

THE Radio Constructor

RADIO
TELEVISION
AUDIO
ELECTRONICS

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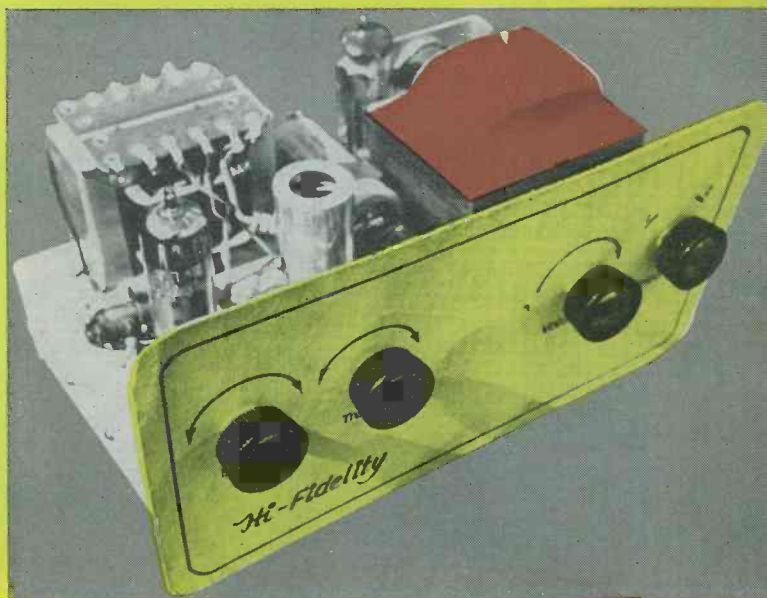
June 1964

"Double-Two" Audio Amplifier

8.5 watts Output
using the new

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double audio pentode



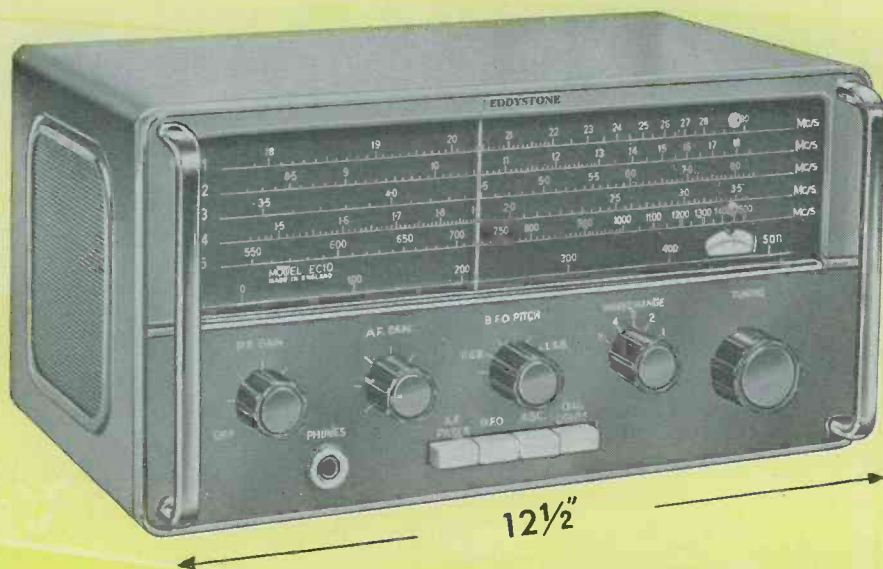
Transistor Tape
Recorder Circuits

Basic Superhet
for Beginners

Mains Overload
Protection Device

Transistor and
Diode Tester

A NEW **EDDYSTONE** MODEL THE RUGGED COMPACT 'EC 10' TRANSISTORISED COMMUNICATIONS RECEIVER



LIGHT and PORTABLE
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550 kc/s to 30 Mc/s

Five ranges give complete coverage from 550 kc/s to 30 Mc/s. Precision flywheel-loaded slow-motion drive with 110/1 reduction ratio. Uses thirteen semi-conductors, including stabilising Zener diode, resulting in excellent performance on all ranges. Internal speaker and jack for telephones.

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List Price £48

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LASKY'S RADIO

FOR THE FINEST RANGE OF TRANSISTOR RECEIVERS

We consider our construction parcels to be the finest value on the home constructor market. If on receipt you feel not competent to build the set, you may return it as received within 7 days, when the sum paid will be refunded, less postage.



THE SKYROVER and the SKYROVER DE LUXE

GENERAL SPECIFICATION. 7 transistor plus 2 diode superhet, 6 waveband portable receiver. Operating from four 1.5V torch batteries. The SKYROVER and SKYROVER DE LUXE cover the full medium waveband and short waveband 31-94 M, and also 4 separate switched band-spread ranges, 13 M, 16 M, 19 M and 25 M, with band-spread tuning for accurate station selection. The coil pack and tuning heart is completely factory assembled, wired and tested. The remaining assembly can be completed in under three hours from our easy to follow, stage by stage instructions.

SPECIFICATION: Superhet, 470 kc/s. All Mullard transistors and diode. Uses 4 U2 batteries, 5" Ceramic Magnet P.M. Speaker. Easy to read Dial Scale, Band-spread Tuning, 500mW Output. Telescopic Aerial and Ferrite Rod Aerial.

WAVEBAND COVERAGE: 180-576 M, 31-94 M, and band-spread on 13, 16, 19 and 25 metre bands.

All components available separately. Four batteries included free. Data for each receiver, 2/6 extra, refunded if you purchase the parcel.

THE SKYROVER

Controls: Waveband Selector, Volume Control with On/off Switch, Tuning Control. In plastic cabinet, size 10" x 6 1/2" x 3 1/2", with metal trim and carrying handle.

Can be built for **£10.19.6**
H.P. Terms:—
22/- dep. & 11 months at 21/-
P. and P. 5/- extra

THE SKYROVER DE LUXE

Tone Control circuit is incorporated, with separate Tone Control in addition to Volume Control, Tuning Control and Waveband Selector. In a wood cabinet, size 11 1/2" x 6 1/2" x 3", covered with a washable material, with plastic trim and carrying handle. Also car aerial socket fitted.

Can be built for **£12.19.6**
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★ 7-transistor Superhet. ★ 350 milliwatt output into 4" high flux speaker. ★ All components mounted on a single printed circuit board, size 5 1/2" x 5 1/2" in one complete assembly.

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★ I.F. frequency 470 kc/s. ★ Ferrite rod internal aerial. Operates from PP9 or similar battery. ★ Full comprehensive data supplied with each receiver. ★ All coils and I.F.s, etc., fully wound ready for immediate assembly.

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P. and P. 4/6
PP9 Battery, 3/9. Data and instructions separately, 2/6. Refunded if you purchase the parcel.



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With the same specification as standard model —PLUS a superior wood cabinet in contemporary styling. ALSO a full vision circular dial

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LASKY'S PRICE 69/6

complete with all accessories. Post Free.

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TF-01D 470 kc/s ± 2 kc/s

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RECORDING TAPE SPLICER

By famous manufacturer, all metal nickel plated construction. With separate razor blade—securely clamps tape while splicing.

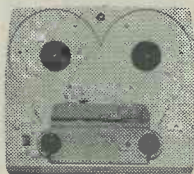
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Crystal—high imp. Size only 1 1/2" x 2" x 1/2". Clips to fingerboard—no screws. Complete with cable.

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FAMOUS MAKE TAPE DECKS



MODEL R7 BY
WELL KNOWN
BRITISH MAN-
UFACTURER

Two speeds—3 1/2 and 7 1/2 i.p.s.; three high quality motors. Will record and replay IN BOTH DIRECTIONS. Fast forward and rewind. Supplied less heads, space is provided for fitting 4 heads of any type, to give full working in both directions on either 1, 2 or 4 track. Unit plate size 13" x 15", depth below top of plate 5 1/2". Will take 7" spools. Tape position counter fitted. For 200-250 volt 50 c.p.s. mains. Two-tone grey finish. Perfect order. Supplied less heads.

LASKY'S PRICE £9.19.6

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TAPE DECK MOTORS



Motors for the Collara Studio Deck—new and unused. 200-250V A.C. Take-up, rewind and capstan. Listed at £2 5s. each, **LASKY'S PRICE 14/11** each. P. & P. 2/6. Set of three 35/-, P. & P. 6/-.

High quality tape deck capstan motor made by E.M.I. Holland. Bi-directional. Size: 4" dia., x 2" high. 1" x 1/2" spindle.

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CAN BE BUILT FOR **79/6** P. and P. 3/6 extra



★ Six-Transistor Superhet Miniature Personal Pocket Radio
★ Long and medium wavebands
★ Ferrite Rod Aerial
★ I.F. Frq. 470 kc/s
★ 3" speaker

★ Printed circuit 2 1/2" x 2"
★ In Plastic Case. Size 4" x 2 1/2" x 1 1/2".

In order to ensure perfect results, the SPRITE is supplied to you with R.F. and L.F. stages. Driver and output stages ready built with all components mounted on the printed circuit. The SPRITE pre-assembled, plus cabinet, speaker and all components for final construction, can be built for 79/6. Postage and package 3/6 extra. Data and instructions separately 2/6. Refunded if parcel is purchased. Real calf leather case, wrist strap, personal earphone and case for earphone and battery, 12/6 the lot extra. Make no mistake, this is a SUPERHET receiver of genuine commercial quality. It is not a regenerative circuit.

HEADPHONES

S. G. Brown type F earphones—moving iron 2,000Ω. Hand-held type, but a headband could easily be fitted.

LASKY'S PRICE 14/6 PAIR P. & P. 1/6

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HI-FI AMPLIFIERS — TUNERS — RECORD PLAYERS

S-33



HI-FI 6W STEREO AMPLIFIER. Model S-33. 3 watts per channel 0.3% distortion at 2.5W/chnl., 20dB N.F.B. Inputs for Radio (or Tape) and Gram, Stereo or Monaural, ganged controls. Sensitivity 200mV. **£13.76**

S-99



DE LUXE STEREO AMPLIFIER. Model S-33H. De luxe version of the S-33 with two-tone grey perspex panel, and higher sensitivity necessary to accept the Decca Deram pick-up. **£15.176**

HI-FI STEREO AMPLIFIER. Model S-99. 18W output. Ganged controls. Stereo/Mono gram., radio and tape inputs. Push-button selection. Printed circuit construction. **£27.19.6**

POWER SUPPLY UNIT. Model MGP-1. Input 100/120V, 200/250V. 40-60 c/s. Output 6.3V, 2.5A A.C. 200, 250, 270V, 120mA max. D.C. **£5.2.6**

A wide range of American equipment available under direct mail order scheme. Full details and catalogue 1/- post paid.

GL-58



GOLDRING Lenco TRANSCRIPTION PLAYER. Model GL-58. With G-60 pick-up arm and Ronette 105 cartridge. **£18.19.2**

MA-12



GARRARD AUTO/RECORD PLAYER. Model AT-6. With R 105 cartridge. **£13.12.1** With Decca Deram pick-up **£14.6.1**

SUGDEN MOTOR UNIT "CONNOISSEUR CRAFTSMAN". Heavy duty motor operating at 33½ and 45 r.p.m. Very heavy 12" turntable. Virtually no rumble. **£16.6.6**

HI-FI MONO AMPLIFIER. Model MA-5. A general purpose 5W Amplifier, with inputs for Gram., Radio. Presentation similar to S-33. **£10.19.6**

HI-FI MONO AMPLIFIER. Model MA-12. 12W output, wide freq. range, low distortion. **£11.18.0**



Enjoy Yourself and Save Money

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PA-1

PA AMPLIFIER PA-1. The ideal compact unit for VOCALISTS, INSTRUMENTALISTS, RECORDS, with 50 Watt output, 2 Heavy Duty Speakers. Variable TREMOLO. Elegant modern cabinet. Send for full specification. **£54.15.0**

Legs optional extra 17/6 set of 4.

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(fully transistorised)

Ideal for Soloists, Home use, Groups. Full 20 WATTS VOLUME. Matching bench **£14.10.0** extra.

£187.10.0

TRANSISTOR RADIOS

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



UXR-2

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JUNIOR TRANSISTOR RADIO. Model UJR-1. Single transistor set. Excellent introduction to radio. **£2.7.6**

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5" GENERAL-PURPOSE LABORATORY OSCILLOSCOPE. Model IO-12U. This outstanding oscilloscope, with its professional specification and styling, fulfills most laboratory and service requirements. Vertical frequency response 3 c/s to over 5 Mc/s, sensitivity 10mV r.m.s. per cm. at 1 kc/s. T/B covers 10 c/s-500 kc/s. Please send for full details. **£32.12.6**

2½" PORTABLE SERVICE SCOPE. Model OS-1. This is a light, compact oscilloscope, ideal for servicing, etc. Dimensions 5" x 8" x 14½" long. Weight 10½ lb. **£21.18.0**



S-3U

ELECTRONIC SWITCH. Model S-3U (Oscilloscope Trace Doubler). Enables a single beam oscilloscope to give simultaneous traces of two separate and independent signals. Switching rates approx. 150, 500, 1,500, 5,000 and 15,000 c/s. Sig. freq. response 0-100 kc/s. ±1dB. Separate gain controls and sync. output. Sig. input range 0.1-1.8V r.m.s. **£12.18.0**



AG-50U

AUDIO SIGNAL GENERATOR. Model AG-50U. 10 c/s to 100 kc/s, switch selected. Distortion less than 0.1%, 10V sine wave output metered in volts and dB's. **£22.10.0**

RESISTANCE/CAPACITANCE BRIDGE. Model C-3U. Measures capacity 10pF to 1,000µF, resistance 100Ω to 5MΩ and power factor. 5-450V test voltages. With safety switch. **£10.10.0**

New! DE LUXE LARGE-SCALE

VALVE VOLTMETER. Model IM-13U. Circuit and specification based on the well known model V-7A but with many worthwhile refinements. 6" Ernest Turner meter. Unique gimbal bracket allows operation of instrument in many positions. Modern styling. Please send for full details **£18.18.0**



IM-13U

CAPACITANCE METER. Model CM-1U. Direct-reading 4½" scale. Full-scale ranges 0-100µF, 0-1,000µF 0-0.01µF and 0-0.1µF. **£15.15.0**

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 0.1Ω to 1,000MΩ with internal battery. D.c. input impedance 11MΩ. dB measurement, has centre-zero scale. Complete with test prods, lead and standardising battery. **£13.18.6**



V-7A

MULTIMETER. Model MM-1U. Ranges 0-1.5V to 1,500V a.c. and d.c.; 150µA to 15A d.c.; 0.2Ω to 20MΩ. 4½" 50µA meter. **£12.18.0**

R.F. SIGNAL GENERATOR. Model RF-1U. Up to 100 Mc/s fundamental and 200 Mc/s on harmonics and up to 100mV output on all bands. **£13.8.0**



RF-1U

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COLLARO



D-83/4



FM-4



AM/FM

COLLARO "STUDIO" TAPE DECK. The finest buy in its price range. Operating speeds: 1 1/2", 3 1/4" and 7 1/2" p.s. Two tracks, "wow" and "flutter" not greater than 0.15% at 7 1/2" p.s. **£17.10.0**

TRUVOX D93/2 & D83/4 TAPE DECKS. High quality mono/stereo tape decks.

D93/2, 2 track, **£36.15.0** D83/4, 4 track, **£29.8.0**

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—£21.16.6). Printed circuit board, 8 valves. Covers L.W., M.W., S.W., and F.M. Built-in power supply. Total **£26.10.0**

HI-FI FM TUNER. Model FM-4U. Also available in two units. R.F. tuning unit (£2.15.0 incl. P.T.) with I.F. output of 10.7 Mc/s, and amplifier unit, with power supply and valves (£13.3.0). Total **£15.18.0**

TAPE RECORDING/PLAYBACK AMPLIFIER. Thermometer type recording indicators, press-button speed compensation and input selection. Mono Model TA-1M, **£19.18.0** Stereo Model TA-1S, **£25.10.0**

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. **£8.12.6**

STEREO CONTROL UNIT. Model USC-1. Push-button selection accurately matched ganged controls to ±1dB. Negative feedback, rumble and variable low-pass filters. Printed circuit boards. **£19.10.0**

Building these Heathkit models



AMATEUR EQUIPMENT

SINGLE SIDEBAND ADAPTOR. Model SB-10U. May be used with most A.M. transmitters. Less than 3W R.F. input power required for 10W output. Operator on 80, 40, 20, 15 and 10m bands on U.S.B., L.S.B. or D.S.B. **£39.5.0**

AMATEUR TRANSMITTER. Model DX-40U. Covers all amateur bands from 80 to 10 metres; crystal controlled. Power input 75W C.W., 60W peak controlled carrier phone. Output 40W to aerial. Provision for V.F.O. Filters minimise TV interference. **£33.19.0**

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COMMUNICATIONS TYPE RECEIVER.

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. Send for full specification. **£39.16.0**

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SB-10U



DX-40U

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. Amplifier Stage. Send for spec. **£39.6.6**

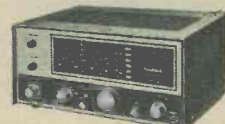
THE "MOHICAN" GENERAL COVERAGE RECEIVER. Model GC-1U. With 4 piezo-electric transmitters, variable tuned B.F.O. and Zener diode stabiliser, this is an excellent fully transistorised general purpose receiver for Amateur and Short wave listeners. Printed circuit boards, telescopic whip antenna, tuning meter and large slide-rule dial, 10 transistors. **£37.17.6**

AMATEUR TRANSMITTER. Model DX-100U. The world's most popular, compact and completely self-contained Amateur Transmitter. Covers all amateur bands: 160-10 m. 150W d.c. input. Careful design has achieved the stability and high performance for which the DX-100U is noted and no less than 35 disc ceramic capacitors reduce TVI to a minimum. **£79.10.0**

A wide range of American amateur equipment.



RG-1



RA-1



SSU-1



MFS

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THE "COTSWOLD". This is an acoustically designed enclosure 26" x 23" x 15 1/4" housing a 12" bass speaker with 2" speech coil, elliptical middle speaker together with a pressure unit to cover the full frequency range of 32-20,000 c/s. Capable of doing justice to the finest programme source, its polar distribution makes it ideal for really Hi-Fi Stereo.

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TELEVISION SETS, RECEIVERS AND TRANSMITTERS

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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.
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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.

Why not BE PRUDENT AND INSURE your installation—it is well worth while AT THE VERY LOW COST INVOLVED. If you will complete and return this form to the Corporation's Office at the above address, a proposal will be submitted for completion.

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J/B

THE MODERN BOOK CO

Beginner's Guide to Electronics. By T. L. Squires. 15s. Postage 9d.

ABC's of Transistors. By G. B. Mann. 5s. Postage 6d.

Electronic Organ Handbook. By H. E. Anderson. 40s. Postage 1s.

Radio Servicing Problems. By W. L. Smith. 5s. Postage 6d.

Modern Tape Recording and Hi-Fi By K. Peters. 30s. Postage 1s.

The Radio Amateur's Handbook. By A.R.R.L. 1964 Ed. 36s. Postage 2s. 3d.

Single-Sideband Communications Handbook. By H. D. Hooton. 50s. Postage 1s.

Radio Valve Data, 7th Ed. Compiled by "WW" 7s. 6d. Postage 10d.

The Transistor Radio Handbook. By D. L. Stoner and L. A. Earnshaw. 44s. Postage 1s.

Understanding Television. By J. R. Davies. 37s. 6d. Postage 1s. 6d.

How to Listen to the World, 1963-64. 14s. 6d. Postage 1s.

Maintenance Manual. By Mullard. 16s. Postage 1s.

World Radio TV Handbook, 1964. 22s. Postage 1s.

Radio Servicing Pocket Book. By J. P. Hawker. 12s. 6d. Postage 8d.

How to Build Tiny Electronic Circuits. By M. Moses. 30s. Postage 1s.

Circuits for Audio Amplifiers. By Mullard. 8s. 6d. Postage 1s.

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More Micro-6 Developments

Because of the enormous interest in the Micro-6, we at Sinclair Radionics have been devoting much of our time to the development of accessories which add to its usefulness. The first of these, the TR.750 power amplifier was introduced last month. This remarkably low-priced high performance design has, of course, a great many applications but in conjunction with the Micro-6 or the Slimline it can form a really powerful car, home or portable radio.

The latest Micro-6 accessory is just as exciting! We have designed and produced an elegant nylon wrist strap which clips straight on to the Micro-6, converting it into a wrist radio—the first of its kind in the world! The earpiece lead may then be run up the sleeve and the radio listened to without any trailing wires. The wrist strap may be removed instantly when desired, but in use it is firmly attached and the set cannot come loose. It will add immensely to the pleasure and usefulness of your Micro-6, particularly when out of doors.

THE MICRO-6 CIRCUIT

Many readers may be curious to know how we achieve the high performance we claim for the Micro-6 in a set of such minute dimensions. That our claims are genuine is, of course, proved by the countless constructors' letters we receive, more of which we give below, but you may like to know more about the design. The circuit is a completely new one based on our micro-alloy transistors (MATs). These transistors have higher gains than any other types at low voltage levels and, as they are also very small, are ideal for miniaturised equipment. The

From our Postbag

J.S.P., M.A., M.I.E.E., from Hampton, Middlesex, writes: "Thank you for the two Micro-6 kits. I have just completed assembly of one of these, and should like to say how satisfied I am. Neither in design nor performance is it in any sense a compromise."

J.A., Warton, near Carnforth, Lancs., tells us—"I have just built the Sinclair Micro-6 with quite remarkable results in an area where M.W. reception is notoriously poor."

W.A.S., Beaconsfield, Bucks., writes: "I have made up two Micro-6 units and am delighted with the performance . . . reproduction is excellent."

Micro-6 has two high gain stages of R.F. amplification, a double diode detector and three stages of A.F. amplification. Thus we have used exactly the same number of stages of gain as are employed in conventional 6 transistor superhets.

We are able to do this because we use genuinely micro-miniature components. For example, all the resistors are only $\frac{1}{8}$ in in length. These tiny components help to make the Micro-6 simple to construct because we don't have to pack them so closely together. If you would like more details just send 1/- for our booklet on the Micro-6 which gives the complete circuit diagram and technical description.

BRITISH BEATS THE WORLD!

We recently launched an export drive for all our products. We have already received enquiries for the Micro-6 from over 30 countries and samples are now going to agents throughout the world. One well-known company in the U.S.A. has ordered 1,000 TR.750 amplifiers and 1,000 Micro-Amplifiers. Naturally, we are particularly pleased by this as the orders were obtained in the face of very tough Japanese competition.

Am. S. C.

Says
**Mike
Farrard**
our
faithful
enthusiast

"I've made two for me, one for Uncle Bert, one for Mabel, two for the kids and one for Grandma. The dog will have to wait!"



Ken Ward

SINCLAIR MICRO-DESIGNS

BUILD A SET TO WEAR LIKE A WRIST WATCH

WEIGHS LESS THAN AN OUNCE

SIZE
1 4/5" x 1 3/10" x 1/2"



SPORTS EVENTS

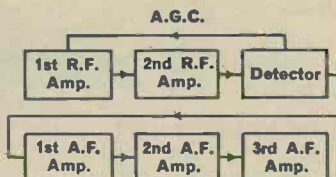


DRIVING



TRAVELLING

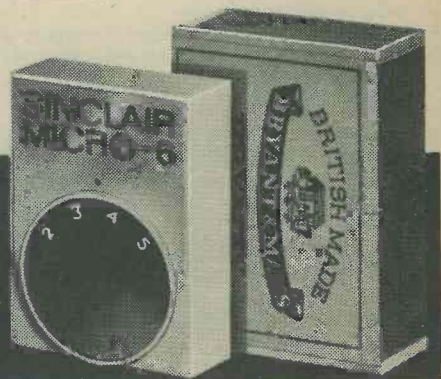
The unbelievably small size and fantastic power of the Micro-6 make it possible to wear this set like an ordinary wrist watch, and for this we now introduce our special "Transrista" reinforced nylon strap. The Micro-6 can be attached to it instantly and removed whenever required. This opens still further new and exciting approaches to radio listening and ensures your obtaining enjoyment such as you have never known before from any radio receiver. You can build the Micro-6 and have it working within the space of a single evening, and with a "Transrista" strap for using your set out of doors you will indeed have the radio of tomorrow today. Tunes over entire medium waveband, with bandspread at H.F. end for good separation.



6-STAGE CIRCUITRY GIVES POWER AND SELECTIVITY

Circuit comprises two stages of R.F. amplification, double-diode detector and high-gain 3-stage A.F. amplifier. Powerful A.G.C. ensures fade-free reception from distant stations.

SINCLAIR
MICRO-6
THE SMALLEST SET IN THE WORLD



Build it in an evening!

Building is simple and straightforward when the meticulously detailed instructions are followed. All parts including MAT transistors, diodes, printed circuit board, lightweight earpiece, case and dial, and well-printed instructions come to

Two Mallory Mercury Cells in the Micro-6 give it maximum performance. Price 1/11 each.

Sinclair "Transrista" well-styled, strong nylon strap, grey or black, 7/6 CAN BE USED WITH EXISTING MICRO-6 SETS

59/6

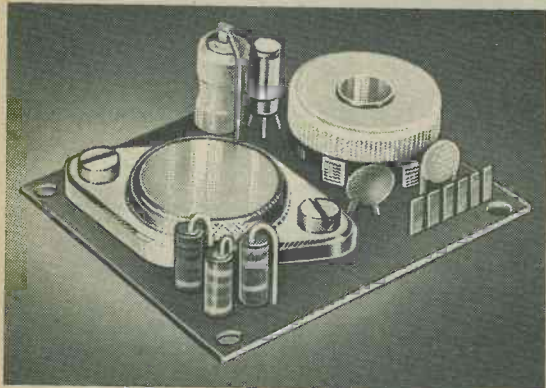


MALLORY 6-CELL PACK OFFER

Single Mallory Mercury Cells, 1/11 each. Pack of 6, at special price of

10/6

BRING 1970 STANDARDS TODAY!



ACTUAL SIZE

THE TR750 HAS STUPENDOUS POWER

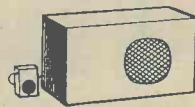
This latest Sinclair power amplifier builds on to a printed circuit board 2in square and includes its own volume control with on-off switch. With a transformerless output of 750 milliwatts, the TR750 is primarily intended to provide powerful loudspeaker reproduction from the Sinclair Micro-6 or Slimline receivers, thus enabling owners of these sets to use them also for car radios, loudspeaker portable or domestic sets. The TR750 has many other applications. It makes an amazingly good record reproducer, singly for mono or paired for stereo. It can make the heart of an efficient intercom or baby alarm system and its power in relation to its size is absolutely fantastic.

BRILLIANT FEATURES OF THE SINCLAIR TR750

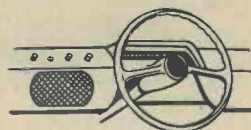
Performance characteristics are brilliant. The TR750 gives an effortless $\frac{1}{2}$ watt transformerless output with frequency response within ± 1 dB from 30 to 20,000 c/s—hi-fi by any standards, and volume with more than enough to spare. Input—10mV into 2k Ω for 750 milliwatts output for feeding into any standard 25 to 35 Ω loudspeaker arrangement. Operating requirements from 9 to 12 volts.



AS A RECORD PLAYER OR RADIOGRAM



RADIO REPRODUCER WITH MICRO-6 OR 'SLIMLINE'



AS A CAR RADIO

TR750 POWER AMPLIFIER

Full building and operating instructions are included with parts for the TR750, which includes latest type Metal Alloy driver transistor and new Sinclair "MagnaGain" output transistor, micro-miniature components including volume control with on-off switch, and printed circuit board. Total cost comes to

39/6

★ OTHER OUTSTANDING SINCLAIR CONSTRUCTIONAL DESIGNS

Ready built and tested, **45/-**

Sinclair Micro-injector

Using two MATS it generates and injects a test signal into any part of equipment at any frequency from 1 kc/s to 30 Mc/s to locate faults rapidly.

1 1/5 x 1 3/10 x 1/2 in, excluding probe.

All parts with instructions come to



27/6

Ready built and tested **32/6**



SINCLAIR MICRO AMP.

Smaller than a 3d. piece. Frequency response 30 to 50,000 c/s ± 1 dB, power gain 60dB (1,000,000 times)—makes a superb broadband R.F. amplifier also a sub-miniature hi-fi amplifier with an output suitable for any earpiece or even loudspeaker. With MAT transistors and all parts. **28/6**

'Slimline' Vest Pocket Receiver

Has self-contained ferrite rod aerial and takes standard PP5 battery, yet measures only 2 1/2 x 1 1/2 x 1/2 in. Tunes over the medium waveband. Great power and quality. Building is particularly easy.

All parts, including royal blue and gold case, earpiece, and instructions come to **49/6**



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The first four titles in a series of six books which are grouped together to form a comprehensive manual on the repair of radio receivers. All are written in simple language; each book deals with a specific subject. These books are part of the larger PHILIPS PAPERBACKS series, published at attractively low prices, the technical authority behind the books being the world-famous electrical company Philips of Eindhoven, Holland.

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COMPONENTS FOR THE "ALL BAND COMMUNICATION RECEIVER"

as featured on page 699 in the May issue

COIL TURRET CT.7/B

This turret is the basic portion of the CT.7. It comprises cadmium plated steel frame (5½" deep x 4½" high x 3½" wide), silver plated contacts, polystyrene insulation and rotary turret movement, incorporating Aerial, Mixer and Oscillator Coils for the three bands 1.5-4 Mc/s, 4-12 Mc/s and 10-30 Mc/s. Price 75/-

Coil strips for the long and medium wavebands may be purchased separately for incorporation in the turret. Price 10/6 each

The turret requires a 315pF tuning capacitor. A suitable 3-gang component with ceramic insulation is available. Price 19/-

Air spaced concentric trimmers 3-30pF Price 3/6 each

I.F. TRANSFORMER IFT.11/465 kc/s

A miniature I.F. Transformer for 465 kc/s giving excellent performance at low cost. Coils are litz wound and permeability tuned with high-grade iron-dust cores and silver mica capacitors. Screening Can 1½" x 1½" square. Price 6/6 each

Also available for 1.6 and 10.7 Mc/s.

BEAT FREQUENCY OSCILLATOR COIL BFO.2/465 kc/s

These compact coils are wound on a bakelite former complete with adjustable iron-dust cores enclosed in an aluminium screening can measuring 1½" x 1½" square. Price 5/- each

Also available for frequencies of 85 kc/s, 100 kc/s and 1.6 Mc/s.

MAXI-Q

"BASIC SUPERHET FOR BEGINNERS"

as featured on page 688 in the May issue

COIL PACK CP.3/F

This 4-waveband coil pack is for use with a 500pF 2-gang condenser and covers the standard Long, Medium and Short Wavebands with the addition of the band 50-160 metres (1.85-6 Mc/s). It comprises of Aerial and Oscillator coils with iron-dust tuning cores, wavechange switch and mica compression trimmers mounted on an aluminium plate measuring 4½" x 2½" x 1" (not including spindle). Price 49/- plus 8/2 P.T. = Total 57/2

Two-gang 315pF Tuning Condenser Price 14/8

General Catalogue covering full range
of components, send 1/6 in stamps

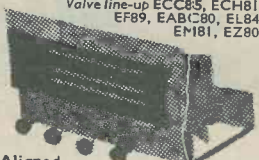
PLEASE SEND S.A.E. WITH ALL ENQUIRIES

DENCO (Clacton) LTD

(DEPT. RC), 357/9 OLD ROAD
CLACTON-ON-SEA, ESSEX

7 VALVE AM/FM RADIOGRAM CHASSIS

Three Waveband & Switched Gram positions. Med. 200-550m. Long 1,000-2,000m. VHF/FM 88-95 Mc/s. Phillips Continental Tuning insert with permeability tuning on FM & combined AM/FM IF transformers. 460 kc/s and 10.7 Mc/s. Dust core tuning all coils. Latest circuitry including AVC & Neg. Feedback. 3 watt output. Sensitivity and reproduction of a very high standard. Chassis size 13 1/4" x 6 1/2" Height 7 1/4". Edge illuminated glass dial 11 1/4" x 3 1/4". Vert. pointer Horiz. station names. Gold on brown background. A.C. 200/250V operation. Magic-eye tuning. Circuit diag. now available.



Valve line-up ECC85, ECH81, EF89, EABC80, EL84
 Aligned and tested ready for use. **£13.10.0** Carr. & Ins. 7/6.

Comp. with 4 knobs—walnut or ivory to choice. Indoor FM aerial 3/6 ex. 3 Ω P.M. Speaker only required. Recommended Quality Speakers 10" Elac H/D, 30/-, 13 1/2" x 8" E.M.I. Fidelity, 37/6 12" R.A. with conc. Tweeter, 42/6. Carr. 2/6.

TAPE DECK BARGAINS!

BSR MONARDECK Type TD2		COLLARO STUDIO 3-SPEED DECK	
Twin-track	£7.70	Twin-track	£10.10.0
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	Carr. 5/-		Carr. 7/6

New Boxed	Valves	Reduced Bargain Prices	Electrolytics All Types New Stocks
1T4	3/6	ECC83 7/-	PCC84 8/-
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155	6/-	ECL80 9/-	PCL83 10/6
354	7/-	EF80 7/6	PCL84 10/6
3V4	7/-	EF86 8/6	PL81 9/6
DAF96	8/-	EL84 7/-	PL82 9/6
DF96	8/-	EY51 9/-	PL83 8/6
DK96	8/-	EY86 9/-	PY32 10/6
DL96	8/-	EZ81 7/-	PY81 8/-
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ECC82	7/-	EM84 8/6	U25 10/6
			25/25V 1/9
			50/12V 1/9
			50/50V 2/-
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			16+16/450V 5/6
			32+32/450V 6/6
			1000/25V 3/9
			2T5
			2000+4000/6V
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Famous Mfr. Bulk Purchase—Genuine recommended Tape Bargain.
 Uncond. Guar. Fitted Leader & Stop Foils (except 3").
 St'd. (PVC base) L.P. (PVC base) D.P. (Milar base) Triple Play

3" 150ft.	3/9	225ft.	4/9	300ft.	6/6	3" 450ft.	12/6
5" 600ft.	11/6	900ft.	15/-	1,200ft.	23/6	4" 900ft.	25/-
5 1/2" 850ft.	14/6	1,200ft.	17/6	1,800ft.	29/6		
7" 1,300ft.	17/6	1,800ft.	22/6	2,400ft.	37/6		

Post and Packing—3" Reels 6d. Each additional Reel 3d. 4" to 7" Reels 1/-.
 Each additional Reel 6d.
EMPTY TAPE REELS (Plastic): 3" 1/3; 5" 2/-, 5 1/2" 2/-, 7" 2/3.
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Jack Plugs. Standard 2 1/2" Igranite Type, 2/6. Screened Ditto, 2/6. Miniature scr. 1 1/2", 2/3. Sub-min. 1/3.
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Grundig Continental. 3 p. or 5 p. plug, 3/6. Sockets, 1/6.

Soldering Irons. Mains 200/220V or 230/250V. Solon 25 watt Inst., 22/6. Spare Elements, 4/6. Bits, 1/- to 65 watt, 27/6 etc.
Alumin. Chassis. 18g. Plain Undrilled, folded 4 sides, 2" deep, 6" x 4", 4/6, 8" x 6", 5/9, 10" x 7", 6/9, 12" x 6", 7/6, 12" x 8", 8/- etc., **Alumin. Sheet.** 18g. 6" x 6", 1/-, 6" x 9", 1/6, 6" x 12", 2/-, 12" x 12", 4/6 etc.

DE LUXE RECORD PLAYER KIT

Incorporating 4 Speed Garrard Auto-Slim unit and Mullard latest 3 w. amplifier (ECL 86 and EZ 80), volume, bass and treble controls, with 8" x 5" 10,000 line speaker.
 Contemporary styled two-tone cabinet, charcoal grey and off-white with matching blue relief.
 Size: 17 1/2" x 16" x 8".

COMPLETE KIT
 Carr. & ins. 10/- **£13.19.6**

Catalogue and Construction details 2/6 (free with kit).

FRONT SECTION, which houses amplifier and speaker, is detachable from cabinet. Price as separate unit for stereo, £5.17.6. Carr. 5/-.



Volume Controls—5K-2 Megohms, 3" Spindles Morganite Midge Type, 1 1/4" diam. Guar. 1 year. LOG or LIN ratios less Sw. 3/-. DP, Sw. 4/6. Twin Stereo less Sw. 6/6, D.P. Sw. 9/6 (100 k. to 2 Meg. only). 1 Meg. VOL Controls D.P. Sw. 1/3" flatted spindle. Famous Mfrs. 4 for 10/- post free.

COAX 80 OHM CABLE

High grade low loss Cellular air spaced Polythene 1/4" diameter. Stranded cond. Famous mfrs. New only 6d. per yard.

Bargain Prices—Special lengths:
 20 yds. 9/-, P. & P. 1/6.
 40 yds. 17/6, P. & P. 2/-.
 60 yds. 25/-. P. & P. 3/-.
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Condensers—S/Mica all values 2pF to 1,000pF 6d. Ditto Ceramic 9d. each, .005, .01 and .1, etc., 1/-. Paper Tubular 450V .001 mfd. to .01 mfd and 1,350V 9d. .02-1 mfd 1/-, .25 mfd 1/6, .5 mfd 1/9.

Closed Tol. S/Micas—10% 5pF-500pF 8d. 600-5,000pF 1/-. 1% 2pF-100pF 9d. 100pF-500pF 11d. 575pF-5,000pF 1/6. Resistors—Full Range 10 ohms-10 megohms 20% 1/2 and 1/4W 3d., ditto 10% 4d., 1/2W 5d. (Midget type modern ratings) 1W 6d., 2W 9d. Hi-Stab 5% 1/2W 100 ohms 1 megohm 6d. Other values 9d. 1% 1/4W 1/6, W/W Resistors 25 ohms to 10K 5W 1/3, 10W 1/6, 15W 2/-. Pre-set T/W Pots. W/W 25 ohms-50K 3/-. 50K-2 Meg. (Carbon) 3/-.
TRANSISTOR BARGAINS
 Brand New—BVA 1st Grade.
 OC44 8/6 OC70 5/6
 OC45 8/- OC71 6/-
 OC81D 7/6 GEX34 2/9
 2/OC81 15/6 OA70 2/9
 GET14 6/6 OA81 2/9
 OC72 7/6 GEX13 2/9
 AF117 9/6

Speakers P.M.—3 ohms 2 1/2" E.M.I. 15/6. Goodmans 3 1/2" 16/6. 5" Rola 15/6. 6" Elac 16/6. 7" x 4" Goodmans 15/6. 8" Rola 15/6. 10" R. x A. 25/-. 9" x 6" Goodmans 22/6. E.M.I. Tweeter 22/6.
Speaker Fret—Expanded gilt anodised metal 1/2" x 1/2" diamond mesh, 4/6 sq. ft., multiples of 6" cut. Max. size, 4ft. x 3ft. 47/6. Carr. extra.

TYGAN FRET (contemp. pat.) 12" x 12" 2/-, 12" x 18" 3/-, 12" x 24" 4/-, 18" x 18" 4/6, etc.

BONDACOUST Speaker Cab. Acoustic Wadding, superior grade, 1" thick, 12" wide, any length cut 1/6 per ft., 4/- per yd.
ENAMELLED COPPER WIRE— 1lb reels, 14/-, 20/-, 2/6; 22/-, 28/-, 3/-; 36/-, 38/-, 4/3; 39/-, 40/-, 4/6, etc.
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PVC CONNECTING WIRE— 10 colours (or chassis wiring, etc.)—Single or stranded conductor, per yd., 2d. Sleeving, 1mm and 2mm., 2d. yd., etc.
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TRANSISTOR COMPONENTS

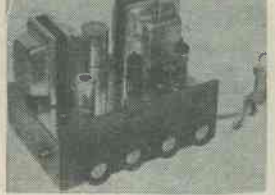
Midget I.F.S.—465 kc/s 1/2" diam. 5/6
 Osc. Coil—1/2" diam. M/W. 5/3
 Osc. coil M. & L. W. 5/9
Midget Driver Trans. 3.5:1 6/9
 Ditto O/Put Push-pull 3 ohms 6/9
 Elect. Condensers—Midget Type 15V 1mfd-50mfd, ea. 1/9. 100mfd. 2/-.
Ferrite Aerial—M. & L. W. with car aerial coupling coil, 9/3.
Condensers—150V wkg. .01 mfd. to .04 mfd., 9d. .05 mfd., .1 mfd., 1/-, .25 mfd., 1/3. .5 mfd., 1/6, etc.
Tuning Condensers. J.B. "00" 208+176pF, 8/6. Ditto with trimmers, 9/6. 365pF single, 7/6. Sub-min. 2" DILEM 100pF, 300pF, 500pF, 7/-.
Midget Vol. Control with edge control knob, 5kΩ with switch, 4/9, ditto less switch, 3/9.
Speakers P.M.—2" Plessey 75 ohms, 15/6. 2 1/2" Continental 8 ohms, 13/6. 7" x 4" Plessey 35 ohms, 23/6.
Ear Plug Phones—Min. Continental type, 3ft. lead, jack plug and socket. High Imp. 8Ω. Low Imp. 7/6. High sensitivity M/coil 8-10 ohms, 12/6.
Brand New. Mfrs. surplus 1st grade. 1 OC44 & 2 OC45, 15/6. 1 OC81D & 2 OC81, 15/-.
 All above and OA81, 32/6, post free.

JASON FM TUNER UNITS

Designer-approved kit of parts:
FMT1, 5 gns. 4 valves, 20/-.
FMT2, £7. 5 valves, 35/-.
JTV MERCURY 10 gns.
 3 valves, 22/6.
 3 valves, 22/6. 4 valves, 28/6.
NEW JASON FM HANDBOOK, 2/6. 48 hr. Alignment Service 7/6. P. & P. 2/6.

TRIMMERS, Ceramic (Compression Type)— 30pF, 50pF, 70pF, 9d.; 100pF, 150pF, 1/3; 250pF, 4/6; 600pF, 1/9. Philips Concentric Type—2-10pF, 1/-; 3-30pF, 1/-.
METAL RECTIFIERS—STC Types— RM1, 4/9; RM2, 5/6; RM3, 1/3; RM4, 16/-; RM5, 21/-; RM4B, 17/6.

MULLARD "3-3" HI-FI AMPLIFIER



3 VALVES 3 WATT
 3 ohm and 15 ohm Output.
 A really first-class Amplifier giving Hi-Fi quality at a reasonable cost. Mullard's latest circuit. Valve line-up: EF86, EL84, EZ81. Extra H.T. and L.T. available for Tuner Unit addition. This is the ideal companion Amplifier for FM tuner units.

TECHNICAL SPECIFICATION—Freq. Response: ± 1dB. 40 c/s-25 kc/s. Tone controls, max. treble cut 12dB at 10 kc/s. Max. Bass Boost 14dB at 80 c/s sensitivity: 100MV for 3W output. Output Power (at 400 c/s): 3W at 1% total harmonic distortion. Hum and Noise Level: At least 70dB below 3W.
COMPLETE KIT (incl. valves, all components, wiring diagram and special quality sectional Output Trans.) **BARGAIN PRICE** £6.19.6 carr. 4/6. Complete wired and tested, 8 gns. Wired power O/P socket and additional smoothing for Tuner Unit, 10/6 extra.
Bronze Escutcheon Panel, Printed Vol., Treble, Bass, On-Off, supplied with each kit.
 Recommended Speakers—R. Allen 12" with tweeter 42/6, WBHF10-12 £4.7.6, Goodmans Axiette £5.5.0, Axium 10 £6.5.0, Audiom 51 £8.10.0. Carr. extra.

Send for detailed bargain lists, 3d. stamp. We manufacture all types Radio Mains Transf. Chokes, Quality O/P Trans., etc. Enquiries invited for Specials, Prototypes for small production runs. Quotation by return.
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 Est. 1946

HOME RADIO of MITCHAM

DEPT. RC, 187 London Road, Mitcham, Surrey. MIT 3282

SOME UNREPEATABLE BARGAINS!!

Some exceptionally well made S.W. Tuning Condensers, silver plated and split end vanes. $\frac{1}{4}$ " spindle with extension for coupling two or more together.

Single gang size $1\frac{1}{2}$ " x $1\frac{1}{2}$ " x $1\frac{1}{4}$ " Cap. 50 Pf. 4/6 Worth 10/-

Single gang size $1\frac{1}{2}$ " x $1\frac{1}{2}$ " x $1\frac{1}{4}$ " Cap. 60 Pf. 5/6 Worth 11/6

Twin gang size $2\frac{1}{4}$ " x $1\frac{1}{2}$ " x $1\frac{1}{4}$ " Cap. 50 Pf. 8/6 Worth 15/-

Also for S.W. Work:

Air Tuner Condensers. $1\frac{1}{2}$ " x $1\frac{1}{2}$ " x 1" Cap. 20 Pf. 3/9
Worth 6/9

Air Trimmer Condensers. $1\frac{1}{2}$ " x $1\frac{1}{2}$ " x 1" Cap. 100 Pf. 2/6 for 3
Worth 21/-

Air Dielectric High Efficiency Tuning Condensers with widely spaced Log-shaped Plates. 2" x 2" x $1\frac{1}{4}$ " 20 Pf. 4/6
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Similar Condenser to above, but plates not so widely spaced. 2" x $1\frac{1}{2}$ " x $1\frac{1}{4}$ " 160 Pf. 4/-
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2 Gang 500 Pf. Tuning Condenser 3/6

NON ELECTROLYTIC DUBILIER

NITROGOL CONDENSERS

8Mf 600 volts	17/6
4Mf 600 volts	5/6
2Mf 800 volts	5/6
2Mf 600 volts	4/6
2Mf 500 volts	2/6
2Mf 500 volts (WEGO) ...	1/-

Meters by WESTON 2 inch scale

500 Micro Amp full scale deflection. Scaled 0-15 and 0-600.

Price 17/6

A high quality Output Transformer

Primary 7000 Ohms. Secondary 3 Ohms.
Suitable for Mullard ECL86 Valve.

Price 6/6 Worth 12/6

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Transistor Tape Recorder Circuits

by C. Swires

PART 1

The first of a two-part series describing tested transistor applications in home constructed tape recorders

ALTHOUGH TRANSISTORISED TAPE RECORDERS HAVE been in commercial production for some years, there has not been a great deal of information in the home-constructional journals on the circuit designs and techniques employed. This article describes the circuits needed for a complete battery/mains operated tape recorder using transistors throughout, and it should be added that these circuits have been fully tested in practice in a portable tape recorder constructed by the author. The tape recorder also incorporated a completely home-built tape deck but, since the construction of this deck involves the use of motors and other components which are not readily available, it was considered preferable to devote these articles to the transistor circuits only. If it appears that readers are interested in details of the home-constructed tape deck as well, a further article covering this subject can be prepared.

Despite the fact that the tape deck itself is not described, it is intended to give brief details of the overall layout employed for the various units in the writer's recorder. This will then provide an illustration of how the various units may be assembled and interconnected, and the writer's layout and approach can be adapted to meet alternative tape deck and cabinet requirements.

The Overall Instrument

The complete instrument is intended to operate from the a.c. mains at 200 to 250 volts, or from a 12 volt d.c. battery supply. The current consumption of the transistor circuits, when run from the battery supply is approximately 25mA for record, and 30mA for playback at normal listening level.

There are separate record and playback amplifiers and these feed separate heads, this being a technique which leads to considerable easing of switching requirements. In the prototype, the record head preceded the playback head. The heads employed for both record and playback are the Wearite half-track heads type FR7. The FR7 heads have two windings, these consisting of a signal winding

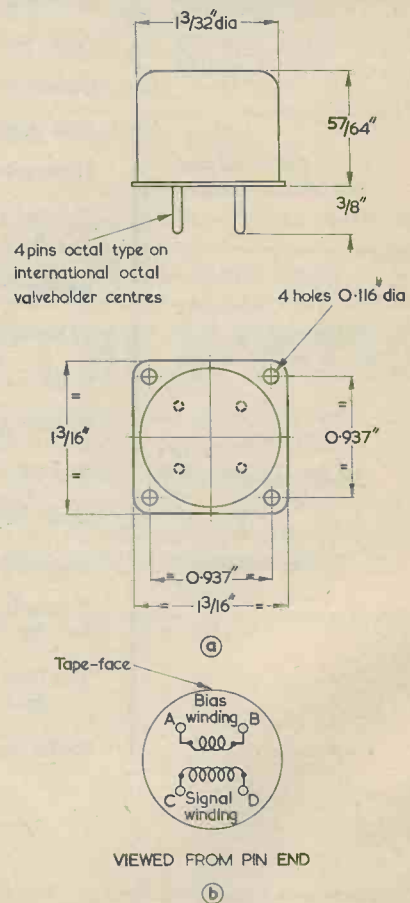


Fig. 1 (a). - The dimensions of the Wearite head type FR7
(b). The connections to the bias and signal windings (Courtesy Wright and Weaire Ltd.)

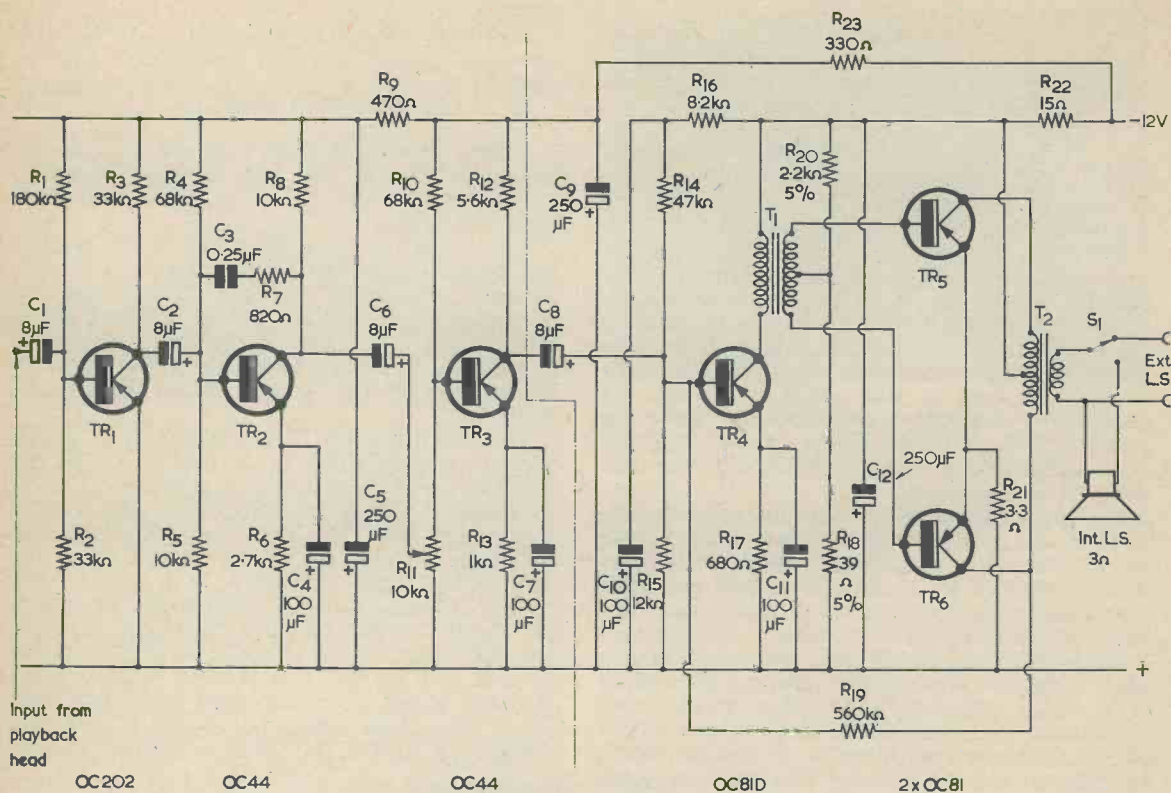


Fig. 2. The playback amplifier circuit

Components List (Fig. 2)

Resistors (All fixed resistors are $\frac{1}{4}$ watt 10% unless otherwise stated)

R ₁	180k Ω
R ₂	33k Ω
R ₃	33k Ω
R ₄	68k Ω
R ₅	10k Ω
R ₆	2.7k Ω
R ₇	820 Ω
R ₈	10k Ω
R ₉	470 Ω
R ₁₀	68k Ω
R ₁₁	10k Ω potentiometer, log track
R ₁₂	5.6k Ω
R ₁₃	1k Ω
R ₁₄	47k Ω
R ₁₅	12k Ω
R ₁₆	8.2k Ω
R ₁₇	680 Ω
R ₁₈	39 Ω 5%
R ₁₉	560k Ω
R ₂₀	2.2k Ω 5%
R ₂₁	3.3 Ω
R ₂₂	15 Ω
R ₂₃	330 Ω

Capacitors

C ₁	8 μ F electrolytic 6V wkg.
C ₂	8 μ F electrolytic 12V wkg.
C ₃	0.25 μ F
C ₄	100 μ F electrolytic 6V wkg.
C ₅	250 μ F electrolytic 18V wkg.
C ₆	8 μ F electrolytic 12V wkg.
C ₇	100 μ F electrolytic 6V wkg.
C ₈	8 μ F electrolytic 12V wkg.
C ₉	250 μ F electrolytic 18V wkg.
C ₁₀	100 μ F electrolytic 18V wkg.
C ₁₁	100 μ F electrolytic 6V wkg.
C ₁₂	250 μ F electrolytic 18V wkg.

Transistors

TR ₁	OC202
TR ₂	OC44 (or OC45)
TR ₃	OC44 (or OC45)
TR ₄ *	OC81D
TR ₅ *	OC81
TR ₆ *	OC81

} matched pair, with heat sink and brackets (see text)

*TR₄, TR₅ and TR₆ may be obtained as Audio Transistor Package LFH3.

Transformers

- T₁† Driver transformer 3.5:1+1 (primary <130Ω, each half secondary <40Ω)
T₂† Output transformer 3.1+3.1:1 (each half primary <1Ω, secondary <0.2Ω)

with a nominal inductance of 120mH, and a bias winding with a nominal inductance of 6mH. The dimensions and connections for the FR7 head are shown in Figs. 1 (a) and (b).

The FR7 is a very suitable head for matching to transistor circuits because of the medium impedance of its signal winding, this being slightly in excess of 750Ω at 1 kc/s. Decks may be available having heads of similar impedance, and it is probable that such heads should work equally well with the circuits discussed in this article. However, no alternative heads have been checked by the writer and so the performance of the circuits described here cannot be guaranteed when heads other than the FR7 are employed.

The prototype recorder had no erase facility since it was possible to erase tapes, when desired, on a mains driven machine. Alternatively, permanent magnet erase could be tried, but great care would need to be taken to ensure that only one track was erased.

Other features include two recording inputs, each with its own volume control. One input is at "high sensitivity" and offers a low input impedance. It is suitable for moving coil microphones. The second input is at around 68kΩ impedance, and is suitable for radio or gram signals.

Also provided is a level meter.

The Playback Amplifier

The circuit of the playback amplifier appears in Fig. 2.

As was just mentioned, the playback head selected has a signal winding impedance of slightly more than 750Ω at 1 kc/s. The impedance of the head increases with frequency, so that a first stage input impedance of about 10kΩ would appear to be desirable, in order to avoid attenuation of high frequencies due to mismatching. In this instance, however, the input impedance of the first stage is of the order of 4kΩ, the slight loss of high frequencies which results being compensated for in later stages.

The first stage employs a silicon transistor type OC202. The choice of a silicon transistor here is due to two main reasons: the first being that a low noise performance is offered, and the second being that a silicon transistor has a better temperature stability than a germanium transistor as well as a lower leakage current. The first stage can be run at a very low collector current (in this circuit 250μA) without temperature variations causing the transistor to be cut off. A high value collector load may, in consequence, be used and this can lead to an improvement in gain.

†To suit Mullard common emitter push-pull LFB3 amplifier. (R. F. Gilson Ltd.)

Speaker

Internal speaker, 3Ω impedance

Switch

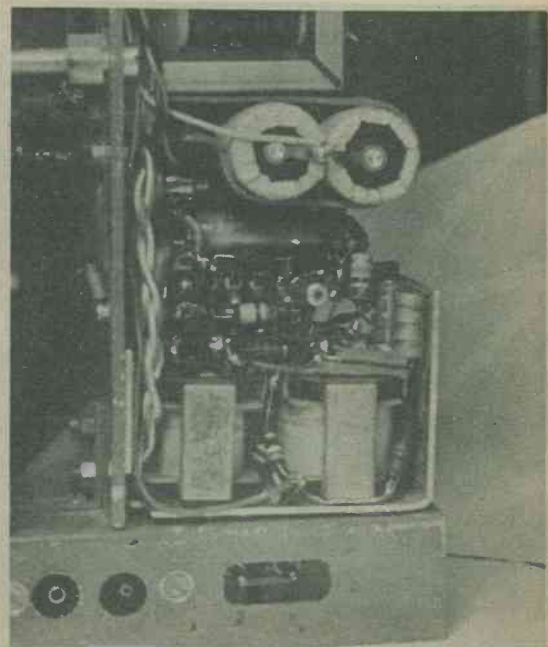
S₁ s.p.d.t. slide or toggle

Silicon transistors other than the OC202 may be satisfactory in the TR₁ position. However, the author chose the OC202 as it has a relatively high-gain figure.

The second transistor, TR₂ is an OC44, and this has frequency-selective negative feedback applied between its collector and base. The components concerned are C₃ and R₇, and the feedback circuit provides the major part of the bass boost which is required in the amplifier. An OC45 could be employed in the TR₂ position instead of the OC44, if desired.

The next transistor, TR₃, appears in a normal amplifying stage. This is specified as OC44, but an OC45 could be used instead, if desired.

Transistor TR₃ is preceded by the gain control R₁₁, and it feeds into the driver transistor TR₄. TR₄ is an OC81D and, in its turn, it drives the two OC81 output transistors in a conventional circuit. These last two transistors give an output of 1 watt and are mounted by means of metal clips to a heat sink of 18 s.w.g. aluminium having an area of 6 sq. in. This plate is, in the writer's recorder, bolted to the underside of the tape deck panel, whereupon additional cooling is provided. Alternative layouts may require different cooling



View of the power amplifier of Fig. 2, showing the manner in which the driver and output stages are built inside the heat sink

arrangements.¹ A small amount of negative feedback is applied over the output stage by way of R_{19} . If positive feedback occurs when the amplifier is first switched on, R_{19} should be wired to the other output transistor collector.

The output stage is substantially the same as the Mullard 1 watt LFH3 design, and the transformers employed are manufactured by R. F. Gilson Ltd. The output impedance is 3Ω , and the output signal may be applied to either the internal speaker or an external speaker. In the prototype recorder a 7 x 4in elliptical speaker was used, and this gave very good results.

The frequency response of the playback amplifier is illustrated in Fig. 3. This curve was obtained by applying a Jason AG-10 Audio Generator to the input of the amplifier via a $470k\Omega$ resistor, and it demonstrates that the necessary bass boost for a playback amplifier has been achieved. A small amount of treble boost above 10 kc/s is also evident, this being introduced in the hope that there may be something audible at these frequencies! The treble boost is achieved by the simple process of omitting the usual treble-cut components in the output stage. In the Mullard 1 watt output stage, on which the present circuit is based, the primary of the output transformer is shunted by a $0.25\mu F$ capacitor and a 120Ω resistor in series. These components are omitted here.

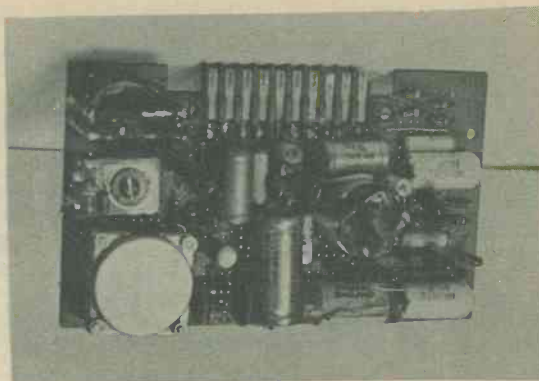
There is a fall-off in response below 100 c/s, and this is due to the values of the coupling capacitors between stages. Since the type of speaker used in the recorder (in company with other small speakers) is rarely capable of any worth-while reproduction below about 100 c/s, there was no audible loss of quality with the prototype.

The playback amplifier constructed by the writer was built in two units. One unit comprised all the components to the left of the chain-dotted line in Fig. 2, and all parts were fitted in a small metal box which provided complete screening. The second unit comprised the remaining components, and these were wired on tag-boards mounted on the heat sink for the output transistors.

The Record Amplifier

The record amplifier circuit is illustrated in Fig. 4. The components to the left of the chain-dotted line constitute a microphone pre-amplifier, and they were fitted to a small tag panel mounted near the input level potentiometers R_{25} and R_{29} . The "high sensitivity" input (Input 1) has a low input impedance, and is suitable for a moving-coil, or dynamic, microphone.

Input 1 is connected, via gain control R_{25} , to TR_7 , this being an OC44 connected up as a conventional amplifier. An OC45 could also be used here. The output from TR_7 is then fed to TR_8 into whose base may also be fed a radio/gram input (Input 2).



In the author's prototype, the second section of the record amplifier, oscillator and level meter circuit are mounted on one board, as shown here

Resistor R_{30} has a value of $68k\Omega$, thereby allowing this impedance to be presented at the Input 2 terminals. If desired, this input impedance may be increased by increasing the value of R_{30} , but there will, of course, be a consequent loss in gain. R_{29} controls the amplitude of the radio/gram signal. As will be noted, R_{29} and R_{25} can be operated independently, and it is possible to mix the two inputs together.

The treble boost required in the record amplifier is obtained by way of the network between the collector and base of TR_8 . This network incorporates the tuned circuit L_1 , C_{19} , and it resonates at 10 kc/s, which represents the highest frequency the unit is capable of recording. The Q of the tuned circuit is damped very slightly by the parallel $15k\Omega$ resistor R_{33} .

The $5k\Omega$ pre-set potentiometer R_{36} in series with the network controls the amount of feedback and, therefore, the amplitude of the 10 kc/s peak. In the original circuit it was found that a value of $4k\Omega$ in this potentiometer gave the desired results. If the constructor wishes, R_{36} could, therefore, be replaced by a $3.9k\Omega$ fixed resistor.

The coil L_1 was wound on a Mullard LA1 pot

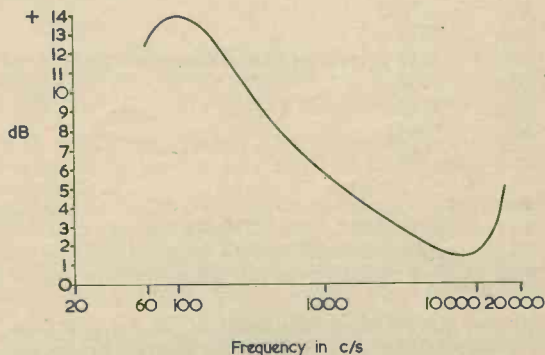


Fig. 3. The frequency response of the playback amplifier

¹ See "Reference Manual of Transistor Circuits", published by Mullard Ltd., first edition, page 160. With the Fig. 2 circuit it is recommended that the output transistors be mounted on heat sinks of 16 s.w.g. aluminium measuring 5 x 7 cms. Each transistor should be bolted down to its heat sink by close-fitting cooling clips, available from Kimber-Allen Ltd., or distributors.

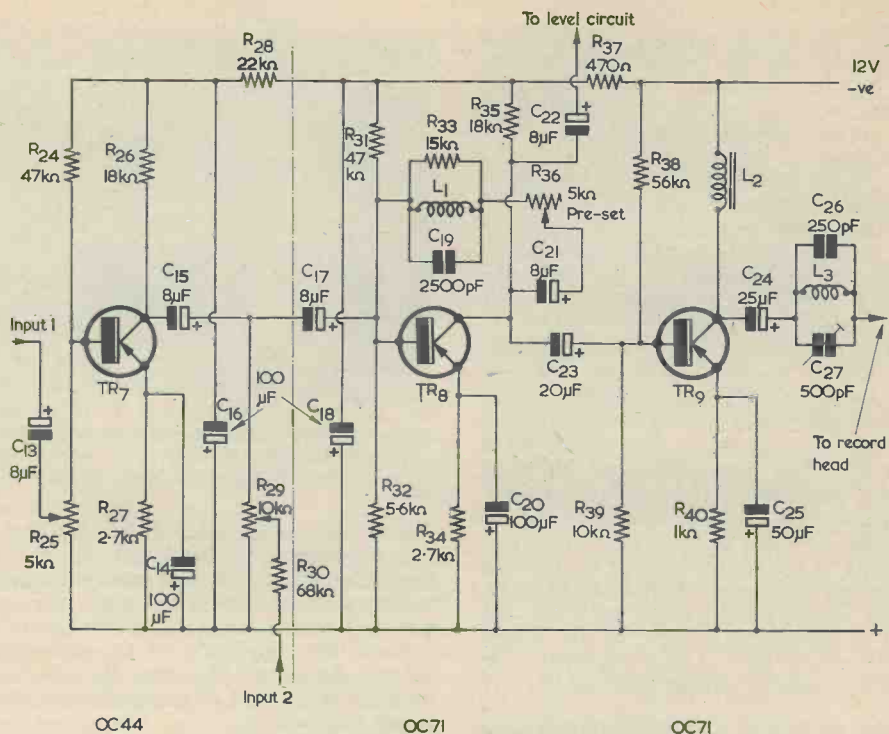


Fig. 4. The record amplifier

Components List (Fig. 4)

Resistors (all fixed resistors are 1/4 watt 10%)

- R₂₄ 47kΩ
- R₂₅ 5kΩ potentiometer, log track
- R₂₆ 18kΩ
- R₂₇ 2.7kΩ
- R₂₈ 22kΩ
- R₂₉ 10kΩ potentiometer, log track
- R₃₀ 68kΩ
- R₃₁ 47kΩ
- R₃₂ 5.6kΩ
- R₃₃ 15kΩ
- R₃₄ 2.7kΩ
- R₃₅ 18kΩ
- R₃₆ 5kΩ pre-set potentiometer (see text)
- R₃₇ 470Ω
- R₃₈ 56kΩ
- R₃₉ 10kΩ
- R₄₀ 1kΩ

Capacitors

- C₁₃ 8μF electrolytic 12V wkg.
- C₁₄ 100μF electrolytic 6V wkg.
- C₁₅ 8μF electrolytic 12V wkg.

- C₁₆ 100μF electrolytic 18V wkg.
- C₁₇ 8μF electrolytic 12V wkg.
- C₁₈ 100μF electrolytic 18V wkg.
- C₁₉ 2,500pF mica
- C₂₀ 100μF electrolytic 6V wkg.
- C₂₁ 8μF electrolytic 12V wkg.
- C₂₂ 8μF electrolytic 12V wkg.
- C₂₃ 20μF electrolytic 12V wkg.
- C₂₄ 25μF electrolytic 18V wkg.
- C₂₅ 50μF electrolytic 6V wkg.
- C₂₆ 250pF mica
- C₂₇ 500pF compression trimmer

Transistors

- TR₇ OC44 (or OC45)
- TR₈ OC71
- TR₉ OC71

Inductors

- L₁ 91mH (see text)
- L₂ 2 to 8H, resistance <300Ω (see text)
- L₃ 12.6mH (see text)

core and consisted of 600 turns of 36 s.w.g. enamelled wire random wound on the former provided. The measured inductance was 91mH.

The signal from TR₈ is passed to the recording

amplifier output transistor, TR₉, by way of C₂₃. The output stage is designed, as far as is possible, to meet the requirement that the recording head be fed from a constant current source.

In valve practice it is normal to feed the recording head via a high value resistor. In battery operated circuits the maximum voltage swing available is only about 12 volts, in contrast with mains valve circuits where a maximum voltage swing of up to 250 volts can be obtained. Even with a high value series resistor, valve circuits still allow a volt or so to appear across the head. The high series resistor provides what is, effectively, a constant current source. With a transistor output circuit a high value of series resistor cannot be used, owing to the high attenuation it would give.

An alternative method of providing a constant current drive is used in Fig. 4, and it is obtained by employing a choke output circuit. At low frequencies, choke L_2 has a low reactance, thus offering a low collector load impedance and, in consequence, low voltage gain. At high frequencies the choke has a high reactance, thereby providing a high collector load impedance and consequently higher voltage gain. At the same time, the recording head has a low impedance at low frequencies and, therefore, draws a high current. At high frequencies it has a high impedance and takes a low current.

By combining these two effects it is possible to obtain an approximation to constant current drive. When low frequencies are being handled the recording head attempts to draw a large current, but the voltage fed to it is low and so the current rise is restrained. At high frequencies the head can only draw a low current, but the voltage at high frequencies is increased and the current is consequently maintained.

The output choke, L_2 , should have an inductance of between 2 and 8H, and a resistance of less than 300Ω. A suitable choke is a midget component in the RadioSpares range, this having a resistance of 290Ω, and an inductance of 5H at 40mA.²

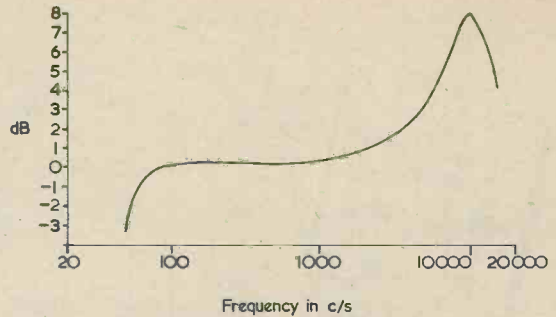


Fig. 5. The response of the record amplifier

The 25μF capacitor, C_{24} , is connected in series with the recording head to prevent the passage of d.c.

The overall response of the record amplifier is shown in Fig. 5. This curve was taken by applying a Jason Audio Generator type AG-10 to Input 2, the output voltage being measured across a 100Ω resistor in series with the recording head.

A tuned circuit, given by L_3 , C_{26} and C_{27} , is connected in series with the recording head, its function being to prevent bias oscillations appearing in the record amplifier, where they would cause distortion. This tuned circuit is resonant at the bias frequency of 58 kc/s, and is adjusted by means of C_{27} . The coil employed by the writer consisted of 250 turns of 30 sw.g. enamelled wire on a Mullard LA1 pot core, its inductance being 12.6mH.³

² This choke is available from Home Radio (Mitcham) Ltd. under Cat. No. CLF19A.

³ It is possible that a Wearite rejector coil type 666 could be employed here, but the writer has not checked this point in practice.

(To be concluded)

Additional Countries Order Ultra Sonic Aid for the Blind

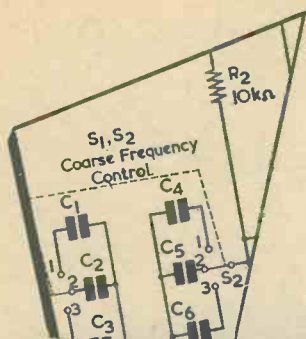
Canada and Denmark are the latest countries to place orders for the Ultra Sonic Aid for the Blind. In addition to the United Kingdom, eleven other countries have now ordered units for delivery from this year's pilot production run—Australia, Canada, Denmark, Germany, Holland, New Zealand, Northern Rhodesia, Norway, Sweden, Switzerland, and the United States.

All the orders are from approved blind organisations, who will be able to carry out simultaneous evaluation programmes. The number of units ordered for overseas now matches the home orders, of which 50 are going to St. Dunstan's, who carried out the initial tests with the prototype models.

The latest United States order, in addition to 14 units already earmarked for the states of Kentucky, Ohio and New Jersey, is for 10 units from the Veteran's Administration Hospital in New York City.

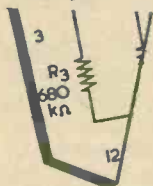
The Canadian National Institute for the Blind, in Toronto, and the National Research Council, in Ottawa, are numbered among the organisations to place the most recent orders, along with Danish State Schools in Copenhagen and Kalundborg; the Professor Strahl Blind Institute in Marburg, West Germany; and, in Britain, the Exeter Society for the Blind.

With the ever-widening appeal of the device, plans are being hastened for full production, with the progress being watched at all stages by a Working Party Committee, on which Ultra engineers are joined by representatives of St. Dunstan's, the National Research Development Corporation, the National Physical Laboratory, and the designer, Dr. Leslie Kay.



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

suggested circuits



No. 163 Mains Overload Protection Device

IT IS AN UNFORTUNATE FEATURE OF life in this country that, even in our present day and age, a number of people receive mains electricity supplies which are poorly regulated with regard to voltage. This situation is usually encountered in country areas which are supplied from heavily loaded substation transformers. During winter, low voltage mains supplies become evident over much wider areas, and are due to deliberate voltage reductions by the generating authorities at periods of peak consumption.

The writer has received several letters from readers asking for the circuit of a device which will switch off an item of mains equipment when the supply voltage exceeds a certain figure. Judging from these letters, the basic problem here has to do with television receivers, which are of course particularly susceptible to low voltage supplies. In order to obtain a picture of reasonable quality, readers have stated that it is necessary to re-set the mains tapping on the television receiver to a lower voltage than normal during voltage cuts and the like. If the mains voltage later returns to its nominal value the receiver has then to be switched off immediately, or it may suffer damage due to the excessively high h.t. voltages which are formed in it. The writer has been asked to produce a device which will automatically switch off such a receiver when the mains supply returns to its normal voltage, and a suggested

circuit to meet this requirement provides the subject for this month's article.

The Circuit

The circuit of the overload protection device appears in Fig. 1. In this diagram, the incoming mains voltage is applied, via S_1 , to the outside terminals of a centre-tapped transformer winding. This winding, in conjunction with D_1 and D_2 , forms part of a full-wave circuit which allows a rectified voltage to appear across reservoir capacitor C_1 . If there were no subsequent loading, this rectified voltage would be equal to the peak value of half the applied mains voltage. Loading is, however, provided by the two resistors R_2 and R_3 in series, whereupon the rectified voltage has a value which is lower than the peak value. A proportion of the rectified voltage is applied to the relay coil and the VR105/30 regulator valve in series.

If S_1 is closed when the mains supply is at a low level, the voltage applied to the relay coil and the VR105/30 is not sufficient to allow the latter to strike. As a result, no current flows through the relay coil and its normally-closed contacts remain closed. The mains supply is, in consequence, passed to the protected equipment via these contacts and switch S_2 . If at any time the mains voltage rises above a pre-determined level, the regulator valve strikes, whereupon the voltage across it drops immediately from the

striking potential to the operating potential and causes a relatively heavy current to flow through the coil of the relay. The latter energises, and its contacts break the supply to the protected equipment.

Once the regulator valve has struck, it remains illuminated until the voltage applied to it falls below the operating potential. This is considerably lower than the striking potential, with the result that regulator current continues to flow even when the mains voltage is reduced well below that which originally caused the relay to energise. The relay will, then, only de-energise if the mains voltage is sufficiently reduced to extinguish the regulator valve, or until regulator current is too weak to maintain the armature in the energised position. In either case, the corresponding mains voltage will be lower than that which originally tripped the device.

It will be noted that an indicator neon, together with a series resistor R_4 , is connected across the supply after the relay contacts. The function of this neon is to provide a visual indication of the state of the circuit, and it should be mounted on the front panel of the device.

Operation

It will prove helpful, at this stage, to give an example of the manner in which the circuit may be operated in a typical application. We will assume that the protected equipment is a television receiver.

Initially, S_1 and S_2 are set to the "Off" position, and the receiver is switched on. S_1 is then closed. If the indicator neon becomes illuminated it may be assumed that the mains voltage is lower than the predetermined trip value to which the device has been set up, because the regulator valve has not struck and the relay remains de-energised. The mains voltage adjustment for the receiver can then, if desired, be tapped down. After this operation S_2 is closed, whereupon the supply is fed to the receiver, which functions in normal manner.

If the mains voltage rises above the predetermined level the regulator valve strikes, and the supply to the receiver is broken. Also, the indicator neon becomes extinguished, denoting that the circuit has tripped. The relay will then remain energised even if the mains voltage falls. S_2 should now be opened, as also should S_1 . Opening S_1 will cause the regulator to extinguish and the relay to de-energise. If when S_1 is closed again the relay re-energises, the indicating neon will once again fail to light, thereby indicating that the mains voltage is still above the predetermined level. S_1 should then be opened again. The receiver mains voltage selector is next reset to agree with the nominal mains figure, whereupon the receiver may operate in normal manner by closing S_2 on its own.

With the above procedure, the only receiver switching operation which is carried out by the relay contacts occurs if and when the relay energises. All other receiver switching operations are carried out by S_2 . The relay contacts are, therefore, subjected to the minimum amount of wear.

If desired S_2 could be omitted, because its function can be carried out by the on-off switch on the receiver itself. However, it will probably be found more convenient to work with S_2 , which may be mounted alongside S_1 , than to use the receiver switch.

Setting Up

The procedure for setting up the device consists of finding values for R_2 and R_3 which cause the regulator valve to strike when the predetermined mains voltage is applied. These values are best found empirically, as there are quite a number of variables in the circuit which have to be taken up. The variables include the predetermined voltage itself (which has to be selected by the constructor to suit his own particular case), losses in the centre-tapped transformer

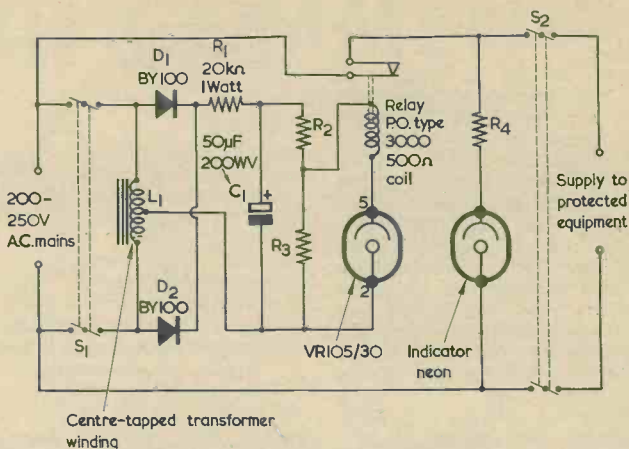


Fig. 1. The circuit of the protection device. The values of R_2 , R_3 and R_4 are discussed in the text

winding and variations in striking voltage between one regulator valve and another.

The writer made up a prototype for the circuit, employing a P.O. type 3,000 relay with a 500Ω coil, and working to an arbitrarily chosen trip voltage of 240. Under these conditions the circuit functioned satisfactorily (with the particular regulator employed) when R_2 had a value of 390Ω and R_3 a value of 3.6kΩ.

With the prototype, an input mains voltage of 240 caused approximately 133 volts to appear at the junction of R_2 and R_3 , whereupon the regulator valve struck. The voltage across the regulator then dropped to 105, and approximately 25mA flowed through the relay coil.

If the regulator employed has a higher striking voltage than that used by the writer, or if the predetermined mains trip voltage is to be lower, the value of R_3 has to be increased. Not only will this cause a greater proportion of the rectified voltage across C_1 to appear at the junction of R_2 and R_3 , but it will also cause the rectified voltage itself to increase due to the reduced loading across C_1 . R_2 should have a final value which allows about 20 to 25mA to flow through the relay coil at the predetermined mains voltage level when the regulator valve has struck. Too low a relay current may not give reliable and swift energising, whilst too high a current may result in excessive dissipation in the regulator valve when the mains voltage exceeds the predetermined level. As a guide it may be mentioned that, when

employed with one contact set, the P.O. type 3,000 relay which is specified energises at about 10mA, and that the maximum operating current for the VR105/30 is 40mA. Incidentally, a convenient method of measuring relay current consists of connecting a voltmeter across the coil and working from Ohm's Law.

As may be gathered from the above, the values of R_2 and R_3 are interdependent, since their sum affects the rectified voltage appearing across C_1 , and their ratio affects both the voltage applied to the regulator before striking and the relay current which flows after striking. The simplest approach will probably consist of starting with the values employed in the writer's prototype (390Ω for R_2 and 3.6kΩ for R_3) and working from there. The resistors finally employed should, of course, have adequate wattage ratings according to their values and the voltages which appear across them.

When the final values for R_2 and R_3 are established, it may prove helpful to replace R_3 with a fixed resistor and variable preset resistor, as shown in Fig. 2. This combination could give the required value for R_3 when the slider of the preset resistor is at the centre of its track, whereupon any small adjustments which may be later required can be conveniently carried out.

Different mains voltages for setting-up purposes can be obtained from the primary taps of a standard mains transformer.

Circuit Details

There are several points in the

circuit which require a little further discussion.

It was decided to employ a rectifier circuit which operated from what is effectively half the mains voltage instead of the full mains voltage because the resultant rectified voltage is only slightly higher than the striking voltage of an easily obtainable regulator valve. If the full mains voltage had been rectified, the resultant direct voltage would have been considerably higher than the striking voltage of any readily available regulator, and the appropriate potential divider (corresponding to R_2 and R_3 in Fig. 1) would have had to draw a heavy current in order to provide a satisfactory relay current.

The centre-tapped winding, L_1 , can consist of a 200-0-200 or 250-0-250 volt h.t. secondary on a standard mains transformer, the remaining windings being left unconnected. Alternatively, a mains transformer with a centre-tapped primary can be used, if available.

The writer employed BY100 rectifiers in the D_1 and D_2 positions as these happened to be available. Rectifiers with a p.i.v. of 400, such as the OA210, could be used in their place.

The relay chosen is not particularly critical provided that it is capable of energising at about 10mA,

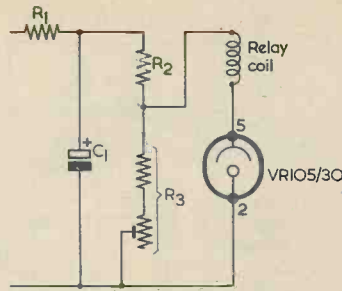


Fig. 2. R_3 may be replaced by a fixed resistor and a preset variable resistor in series

has a coil resistance not greatly in excess of 500 Ω , and has a pair of normally-closed contacts which can operate at mains voltages.

The indicator neon may be any small type capable of being mounted on a panel, the value of R_4 being chosen to suit the type employed. A rather elegant alternative would consist of employing an a.c. voltmeter in place of the neon and its series resistor.

So far as the regulator valve is concerned, it is important to note that reliance is placed on its *striking* voltage rather than on its *operating* voltage. From the writer's experience, individual regulators exhibit

constant striking potentials and so no difficulties should arise on this point.

A weakness in the circuit is that, if C_1 loses its capacitance with time, the rectified voltage which appears across it may fall, whereupon the circuit may trip at a voltage higher than the predetermined level. This capacitor has, however, been given a high value, and a relatively large drop in capacitance would be needed before this effect became significant. Nevertheless, it would be advisable to employ a new component for C_1 and to mount it well clear of heat-dissipating components. The device can, of course, be checked from time to time to ensure that there is no loss of sensitivity.

It should be mentioned that some regulator tubes tend to be slow in striking if they are operated in complete darkness. It would, in consequence, be preferable to avoid operating the VR105/30 in this manner in the present circuit.

Finally, it should be noted that, with the circuit of Fig. 1, it is possible to work to a predetermined trip level which can be as low as 200 volts. With this input voltage, the rectified voltage across C_1 , for high values of R_3 , can rise nearly to the peak value of 140. This satisfies the minimum striking voltage of 135 for the VR105/30.

New Base for Double Pentodes

ONE METHOD OF ACHIEVING MINIATURISATION in valve circuitry involves the use of more than one valve in each envelope. However, this increases the minimum number of base pins which must be used. In order to allow two pentodes to be included in one envelope with separate connections to all of the electrodes except the suppressor grids, a new ten pin base has been introduced. This type of base is known as the "decal" or B10B base. The pins of B10B valves are placed in a circle of the same diameter as those of B9A valves, but the pins are slightly closer together in order to provide enough space for the tenth pin. There is a gap between pins 1 and 10 of 54°, the other pins being spaced at intervals of 34°.

The B10B base has been selected for the new PLF200 double pentode valve which has been specially designed for future television receivers. The "L" or power output section of the PFL200 is a high gain video pentode capable of producing

a large output voltage across an anode resistor of low value (e.g. 100 volts peak-to-peak across 2k Ω). The control grid, of the frame type, enables a mutual conductance of 21mA/volt at 30mA anode current to be obtained. The high gain of this section will make the valve especially useful in hybrid television receivers in which the last i.f. amplifier is transistorised.

The "F" or amplifier section of the PFL200 is a medium slope voltage amplifying pentode designed for any one of a number of applications. In British receivers it is most likely to be used as a synchronising pulse separator, but in receivers for the overseas market it can be used as a high gain a.g.c. amplifier or as an intercarrier sound i.f. amplifier.

Further details of the PLF200 are given in the Mullard publication *PLF200 double pentode for video output and sync. separator applications* (Publication No. TP798).

NEWS AND COMMENT . . .

Lady Servicemen ?

The above sounds a contradiction in terms but we have yet to hear a radio and television dealer say that he is sending a servicewoman round to check a radio or TV fault—perhaps there are none to send!

The foregoing thoughts were prompted by a charming letter we have received from a young lady who wishes to enter the radio and television servicing trade, but is finding it almost impossible to do so despite six months training in practical radio servicing and having been a keen home constructor for more than 10 years, and having a good knowledge of physics and mathematics.

Various reasons have been given to her as to why women cannot be employed in servicing, "We don't want to be the first to employ a girl" —"You would distract the engineers"—"We haven't the facilities available for women," etc., etc. No doubt there are genuine difficulties, but were not similar objections made to the employment of women in offices 50 years ago? In other words, despite certain difficulties, is it a case of the frightened male jealously trying to maintain one of his preserves?

We will not pursue the topic any further in case we find ourselves embarking on the vast subject of the education of women and their place in society, however if you have any comments which you think may be of interest, we shall be pleased to hear from you.

Talking Book Library

In the early 'thirties The Royal National Institute for the Blind and St. Dunstan's initiated the Talking Book Library of recorded books for the blind, pioneering the use of long playing records. By 1960 membership had reached a total of some 7,000, a limit which was imposed by problems of supply and distribution as exemplified by the fact that in that year alone no fewer than two million individual discs were despatched and returned, each of which had to be individually checked visually and aurally before re-issue.

The Library, as a result of the interest which the late Lord Nuffield took in it, is now known as the Nuffield Talking Book Library.

Although magnetic tape recording is generally accepted as a post-war development it was being considered for Talking Books prior to the war and by 1951 a prototype of an entirely original design had been evolved. It was, however, some years before commercial tape could be considered sufficiently reliable to warrant its use for mass production in this respect.

In 1959 the important decision was made to convert the Library from disc to tape. The present system, utilising a half-inch tape carrying 18 tracks, provides some 21 hours of reading time in one cassette; complete simplicity of operation; maximum protection of the tape and reproducing mechanism; minimum maintenance and high-speed copying from the master tape enabling the library to circulate new books within days of the original recording.

As a result there is, for the first time in the history of the Library, virtually no waiting list, new members can be enrolled on demand and have increased the readership to some 12,500. Six hundred and twenty-two titles are now listed in the tape catalogue and are being added to at the rate of 250 each year.

Plans are now nearing completion for the compilation of a library of recorded text-books for blind students. The incorporation of a fast-wind device on the reproducer combined with a track selection sprocket on the cassette will permit reference to any pre-determined passage within four to five minutes.

No progress report of Talking Books would be complete without a tribute to the network of volunteers throughout the country who help to install and service Talking Book machines. They are all electronics enthusiasts, radio amateurs and the like, who are prepared to turn out in their own time to look after the Talking Book readers in their particular area.

Mr. D. Finlay-Maxwell, A.M.I.E.E., Honorary Organiser of Servicing Volunteers, would be glad to hear from suitably qualified people within the Bolton area who would be prepared to help in this vital and rewarding work. Potential volunteers should write to him care of J. Gladstone & Co. Ltd., Wellington Mills, Huddersfield, Yorks.

New Selenium Rectifiers

A new miniature selenium rectifier, made up of 150 tiny discs stacked inside a 3-inch long tube, has taken the place of the 16,000-volt picture tube rectifier valve in 17 brands of TV sets now made in Britain.

The new rectifier is made by Standard Telephones and Cables Limited and has succeeded in bringing miniature selenium units back into TV e.h.t. circuits. It represents a significant step forward in the development and assembly of selenium plates of very small area—the new rectifier discs are only two millimetres in diameter.

Known as the X80/150, the new rectifier is being used in conjunction with a more compact line output transformer.

Parliamentary Question

The Secretary of State for Scotland was asked by Mr. Dempsey, M.P. for Coatbridge and Airdrie, if he would take steps to equip traffic police with tape recorders as an experiment for charging drunken drivers. Lady Tweedsmuir, Under-Secretary, Scottish Office, stated in her reply that she felt that better evidence can be obtained by existing methods.

In a further question Mr. Dempsey suggested that by playing the tape the sound of the voice could help the court decide a person's condition and would act as a deterrent to drunken driving. Lady Tweedsmuir, in the course of her reply, said there was a point of view that a tape recording of speech is not necessarily reliable evidence of, for example, slurred speech.

Parliamentary Quote

"Popularity ratings reveal only what people actually watch and not what they would like to watch. Here lies the great opportunity of the B.B.C. with its second programme." —The P.M.G.

Cartoon

An amusing cartoon appeared in the *New Scientist* recently. It showed a member of the public gazing at a notice in the science section of a public library. The notice read "Quiet please (max. 5 decibels)".

Transistor and Diode Tester

by C. G. Menzies

THE INSTRUMENT DESCRIBED IN this article is of the utmost simplicity in construction, and yet the most comprehensive of tests may be made with it. It is capable of carrying out a considerable number of tests on p.n.p. transistors and on diodes, and it also provides a variable output voltage for other equipment which is fully monitored for voltage and current.

The Circuit

The circuit of the tester appears in Fig. 1. In the prototype, the mains transformer T_1 was an ex-bell transformer which offered secondary voltages of 6 and 25. The 6 volt secondary was employed for the pilot lamp, whilst the full secondary winding provided 25 volts for the bridge rectifier D_1 to D_4 . However, any mains transformer capable of offering a secondary voltage between 20 and 30 volts at a maximum current of 100mA (together with a suitable voltage for a pilot lamp) could be used. The bridge rectifier was salvaged from a model railway and, with the smoothing circuit shown, gave negligible hum when checked with an oscilloscope. Any standard diodes or bridge rectifier having suitable ratings could be employed here.

The smoothing resistor requires some comment. This was provided by the coil of a relay (RY_1) which energised at about 24 volts and gave some measure of protection for meters and other components. If excessive current is drawn through the coil the relay energises, holds on by its own contact via R_2 , and disconnects the h.t. supply.

The smoothing capacitors are of the type commonly found in television receiver bias circuits.

The variable resistor VR_4 provides coarse voltage control whilst VR_3 provides fine voltage control. Both these variable resistors are wire-wound. The voltage tapped off by

the slider of VR_3 is monitored by M_3 in conjunction with the various series resistors switched in by S_4 . A suitable f.s.d. for M_3 is 1mA, but meters with somewhat higher or lower sensitivities could also be employed, since the accuracy of the circuit does not depend greatly on the type of meter employed here. The number of positions in S_4 , and the number of series resistors consequently required, is a matter for personal choice. The highest voltage range switched in by S_4 must, however, be greater than the maximum voltage available from M_3

and VR_4 . The author used a 10-way switch in the S_4 position, this offering ranges from 0.1 to 50 volt in conjunction with a 0-1mA meter. The values of the series resistors depend, of course, upon the meter and ranges chosen.

Meter M_2 is in series with the positive supply to the transistor test circuit and should have as low an f.s.d. as possible, since it is required to measure leakage current. The author's component had an f.s.d. of 500 μ A. Shunts for the meter are switched in by S_4 and, here again, the number of ranges employed is a matter of preference. Nevertheless, the writer would suggest that ranges of 5mA, 10mA and 100mA be included. The values of shunt resistance required depend upon the meter and ranges selected, and may be made up with suitable resistance wire.

The unit provides outputs for auxiliary equipment at the three output terminals shown. One terminal offers a common positive, a second terminal provides the negative voltage appearing immediately after the smoothing circuit, whilst the third output terminal provides the negative voltage which is monitored by M_3 . Meter M_2 is in series with the positive output and thereby

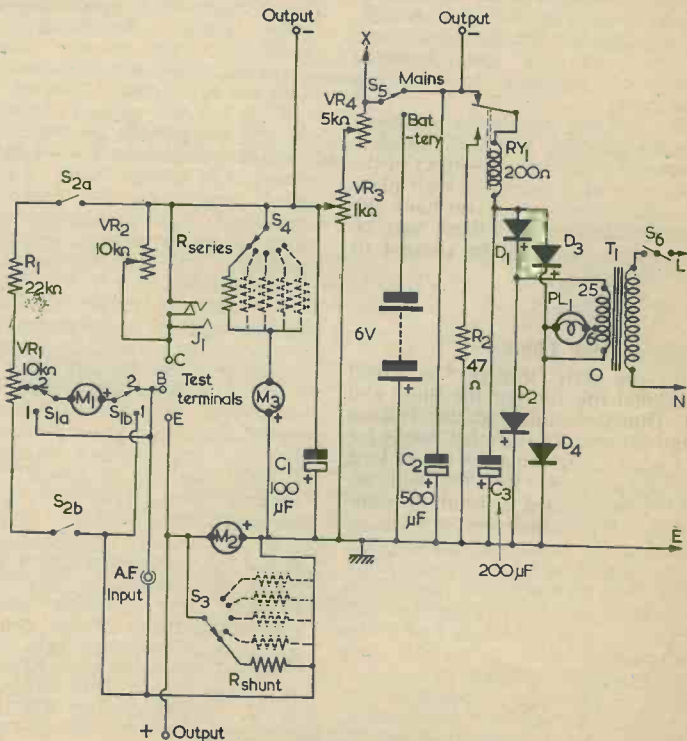


Fig. 1 The circuit of the transistor test unit

indicates the current drawn by external circuits. For this reason it is considered desirable that it be capable of reading currents up to 100mA.

The negative voltage appearing at the slider of VR₃ is applied to the collector of the transistor under test by way of VR₂ and jack J₁. The jack short-circuits VR₂ when no plug is inserted. VR₂ is a linear component, and should preferably be wirewound. Its function is to offer a variable collector load, and it is fitted with a scale calibrated in terms of the resistance it inserts in circuit. A crystal earpiece can be connected across VR₂ by plugging it into J₁. This earpiece may then be used to evaluate the a.f. performance of a transistor under test for different values in VR₂, an a.f. oscillator being coupled into the

Components List (Fig. 1)

Resistors

- R₁ 22kΩ 10% ½W
- R₂ 47Ω 20% ½W
- R_{Shunt} Group of meter shunt resistors
- R_{Series} Group of meter series resistors
- VR₁ 10kΩ linear potentiometer
- VR₂ 10kΩ linear potentiometer (preferably wirewound)
- VR₃ 1kΩ wirewound potentiometer
- VR₄ 5kΩ wirewound potentiometer

Capacitors

- C₁ 100μF electrolytic 25V wkg.
- C₂ 500μF electrolytic 25V wkg.
- C₃ 200μF electrolytic 25V wkg.

Switches

- S₁ d.p.d.t. switch
- S₂ d.p.s.t. switch. May be ganged with VR₁
- S₃ Current range switch. See text
- S₄ Voltage range switch. See text
- S₅ s.p.d.t. switch
- S₆ s.p.s.t. mains on-off switch

Meters

- M₁ 0-1mA moving coil. See text
- M₂ 0-500μA moving coil. See text
- M₃ 0-1mA moving coil. See text

Miscellaneous

- T₁ Mains transformer. See text
- D₁-D₄ Bridge rectifier. See text
- J₁ Phone jack with shorting contact
- RY₁ Relay, 200Ω coil. See text
- PL₁ Pilot lamp
- Crystal earpiece with jack plug.

base circuit. The earpiece may also, without the a.f. oscillator input, give some indication of transistor noise level.

In position 1, switch S₁ allows meter M₁ to measure base leakage when earthed. In position 2 it enables M₁ to measure the base current selected by potentiometer VR₁. This potentiometer is connected across the supply in series with R₁, and it allows varying base currents to flow in the transistor under test. The value of R₁ should be such that, with maximum voltage from VR₃ and VR₄, and with S₁ in position 2 and VR₁ slider at the top of its track, meter M₁ indicates slightly more than f.s.d. With the prototype this condition was satisfied by giving R₁ a value of 22kΩ and the meter an f.s.d. of 1mA. VR₁ and R₁ are switched across the supply by S₂, and the latter could, if desired, be ganged with VR₁ such that it becomes closed when VR₁ slider leaves the lower end of its track. However, this is an optional point, and S₂ could just as usefully be a separate component instead.

If it is desired to operate the tester from a battery supply instead of from the mains, this may be achieved with the aid of S₅. This switch disconnects the output of the mains unit and connects a 6 volt battery into circuit instead.

D. C. Tests

The operation of the instrument is very simple, as is demonstrated by the d.c. tests which can be carried out. When commencing a test, the slider of VR₁ should be set to the bottom of its track and switch S₂ opened. S₁ should be set to position 1. Also, VR₃ should be set to minimum voltage. The transistor under test may now be connected up and the tester switched on, whereupon the pilot lamp will glow. S₄ may be set to give an f.s.d. in M₃ of, say, 10 volts, and VR₃ adjusted to apply several volts to the transistor. M₁ will now read base-emitter-collector leakage and M₂ will read base and collector current, from which readings the gain of the transistor may be calculated. (M₂ is inserted in the emitter circuit instead of the collector circuit because it then allows the provision of an external supply monitored for current).

A.F. tests (to be described shortly) may be carried out after completing the d.c. tests.

Turnover voltages, and variations

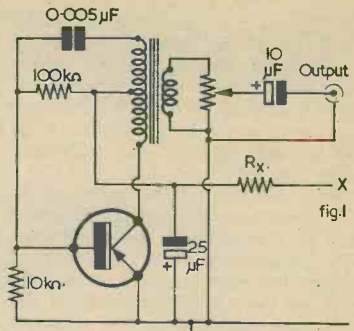


Fig. 2. The a.f. oscillator employed in the prototype

due to thermal and light conditions may similarly be checked with the instrument. There is, indeed, considerable scope for experiment. Diodes may also be tested for forward and reverse currents at various voltages, simply by connecting them between the emitter and collector test points.

A.F. Tests

An a.f. oscillator of very simple type is incorporated in the instrument, and that employed in the prototype has the circuit shown in Fig. 2. In this diagram the transformer is a push-pull valve output type, and it operates in conjunction with any audio transistor. The value of the series resistor R_X should be such as to allow a safe working voltage for the transistor. However, the circuit employed for the oscillator is not critical and any suitable type, including a multivibrator, could be used. The output of the oscillator

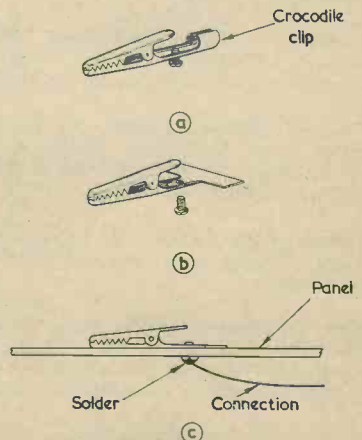


Fig. 3. Illustrating how crocodile clips were modified to provide test terminations

connects to a coaxial socket on the front panel, and this may be linked by a coaxial cable to a similar socket connected to the base of the transistor under test. With S_1 in position 2, therefore, an a.f. input may be fed to the base of the transistor under test.

With the test circuit linked up in this manner, the crystal earpiece may be plugged into J_1 , whereupon VR_2 becomes switched into circuit. It then becomes possible to roughly evaluate the a.f. performance of the transistor under test for different conditions of base and emitter voltage and current. It will be found that VR_2 will offer a setting which gives maximum volume in the phones. The resistance inserted by VR_2 , which may be read from its scale, then indicates the optimum resistive collector load under the conditions in which the transistor is being run.

The transistor in the a.f. oscillator circuit is fitted to a transistor holder mounted on the front panel. If desired, other transistors may then be fitted to this holder, whereupon they may be checked for operation in the oscillator circuit. The presence of oscillations is checked by connecting a known good transistor to the test terminals and using the earpiece.

Constructional Points

The layout of the instrument is not critical. The prototype was built into a small wooden case having an insulated front panel, on which were mounted the meters and controls, etc. The 6 volt supply was provided by four U2 cells, these being retained by Terry clips.

The method of holding the transistor while under test requires

comment. It was found that a standard transistor holder was perfect at first, but that after a few tests it broke in some way. Thus, in addition to this, a standard B7G valveholder was included, and this enabled transistors with medium length leads to be tested. Special clips were devised, also, for testing transistors or diodes with long leads, these consisting of standard crocodile clips modified as shown in Fig. 3. The wire clamp at the end remote from the jaws was opened out and flattened, as in Fig. 3. (b), after which the screw was removed. The screw was then passed through a hole in the insulated front panel to secure the clip in the manner illustrated in Fig. 3 (c). A connecting wire was finally soldered to the screw on the inside of the panel. The collector clip may be painted black, if desired, to indicate polarity.

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.

Homelab Signal Generator, Type 10.—F. Greenwood, Laurel Cottage, Prospect Place, London, N.2, requires circuit diagram, loan or purchase.

R206 Receiver Mk. II.—P. Berry, 8 Fouracres Road, Newall Green, Wythenshawe, Manchester 23, wishes to purchase or obtain loan of circuit or service manual.

Transistorised Pre-amplifier/Tone Control.—D. Roberts, G3NSZ, 18 Alexandra Drive, Rock Ferry, Cheshire, would like to obtain a suitable circuit giving 0.4V output suitable for crystal pick-up.

Halicrafter Marine Radiophone Model HT11 or 11a.—K. E. Le Masurier, "Aqir", Feugre, Cobo, Guernsey, requests any information, service sheet or manual.

German AM/FM Receiver.—H. H. Le Riche, 48 Lancaster Road, St. Albans, Herts., is anxious to obtain service sheets, loan or purchase, of this receiver, marked —Nora, Mazurka 56, W.940.

Etronic Model RA640.—K. Bartram, 157 Middlebridge Street, Romsey, Hants, requires loan of service sheet for this receiver.

Basic Frequency of Performance Meter.—P. G. Peters, Oakleigh, Oakdene Road, Pitsea, Basildon, Essex, requires the handbook or any details of this instrument (Design 2) made by Parmeko Ltd., Leicester in 1944.

Valve Tester/Multi-Range Meter.—E. J. Catt, 21 Chip-house Road, Kingswood, Bristol, has obtained this U.S.A. surplus equipment (Espey Model 104 TC, Type SC) part of Test Set 1-56-D and would like manual or information.

R208 Reception Set.—R. J. Buckley, 79 Golborne Avenue, Withington, Manchester 20, would like to purchase manual or circuit for this receiver.

Invicta PCR3 and AM Receiver Type 1116A.—J. Higgins, 47 Crawford Street, Greenock, Renfrewshire, Scotland, wishes to purchase or borrow the manuals for these receivers.

144 Mc/s Converter.—A. R. Brackenborough, 41 Poets Corner, Margate, Kent, would like to correspond with any reader who has constructed the design described in the May and June (1961) issues of this magazine.

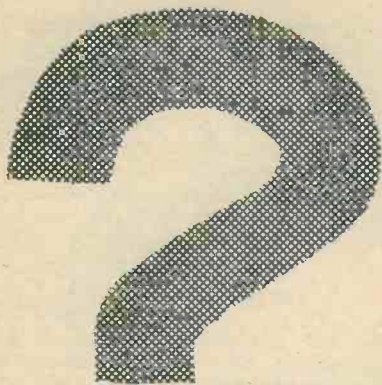
UHF Receiver Halicrafters S36.—4037402 Sgt. Wilson, S. O., 5 Willow Crescent, West Barrier, Finningley, Doncaster, Yorks., wishes to borrow or purchase the circuit diagram.

Transmitter Type BC375E.—J. Donaldson, 13 Ersham Road, Canterbury, Kent, would like to purchase or borrow the circuit or manual and especially any information on the power supply units and the junction box.

R1155A Receiver.—D. Burrage, 85 Walker Crescent, Wyke Regis, Weymouth, Dorset, requires loan or purchase of the circuit.

Ferguson 6208T Export Model.—A. J. Anderson, 63 Carlingford Road, West Green, London, N.15, requires circuit or any information on this TV.

"Microphones", B.B.C. Engineering Training Manual.—W. B. Yarnold, 29 Blackmore Road, Malvern, Worcs., is anxious to purchase a copy of this book, now out of print (published by Iliffe & Sons at 15s.).



The thirty-third in a series of articles which, starting from first principles, describes the basic theory and practice of radio

part 33

understanding radio



By W. G. MORLEY

IN LAST MONTH'S ISSUE WE INTRODUCED THE moving-coil loudspeaker, and saw how, by passing a current through its coil, the latter could be made to move in or out of the magnet and pole-piece assembly according to the direction of the current. By fixing a cone to the coil former it then became possible for the movements of the coil to cause compressions and rarefactions in the air and thus reproduce, as sound, the electrical signal applied to the coil.

In this month's article we shall continue to discuss the moving-coil loudspeaker.

Practical Loudspeaker Construction

The practical construction of moving-coil loudspeakers of the type employed in domestic radio and television receivers is not very much more complicated than the assembly we arrived at from first principles in Fig. 209 (b).¹

A typical practical loudspeaker is shown, in cross-sectional form, in Fig. 210. In this diagram we have the same magnet and pole-piece assembly as before, but the air gap is smaller than was indicated in Fig. 209. A small air-gap is needed to ensure that a high field strength exists in the gap. In practice, the air-gap is just sufficient to allow the coil on its former to move freely without the risk of rubbing on either side of the gap.

The coil, which is known as the *speech coil*, or *voice coil*, is wound on a thin-walled former made of Bakelised paper or similar material. The coil may be wound in two layers with enamelled copper wire as shown in Fig. 211, although other methods of winding may also be encountered. Aluminium ribbon is sometimes used in more expensive loudspeakers to reduce weight. The coil former is secured to the apex of the core and

is maintained in position by a centring device consisting of a circle of cambric material having concentric corrugations. Earlier loudspeakers employed a *spider* as the centring device, this being made of semi-flexible Bakelised material, or similar, whose centre was secured to the central pole-piece of the magnet assembly by means of a bolt and spacer. See Fig. 212. After the voice coil of such a speaker had been centrally aligned in the air-gap this bolt was then tightened to lock the spider in position, the process being described as "centring" the loudspeaker. Most modern loudspeakers employ the peripheral centring device illustrated in Fig. 210 and are "centred" at the factory. Some-

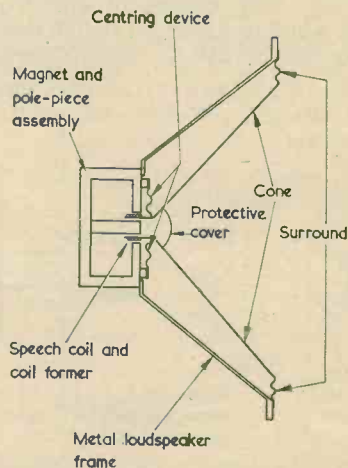


Fig. 210. A cross-sectional view through a typical moving coil loudspeaker. The flexible wires which connect to the speech coil (see Fig. 213) are not shown here

¹ Published in last month's issue.

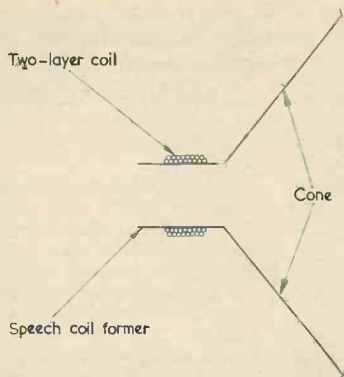


Fig. 211. It is frequent practice to wind the speech coil in two layers

times, the peripheral type of centring device is also referred to as a spider.

Connection to the speech coil is made by way of two flexible leads soldered to anchor points near the apex of the cone, as shown in Figs. 213 (a) and (b). The other ends of the flexible leads are secured to connecting tags, or terminals, mounted on the metal frame of the loudspeaker.

A cone is employed instead of a flat diaphragm because the cone shape has much greater rigidity.² Fig. 214 shows a cone shape in which the angle narrows as the apex is approached, this shape being frequently encountered in practical loudspeakers. Alternatively, the cone sides may be straight, as in Fig. 210.

In most loudspeakers, the cone material has a paper-like quality, and may be made from pulp fibres which are treated and pressed into shape in a mould. Such cones are referred to as *paper cones*. Alternative materials, normally found in more expensive loudspeakers intended for high fidelity³ use, may consist of stiffened cambric or of thin metal or expanded polystyrene.

A paper cone is usually manufactured complete

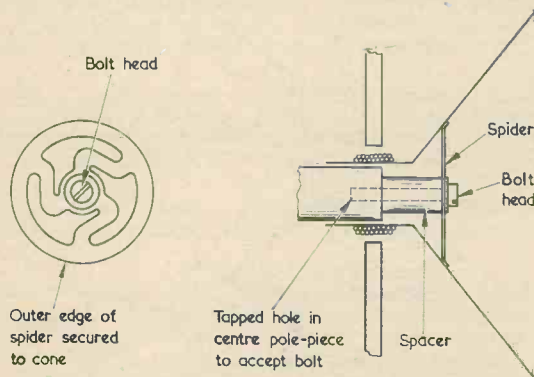


Fig. 212. Two views of the "spider" centring device which was employed in earlier loudspeakers. The bolt passes into a tapped hole in the centre pole-piece. When a spider of this type is employed, the protective cover shown in Fig. 210 cannot be fitted

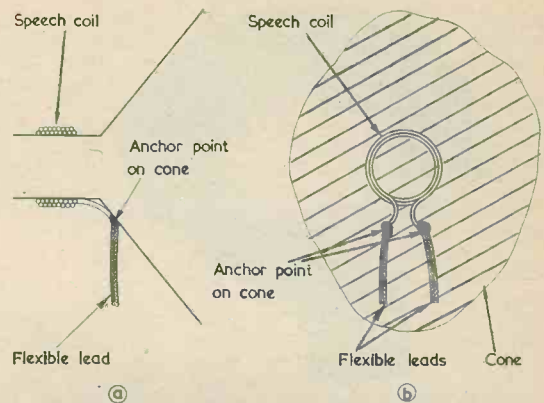


Fig. 213 (a). Cross-sectional view, showing one of the anchor points fitted near the apex of the cone which provide junctions for the speech coil and the flexible leads

(b). Rear view of the speech coil and cone. The two flexible leads connect to tags or terminals mounted on the loudspeaker frame

with its *surround*, the latter providing a flexible coupling between the cone proper and the metal frame of the loudspeaker. The material in the surround may be made thinner than that in the cone in order to impart flexibility, and it is given concentric corrugations to assist in reducing rigidity. With cambric cones, the surround may be of the same material as the cone, but it is not subjected to the same stiffening processes. Surrounds may also be made of p.v.c. or a similar flexible material, this point applying in particular to the cases where cone material is other than paper or cambric.

A protective cover is fitted over the centre of the cone near the apex, to prevent dust and other particles entering the air-gap. Sealing of the gap

² In some texts, the cone may be referred to as a "diaphragm".

³ The term "high fidelity" (or "hi-fi") applies to specialised equipment whose function is to reproduce sound with a minimum of distortion, and it infers that the equipment is of a considerably higher standard than that encountered in domestic radio receivers and the like. Unfortunately, the indiscriminate use of the term by some manufacturers has caused it to lose some of its potency. An older term which is still encountered defines higher standard sound reproducing equipment as "high quality" equipment. Neither of these expressions is precise, but it is fairly safe to assume that "high quality" equipment offers better reproduction than, say, the average domestic radio receiver, whilst "high fidelity" equipment is better again.

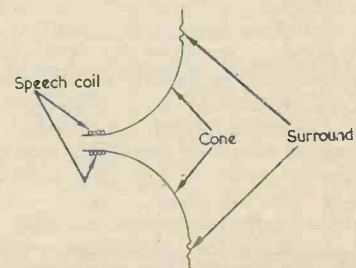


Fig. 214. Some loudspeakers employ a cone shape similar to that shown here

is further ensured by securing the centring device to a raised concentric section on the surface of the outside pole-piece.

When the speech coil is in motion, it is essential that it moves only forwards and backwards inside the air-gap. If the speech coil and former moved at an angle, as shown in exaggerated form in Fig. 215, there would be an increased risk of rubbing against the sides of the gap. Correct axial movement is normally ensured by the centring device and the surround of the cone.

Cone Performance

The material employed for the cone has an important bearing on the performance offered by the moving-coil loudspeaker over the range of audio frequencies it is intended to reproduce. The subject of cone material and manufacture is very complex, however, and it would be impossible to deal with it fully in the present context. Nevertheless, some of the simpler aspects of cone design will now be discussed.

Speaking in general terms, it is difficult to manufacture a loudspeaker cone which is capable of truthfully reproducing the whole range of audio frequencies. One of the problems which has to be overcome is concerned with the hardness of the cone material. At low frequencies, the cone tends to move as a whole, this applying whether the cone is made from a hard material or a soft material. At high audio frequencies, a cone made of hard material offers too high an inertia to adequately follow the faster vibrations imparted to it by the coil, and high frequency reproduction may fall in efficiency. If a cone made of soft material is used, this may follow the voice coil movements efficiently at its centre, but the soft material may not allow these to be fully transmitted to the edge of the cone.⁴ Thus, the central section of a soft cone may have a wide overall movement at high audio frequencies, whilst the outside edge of the cone is virtually at rest.

Another problem which arises with loudspeaker cone materials is given by *break-up*. If a cone made of a weak material is caused to vibrate at high audio frequencies it is possible for individual sections to vibrate separately, thereby producing a distorted version of the electrical signal fed to the speech coil.

In normal domestic radio and television receivers a high degree of fidelity of reproduction is not expected from the loudspeaker. Also, the requirements of economical cabinet design usually dictate that the loudspeaker fitted should be of small dimensions, and that it should have a cone with a relatively small diameter. Under these conditions it becomes possible to reach a compromise in the quality of cone material which enables acceptable reproduction to be achieved. Since the cone is small, it offers a relatively low inertia at high

⁴ The last two points apply more particularly to cones having a diameter greater than some 5in or so. As we shall see later, smaller cones are more readily capable of handling the higher audio frequencies.

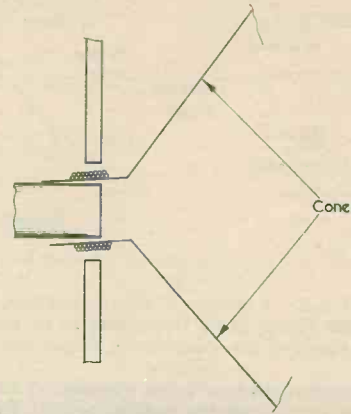


Fig. 215. Illustrating, in exaggerated form, the effect given if the speech coil former is tilted in the air-gap

audio frequencies, and the possibility of break-up becomes reduced. Usually, the cone material is sufficiently soft to allow an adequate high frequency cone movement near the apex at high frequencies, with a lesser movement at the edges. Thus, the cone moves as a whole at low audio frequencies, whilst high audio frequencies are mainly reproduced by the section of the cone which is nearer to the apex. In some cases, the cone material around the apex may be purposely stiffened, by a dipping operation during manufacture, to ensure that a good high frequency response is given by this section. The cone shape illustrated in Fig. 214 also helps to provide a good high frequency response from the cone material near the apex, since the reduced angle between the sides offers the same effect as is given by stiffening. In this instance, the "stiffening" reduces gradually as the angle between the sides of the cone increases.

An alternative technique, which will more usually be found in larger and more expensive loudspeakers than those employed in domestic radio and television receivers, consists of incorporating a concentric rib into the cone shape, this appearing about half-way between the apex

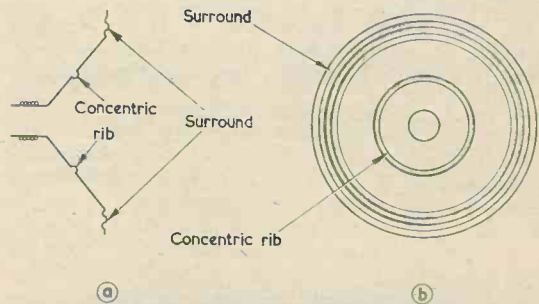


Fig. 216. If a concentric rib is incorporated into the loudspeaker cone, it enables the central section of the cone to vibrate more freely at the higher audio frequencies. A cross-sectional view is given at (a), whilst (b) shows the front of the cone

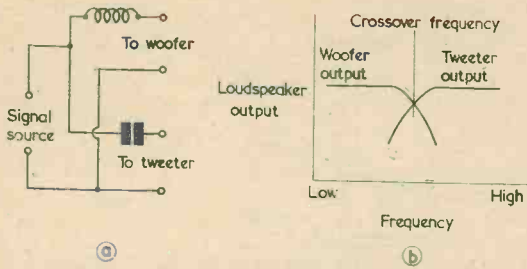


Fig. 217 (a). A simple crossover network, which allows the higher audio frequencies to be passed to the tweeter and the lower audio frequencies to the woofer

(b). Graphical representation showing, in somewhat idealised form, how the audible outputs from the woofer and tweeter combine together to provide reproduction over a wide range of audio frequencies

and the edge, as shown in Figs. 216 (a) and (b). This rib partly isolates the outer section of the cone from the inner section, with the result that only the inner section vibrates at the high audio frequencies, whilst the whole cone vibrates at the low audio frequencies.

Loudspeakers intended for miniature transistor receivers have cones with very small diameters, these being of the order of 2 to 3in only. Small cones such as these are capable of movement, over their whole area, at the higher audio frequencies.

Speaking in very general terms the ability of a loudspeaker to reproduce the lower audio frequencies increases with increase in cone diameter. Thus, a loudspeaker with a cone diameter of 10in would be expected to give better reproduction of the bass notes provided by an orchestra than one with a cone diameter of 5in. It will be noticed that the techniques we have just examined go some way towards meeting this requirement, since they allow the whole cone to vibrate at low frequencies and only the more central section to vibrate at the higher frequencies. As may be imagined, the very small loudspeakers fitted in miniature transistor receivers offer very little bass response.

In high-fidelity installations it is a common practice to employ two loudspeakers. One of these, known as a *woofer*, has a relatively heavy

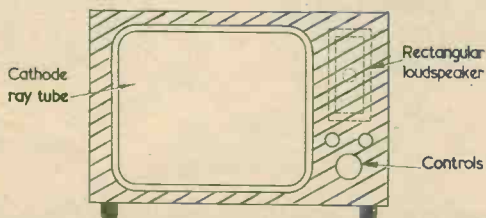


Fig. 218. Rectangular and elliptical loudspeakers can offer a relatively large cone area in a compact cabinet layout. An instance is given by the typical television receiver cabinet layout shown here

cone with a wide diameter, and it is intended to reproduce low audio frequencies only. The second loudspeaker, known as a *tweeter*, has a much smaller and lighter cone, and it reproduces the higher audio frequencies. Both loudspeakers operate from a single signal source, the low frequency signals being passed to the woofer and the high frequency signals to the tweeter by way of a filter circuit which is known as a *crossover network*.

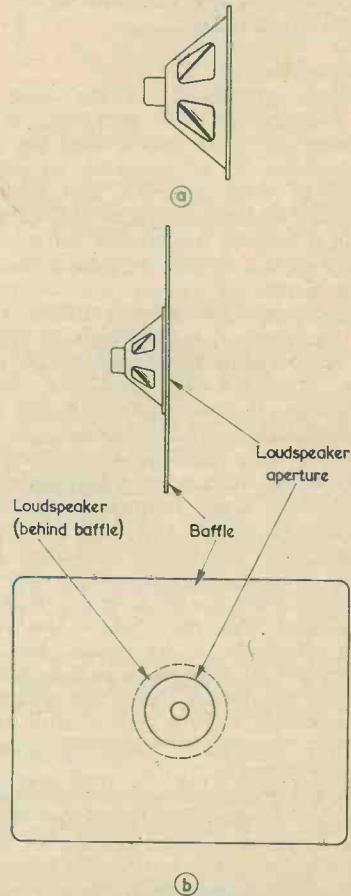


Fig. 219 (a). A loudspeaker mounted in free air offers poor reproduction at the lower audio frequencies because compressions produced at the front of the cone tend to flow round the cone edge to meet rarefactions produced at the rear. Rarefactions at the front similarly meet compressions from the rear (b). Sound produced at the front of the cone may be separated from that produced at the rear by mounting the loudspeaker on a baffle. A side view is shown above and a front view below

A very simple, but quite practicable, crossover network is illustrated in Fig. 217 (a). In this diagram, the capacitor offers negligible reactance to the higher audio frequencies and these are passed without significant loss to the tweeter. Below a predetermined frequency, which depends on capacitor value and loudspeaker impedance,

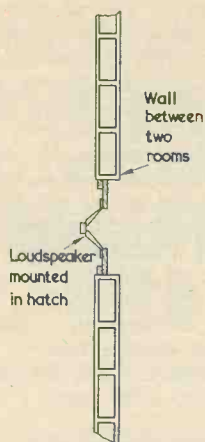


Fig. 220. An exceptionally efficient baffle is given by fitting a loudspeaker to a hatch in a wall between two rooms

the capacitor reactance becomes sufficiently high to affect the signal level fed to the tweeter, and this level falls relatively sharply with decrease in frequency. The inductor gives a reverse effect. At low frequencies it offers negligible reactance but, above a predetermined frequency, this becomes significant and the signal passed to the woofer falls relatively sharply with increase in frequency. By a careful choice of component values in the crossover network it becomes possible for the commencement of output level fall in the tweeter circuit to coincide with the commencement of output level fall in the woofer circuit, as shown in Fig. 217 (b). If the complete assembly has been carefully designed, the sounds from the woofer and tweeter then blend together, and they provide a means of sound reproduction which has a very wide frequency range.

It is possible to employ more complex crossover filters than the simple example shown in Fig. 217 (a), these providing a steeper fall-off in output after the crossover frequency. The crossover frequency chosen depends upon the characteristics of the loudspeakers.

Rectangular and Elliptical Speakers

It is common practice to manufacture loudspeakers having elliptical or rectangular cones instead of the round cones we have considered up to now. Because of their shape, such loudspeakers are particularly useful in small radio receivers, television receivers and tape recorders since, although they offer a large effective cone area, they can still be conveniently fitted into small cabinets. A typical example is shown in Fig. 218, which illustrates a rectangular speaker mounted alongside the cathode ray tube in a television receiver. A larger (and more expensive) cabinet would be required if a round loudspeaker of similar cone area were to be fitted in the same position.

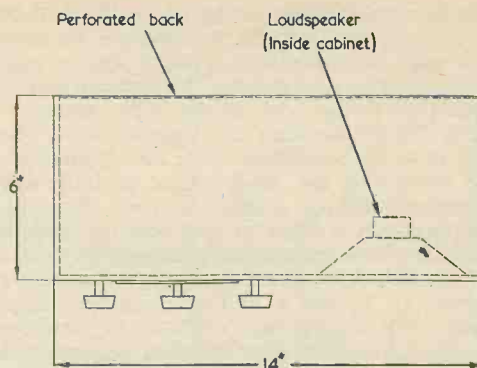


Fig. 221. Top view of a table radio receiver cabinet, with typical dimensions

Rectangular and elliptical loudspeakers offer no significant advantage in performance over round loudspeakers in the same price range.

The Baffle

Fig. 219 (a) illustrates a moving coil loudspeaker mounted in free air. If a signal is fed to the speech coil of this loudspeaker, the cone will move in sympathy. When the cone moves forward (i.e. away from the magnet assembly) it causes a compression to be formed in the air in front of it and a rarefaction in the air behind it. Similarly, when the cone moves backwards its front surface produces a rarefaction, and its rear surface produces a compression.

At low audio frequencies, a compression at the front of the cone will tend to travel round the cone edge to equalise the rarefaction produced at the back (which similarly travels round the cone edge). At the same time, a rarefaction at the front will travel round the cone edge to equalise the compression produced at the back. Only a very small proportion of the low frequency sound is thus radiated forwards by the cone. This effect is especially pronounced at low frequencies because the time taken for a compression or rarefaction to travel round the edge of the cone is shorter than the time occupied by one half-cycle of the sound.

To overcome this effect it is necessary to provide a means of separating the sound produced at the front of the cone from that produced at the rear. The simplest method of achieving this is to mount the loudspeaker on a flat baffle, as illustrated in Fig. 219 (b). Such a baffle, which is made typically of wood, has a large surface area, and it provides physical separation between the sound waves at the front of the cone and those at the rear.

Unless the baffle has a very large area, it is still possible for the lower frequency sounds from the front and rear of the cone to meet at the baffle edge and result in a reduction in sound output. As is to be expected from a consideration of the time taken for the sound to travel to the edge of

the baffle and the time occupied by the half-cycle period, the larger the baffle the lower the frequencies which may be reproduced without loss of sound output. To give an example, the distance from the loudspeaker to the edge of the baffle needs to be at least 5ft if reduction of response below about 60 c/s is to be prevented. It is also preferable to avoid mounting the loudspeaker centrally on a symmetrically-shaped baffle, as there may be a pronounced cut in sound output near the frequency at which the baffle commences to become inoperative. It is more desirable to have the loudspeaker mounted off-centre or to use a baffle having an irregular outline. An interesting method of employing the baffle technique consists of fitting the loudspeaker in a common wall between two rooms, as shown in Fig. 220. With this method of mounting it is impossible for compressions and rarefactions at the rear of the cone to affect the compressions and rarefactions at the front.

The points referred to in the last paragraph are more applicable to the field of high-fidelity

reproduction than to the situations encountered with normal domestic radio receivers. A typical domestic radio receiver cabinet may, for instance, have the layout and dimensions shown in Fig. 221. As can be seen, the receiver cabinet provides a measure of separation between the front and rear of the loudspeaker cone, in so far that sound from the rear of the cone has to travel backwards around the rear edge of the cabinet before it can interfere with sound from the front. It is obvious, however, that the effective "baffle" given by the cabinet is not at all adequate at the lower audio frequencies and that there will be a loss of bass reproduction in consequence. Nevertheless, the reproduction from such a receiver meets average domestic requirements, and is considered acceptable for equipment in its price range.

Next Month

In next month's issue we shall briefly discuss loudspeaker enclosures, after which we shall carry on to further aspects of the moving-coil loudspeaker.

MERSEY TUNNEL CLOSED-CIRCUIT TV SYSTEM

Every year, the number of vehicles using the Tunnel increases. Largest number recorded this year in a single day is 56,175, with peak rates of flow up to 1,400 vehicles per lane per hour. When such quantities of traffic are being handled, the speed of any build-back caused by delays in the Tunnel has serious effects on Liverpool and Birkenhead traffic, particularly on scheduled bus services.

Closed-circuit TV will help the Tunnel police in several ways. It will permit the immediate detection of accidents and congestion at the point of occurrence and in sufficient detail to evaluate the situation. It can be incorporated in any overall plan for the simultaneous despatch of police, fire and emergency vehicles. It will enable a trained observer to assess potential traffic at all four entrances at once, so allowing more flexibility in the peak-hour tidal flow of commuter traffic and the handling of special events. It can also be extended to include methods of traffic light and lane control.

Some of the cameras command views of the approach roads feeding the four entrances to the Tunnel. Others observe conditions at the two underground junctions and in the central section. This initial siting of the cameras will be subject to amendment and additions in the light of experience. A battery of TV receivers is being housed in the traffic inspector's office at the Kingsway end of the Tunnel, until a permanent traffic control building is constructed.

All cameras used are EMI Type 6 minicameras, to facilitate unobtrusive siting. The cameras in outdoor positions are fitted with remotely-controlled zoom lenses and pan and tilt facilities. They are enclosed in all-weather housings equipped with windscreen wipers and thermostatically-controlled heating. So the traffic controller can see long shots or close-up views in all directions, whatever the weather.

Use of closed-circuit television was first considered by the Mersey Tunnel Joint Committee early in 1962. As a result of a series of tests before the Committee, the Traffic Manager recommended its adoption to cope with the persistent increase in Tunnel traffic. At the same time, the reorganisation of the Tunnel police was envisaged to allow officers to specialise in this new method of traffic control.

Consultants to the Mersey Tunnel closed-circuit television scheme are Atro Ltd. of Weston-super-Mare.

Current Limiting Protector for Transistor Circuits

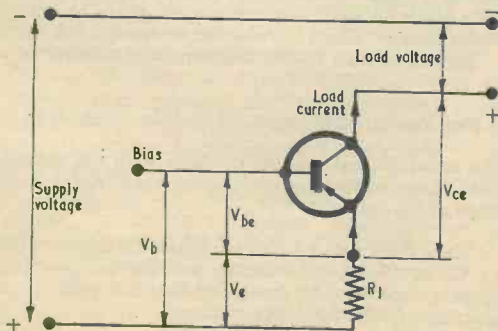
By L. E. CROCKFORD

THE MAJORITY OF ACCIDENTS TO transistors happen when the circuit, whether it is a well constructed printed circuit or a hurriedly built experimental hook-up, is first connected to its supply for testing. None of us are infallible and mistakes are frequent and very often costly. A small wiring error, a short-circuit between tracks on a printed circuit, or a wrong resistance value can quickly reduce a transistor to an open circuit. Even if we play safe and make a resistance check before switching on there is still the risk of thermal runaway, or of a slip with a screwdriver or a meter prod, with the same discouraging results.

If fuses of low current rating were readily available they would still not offer much protection, since a transistor can destroy itself in about the same time, or less, that a fuse wire takes to melt. What is required is a protection device that works instantaneously at a low and accurately known current. The device to be described exhibits these properties, with the additional advantage that it is self-restoring. That is to say, unlike a fuse which has to be renewed, it is ready for use again immediately the fault is cleared.

Theoretical Description

Referring to Fig. 1, it can be seen



that the protector consists simply of a transistor with a bias arrangement and an emitter resistor R_1 . The load current, which is the current taken by the circuit being tested, flows through this resistor and produces a voltage drop across it, V_e . If all is well, and the load current is small, then V_e is small and the transistor has more than sufficient input voltage, V_{be} , to sustain the load current. Under these conditions the transistor is turned hard on, V_{ce} is small, and most of the supply voltage appears across the load. If a fault exists, however, the load current cannot

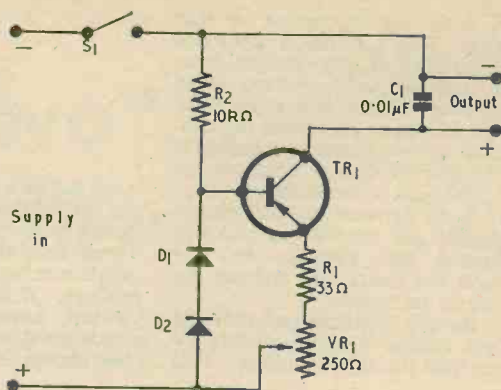
exceed a value given by $\frac{V_b - V_{be}}{R_1}$ and

in this case the transistor, having just sufficient input voltage to maintain this maximum current, is no longer turned hard on. Thus, V_{ce} rises and the voltage across the load must fall.

It will be seen that the cut-off current can be set by suitably adjusting the value of R_1 , and also that the power delivered to the load cannot exceed a value given by supply volts times cut-off current.

Practical Circuit

A practical version of the limiter is shown in Fig. 2. This can be used for any supply up to 12V, and the cut-off current may be varied be-



COMPONENTS LIST (Fig. 2)

Resistors

- R_1 33 Ω $\frac{1}{4}$ watt 10%
- R_2 10k Ω $\frac{1}{4}$ watt 10%
- VR_1 250 Ω variable

Capacitor

- C_1 0.01 μ F

Semiconductors

- TR_1 OC84 (Mullard)—see text
- D_1, D_2 OA81 (Mullard) or similar

tween 2 and 20mA.

The transistor used is a Mullard OC84, which has a power rating of 240mW at room temperatures.* However, practically any germanium medium-powered transistor can be used, remembering that it must be able to dissipate power equal to the maximum supply voltage times the maximum cut-off current.

The bias is obtained from the voltage drop across two OA81 diodes. These can be replaced by similar germanium diodes or, alternatively, by a single silicon diode such as the OA202.

Construction can of course take any suitable form, though it is better to mount the unit in a convenient box with reliable and accessible terminals, otherwise one is tempted not to use it and to take risks.

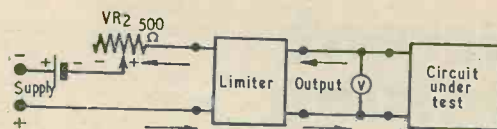
Setting Up

If it is intended to use the limiter always with the same supply voltage, VR_1 can be calibrated in terms of cut-off current. This process is simplicity itself. A milliammeter is connected directly across the load terminals and the supply connected. The meter reading at any setting of

* The OC84 has a maximum power dissipation of 240mW at 25°C without cooling clip. With a suitable cooling clip this increases to 400mW and, with a suitable cooling clip and heat-sink to 600mW at 25°C.—EDITOR.

VR₁ is the cut-off current for that setting. This calibration does not hold for other supply voltages, however, because the bias voltage across the diodes will vary with input. The temperature can also affect the calibration so that a better procedure is as follows: (a) estimate a safe current for the circuit to be tested; (b) connect a milliammeter to the output terminals and set VR₁ to give this estimated safe current; and (c) remove the meter and connect the circuit to be tested.

It should be mentioned that the output voltage is approximately 1V lower than the supply voltage. This



need not be a disadvantage. It could be argued that the test is being performed under adverse conditions and therefore, if the circuit works, it will work even better with the full supply voltage. If the voltage required is critical, however, the loss can be made good by the simple modification shown in Fig. 3. A single 1.5V

cell is added in series with the supply and about 0.5V is dropped across VR₂, thus adding 1V to the input and restoring the output voltage to the original supply voltage. VR₂ must be adjusted with reference to a voltmeter connected across the output in parallel with the circuit under test.

Recent Publications

ELECTRONICS EXPERIMENTS AND PROJECTS. By Len Buckwalter. 127 pages, 5½ x 8½ in. A Foulsham-Sams Technical Book. Published and distributed by W. Foulsham & Co. Ltd. Price 25s.

Electronic Experiments and Projects is one in a series of Foulsham-Sams Technical Books. The body of each of these books is printed in U.S.A. and incorporates American terminology and spelling. This is bound in with a short introduction for readers in this country which explains such points as the difference between American and British mains voltages and the fact that American law permits low power transmissions whereas British law does not. The subjects covered in *Electronic Experiments and Projects* include: experimenting on a breadboard; an explanation of the working of basic electronic parts; electronic sending and receiving; detection, control and alarm; man-made lightning; electroplating; weather-indicating devices; and the assembly of a simple computer.

The following are further titles in the Foulsham-Sams Technical Book series. These all have a page size of 5½ x 8½ in.

TAPE RECORDERS—HOW THEY WORK. By Charles G. Westcott and Richard F. Dubbe. 177 pages. Price 24s.

ABC'S OF ELECTRICITY. By the Howard W. Sams Editorial Staff. 96 pages. Price 16s.

ELECTRONICS FOR THE BEGINNER. By J. A. Stanley. 190 pages. Price 25s.

COMPUTER CIRCUIT PROJECTS YOU CAN BUILD. By Lee Boschen. 143 pages. Price 21s.

INTRODUCTION TO ELECTRONIC SERVICING FOR THE BEGINNER. By J. A. Stanley. 159 pages. Price 24s.

HOW TO READ SCHEMATIC DIAGRAMS. By Donald E. Herrington. 128 pages. Price 18s.

TRANSISTOR CIRCUIT MANUAL. By Allan Lytel. 255 pages. Price 35s.

DIODE CIRCUITS HANDBOOK. By Rufus P. Turner. 128 pages. Price 18s.

DISC RECORDING AND REPRODUCTION. By P. J. Guy. 232 pages, 5½ x 8½ in. Published by Focal Press Ltd. Price 42s.

This is a comprehensive work by an author who is senior lecturer in the Technical Operations section of the B.B.C. Engineering Training Department. The book, which appears in the Focal Press "Technique of Sound Reproduction" series, includes amongst its subjects the theory and practice of modern disc recording, including coarse and fine groove techniques. The main body of the book is devoted to disc reproduction both from popular and high fidelity record players, and covers the turntable motor, pick-up cartridge and arm, stylus, amplifier, and frequency correction networks. Also dealt with are care and maintenance, together with the avoidance of hum, wow and flutter.

RADIO RECEPTION. By H. Henderson. 250 pages, 5½ x 8½ in. Published by Focal Press Ltd. Price 42s.

This book, which is also in the Focal Press "Technique of Sound Reproduction" series, offers an extensive guide to the circuitry, construction and operation of all types of radio tuner. There is a chapter covering v.h.f. multiplex stereo, this dealing in particular with the Zenith-G.E. system. Service manual circuit diagrams of a number of commercially manufactured a.m. and f.m. tuners are also included.

MODERN TAPE RECORDING AND HI-FI. By Ken Peters. 247 pages, 5½ x 8½ in. Published by Faber and Faber Ltd. Price 30s.

This practical book, which is aimed primarily at the non-technical enthusiast, deals with the selection of a tape recorder, its maintenance, and its use. Amongst a wide range of further subjects covered, there is advice on the production of tape plays and features, and on the formation of tape clubs.

STEREOPHONY. By N. V. Franssen. 85 pages, 6 x 9 in. Published by Philips' Technical Library. Price 21s.

Stereophony, translated from the original Dutch by G. du Cloux, sets out to provide an understanding of the mechanism of auditory perception with especial reference to stereo. Particular attention is paid to the subjective impressions which are given by the stereophonic reproduction of different types of sound.

"Double Two" Audio Amplifier

Cover Feature

By A. S. Carpenter, A.M.I.P.R.E.

Although this design employs only two valves in the amplifier section, it is capable of offering 8 watts push-pull output for an input signal of the order of 500mV. The amplifier also features an unusual and ingenious treble control circuit

THE FAIRLY RECENTLY RELEASED VALVE TYPE ELL80 is a miniature double audio pentode with a common cathode designed primarily for use either in the output stages of stereophonic amplifiers—each section operating in single-ended mode—or as a complete monaural push-pull output stage. Each section has a mutual conductance of 6mA/volt and anode and screen-grid current demands are modest, these being typically 24 and 4.5mA respectively per section from a 250V supply source. The heater is intended for use in a parallel-connected circuit and operates at 0.55 amps from 6.3V.

The 3 watts of audio obtainable from a single section might be considered adequate for some applications but is barely comparable with the 8.5 watts which is given when both sections are utilised in push-pull—which is the system adopted in the audio amplifier design presented here.

One of the benefits derived from the push-pull configuration is the effective suppression of second harmonic distortion, and amplifiers using a push-pull output stage offer the critical ear a discernible silkiness of response which is unobtainable from simple single-ended systems.

The pentodes may be operated in various push-pull modes but Class AB₁ is recommended. For an output of 8.5 watts with 5% distortion a grid-to-grid input of about 16 volts r.m.s. is necessary when the recommended anode-anode load is 11,000Ω. To provide adequate amplifier sensitivity a stage of amplification between the input socket(s) and the output stage is essential, and a phase-splitting stage must also be employed to provide the anti-phase voltages.

Fortunately both requirements can be met very simply by employing another "double" miniature valve, viz., the well-known 12AX7 (ECC83) high-μ double triode, each section of which has a quoted amplification factor of 100. The distortion level can also be lowered at the expense of a little gain

by incorporating degenerative feedback in the amplifier. Some 8 watts of good quality audio can then be secured from an input of about 500mV, which is adequate for many applications. The amplifier proper may thus contain no more than two "bottles" (although a rectifier must also be incorporated) and the overall size can be made reasonably small.

The Circuit

The theoretical circuit of the amplifier is shown in Fig. 1. In this diagram, valves V₁ and V₂ perform the essential audio duties, the additional valve, V₃, being the h.t. rectifier. Two inputs are catered for and either may be selected by means of S₁, whilst the output to the loudspeaker is given by a pair of sockets which mate with banana-type plugs. R₁ is fitted to provide attenuation and supply adequate loading for modern high output crystal pick-ups, whilst further frequency compensation is effected by C₁, C₂ and R₂. These components can be experimentally adjusted in value to suit the user's need if desired.

When S₁ is set to position "1" input is direct to the volume control VR₁ and, thence, to the treble control VR₂. VR₂ is a special centre-tapped linear potentiometer of 500kΩ arranged to be ineffective at 1,000 c/s when its slider is at the mid-position.

One half of V₁ functions as a voltage amplifier, and gives a stage gain of approximately 60 with the value of anode load resistor specified. Its output is fed to the other half of the valve, where phase-splitting occurs and equal voltages which are opposite in polarity appear in the anode and cathode circuits. Resistors R₄ and R₁₂ and capacitor C₄ are merely cathode bias components. Bias for the output stage is provided by R₁₇ and C₁₀.

Injection of signals from V_{1(b)} into the respective grids of V₂ is effected via R₁₃ and R₁₄ and, since these are "stopper" resistors, one end of each

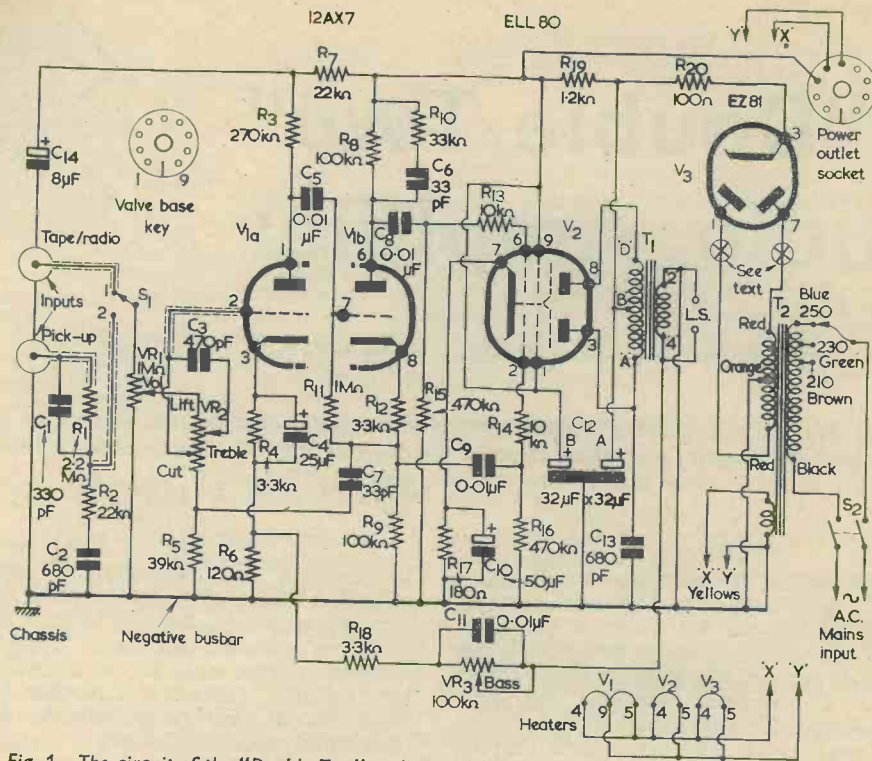


Fig. 1. The circuit of the "Double-Two" audio amplifier

Components List

Resistors

(All fixed resistors $\frac{1}{2}$ watt, 10% unless otherwise stated)

R ₁ *	2.2M Ω
R ₂ *	22k Ω
R ₃ *	270k Ω
R ₄	3.3k Ω
R ₅ *	39k Ω
R ₆	120 Ω
R ₇	22k Ω
R ₈	100k Ω
R ₉	100k Ω
R ₁₀	33k Ω
R ₁₁ *	1M Ω
R ₁₂	3.3k Ω
R ₁₃	10k Ω
R ₁₄	10k Ω
R ₁₅	470k Ω
R ₁₆	470k Ω
R ₁₇	180 Ω , 1W
R ₁₈	3.3k Ω (see text)
R ₁₉	1.2k Ω , 1W
R ₂₀	100 Ω , 1W
VA ₁	1M Ω log. (with switch S ₂)
VR ₂	500 Ω 1in centre tapped
VR ₃	100k Ω log

* Preferably high stability types.

Capacitors

C ₁	330pF mica or ceramic
C ₂	680pF mica or ceramic
C ₃	470pF mica or ceramic
C ₄	25 μ F, electrolytic, wire ended, 6V wkg.
C ₅	0.1 μ F paper or 10,000pF ceramic
C ₆	33pF mica or ceramic
C ₇	33pF mica or ceramic
C ₈	0.01 μ F paper
C ₉	0.01 μ F paper
C ₁₀	50 μ F, electrolytic, wire ended, 25V wkg.
C ₁₁	0.01 μ F paper
C ₁₂	32+32 μ F, electrolytic, wire ended, 350V wkg.
C ₁₃	680pF ceramic

Valves

V ₁	12AX7
V ₂	ELL80
V ₃	EZ81

Transformers

T ₁	Multi-ratio output transformer type MRT/10 (Osmabet)
T ₂	Mains transformer. Secondaries: 250-0-250V 100mA, 6.3V 3.5A. Drop-through type. (R.S.C. Ltd., 5 County Arcade, Leeds, 1.)

Switches

- S₁ s.p.d.t. rotary
- S₂ d.p.s.t. ganged with VR₁

Chassis, Panel, Bracket

- 4 × 8 × 2in Universal chassis. (Home Radio (Mitcham) Ltd.)
- 8 × 4in panel (Fig. 5)
- Material for bracket (Fig. 6)

Valveholders

- 4 valveholders, B9A

Sockets

- 2 coaxial input sockets, type L604/S (Belling-Lee)
- 2 output sockets (to take banana plugs)

should be soldered directly to the appropriate pin at the valveholder. It has been found that, without these resistors, trouble is very likely to result due to parasitic oscillations.

The outputs from V₂ anodes are combined in T₁, and it will be noted that the centre-tap of the primary of this component is fed direct from the unsmoothed h.t. voltage across C_{12(a)}, the remainder for the circuit being fed via R₁₉ and C_{12(b)}. This method of operation not only allows the output valve anodes to receive the maximum available h.t. voltage, but also permits the use of a relatively low wattage smoothing resistor in the R₁₉ position.

Tone Controls

The treble control is relatively ineffective at 1,000 c/s when its slider is at the mid-position and the input signals reach V_{1(a)} grid via one half of the potentiometer track. If, however, the slider is turned towards "Lift", C₃ becomes operative and high frequencies are passed more readily. If, on the other hand, the slider is rotated towards

Speaker

- 3Ω impedance (see text)

Indicator Lamp (If Required)

- 1 indicator lamp type D.841/250V (Bulgin)

Miscellaneous

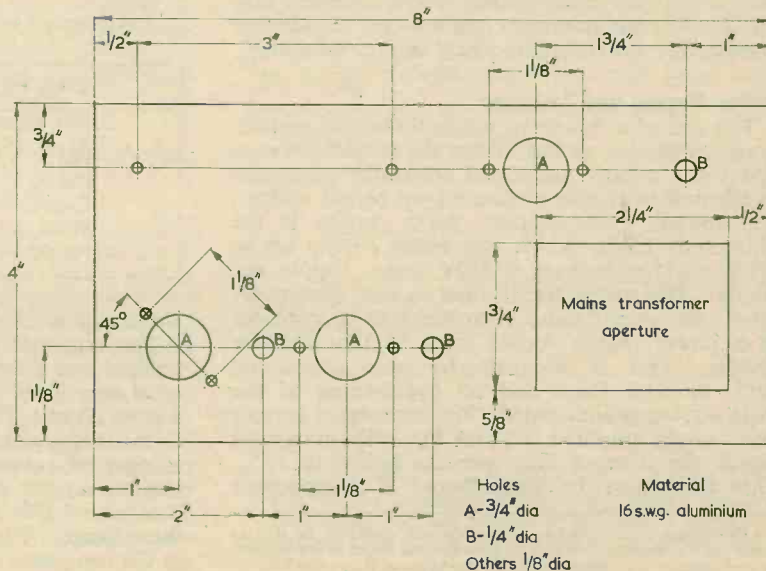
- 4 control knobs
- 2½in spacers
- 3½in grommets
- 2 5-way tagstrips (no tag earthed)
- 1 clamp for C₁₂
- 1 clamp for C₄
- Screened cable, etc.

"Cut", high frequencies are attenuated due to degenerative feedback developed across R₅ and extracted from the anode circuit via C₇. The presence of R₅, C₇, VR₁ and VR₂ in the cathode circuit of V_{1(a)} is offset by a compensating network in the anode circuit, and the result is an excellent response at all frequencies.

Making use of components in the degeneration loop is an acceptable way of effecting a degree of bass control. Degeneration is applied to the input valve cathode at the junction of R₄ and R₆, the feedback being obtained from the output transformer secondary winding via R₁₈, C₁₁ and VR₃. The effectiveness of C₁₁ is determinable by the setting chosen for VR₃ slider, and bass boosting occurs when this potentiometer is suitably adjusted.

The overall usable frequency response of the prototype, as checked with oscilloscope and audio waveform generators, was in the range 60 c/s to 18 kc/s, a limit being set to low frequencies by the relatively inexpensive output transformer employed.

Fig. 2. Essential drilling details for the chassis top-plate. Extra holes will be required for mounting C₄, C₁₂, the power output socket bracket and the mains transformer, and these may be marked out from the components themselves.



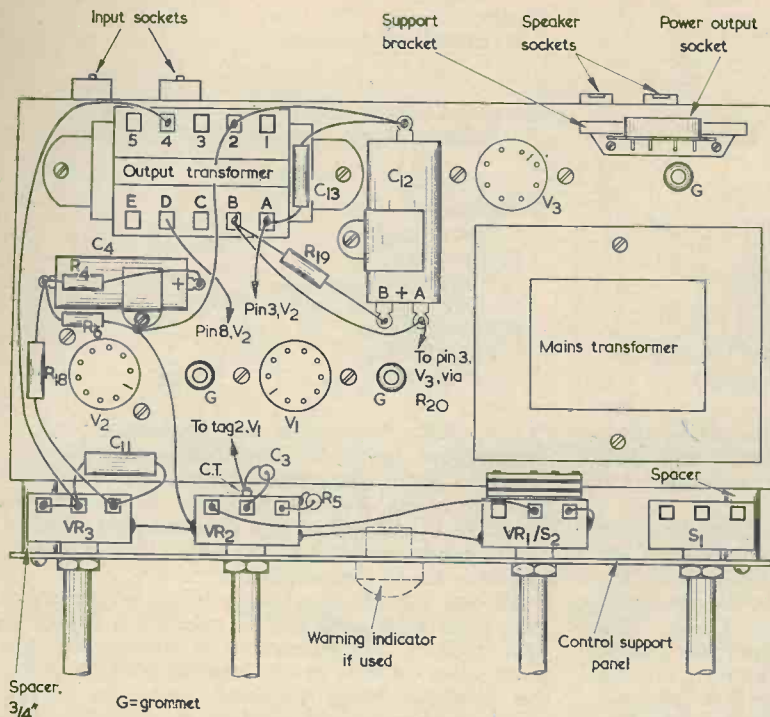


Fig. 3. Principal wiring above the chassis. All wiring in the grid circuit of $V_{1(a)}$ should be screened. (The screening is not shown here). This diagram shows the metal covers of the three potentiometers bonded together by wires soldered directly to the cases. If the potentiometers employed have earthing lugs, the earthing wire may be connected to these

A higher grade component here and the use of $0.1\mu\text{F}$ components for C_5 , C_8 and C_9 would undoubtedly extend the low frequency response, but C_{11} might then also require adjustment.

It should also be appreciated that this is a "One-Off" design and, as experienced constructors will know, another seemingly identical version might not perform in exactly the same way. No wide differences need be anticipated but whilst one unit might prove completely stable another may give trouble and parasitics might occur. In another version, for instance, C_{13} might not be needed.¹

Power Supply and Voltages

The use of a full-wave indirectly-heated rectifier is recommended as this allows the amplifier valves and those of any associated apparatus connected to the unit to receive a warming-up period without h.t. voltage. The rectifier valve chosen is the ubiquitous EZ81, which can easily supply up to 350V at 150mA from a 350V r.m.s. supply per anode. The mains transformer is also generously rated and permits some 25 to 30mA to be available at a power output socket fitted to the amplifier chassis. This is adequate for any unpowered v.h.f. or a.m. tuner and no overloading of the main section is anticipated. The zero signal current drain of the amplifier is 62mA but, with maximum signal, the demand may increase by up to 17%. This fact must be remembered if components

with lower ratings are to be used for V_3 or T_2 . If, for example, the power supply socket is omitted, the h.t. secondary of T_2 could be de-rated to 80mA and an EZ80 used in place of the EZ81.

Using the circuit as shown, measured d.c. voltages should agree approximately with those given in the Table. A high resistance voltmeter should be employed.

Table
Measured voltages with respect to chassis.

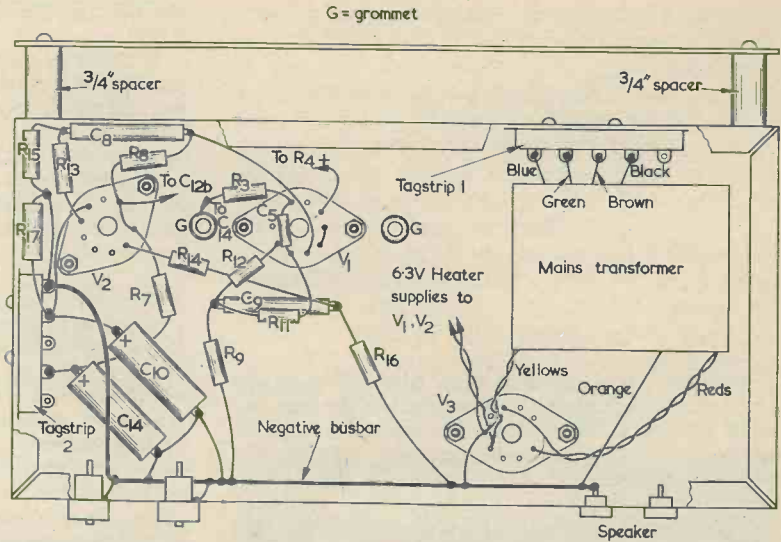
Location	Volts d.c.
Pin 3, V_3	300
Pin 9, V_2	280
$C_{14}+$	250
Pin 7, V_2	9.2
Pin 3, V_1	1.2

Constructional Details

The amplifier proper requires only two valve-holders and if these are carefully orientated wiring up is simplified. The choice of a readily obtainable 5-piece chassis, the sections of which bolt together, further aids construction. Only a few minor items—input and output sockets, tagstrips, etc.—are located on the front, rear and side flanges and because of this no drilling details are given for these flanges. Fig. 2 shows the main holes required in the top plate. It will be noted that the amplifier

¹ Difficulties with regard to instability will probably be due to phase shift in the small output transformer. It could prove helpful, in such instances, to slightly increase the value of R_{18} .—EDITOR.

Fig. 4. The principal wiring below the chassis



proper occupies only one half of the surface, the remaining portion being taken up by the power supply components. The top plate is finally secured to its complementary 2in. deep rectangle of flanges to make a rigid assembly. Figs. 3 and 4 show the more critical sections of the wiring and the layout above and below chassis, whilst the panel required is illustrated in detail in Fig. 5. This panel *must* be held clear of the front of the chassis by at least $\frac{3}{8}$ in or the on/off switch tags associated with VR₁ will foul the mains transformer casing. The spacers are shown clearly in Figs. 3 and 4.

Control knobs are spaced symmetrically along the panel, sufficient space having been left for a warning indicator such as the Bulgin D841/250V (Red, or Transparent Water Clear) Neon Signal Lamp to be fitted centrally if required. The panel will not, however, be visible if the amplifier is housed in an equipment cabinet and is therefore only expected to form a supporting device for the various controls. It may be noted that no room exists for groupboard construction, so small items together with the flying leads from T₂ are anchored to tagstrips 1 and 2 as shown in Fig. 4.

Precautions To Be Taken Against Hum

Because mains-derived hum can prove troublesome in high gain audio amplifiers precautions must be taken. For example, all heater wiring must be tightly twisted and kept away from the input circuit. The use of a negative bus-bar to which chassis returns are made is also beneficial and the location of this is clearly indicated in Fig. 4. Chassis currents are thus kept at minimum. The layout permits very short direct wiring and it is not likely that much improvement can be made in this direction. Valveholders should be oriented as shown, and all signal-carrying leads associated with the input up to the grid of V_{1(a)} should be made in screened cable, the screening being connected to chassis at both ends of each run. In the

prototype there is neither hum nor instability.

If the power output socket is to be fitted it may be either mounted on a small L-shaped bracket as depicted in Fig. 6 or it may be built into the chassis rear flange. Fuses could also be provided, but these would be superfluous if a fused mains plug were used.

Checks

A thorough check of all wiring should be made on completion and if all seems in order the valves may be placed in their respective sockets. With the mains plug *not* inserted in its socket an ohmmeter should be brought into use to ensure that no direct circuit exists between any tag on tagstrip 1 (Fig. 4) and chassis but that a low resistance reading is obtainable between any two of the tags. Since the major section of the mains transformer primary winding is between the black and brown lead-outs, this should show a considerably higher resistance than occurs between the brown and green wires

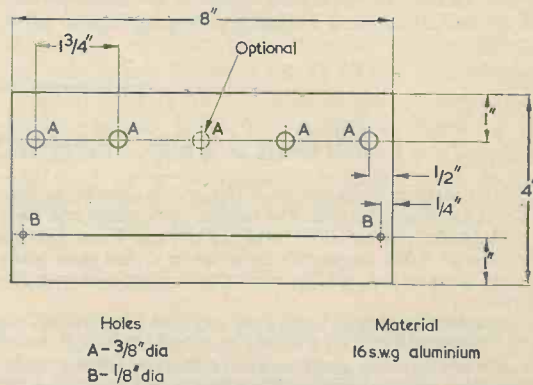


Fig. 5. The dimensions of the control panel. This is secured to the front section of the chassis with $\frac{3}{8}$ in spacers. The centre hole is optional, and is intended for an indicator lamp

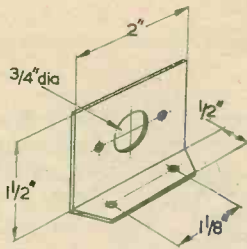


Fig. 6. The bracket for the power output socket

or between the green and blue wires. The mains input should, of course, be connected to the lead-out wires which correspond to the mains voltage to be used. The ohmmeter negative test should next be clipped to chassis and readings taken from pins 2 and 7 of V_1 and pins 2 and 6 of V_2 ; these readings should be high due to the grid resistors. Fairly low readings, corresponding to the resistance in the cathode circuits, should be obtained from pins 3 and 8, V_1 and pin 7, V_2 . Low readings should also be obtained from pins 1 and 7, V_3 . The positive test prod should then be applied to pin 3 of V_3 , whereupon the needle should swing rapidly over towards zero ohms then climb steadily to a high resistance reading as the electrolytic capacitors become charged. Should the meter continue to read zero ohms or a low value a fault exists on the h.t. feed line, and the mains supply should on no account be connected until this has been cleared.

Assuming that all is well the meter should be set to read volts, d.c., and the positive prod disconnected. The speaker should next be connected and the amplifier switched on—remembering that the primary tags of T_1 (A to E) are “hot”. The valve heaters should commence to glow fairly quickly and a series of readings should be taken: these should agree more or less with those given in the Table. If no heater glow is detected switch off immediately and check the wiring again after

discharging the electrolytics via a resistor of about $15k\Omega$.

If a fierce oscillation should occur as the amplifier warms up it should be switched off at once. The trouble will probably be due to incorrectly phased feedback from the output transformer secondary, whereupon it can be cleared by reversing tags 2 and 4 of this transformer.² Changes should not be made whilst the amplifier is switched on, nor should it be operated at any time without a speaker connected.

Preliminary Testing with Signals

If all is in order, VR_1 , VR_2 and VR_3 should be set to approximately mid-travel, and the output from a crystal pick-up, tuner or tape recorder applied to the correct socket on the amplifier via a length of screened cable and plug. The results should be very pleasing and the various controls may be experimented with to become familiar with their functioning. The output from the diode of a conventional transistorised superhet tuner can also provide very good signals.

Conclusion

For normal home use it is unlikely that VR_1 will ever need to be turned to more than about 50% of full travel, especially when records are being played. The amplifier runs at a moderately high temperature and it should not, in general, be used unless contained within a suitable cabinet, the design of which allows a flow of cooling air from below.

A control panel or escutcheon may be drawn up using black lettering on gilt protected with clear Perspex, or marked knobs may be fitted. Spindle lengths will depend on circumstances and extensions via couplers can be made as required. The amplifier should never be connected to any a.c./d.c. type of equipment or to so-called a.c. equipment that does not include a mains-isolating transformer or there will be a serious risk of shock.

² The use of a 3Ω speaker is assumed and, although matching does not seem to be unduly critical with the type of output transformer specified, tags 1 and 4 should be tried if a 15Ω speaker is connected. R_{13} should then be increased to $6.8k\Omega$.

BRITAIN'S NEW "MEMORY" FOR FASTEST COMPUTERS

First British magnetic thin film store system to be made available commercially is announced by EMI Electronics Ltd. It can operate with the fastest computers and data logging systems at present in use.

Magnetic elements or “bits” of the store are discrete spots of a nickel-iron alloy evaporated in a high vacuum to a thickness of 1,000 Angstrom units on to a thin glass plate. The drive and sense conductors are photo-etched on a pair of glass fibre boards which, with the magnetic elements inserted, represent a “plane” of 64 “words” each word having 50 bits.

Special techniques have been evolved to wire the planes together into a complete store. The store capacities are in the range 128 to 1,024 words each, with a maximum of 50 bits per word.

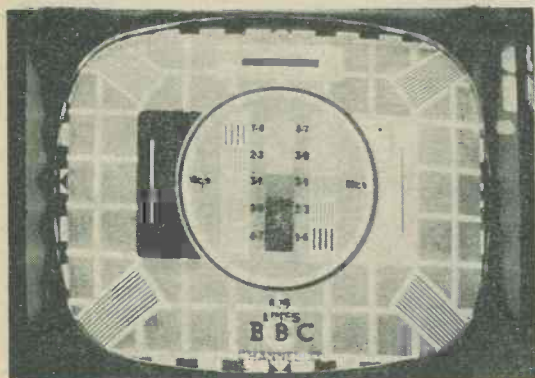
Drive and sense electronics are built on conventional printed circuit panels using solid state circuitry. The panels are stacked into an appropriate number of frames on a 19in or 26in racking system complete with power supplies. The circuitry is so designed that a high degree of reliability is obtained.

Read-rewrite cycle times of the 1,024 word and 128 word stores are $\frac{1}{2}$ and $\frac{1}{3}$ microsecond respectively and a wide range of modes of operation is available. The stores are being marketed as planes, or as complete stores with or without electronics and power supplies.

BBC 2 IN HOLLAND

Excellent Reception of Trade Test Transmissions

INTEREST IN B.B.C.2 IS BY NO MEANS SOLELY CONFINED to this country. TV enthusiasts on the Channel and North Sea coast of Europe go to considerable trouble to view English television programmes. One particularly keen enthusiast in this sphere is Mr. Jan Adama, PAØFB, of the Hague, who has sent us an excellent series of photographs which he has taken from his TV screen of the new B.B.C.2 transmissions during the Trade Test period. He has been a regular viewer of the East Anglian Tacolneston (Channel 3) and Mendlesham (Channel 11) TV transmitters for a number of years, and he has appeared personally on "Anglia TV" more than once, giving Anglia viewers his impressions of British TV and kindred matters.



The B.B.C.2 Test Card, received in Holland on Channel 33. This picture was photographed on 18th January

In his letter, he says: "You see that I get really good reception of B.B.C.2 programmes at times. It certainly depends on *very* good conditions, unlike the reception of Mendlesham and Tacolneston, which I can practically always get because of the propagation being only across water. There appear to be many more temperature inversions above the sea—though they may be only minor ones—than there are over land."

Mr. Adama's u.h.f. set-up includes a 52 element FUBA broadband (Bands IV and V) beam aerial positioned 45ft above ground (66ft above sea level); a German all-transistor u.h.f. converter (2 x AF139 transistors) and a standard Philips domestic 625 line TV receiver. Since the Philips receiver has 5.5 Mc/s intercarrier sound, as is



A later B.B.C.2 picture (11th March), which illustrates the excellent quality obtainable under good reception conditions

required for Western European vision and sound carrier spacing, a separate receiver is needed to pick off the B.B.C.2 sound, with its 6 Mc/s spacing. This is achieved by coupling a Hallicrafter SX42 to the last i.f. valve of the TV receiver. The aerial terminal of the Hallicrafter receiver is connected to a screening can placed over the i.f. valve, the can being insulated from chassis. The additional receiver is then adjusted for 33 Mc/s f.m. reception.

As a final point we would like to refer to a further extract from Mr. Adama's letter: "I am hopefully waiting until a 625 u.h.f. TV transmitter will start up in Norfolk or Suffolk! And if they would start a colour TV programme, I would have a colour TV set in a very short time!"

BUILDING CONTRACT FOR BBC'S PITLOCHRY TV AND VHF SOUND RELAY STATION

The B.B.C. has awarded a contract to William Duff & Sons (Builders) Ltd., of Strathtay, Perthshire, for the construction of the building for the Pitlochry television and v.h.f. sound relay station. The site is on An Suidhe Hill in Fanob Forest, 1½ miles south-west of Pitlochry.

It is expected that this new relay station will be brought into service before the end of this year. It will bring B.B.C.-1 television and the three sound programmes on v.h.f. to the Pitlochry and Aberfeldy areas, which are beyond the range of these services from other B.B.C. transmitting stations.

Remote Control of Uniselectors

By A. D. BEAN, A.I.S.T.

The design of unselector equipment is a fascinating sideline of electronics, and this article describes two circuits which are especially intended for the experimenter. One of these provides unselector selection by manual operation of a remote press-button, whilst the other employs a particularly ingenious principle to give completely automatic selection by operation of a remote switch

IN CONTROL EQUIPMENT THE USE of uniselectors is nearly always incurred for controlling various sequential switching operations, such as taking large numbers of measurements, remote control tuning selectors and counting.

When unselector switches are operated there are usually two steps. Firstly, the switch must be rotated to the correct position and, secondly, when measurement, counting or timing have been completed, the unselector must be returned to zero. To carry out these operations at any distance it is desirable to keep both the number of interconnecting wires and the number of manual operations to a minimum.

In this article the writer describes two circuits which he has found

quite successful. The first is completely manual in operation and requires three interconnecting wires, the second is fully automatic and it uses only two wires.

The Unselector

For people who have not yet acquainted themselves with the unselector, it should be stated that this is an extremely useful piece of electromechanical equipment. It consists typically of from two to eight banks, or arcs, of 25 contacts, over which associated wipers pass, these wipers being driven by an electro-magnet through a ratchet and pawl. The wiper moves round one position every time the electromagnet receives a short pulse of electricity. A typical electromagnet

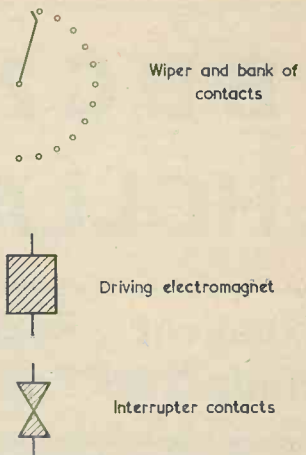


Fig. 1. The unselector symbols employed in this article

operates at about 25 volts and requires 30 watts.

Interrupter contacts are provided so that the mechanism can be arranged to step and rotate continuously. This continuous rotation is very useful when bringing the unselector switch back to zero after any given operation.

A Manual Unselector Control Circuit

The first circuit around which this article is written was used in a prototype intercom installation which had ten stations to select from. However, because of the three wires

Components List (Fig. 2)

Capacitors

C₁ C₂ 50μF electrolytic 50V wkg.

Rectifiers

D₁ 24 volt 1.5A selenium
D₂ 15 volt 1A selenium

Switches

S₁ s.p.d.t. toggle
S₂ Press-button, push to make
S₃ d.p.s.t. toggle

Relays and Unselector

$\frac{A}{1}, \frac{B}{1}$ Post Office type 3000. 2kΩ coil with single make contacts
Unselector 25 volt energising. See text

Transformer

T₁ Secondary: 15 and 24 volts at 2A. Douglas type MT3

Fuse

5A fuse and fuseholder

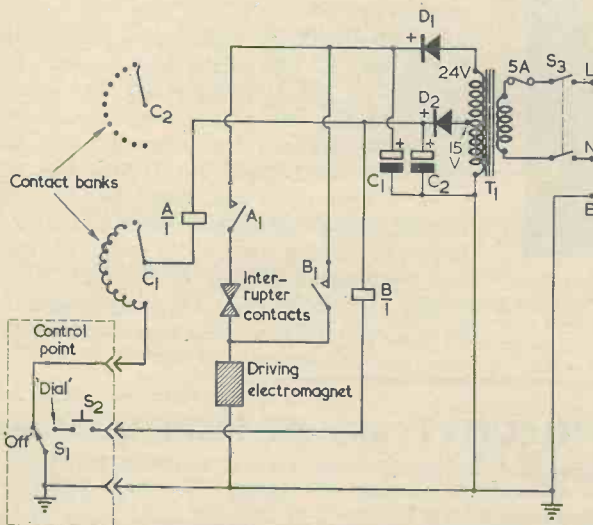


Fig. 2. The manual control unselector circuit. The unselector moves one step each time the remote button is pressed

Components List (Fig. 3)

Resistors

(All resistors 5% $\frac{1}{4}$ watt unless otherwise specified)

R ₁	1k Ω 1W 10%
R ₂	4.7k Ω $\frac{1}{2}$ W 10%
R ₃	3.3k Ω 10%
R ₄	22k Ω 10%
R ₅ , R ₆	1k Ω $\frac{1}{2}$ W
R ₇ , R ₃₀	100 Ω
R ₈ , R ₃₁	200 Ω
R ₉ , R ₃₂	300 Ω
R ₁₀ , R ₃₃	390 Ω
R ₁₁ , R ₃₄	510 Ω
R ₁₂ , R ₃₅	620 Ω
R ₁₃ , R ₃₆	750 Ω
R ₁₄ , R ₃₇	820 Ω
R ₁₅ , R ₃₈	910 Ω
R ₁₆	1.1k Ω
R ₁₇	1.2k Ω
R ₁₈	1.3k Ω
R ₁₉	1.39k Ω
R ₂₀	1.51k Ω
R ₂₁	1.62k Ω
R ₂₂	1.75k Ω
R ₂₃	1.82k Ω
R ₂₄	1.91k Ω
R ₂₅	2.1k Ω
R ₂₆	2.2k Ω
R ₂₇	2.3k Ω
R ₂₈	2.39k Ω
R ₂₉	2.51k Ω
R ₃₉	1k Ω
R ₄₀	2k Ω

Capacitors

C ₁ , C ₂	50 μ F electrolytic 50V wkg.
C ₃	1,000 μ F electrolytic 25V wkg.
C ₄ , C ₅	50 μ F electrolytic 50V wkg.
C ₆	150 μ F electrolytic 15V wkg. (see text)
C ₇	50 μ F electrolytic 15V wkg. (see text)

Rectifiers and Diodes

D ₁	24 volt 1.5A selenium
D ₂	15 volt 1A selenium
D ₃ , D ₄	OA81

Switches

S ₁	1 pole, 12 way
S ₂	1 pole, 3 way
S ₃	d.p.s.t. toggle

Relays and Uniselector

As for Fig. 2

Transformers

T ₁	As for Fig. 2
T ₂	Interval transformer, 4:1

Fuse

As for Fig. 2

Transistors

TR ₁ , TR ₂ , TR ₃	OC72
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and the number of operations entailed when selecting a station, the manual system was later shelved and the second circuit used.

Before explaining the uniselector circuits, it may be as well to acquaint the reader with the symbols to be used. Fig. 1 shows the three main components: the interrupter contacts, which are normally closed; the driving electromagnet which, when energised, opens them; and the wiper and bank of contacts.

In Fig. 2 the first of the two control circuits is shown, this being completely manual in operation. The control point, of which there can be any number, has two switches: a two-way switch, S₁, and a press switch, S₂.

To rotate, or dial, the uniselector to a desired position, switch S₁ is turned to "Dial" and S₂ depressed the required number of times, bearing in mind that one press of S₂ gives one step of the uniselector, Bank C2 is then used to carry out the operations. When the operator has finished, switch S₁ is then turned to "Off", whereupon the uniselector returns to zero.

To explain the uniselector controlling equipment of Fig. 2, we may

start with the mains switch, S₃. When S₃ is closed, power is fed to transformer T₁, whereupon this transformer supplies two secondary voltages, both having a common earth. The higher voltage, 24 volts, is used to operate the uniselector driving electro-magnet and the lower voltage, 15 volts, to operate the two

relays $\frac{A}{1}$ and $\frac{B}{1}$.

The power for the uniselector driving magnet is controlled by both

relays. Relay $\frac{A}{1}$ supplies voltage to

one side of the interrupter contacts, the other side of the contacts connecting to the driving magnet. This part of the circuit is used for zeroing the uniselector.

When switch S₁ is turned to "Off" after any given operation, relay

$\frac{A}{1}$ is energised. This switches

power to the interrupter contacts, whereupon the driving magnet closes, moves the wiper round one position and breaks the interrupter contacts. The driving magnet is then de-energised, reconnecting the inter-

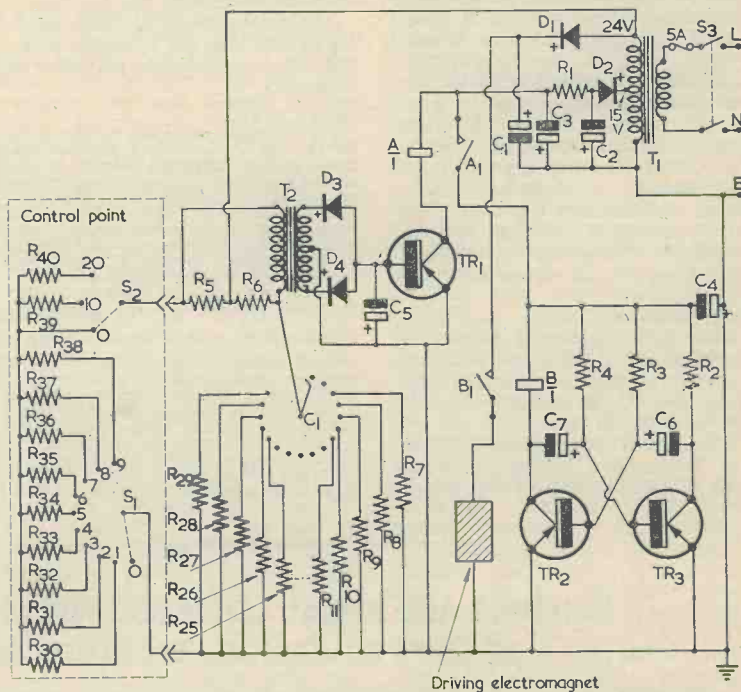


Fig. 3. In this circuit, automatic selection is achieved by operation of the switches at the control point. The uniselector selects the required position by searching for a resistance value which causes the bridge to balance. This circuit has the further advantage that only two wires are needed between the main unit and the remote unit.

rupter contacts, whereupon the whole cycle is repeated until wiper C₁ finds a contact which is open-circuit. This represents zero on banks C1 and C2. For dialing purposes relay $\frac{B}{I}$ is used. When switch S₁ is turned to "Dial" and S₂ is pressed, relay $\frac{B}{I}$ is energised. This supplies voltage direct to the uniselector driving magnet, and moves the wiper on bank C2 round one position at a time until the desired contact is found.

The advantage of this circuit lies in the simplicity of the controlling equipment needed, i.e. two relays and a power supply. However, this gives only one advantage which must be weighed against two disadvantages. The first disadvantage is the need for three wires which, when control points are at some distance, leads to quite an extra cost in wire. If the third wire is coupled with, perhaps, two other wires for use in additional circuitry, it can make all the difference between five wires and a standard 4-core cable. The second disadvantage lies in the dialing system. If we want to select say, the fifth position, then all we have to do is press button S₂ five times. This is easy enough, but if we require the twentieth position it is obvious that we shall suffer from any of three possible pitfalls: firstly, the sheer time involved, secondly, tiredness on the part of the forefinger or thumb and, thirdly, the second human failing of forgetting the number of times the button has been pressed. All of these failings are "ironed out", so to speak, in the second circuit.

Fully Automatic Circuit

The fully automatic circuit is shown in Fig. 3. Whilst this circuit is somewhat more complicated than that of Fig. 2, it is extremely reliable and very easy to operate.

The control circuit is essentially an a.c. Wheatstone bridge in which bank C1 is one arm of the bridge

and any of the numerous control points which are possible represents the second arm. In the zero position both the control points and the bank C1 are open circuits. When S₁, giving units 1 to 9, and S₂, giving tens (i.e. 0, 10 and 20) are brought into operation, the bridge is immediately unbalanced. The unbalanced condition of the bridge energises relay $\frac{A}{I}$ which switches on

a multivibrator in which relay $\frac{B}{I}$ is used as a collector load for transistor TR₃. The set of make contacts on $\frac{B}{I}$ supplies energy to the driving magnet of the selector switch. The multivibrator continues to function until $\frac{A}{I}$ is de-energised due to the rebalancing of the Wheatstone bridge. The speed of the multivibrator is about 2 c/s, which represents under half the dialling speed of the previous control unit.

When the desired operations have been carried out the switches S₁ and S₂ are returned to zero, whereupon the control unit, now out of balance, retraces the steps outlined above until the uniselector reaches zero.

Having described the basic working of the unit, the functions of the individual components may now be explained.

Editor's Note

The uniselector employed by the author for the Fig. 3 circuit is a forward-acting type. That is, the wipers move to the next contact when the armature actuates instead of, as in the reverse-action uniselector, when the armature releases. Due to the time needed for the multivibrator to stop after the bridge balances, it is probable that a reverse-action uniselector would not function reliably in the circuit.

Two spare contacts are left in the uniselector bank for starting efficiency. The multivibrator relay $\frac{B}{I}$ gives a short kick before running smoothly, and this would lead to problems when selecting position 1.

Although it may seem that the tolerance is high in some instances, the writer states that he has obtained reliable nulls in the bridge with 5% resistors, as specified in the Components List for Fig. 3. Some of the values will, of course, have to be made up by combinations of two or more resistors.

The power supply is practically the same as in the Fig. 2 unit, except that the 15 volt supply is now negative and has a small amount of smoothing given by the resistor R₁ and the capacitor C₃.

The 15 volt supply is used for relay $\frac{A}{I}$ and the multivibrator, including relay $\frac{B}{I}$. Both this relay and the capacitors C₆ and C₇ may need adjusting to obtain the desired 2 c/s operation.

A third lead is taken from the a.c. side of the 24 volt supply and is used to power the Wheatstone bridge. The unbalanced signal across the two arms of the bridge passes through a transformer, T₂, having a ratio of 4:1, and is then rectified by D₃ and D₄. The rectified voltage is smoothed by C₅ and is fed on to the base of TR₁ which, in turn, energises relay $\frac{A}{I}$.

The advantages of this system are the direct opposite of the previous unit. Only two wires are needed between control unit and control points, the number of operations are reduced to turning one or two switches to the desired number, and the time factor is cut by more than half. The only disadvantage is that more equipment is needed in the control unit.

The author has, operating at his home, an intercom system which consists of six stations, any one of which can call any other station. These stations are situated throughout the house and workshop, the latter being at the end of the garden. Also obtainable by any of the stations are the Home, Light and Third B.B.C. programmes, together with the opening and closing of garage doors.

These notes are added to give an example of the many uses of the uniselector control unit. Both the manual control and automatic control systems have been tried, choice finalising on the latter, which has given three years trouble-free service.

BUILDING AND AERIAL CONTRACTS FOR UHF INSTALLATION AT BBC'S ROWBRIDGE TRANSMITTING STATION

The B.B.C. has awarded a contract to the J. L. Eve Construction Company Limited for the construction of an extension to the existing building at the B.B.C.'s Rowridge, Isle of Wight transmitting station. The extension will accommodate the u.h.f. transmitters and associated equipment needed for the B.B.C.-2 programme service which is expected to be transmitted from Rowridge by the end of 1965.

The u.h.f. transmitters for Rowridge are already on order and a contract has been placed with the Marconi Company for the supply and erection of the u.h.f. transmitting aerial on the existing 500ft mast.

IN YOUR WORKSHOP

This month Smithy the Serviceman, aided as always by his able assistant Dick, embarks on one of those incredible periods when everything goes exactly right. However, this has the advantage of allowing the pair to examine some of the more recent aspects of u.h.f. tuner design, and to clear a rather unusual source of noise



IT WAS ONE OF THOSE IMMACULATE afternoons.

A gently warming June sun shone serenely through the Workshop windows, picking out the still forms of the engrossed Serviceman and his equally engrossed assistant. Everything was going perfectly. The receivers under process of repair all had the sort of fault which restores a service engineer's faith in his lot. No snags were so difficult that they necessitated any great concentration and experiment for their diagnosis, nor were they so obvious that they denied our industrious pair a sense of achievement when they were eventually tracked down. There were no intermittent faults, and there were no faults requiring large-scale dismantling of the chassis for their repair. A kind of magic had taken over, causing Dick and Smithy to be in complete rapport with each other and the world.

Even the Workshop seemed to share in the pervasive equanimity. Inanimate though it may be, a building can still acquire, if only by association, its own recognisable personality. So it was on this excellent afternoon, and the Workshop administered kindly to its occupants by keeping them free from draughts and by maintaining both the ambient temperature and the relative humidity at exactly those levels which give optimum comfort. And, in company with all the other better-class service establishments throughout the country, it tended to their more technical

needs by proudly displaying on its book shelf a brand-new copy of *Understanding Television* by J. R. Davies.

U.H.F. Tuner Fault

With an expression of contentment, Dick snapped on the back of the little transistor radio he had just repaired, and took it over to the racks. He then surveyed the sets which were awaiting service and, after a little thought, selected a 19in dual-standard television receiver. He carried this back to his bench, connected it up to the mains supply, and switched on.

Nothing happened.

Dick turned the receiver round and peered through the perforated back of the cabinet. The interior presented a completely black scene, unrelieved by any heater glow whatsoever. It was evident to Dick that either the mains supply to the receiver was broken or that there was an open-circuit in the heater chain. With an automatic reaction imparted by long experience, Dick did not at once remove the back of the receiver. Instead, he pulled its mains plug from the bench socket and quickly unscrewed the plug cover. There was, however, no evidence of a poor connection here.

This point established, Dick replaced the cover of the plug, took off the receiver back and removed the mains cartridge fuse-link. This also checked satisfactorily and was, in its turn, replaced. Dick glanced over the chassis to see if any obvious

disconnections were visible, found none, and walked over to the service manual cupboard.

The unusual sound of this cupboard being opened so soon after Dick's selection of a receiver caused Smithy to turn a quizzical eye on his assistant.

"It's not like you," he remarked, "to fall back on the service sheet as quickly as this."

Dick turned round for a moment, and glanced at the Serviceman.

"I think I've got an open-circuit heater chain," he explained. "And I don't feel like digging around in the dark to find out where the break is."

"Very wise," commented Smithy approvingly. "The heater chains in present-day TV sets wander around so much, from one printed circuit board to another and with fly leads to the tube and so on, that the easiest thing to do is to work from the service sheet right from the beginning."

Armed thus with Smithy's approbation, Dick selected his circuit manual and returned to his bench. He opened the manual at the circuit diagram and studied the heater chain. (Fig. 1). He then located the thermistor on the receiver chassis, reconnected the mains supply and switched on. His next action was to clip one of his testmeter leads to the receiver chassis and to apply the other to the metal ends of the thermistor. His meter indicated the full mains voltage at either end of the thermistor.

"Aha!" said Dick.

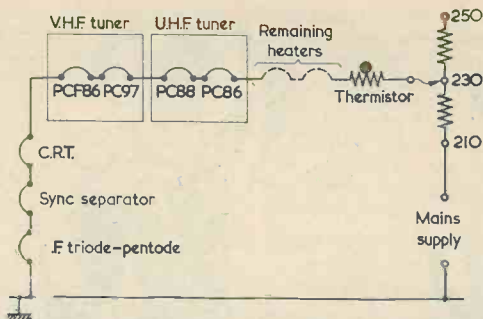


Fig. 1. The dual-standard receiver heater chain encountered by Dick. Since the cathode ray tube heater and the tuner unit heaters are not at chassis potential, it is worthwhile checking continuity to chassis from the immediately available heater points these provide before testing elsewhere. The h.t. circuit and main on-off switch are not shown here

Knowing now that the trouble was, indeed, an open-circuit in the heater chain, Dick switched the receiver off again and removed the mains plug. Selecting a resistance range on his testmeter, he looked around for easily available points to apply his test prod. The cathode ray tube base was the most obvious, and he applied his prod to the heater pins, only to find that there was a low resistance to chassis from both of these. So the tube, and the heaters below it in the chain, were satisfactory. The two heater leads to the v.h.f. tuner came next, and Dick checked at the appropriate feed-through capacitors on the tuner chassis. Again, his testmeter indicated low resistance to chassis.

Dick gazed doubtfully at the u.h.f. tuner, which presented the only remaining heater chain tags which were immediately available. He applied his test prod, to find that only one of the heater supply feed-through capacitors gave the requisite low resistance reading to chassis.

Examining the Tuner

With the inevitability of a diesel locomotive breaking down on British Railways, Dick's voice resounded across the Workshop.

"Smithy!"

"Hello!"

"You told me," called out Dick, "that if I ever had a fault on a u.h.f. tuner I was to let you know."

"Quite right, too," said Smithy amiably, putting his soldering iron down on its rest. "These tuners are a bit new to us and we want to get as much experience with them as we can."

A puzzled frown crossed over Dick's face.

"I don't get it," he commented.

"Don't get what?"

"Your attitude," replied Dick.

"Normally when I call you over for anything you grumble and groan and bang things about like nobody's business. Right now, though, you're carrying on as if you really like giving me a hand."

"I'm always ready to oblige," said Smithy equably, "although I must admit that I feel rather more

obliging than usual at the moment. Come to think of it, I haven't heard any grumbles from you, either. I'd have thought it impossible for you to get through half an hour without having at least one prize moan about something or other."

"That's a point," said Dick thoughtfully. "For some strange reason, everything seems to have gone right this afternoon. I can't even think of anything to moan about!"

"Same here," agreed Smithy. "I feel so contented I'll be chewing the cud soon."

"I hope," said Dick, a little worriedly, "it's all right our being like this. I wouldn't like to think we were sickening for anything, or something like that."

"Nonsense," replied Smithy cheerfully. "Anyway, what's the fault with this u.h.f. tuner?"

"It's causing an open-circuit in the heater chain," said Dick. "One of its valves may have burnt out."

"Fair enough," commented Smithy, examining the tuner. "We'll whip them out then."

After removing their screening cans, Smithy took out the tuner valves and passed them over to Dick for checking. But each valve gave a low resistance reading between its heater pins.

"Well, they're O.K.," said Smithy philosophically, as he replaced the valves and their screening cans. "It looks as though we'll have to get the tuner out itself. Which means we've got to get the chassis out, too."

Dick removed the chassis from the cabinet, after which Smithy carefully uncoupled the drive to the variable tuning capacitor of the u.h.f. tuner and unscrewed its mounting bolts. After several minutes, the tuner was free of the chassis, and was coupled to it only by the fly leads which carried its heater and h.t. supplies, together with the i.f. output.

"There you are," said Smithy. "One u.h.f. tuner!" (Fig. 2).

Carefully, Smithy commenced to remove the bolts securing the screening cover.

"Hey!" interjected Dick. "I thought that u.h.f. tuners weren't supposed to be meddled about with."

"Neither are they," replied Smithy. "But it's probable that the fault we've got in this particular instance is of a very simple order only. We may be able to repair it without upsetting any of the r.f. circuits."

As he spoke, Smithy removed the last securing bolt. He took off the screening cover and displayed

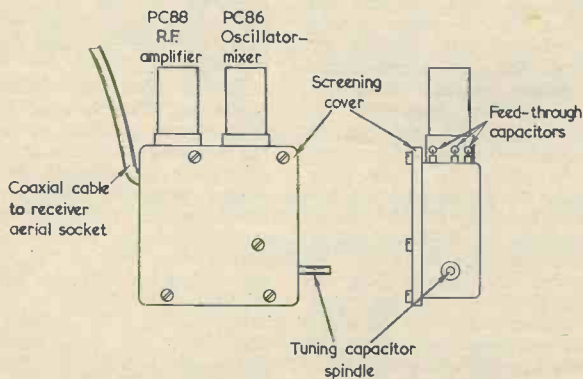


Fig. 2. The external appearance of a typical u.h.f. tuner

the internal assembly of the tuner to Dick. (Fig. 3).

"Now, I don't want to go into detail concerning all the circuits inside this tuner," he remarked, "because we went into these, you and I, quite some time ago.* Suffice it to say that we have the aerial tuner line, the primary line, the secondary line and the oscillator line, and that each of these sits on its own little screened compartment. There is a fifth compartment, also, for the i.f. output coil. A 4-gang variable capacitor tunes all the lines including the aerial line. Incidentally, it's necessary to tune the aerial line rather than have it aperiodic, because the channel spacing adopted for Britain is liable to cause second channel interference to be troublesome. As a result, you need as much selectivity before the mixer as you can get."

"What are those bent-up gubbinses?" asked Dick, pointing to four metal strips soldered to the sides of the compartments. (Fig. 4).

Smithy examined the strips. "Those," he commented, "are trimmers."

"Hey?" Dick's ejaculation was couched in utter disbelief.

"They're trimmers," repeated Smithy firmly. "Don't forget that you need a trimmer across each section of the four-gang capacitor. In this particular model, such trimmers are provided by these strips. You'll notice that each strip presents a flat surface area to the mounting plate which holds the fixed vanes of the corresponding section of the tuning capacitor. So, if you bend each strip towards the plate you increase trimming capacitance, and vice versa. In other words, you trim by bending the strip in the appropriate direction."

"I'm convinced!" said Dick. "It looks as though you've got to take jolly good care to avoid bending them accidentally, if you ever do any service work inside the tuner."

"You've got to take care," replied Smithy, "to avoid bending or moving anything in the r.f. circuits of a u.h.f. tuner. For instance, the wires which run alongside the lines are intended for coupling purposes, and they must never be pushed about or the response of the tuner will be ruined."

Smithy paused, and indicated a rectangular loop of tinned copper wire soldered to the screen between the primary and secondary line compartments. (Fig. 5).

"You may recall," he continued,

"that the primary and secondary lines of a u.h.f. tuner act in the same manner as the primary and secondary bandpass coils in a v.h.f. tuner. In the particular u.h.f. tuner we have here, this rectangular loop of wire provides a variable coupling between the two lines. If one section of the rectangular loop is pushed down towards the line underneath it, coupling is increased and the response widens. Similarly, if one section is pulled up, away from the line underneath it, coupling is reduced and the response narrows. Moving the sections of the loop may also cause detuning of the appropriate line, and so its adjustment is quite definitely a factory job. It has to be left severely alone during servicing, or you may wreck the response of the tuner. And, as I said just now, the same applies to all the other wires in the tuner r.f. circuits."

But Dick's attention had wandered to the screening cover Smithy had removed. (Fig. 6).

"What's the copper foil for here?" he asked. "Wouldn't the metal cover on its own provide adequate screening?"

"Not with a u.h.f. tuner," said Smithy. "As you can see, the copper foil rests on a soft p.v.c. pad which is about a sixteenth of an inch thick. The result is that, when the mild steel screening cover is bolted on, the surface of the copper is forced into intimate contact with the outside edges of the tuner chassis, as well as with the edges of the screens between the compartments. In consequence, you get excellent screening between each compartment and the outside world, as well as between each compartment and its neighbours. If you didn't have this intimate contact, the outside screen could even provide

a coupling between one compartment and the next."

"Blimey," said Dick impressed. "These u.h.f. tuners look simple at first but there isn't half a lot of hidden things about them. I must say that it seems rather funny having lines instead of coils to provide the inductances."

"There are plenty of coils around as well as lines," chuckled Smithy, "and since we are supposed to be chasing an open-circuit heater chain we'd better turn our attention to them."

Heater Chokes

"What coils," asked Dick, "are these?"

"They're the heater chokes," replied Smithy, "and there's no less than five of them in the heater circuit. If you look at the circuit diagram for the tuner you'll see that one of the heater supply leads

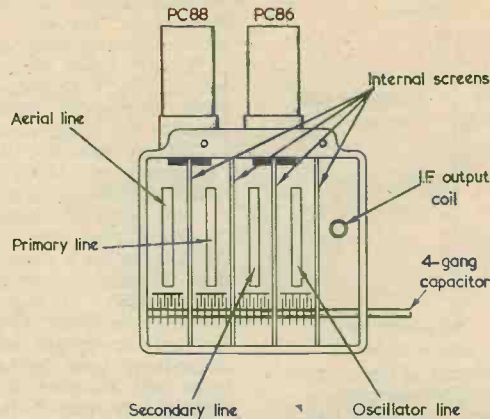


Fig. 3. The principal components inside the u.h.f. tuner of Fig. 2

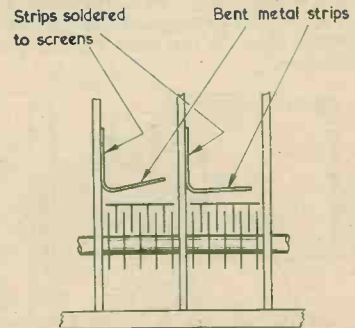


Fig. 4. A detail showing two of the four "trimmers" in the u.h.f. tuner. The trimming capacitance across each section of the 4-gang capacitor is varied by bending each strip closer to or further away from the adjacent fixed vane assembly

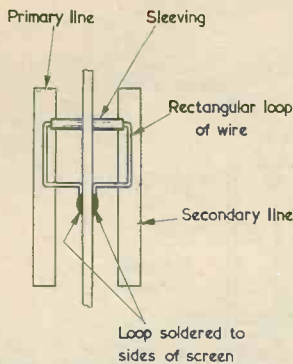


Fig. 5. A means of obtaining pre-set coupling between primary and secondary lines. The loop connects to the internal screen between the lines only at the points where it is soldered. Coupling may be increased by bending the wires of the loop closer to the lines below them

enters the aerial line compartment by way of a 1,000pF feed-through. (Fig. 7). It then passes through a choke to the heater of the PC88 r.f. amplifier, after which you have another choke taking it to a second 1,000pF feed-through mounted on the screen between the aerial and primary line compartments. The heater circuit then carries on through a further choke in the primary line compartment and on to yet another feed-through in the next screen. We're now in the secondary line compartment, whereupon we have the heater connections to the PC86 oscillator-mixer, together with chokes number 4 and 5. We finally pop up above the surface again via a fourth 1,000pF feed-through fitted at the secondary line compartment, after which we get back to the heater chain in the main part of the receiver."

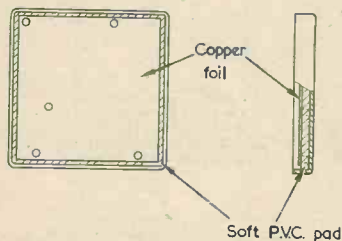


Fig. 6. The inside of the screening cover. The soft p.v.c. pad ensures that the copper foil is pressed against the tuner chassis and the edges of the screens between the compartments. The holes are intended for the mounting bolts

"That heater circuit isn't just decoupled," grinned Dick, "it's well-nigh excommunicated!" "U.H.F. tuner designers," admitted Smithy, "certainly do go to some lengths to prevent coupling between the different stages." "I'll say they do," agreed Dick. "Putting in all those chokes must cost a fortune in production." "Not really," replied Smithy. "I would guess that the cost with the chokes isn't very much more than if plain connecting wire were used instead. If you look at the chokes themselves (Fig. 8) you'll see that they're just self-supporting single-layer coils having about 10 turns and an internal diameter of slightly less than 0.1in. The wire itself is of the order of 32 s.w.g. The inductance of these little chokes shouldn't be at all critical, whereupon it would be a piece of cake to wind them on an automatic winding machine using T.N.A. wire."

and distributes it over the surface of the coil. But the acetone soon evaporates away, leaving a skin of hard acetate over the coil which then holds the turns firmly together." "I also seem to remember," commented Dick, "that you can solder straight through the insulation of T.N.A. wire." "That's right," agreed Smithy. "You can pop it into a tag or wrap it round a terminal pin without having to strip the insulation back at all. If you apply a soldering iron and solder, the acetate and nylon melt, allowing the solder to get straight through to the tinned copper underneath. And that is what has been done in the u.h.f. tuner we've got here. The chokes have had their lead-outs either popped into the valveholder heater tags or wrapped around the centre pins of the feed-throughs, after which they've been soldered without

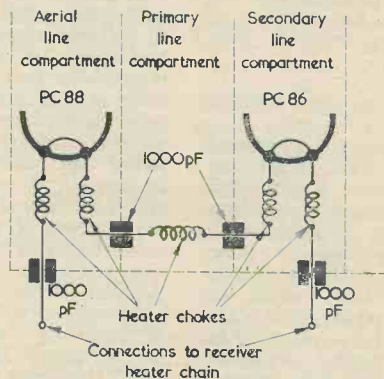


Fig. 7. Circuit showing the extensive heater coupling employed inside a u.h.f. tuner

"T.N.A. wire?" queried Dick thoughtfully. "We always seem to bump into T.N.A. wire every now and again." "We're bound to," commented Smithy. "Especially since it's been used in the set-making industry for at least the last eight years or so. As you should know, T.N.A. wire consists of ordinary tinned copper wire covered with nylon and an outside lapping, in the opposite direction, of acetate." "I remember, now," chimed in Dick. "The acetate dissolves if you apply acetone, with the result that it's possible to wind a single-layer close-wound coil, splash a bit of acetone on it, and cause the whole lot to become covered in a continuous skin of acetate." "That's the idea," agreed Smithy. "The acetone dissolves the acetate

stripping back the insulation at all. So, although there is a multiplicity of chokes, the process of wiring them into circuit would not be much harder than if tinned copper wire had been used instead." "Multiplicity", mused Dick with approval. "Now, that's what I call a really impressive long word." "Don't," said Smithy sternly, "take the mickey." "I'm quite serious," protested Dick. "I like long and impressive words instead of short ones, particularly in the radio and TV game. Have you ever noticed, for instance, that hardly anyone ever seems to turn a component in electronics. They always orient it. And you don't have a third winding on a transformer, you have a tertiary winding. One of these days I must make up a list of these words

just so that I can bewilder people. You know what they say, don't you? Bull-dust baffles brains!"

"Let us," said Smithy patiently, "get back to the job in hand."

"Okey-doke," replied Dick cheerfully. "What do we do now?"

"We stop nattering," said Smithy, "start work with the testmeter, and get on to finding the break in that tuner heater circuit!"

Obediently, Dick picked up his testmeter prod and applied it to the feed-through capacitor in the aerial line compartment. His meter indicated the low resistance to chassis he had previously encountered. He next checked on the pins of the PC88, and again obtained a low resistance reading. There was, however, no low resistance reading when he applied his prod to the centre pin of the feed-through capacitor between the aerial line and primary line compartments.

"The second choke," he remarked carelessly, "has gone open-circuit."

"Nonsense," snorted Smithy. "It's much more likely that there's a cold joint at one of its ends. Sometimes, the girls at the factory don't leave the soldering iron on long enough to fully melt the nylon and acetate covering. Here, let me have a go!"

Elbowing Dick to one side, Smithy picked up a soldering iron and carefully applied it, in company with a piece of resin-cored solder, to the joint on the centre pin of the feed-through capacitor. He allowed a small amount of additional solder to flow into the joint, and watched the latter assume its shiny, molten, state. After a short second he removed the iron.

"Now check it," he commanded.

Obediently, Dick applied his test prod once more, to find that there was now complete continuity through the heater circuit of the tuner.

"That was a bit of luck," admitted Smithy. "I was keeping my fingers crossed that it wasn't the joint at the other end of the choke which was the cold one. It would have been a very fiddling job getting the iron up to the valveholder tag."

"What did you add the extra solder for?" asked Dick. "There was plenty of solder on the joint already."

"I applied the solder," replied Smithy, "because it was a convenient way of getting a bit of its resin core into the joint to act as flux."

"I see," said Dick thoughtfully. "Well, it looks as though all my troubles are now over."

He picked up the receiver mains plug and inserted it into the socket on the bench. He next turned

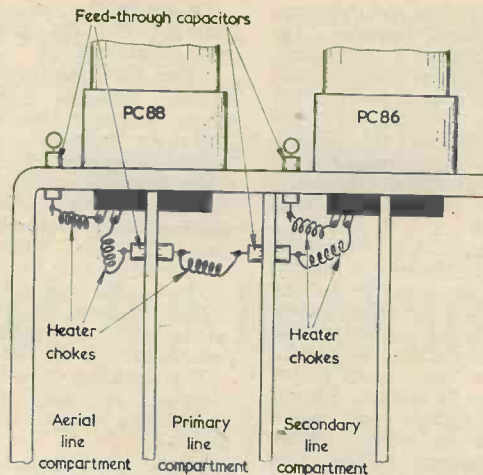


Fig. 8. Internal layout, showing how the chokes are mounted in practice

the receiver on and, after a short while, was rewarded with a comforting glow from the heaters. Dick switched the set off again.

"And that," said Smithy with satisfaction, "is that. Just one fiddling little fault in the u.h.f. tuner, yet it causes the whole set to go kaput."

"At any rate, it's been an instructive little episode," commented Dick. "Especially as we haven't got u.h.f. in our particular district yet!"

Noisy Reception

Smithy grinned and wandered back to his own bench again, to resume his interrupted work.

The afternoon continued to hold its spell over the two, and they carried on in an atmosphere of

complete contentment. Dick refitted the screening cover to the side of the u.h.f. tuner, mounted it in its original position on the chassis and switched on the receiver once more. A look of pleasure spread over his face as he noted that it now reproduced a perfect picture accompanied by perfect sound. Happily, he re-installed the chassis in its cabinet and gave the receiver its final test. Again, there was a perfect picture with perfect sound.

It was only at the instant that his hand finally moved forward to turn off the set that the crackling commenced.

Frowning, Dick adjusted the volume control. Regardless of its setting, the loud continuous crackling continued to emerge from the loudspeaker. Dick swung the v.h.f.

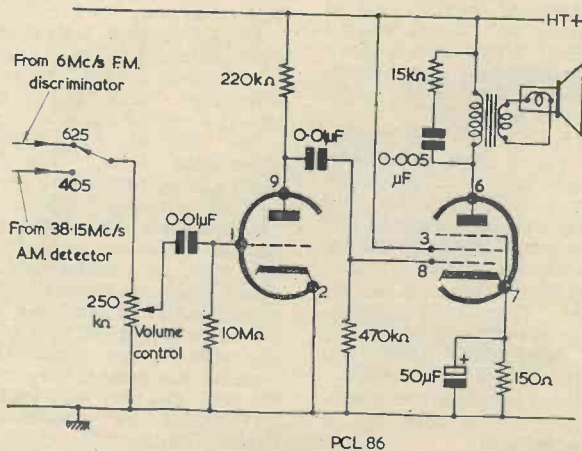


Fig. 9. A typical PCL86 a.f. voltage amplifier and output stage, with representative values

tuner to another channel, but the crackling continued unabated. He switched the receiver to 625 lines, without the slightest effect whatsoever. Heaving a sigh, he returned the set to its original 405 line channel and gazed for a few minutes at the picture, which remained as good as it had been previously, and listened to the crackling from the loudspeaker.

With a disgruntled expression Dick returned to the service manual and directed his attention to the audio stages. (Fig. 9). The receiver employed a PCL86 triode-pentode here, and Dick decided to replace this before he once more pulled the chassis from its cabinet. Several minutes later, Dick was again gazing at the set which, replete with a replacement PCL86, was still reproducing its loud crackle.

Some of the enchantment of the afternoon disappeared.

"Smithy!"

This time the soldering iron was lowered on its rest with a significantly greater force than had occurred previously.

"What," called the Serviceman over his shoulder, "is the trouble now?"

"It's this darned set," complained Dick. "It's developed a loud and continuous crackle on sound."

There was a noticeable reduction in the enthusiasm with which Smithy walked over to rejoin his assistant. He listened carefully to the crackling and noticed that adjustment of the volume control had no effect.

"It still keeps on," volunteered Dick, "if I switch over to a dead channel or, even, to u.h.f."

"I see," said Smithy, "although I don't feel that there was much point in changing channels and so on if altering the volume control had no effect. Whatever it is that's causing the crackling must almost certainly be in the audio stages after the volume control."

"I thought I'd try another channel anyway," replied Dick defensively, "there might have been an intermittent short on the h.t. line with the first channel, or something like that, which was causing the crackle to find its way into the a.f. stages."

"Fair enough," conceded Smithy reluctantly. "There is, I suppose, a vague possibility of something like that happening. Have you changed the a.f. triode-pentode?"

Dick nodded an affirmative, whereupon Smithy's face took on a resigned expression.

"Out it comes," he remarked, indicating the chassis.

Once more the knobs were removed and the chassis-securing bolts unscrewed.

"This shouldn't take too long," Smithy remarked. "Let's switch the set on again and short the odd grid down to deck."

Dick switched on the receiver, whereupon the crackle once more became audible. Picking up a piece of wire, Dick short-circuited the grid of the triode section of the triode-pentode to chassis.

The crackle continued.

Dick removed his wire from the triode grid and applied it to the control grid of the pentode section.

The crackling ceased.

"This," remarked Dick, pleased, "looks like being a nice easy job, after all."

"Perhaps so," commented Smithy cautiously. "At any rate, there aren't many components between those two grids which need checking. The most likely culprit is the coupling capacitor from the triode anode to the pentode grid. See if there's any positive voltage on the grid of the pentode."

Dick switched his testmeter to a voltage range and applied it between the pentode grid and chassis.

"There's nary a sausage," he called out. "Exactly zero volts!"

"Nevertheless, I should try changing the capacitor," said Smithy. "It might still be causing the crackle, and it's certainly the likeliest component."

Dick switched off, found a suitable capacitor in the spares cupboard and switched on again. The crackle returned, undiminished.

"Try the voltage," said Smithy, "on the anode of the triode."

"Right you are," said Dick, busy with his meter. "It's just below 100 volts."

Smithy grunted and stroked his chin reflectively.

"It's quite a time," he remarked eventually, "since I last bumped into this sort of thing."

"So far as I'm concerned," commented Dick, "I'm baffled! What else is there left to check?"

"Lots of things," replied Smithy. "In the past I've had crackling like this which was caused by such things as an intermittent short-circuit inside the valveholder. Such a short could be occurring between the triode anode pin and any other pin with a low potential. I've bumped into quite a few of these in the past, and they were particularly prevalent if the valveholder used Paxolin insulation."

"The present valveholder," Dick pointed out, "is a moulded type.

It's one of the special moulded types intended for printed circuit boards."

"That," replied Smithy, "is exactly what I'm worried about."

Dick groaned.

"You don't mean," he queried, "that there might be an intermittent leak in the board itself?"

Smithy nodded gravely.

"Before we get too despondent, however," he said, "there's at least one further component to suspect. Let's try swapping the triode anode lead resistor."

"But I'm getting very nearly 100 volts on the triode anode," protested Dick. "There can't possibly be anything wrong with the resistor."

"Nevertheless," said Smithy, "we'll try it all the same."

With the attitude of one who is setting about a completely useless errand, Dick returned to the spares cupboard, selected a replacement resistor, and carried it back to his bench. Carefully, he removed the entirely innocuous-looking resistor which was already installed, and fitted the new component in its place. He switched on and waited.

After a few seconds, the receiver came to life and reproduced a welcome burst of music. What was even more welcome was the fact that all traces of the crackling had disappeared.

"Well, I'm dashed," said Dick exultantly. "It was a dead easy snag after all!"

Just A Perfect Afternoon

"I must confess," agreed Smithy, "that you're perfectly correct. I mentioned the idea of changing that resistor merely as a last-ditch suggestion, and I'm just as surprised as you are that it did the trick."

"There's something funny here," commented Dick thoughtfully. "We've just found a resistor which, although it looked perfectly good and gave the right voltage so far as the testmeter was concerned, still introduced the dickens of a lot of noise into the a.f. stages."

"Well?"

"If," continued Dick, "we've found one innocent-looking little resistor doing this, how are we to be sure that all the other resistors in the receivers we handle are not similarly introducing noise into the stages they are connected in?"

"That," commented Smithy, "is too horrible a thought to bear with! Let's just assume that a resistor becomes very noisy only on occasion, and that when it dies it can be located by a straight swap."

"As you like," conceded Dick. "At any event, the one we've found represents yet another snag which has turned out to be dead simple in the end. I don't think I've ever had an afternoon as easy as this!"

"I couldn't agree more," said Smithy. "Still, it's nice to know

that these good periods do occur every now and again."

And there we are. Little did the cheerful Dick know that, lurking on the shelves awaiting his next selection, was a television receiver whose intermittent fault could only be induced to appear after it had been switched on for an hour

with the chassis in the cabinet. Nor did Smithy, currently in one of his rare optimistic moods, realise that the next job he would tackle had virtually impenetrable faults in both the gated a.g.c. and flywheel sync sections.

As they say, it is far better to travel hopefully than to arrive.

Basic Superhet for Beginners

by James S. Kent

Part 2

This article describes how an extra i.f. stage; b.f.o. stage; "magic-eye" tuning indicator; voltage stabiliser and additional panel controls may be fitted in order to enhance the performance and versatility of the basic circuit discussed last month

IN ORDER TO OBTAIN STILL GREATER GAIN AND selectivity from the receiver it is necessary, especially for short wave working, to add a further i.f. stage to the circuit. This is shown in Fig. 7, from which it will be seen that a further EF41 r.f. pentode has been incorporated, the circuit itself being exactly the same as that of the i.f. stage shown in Fig. 1 (published last month), except that h.t. decoupling is provided by R_4 and C_4 .

This stage should be inserted between the frequency changer stage (V_1 of Fig. 1) and the already existing i.f. stage (V_2 of Fig. 1). The physical positioning of all the added stages discussed this month is shown in Fig. 15 (above-chassis layout) and in Fig. 16 (panel layout).

In order to add the i.f. stage, certain small alterations to the existing wiring must be made, assuming that the circuit of Fig. 1 has been completed.

Disconnect lead "B" (see Fig. 1) from the grid of the existing i.f. valve (pin 6), and connect this lead to pin 6 of the newly added valveholder. Having added the additional i.f. transformer shown in Fig. 7, connect tag 3 of the transformer to the anode (pin 2); tag 1 to the main h.t. line by way of R_4 and C_4 ; tag 6 to the grid (pin 6) of the i.f. valve already existing (V_2 of Fig. 1), and tag 4 of the i.f. transformer to the a.g.c. line at point "E" of Fig. 1 after having previously soldered into circuit the decoupling components R_3 and C_3 as shown in Fig. 7. Having included all the other additional components, as shown, switch on the receiver and slightly adjust the i.f. transformer cores for the maximum signal strength.

We now have two i.f. stages, both being a.g.c. controlled. For communications work however, a few additional refinements to this newly added i.f. stage would be of very great advantage to the operator.

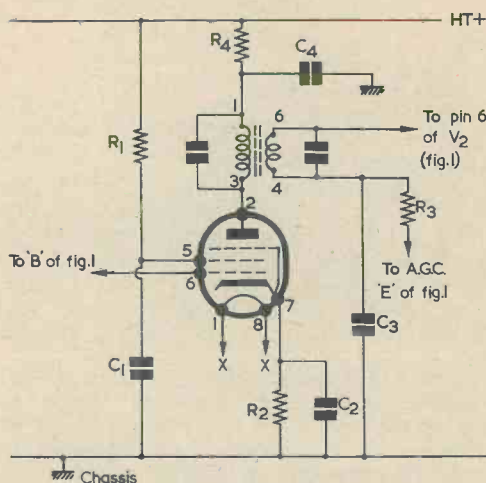


Fig. 7. Circuit of the additional i.f. stage

Components List

(Fig. 7)

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

R_1 100k Ω

R_2 270 Ω

R_3 1M Ω

R_4 22k Ω

Capacitors

C_1 0.1 μ F tubular (Mullard)

C_2 0.01 μ F tubular (Mullard)

C_3 0.05 μ F tubular (Mullard)

C_4 0.05 μ F tubular (Mullard)

Valve

EF41 (Mullard)

I.F. Transformer

465 kc/s type IFT11 (Denco Ltd.)

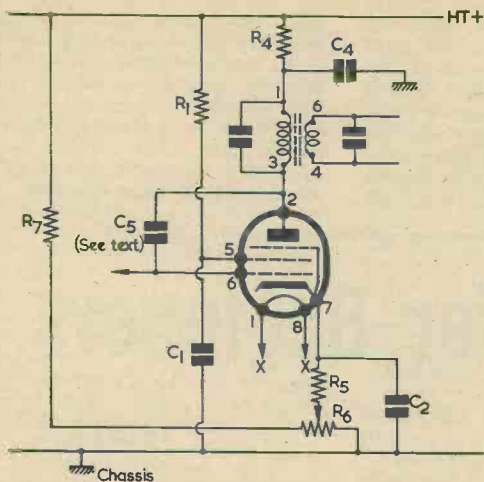


Fig. 8. Circuit of the additional i.f. stage with added gain control

Components List (Fig. 8)

Resistors

- R₅ 150Ω ½ watt 20%
- R₆ 10kΩ potentiometer
- R₇ 47kΩ 2 watt 10%

Added Refinements to I.F. Stage

For a communications type superhet, an i.f. gain control and some additional selectivity, over and above that of the ordinary receiver, is required. In Fig. 8 will be found a method of achieving this desirable state of affairs in the newly added i.f. stage. These advantages may be obtained easily and cheaply and are well worth incorporating into the design.

To carry out the modifications, an additional 10kΩ potentiometer is required, and this should be mounted on the front panel (see Fig. 16) where, by a suitable amount of rotation, the i.f. gain of the stage may be controlled or altered at will. The value of the existing cathode resistor (R₂) will require to be altered from 270Ω to 150Ω. The capacitor C₂, together with C₁ and R₁, are unaltered in value.

It will be noted from Fig. 8 that a coupling has been made from anode to grid via C₅. This capacitor is not an actual component as such but is formed by first soldering to the anode a short length of systoflex-covered wire and by similarly soldering to the grid a further small length of systoflex-covered wire. Ensure that the actual wires are completely covered with the insulating systoflex material. Switch on the receiver and set the i.f. gain control (R₆ of Fig. 8) to a point near the maximum gain setting. Slowly bring the grid wire near to the anode wire (remember that the anode wire is carrying h.t. potential) until a point is reached where the receiver oscillates or even "blocks" (i.e. signal

ceases). As the latter condition is undesirable, slowly part the two wires until oscillations are again achieved. At this point, the receiver is at its most selective by virtue of the positive feedback introduced by the grid-anode coupling introduced in the two wires forming the capacitor. These two wires should preferably be of a stout gauge in order that they will remain rigidly in place once correctly adjusted. Any movement of these two wires, once adjusted for maximum selectivity, will result in either less selectivity than that obtained at the critical point or, conversely, in the unwanted "blocking" effect. Some "cut and try" is called for with the adjustments to the grid wire and the i.f. gain control until a satisfactory arrangement is arrived at. The main point about these modifications is that the i.f. gain control must be at near maximum gain position before oscillation takes place.*

Adding a B.F.O. Stage

For the reception of c.w. (continuous wave) or

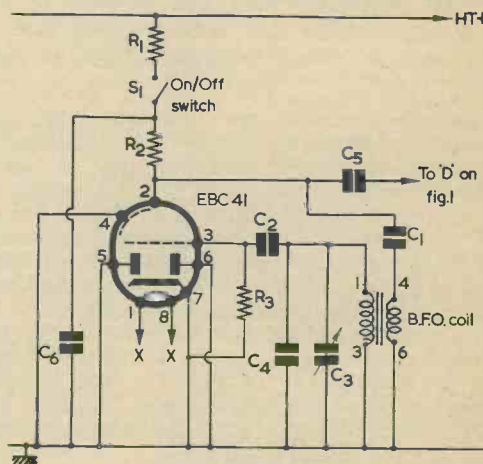


Fig. 9 Circuit of the b.f.o. stage

Components List (Fig. 9)

Resistors (all ½ watt 10%)

- R₁ 47kΩ
- R₂ 47kΩ
- R₃ 47kΩ

Capacitors

- C₁ 100pF silver mica
- C₂ 100pF silver mica
- C₃ 15pF variable (Wavemaster)
(Home Radio Ltd. Cat. No. VC68)
- C₄ 140pF silver mica
- C₅ 5pF silver mica or ceramic
- C₆ 0.1μF tubular (Mullard)

Valve

EBC41 (Mullard)

B.F.O. Coil

BFO2/465 (Denco Ltd.)

Switch

S₁ s.p.s.t.

Morse signals, a b.f.o. (beat frequency oscillator) provides an oscillation which, when mixed with the i.f. signal produces a beat note within the audio range. The pitch of the note can be varied by means of a variable capacitor (C_3 of Fig. 9). The note can be altered to suit the requirements of the operator and also, as an added advantage, to minimise interference with the signal required.

For those readers who do not require the b.f.o. stage as such, or who prefer a cheaper method of obtaining c.w. reception, it should be mentioned that, with the i.f. regeneration previously described, it is possible to read c.w. signals by the simple method of allowing the added i.f. stage to oscillate. This however is not a satisfactory method of achieving the object, mainly by virtue of the noise inherent in an i.f. stage under near full gain conditions when oscillating. Additionally, the pitch of the note cannot be altered as conveniently.

Reference to Fig. 9 will show that the added b.f.o. stage is built around the EBC41 double-diode-triode, this valve having been chosen not only for its suitability but also to keep the number of valve types used in the receiver to a minimum. Thus, should the detector of Fig. 1 (also an EBC41) fail,

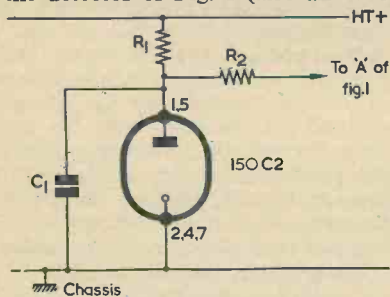


Fig. 10. Voltage stabiliser circuit

Components List (Fig. 10)

Resistors

- R_1 4.7k Ω 5 watt 10%
- R_2 22k Ω ½ watt 10%

Capacitor

- C_1 0.01 μ F tubular (Mullard)

Stabiliser

- 150C2 (Mullard)

* There will be a considerable degree of i.f. gain when the additional i.f. stage is fitted and great care should be taken to ensure that all i.f. anode and grid leads are kept short, and that each anode lead is kept well away from the grid lead for the same valve. Small earthed screens may be soldered across each valveholder to screen anode wiring from grid wiring. It would be preferable to bring the i.f. amplifier up to full working order before fitting the optional capacitor C_5 of Fig. 8, as the capacitance offered here may mask the effects of instability caused elsewhere in the i.f. amplifier. If, without C_5 , there is instability at full i.f. gain, it would be permissible to insert a resistor of some 10 to 20 Ω in series with the grid of V_2 in Fig. 1. Such a resistor will reduce gain (without reducing selectivity) and should only be employed when all other attempts at eradicating instability have proved unsuccessful. It is possible that the risk of instability will be lessened if a 0.1 μ F capacitor is connected between chassis and the h.t. positive line at IFT₂ of Fig. 1. Also, a 22k Ω decoupling resistor and 0.05 μ F bypass capacitor could be inserted in the h.t. feed to IFT₁ in the same manner as is done in Fig. 7.
—EDITOR.

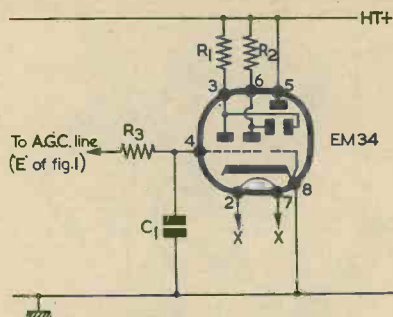


Fig. 11. The EM34 "Magic-Eye" circuit

Components List (Fig. 11)

Resistors (all ½ watt 10%)

- R_1 1M Ω
- R_2 1M Ω
- R_3 1M Ω

Capacitor

- C_1 0.05 μ F tubular (Mullard)

Valve

- EM34 (Mullard)

Valveholder

- International Octal

the b.f.o. valve may be inter-changed until a replacement is effected. The circuit of Fig. 9 is perfectly straightforward and, with the two diodes (pins 5 and 6) connected to chassis, the EBC41 is used as a normal triode valve. The valve has an internal screen (pin 4) which should be connected direct to chassis and this, to some extent, cuts down unwanted radiation. This stage should be mounted on the chassis fairly near the front panel and the detector stage, as shown in Fig. 15.

The anode is connected to the h.t. line via R_1 , the on/off switch and R_2 . Also connected to the anode is the feedback winding of the b.f.o. coil via the capacitor C_1 . C_5 passes the b.f.o. signal to the EBC41 diode (pin 5) of Fig. 1, at point "D".

Tags 3 and 6 of the b.f.o. coil should be joined with a length of wire and the other end of this wire connected to chassis at a suitable point. The variable capacitor C_3 (pitch control) should be mounted on the front panel at a point as near as possible to the b.f.o. coil. The coil itself is screened within its metal can and leads emanating from this are liable to radiate oscillations which may be picked up in other parts of the circuit. This is undesirable and therefore all leads from the can must be as short and direct as possible. The on/off switch is mounted on the front panel (see Fig. 16).

In order to obtain the most satisfactory performance whilst receiving c.w. signals, it is necessary to switch off the a.g.c. before switching on the b.f.o. This being so, a further switch should be wired across from the a.g.c. line to chassis at point "E" (see Fig. 1). When this latter switch is closed, the a.g.c. line is short-circuited to chassis. This a.g.c.

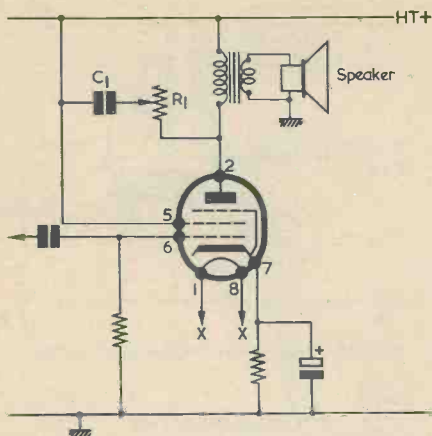


Fig. 12. Output stage with tone control circuit

Components List (Fig. 12)

Resistor

R_1 50k Ω potentiometer

Capacitor

C_1 0.05 μ F tubular 350V wkg

on/off switch must also be fitted to the front panel, and its position is shown in Fig. 16.

To align the b.f.o. stage, the variable capacitor C_3 should be set at half-mesh and the core of the coil slowly rotated, using a filed-down plastic knitting needle for the purpose, until a strong beat note is heard. The aim is to set the core to the "silent" position between the falling and rising beat note, these being obtained as the core is taken through the correct frequency. The variable capacitor should be in the mid-position as the core is adjusted.

With the components specified, the frequency coverage of the b.f.o. stage will be from 450 to 470 kc/s depending upon the position of the iron-dust core and the variable capacitor C_3 .

Adding a Voltage Stabiliser

The advantage of using a voltage stabiliser lies in the fact that, once connected into circuit, it allows a constant voltage to be delivered to the frequency changer oscillator anode. In so doing, it prevents any fluctuation of the applied mains voltage—and consequently the receiver h.t. line voltage—from affecting the oscillator anode supply. This, in turn, guarantees that the receiver oscillator remains stable, and that no frequency variation occurs when the main h.t. supply rises or falls.

Fig. 10 shows how a 150C2 voltage stabiliser may be incorporated into the basic receiver. Pins 2, 4 and 7 of the stabiliser should be connected by a short length of wire, the other end of which is connected to chassis. R_1 and R_2 should be connected to pins 1 and 5 of the valveholder, these two pins being similarly joined together.

The resistor R_2 should be connected to the oscil-

lator anode h.t. supply at point "A" of Fig. 1, the existing h.t. feed resistor (R_6 of Fig. 1) being removed altogether from the circuit. The voltage stabiliser is mounted on the chassis close to the frequency changer. Resistor R_2 (Fig. 10) should be connected direct to pin 3 of V_1 valveholder, a short connection here being more important than that between R_2 and the stabiliser.

Some readers may also prefer, at this stage of construction, to apply voltage stabilisation to the b.f.o. circuit of Fig. 9, in which case R_1 of that circuit should be disconnected from the h.t. positive line and re-connected to the anode of the stabiliser. The b.f.o. stage may require a slight adjustment to the core after this modification has been carried out.

Adding a Magic-Eye

With a selective superhet receiver, such as the design described here, some means of visual indication of correct tuning and/or signal strength is required. The cathode ray type tuning indicator, popularly known as the "magic-eye", is probably as good a device as any available for this function. The Mullard EM34, which consists of a triode amplifier with a miniature cathode ray device, the latter portion of which is visible through the end of the glass envelope, admirably fills the bill.

This valve produces two "shadows", or indications, of reception. One such indication is for weak signals whilst the other is for the strong signals. Once mounted into position with the end of the valve visible through the front panel of the receiver, the smaller shadow should be positioned at the top.

As shown in Fig. 11, pin 5 of the EM34 is connected directly to the h.t. positive line and from the same point two 1M Ω resistors are connected to pins 3 and 6. The grid (pin 4) is connected to the receiver

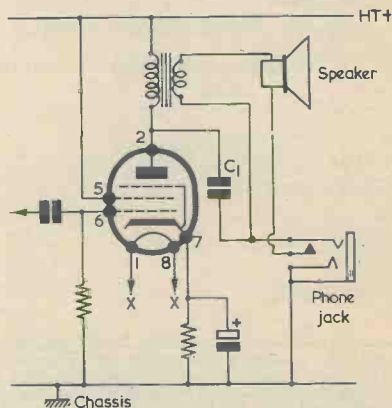


Fig. 13. Output stage with headphone jack

Components List (Fig. 13)

Capacitor

C_1 0.05 μ F tubular 350V wkg

Phone Jack

Igranic (H. L. Smith & Co.)

a.g.c. line via R_3 and bypassed to chassis via C_1 . Connection to the receiver a.g.c. line should be made at the point marked "E" in Fig. 1, this being the same connection as for the a.g.c. on/off switch. R_3 should be positioned close to the a.g.c. line. The a.g.c. voltage will cause the grid of the EM34 to take up various values of negative voltage as the received signal, and therefore the derived a.g.c. voltage, varies. With no signal the a.g.c. voltage is virtually at zero and therefore no bias is applied to the grid of the magic-eye. This results in a high current in both anodes and, since these are supplied via high value resistances, results in a low anode voltage. This voltage, applied to the ray control electrodes produces wide shadows. Tuning in a station results in the control grid going negative, thereby reducing anode current and increasing the ray control electrode voltages. The result is that the shadows reduce.

The inclusion of the magic-eye is of great advantage whilst operating over the short wave bands where the tuning of a station can sometimes be rather difficult. In addition to this, the indication of received signal strengths is often of advantage, especially where listener reports are being compiled. Such indications as fading (QSB) are of great interest in such reports and this phenomenon is clearly visible with the aid of a magic-eye.

The magic-eye could be mounted on the front panel between the two tuning dials.

Panel Control Circuits

Beginners will no doubt be interested in the additional panel controls and associated simple circuits which may be connected into the design as it now stands. Generally speaking, the more circuits under the direct control of the operator, the better is the receiver and the results obtained from it. In the following paragraphs these additional controls are discussed and, whilst the individual reader may prefer not to incorporate them in their entirety,

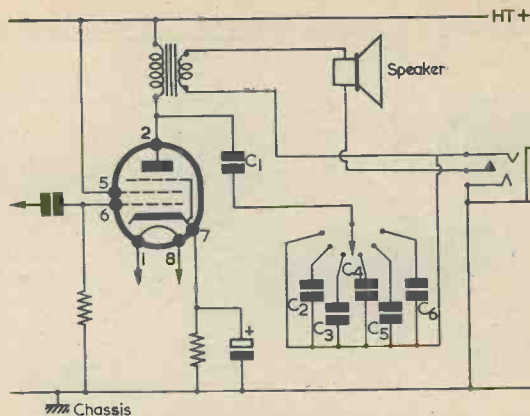


Fig. 14. Output stage with simple audio filter

Components List (Fig. 14)

Capacitors

- C_1 As for Fig. 13
- C_2 0.01 μ F tubular 350V wkg
- C_3 0.005 μ F mica or paper 350V wkg
- C_4 0.001 μ F mica or paper 350V wkg
- C_5 0.0003 μ F mica 350V wkg
- C_6 100pF mica 350V wkg

Switch

Single Pole, 6-way

some of them may prove attractive. All the additional controls are easily added and their inclusion will be found to be inexpensive. The panel layout drawing of Fig. 16 shows the positions of all these controls.

Tone Control

There are several methods of achieving tone control in a receiver and one of these is shown in Fig. 12. In this, as in Figs. 13 and 14, the values

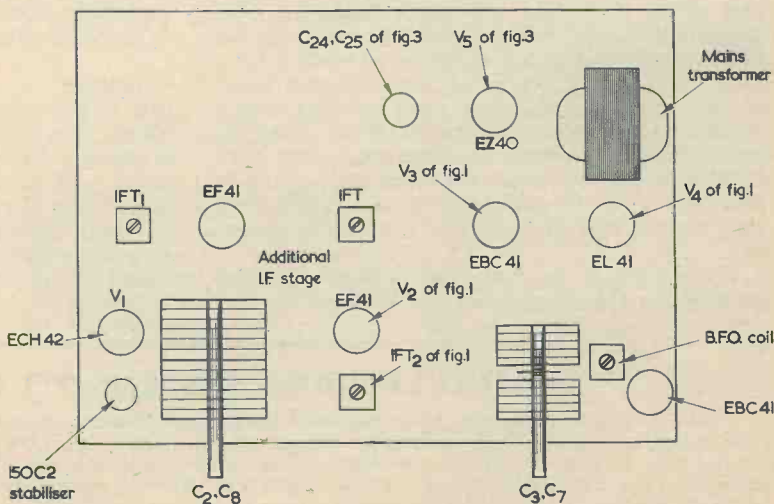


Fig. 15. Layout of the chassis with additional stages

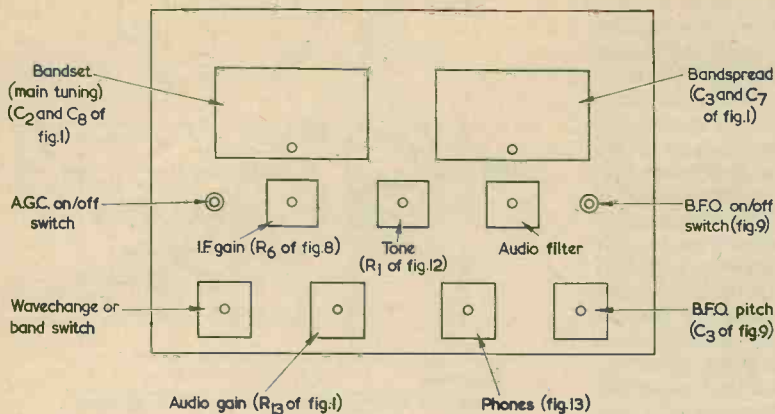


Fig. 16. Front panel layout

of the unmarked components are the same as those shown in Fig. 1. Only the additional components are discussed and shown with values in the respective circuits.

The tone control shown in Fig. 12 is given by the inclusion of C_1 and R_1 in the anode circuit of the output stage of Fig. 1. The potentiometer R_1 should, of course, be mounted on the front panel. It is important that capacitor C_1 be of a suitable working voltage rating, in this case 350V. C_{21} of Fig. 1 is deleted when the circuit of Fig. 12 is used.

An alternative to the potentiometer shown would be the inclusion of a Yaxley switch, the wiper of which is connected to C_1 and the various contacts wired to the anode via suitable values of resistance. This would result in a switched control to give pre-determined depths of tone.

Headphone Jack Connections

The inclusion of a headphone jack in the output stage is of advantage where serious short wave work is desired. In the main, this is carried out late at night and, in order to avoid disturbing other members of the household, the use of headphones becomes imperative. Additionally, of course, the use of headphones is much to be preferred where serious short wave work is concerned. Good quality headphones are, of course, much more sensitive than a speaker. High resistance types ($2,000\Omega$) should be used with this receiver. The headphone jack must be wired into circuit such that, when the headphone plug is inserted into circuit, the speaker is automatically muted. Fig. 13 shows how this may be carried out.

The position of the phone jack on the front panel is shown in Fig. 16 and the jack earth connection

in Fig. 13 is automatically made when the jack is secured to the metal front panel.

Audio Filter

An audio filter is often of advantage especially when reading c.w. signals. By its use, the beat note being received can, with adjustment of the b.f.o. pitch control, be made virtually a "silhouette of sound", so that the legibility of the signal is greatly increased. Phone signals can also be very much improved in this respect when interference is apparent on the signal. When the receiver is at its most selective, audio is apt to be somewhat low in tone owing to the loss of sidebands. The use of this simple filter will tend to compensate for this effect although, with its use, the audio gain will need to be advanced.

From Fig. 14 it will be seen that this simple arrangement is only applicable when employing headphones, these being used in preference to the speaker when listening to DX signals. The switch must be in position 1 for speaker reception.

The Yaxley switch shown, together with the five capacitors, should be mounted on the front panel as shown in Fig. 16.

Conclusion

It is to be hoped that the radio enthusiast for whom these articles were written—the beginner graduating from t.r.f. designs to the superhet receiver—will have found much of interest and help. Most of the circuits shown in this instalment could, of course, be included in existing receivers if desired and not necessarily only in the design described in Part I of this series.

(Conclusion)

BLIND LANDING SYSTEMS TO BE TAPED

Blind landing systems soon to be evaluated on British European Airways' Trident airliners will feed data into professional tape recorders, for subsequent comparison with pilots' logs at the R.A.E., Farnborough.

For this purpose, the Ministry of Aviation has recently takep delivery of 30 Type RE321 battery-operated tape recorders from EMI Electronics Ltd. It is envisaged that, after five years of these tests, sufficient data will be available to decide whether to adopt the blind landing system as standard equipment.

The Unijunction Transistor

by H. N. Rutt

THE UNIUNCTION TRANSISTOR IS a relatively new and little known semiconductor device which exhibits an N type, or current stable, negative impedance region in its characteristic. These transistors are now reasonably easy to obtain, and the price is quite moderate.

The usual symbol for the unijunction transistor is shown in Fig. 1, the three connections being: "base 1", "base 2", and "emitter". Although the device may not be immediately ruined by reversing the polarity of the two bases, it should be connected with base 2 positive of base 1. (It should be noted that the term "base" has no connection with the "base" of the normal type of transistor). When base 2 is made positive of base 1, and if the emitter voltage is plotted against emitter current, the resulting curve is that shown in Fig. 2. At first, when V_E is small, only a leakage current of a few micro-amps flows, but when V_E exceeds a certain fraction of V_{BB} , a much heavier current begins to flow in the emitter circuit. As the current rises further the emitter voltage drops, and thus this is a negative

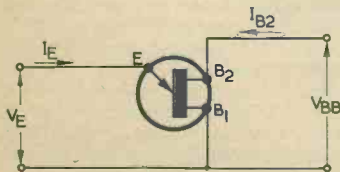


Fig. 1. The circuit symbol for the unijunction transistor. Also shown are the emitter and base voltages and currents

impedance region. The fraction of V_{BB} at which an appreciable current begins to flow in the emitter circuit is termed the intrinsic stand-off ratio, and is given the symbol η .* If the emitter current is further increased, the impedance remains negative until the "valley point" is reached, and here it becomes positive again.

Applications

The unijunction transistor may be used in many types of circuit

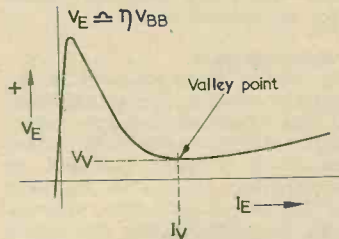


Fig. 2. The emitter voltage/current characteristic

including, in particular, waveform generators and timers. The simplest type of unijunction transistor oscillator is shown in Fig. 3. When the supply is switched on, C_1 begins to charge through R_1 , and continues to do so until the emitter turn-on voltage is exceeded (i.e. $V_E > \eta V_{BB}$).

* In General Electric literature on unijunction transistors, η is defined by the equation $V_P = \eta V_{BB} + \frac{200}{T_1}$ where V_P = peak point emitter voltage (at the peak of the curve of Fig. 2), V_{BB} = interbase voltage and T_1 = junction temperature in degrees Kelvin.
—EDITOR.

C_1 then discharges through the emitter, the voltage falls below that which will hold the emitter "on", the capacitor begins to charge again, and the cycle restarts. This very simple circuit provides a sawtooth waveform across C_1 , and a positive-going pulse across R_2 at the "fly-back" of the sawtooth. If R_2 were replaced by some form of constant current source this could form the heart of a transistorised timebase, positive-going sync pulses being applied to the emitter. The period of oscillation is dependent on the time constant $C_1 R_1$, η , and the supply voltage. If R_2 were placed in

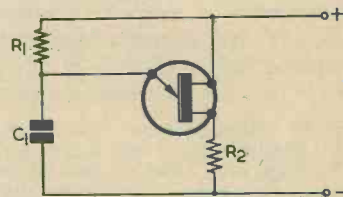


Fig. 3. A simple relaxation oscillator

the base 2 lead instead of in the base 1 lead, then the pulse would be negative-going, and would have a much higher source impedance. This type of circuit will not operate well much above 100 kc/s, and the maximum frequency at which the unijunction transistor is useful is of the order of 500 kc/s.

The type of circuit shown in Fig. 3 may also be used as a frequency divider (positive sync again being applied to the emitter), as a marker pip generator, and as a timing circuit. For the last application, C_1 and R_1 are made large, and a relay is included in the base 2 lead. When the relay operates it can be made to supply, via its contacts, a "holding" current to the emitter, so that the relay remains energised until manually released. When designing this type of circuit, the manufacturer's data must be consulted with regard to the maximum value of capacitor which can be safely discharged through the emitter-base 1 circuit.

The parameters of the cheaper types of this device are not usually closely defined, but a typical unit might have an interbase resistance of $6k\Omega$, an intrinsic stand-off ratio of 0.6, a maximum interbase voltage of 30, and a maximum total power dissipation of 0.5 watt.

Editor's Note

Unijunction transistors are available in the U.K. from International General Electric Company of New York Ltd., Lincoln House, 296-302 High Holborn, London, W.C.1.

"Autoflex" Transistor Circuit

Sir Douglas Hall,
K.C.M.G., B.A. (Oxon.)

By operating a single transistor as a common collector amplifier at r.f., and as a common base amplifier at a.f., the "Autoflex" circuit proposed here is capable of offering significant advantages over conventional reflexed configurations.

THE COMMON BASE TRANSISTOR amplifier has a very low input impedance, and a very high output impedance. Provided the collector load is high and is not damped by the following transistor, very high amplification of voltage can be obtained. There is no current amplification. Conversely, the common collector amplifier can have a very high input impedance with a low output impedance. With a high input impedance, and provided the output load is not too small, a high amplification of current can be obtained. There is no amplification of voltage. The output of a common collector amplifier and the input of a common base amplifier both occur between the emitter and earth.

It appeared to the author that these facts should make it possible to arrange a transistor with a high input impedance for high frequency

current, and a high output impedance for rectified low frequency current and that this, with suitable loads, should form a very sensitive arrangement. This supposition was borne out in practice, and Fig. 1 shows the basic details of a circuit which has been given the name "Autoflex" for reasons which should become apparent. It will be seen that TR₁ is, in fact, a reflex amplifier, though it is different from all others in that the coupling back of the low frequency signal, after demodulation, takes place automatically and without the need for coupling components. The result is extremely simple and very efficient, since losses are minimised.

Circuit Operation

At radio frequencies TR₁ in Fig. 1 is a common collector amplifier with the whole of a sharply tuned circuit as the input load. The collector is at earth potential at radio frequencies due to C₃, and the high frequency output appears across D₁. D₁ rectifies the signal and then functions as a load for audio frequencies. TR₁ now becomes an audio frequency, common base, amplifier. At these frequencies the base is at earth potential due to C₁, and the amplified result appears across R₁, which may be a resistor, as shown, or an inductor. If it is a resistor it has the unusually high value of 47kΩ. An inductor should have a value of about 250 H. Reaction is provided by coupling back a portion of the high frequency signal. As the slider of VR₁ moves downwards, the reaction coil is progressively short-circuited and full control results. At zero setting, the reaction coil is completely short-circuited and this effectively prevents the

main winding from picking up any signal. Many constructors will have experienced the drastic result of a shorted turn on a frame aerial or of a loop of wire on a ferrite rod aerial.

With a 47kΩ resistor, TR₁ has to function with from 1 to 2 volts between collector and emitter, and with a current of only about 100 to 150μA. It is essential that it should be a MAT101, which functions excellently with this minute power.

The frame or ferrite aerial should be arranged so that the medium wave reaction coil has one quarter of the turns of the main winding. For the long wave winding the reaction coil should have one sixth of the number of turns of the main loading coil. Some standard ferrite rod aerials will function using the base winding as a reaction coil; but with others the coupling coil may prove to be too small, particularly on the medium wave band. Provided frame aerials are used, well separated from each other, there is no need to short-circuit the long wave reaction coil when medium waves are being received. But if a ferrite rod is used either the medium and long wave coils should be quite separate and the live ends of the coils should connect to a 2-pole 2-way wavechange switch, or two rods should be used with both long wave windings short-circuited when listening on medium waves. In the prototypes, fairly large frame aerials are used measuring 14 x 7in in the one case, and 11 x 11in in the other. Using the annotation in Fig. 2, L₁ consists of 12 turns of 32 s.w.g. wire and L₂ has 3 turns of 38 s.w.g. wire. L₃ is wound with 36 turns of 38 s.w.g. wire and L₄ with 6 turns of the same gauge wire. It may be found necessary to remove one turn from L₁ if it is wished to receive the Third programme on 194 metres. There is no phase change through TR₁, so that the top end of L₂ is taken to VR₁ and the lower end to earth. This is the opposite arrangement to that required in a reaction coil in the collector circuit of an orthodox common emitter amplifier.

Practical Form

Fig. 2 shows a practical form of the "Autoflex" circuit followed by two further stages of low frequency amplification. This circuit will provide excellent loudspeaker results from a number of stations. On test in South Devon, 33 stations were received on the loudspeaker in the course of half an hour, using the frame aerials described.

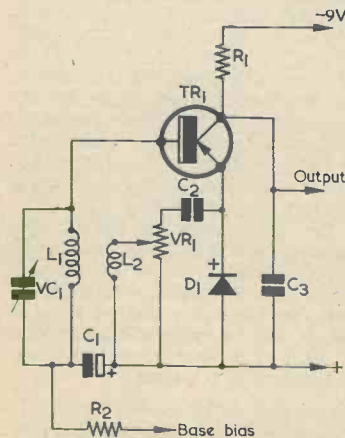


Fig. 1. The basic "Autoflex" circuit

Components List (Fig. 2)

Resistors

(All fixed resistors 10% ¼ watt)

- R₁ 47kΩ
- R₂ 27Ω
- R₃ 75Ω
- R₄ 1kΩ
- VR₁ 5kΩ potentiometer, linear

Capacitors

- C₁ 100μF electrolytic, 6V wkg.
- C₂ 0.01μF
- C₃ 1,000pF
- C₄ 0.1μF
- C₅ 100μF electrolytic, 6V wkg.
- VC₁ 500pF variable

Inductors

- L_{1, 2, 3, 4} (See text)
- T₁ Output transformer, 19.4:1, Rex LT700 (Henry's Radio Ltd.)

Semiconductors

- TR₁ MAT101
- TR₂ OC72
- TR₃ OC72
- D₁ OA81

Switch

- S_{1, 2} 3-pole 3-way (see text)

Because it is necessary for the collector load of TR₁ to be maintained at a high value, TR₂ is a common collector amplifier. As most of the voltage available is dropped across R₁, direct coupling to TR₂ is an easy matter. TR₂ will take slightly more than 1mA, resulting in a voltage drop across R₄ of a little over 1 volt. TR₃, a common emitter amplifier, is therefore suitably fed direct from R₄. R₂ plus R₃ provides a suitable resistance to limit the collector current of TR₃ to about 10 or 11mA. R₂ and R₃ are also of suitable value to provide a tapping point for base bias for TR₁. Stabilisation is excellent. If TR₃ tends to take more current, there is a larger voltage drop across R₂. This increases the consumption of TR₁, its base becoming more negative. More voltage is then dropped across R₁ so that the base of TR₂ becomes more positive. This reduces the voltage drop across R₄. The base of TR₃ then becomes more positive and the current consumption of TR₃ is therefore reduced. Stabilisation is so good that, in practice, there can be quite wide discrepancies in the values of the various resistors and in the characteristics of D₁ and the transistors with only a very small change in the current consumption of the three transistors.

To sum up the circuit of Fig. 2, it

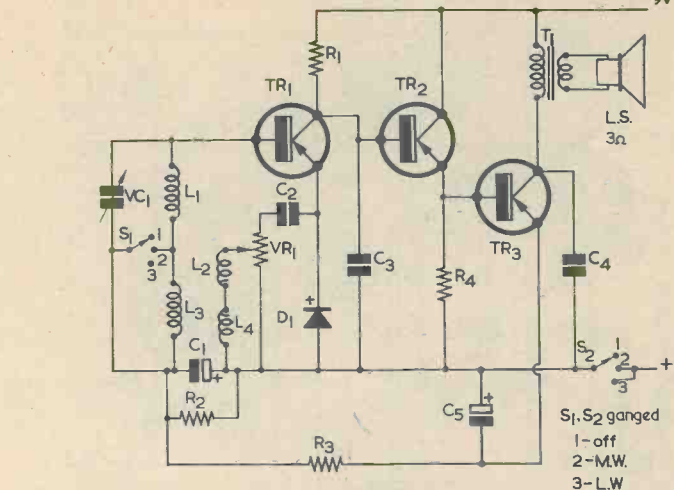


Fig. 2. A complete 3-transistor receiver employing the "Autoflex" circuit

consists of a common collector high frequency amplifier followed by a diode detector. There are then three stages of low frequency amplification which are common base, common collector and common emitter respectively.

Reaction should be beautifully smooth and free from backlash and great sensitivity should be obtained at the point of oscillation, which will occur when VR₁ is set at a point about 60 degrees or so from maximum. It will be found that this position remains remarkably constant for a large part of the wave range covered. If there is any instability in the reaction circuit it will probably be due to r.f. currents in the wrong places. C₄ should be checked for sound connections and the position and orientation of T₁ should be checked. It may be found that a reversal of the leads of either the primary or secondary of T₁ may stop unwanted oscillation if this is due, as it can be, to interaction between T₁ and the frame aerial.

Choke Coupling

TR₁ can be made even more efficient by adopting choke coupling between it and TR₂, thus maintaining a high impedance load but increasing the voltage available for TR₁ from under 2 to over 8. A very sensitive and economical receiver can be made by feeding this arrangement into a modified form of the "Economic Amplifier" recently described in this journal.* The resultant 4-transistor circuit is shown

* Sir Douglas Hall "An Economical Amplifier and Variable Inductance Tuner" *The Radio Constructor*, January 1964.

in Fig. 3. As there is plenty of amplification available, resistance coupling is used between TR₃ and TR₄ and negative feedback provided by R₁₁. The output transistor has its standing current slightly increased by reducing the negative arm of the base bias potentiometer from 150kΩ to 100kΩ. Standing current for the whole receiver becomes a little over 4mA, with an average consumption at full volume, of about 7mA.

L₆ is a Radiospares 5:1 "Midget" intervalve transformer with the two windings in series, the two centre leads being joined together. Coupling is through C₆, R_{1a} providing bias for the base of TR₂. A potentiometer network is not practicable for this purpose as it would damp L₆ too heavily, but with R₄ in the emitter lead of TR₂ there is little risk of thermal runaway.

R₂ and R₃ are changed in value to R_{2a} and R_{3a} respectively to maintain correct bias for TR₁ and TR₃. TR₃ is fed directly by R₄ and is an OC72 rather than the OC44 specified in the previous article on the amplifier, as this transistor does not now have to amplify at high frequency. C₇ is added to bypass unwanted r.f. currents, and R₅ and C₈ serve to decouple the two pair of transistors. Without these components there may be instability as the battery runs down.

L₅ is an anti-breakthrough choke of 2.5mH. It is arranged to be in circuit on the long waveband but is short-circuited when medium waves are being received. This was found to be necessary owing to breakthrough of the local station (West on 285 metres) at a reading of about

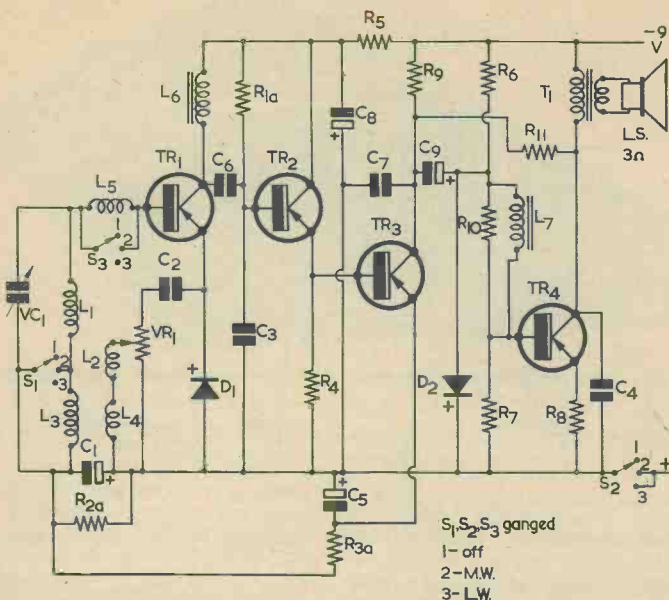


Fig. 3. A 4-transistor version, incorporating an economy amplifier section

1,700 metres. With the 3-transistor circuit, breakthrough was barely perceptible but it will be seen that a 3-pole 3-way switch is specified in the main Components List so that the choke can be included in the circuit in Fig. 2 if it is found to be necessary.

In the original amplifier circuit the secondary of an interstage transformer was used to ensure that the correct d.c. voltage was available to increase the base bias of TR₄ with an increase in the signal. With resistance coupling it was found necessary to modify this arrangement, and, although the same transformer is used, a Rex LT44, the larger primary winding is now used. This is shunted by a 4.7kΩ resistor and this arrangement results in a correct relationship being maintained between a.c. and d.c. voltages. The primary winding of the LT44 transformer appears as L₇ in Fig. 3 and it will be seen that this choke, with R₁₀ across it, offers less impedance to d.c. voltages than it does to the signal which is, of course, a.c. It also acts to some extent as a tone control, as impedance is greater for the higher audio frequencies than for the lower notes.

With four low frequency amplifying stages there is always the risk of instability and the exact positioning of T₁ in relationship to the frame aerials—particularly the long wave frame—may prove important. It is recommended that T₁ be wired up but not mounted until its best position and angle has been found

by experiment. It may be found that it will need to be fixed at an angle of 45 degrees to the long wave frame aerial in order to ensure stability and freedom from distortion due to uncontrolled positive feedback.

As all the components for the 3-transistor version, with the exception of R₁, R₂ and R₃, are required for the circuit in Fig. 3, it is useful to build the 3-transistor set first and then, when it is working nicely, add the extra components, bearing in mind that it may be necessary to move T₁ if oscillation or distortion takes place. Planning the layout can quite easily take this scheme into account.

Two-Transistor Version

The "Autoflex" circuit is so sensitive that it is possible to obtain excellent loudspeaker results from local stations, and reasonable "bed-side" volume from a number of others, using only two transistors together with 6in ferrite rods as the only means of pick-up.

For the 2-transistor version shown in Fig. 4, it is essential for the second transistor to be a common emitter amplifier in order to obtain the necessary gain and power to drive a loudspeaker. Also, the speaker should be a high flux type, and not too small. A difficulty is encountered in that the output impedance of TR₁ is of the order of 1MΩ, whereas the input impedance of TR₂, wired as a common emitter amplifier, is only about 1kΩ. The problem is

Components List

(Fig. 3)

These components are additional to, or replace, those listed for Fig. 2.

Resistors

(All fixed resistors 10% ¼ watt)

- R_{1a} 150kΩ (replaces R₁)
- R_{2a} 220Ω (replaces R₂)
- R_{3a} 680Ω (replaces R₃)
- R₅ 1kΩ
- R₆ 100kΩ
- R₇ 3.9kΩ
- R₈ 15Ω
- R₉ 2.7kΩ
- R₁₀ 4.7kΩ
- R₁₁ 22kΩ

Capacitors

- C₆ 0.1μF
- C₇ 0.01μF
- C₈ 100μF electrolytic, 12V wkg.
- C₉ 4μF electrolytic, 6V wkg.

Inductors

- L₅ 2.5mH choke (Repanco)
- L₆ 5:1 midget intervalve transformer (Radiospares)
- L₇ Transistor transformer, 4.47:1 (see text) Rex LT44 (Henry's Radio Ltd.)

Semiconductors

- TR₄ OC72
- D₂ OA81

solved by using a special transformer, made by Ardenie, which has a primary inductance of 250H, and a ratio of 32:1. The impedance ratio is thus about 1,000:1, which is exactly what is needed. Not only is proper matching achieved, but TR₁ is enabled to give very high amplification with a high impedance in its collector circuit which is virtually unchanged by TR₂. This amplification is of voltage, but a current gain of 32 times is provided by the transformer, and power is thus available to drive TR₂.

The Ardenie D102 is designed for matching a crystal microphone to a common emitter amplifier, and with its large primary winding only a very small current can be handled before saturation sets in. Experiment showed that from 70 to 90μA was the optimum current to ensure a good inductance value coupled with good amplification by TR₁, and the bias resistors have to be selected accordingly. The current taken by TR₁ is less than that taken in the circuits in Figs. 2 and 3, but the voltage available rises to over 8, as with the choke coupling in Fig. 3, and TR₁ will load TR₂ fully without distress.

The current drawn by TR₁ is fairly critical for best results, and although 2.7kΩ for R₁ will probably work

Components List (Fig. 4)

Resistors

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

- R₁ (See text)
- R₂ 68k Ω
- R₃ 1k Ω
- R₄ 15k Ω
- R₅ 56 Ω
- R₆ (See text)
- VR₁ 5k Ω potentiometer, linear

Capacitors

- C₁ 0.01 μ F
- C₂ 1,000pF
- C₃ 100 μ F electrolytic, 6V wkg.
- C₄ 100 μ F electrolytic, 6V wkg.
- C₅ 100 μ F electrolytic, 6V wkg.
- C₆ 100 μ F electrolytic, 6V wkg.
- VC₁ 100pF variable

Inductors

- L_{1, 2, 3, 4} (See text)
- L₅ 2.5mH choke (Repanco)
- T₁ Transformer, 32:1, type D102 (Ardente)
- T₂ Output transformer, 19.4:1, Rex LT700 (Henry's Radio Ltd.)

Semiconductors

- TR₁ MAT101
- TR₂ OC72
- D₁ OA81

Switch

- S_{1, 2, 3} 3-pole 3-way

with any specimens of MAT101 and OA81, it is preferable for a 5k Ω pre-set variable resistor to be used. Ideally a microammeter should be connected in the collector circuit and R₁ adjusted for a reading of 80 μ A. But adjustment can also be made by ear. Too high a current value will produce thin results with no bass. Too low a value will reduce amplification and make it necessary to advance the reaction control excessively to obtain oscillation.

Similar frame aerials to those described can be used, with a 500pF tuning capacitor, but the prototype uses 6in ferrite rods of $\frac{3}{8}$ in diameter, one for each waveband. L₁ consists of 80 turns and L₂ of 20 turns of 32 s.w.g. enamelled wire. The windings are separated by $\frac{1}{4}$ th in. L₃ and L₄ consist of 400 turns and 70 turns respectively of 38 s.w.g.

enamelled wire and are also separated by $\frac{1}{4}$ in. All windings are close wound. These aerials will be found to tune from about 190 to about 465 metres and from 1,100 to over 2,000 metres respectively with a 100pF tuning capacitor. The L/C ratio is excellent and the larger than normal windings provide good pick-up. The rod aerials can, of course, be used with the circuits in Figs. 2 and 3, VC₁ then becoming 100pF instead of 500pF. However, sensitivity is rather less than with the large frame aerials specified.

C₆, R₆ and L₅ are optional components which can be included to provide positive feedback at low frequency, the feedback rising as the frequency falls. Their inclusion provides a really useful degree of extra amplification, particularly of the low notes, and helps to compensate for the lack of a third transistor. R₆ should be about 10 Ω . The right way to connect the secondary of T₂ must be found by experiment. If it is found that there is instability, which will take place at a lowish frequency, R₆ should be increased in value to about 15 or 20 Ω . If there is space, R₆ can be in the form of a

small wirewound potentiometer with a resistance of about 50 Ω . It will then form a useful variable base boost control and will be found particularly handy with weak signals which can be brought up to the point of instability.

The power output of the 2-transistor version is cut to about 18 milliwatts, which will be found quite adequate with a sensitive loud-speaker, and results in a modest power consumption of 6mA from a 9 volt battery.

To sum up, the 3-transistor set in Fig. 2 is highly efficient and very simple and cheap to build. The 4-transistor version has an unusual degree of sensitivity with excellent economy and good output, ample for a large room or for use in the garden. Quality is very good. The 2-transistor set makes a very efficient little receiver which will give more than local station results. But it costs more than the 3-transistor version, unless the Ardente transformer is already to hand, and it is not so sensitive, unless it is used with one of the large frame aerials, whereupon it will give comparable sensitivity.

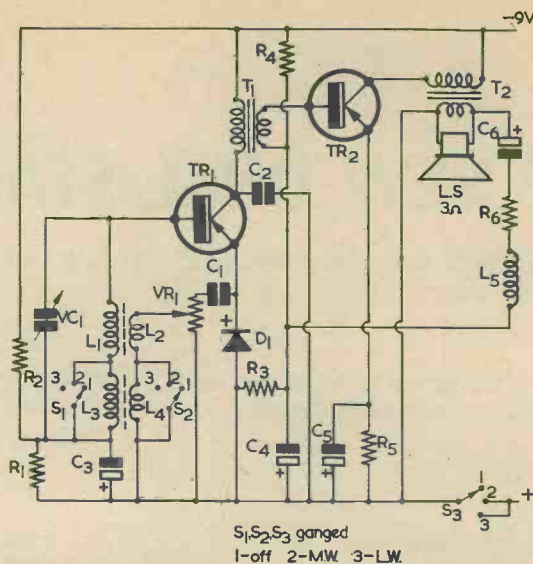


Fig. 4. Using the "Autoflex" circuit in a 2-transistor receiver

REGION 16. R.S.G.B. ORDINARY REGIONAL MEETING

The meeting referred to above will be held at Great Yarmouth on Sunday, 14th June. The venue of the meeting will be the New Power Station on the South Downs. In addition to the business meeting which commences at 2.45 p.m. it is proposed to arrange for:

- An exhibition of home built equipment.
- An exhibition of manufacturers equipment.
- A Raynet stand—type of equipment used.
- A lecture on Astronomy by Major West, B.Sc., F.R.A.S.
- A minor Rally with prizes.
- A buffet tea.

Particulars from: Mr. L. A. Jackson (G3HPR), 8 Arnott Avenue, Gorleston, Great Yarmouth.

THE NEW DUAL-STANDARD TV SETS

By Gordon J. King, Assoc. Brit. I.R.E., M.T.S., M.I.P.R.E.

PART 2

This is the second article in our series on 405–625 line television receivers, and it deals with the different transmission characteristics together with the i.f. responses needed to accommodate them.

Transmission Characteristics

IT WILL BE RECALLED THAT LAST MONTH WE investigated the parameters of the 405 and 625 signals. This month we start by examining the transmission characteristics of the 625 signal and see how they compare with those of the 405 signal.

Fig. 5 shows the 625 signal as it leaves the transmitter. It should be understood that this diagram does not represent response curves or response characteristics in the true sense of the word. The sound and vision carriers alone, of course, have no width at all, and it is only when modulation is applied to the carriers that the signals expand to a maximum as governed by the high order sidebands.

These curves provide, therefore, an idea of how the sound and vision signals expand from their carriers in terms of sidebands when audio and video modulation is applied.

Two distinct features are highlighted in Fig. 5. One is that the sound carrier is 6 Mc/s above the frequency of the vision carrier (this parameter was dealt with last month) and the second is that the lower sidebands of the vision signal are considerably suppressed at the transmitter so that these expand to little more than 1.25 Mc/s, as the diagram shows.

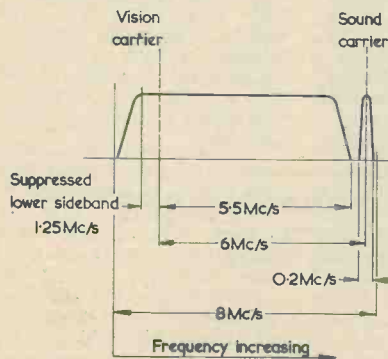


Fig. 5. Transmission characteristics of the 625 line signal

The channel width for the sound and vision modulated signals is 8 Mc/s, and the video sidebands extend to a maximum of about 5.5 Mc/s.

Fig. 6 shows the 405 line signal as it leaves the transmitter. This characteristic is probably well known but, for the sake of completeness and comparison we shall briefly look at it again here.

This time the sound carrier is 3.5 Mc/s below the vision carrier, the higher sidebands of the vision signal are suppressed so that they rise to little more than about 0.75 Mc/s on the high-frequency side of the vision carrier, the video sidebands extend to a maximum of about 3 Mc/s and the overall channel width is 5 Mc/s. At this stage it is worth while to compare the two diagrams so that the differences can be brought to mind.

Last month we saw that the 625 signals are in Great Britain accommodated in the u.h.f. bands (Bands IV and V) and that the 405 signals are accommodated in the v.h.f. bands (Bands I and III). In Eire 625 signals are transmitted in the v.h.f. bands only, and the 8 Mc/s 625 channels are known by letters instead of by numbers. There are three 625 channels in Band I (Channels A, B and C) and six in Band III (Channels D, E, F, G, H and I). Band I in Eire is the same as in Great Britain and carries five 405 signals, but Band III extends to about 220 Mc/s and carries nine 405 signals.

Dual standard sets are thus employed in Eire, but they differ from their British counterparts in that a u.h.f. tuner is not necessary.

Tuners

A British dual standard receiver (note that multi-standard sets are in use over several standards in Europe) accepts and selects the required v.h.f. channel by means of a v.h.f. tuner, and the u.h.f. channel by means of a u.h.f. tuner.

The "standard change" switch in such a receiver selects the appropriate tuner by applying h.t. voltage to the tuner required and removing the supply from the tuner not in use at the time.

It is sometimes dual standard practice to adopt the mixer section of the v.h.f. tuner as an additional i.f.

amplifier stage on the 625 line standard. In this event, the "standard change" switch breaks the h.t. supply to the v.h.f. r.f. amplifier valve and local oscillator while switching the u.h.f. tuner i.f. output to the signal grid circuit of the v.h.f. mixer valve when it is in the "625" position. The diagram in Fig. 7 makes this point clear.

I.F. Signals

The signal from the output of either tuner, therefore, is at the appropriate intermediate frequency. On the 405 line v.h.f. channels, the standard intermediate frequencies of 38.15 Mc/s sound and 34.65 Mc/s vision are used, while on the 625 u.h.f. channels the "standard" intermediate frequencies are 33.5 Mc/s sound and 39.5 Mc/s vision.

A reversal of sound and vision frequencies is thus attained on both standards due to the fact that the local oscillator of each tuner is working *above* the signal frequency (that is, the oscillator works at the i.f. above the carrier frequency). It will be recalled that at carrier frequency the sound frequency relative to the vision frequency is low on 405 lines and high on 625 lines. (See Figs. 5 and 6.)

The "standard" intermediate frequencies were chosen after considerable research into the possibilities of pattern interference arising from harmonics and beat effects.

At this juncture it is as well to have in mind that the sound i.f. is rarely exploited on the 625 standard in the same way as it is on the 405 standard. This is because a technique known as "intercarrier sound" is used on 625 lines. Both the sound and vision signals (at i.f.) are passed through a common amplifier stage and arrive together at the vision detector. Filter circuits are arranged so that the sound i.f. signal is some thirty times below the level of the vision signal at the detector. The two signals then heterodyne or "beat" together, and form a new signal whose frequency is equal to the difference between the sound and vision carrier frequencies. This is, of course, 6 Mc/s.

The 6 Mc/s intercarrier signal is filtered out and amplitude limited before being applied to the f.m. detector in the sound channel. It will be understood that the signal is modulated both at a.m. due to the vision signal and at f.m. due to the sound signal. The a.m. is suppressed by the limiting action while the f.m. is discriminated in the usual manner. We shall consider the intercarrier technique in greater detail later.

It is clear that the response of the i.f. channel must differ considerably to accommodate the two signals. The difference is achieved by a process of switching. The general practice is the employment of a long slider-type switch which extends the length of the chassis with sections positioned at points close to the various circuits which need switching to cater for the two signals. The switch is often mechanically coupled to the v.h.f. tuner, so that when this is set to the "u.h.f." position the switch sections change over to the "625" position. On the v.h.f. channels the switch remains in the "405" position.

It is interesting to note that on some models it is

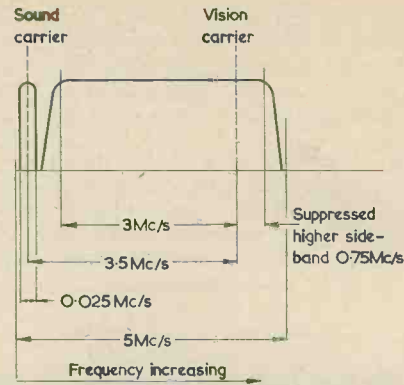


Fig. 6. Transmission characteristics of the 405 line signal. These should be compared with the 625-line characteristics in Fig. 5

possible to arrange the switching so that the circuits can be switched to the 625 condition even when the tuner is set to one of the v.h.f. channels. This, of course, is the usual arrangement on sets designed for use in Eire; but in Great Britain the same arrangement may be required when a set is operated from a coaxial relay system, for with such systems it is not possible to distribute the signals at u.h.f. It is necessary at the aerial station to translate the u.h.f. signals to an unused channel in Band I or Band III and then distribute them in the ordinary way at v.h.f.

It will be understood that the signal losses in coaxial cable rise as the square-root of the frequency increases (approximately). Thus, if a 100 yards of cable has a loss of, say, 10dB at 50 Mc/s, then the loss at 450 Mc/s (9 times the frequency) will be 3 times 10dB, or 30dB. Hence, the distribution loss at u.h.f. would be far too great to handle on a relay system.

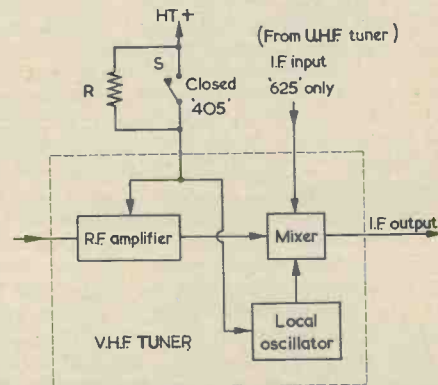


Fig. 7. The "mixer" section of v.h.f. tuners is sometimes used as an extra i.f. amplifier on the 625 standard. On 625 lines switch S opens and mutes the v.h.f. r.f. amplifier and local oscillator, whilst the u.h.f. i.f. signals are fed to the input of the mixer. Resistor R across the switch maintains a very small flow of current to avoid "cathode poisoning" of the r.f. and oscillator valves

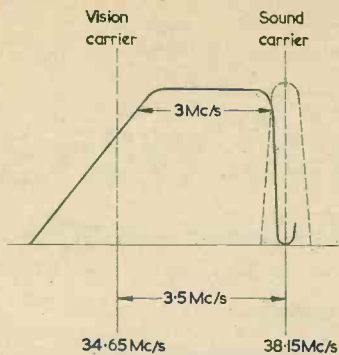


Fig. 8. The vision i.f. channel response characteristics for a 405 signal. Note that rejectors cause the response to dip to a very high value of attenuation at the sound carrier (i.f.) frequency. The broken-line curve shows the response of the sound i.f. channel

This extra high u.h.f. loss is also very important so far as the u.h.f. aerial feeder is concerned. It is essential that good quality, low-loss coaxial cable be used on all u.h.f. aerial installations, for that extra 2 or 3dB of signal can make all the difference so far as picture grain is concerned.

I.F. Stages

Now to get back to the i.f. stages again! Fig. 8 shows the kind of response required in the i.f. channel to cater for the 405 signal. This is the well-known vision i.f. response curve, with the vision carrier falling at the 6dB point on the sloping side of the curve. The reason for this is to compensate for the double modulation power in the sidebands up to 0.75 Mc/s (see Fig. 6). It is not possible, of course, to completely eliminate the upper sidebands of the vision signal at the transmitter. The small amount of sidebands remaining (up to 0.75 Mc/s in the 405 case) is called the "vestigial sideband", just a vestige (or trace) of the upper sidebands remains. Clearly, then, both the upper and lower sidebands of the vision signal appear at the vision detector up to 0.75 Mc/s, while after 0.75 Mc/s only the lower sidebands are present. To avoid over-emphasis of the low video frequencies the vision carrier is put at the 6dB point on the vision response curve.

The tuned circuits are designed and tuned so that the curve has a width of about 3 Mc/s to maintain relatively constant amplification of the video sideband frequencies from low to high. At the sound i.f. the response dips down to a high value of attenuation (60dB or so) to prevent sound-on-vision interference. The sound i.f. channel is tuned to this same frequency, and the response in that section of the receiver is shown by the broken line curve. Other relevant frequencies are also shown on the diagram.

Fig. 9 shows the kind of response required in the i.f. channel to cater for the 625 signal. Here again the vision carrier is arranged to fall on the sloping side of the curve, but this time at the high-frequency

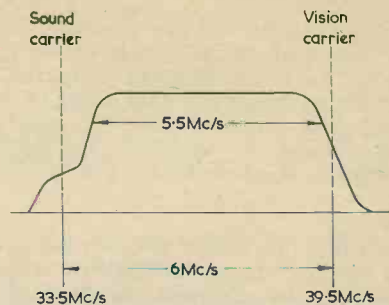


Fig. 9. The vision i.f. response characteristics for a 625 signal. The sound carrier is permitted to pass through the channel at reduced response (about 30dB down) as the diagram shows. The beat of the sound and vision carriers at the vision detector produces the intercarrier signal at 6 Mc/s

end (since the sidebands suppressed on the 625 signal are opposite to those suppressed on the 405 signal). It will be seen that the curve has a width of about 5.5 Mc/s to accommodate the higher order sidebands of the higher definition 625 line transmissions.

A point to note is that the response is maintained even at the sound i.f. Actually, the dip at that frequency is in the order of 30dB to provide the most desirable ratio of sound to vision signal at the vision detector. Too great a sound signal level can produce severe harmonic distortion while too little signal can result in an effect called "intercarrier buzz", about which we shall have more to say later on.

On the 625 standard the 405 line 38.15 Mc/s sound i.f. is not used, and the sound i.f. channel is switched to respond to the 6 Mc/s intercarrier signal.

A British dual standard set, therefore, is designed in such a way that the vision i.f. response characteristics can easily be switched to match those shown in Figs. 8 and 9. Next month we shall see how filter circuits are used to suppress the response for 405 line working, the channel essentially being designed for the 625 signal.

The sound channel sometimes takes the form of the i.f. stages in an A.M./F.M. receiver where series-connected tuned filters and transformers are employed in the grid and anode circuits. By careful design, and since the frequencies are sufficiently far removed from each other, the sound channel is made responsive to the 405 sound i.f. of 38.15 Mc/s and the 625 intercarrier frequency of 6 Mc/s, often without any switching at all; but this is another section of the circuit that will have to be considered in a future article.

(To be continued)

Author's Note

The writer would like to refer to an error which cropped up in Part 1 (May issue) of this series. The Belling and Lee aerial illustrated was referred to as

"two arrays stacked". This is incorrect since the picture shows a broadside array, i.e. aerials side-by-side. "Stacked array" is the term given when aerials are placed one above the other.

Belling and Lee do, of course, produce a stacked broadside array of four aerials. The writer's apologies go to Belling and Lee Limited for this mis-statement.

Another point in the article which should be clarified is the statement "u.h.f. aerials have an inherently wider bandwidth than comparable v.h.f.

aerials." This is true of "practical" aerials, for the bandwidth of an aerial is a function of the diameter-to-length ratio of the elements—the larger this ratio the wider the bandwidth. On u.h.f. aerials of small length this ratio is exceptionally large as also, then, is the bandwidth.

An aerial at u.h.f. with the same length-to-diameter ratio as an aerial at v.h.f. would have a bandwidth equal to that of the latter. The addition of the reflector and directors tends to reduce the bandwidth while sharpening the beamwidth.

RADIO TOPICS . . . by Recorder

I NOTICE, WITH SOME PLEASURE, that the Ministry of Education has recently awarded a grant of £9,000 for further studies on the I.T.A. The I.T.A., I must hasten to add, does not refer to the Independent Television Authority, but to Sir James Pitman's Initial Teaching Alphabet for use in infants' schools.

Many readers will recall that this alphabet has been referred to from time to time in the popular press, and that it consists of 44 symbols, each of which represents one of the individual sounds which appear in the English language. These symbols are, also, very similar to the letters they replace in our normal written alphabet.

The First Hurdle

The great advantage offered by the Pitman alphabet is that it allows children to find a new dimension of expression in which the sounds they utter can be translated directly, and without any further complication, into symbols written on paper. This is not the same as occurs when children first encounter the standard alphabet. "The cat sat on the mat" does not raise any difficulties to the young mind, but things become very much harder when that same young mind has to carry on to words such as "hook" and "hoop". Why, asks the child, should the "oo" in the one word sound different from the "oo" in the other word? When this encounter is followed by that shockingly aberrant group—"tough", "cough", "dough", "bough" and "thorough"—many an infantile brain finds the illogicalities in the different spellings too difficult to be grasped at one step.

What the child wants to do at the very beginning is to investigate the exciting new field of converting

sounds to symbols and back again. But when he discovers that symbols alone are not enough and that he has also to remember a *group* of symbols for almost every word he encounters, the initial hurdle of going straight from speech to paper becomes very much more difficult to overcome than it ought to be. Indeed, some children become so disheartened at the outset that they may pass all the way through life with an almost complete inability to transpose speech to writing and writing to speech.

The beauty of the Pitman approach is that the first hurdle is overcome almost painlessly, because the child does not have to immediately tackle the irregularities and exceptions which make up the written English language.

After having become familiar with the Pitman symbols, the child has next to transfer to the normal alphabet. According to reports, this process of transition is extremely simple. The child who has mastered the Pitman alphabet is surrounded by newspapers, magazines and books, and these all have normal alphabet symbols which are very close to those he has learned already. The result is that he soon finds himself reading these symbols and, later, writing them down. He can attack the normal alphabet symbols with confidence because the mental "block" which they might otherwise produce has been smoothed over by the Initial Training Alphabet.

Investigations in over 200 schools have shown that the new alphabet results in a 300% improvement in reading ability as compared with the more conventional methods of teaching. It is these results which have caused the Ministry of Education to give its blessing to the new alphabet,

together with its grant for £9,000.*

I refer to this brief history of the Pitman alphabet not only because of its own interest but also because it provides a number of intriguing parallels with our own specialised field of radio and electronics.

Starting in Electronics

To take an example, the method adopted in Pitman alphabet teaching bears a very close similarity to the manner in which quite a lot of us started off in electronics.

I feel certain that many established professional engineers managed to pick up an initial semi-practical concept of electronics at a very early age by knocking up simple radios, working from magazine articles or kit designs. They would then be delighted to find that their mysterious assemblies produced music and speech as soon as they were switched on. I can always remember my own pleasure when the first set I ever made, a single-valve battery job with reaction, started to give results as soon as I connected up the batteries. At that time it was practice first and blow the theory! It was only after I became more ambitious and wanted to design my own equipment that the theory became more interesting than it had been hitherto. From that moment, practice and theory advanced hand-in-hand.

We have, thus, an analogy with the Pitman alphabet technique. The newcomer to electronics looks doubtfully at the unfamiliar bits and pieces he has acquired, and privately doubts that he will ever be able to put them together in such a manner that they will actually work. Never-

* Although I cannot help but cynically wonder what salary and overhead costs, compared with £9,000, were incurred by the good Ministry in reaching its decision.

theless, he tries, and the finished job *does* work. So the first hurdle is overcome, and the process gives the newcomer the confidence he needs to delve further into the subject, in just the same manner as the child embarking on reading and writing is given confidence by means of a set of written symbols which similarly work.

Another pertinent point about the Pitman alphabet is that it brings into prominence the use of symbols themselves. In the course of my work I frequently scan the pages of a fairly large number of radio and electronic magazines which are published throughout the world. These come from Western Europe, from North and South America, from Australia and New Zealand, and from the Iron Curtain countries. I take no pride in my linguistic ability, and I must confess that the written text in those magazines which are not printed in English is quite often beyond my powers of immediate translation. But for much of the time this doesn't matter because the text is almost always accompanied by circuit diagrams, and circuit diagrams are the same the whole world over! There are some minor dissimilarities in presentation between countries, admittedly, but these do not cause any serious difficulty. Many Continental circuit diagrams, for example, show the cathode of a valve as a round blob instead of using the shape which we employ in this country. Resistors have a tendency to appear as rectangles; but this, again, is only a minor point. So far as the newer devices are concerned, all countries seem to be in agreement. Everyone for instance, shows a p.n.p. transistor in the same form as we do, with the emitter arrow pointing towards the base, and an n.p.n. transistor with the emitter arrow pointing away from the base. The main discrepancies to watch out for lie in the Continental habit of using a comma to depict the decimal point when showing component values, and of using the abbreviation "nF" (for "nanofarad") for some values of capacitance. (A nanofarad, by the way, is half-way between a microfarad and a picofarad. It equals $0.001\mu\text{F}$, or $1,000\text{pF}$.)

Whilst language may be a bar between countries, circuit diagrams offer a means of instant communication.

Style

A further point is concerned with the use of the written word itself. This applies to ourselves, in particular, because of our necessary

reading of technical articles and technical books.

As readers will know, different authors employ different techniques to put over their subjects. Some writers use a very breezy style, whilst others rely on a completely formal dissertation of the facts. There are many variations on these two extremes, and many graduations between them. Occasionally, one encounters an author who allows a strong personal opinion to obtrude into a technical text, and this is by no means a bad thing if the presentation of his main theme does not suffer as a result.

So far as I, myself, am concerned, I can read with pleasure any technical article or book on a subject in which I am interested regardless of the author's style, provided that he introduces his topics in logical order, does not make the assumption that I know as much about the subject as he does (otherwise, why should I be reading him?), and is accurate.

Sometimes one bumps into an author who has the delightful habit of occasionally inserting a completely unsuspected gag into what is otherwise a conventional and sober text. A typical example occurs in a favourite reference book of mine, *Thermionic Valve Circuits*, written by Emrys Williams (and published by Pitman at 27s. 6d.). To give an idea of Professor Williams's approach we find, at the end of a three-page section dealing quite seriously with flip-flop circuits, the following engaging paragraph.

"The author has not been able to discover which of that happy company of radar pioneers was responsible for the inspired title "Flip-flop". "Flip" suggests the triggering process and "flop" certainly suggests the precipitate descent from an unstable state. Attempts to popularise the (highly logical) names "Flip-flip" and "Flop-flop" for bistable and free-running circuits respectively have met with little success. It seems that there is a level of flippancy which must not be exceeded."

Break-away Design

Illogical as it may sound, the main reason which has prevented British TV design emerging from the rut it has occupied for the last four or five years has been the introduction of 625 lines. Manufacturers' research teams have been so busy with the design of receivers capable of working on the two systems that they haven't had time to introduce new developments which are applicable to any system. Ideas which could, by now, have been incorporated in

405-only sets have had to be held back whilst the more pressing problems of 625 line reception are ironed out.

A welcome sign that this state of affairs is being relegated to the past is evident in the announcement of the new "900" series of television receivers from the Thorn Group (who produce under a large number of trade marks, including H.M.V. and Ferguson). The Thorn "900" chassis embodies refinements which represent quite significant changes from the established designs of recent years.

The first innovation is the introduction of an autotransformer to replace the mains heater dropper. The total voltage for the heater chain in the "900" series is of the order of 150, which means that some 90 volts have to be dropped when operating from 240 volt supplies. At the normal heater current of 0.3 amps, this would represent a dropper resistor dissipation of 27 watts, all of which would take place inside the cabinet. The use of an autotransformer obviates this dissipation, and results in a considerably cooler chassis. The autotransformer employs C-cores, incidentally, as also does the vertical output transformer.

The line output transformer changes from the conventional construction using two U-cores to a pot-core assembly. The high inductance offered by the pot-core, together with a considerable reduction in leakage reactances, results in a simple assembly which can be built into a much smaller space than has previously been the case. A silicon gel impregnant is employed.

Also new is the elimination of the thermionic e.h.t. rectifier. In the "900" chassis, e.h.t. rectification is carried out by three silicon rectifiers in series, each having a p.i.v. of 7kV. This confers three advantages at one step: the thermionic rectifier (a somewhat unreliable component) is obviated; the heater winding it requires on the line output transformer is not needed (thereby further simplifying transformer design); and there is a considerable reduction in warm-up time after switching on before a picture is resolved.

Further features of the design are the use of a single printed circuit deck, instead of the multi-deck assemblies with interconnecting cables which have become so familiar lately, and the introduction of a 2-transistor u.h.f. tuner. The latter has an improved noise performance over the valve version, and is capable of working comfortably in the lower temperatures which appear inside the "900" series cabinet.

Earthing of Consumers' Electrical Installations to Water Pipes

The electrical hazards which may arise from the increasing use of non-metallic water mains and water pipes have been the subject of recent joint discussions between representatives of the Institution of Electrical Engineers and the Institution of Water Engineers, and the Councils of the two Institutions have authorised the issue of the following joint statement.

Efficient earthing is one of the best means of ensuring freedom from fire and shock in a consumer's electrical installation. This earthing is his responsibility but the Electricity Boards will always try to help consumers to ensure that their installations are satisfactorily earthed.

For new installations, the form of electrical earth to be provided, independently of the water system, will be determined on the advice of the Electricity Board concerned. In such installations, the water pipes would not form a part of the electrical earthing system (though they might be bonded to it as a safety precaution) and any change in them from metallic to non-metallic material would not introduce any electrical hazard.

Many existing electrical installations, however, are earthed only to water pipes and if these pipes, whether underground or in the building, are repaired or replaced with non-metallic materials (e.g. plastics or asbestos-cement) the earth connection may be rendered ineffective.

No electrical risk is likely to arise where changes in water mains and water pipes are carried out by the local water supply undertaking, as arrangements exist for liaison between the two supply industries in regard to such changes, and the consumer will be warned by his Electricity Board if the changes are likely to affect his earthing arrangements.

Where a consumer with an existing installation intends to make alterations or repairs to his water supply system which may involve the replacement of any part of the system with non-metallic materials, he should ask his Electricity Board (or other approved Electrical Installation Contractor) to advise whether the earthing of the electrical installation is likely to be adversely affected, and to carry out tests after the changes have been made in order to ensure that the earthing remains satisfactory.

If a builder or plumber carries out for a consumer any such alterations or repairs with non-metallic materials, he should himself advise the Electricity Board unless the consumer has already done so.

Queries. We regret that we are unable to answer queries other than those arising from articles appearing in this magazine nor can we advise on modifications to equipment described. Queries should be submitted in writing.

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Contributions on constructional matters are invited, especially when they describe the building of particular items of equipment. Articles should be written on one side of the sheet only and should preferably be typewritten, diagrams being on separate sheets. Whether handwritten or typewritten, lines should be double-spaced. Diagrams need not be large or perfectly drawn, as our draughtsmen will re-draw in most cases, but all relevant information should be included. Photographs should be clear and accompanied by negatives. Details of topical ideas and techniques are also welcomed and, if the contributor so wishes, will be re-written by our staff into article form. All contributions must be accompanied by a stamped addressed envelope for reply or return, and should bear the sender's name and address. Payment is made for all material published.

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continued on page 789

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6A8G	5/9	12Q7GT	3/6	EBF80	5/6	HABC80	9/3	UABC80	5/-	OA70 3/-
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6AC7	4/9	12SC7	4/9	EB89	6/3	HL2DD	8/6	UBC41	3/3	OA79 3/-
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6AQ5	5/9	12SQ7	8/-	EC70	4/9	HVR2	8/3	UBF80	5/9	OA85 3/-
6AT6	3/9	19AQ5	7/3	EC81	27/6	HVR2A	8/9	UBF89	6/9	OA86 4/-
6AU6	5/3	19H1	6/-	EC92	6/6	KT33C	4/-	UBL21	9/9	OA90 3/-
6AV6	5/6	2D1	11/6	EC92	4/-	KT36	29/-	UC92	6/3	OA91 3/-
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6BH6	5/3	20P3	12/-	ECC82	4/6	KTW62	5/6	UCH21	8/3	OC16W35/-
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6BQ7A	7/6	20P5	12/3	ECC84	5/9	KT66	12/3	UCH81	6/6	OC22 23/6
6BR7	8/3	25A6G	7/6	ECC85	6/3	KT88	28/-	UCL82	7/6	OC23 57/-
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1st choice												
2nd choice												
3rd choice												
4th choice												
5th choice												
6th choice												
7th choice												
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continued from page 787

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continued on page 791

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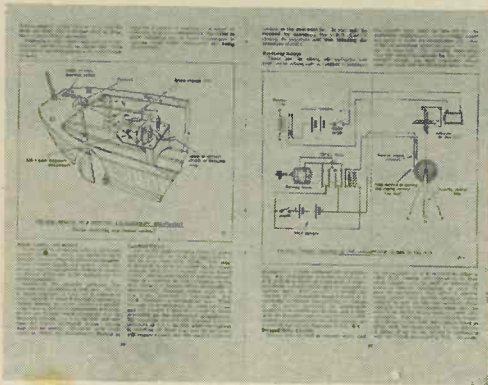
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continued from page 789

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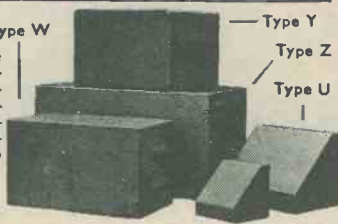
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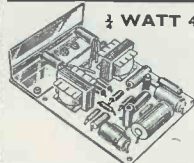
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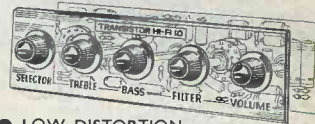
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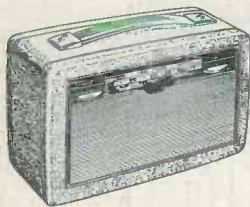
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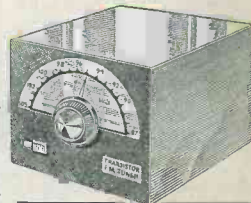
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Complete in every detail
● Pre-built units—Collaro Studio Decks—Portable Cabinets with Speakers. 6 valve designs.

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Scotch Boy 3 1/2" 300-ft L.P. Tape. Complete with spare spool.

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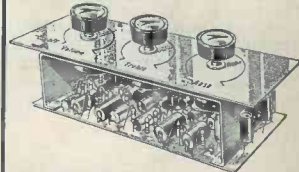
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