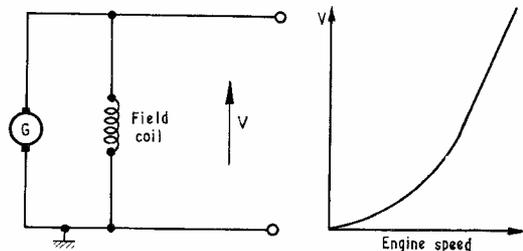


Fig. 2. Characteristic of a shunt generator

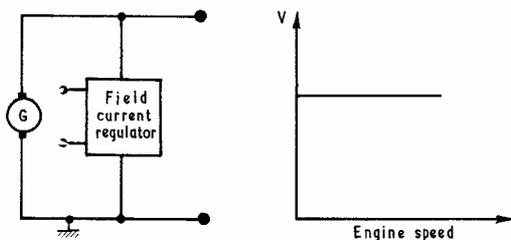


Fig. 3. The ideal voltage regulator

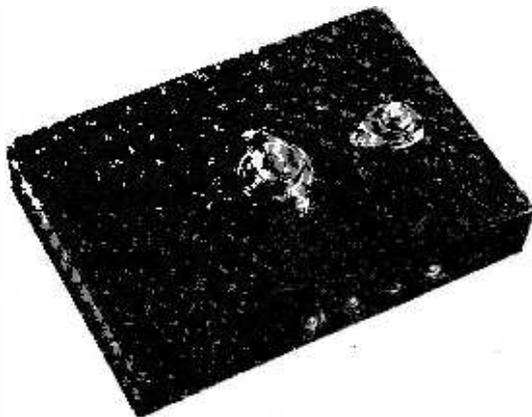
the generator voltage to fall. Even the thermistor TH₁ could only keep the output constant over a limited temperature range.

The Modified Version

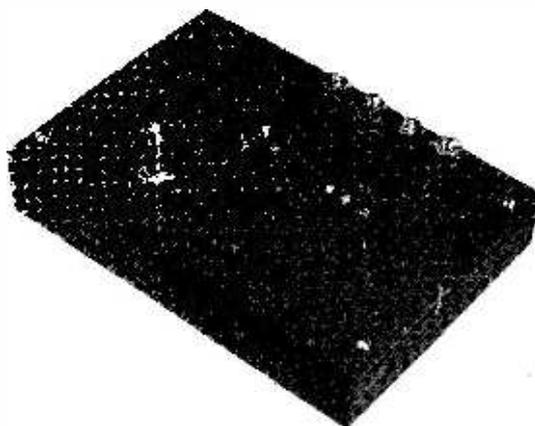
The high gain of the original controller was unnecessary, and so a circuit employing only two transistors was tried. (See Fig. 3). This provides less severe regulation; about 0.25 volts are required for full variation of field current. The first transistor is operated at a much higher current, with the result that the leakage current has less effect. This controller was used on a 12 volt system, so a zener diode with a higher breakdown voltage (and hence a positive temperature coefficient) could be used. This modified version has successfully avoided the pitfalls of the original design, and is recommended for a 12 volt system.

Power Transistor Ratings

Before the first controller was built the field current of various generators was measured, and was found not to exceed 2.5 amps on a 6 volt system, and 1.5 amps on a 12 volt system. This current rating is well within the capabilities of most power transistors. It must be admitted, though, that some fears were experienced about voltage ratings, as the field coil is highly inductive, and voltage "spikes" could be



The voltage regulator unit intended for 6 volt operation. The heat sink on which the power transistor is mounted measures 6 x 4ins



The other side of the 6 volt regulator unit, showing the terminals and potentiometer mounted on a sheet of Paxolin

easily generated. However, a year's operation has proved these fears to be groundless. Sudden switching of heavy loads, and a collapsed generator bearing, have had no ill effects upon the power transistor.

The Cut-Out

Mechanical regulators also include a voltage-controlled relay, which opens when the generator voltage falls (for example, on tick-over), so preventing the battery from trying to drive the generator. As an experiment a 25 amp silicon diode was used instead of the mechanical cut-out (see Fig. 7). On the

6 volt system the diode was not very successful; at full load the voltage drop across the diode reached 2 volts, representing a dissipation of 50 watts. This was awkward and inefficient, and also meant that the engine had to run about 30% faster before charging began.

On the 12 volt system the diode was more successful, as currents are typically one-half of those on 6 volts, and the cut-in speed is only 10 to 15% higher. However, the advantages are not marked, and the use of a diode is not recommended.

Field Coil Connections.

It may be seen that the circuit of Fig. 4 and those in Figs. 5 and 6 differ in one important respect. In Fig. 4

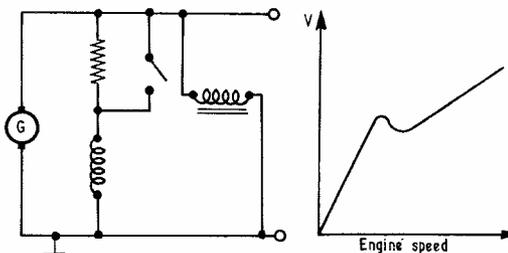


Fig. 4. Characteristic of a mechanical regulator

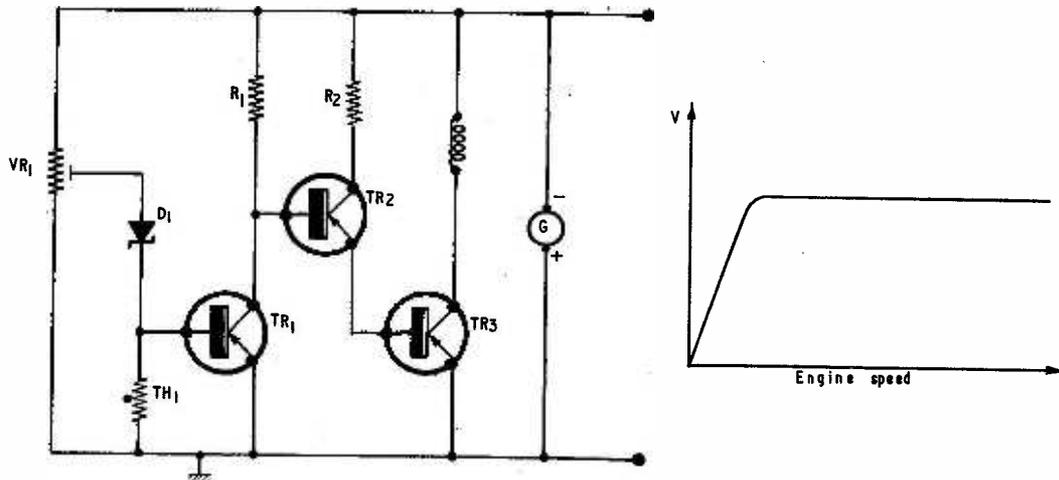


Fig. 5. Circuit diagram and characteristic of the first regulator constructed. This is intended for a 6 volt system

COMPONENTS

(Fig. 5)

Resistors

- R₁ 2.7kΩ, ½ watt, 10%
- R₂ 68Ω, ½ watt, 10%
- VR₁ 250Ω wirewound

Semiconductors

- TR₁ OC71
- TR₂ OC72
- TR₃ OC29
- D₁ 4.7 volt zener diode, e.g. OAZ200 (Mullard) or VR475-B (A.E.I.)

Thermistor

- TH₁ 500Ω at room temperature

transistor, and could only be overcome by putting the field coil in the emitter circuit, or by using an n-p-n transistor, as in Fig. 8.

However, it is not difficult to remove the generator back-plate and re-arrange the field coil connections, as in Fig. 9. Polarity must be watched, or the generator will have to be run backwards!

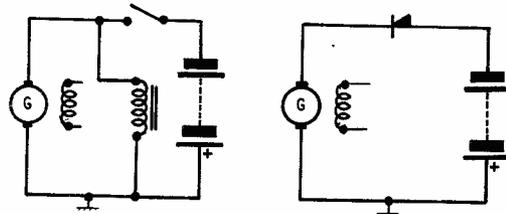


Fig. 7. The mechanical cut-out and its electronic equivalent

the field coil is returned to the positive (earth) line, whereas in Figs. 5 and 6 it is connected to the negative line. This is necessitated by the use of a p.n.p. power

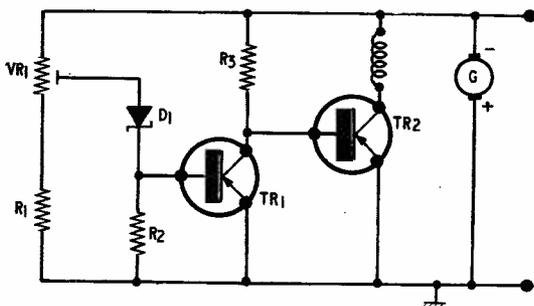


Fig. 6. Circuit diagram of the modified regulator. This operates in a 12 volt system

COMPONENTS

(Fig. 6)

Resistors

- R₁ 680Ω, ½ watt, 10%
- R₂ 1kΩ, ½ watt, 10%
- R₃ 270Ω, 1 watt, 10%
- VR₁ 250Ω wirewound

Semiconductors

- TR₁ OC72
- TR₂ OC29
- D₁ 9 volt zener diode (e.g. OAZ207 (Mullard) or VR9-B (A.E.I.))



The internal wiring and components of the regulator unit

construction. The aluminium heat sink measured 6 by 4in, and the power transistor was never found to be more than just warm. It would probably be safe to halve the area of the heat sink, *provided that the unit is not mounted in the engine compartment*. Unless silicon transistors are used, it is not wise to put transistors near an engine—the temperatures encountered can be much too high. It is much safer to mount the unit in the glove box, behind the dashboard, or anywhere that moderate temperatures are encountered.

If the heat sink is likely to touch earth, the power transistor should be mounted with an insulating mica washer.

High Sensitivity Transistor VHF Portable

In Fig. 1 of this series, published on page 424 of the February issue, the negative supply line for transistors TR₁ to TR₅ bears the legend “-8V”. This should be “0V” and the supply line in question is at chassis potential.

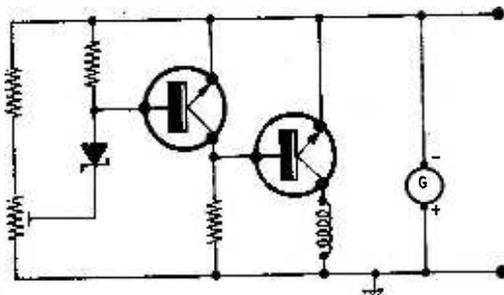


Fig. 8. Re-arranged version of Fig. 6, using n.p.n. transistors and an unmodified generator

The only other points to watch are the connections, which should be good. The regulator earth lead should go directly to the engine, or battery earth, and the negative supply should come through the ignition switch—the “SW” terminal on the ignition coil is a suitable take-off point. The existing field supply lead

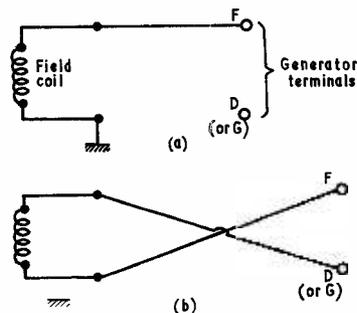


Fig. 9. The modifications required for the field coil connections inside the generator; (a) before, (b) after alteration

can be disconnected at the generator and the new lead may be substituted.

Voltage Setting

With the engine running moderately fast, and either the cut-out wedged open or the battery disconnected, VR₁ should be set to give a generator voltage of about 7.2 volts for the original (6V) circuit, or approximately 1.5 volts for the modified (12V) circuit. As the setting is fairly critical it is best found by trial and error, for most multimeters are insufficiently accurate to make it worth while quoting a closer value.



Heathkit Catalogue

Latest edition of the well-known Heathkit catalogue, now with extra pages, some in colour, and featuring many new models, is available to those interested.

The 32 pages in the catalogue are packed with Britain's largest selection of electronic kit-sets . . . over 150 in all . . . complete lines of Stereo/Hi-Fi models, Radios, Amateur Radio Gear, Test and Laboratory Instruments, PA/Guitar Amplifier, Intercom and Educational kits. Includes helpful information on Hi-Fi in the home and planning a Hi-Fi system.



THE "EXPLORE

The "Explorer" receiver is presented in this end construction is described fully makes an ideal project for the beginner high-quality 1-valve short wave receiver will describe the wiring-

a design for

ALL BEGINNERS HAVE TO START SOMEWHERE IN the hobby of radio. This statement is so obviously true that it hardly needs saying, and yet it is surprising just how many enquiries are received by the Editor (so the writer is informed) from beginners and parents alike all posing the same question: ". . . how can I/my son start and what can I/my son build?" The 1-valve design offered here has been designed for the beginner and, to this end, it has been kept as simple and as inexpensive as possible. But it is not a "junk" receiver, using such things as protractors for dials etc., and only the best types of component have been incorporated. To obtain good results quality parts are essential. This is especially true of the dial and drive in a short wave receiver where the tuning must be silkily smooth, and where the facility to return to a precise dial reading, to find a particular transmission, is of paramount importance.

Both from the front cover and the heading illustration, it will be seen that the front panel has a pleasing appearance. The controls at the bottom are On/Off switch on the left and reaction control on the right. In the centre is the slow-motion tuning drive and dial with cursor. Upper left is the On/Off indicator pilot lamp and upper right is the "Explorer" motif.

With the coils specified—see Components List—the receiver covers the frequencies 1.67 to 31.5 Mc/s in three bands. The coils are of the plug-in type, thus avoiding the introduction of a switch, with its attendant wiring, into the circuit.

Circuit

The circuit is shown in Fig. 1 and from this it will be seen that the valve chosen is the ECC82 double-triode. One half of this ($V_{1(a)}$) operates as a leaky-grid detector, whilst the other half, ($V_{1(b)}$), functions as an audio frequency amplifier.

The aerial is fed, via a short length of coaxial cable, to the aerial winding (L_1) of the coil. The required signal is selected by the tuned circuit

L_3 , C_2 , and passed to the grid of $V_{1(a)}$ via the capacitor C_3 . Reaction is provided by C_1 in conjunction with winding L_2 , the values of C_3 and R_1 being such that smooth reaction, free of backlash, is obtained over the entire tuning range. Each of the plug-in coils specified has three windings, these being identified in Fig. 1 as L_1 , L_2 and L_3 respectively. The figures adjacent to the windings apply to the pins of the B9A valveholder into which the coils are fitted.

The positive h.t. supply to the anode of $V_{1(a)}$ is via the resistor R_2 and the r.f. choke. The detected

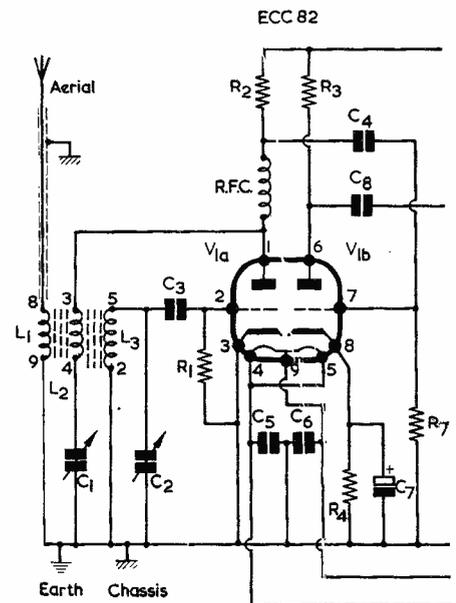


Fig. 1. Circuit of the "Exp

Part IV" RECEIVER

is specifically for the beginner and to
by reason of its simplicity, the design
to undertake, and the end result is a
Part 2, to be published next month,
and testing of the receiver

for the beginner

audio frequency signal at the anode of $V_{1(a)}$ is passed, via the coupling capacitor C_4 , to the grid of $V_{1(b)}$.

This second half of the valve acts as an a.f. amplifier for the detected signal received from the first half of the valve. This further amplified signal is then passed to the headphones via the capacitor C_8 .

The power supplies for the receiver are supplied from a mains transformer providing complete isolation from the a.c. mains supply. The high tension voltage is obtained by way of a contact-

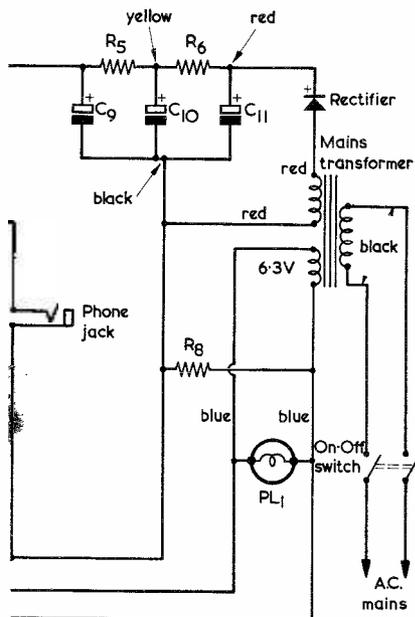


Fig. 1 - 1-valve receiver

COVER



FEATURE

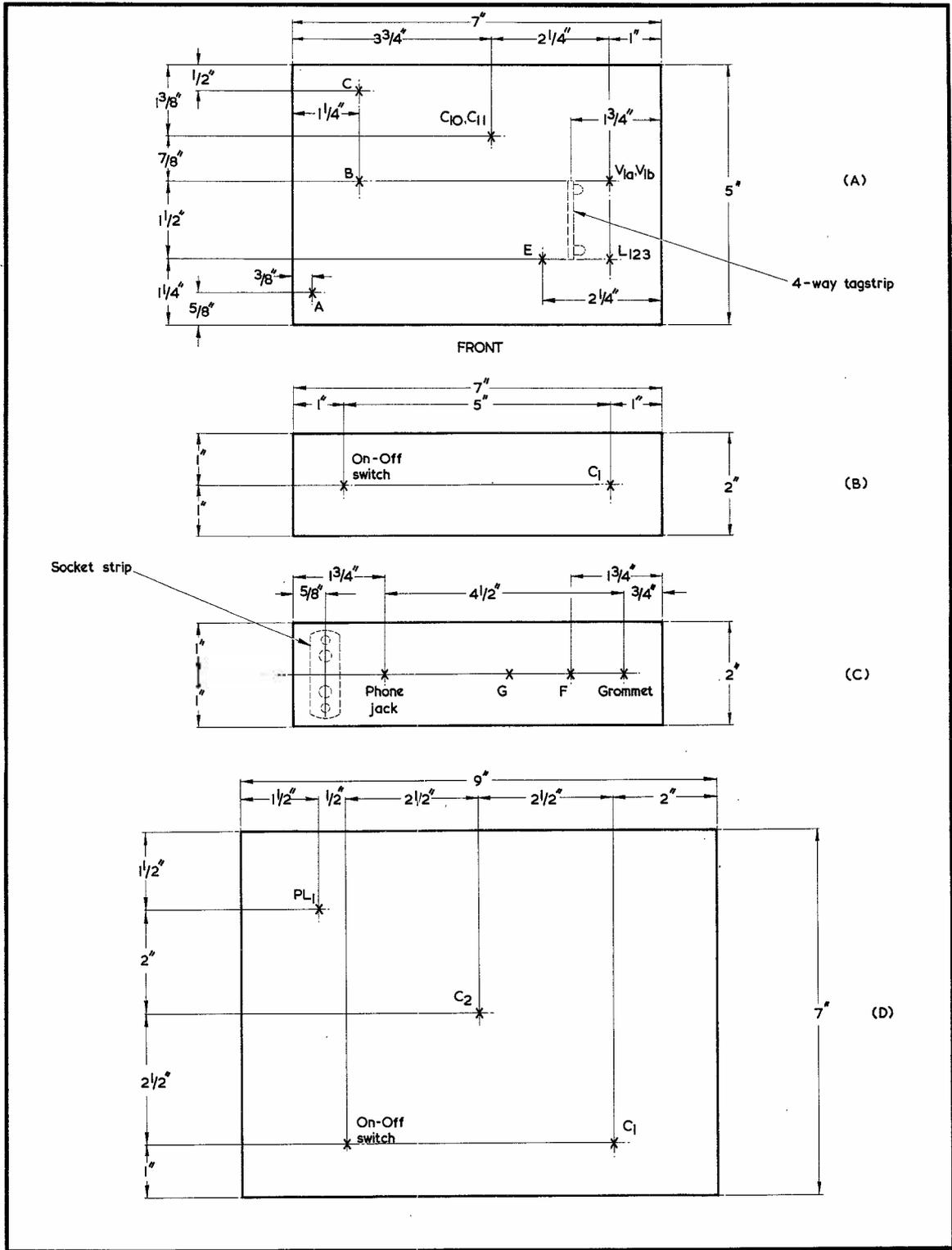
cooled rectifier and the smoothing components R_5 , R_6 , C_9 , C_{10} and C_{11} . It will be noted that double-smoothing of the h.t. supply is a feature of this design, and this has been done for the reason that one of the main bug-bears of headphone reception in a simple receiver of this type is that of a.c. mains hum superimposed on the signal being received. Double-smoothing of the h.t. supply, together with the two 5,000pF ceramic capacitors from each side of the heater supply to chassis, ensure that hum-free reception is provided. C_{10} and C_{11} consist of a dual electrolytic capacitor which is mounted vertically at a hole in the chassis by means of a fixing clip. The component quoted in the Components List has a higher working voltage than is actually needed in this circuit, but it may sometimes be found a little difficult to obtain dual capacitors of the value specified at lower working voltages. The minimum working voltage required in C_{10} and C_{11} is 350 volts, and a component with such a working voltage, or greater, could be employed in place of that used in the prototype receiver.

The purpose of the resistor R_8 , connected from one side of the heater supply to chassis, obviates the risk of the heater circuit picking up a high static charge, the $1M\Omega$ component providing the necessary resistive connection to chassis.

The pilot lamp assembly, PL_1 , is mounted on the front panel and provides a visual indication that the set is switched on. A double pole, single-throw, switch (also mounted on the front panel) completely isolates the a.c. mains from the receiver when switched off.

The headphone jack is mounted on the chassis rear apron in the author's model. Alternatively, it may be mounted, if preferred, on the front panel in a position mid-way between the On/Off switch and the reaction control, C_1 .

As already mentioned, the smoothing capacitors C_{10} and C_{11} are both contained in a single can and are mounted on the chassis deck by means of a mounting clip. The remaining smoothing capacitor,



COMPONENTS

Resistors

(All $\frac{1}{2}$ watt 10%)

- R₁ 1.5M Ω (brown, green, green)
- R₂ 100k Ω (brown, black, yellow)
- R₃ 33k Ω (orange, orange, orange)
- R₄ 1k Ω (brown, black, red)
- R₅ 5.6k Ω (green, blue, red)
- R₆ 6.8k Ω (blue, grey, red)
- R₇ 470k Ω (yellow, violet, yellow)
- R₈ 1M Ω (brown, black, green)

Valve

ECC82 (Mullard)

Mains Transformer

Secondaries: 250V, 50mA; 6.3V, 1.5A;
type 6BR10, (H. L. Smith & Co, Ltd)

Dial & Drive

6:1 Slow motion drive, Jackson Bros Ltd.
(Home Radio Ltd, Cat. No.: DL3A)

Coils

Miniature Dual-Purpose, Green, ranges 3, 4
and 5 (Denco Ltd)

Panel Lamp Assembly

Type LES (H. L. Smith & Co. Ltd) 6.5V,
0.15A

Switch

d.p.s.t. (Pear Dolly) Bulgin type S300

Headphones

2000 Ω complete with jack plug.

Valveholders

- 1 B9A with centre spigot
- 1 B9A with centre spigot, skirt and screen

Socket Strip

Aerial/Earth socket strip (Home Radio Ltd.
Cat. No. Z101A)

Capacitors

- C₁ 100pF variable, Jackson Bros, Ltd,
type C804
 - C₂ 310pF variable, Jackson Bros Ltd, Cat.
No. 4507, 1-gang
 - C₃ 100pF silver mica
 - C₄ 0.01 μ F tubular, Mullard, 400V. wkg
 - C₅ 5,000pF ceramic
 - C₆ 5,000pF ceramic
 - C₇ 12 μ F electrolytic, 6V wkg
 - C₈ 0.1 μ F tubular, Mullard, 400V wkg
 - C₉ 16 μ F electrolytic, 350V wkg
 - *C₁₀ 16 μ F electrolytic, 500V wkg
 - *C₁₁ 8 μ F electrolytic, 500V wkg
- *Contained in single can, complete with
fixing clip, upright mounting

Headphone Jack

Bulgin, type J2 (H. L. Smith & Co, Ltd)

Chassis

7 \times 5 \times 2in (H. L. Smith & Co, Ltd)

Panel

9 \times 7in (H. L. Smith & Co, Ltd)

R. F. Choke

2.5mH, type CH1 (H. L. Smith & Co, Ltd)

Knob

1 (for C₁) (H. L. Smith & Co, Ltd)

Tagstrip

4-way, 2 end tags earthed

Rectifier

250V, 50mA, contact-cooled (H. L. Smith &
Co, Ltd)

Miscellaneous

Wire, solder, nuts and bolts, 6in coaxial cable.
grommets (5 off $\frac{3}{8}$ in)

C₉ is a wire-ended type and is wired into circuit below the chassis deck.

Construction

Fig. 2 shows the drilling details for (a) the chassis deck; (b) the chassis front apron; (c) the chassis rear apron and (d) the front panel. The very first task is therefore to ascertain that all the tools required for drilling the various holes are available. Before proceeding further the beginner is advised to obtain the tools mentioned in the following section. Such tools, once purchased, will last for

Fig. 2. Drilling measurements for (a) chassis deck, (b) chassis front apron, (c) chassis rear apron and (d) front panel

many years if properly used, and each is necessary for the hobby of radio construction.

Tools Required

The first requirement is, of course, an electric soldering iron of the pencil-bit type and a supply of good quality cored solder, such as Ersin Multi-core.

A supply of small and medium-sized screwdrivers, together with a pair of small round-nosed pliers, a set of high speed steel twist drills (useful sizes being $\frac{1}{16}$, $\frac{1}{8}$, $\frac{3}{16}$, $\frac{1}{4}$, $\frac{5}{16}$, $\frac{3}{8}$ and $\frac{1}{2}$ in—these being those most frequently used in radio work) and a hand drill will start the collection. Following this, the next items of importance are two chassis cutters for octal and B9A valveholders, these

again being sizes which are commonly used.*

A handbrace will also be required, together with two further drills— $\frac{3}{8}$ in and $\frac{1}{2}$ in for drilling the holes required for various panel controls and fittings, etc.

A self-tapping centre-punch and a steel rule will greatly assist with measuring and marking of panel and chassis.

Drilling the Chassis

Refer to Fig. 2 (a) and measure and mark the drilling points for $V_{1(a)(b)}$, $L_{1,2,3}$ and C_{10} , C_{11} . The valve and coil both fit into B9A valveholders. Remember that the valveholder for $V_{1(a)(b)}$ is the one with a skirt which takes the screening can. The dual capacitor C_{10} , C_{11} is positioned over a $1\frac{1}{4}$ in hole, made with the octal chassis cutter. Firstly, mark the drilling points with a pencil, so that mistakes can be rectified. Having checked that the measurements are correct, mark with the self-tapping centre punch and drill all three holes with the $\frac{1}{8}$ in. drill in the first instance and then enlarge these holes with the $\frac{3}{8}$ in. drill inserted into the handbrace. Follow this by cutting the holes for the valveholder and coilholder (B9A) and the

hole for C_{10} , C_{11} with the octal chassis-cutter.

Next, temporarily fit the two valveholders into their holes and orient them so that pin 1 is nearest the front of the chassis. The four-way tagstrip takes up the position (under the chassis) which is shown in dotted line in Fig. 2 (a) and it was found possible, with the prototype, to secure its two outside mounting lugs at the same holes as are used for the inside securing bolts for the valveholders. However, this may not be possible with all valveholders likely to be used, and it may be necessary to secure one lug of the tagstrip at a valveholder hole, and to drill a second hole for the other tagstrip lug. The $1\frac{1}{4}$ in dimension shown in Fig. 2 (a) is approximate only, and is intended merely as a guide to obtain the correct positioning for the tagstrip. Using the valveholders as templates, mark out and drill two $\frac{3}{8}$ in mounting holes for each valveholder. Drill a fifth $\frac{3}{8}$ in hole for the remaining tagstrip lug, if necessary. None of these components are fitted at this stage.

Next fit the mounting clip to the dual electrolytic capacitor, position this component over its hole and mark out the two mounting holes required, using the clip as a template. One hole is to the rear and one to the front of the capacitor. Drill these two holes $\frac{5}{8}$ in diameter.

Mark out the holes identified as A, B, C and E in Fig. 2 (a), and drill these $\frac{3}{8}$ in, starting the holes with a $\frac{1}{8}$ in drill. Take up the mains transformer and

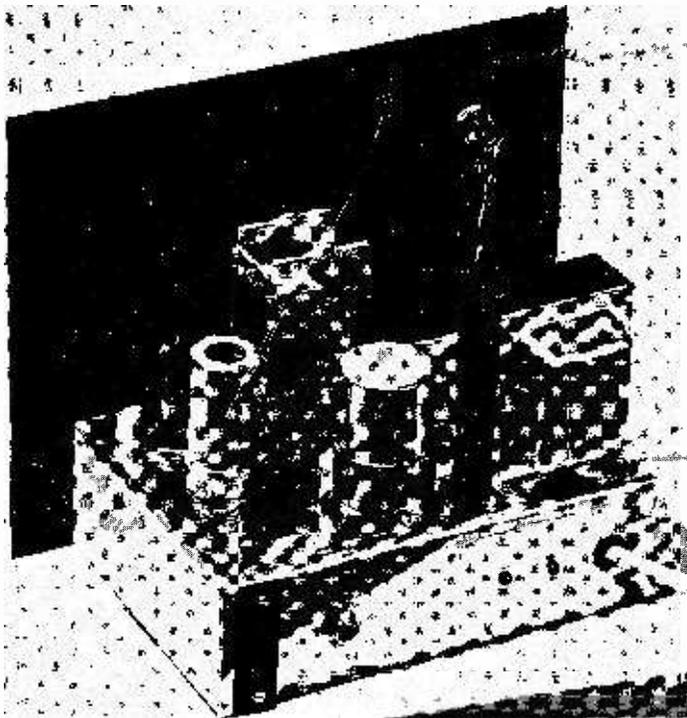
position it on the chassis so that its black leads can pass through hole B and its red and blue leads through hole C. Using the transformer mounting lugs as a template, mark out four holes and drill these $\frac{5}{8}$ in. Do not mount the transformer yet.

Position the tuning capacitor, C_2 , on the chassis so that its spindle is exactly central along the chassis length and the front edges of its mounting lugs are very nearly flush with the front edge of the chassis. Mark out the three mounting holes required and drill these $\frac{1}{2}$ in. Do not mount the capacitor yet.

Deal next with the chassis front apron. See Fig. 2 (b). Mark and drill the two holes shown. The hole for the On/Off switch is $\frac{1}{2}$ in diameter and that for C_1 is $\frac{3}{8}$ in diameter. Start both holes initially with a $\frac{1}{8}$ in hole.

Turn next to the rear apron, shown in Fig. 2 (c). The holes for the phone jack and the grommet are both $\frac{3}{8}$ in. When it is fitted later, the Aerial/Earth two-way socket strip will take up the position shown in dotted outline, with the Aerial socket

* An octal chassis cutter ($1\frac{1}{4}$ in) is available from Home Radio Ltd, under Cat. No. TL14. Also, a B9A chassis cutter ($\frac{3}{8}$ in) is similarly available from Home Radio Ltd, under Cat. No. TL10. Both require Allen keys (for octal Cat. No. TL15C, and for B9A Cat. No. TL12).



Above-chassis view of the receiver showing location of the main components

again being sizes which are commonly used.*

A handbrace will also be required, together with two further drills— $\frac{3}{16}$ in and $\frac{1}{8}$ in for drilling the holes required for various panel controls and fittings, etc.

A self-tapping centre-punch and a steel rule will greatly assist with measuring and marking of panel and chassis.

Drilling the Chassis

Refer to Fig. 2 (a) and measure and mark the drilling points for $V_{1(a)(b)}$, $L_{1,2,3}$ and C_{10} , C_{11} . The valve and coil both fit into B9A valveholders. Remember that the valveholder for $V_{1(a)(b)}$ is the one with a skirt which takes the screening can. The dual capacitor C_{10} , C_{11} is positioned over a $1\frac{1}{4}$ in hole, made with the octal chassis cutter. Firstly, mark the drilling points with a pencil, so that mistakes can be rectified. Having checked that the measurements are correct, mark with the self-tapping centre punch and drill all three holes with the $\frac{1}{8}$ in. drill in the first instance and then enlarge these holes with the $\frac{3}{16}$ in. drill inserted into the handbrace. Follow this by cutting the holes for the valveholder and coilholder (B9A) and the

hole for C_{10} , C_{11} with the octal chassis-cutter.

Next, temporarily fit the two valveholders into their holes and orient them so that pin 1 is nearest the front of the chassis. The four-way tagstrip takes up the position (under the chassis) which is shown in dotted line in Fig. 2 (a) and it was found possible, with the prototype, to secure its two outside mounting lugs at the same holes as are used for the inside securing bolts for the valveholders. However, this may not be possible with all valveholders likely to be used, and it may be necessary to secure one lug of the tagstrip at a valveholder hole, and to drill a second hole for the other tagstrip lug. The $1\frac{1}{4}$ in dimension shown in Fig. 2 (a) is approximate only, and is intended merely as a guide to obtain the correct positioning for the tagstrip. Using the valveholders as templates, mark out and drill two $\frac{3}{16}$ in mounting holes for each valveholder. Drill a fifth $\frac{3}{16}$ in hole for the remaining tagstrip lug, if necessary. None of these components are fitted at this stage.

Next fit the mounting clip to the dual electrolytic capacitor, position this component over its hole and mark out the two mounting holes required, using the clip as a template. One hole is to the rear and one to the front of the capacitor. Drill these two holes $\frac{3}{16}$ in diameter.

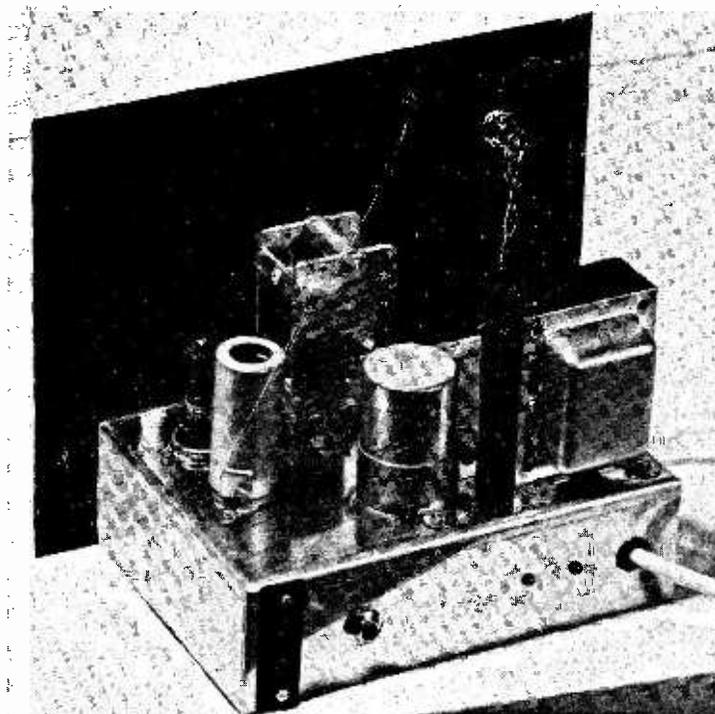
Mark out the holes identified as A, B, C and E in Fig. 2 (a), and drill these $\frac{3}{16}$ in, starting the holes with a $\frac{1}{8}$ in drill. Take up the mains transformer and position it on the chassis so that its black leads can pass through hole B and its red and blue leads through hole C. Using the transformer mounting lugs as a template, mark out four holes and drill these $\frac{3}{16}$ in. Do not mount the transformer yet.

Position the tuning capacitor, C_2 , on the chassis so that its spindle is exactly central along the chassis length and the front edges of its mounting lugs are very nearly flush with the front edge of the chassis. Mark out the three mounting holes required and drill these $\frac{3}{16}$ in. Do not mount the capacitor yet.

Deal next with the chassis front apron. See Fig. 2 (b). Mark and drill the two holes shown. The hole for the On/Off switch is $\frac{1}{8}$ in diameter and that for C_1 is $\frac{3}{16}$ in diameter. Start both holes initially with a $\frac{1}{8}$ in hole.

Turn next to the rear apron, shown in Fig. 2 (c). The holes for the phone jack and the grommet are both $\frac{3}{16}$ in. When it is fitted later, the Aerial/Earth two-way socket strip will take up the position shown in dotted outline, with the Aerial socket

* An octal chassis cutter ($1\frac{1}{4}$ in) is available from Home Radio Ltd, under Cat. No. TL14. Also, a B9A chassis cutter ($\frac{3}{16}$ in) is similarly available from Home Radio Ltd, under Cat. No. TL10. Both require Allen keys (for octal Cat. No. TL15C, and for B9A Cat. No. TL12).



Above-chassis view of the receiver showing location of the main components

at the top. Taking dimensions from the socket strip, drill two mounting holes $\frac{3}{8}$ in diameter and two $\frac{1}{4}$ in holes (or as required for the particular socket strip obtained) to allow the metal sockets to pass through. Ensure that there is plenty of clearance for the aerial socket. Mark out hole F, as shown in Fig. 2 (c). This is one of the mounting holes for the contact-cooled rectifier. Using the rectifier as a template, mark out the other mounting hole, G. Drill both holes $\frac{1}{8}$ in. No components are fitted to the rear apron at this stage.

Next, obtain the panel, refer to Fig. 2 (d) and drill the holes for C₁, the On/Off switch and the pilot lamp assembly PL₁. A $\frac{1}{8}$ in drill will be required here to start these holes.

The hole for the tuning capacitor C₂ may also be drilled at this stage if the same type of component as that specified in the Components List has been obtained. If a differing type (having the same value) is to hand, then the capacitor will have to be temporarily set on the chassis deck in its final position, the panel offered up to the chassis and the position of the spindle marked and drilled ($\frac{3}{8}$ in hole).

The remaining holes to be drilled on the panel are those for the "Explorer" motif and the dial drive assembly. The former has the same measurements from the panel edges on the right as those of the panel lamp assembly on the left, and the dial drive mechanism is supplied complete with drilling instructions for the fitting of both the drive and the cursor. The hole for the "Explorer" motif can be such that the rear projection of the button (suitably filed, if necessary) makes a push-fit into the panel.

Mounting the Components

The components may now be fitted.

First, fit $\frac{3}{8}$ in grommets to holes A, B, C, and E of the chassis (Fig. 2 (a)) and to the grommet hole

at the rear apron (Fig. 2 (c)). Mount the two valve-holders, with the orientation previously mentioned, and the four-way tagstrip. These three components are fitted with 6BA nuts and bolts.

Fit the dual electrolytic capacitor into position, using 4BA nuts and bolts. Carefully feeding its black leads through the grommet at hole B, and its blue and red leads through the grommet at hole C, fit the mains transformer, using 4BA nuts and bolts.

Fit the phone jack to the rear apron. Using 4BA nuts and bolts, mount the two-way Aerial/Earth socket strip on the rear apron, fitting a chassis tag under the nut adjacent to the Earth socket (i.e. at the bottom of the chassis). Fit the contact-cooled rectifier with 6BA nuts and bolts so that its tags point towards the phone jack.

Solder a 4in length of insulated wire to the lower fixed vane tag of the tuning capacitor, C₂, and feeding this wire through the grommet at hole E (Fig. 2 (a)), mount this capacitor, using 6BA nuts and bolts.

Bring the front panel up to the front apron of the chassis and secure it in position by means of the mounting nuts of the On/Off switch and C₁. The On/Off switch should have its tags pointing away from the chassis deck (i.e. towards the bottom of the chassis). Capacitor C₁ need only be secured temporarily at this stage as it has later to be removed for wiring. Fit the dial drive and cursor to the front panel. Also, fit pilot lamp PL₁ and the "Explorer" motif.

Wiring-Up The Receiver

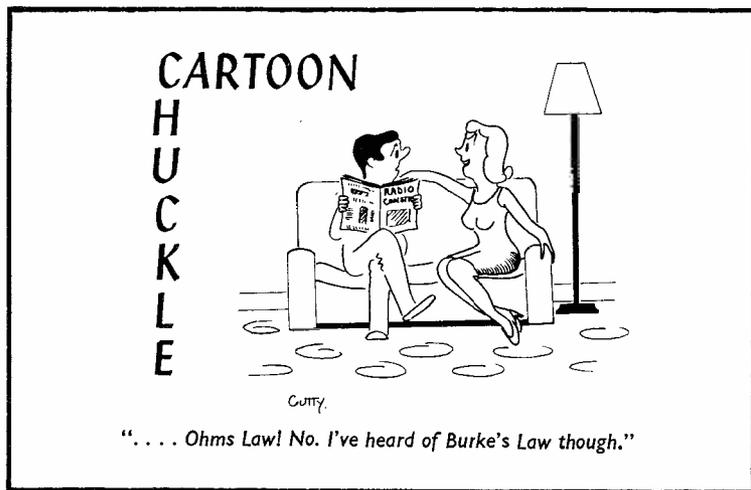
In next month's issue full details of wiring up the "Explorer" receiver will be given.

(To be concluded)

G. W. Smith Catalogue

Newly published by G. W. Smith & Co. (Radio) Ltd., 3 & 34 Lisle Street, London, W.C.2, is a comprehensive catalogue detailing all the components and equipments stocked by this company. The catalogue has 152 large pages, and items range from resistors, capacitors and tagstrips to complete communications receivers. Included are components and equipments for high fidelity reproduction, tape recording, amateur transmitting, and all other activities connected with radio. Also listed in the catalogue are a wide range of panel meters and relays.

The catalogue is well illustrated throughout and contains two 2s. 6d. discount coupons which may be used for the purchase of components. The cost of the catalogue is 5s. plus 1s. postage.



4-Channel Mixer/Pre-amplifier

by C. Raworth

This comprehensive circuit provides completely independent mixing on four channels, the mixer output being fed to an EF86 pre-amplifier stage followed by a passive bass and treble tone control network. The unit is intended for use with a high quality or high fidelity main amplifier.

THE MIXER AND PRE-AMPLIFIER unit described in this article evolved when the writer needed to mix inputs from two guitars and a microphone without interaction between their volume controls. The circuit is simple to assemble and bring into working order, is extremely effective in use, and it employs non-critical components of which quite a number may already be hand in the spares box.

Circuit Description

In the circuit, shown in Fig. 1, sockets SKT₁ to SKT₄ are intended for the various inputs. The inputs at SKT₁ to SKT₃ are fed directly to their associated volume controls, and these may be used for guitars or similar high impedance inputs. Socket SKT₄ is intended for a low impedance moving-coil microphone input, transformer T₁ being the microphone transformer.

The sliders of the input volume controls connect to the grids of the four triodes given by V₁ and V₂. Each triode functions independently as an a.f. voltage amplifier. A saving in components is achieved by employing a common cathode bias resistor and bypass capacitor for the two triodes in each envelope, the bypass capacitors preventing interaction between the cathodes.

The input circuit facilities can be readily altered from those shown in Fig. 1. If a second low impedance microphone input is required, the appropriate microphone transformer can be introduced into another of the input socket circuits, using the same circuitry as appears around T₁ at SKT₄. Should only two inputs be required, V₁ and its associated components may be omitted. In this case some constructors may prefer to leave space so that V₁ and its components may be installed at a later date.

The output from each of the four triodes is applied to the preset gain control, VR₅, by way of a 0.1μF isolating capacitor (C₂ to C₅) and a 100kΩ series resistor (R₅ to R₈). It is desirable to incorporate these series resistors when triodes are employed in a mixer circuit of this nature since, other-

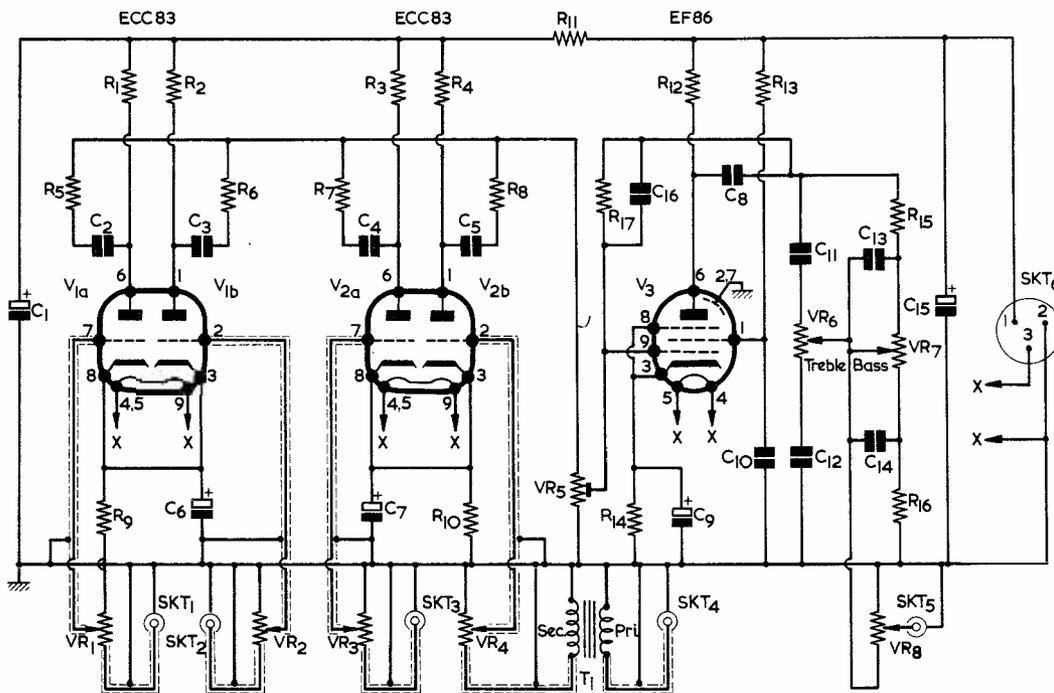


Fig. 1. The circuit of the mixer and pre-amplifier unit

wise, a common anode load would be given and this would be shunted by the anode a.c. resistances of all the valves. This shunting effect would cause a serious reduction in available output voltage before the onset of distortion. In the present circuit the inclusion of R₅ to R₈ prevents the shunting effect from occurring.

The combined signals from V₁ and V₂ appear across preset potentiometer VR₅. This component is adjusted to limit the maximum output of the unit and to prevent overloading of the subsequent stage should high amplitude inputs be employed.

The slider of VR₅ couples to the a.f. pentode, V₃. This is an EF86 provided with a small amount of negative feedback by way of R₁₇. C₁₆ also appears in the feedback loop, it being found empirically that this gave an improvement on overall response.

The output from V₃ feeds into the tone control network given by VR₆, VR₇ and the components around these two potentiometers. The tone control circuit is based on one appearing in the range of valve a.f. amplifiers designed by Mullard Ltd., to whom full acknowledgement is made.

The tone control output is finally applied to master volume control VR₈, and thence to output socket SKT₅. Unlike VR₅, the master volume control is a panel-mounted component and is particularly useful when it is desired to reduce volume on all instruments and microphone without upsetting balance.

For power, the mixer and pre-amplifier unit requires an h.t. voltage of 200 to 250 at some 5mA, and a heater voltage of 6.3 at 0.8 amps. With the prototype a Bulgin 3-way plug and socket assembly (Home Radio Cat. No. P360) was used for the supply connections, the chassis-mounted part being shown in Fig. 1 as SKT₆. Here, pin 1 corresponds to h.t. positive; pin 2 to chassis, h.t. negative and one side of the heater supply; and pin 3 to the other side of the heater supply. The plug and socket assembly is of the shrouded 3-way type associated with mains connections, and any suitable alternative plug and socket can of course be used.

The mixer and pre-amplifier unit may obtain its power supply from the main amplifier, and it will be helpful here if a resistor is inserted in series with the h.t. positive feed at the main amplifier end in order to ensure that the h.t. voltage at the pre-amplifier unit is between 200 and 250 volts. This resistor, in company with C₁₅, will then also provide

Resistors

(All fixed resistors $\frac{1}{4}$ watt 10%)

R ₁	100k Ω hi-stab
R ₂	100k Ω hi-stab
R ₃	100k Ω hi-stab
R ₄	100k Ω hi-stab
R ₅	100k Ω hi-stab
R ₆	100k Ω hi-stab
R ₇	100k Ω hi-stab
R ₈	100k Ω hi-stab
R ₉	1.2k Ω hi-stab
R ₁₀	1.2k Ω hi-stab
R ₁₁	47k Ω
R ₁₂	220k Ω hi-stab
R ₁₃	1M Ω hi-stab
R ₁₄	1.2k Ω hi-stab
R ₁₅	1.5M Ω
R ₁₆	150k Ω
R ₁₇	4.7M Ω

VR ₁	500k Ω potentiometer, log
VR ₂	500k Ω potentiometer, log
VR ₃	500k Ω potentiometer, log
VR ₄	500k Ω potentiometer, log
VR ₅	1M Ω preset potentiometer, log
VR ₆	2M Ω potentiometer, log
VR ₇	2M Ω potentiometer, log
VR ₈	1M Ω potentiometer, log

Capacitors

C ₁	8 μ F electrolytic, 350V wkg.
C ₂	0.1 μ F 350V wkg.
C ₃	0.1 μ F 350V wkg.
C ₄	0.1 μ F 350V wkg.
C ₅	0.1 μ F 350V wkg.
C ₆	50 μ F electrolytic, 6V wkg.

C ₇	50 μ F electrolytic, 6V wkg.
C ₈	0.1 μ F 350V wkg.
C ₉	25 μ F electrolytic, 6V wkg.
C ₁₀	0.1 μ F 350V wkg.
C ₁₁	33pF silver-mica
C ₁₂	680pF silver-mica
C ₁₃	270pF silver-mica
C ₁₄	3,300pF silver-mica
C ₁₅	8 μ F electrolytic, 350V wkg.
C ₁₆	270pF silver-mica

Transformer

T ₁	Microphone transformer (to suit microphone used)
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Valves

V ₁	ECC83
V ₂	ECC83
V ₃	EF86

Sockets

SKT ₁ to SKT ₅	Jack sockets (Igranic)
SKT ₆	3-way power socket (see text)
3 B9A	valveholders with skirts. (Screens may be needed for V ₁ and V ₂)

Miscellaneous

7 pointer knobs
Screened wire
Material for chassis, front panel, etc.

decoupling between the h.t. circuits in the main amplifier and the mixer/pre-amplifier unit.

The output from socket SKT₅ feeds via screened cable into the high impedance input of the main amplifier. It is important to note that a reliable connection between the two chassis must be made by way of pin 2 of SKT₆ and that the screening of the output lead from SKT₅ must *not* be relied upon to provide this inter-chassis connection. Indeed, it may sometimes be found that better results with respect to hum are given if the screening on the lead from SKT₅ is only connected to chassis at one end, say at the main amplifier end.

Components

Little difficulty should be experienced with the components, as these are quite standard. A number of the resistors are specified as high-stability types. It is not entirely essential to use high-stability resistors where these are called for but, since such resistors are nowadays available from home-constructor stockists at quite low cost, it is

worth-while taking advantage of the improved performance which they are capable of offering.

The tone controls, VR₆ and VR₇, both have log tracks. They should be wired so that the slider of VR₆ is at the C₁₁ end when the control is turned fully clockwise, and so that the slider of VR₇ is at the R₁₅ end when this control is turned fully clockwise.

The valveholders for all three valves should be of the skirted type intended to accommodate screening cans. It will possibly be found that the skirts are sufficient, on their own, to prevent hum pick-up in the valves, but it may be necessary in some cases to also fit screening cans for V₁ and V₂.

Construction

Construction should raise few problems, and a suitable front panel layout is illustrated in Fig. 2. The layout of components behind the panel is then automatically controlled by the positions which the controls take up. The prototype unit had the components mounted on a printed
(Continued on page 693)

The SCT/T1 Single Channel Tone Transmitter

In this instalment our contributor continues with the constructional information for the model control transmitter.

WE NOW TURN TO THE TRANSMITTER WHICH forms the main subject of this article.

This transmitter is intended to be used with a sensitive super-regen or superhet receiver employing a sharply tuned "toned switch" and relay less output stage, thereby enabling good range and interference rejection to be obtained with good transmitter battery economy, but at the expense of a slight increase in the size and cost of the actual receiver equipment. Suitable receivers will be described in subsequent issues.

Using the correct super-regen receiver, a ground range of 600 to 800 yards can be achieved by the system, indicating a ground-to-air range of well over $\frac{1}{2}$ mile. The interference rejection of the system is so good that it is possible to operate as many as three outfits in close proximity to one another at the same time, without interaction. The transmitter can be constructed to operate in either the "downwards" or "carrier plus tone" modulation modes, to suit different operating conditions, as required.

The full circuit diagram of the transmitter is given in Fig. 3. The circuit shows the connections for the "downwards" type of modulation, but this can be changed to "carrier plus tone" by using the dotted connections shown between the points marked X. This point is discussed in more detail later.

TR₁ operates as the crystal oscillator stage, using the tuned primary winding of T₁ as its collector load. The r.f. signal from T₁ secondary is passed to the base of TR₂, the power amplifier stage, in which the tuned T₂ circuit, in conjunction with the antenna, forms the collector load. The amplified r.f. signal is fed to the antenna via C₅. Note that the antenna uses a centre loaded and tunable coil, and it is important that the specified antenna be used in this circuit (see Components List).

For TR₂ to operate correctly there must be a d.c.

path between its collector and the positive supply line. If this path is traced, it will be seen that it runs through T₂ and the r.f. choke to the emitter of TR₃, finally reaching the positive supply line by actually passing through TR₃ and TR₄. Clearly, if these two transistors are biased hard on (i.e. fully conductive), there will be negligible restriction of the d.c. path to the TR₂ power amplifier, and the full carrier signal can be radiated by the antenna. If, on the other hand, TR₃ and TR₄ are biased off, no current can flow in TR₂ and no carrier will be radiated. TR₃ and TR₄ can thus be used to modulate the carrier signal.

TR₃ and TR₄ are connected as a "Darlington" or "Super-Alpha" pair, and can be regarded as a single transistor with a very high current gain and high input impedance (to TR₄ base). The audio frequency tone modulation signal is applied to TR₄ base via R₄ and, since the modulator presents a high input impedance, negligible loading is caused to the tone input signal. C₈ and the r.f. choke act as an r.f. filter, and are used to prevent r.f. signals reaching TR₄ base.

TR₅ and TR₆ are wired as an astable multivibrator or tone generator. In the diagram S₂ is shown in its normal open position, so that no negative supply is connected to this part of the circuit, which is thus inoperative; under this condition, TR₄ base is connected to the positive supply line via R₄ and R₅, with the result that modulator is biased hard on and the full carrier signal is radiated (assuming, of course, that the power supply is connected via S₁).

Closing S₂ causes the supply to be completed to the tone generator stage, which then operates to produce a square wave "tone" signal at TR₅ collector and, therefore, at the input of the modulator stage. This signal will alternately switch the modulator (and thus the carrier) on and off at the tone frequency. In other words, it will provide square wave modulation of the carrier to a depth of 100%.

The main frequency-determining components of the tone generator are R₇-C₁₀ and R₈-C₉, while RV₁ enables a considerable degree of variation to be made in the operating frequency when setting up the completed system. Since the transmitter is intended to be used in conjunction with a receiver having a sharply tuned tone "switch", it is important that the

Basic Radio Control (5)
by F. L. Thurston

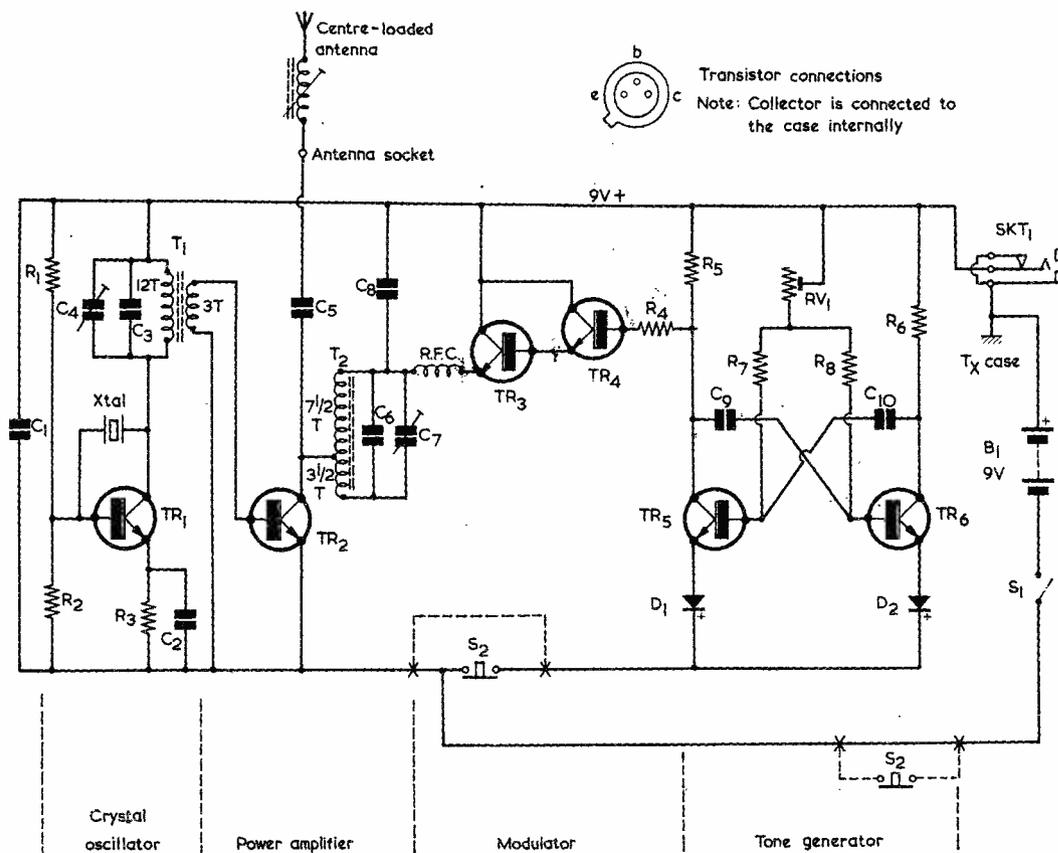


Fig. 3. The circuit of the SCT/T1 transmitter

transmitter tone generator should give a high degree of frequency stability. To this end, diodes D_1 and D_2 are included to stabilise the "base-to-ground" reverse impedances of TR_5 and TR_6 ; the resulting circuit gives an exceptionally high degree of stability.

The positive terminal of the 9-volt supply battery is connected to the transmitter case, whilst the positive supply line for the transmitter circuit is connected to the case via the jack socket SKT_1 . The circuit made via the jack socket can be broken, if required, to either monitor the supply current of the unit or enable an external switching unit to be used to key the transmitter.

When using the "downwards" mode of modulation, S_1 is connected between battery negative and the negative line of the TR_1 and TR_2 stages, enabling carrier only to be transmitted. At the same time, the negative line is connected to the tone generator stage via S_2 , enabling tone modulation to be applied when S_2 is closed. In the alternative "carrier plus tone" mode, however, S_2 should be removed from the position shown and replaced by a shorting link, S_2 then being rewired in series with S_1 as shown by the dotted lines in the diagram.

Construction

Start construction by cutting the Veroboard panel to size, as shown in Fig. 4, and then drill the board as indicated. The holes marked "A" are 6BA clear. Next, break the copper strips, exactly as shown in the diagram, using either a small drill or the special cutting tool that is available. The copper strip should be slightly cut back from around the holes that have been drilled in the panel.

The construction of the transmitter should now be carried out by numbers, in the following manner.

(1). Solder five shorting links, with sleeving, in place on the Veroboard panel, as shown in Fig. 4. Bolt the 0.27in diameter coil formers for T_1 and T_2 , with iron-dust cores, in place on the panel using 8BA screws, nuts, and *insulated* washers under the nuts. The iron-dust cores should be screwed fully in and then locked in place with plastic cement.

(2). Wind T_1 as follows (see Fig. 5 (a)). Bare one end of a length of 24 s.w.g. enamelled copper wire and solder it in place in hole 4i; now wind anticlockwise from the base upwards, keeping the windings tight and close spaced, for a total of 12 turns.

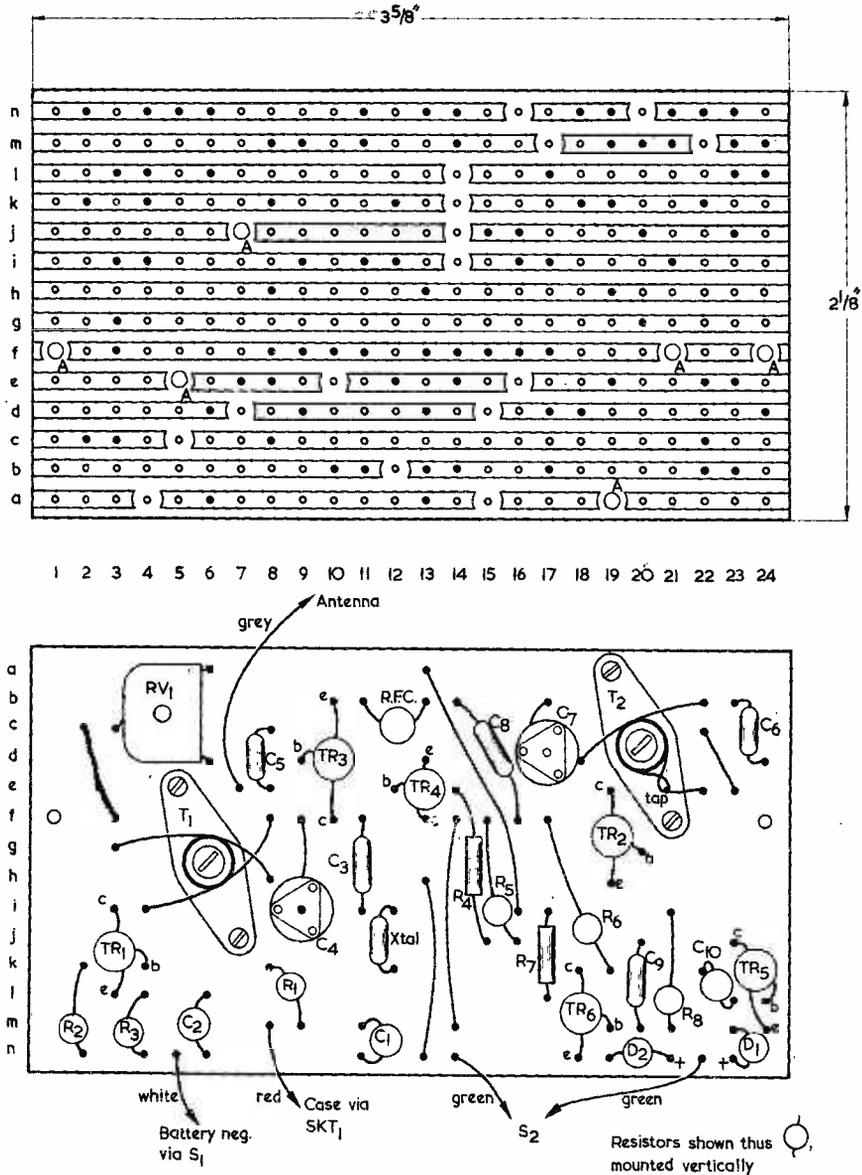


Fig. 4. The copper and component sides of the Veroboard. All holes marked "A" are drilled 6BA clear. The copper must be cut back from the edges of these holes

Finally, take the free end of the wire to hole 8f, taking care *not* to solder it in place at this stage. Instead, ensure that the wire will reach this hole and then bend it upwards for the moment. Now take another length of 24 s.w.g. enamelled wire and solder one end in hole 8h, then, starting about one-third of the way up the primary winding, tightly wind 3 turns in an anticlockwise direction upwards over the primary winding, finally soldering the free end of the wire in hole 3g. The free end of the primary winding can now be soldered into hole 8f, and this completes

the construction of T₁. The enamel must, of course, be cleaned off the wire at the connection points before soldering (unless wire with a solder-through enamel has been obtained).

(3). Wind T₂ as follows (see Fig. 5 (b)). Bare one end of a length of 24 s.w.g. enamelled copper wire and solder in place in hole 18d; now wind clockwise from the base upwards for 3½ turns, form a loop, and then continue the winding, still clockwise, for another 7½ turns. Finally solder the free end of the wire in place in hole 22b. Solder a lead from the tap

COMPONENTS

Resistors

(All fixed values $\frac{1}{2}$ watt)

- R₁ 47k Ω , 10%
- R₂ 8.2k Ω , 10%
- R₃ 120 Ω , 10%
- R₄ 22k Ω , 10%
- R₅ 2.2k Ω , 5%, hi-stab
- R₆ 2.2k Ω , 5%, hi-stab
- R₇ 18k Ω , 5%, hi-stab
- R₈ 18k Ω , 5%, hi-stab
- RV₁ 10k Ω skeleton pre-set, vertical type

Inductors

- T₁ Primary=12 turns 24 s.w.g. e.c.w. close-wound on Radiospares 0.27in former with iron-dust core
Secondary=3 turns 24 s.w.g. e.c.w. close-wound over primary
- T₂ 3 $\frac{1}{2}$ +7 $\frac{1}{2}$ turns 24 s.w.g. e.c.w. close-wound on Radiospares 0.27in former with iron-dust core
- R.F.C. 1 amp T.V. choke or low value R.F. choke

Switches, etc.

- S₁ Any small on-off switch, s.p.s.t., toggle or slide
- S₂ Miniature push-to-make switch (Radiospares)
- SKT₁ Closed circuit jack (Radiospares)

Capacitors

(All miniature types, 12V wkg. or greater)

- C₁ 0.04 or 0.05 μ F, Mylar
- C₂ 0.001 μ F, Mylar or paper
- C₃ 18pF, silver mica
- C₄ 5-30pF concentric trimmer (Philips type)
- C₅ 500pF, ceramic
- C₆ 18pF, silver mica
- C₇ 5-30pF concentric trimmer (Philips type)
- C₈ 75pF silver mica
- C₉, C₁₀ 0.02 μ F Mylar; *not* ceramic

Semiconductors

- TR₁, TR₂, TR₄ ST141 (Sinclair)
- TR₃, TR₅, TR₆ ST140 (Sinclair)
- D₁, D₂ OA200 or 1S940

Crystal

Midget radio control type in 27 Mc/s range.
Note: a matched pair, with 465 kc/s spacing, should be obtained if future projects are to include a superhet receiver

Antenna

Teleradio antenna type CLV80, with fittings.
This type *must* be used

Batteries

9 volt, type DT7, Exide (2 off, 1 spare)

Miscellaneous

Veroboard panel (2 $\frac{1}{2}$ x 3 $\frac{3}{8}$ in or greater) with 0.15in hole spacing
2 off Radiospares 0.27in dia. coil formers, with cores and 8BA mounting screws, nuts, and *insulated* washers
6 x 4 x 2 $\frac{1}{2}$ in standard four-sided chassis with angled corner brackets
Back plate for chassis
Scrap aluminium for brackets, etc. Sponge rubber strip (see Fig. 6)
Self tapping screws, No. 4 PK, $\frac{3}{8}$ in long, pan head. (12 off)
Battery connectors (2 off). 24 s.w.g. enamel covered wire
Rubber grommets, wire, sleeving, etc.

Note: All components are available from
Teleradio Electronics,
325/7 Fore Street,
London, N.9.

who have made available a complete kit of parts, less crystal and antenna.

(i.e. the loop at 3 $\frac{1}{2}$ turns) to hole 22e, as shown. This completes T₂.

(4). Secure the two concentric trimmer capacitors, C₄ and C₇, vertically on the panel, taking care to fix them as near to the surface of the Veroboard as possible. Solder TR₁ in place, as shown. Now solder R₁, R₂, R₃, C₁, C₂, C₃, the crystal, and the red and the white lead in place, as indicated. At this stage, the crystal oscillator circuit may be given a functional check in the following manner. Temporarily connect a 9 volt battery with its positive terminal to the red lead and its negative terminal to the white lead; place the antenna of the field strength meter (described in the August 1966 issue) close to T₁, and check that a reading is obtained, thereby indicating

that the circuit is working correctly. If no reading is obtained, try adjusting C₄; and it may also be necessary to trim the tuning of the field strength meter. If this check is satisfactory, remove the temporary battery connections.

(5). Solder all remaining components and leads to the Veroboard panel, as shown in Fig. 4. Note that RV₁ is a standard 10k Ω skeleton pre-set potentiometer, and that before attempting to solder this component in place the diameter of the mounting legs should be reduced with the aid of a file, so that they fit easily in the holes in the panel. Note also that the legs should be bent so that the component slopes back at an angle of 45° when soldered in place. The r.f. choke may be a normal low value

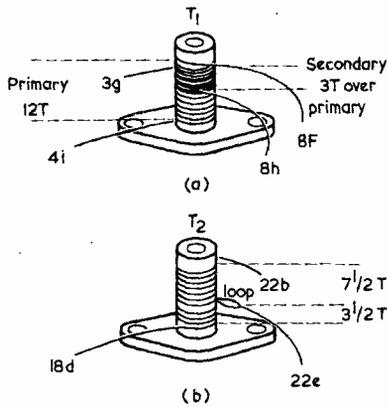


Fig. 5. Details of (a) coil T_1 , and (b) coil T_2

choke, a 1 amp TV choke, or can be made by scramble winding 100 turns of light gauge enamelled wire on the body of a $100k\Omega \frac{1}{2}$ watt resistor, as preferred.* When all components have been soldered in place, the gaps between the copper strips on the rear of the panel should be cleaned up, ensuring that there are no short circuits between them.

(6). Make the transmitter case and metal-work, as shown in Fig. 6 (a). On the prototype, a standard $6 \times 4 \times 2\frac{1}{2}$ in chassis, with angled corner brackets, was used as a case. The antenna specified, which screws into the holder fitted in the large hole at the top of the case, *must* be used. The two batteries (one is a spare, and serves to balance the completed transmitter) are held in place by the sponge-rubber faced bracket of Fig. 6 (b), and this, in turn, is held in place by self-tapping screws. The Veroboard panel is mounted on the two small angle brackets of Fig. 6 (c), which, in turn, are secured to the side of the case by self tapping screws. To prevent the underside of the Veroboard panel short-circuiting against the angle brackets, a pair of rubber grommets are glued

* The "1 amp TV choke" is a small Radiospares component (0.56in long by 0.18in diameter) intended for TV suppression of motors, etc. It has a nominal inductance of $5\mu H$ and a natural resonant frequency of 55-65 Mc/s. It should be noted, incidentally, that Radiospares components may only be obtained through retailers.—EDITOR.



The assembled Veroboard panel for the transmitter

to the brackets with Bostik, and act as shock absorbing stand-off insulations. As a further precaution against short circuits, the brackets should also be covered with Fablon or a similar self-adhesive insulating material. When all metalwork is complete and assembled, the antenna socket, the jack socket (SKT₁), and S₁ and S₂ should be fitted in place. The Veroboard is not fitted yet.

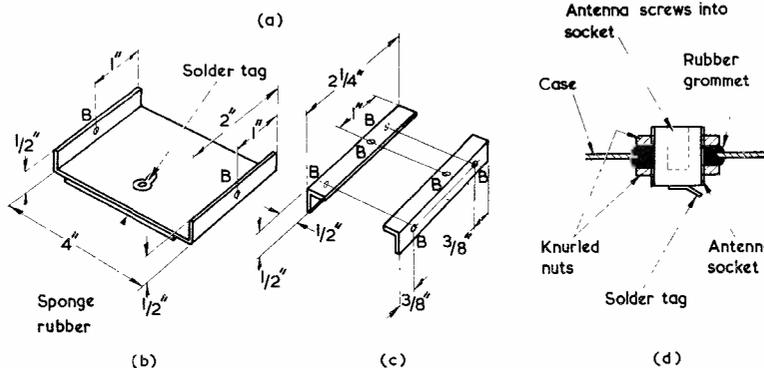
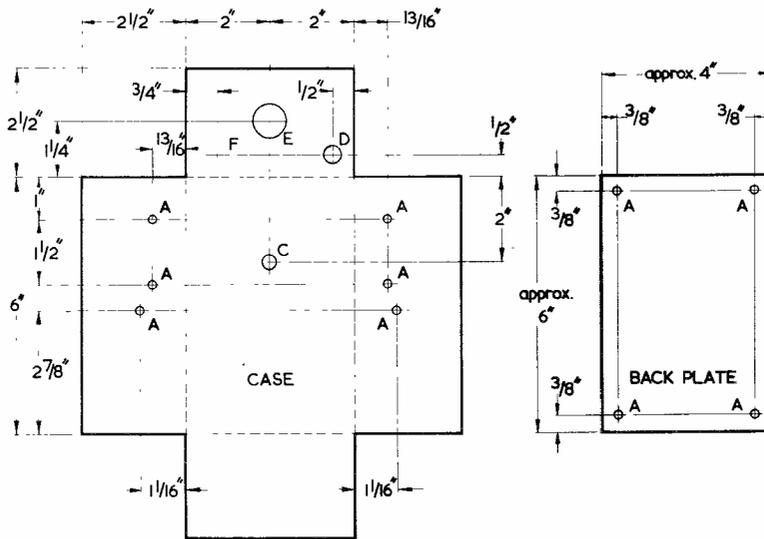
Now, connect the white lead from the Veroboard panel to one terminal of S₁, and connect the other terminal of S₁ to the battery negative clip, ensuring that S₁ is in the Off position. In the prototype a 2-way 2-pole slide switch was used for S₁, but any small on/off switch can, in fact, be used in this position. Connect the red lead from the panel to the jack socket, SKT₁, and wire up in such a way that the red lead is normally connected to the case via the socket, but the connection is broken when a jack plug is inserted. See Fig. 3. Alternatively, SKT₁ may be omitted and the lead taken directly to the case.

Connect a lead from the positive battery terminal clip to the earthed solder tag on the battery securing bracket. Finally, connect the grey lead from the panel to the antenna socket, connect the two green leads to the push-button on/off switch S₂, secure the Veroboard panel in place on the support brackets with the aid of two self-tapping screws, and fit the antenna in its socket.

The transmitter can now be tested and set up. Monitor the transmitter current by either connecting a 100mA meter in series with one of the supply lines directly or via a jack plug inserted in SKT₁. Switch S₁ on, and check that a current reading of between 40mA and 60mA is obtained, adjusting C₄ if necessary. Now adjust C₄ upwards (anticlockwise) until the reading falls sharply, then turn C₄ back clockwise a full turn. Next, with the antenna fully erect, monitor the strength of the radiated signal with the field strength meter, and adjust C₇ and the iron dust core built into the antenna for maximum reading on this meter. It should be possible to obtain a full scale reading at a range of ten feet or so (using a $50\mu A$ movement in the field strength meter). When these adjustments are complete, note the reading on the field strength meter and then press the "tone" button, S₂. If the circuit is working correctly, the field strength meter reading should fall to about half of its earlier value, as also should the reading of the battery current monitor.

Connect a crystal earphone across R₅ and check that, when the "tone" button is pressed, a tone signal is heard, and that the frequency can be varied by means of RV₁. This completes the transmitter tests.

(7). If the transmitter is to be used in the "downwards modulation" mode, the unit can now be regarded as complete. If, however, it is to be used in the "carrier plus tone" mode, it should be modified in the following manner. Remove the two green leads from the Veroboard panel, and connect a shorting link between holes 14n and 22n. Break the connection between battery negative and S₁, and take the battery negative connection to one side of S₂. Connect the other side of S₂ to the free



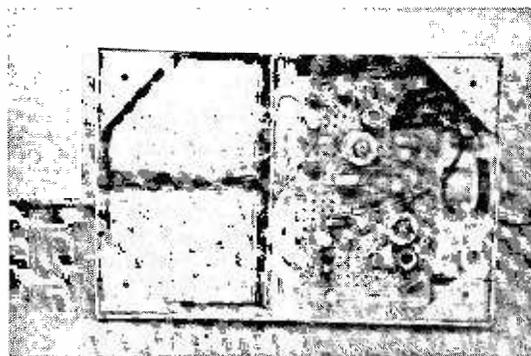
- A - drill to clear self-tapping screw
- B - tap hole for self-tapping screw
- C - drill $\frac{5}{16}$ " dia for S_2
- D - drill $\frac{3}{8}$ " dia for SKT₁ (if fitted)
- E - drill $\frac{3}{4}$ " dia for antenna grommet
- F - drill to suit S_1

Fig. 6 (a). The construction of the metal case and back of the transmitter
 (b). The battery bracket
 (c). The angle brackets employed for mounting the Veroboard
 (d). The method of fitting the antenna to the case

terminal on S_1 . Check that the unit now functions correctly by switching S_1 on and pressing the tone button, noting that a good field strength meter reading is obtained and that monitor current reads between 20 and 30mA. Check that these readings fall to zero when either S_1 or S_2 is set to the Off position. This completes the testing of the unit, and it only remains to fix the back plate to the rear of the case, with the aid of four self-tapping screws, to complete the assembly of the transmitter.

Next month a super-regen receiver, designed to operate with this transmitter, will be described, together with full operating instructions.

(Continued on page 693)



Rear view of the transmitter with the back plate removed. This also shows the four chassis corner brackets, to which the back cover is secured

In your workshop



Whereas nobody expects the butcher to distribute free steaks, or the grocer free fish fingers, everyone assumes that the poor radio repairman has no other function in life than to offer his services gratis to friends and acquaintances alike. Thus it was that Dick became lumbered with the construction of a baby alarm amplifier. As always, however, Smithy comes to the rescue, and the Serviceman is able to recommend an ingenious circuit design which not only offers very high gain but which is also capable of being built at quite low cost

THE TROUBLE WITH ME," SIGHED Dick, as he munched the last of his lunch-time sandwiches, "is that I'm far too innocent and guileless."

Smithy the Serviceman raised his disgraceful tin mug to his lips and cocked an enquiring eyebrow at his assistant.

"What it is," continued Dick, warming to his theme, "is that I'm too obliging and sincere. I'm far too ready to be put upon."

Smithy quaffed prodigiously at the tea in his mug.

"Don't tell me," he remarked

unkindly, "that someone has, at long last, actually managed to get the better of you."

"It's worse than that," replied Dick indignantly. "Not only have I been taken advantage of, but this has been done by one of the oldest mates I've ever had."

Dick brooded darkly over the injustice of his fate.

"It's not him I blame, really," he remarked eventually. "It's *her*."

"Her?"

"His missus," snorted Dick scornfully, "The great nit went and got hitched last year, and he's never been the same since."

A Present For Baby

"People *do* change after they get married," commented Smithy mildly. "Family responsibilities and all that, you know."

"Family responsibilities is right," grunted Dick. "They've just been and gone and had a baby. I called round to pay the old respects yesterday evening and—blow me—almost before I'd got my coat off I was Shanghai'd into promising to make a baby alarm for them!"

"A very laudable gesture on your part," commented Smithy approvingly. "I'm glad to see that you're ready to rally round your friends like that."

"Rally round?" growled Dick. "Blimey, they saw me coming. As soon as I got in the door they were making with the chat about me being so clever with radio and all that sort of thing. Every time I said how short of spare time I was these days they produced the infant, all wet and bubbling, to let it see their nice kind Uncle Dick who was going to make up its baby alarm. Against odds like that I just couldn't win, mate!"

But Smithy was more interested in Dick's potential gift to his married acquaintances than in the manner of its giving.

"A baby alarm, eh?" he remarked, stroking his chin thoughtfully. "Have you considered what circuit and components you're going to use?"

"Not yet," admitted Dick. "As a matter of fact, I was hoping to get a few ideas from you. I've just assumed that there'll have to be a mike at the baby end, a speaker at the other end, and some sort of amplifier in between, and that's about as far as I've got."

"Fair enough," commented Smithy. "It looks as though we'd better get down to some details, then. Would the baby's parents prefer to have the amplifier run from the mains or from batteries?"

"From the mains I would imag-

ine," replied Dick. "They said they wanted to keep the running costs as low as possible and I would guess that battery replacements from time to time would turn out to be more expensive than running from the mains."

"They would," agreed Smithy. "Well then, if the amplifier is to run from the mains it becomes a toss-up as to whether it's going to use transistors or valves."

"Valves?" queried Dick. "Surely, valves are *much* too old-fashioned for a job like this!"

"Old-fashioned they may be," replied Smithy. "Yet in the present instance, where you've got an amplifier which will be run from the mains and which you'll be making yourself, they can still present an attractive proposition."

"But if you use valves," protested Dick, "you'll need a mains transformer for the heaters."

"You'll need a mains transformer with transistors too," said Smithy. "For a baby alarm you definitely want the amplifier circuits to be isolated from the mains because of the shock risk with the microphone and speaker wiring. And so an isolating mains transformer is essential regardless of whether the amplifier uses valves *or* transistors. Another point is that it's very desirable for the amplifier to give an output of at least a watt, so that it will be good and audible when the parents have the radio or TV on. You can get an output of over a watt with no trouble at all from an output valve, but the output circuitry will be quite a bit more complicated if you're going to use, say, two output transistors in Class B with a driver transistor."

"You sound," said Dick, "as though you're much keener on using valves than you are on using transistors."

"In this case I am," confessed Smithy. "You can call me a bit of an old fuddy-duddy if you like, but it's so easy to construct a really high-gain mains driven baby alarm amplifier using valves that I would quite honestly prefer to use them instead of transistors. Also, by using the right sort of circuit, it's possible to make up a valve amplifier for a baby alarm at a surprisingly low cost in components."

"This sounds intriguing," commented Dick. "What sort of valve line-up do you have in mind?"

Despite his earlier protestations, Dick was beginning to show signs of awakening interest.

"Pretty well the simplest you can have," replied Smithy. "The first

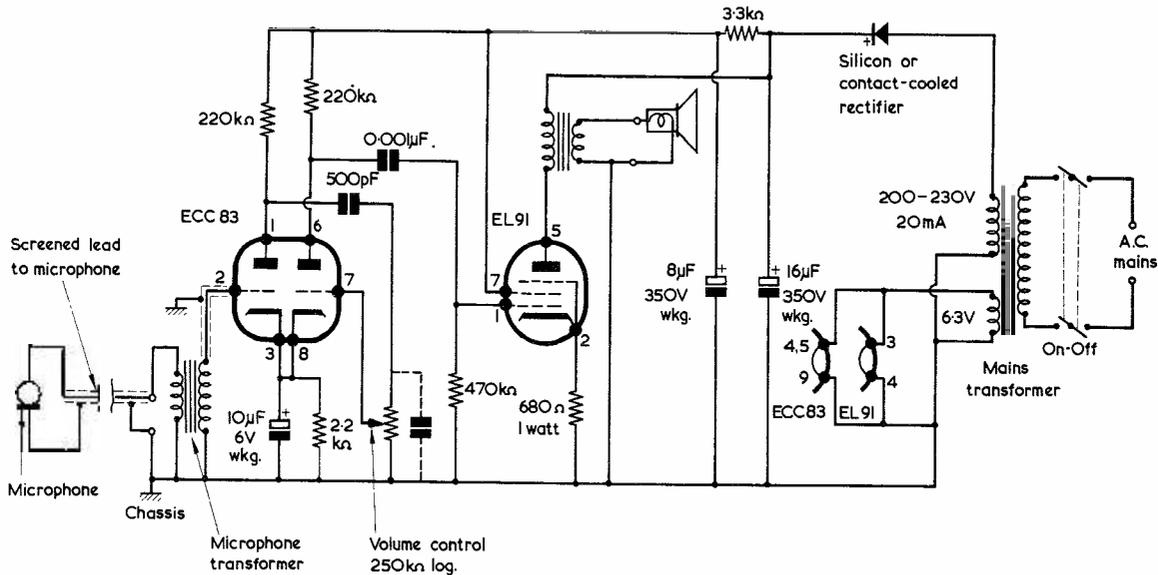


Fig. 1. Despite its simplicity, this circuit provides an extremely high degree of a.f. gain and is ideally suited for a low-cost mains-driven baby alarm amplifier. The microphone can, in practice, be a small 3Ω moving-coil speaker. The output transformer ratio should be around 75:1, and all resistors are $\frac{1}{2}$ watt unless otherwise stated. The capacitor shown in dotted line across the volume control may be needed if high frequency instability occurs

valve would be an ECC83 and the second valve an EL91 output pentode. These types are available through the usual home-constructor suppliers for about five bob each, or even less. The ECC83 is a high-gain double triode, each triode of which gives a voltage gain of about 60 or so, and the EL91 is an output pentode giving a power of 1.4 watts. String these two triodes and the output pentode together in cascade, and you've got more than sufficient gain for a baby alarm amplifier. All you need for a mike is a small and inexpensive moving-coil speaker, and there should be enough amplification to reproduce the sound of the baby's breathing at really good volume."

"I can see the idea behind using an ECC83," remarked Dick, "because this valve is well-known as a high-gain type. But why choose an EL91 as the output valve?"

"The type of valve you use in the output stage isn't all *that* critical," admitted Smithy, "but the EL91 does have the advantage of drawing low anode and screen-grid currents. This allows the amplifier circuit to be kept extremely simple, as I'll be showing you in a minute or two."

Smithy reached over, opened a drawer in his bench, and produced a battered valve manual.

"Let's see what this says about the EL91," he continued, as he turned over the pages. "Ah, here we are! For 250 volts on the anode and screen-grid, the anode current of an EL91 is only 16mA and the screen-grid current is only 2.4mA."

"That," remarked Dick, "will ease power supply requirements, at any rate."

"It does," agreed Smithy. "These low anode and screen-grid currents also enable you to get away with very simple decoupling circuits along the h.t. line as well. I've knocked up quite a few baby alarm amplifiers using an ECC83 and an EL91 in the past, and I just haven't had to use any h.t. decoupling at all."

"This," remarked Dick, impressed, "I'll have to see!"

Smithy drained his tin mug and handed it over to his assistant.

"And so you shall," he replied. "Now, you fill this up for me, Dick, and I'll draw up a circuit for this baby alarm of yours."

Smithy's Circuit

Whilst Dick busied himself at the sink with the motley array of utensils which formed the sole culinary effects of the Workshop, Smithy set to work with note-pad and pencil. Dick returned with the recharged tin mug, then pulled up his stool

alongside the Serviceman as the latter put the finishing touches to his circuit.

"There you are, my boy," said Smithy proudly, as he laid his pencil down on the bench. "What do you think of that?"

Dick peered at Smithy's circuit. (Fig. 1).

"There isn't," he remarked distrustfully, "much in it, is there?"

"That's the beauty of it," replied Smithy cheerfully. "This amplifier circuit gives stacks of gain, and yet the decoupling and bypass components are all cut right to the bone. I wouldn't, of course, claim that the circuit is original, but it's one that definitely lends itself to this baby alarm problem of yours, since it is especially intended to give a good performance with the rock-bottom minimum of components and thereby keep building costs as low as possible. Anyway, let's trace the signal through the circuit. At the input end you've got a microphone, which in practice can be a moving-coil speaker, coupled to a step-up microphone transformer. The secondary of this transformer couples to the grid of the first triode of the ECC83. This triode amplifies in normal manner and its anode couples to the volume control. The slider of the volume control then connects to the grid of

the second triode. This second triode provides further amplification and couples, in its turn, to the control grid of the EL91 output pentode. Finally, the EL91 feeds, via the output transformer, into the speaker, and that's all there is to it. Any questions?"

"I'll say," replied Dick promptly. "For a start, both the cathodes of the ECC83 are tied together and coupled to a single resistor and electrolytic capacitor. What's the reason for that?"

"Economy," grinned Smithy. "One cathode bias resistor and capacitor does the job which would more normally be carried out by two separate cathode resistors and capacitors. The cathode resistor in my circuit has half the value you'd normally use for a single cathode bias resistor, because the cathode current of both triodes is flowing through it. I appreciate that the idea of using a single bypass capacitor for two cathodes looks pretty rough at first sight, but it works perfectly well in practice for this particular application."

"I see," commented Dick, turning his attention to another point.

"Why have you put the volume control in the grid circuit of the second triode? Why not have it in the grid circuit of the first triode?"

"It's in the grid circuit of the second triode," explained Smithy, "to reduce the problem of hum pick-up. There's no particular advantage here in putting a volume control in the grid circuit of the first triode because the signal at this point won't be large enough to overload the valve in any case. So the volume control is in the grid circuit of the second triode, where the wiring to the control is much less liable to pick up hum. You'll probably find that you can use unscreened leads to connect up to the volume control if this component is mounted fairly close to the grid of the second triode."

"Another point," remarked Dick, "is that you've shown a capacitor in dotted line across the volume control. What's that for?"

"You may need a capacitor here," replied Smithy, "in case you get high frequency instability due to the general lack of decoupling in the circuit. The instability may show up as a hiss or distortion, and if it occurs you add the capacitor. It will only need a value of the order of 100 to 300pF or so."

Dick studied Smithy's circuit once more.

"Corluvaduck," he remarked suddenly. "I've just noticed that the first a.f. coupling capacitor is only 500pF!"

"I was wondering," chuckled Smithy, "how long it would take you to spot that one! The second coupling capacitor is pretty small in value, too, it being only 0.001 μ F."

"Why do you use such small values?"

"To reduce response at the lower audio frequencies and therefore keep the hum level down," replied Smithy. "This isn't supposed to be a hi-fi amplifier and there's no point in going to a lot of trouble in preventing hum if you don't want the lower audio frequencies to be reproduced at full level anyway. The small value a.f. coupling capacitors reduce the hum to a very low level indeed, and this is one of the features which make the amplifier so easy to get into working order. I've shown the connection from the microphone transformer secondary to the grid of the first triode as employing screened wire, and that is pretty well all the screening you'll need in the amplifier itself. Incidentally, the low value a.f. coupling capacitors don't upset the response at speech frequencies to any great extent. Using a moving-coil speaker as a microphone, male speech is reproduced at the other end in quite a clear and life-like fashion."

Decoupling

"This amplifier circuit," remarked Dick, "certainly seems to have a lot of hidden points in it. What about the decoupling? Or, rather, the lack of it?"

"You'll notice," said Smithy in reply, "that the h.t. decoupling is very simple indeed. The two triode anodes and the output screen-grid are all bypassed by the single 8 μ F electrolytic which follows the 3.3k Ω smoothing resistor. And the output anode takes its h.t. from the 16 μ F reservoir electrolytic, whereupon this anode is automatically decoupled from the two anodes of the double triode."

"Do you mean," asked Dick, "that the smoothing circuit also provides h.t. decoupling for the output anode as well?"

"That's right," confirmed Smithy cheerfully. "There's nothing like having one set of components do two jobs at the same time!"

"But," objected Dick, "the h.t. at the 16 μ F reservoir electrolytic will have a pretty hefty ripple on it. Won't that ripple be heard on the speaker?"

"Only," replied Smithy, "if you feed the amplifier output to a large speaker in a fully baffled enclosure, or a reproducer of that order. The ripple will be well-nigh inaudible if you use something like a 4 inch speaker in a small cabinet, which is

all you need for a baby alarm. Don't forget that quite a few valve sound receivers have the output anode coupling to the reservoir capacitor in the same manner as I've shown here. An output pentode has a pretty high r_a , with the result that changes in anode voltage have only a small effect on anode current."

"I must admit," remarked Dick in a tone of grudging admiration, "that this circuit really does use a minimum of components. There isn't even a bypass capacitor across the cathode bias resistor for the EL91!"

"I know there isn't," grinned Smithy. "There's a slight loss of gain due to operating the output cathode without the bypass capacitor, but this is more than outweighed by the considerable amount of gain you've got elsewhere."

"Do you know, Smithy," remarked Dick, "I'm beginning to look forward to making up this baby alarm amplifier after all! What about the power supply section?"

"The heater consumption for the two valves," said Smithy, "is only 0.5 amps at 6.3 volts. And the h.t. consumption is only about 20mA at an h.t. voltage of 250. So the h.t. secondary of the mains transformer needs to provide some 200 to 230 volts at this current, and quite a small transformer will cope. I'd better mention though that, if you use a mains transformer which can offer an h.t. secondary current well in excess of 20mA, it might be advisable to insert a limiter resistor between the h.t. secondary and the rectifier, this having a value which keeps the rectified h.t. voltage across the reservoir capacitor to 250 or less. I make this point because a higher current h.t. secondary will have a lower winding resistance whereupon, due to the relatively low current drawn by the amplifier valves, the reservoir capacitor may charge up a bit higher than the maximum anode voltage of 250 specified for the EL91. The rectifier itself can be any half-wave type rated for 250 volts at 20mA or more. A contact-cooled rectifier would be a nice inexpensive choice, as also would a silicon rectifier, such as the BY100."

"Anything to watch out for in the input circuit?"

"There's only one important point," replied Smithy. "The input transformer *must* be a pukka microphone transformer intended for the job. It should have a step-up ratio of 1 : 50 or 1 : 100. Don't fall into the temptation of trying to use a speaker transformer connected wrong way round here, or you'll be disappointed. The microphone transformer should be mounted at the opposite

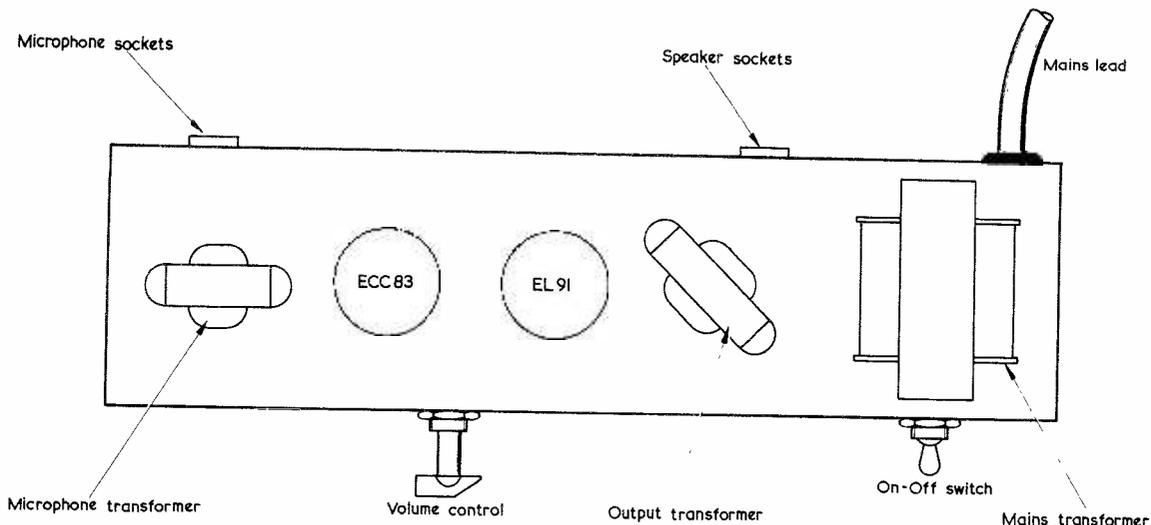


Fig. 2. A good basic layout for the baby alarm amplifier consists of using a long narrow chassis, as illustrated here. This provides good spacing between the mains and the microphone transformers and enables the volume control to be positioned close to the grid of the second triode. Chassis dimensions depend upon the sizes of the transformers employed, and the components not shown here can be mounted below the chassis. If the amplifier is positioned close to unshielded mains wiring, the ECC83 may need a screening can. Pin 7 of the ECC83 should be closest to the volume control

end of the chassis from the mains transformer and, if it is unshielded, you may have to rotate it for minimum hum. You can have quite a long lead, up to 30 feet or more, between the amplifier and the microphone which, as I've already said, need only be a small moving-coil speaker. A 3Ω speaker would be a good choice here, and you can use TV coaxial cable for the microphone lead. In some households you may even find that you can use lighting flex for the microphone lead without picking up too much hum.

"What about the output transformer?"

Smithy picked up his valve manual and consulted it carefully.

"I'm just checking up on that," he remarked. "Now, it says here that the optimum anode load for an EL91 is 16kΩ. So, if the EL91 is to feed into a 3Ω speaker, the output transformer ratio should be the square root of 16,000Ω divided by 3Ω, which is the square root of 5,333. Let's see what that works out to."

Once more, Smithy applied his pencil to his pad.

"The square root," he announced, after a moment, "comes out as 73. In practice, an output transformer

with a ratio of 75 : 1 or thereabouts should do very nicely."

Layout

Smithy picked up his battered tin mug, drained its contents and once again handed it over to his assistant. Following long-established custom, Dick took the mug without question and carried it over to the Workshop sink for further replenishment.

"All I need to do now," he remarked casually over his shoulder, "is to work out the amplifier layout."

After all the time he had known his assistant, Smithy should have been forewarned by the excessive artlessness in Dick's voice as he made this last remark. But Smithy was engrossed in the subject at hand as well as lulled into a semi-comatose state due to heavy infusions of hot tea, and no suspicions rose up in his mind.

"There's no problem there," he replied. "For a simple job like this all you need do is to obtain the actual parts you're going to use and joggle them around for the best positioning."

"I don't think," offered Dick, maintaining the same casual tone, "that I've got a suitable mike

transformer amongst my bits and pieces. Or a mains transformer either, come to think of it. Would you happen to have anything knocking around?"

"I'll have a look in my private box of gear," said the unsuspecting Smithy, as he got off his stool and pulled out a box from under his bench. "I know I've got a mike transformer here and I'm pretty certain I've got a suitable mains transformer as well. And, probably, most of the other parts as well."

On returning from the sink, Dick was delighted to note that Smithy had unearthed all the major components required for the baby alarm amplifier from his personal cache, and was now busily engaged in arranging them out on his bench.

"Have a look at this," said Smithy as Dick placed his mug on the bench. "This is the sort of layout you'll need. All you've got to do now is to knock out a chassis capable of taking this layout and you're made!" (Fig. 2).

"With these components?"

"They're the particular ones," replied Smithy unguardedly, "that I've used for this layout."

"Well, that is decent of you,"

(Continued on page 694)

In last month's article we completed the description of the long, medium and short wave receiver which formed our last constructional project. We shall now return to technical matters for a few issues, after which we will commence a further constructional project

The Output Stage

IN ORDER TO OBTAIN A SIGNAL AT GOOD VOLUME from the receiver whose description was concluded last month, we incorporated a beam tetrode output valve whose specific purpose was to produce a relatively high level of a.f. power for feeding to the loudspeaker. The output valve was employed, despite the fact that we have not yet discussed the operation of valves of this nature, because it enabled the completed receiver to provide loudspeaker reproduction at good entertainment level whilst still allowing the functioning of the preceding stages and circuits to be convincingly demonstrated.

an a.f. signal at adequate power to the loudspeaker, the output valve of a radio receiver also provides amplification as well.

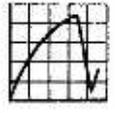
In Fig. 1 (a) we see a valve which we intend to use as an output valve in a sound radio receiver.* An a.f. signal is applied to its grid and we wish to couple its anode to the loudspeaker, which is also shown in the diagram. We may look upon the valve as an a.c. generator and the loudspeaker as a load whereupon, to a first approximation, we could have the circuit configuration shown in Fig. 1 (b), in which diagram the generator connects directly to the load. Note that the generator has an internal resistance, this being shown as a physical resistor connected in series with it. Since the generator is actually the valve of Fig. 1 (a), this internal resistance will be equal to the anode a.c. resistance, or r_a of that valve. Some time ago (in the July 1963 issue) we examined the question of matching an a.c. generator to a load, and we found that maximum transfer of power to the load occurred when the load resistance was equal to the internal resistance of the generator. In Fig. 1 (b), maximum transfer of power would take place, therefore, if the two resistances happened to be equal in value. If (as was also discussed in that earlier article) the two resistances are different,

UNDERSTANDING RADIO

The Output Stage

$$f = \frac{1}{2\pi\sqrt{LC}}$$



by W. G. Morley

An output valve is, in general, the valve in an electronic circuit whose function is to couple the signal generated by that circuit to an external transducer, the latter being any device which converts electrical signal energy into some other form of energy. A loudspeaker is a transducer because it converts electrical signal energy into mechanical energy, the latter producing compressions and rarefactions in the air, which we hear as sound. It was, of course, to a loudspeaker that the output valve of our receiver was coupled.

The output valve of a sound radio receiver is required to provide an adequate level of power in order that the sound from the loudspeaker will be sufficiently loud. This is quite a different function to that of an a.f. voltage amplifier, which amplifies signal voltages at low current levels, and with which very little power is involved. In addition to feeding

maximum transfer of power can still be achieved by interposing a matching transformer, the square root of the transformer turns ratio being equal to the ratio between the two resistances. In the present case it will definitely be necessary to provide a transformer because the generator internal resistance will be of the order of tens of kilohms (which is the sort of r_a figure to be expected from a valve suitable for output purposes) whilst the load would need to be represented as a resistor having a value, for typical moving-coil loudspeakers, of 3Ω or 15Ω . The transformer is introduced in Fig. 1 (c). In Fig. 1 (c) the transformer would have a step-down ratio equal to the square root of the ratio between the r_a and 3Ω or 15Ω , as the case may be, whereupon the circuit will provide maximum transfer of power to the load. Another way of looking at the operation of the circuit is to say that the primary of the trans-

former of Fig. 1 (c) presents an effective load to the generator (at points X and Y) which is equal to the generator's internal resistance.

In Fig. 1 (d) we reintroduce the original valve and loudspeaker of Fig. 1 (a). Keeping the same transformer turns ratio that we had in Fig. 1 (c), we then have the situation where the primary of the transformer presents an effective resistance to the valve anode which is equal to the r_a of the valve. Maximum transfer of a.f. power should, in consequence, take place.

Acceptable Distortion

There are, however, complications which upset this simple state of affairs. Firstly, whilst there may well be maximum transfer of a.f. power to the loudspeaker with the transformer ratio we have chosen, this does not necessarily mean that there will be maximum transfer of power at an *acceptable level of distortion*. With practical output valves it is found that, for a given level of maximum permissible distortion, say 10%, maximum transfer of power occurs when the load presented to the anode by the transformer primary is quite some way removed from the r_a of the valve. Secondly, the loudspeaker cannot be looked upon as a simple resistive load, as was illustrated in Fig. 1 (c). As we have seen earlier (in the August 1964 issue) a moving-coil loudspeaker is quite a complex impedance, and it has different values at different frequencies. In point of fact, the nominal impedance quoted for a loudspeaker is, usually, the impedance it offers at 400 c/s.

Both of these factors, of which the first has greater weight, have to be taken into account when finding the optimum load which may be presented to the anode of an output valve for reproduction at an acceptable level of distortion. For simple general applications, fortunately, it is not necessary for the set designer to find the optimum value for output anode load, because the valve manufacturers already specify this figure in their literature. The optimum anode load figure recommended by the valve manufacturers can then be used for calculating the ratio of the transformer needed to couple the anode to a moving-coil loudspeaker. With most output pentode and beam tetrode valves, the optimum anode load figure for acceptable distortion lies between one-seventh and one-tenth of the r_a figure for the valve.

It will be helpful now to work out an actual example of finding the ratio required in a transformer used for coupling an output valve to a loudspeaker. A typical output valve is the EL84 pentode, for which its manufacturers specify an optimum anode load of 5,200 Ω . We wish to couple this valve to a loudspeaker having a nominal impedance of 3 Ω . Working from what we have just discussed (and which was fully described in the July 1963 issue) the turns ratio required in the transformer will be the square root of $\frac{5,200}{3}$ which (dividing the upper figure by the lower) is the same as the square root of 1,733. This square root works out at 41.6, which means that the transformer re-

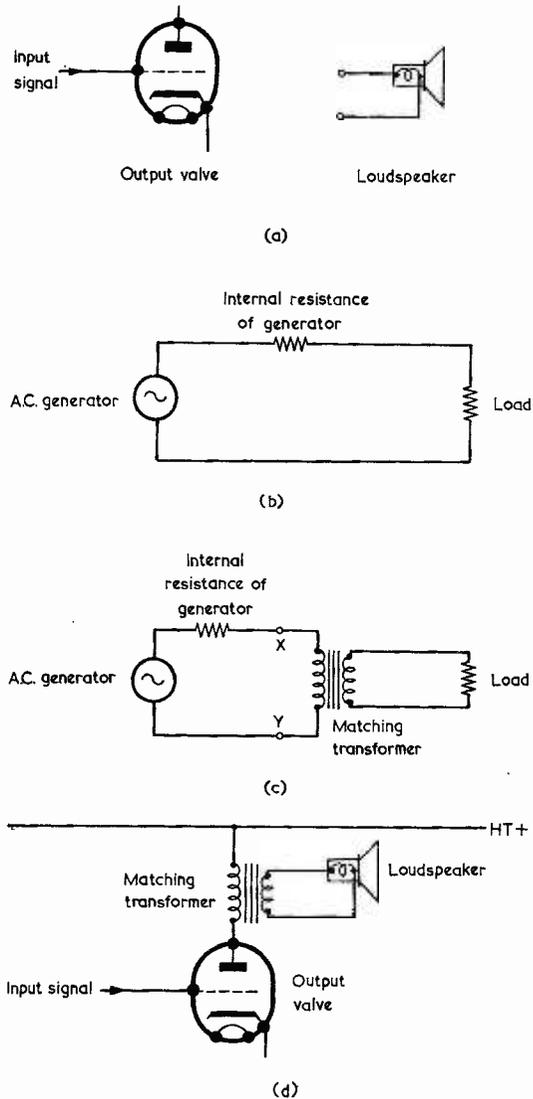


Fig. 1 (a): An output valve (assumed to be a triode) and a loudspeaker. The text discusses the manner in which the valve is coupled to the loudspeaker

(b). Replacing the valve by an a.c. generator, and the loudspeaker by a resistive load

(c). How a matching transformer may be interposed between the generator and the load

(d). Reintroducing the valve and loudspeaker of (a). As is described in the text, the matching transformer ratio which provides maximum transfer of power does not correspond to that which gives maximum transference of power at an acceptable distortion level

quired should have a step-down ratio of 41.6:1. In practice, it would be satisfactory to use a transformer having a ratio of 40:1, this being sufficiently close to the calculated ratio.

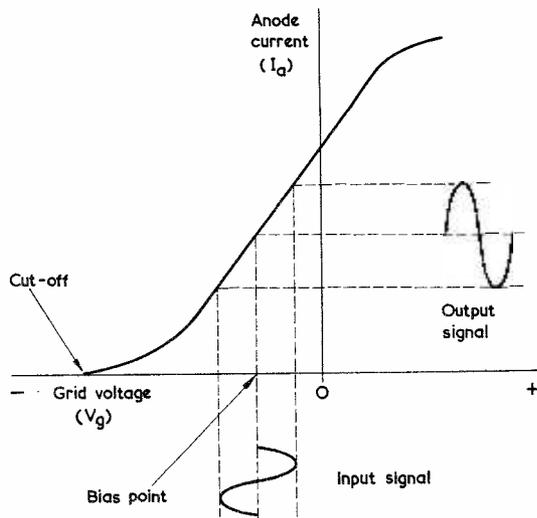


Fig. 2. Illustrating Class A_1 operation, in which the grid is always negative of the cathode

Several further points need to be mentioned before closing on this particular subject. In valve manufacturers' literature it is usual to find the optimum load resistance quoted under a heading such as "Operating Characteristics" or "Operating Conditions". The optimum anode load figure may be referred to as R_a , the capital letter R being used because the quantity is "outside the valve". Output transformers intended for home-constructor applications are often advertised in terms of primary and secondary impedances instead of in terms of ratio. Thus, a transformer advertised as having a "primary impedance" of $5,000\Omega$ and a "secondary impedance" of 3Ω will be quite suitable for coupling an output valve for which the optimum load figure is $5,000\Omega$ to a 3Ω moving-coil loudspeaker. In this case there is no necessity to work out the actual turns ratio. (The $5,000\Omega$ to 3Ω transformer would, incidentally, be quite satisfactory for the EL84 we referred to just now). Other specifications for an output transformer include the maximum anode current its primary winding may safely carry, together with the maximum output power at which the transformer should be used. The anode current (in mA) and output power (in watts) may be ascertained from checking the valve manufacturers' literature for the particular output valve to be used.

We have already referred to the transformer coupling the output valve anode to the loudspeaker as an "output transformer". It may also be described as a "speaker transformer".

Class A Operation

It is possible to operate an output valve under a number of different bias and input signal voltage conditions. Up to the present we have only dealt with voltage a.f. amplifiers, and these are biased in the manner illustrated in Fig. 2, in which diagram

the input signal is applied, at the bottom and along the V_g axis, to the $I_a V_g$ curve for the valve. The corresponding output signal is drawn at the right. The process used to construct the output signal in the diagram is graphical: lines are drawn vertically from the input waveform up to the $I_a V_g$ curve, then continued horizontally to produce the corresponding output waveform. Note that, in Fig. 2, the input signal is a voltage and the output signal is the corresponding anode current.

The input signal in Fig. 2 swings positive and negative of the bias voltage applied to the valve and is at all times applied to the linear (i.e. straight line) part of the curve. In consequence, the output waveform corresponds exactly to the input waveform. Also, the input waveform never causes the grid to go positive of its cathode (that is, to go positive of the zero grid voltage point on the V_g axis) with the result that there is no flow of positive grid current. Also, the input signal does not cause the grid to go beyond cut-off, or to approach the curved section, near cut-off, of the characteristic.

An amplifier valve working under the conditions illustrated in Fig. 2 is described as a *Class A_1 amplifier*.

In practice, it is rare for an $I_a V_g$ curve to have a section which is *exactly* linear, there being some slight curvature even on the straightest part of the curve. It is, however, readily possible to identify the most linear (i.e. straightest) part of an $I_a V_g$ curve, and if the input signal is applied to this most linear part in the manner shown in Fig. 2 then the valve is described as a Class A_1 amplifier.

All a.f. voltage amplifiers operate as Class A_1 amplifiers. So do output valves for radio receivers,

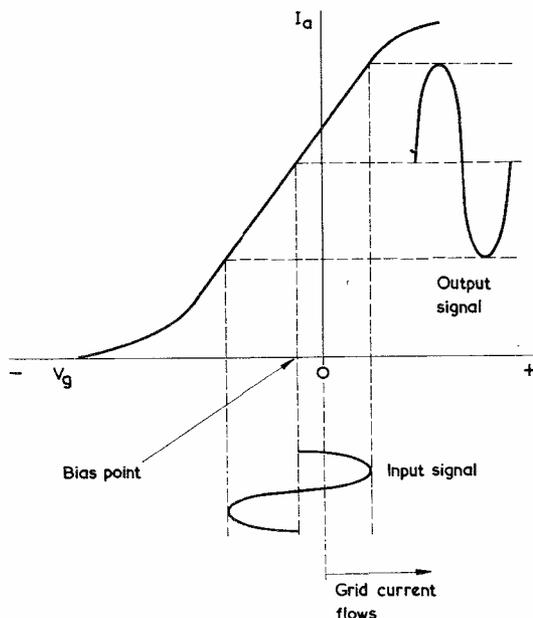


Fig. 3. In Class A_2 operation, positive grid current flows during part of the input positive half-cycle

if they use the typical circuit values that we employed in the receiver which formed our last constructional project. Since no positive grid current flowed at any time during the input cycle, it was possible to obtain the input signal for our output valve from a preceding voltage amplifier. This is a normal practice for radio receivers using valves.

An $I_a V_g$ curve continues to be linear after it has passed to the right of the zero grid voltage point, whereupon an alternative type of Class A operation becomes feasible. This is shown in Fig. 3, wherein the more positive parts of the input cycle cause the grid to go positive of its cathode. The input waveform is still applied to a linear (or very nearly linear) section of the $I_a V_g$ curve, but it is obvious that, in this instance, positive grid current flows during the more positive parts of the input cycle. Because of this the preceding valve will have to be a power amplifier type in order that the correct input waveform shape can be maintained even when grid current flows. The preceding valve could not be a voltage amplifier because its output waveform would become heavily distorted at the onset of grid current.

An output valve operated in the manner shown in Fig. 3 is described as a *Class A₂ amplifier*, the figure 2

indicating that grid current flows over part of the input cycle. This is as opposed to Class A₁ operation, in which the figure 1 indicates that no grid current flows. Class A₂ operation is only employed with valves which deliver power to a load, and never with voltage amplifiers.

Operation in Class A₂ is not attractive for the output stages of radio receivers because of the necessity of preceding the output valve with a valve capable of developing sufficient power to drive the grid. It is a much simpler matter to use an output valve in Class A₁ and precede it with a voltage amplifier.

Since Class A₂ operation is used infrequently in radio receiver work some texts do not mention this method of working at all, referring only to Class A amplification without any subscript figure. Unless otherwise stated, a reference to "Class A amplification" can normally be assumed to apply to Class A₁ working.

Next Month

In next month's article we shall introduce parallel and push-pull output circuits and describe other classes of operation. *

Basic Radio Control (5)

(Continued from page 685)

Licence

A radio control licence must be obtained to operate the transmitter, and application for this should be made to:

Radio Services Department,
Radio Branch,
Amateur Licensing Section,
G.P.O. Headquarters Building,
St. Martins-le-Grand,
London, E.C.1.

No test is involved, and the licence, which costs £1 lasts for five years. *

4-Channel Mixer/ Pre-amplifier

(Continued from page 679)

circuit board but the normal chassis type of assembly may be used instead.

The heater wiring should be earthed to chassis at one point only, this being at pin 2 of socket SKT₆. With conventional wiring, the heater leads should be tightly twisted and kept well clear of grid and anode components. To keep hum loops to a minimum, each input circuit to V₁ and V₂ grids should use a single chassis point for the volume control and screening connections, this being at the chassis connection for the appropriate input socket.

When the unit is to be operated close to the main amplifier it is necessary to ensure that T₁ does not have a hum voltage induced in it due to the field from the main

amplifier mains transformer. This may necessitate positioning the mixer and pre-amplifier unit so that the two transformers are some distance away from each other. It should be added that, if the unit is completely

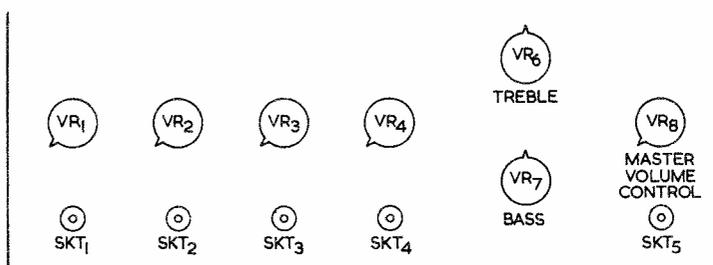


Fig. 2. A convenient front panel layout. Pre-set gain control VR₅ should be adjustable from the rear of the unit, and socket SKT₆ should also be accessible from the back. Panel dimensions depend upon the requirements of the constructor but a neat presentation, without having the control knobs too close together, would be given with outside dimensions of the order of 6½ x 16ins

enclosed in a metal case at chassis ventilation), trouble from hum pick-up potential (with suitable apertures for pick-up will be at a minimum. *

IN YOUR WORKSHOP

(continued from page 689)

said Dick warmly, "I'm certain my friend will appreciate it when I tell him that you were kind enough to supply the main parts for his baby alarm."

The penny dropped.

"Dash it all, Dick," expostulated Smithy. "I only intended this layout to represent an example. I didn't mean that I was actually going to give you these components."

Dick turned a reproachful look on the Serviceman.

"Surely," he remarked, "you don't mean that you're going to deny that poor baby the parts for its baby alarm? How could you be so hard-hearted towards a wee innocent little bairn like that?"

Smithy sighed.

"All right, I give in," he said resignedly. "Take the components! After that heart-rending line of patter I can hardly refuse, can I?"

"You aren't the only one," chuckled Dick, swiftly gathering up the parts from Smithy's bench. "It's precisely the same approach that was successfully worked out on me by my friend and his missus yesterday evening!"



RECENT PUBLICATIONS



TRANSISTOR BIAS TABLES. By E. Wolfendale, B.Sc. (Eng.), M.I.E.E. 71 pages, 9 $\frac{3}{4}$ x 7 $\frac{1}{4}$ in. Published by Iliffe Books' Ltd. Price 21s.

Of the 71 pages which constitute this book, 55 are "written" by a computer! The book consists, in fact, of a series of comprehensive tables which give, amongst other things, calculated values of bias resistance at different values of collector current, supply voltage, beta, I_{CO} and junction temperature, for a transistor connected as a common emitter amplifier. Thus, the tables afford a very useful short-cut for designers of transistorised equipment who wish to find the optimum values of bias resistance under particular circuit conditions.

The tables are grouped in terms of collector current (from 0.1mA to 10A), supply voltage (from 3 to 24V) and transistor beta, the last being arbitrarily chosen as 20, 60 and 200. Columns in each group of figures in the tables also show collector current for beta halved and beta doubled, to give an idea of the changes likely to be caused by transistor spread. Further columns indicate calculated collector currents at 45°, 60° and 85°C under the circuit conditions given.

An introductory text precedes the tables, this explaining how they are derived and how they may be used. The tables themselves are reproduced direct from the computer print-out, a fact which demonstrates, incidentally, how economic this method of book production can be.

Intended for the design office or laboratory, the tables are printed on strongly-bound stout paper, so as to stand up to constant handling when used for reference. The tables are intended for germanium transistors only.

LOUDSPEAKERS AND LOUDSPEAKER CABINETS. By P. W. Van Der Wal. 107 pages, 8 $\frac{3}{4}$ x 5 $\frac{1}{2}$ in. Published by Iliffe Books, Ltd. Price 15s.

This book, which appears in the Philips Paperback series and is translated from the Dutch by J. Nicholls, will be of particular interest to high fidelity enthusiasts who have a penchant towards home-carpentry. Starting from basic principles, the book explains loudspeaker operation, carrying on to mono and stereo speaker installations, indoor acoustics, and the principles of baffles and bass reflex cabinets. There are then 33 pages describing the practical construction of cabinets. Fully dimensioned drawings are given for no less than 24 different models, including a simple baffle, 8 bass reflex cabinets and a range of "acoustic boxes" (closed enclosures with internal sound-absorbent material) and closed column cabinets. These cabinets are intended for specific Philips loudspeakers, whose type numbers are quoted and which should be available from hi-fi dealers handling Philips products.

RAPID SERVICING OF TRANSISTOR EQUIPMENT. By Gordon J. King, Assoc.I.E.R.E., M.T.S. 151 pages, 8 $\frac{1}{2}$ x 5 $\frac{1}{2}$ in. Published by George Newnes, Ltd., Price 30s.

"In this book I have endeavoured to discuss transistors, transistor circuits and their faults as though thermionic valves had never existed." This, the first sentence in the preface, combined with the adjective "rapid" in the title, gives a very good indication of the forward-looking and practical approach in this excellent book.

Gordon J. King writes, here, for the service engineer changing over to transistors, for the student starting a career in electronics and for the enthusiastic amateur, and he covers fault-finding in transistor circuits from simple radio receivers to television circuits, u.h.f. amplifiers and high fidelity equipment. After introductory chapters on transistor fundamentals and testing techniques, the book proceeds to separate chapters devoted to fault finding in audio and video circuits, in r.f. circuits, in oscillator circuits, and in transistor radios and hi-fi amplifiers. A final chapter deals with general practice in transistor servicing.

The text is straightforward and non-mathematical in the treatment of its subject, and there are a large number of clear illustrations and photographs. This is a very useful book for anyone who is starting work with transistors in any category.

OUTLINE OF RADIO AND TELEVISION. By J. P. Hawker. 399 pages, 8 $\frac{1}{2}$ x 5 $\frac{1}{2}$ in. Published by George Newnes, Ltd. Price 30s.

As Communications Correspondent for *Electronics Weekly*, J. P. Hawker is, of course, widely experienced in the field of journalism as well as that of communication equipment. This fact is well reflected in *Outline Of Radio And Television*, which covers the whole gamut of radio, television and electronics, as applicable to equipment likely to be encountered in the home.

The large number of pages in this volume allow its 22 chapters to cover d.c. and a.c. fundamentals, amplifiers, radio and TV receivers, tape recorders and aerials. Every subject is dealt with at sufficient depth to give a good overall understanding of operation, and a clear and concise text is augmented by good, illustrative diagrams. Complete circuit diagrams are given to demonstrate radio and TV receivers and tape recorders. A useful bonus is that, where applicable, brief references to the history of devices are included.

The material is modern and up-to-date and the book is an ideal and authoritative primer for anyone who is starting to study, or evincing an interest in, the subject of radio and electronics.



Radio Topics

By Recorder

ONE OF THE CHARMS OF RADIO construction as a hobby is that it can be pursued at quite low expenditure in terms of cash. Even now, there are still plenty of government surplus items knocking around which can be bought at give-away prices and which yield quite a rich harvest in terms of components, nuts, bolts and other assorted oddments of hardware. Old TV's and sound radios similarly offer a good hunting-ground for spare parts. Whilst components obtained from these sources must obviously be looked upon as being less reliable than components bought brand-new, they still enable even the most impecunious hobbyist to get at least a basic stock of parts together.

Two Essentials

But radio construction does not merely consist of obtaining the parts for a project; it also includes the more fascinating procedure of assembling them together and getting the finished project to work correctly. So far as the experienced constructor is concerned, this last process involves no great problems. At the same time, however, there are always newcomers joining our ranks and some of these may well, this month, be reading these particular notes. In consequence, I hope that the more case-hardened enthusiasts will excuse me if I devote my space in this issue to the beginner and the basic equipment he will need if he is to extract maximum enjoyment from the hobby he has taken up.

The beginner will, of course, require a few simple tools for tackling the chassis-bashing part of radio construction, and these are of the same order as would be

needed in any other pursuit which involves the handling of metal and plastics, etc. But he will also require two items which are peculiar to radio work alone. The first of these is a good soldering iron specifically intended for radio wiring, and the second is a good multi-testmeter. Fortunately, like the components, these two items need not necessarily involve the constructor in a great deal of expenditure.

So far as the soldering iron is concerned, a rating of about 15 to 30 watts represents what will normally be needed for radio work, and a good range of irons suitable for operation from the mains is available from radio component retailers. Prices, brand-new, are around the 30 shilling mark for the iron on its own, and a little shopping around will soon enable the budding constructor to choose the model he thinks will suit him best. For home-constructor soldering, Ersin Multicore Savbit alloy represents a good buy. There is a small percentage of copper in Savbit alloy and this counteracts the migration of copper from the soldering iron bit into the joint which occurs when using normal tin-lead solders. Your soldering iron bit will last longer if you use Savbit.

Like other cored solders, Savbit has its own flux in the cores along its length, and no extra flux is needed at all for radio wiring and assembly. Beginners must never submit to the temptation of using paste or liquid fluxes when wiring up any electronic project, since this represents extremely *bad* practice. After soldering, a paste or liquid flux leaves a residue at the insulation around the component tags, and this may later provide an unwanted conductive path. Some of the more

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active liquid fluxes may even cause damage to insulation.

The knack of soldering is very easily acquired, but the newcomer still has to acquire it, nevertheless. Apply the soldering iron to the work (i.e. the parts of the joint which are to be soldered), apply at the same time the cored solder to the point of contact between the iron and the work, then wait for the very short period needed for the work to acquire soldering temperature. The solder will then flow over the work. In most cases the solder will flow almost immediately, and you will then see it run smoothly over the joint, covering all the interstices and crannies. As soon as sufficient solder has flown over the work remove the soldering iron and the solder—and that's it!

It is helpful to remember that the function of the flux in the solder is to break down the oxides on the surfaces of the work so that the molten solder meets virgin metal when it flows, whereupon it forms the required bond to the metal. What is described as a "cold joint" is one in which the oxide film on the work hasn't broken down, whereupon the solder has merely covered it without making a true bond. This will give rise to trouble later, because a good electrical connection has not been made. "Cold joints" occur when the work is dirty, with a heavy oxide coating which the flux hasn't been able to break down, when the soldering iron hasn't been applied sufficiently long for the flux to do its job, or when there is a combination of both effects. Good quality radio component wires and solder tags are specially plated for low oxide formation and for quick "wetting" by the solder, and they allow joints to be soldered in virtually no time at all. If the beginner practices with a few odd tagstrips and bits of wire he will soon pick up the knack of soldering. After a little experience, you can tell when you're making a good solder joint because of the smooth way the solder flows over the work.

The Multi-Testmeter

Let us now turn to the second requirement for radio constructional work, if this is to be pleasurable and rewarding. One of the fascinations of our hobby is that it is impossible to see what goes on in the items we make up. We know that we have electrons scurrying around all over the place in our wires and terminals, but the only way we can

find out what they are up to is to connect a device which translates electrical signals into a form which can be perceived by our senses. Thus, when we assemble a radio receiver we have to connect a speaker to its output to hear what results the circuit is giving. If the right sounds come out of the speaker, then we know that the electrons in the circuit are doing their job as they should!

Another device which translates electrical quantities into perceivable form is the voltage or current reading meter. Such an instrument is, to my mind, entirely necessary if any serious radio work is to be attempted. Should you build a receiver and find it doesn't work, you can waste hours poking around at its components before you discover what's wrong. If, on the other hand, you've got a good voltmeter, you only need to take a few voltage readings and, more likely than not, you'll be able to pin-point the trouble in a matter of minutes.

The general practice, nowadays, is to use a multi-testmeter. This is an instrument which combines a single meter movement with a switching circuit which enables a wide range of voltages and currents to be measured. The multi-testmeter will also, by means of an internal battery, measure resistance. The battery applies a voltage to the resistance to be checked, the current which flows is measured by the meter, and the result is indicated on a scale calibrated in units of resistance.

Multi-testmeters can be home-constructed as well as being bought ready-made. On its own, the assembly of test equipment is an intriguing pursuit, and many enthusiasts specialise in this field. Indeed, lots of amateur work is done with the aid of home-constructed multi-testmeters. The beginner who wants to make his own multi-testmeter might be best advised to work from a kit with good assembly instructions. If he is working entirely from scratch, with every item obtained separately, it might be necessary to check results against another meter and this may not be available to him.

Manufactured multi-testmeters can, at present, be bought at very low cost. It is possible, for instance, to purchase a testmeter having five d.c. voltage ranges, five a.c. voltage ranges, three d.c. current ranges and a resistance range, for less than £2 retail. This instrument has a sensitivity of 1,000Ω per volt, which is about the minimum for radio work. More expensive multi-

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testmeters, with higher sensitivities and more ranges, can also be obtained. In general, one would expect the more expensive instruments to have a greater accuracy and to be more robust physically. However, all test meters are precision instruments and even the most costly of them can still suffer damage if they are knocked around or otherwise maltreated.

The "ohms per volt" figure quoted for a multi-testmeter can be confusing to some beginners. This figure applies to the voltage ranges only, and the manner in which it is derived is quite simple. A voltmeter is, essentially, a current reading meter with a resistor in series. If you have a current reading meter whose needle indicates full-scale deflection at 1mA and you connect a 10k Ω resistor in series with it, you will then have a voltmeter with a full-scale deflection of 10 volts. This is because, when 10 volts is applied to a 10k Ω resistor, a current of 1mA flows. With a 100k Ω resistor in series with the current reading meter the arrangement becomes a voltmeter with a full-scale deflection of 100 volts. A circuit arrangement of this type is, indeed, what appears inside a multi-testmeter; the range switch on the voltage ranges inserts different values of resistance in series with the basic current reading meter. In the example I've just mentioned, it is assumed that the meter itself has no resistance. In practice it has a small resistance (given by the wire in the coil which actuates the needle) and this has to be taken into account when low-value series resistances are worked out for the lower voltage ranges.

Note that, in the example, we had 10k Ω for the 10 volt range and 100k Ω for the 100 volt range. Our voltmeters had, in consequence, a sensitivity of 1,000 Ω per volt. A multi-testmeter with a basic 1mA meter and the same series resistances for its 10 and 100 volt ranges would also be described as having a sensitivity of 1,000 Ω per volt. If we switched such a testmeter to, say, a 25 volt range, the series resistor switched in would cause the resistance between the testmeter terminals to be 25 times 1,000 Ω (i.e. 25k Ω) and so on. Were we to use a more sensitive basic meter with a full-scale deflection of 100 μ A (which is one-tenth of a milliamp) our 10 volt range would have a series resistance of 100k Ω , and our 100 volt range one of 1M Ω . This second instrument would then be described as having a sensitivity of 10k Ω per volt.

High voltmeter sensitivities are desirable for radio work but not essential. Let us consider the case where the anode of a valve couples to an h.t. positive line by way of a 100k Ω resistor, and we want to measure the voltage between this anode and chassis with a multi-testmeter switched to a 200 volt range. If it were a 1,000 Ω per volt instrument it would present a resistance of 200k Ω between the anode and chassis. This would draw an additional current through the 100k Ω anode resistor and the reading obtained would be lower than the voltage which existed before the meter was applied. The voltage would still be lower if a 10k Ω per volt meter were used, but the error would now be less because this second meter would present a resistance of 2M Ω . This state of affairs does not preclude the use of a 1,000 Ω per volt meter for radio measurements. All that has to be remembered is that voltage readings will be low if there is a high series resistance in the circuit being checked. The resultant error becomes less with a more sensitive meter.

Correct Treatment

Finally, if you are about to become the proud possessor of a multi-testmeter, let me pass on some tips which I've picked up over the years.

Always leave the instrument switched to a high voltage range when a series of tests has been completed. This will prevent any accidents, as would occur if the instrument were left on a low-current range and, later, you absent-mindedly applied it to a source of high voltage.

Never tap the glass of the meter. If the needle sticks at any point along the scale there is something wrong with the movement and it needs fixing. Tapping the glass merely causes it to eventually come unstuck!

When measuring an unknown voltage or current, always make the first measurement with the testmeter switched to the highest voltage or current range which would appear sensible. If you commence with too low a range the meter may be overloaded when the test is made.

Always treat the meter carefully and with respect and, preferably, keep it in its box when not in use.

And, in conclusion, a note which applies to all new electronic equipment. Before using it, read the manufacturer's instructions!



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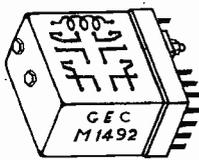
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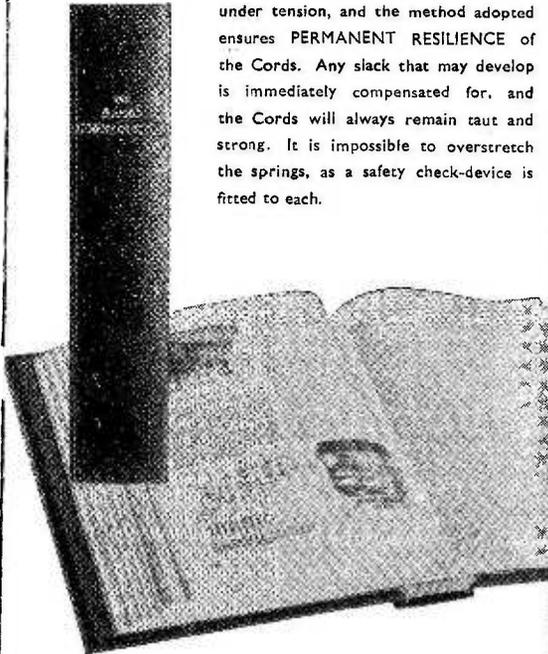
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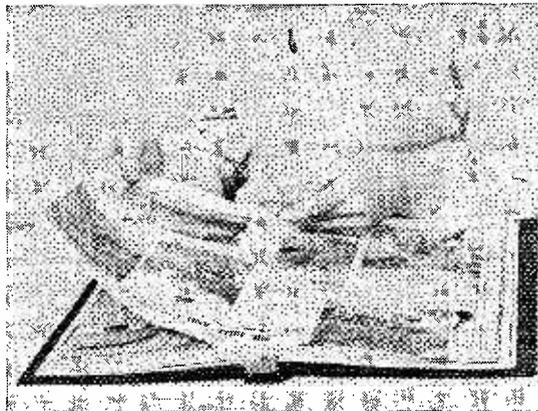
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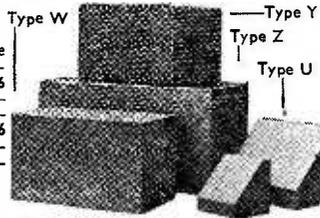
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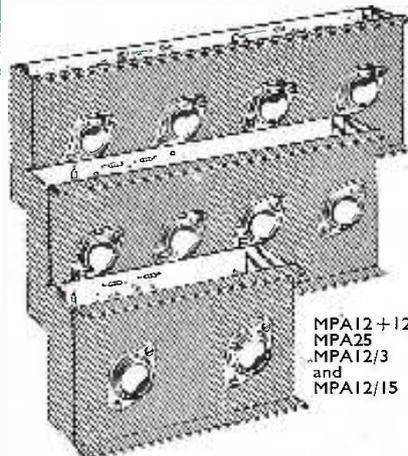
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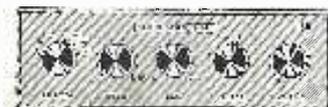
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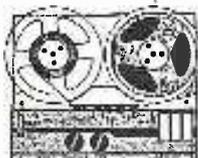


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