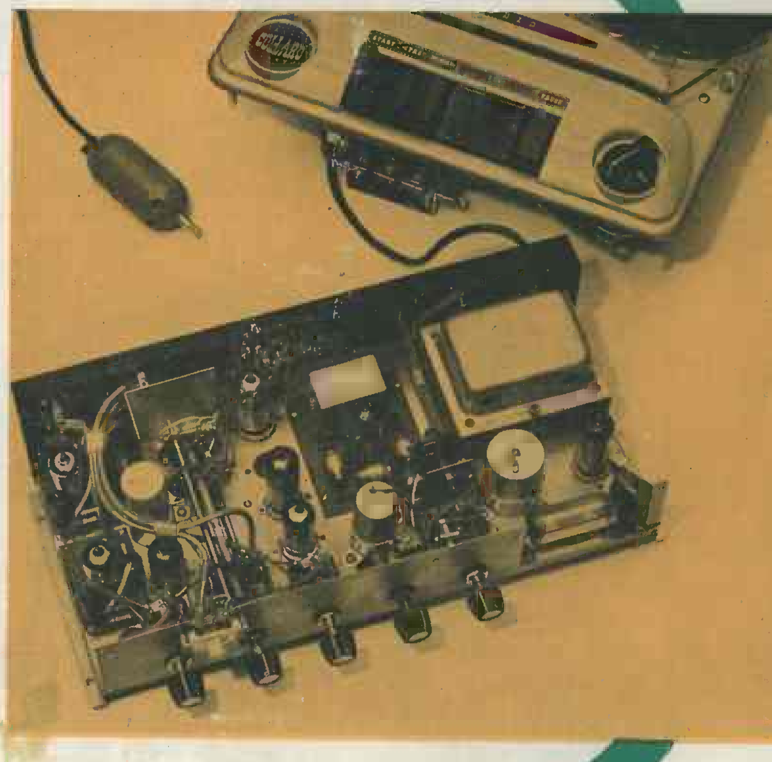
84

THE Radio Constructor

RADIO
TELEVISION
AUDIO
ELECTRONICS

VOLUME 15 NUMBER 2
A DATA PUBLICATION
PRICE TWO SHILLINGS

September 1961



The JR1 Stereo Tape Recorder Unit — design details

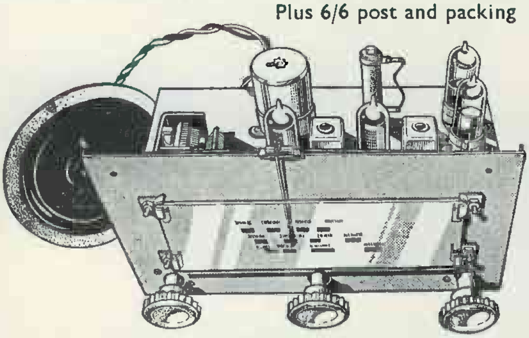
● Pocket Audio Injection Probe ● Unusual 2-Valve Superhet ● Microphone Pre-amplifiers, Attenuators and Mixers ● Transistor Shorted Turns Tester ● Magnetic Guitar Pick-up and Transistorised Tone Control Pre-amplifiers ● The "Finger-Tip Five" Receiver ● Understanding Radio, Pt. 2 ● Resistance Measurement

HARVERSON SURPLUS CO. LTD

2-BAND SUPERHET CHASSIS WITH SPEAKER

ONLY £5.17.6

Plus 6/6 post and packing

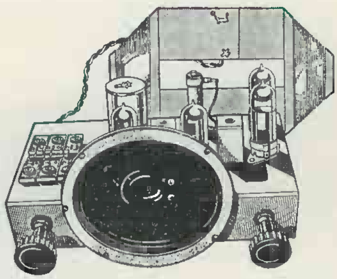


A quality 4 valve AC/DC superhet chassis made by a world famous manufacturer. Long and Medium wave coverage. Fitted with a cord and drum reduction tuning drive and attractive illuminated glass dial (size 6½" x 2½"). Controls: volume on/off, tuning and wave change. The receiver is self-powered, employing a mains dropper and a valve rectifier. Chassis dimensions 6½" x 9" x 5½" high. Supplied complete with a good quality 5" loudspeaker, valves (UCH42, UAF42, UL41, UY41), AC/DC mains input lead, ivory knobs, etc. **Don't hesitate, Order Now! This unbeatable bargain is bound to sell out quickly at only £5.17.6, plus 6/6 post and packing.**

4-STATION PRESET CHASSIS WITH SPEAKER

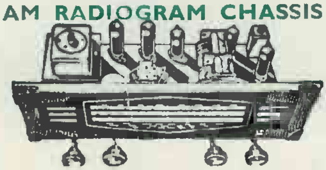
ONLY £4.17.6

Plus 6/6 post and packing



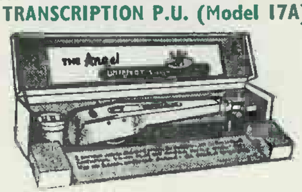
A compact, 4 station preset mains transportable receiver, for operation from AC/DC mains. Two simple controls, volume on/off and 4 position station selector. The latter is set to Light programme (Long wave), Third programme, Home service and Light programme (Medium wave), but may of course be adjusted to alternative selections if required. A frame aerial with throw-out extension is supplied, making this receiver ideal as a general purpose transportable set for the home. A fully smoothed power supply is provided from AC/DC mains input by a mains dropper and a valve rectifier. The good tonal qualities are assisted by the provision of a quality 5" speaker, which is ready-mounted on the chassis (this is easily detachable if alternative positioning is required). Valve line-up: UCH42, UAF42, UL41, UY41. This chassis (size 9" x 6½" x 5½" high) is supplied complete with valves, knobs, mains lead, aerial, etc. It is beautifully made by a famous maker, and is a first-class buy at the rock bottom price of £4.17.6.

AM RADIOGRAM CHASSIS



A chassis of distinction by a famous maker. Covering Long, Med. and Short waves, plus gram position, this chassis (size 15½" x 7" x 6½" high) incorporates the latest circuitry, using fully delayed a.v.c. and negative feedback. Controls: tone, volume on/off, wave-change (L.M.S. and gram), tuning. Tapped input 200-250V a.c. only. An attractive brown and gold illuminated dial with matching knobs make this one of the most handsome, in addition to being one of the best performing, chassis yet offered. Complete with valves (ECH81, EF89, EBC81, EL84, EZ81), knobs, output transformer, leads, etc. OUR PRICE ONLY plus 4/6 post & packing **£9.19.6**

THE WORLD FAMOUS E.M.I. ANGEL TRANSCRIPTION P.U. (Model 17A)

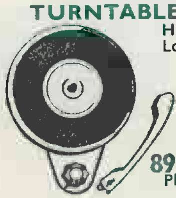


A Pick-up for the connoisseur originally priced at £17.10.0. The last remaining few offered at **£4.10.0** Plus P. & P. 5/–

OUTPUT STAGE AND SPEAKER FOR FM TUNER UNIT

All parts including speaker, ECL82 valve and simple instructions to make two-stage output unit, for converting f.m. tuner into f.m. receiver. **ONLY 45/-** plus 4/6 P. & P.

E.M.I. 4-SPEED RECORD TURNTABLE AND PICK-UP



Heavy 8¾" metal turntable. Low flutter performance, 200/250V shaded motor with tap at 80V for amplifier valve filament if required. Turnover LP/78 head.

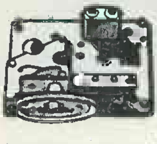
89/6 COMPLETE Plus 4/6 P. & P.

SUPER STEREO KIT MARK II

A kit of ready-built units only requiring interconnection. Comprising two midget 3W amplifiers, push-button switch, transformer, control unit (bass, treble and vol.), power pack, two speakers, indicator light, valves (ECL82, EZ80 range), and comprehensive instructions.

£3.9.6 plus 6/6 P. & P.

FM TUNER HEAD

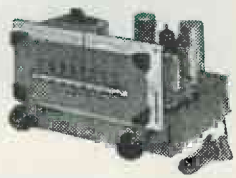


A permeability tuned tuner head by a famous maker, supplied without valve (ECC85).

18/6 plus 1/9 P. & P.

Valve 8/6 extra

HARVERSON'S FM TUNER KIT



At last a quality FM Tuner Kit at a price you can afford. Just look at these fine features, which are usually associated with equipment at twice the price!

★ FM tuning head by famous maker. ★ Guaranteed non-drift. ★ Permeability tuning. ★ Frequency coverage 88–100 Mc/s. ★ OAB1 balanced diode output. ★ Two i.f. stages and discriminator. ★ Attractive maroon and gold glass dial (7" x 3"). ★ Self powered, using a good quality mains transformer and valve rectifier. ★ Valves used ECC85, two EF80s and EZ80 (rectifier). ★ Fully drilled chassis. ★ Everything supplied, down to the last nut and bolt. ★ Size of completed tuner 8" x 6" x 5½". ★ All parts sold separately.

£4.19.6 Plus 8/6 P.P. & Ins.

Circuit diagram and illustrations, 1/6 post free.

WESTERN ELECTRIC TRANSISTOR SPEAKER

Size 2½" x 1⅝" deep. 3 ohm impedance.

11/9 P. & P. 1/6

83 High St. Merton SW19

CHErrywood 3985/6

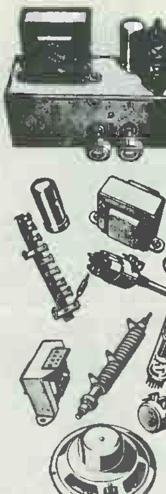
Please turn page for valve Bargains

Introducing . .

HARVERSON'S

39/6

Monaural Amplifier Kit



In response to numerous requests from delighted purchasers of our "SUPER STEREO KIT" we have produced a "MONAURAL AMPLIFIER" on similar lines.

★ A UCL82 valve provides a triode amplifying stage, and a pentode output stage (3 watts), enabling good amplification and sparkling reproduction to be combined with physical compactness (amplifier size 7" x 3¼" x 6½" high).

★ Modern circuitry design, good quality o.p. transformer (to match 3Ω) keep hum and distortion to a low level.

★ The controls, volume on/off and tone, are complete with attractive cream and gold knobs.

★ The amplifier has a built-in fully smoothed power supply, using a good quality mains transformer (a.c. mains only) and metal rectifier.

★ All you need is supplied including easy to follow instructions which guarantee good results for the beginner and expert. All components, leads, chassis, valve, knobs, etc., are first grade items by prominent manufacturers.

OUR PRICE 39/6
Plus 4/6 Post and Packing

5" LOUDSPEAKER TO SUIT, 14/6 EXTRA

CHILD'S NURSERY LAMP

A child's night light of unusual design. Contemporary styled lampholder of robust construction finished in either red or yellow. Entirely safe (bulb socket shielded from "prying fingers",) complete with flex and a push-button switch. 200/250 volts a.c. only. The low-consumption bulb element is made in the shape of either flowers or angel fish, and when switched on, glows in fluorescent colours (the flowers pink with green leaves, or the fish green with purple weed). Made by a famous manufacturer and originally priced at 29/6.

Please state lampholder colour preference and whether fish or flower element is required.

OUR BARGAIN PRICE ONLY 10/9
plus 9d. post and packing

SUPERHET CHASSIS — LESS VALVES & CABINET

Modern AC/DC chassis with printed circuit and ferrite rod aerial. Although not completely built, the main components are mounted. L. & M. wave coverage, 4 valves (UBF89, UCL83, UCH81, UY85). Everything supplied except valves and cabinet. With simple instructions.

£3.6.6 Plus 3/6 P. & P.

TRANSISTOR AMPLIFIER KIT

A complete kit of parts to build a compact 4-transistor amplifier, with tone and volume controls. Two GT3 driver transistors, transformer coupled. Output 1 watt from matched pair GT15. Complete with output transformer to matched 3 ohm speaker, transistors and attractive dial plate.

OUR PRICE 59/6 P. & P. 4/6

CONDENSER/RESISTOR PARCEL

50 mixed pF Condensers and 50 mixed Resistors. An assortment of useful values. All popular sizes—all new—a must for the serviceman and constructor.

P. & P. 1/- **ONLY 10/-**

AT ½ PRICE WHILE THEY LAST!

GOLDRING MU-METAL CASED CARTRIDGES

Sapphire styli. Brand new and boxed

OUR PRICE £2.15.0 *Plus P.P. 1/6 inc. ins.*

BARGAIN MONTH FOR TRANSISTORS

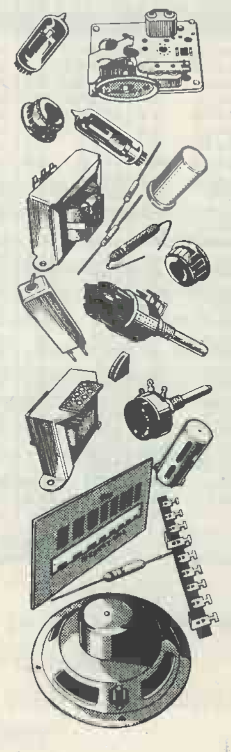
POWER			
OC36	10/-	GET102	7/6
OC44	9/-	XA103	8/6
OC45	8/-	PXA101	9/6
OC71	5/-	PXA102	9/6
OC75	6/6	**AMERICAN**	
OC76	6/6	2N388	6/6
OC78	6/6	2N1485	6/6
OC78D	6/6	2S712	7/6
GET15	9/-	**DIODE**	
GET15 (matched pair)	16/6	OA81	3/-

Postage 6d. each

THE HARVERSON COMPLETE FM/VHF RECEIVER KIT £6.19.6

At last! A complete FM Receiver in kit form.

Specially designed with the home constructor in mind, this kit enables the construction of a completely self-contained VHF receiver at a fraction of the normal cost of comparable equipment. This is basically a quality self-powered FM tuner plus 2 audio amplifier stages and output transformer & speaker.



★ FM tuning head by famous maker
★ Guaranteed non-drift
★ Permeability tuning
★ Frequency coverage 88–100 Mc/s
★ OA81 balanced diode output
★ Two i.f. stages and discriminator
★ Self-powered, using a good quality mains transformer and valve rectifier
★ Valves used: ECC85, two EF80s and EZ80 (rectifier)
★ Fully drilled chassis
★ A good quality speaker
★ Well designed output transformer
★ Attractive maroon and gold glass dial
★ Two output stages (using ECL82 valve)
★ Everything supplied, down to the last nut and bolt
★ Compact size
★ All parts sold separately

OUR PRICE £6.19.6 Plus 4/6 P. & P.

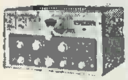
THE WORLD-FAMOUS Heathkit RANGE OF EQUIPMENT

For the Discerning who require
THE BEST PERFORMANCE AT MINIMUM PRICE

HI-FI FM TUNER

This model is available as two units which, for your convenience, are sold separately. They comprise an R.F. Tuning Unit, Model FMT-4U (**£3.5.0** including purchase tax) with I.F. output of 10.7 Mc/s, and an Amplifier Unit complete with attractively styled cabinet, also power supply and valves. Model FMA-4U (**£11.11.0**) making a total cost for the equipment of **£14.16.0**

AMATEUR TRANSMITTER Model DX-100U



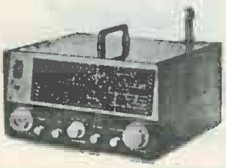
This is the most popular Amateur transmitter in the world and requires no introduction to "Hams" the world over. Covers all bands from 160-10 metres. Self-contained, including power supply, Modulator and V.F.O. 150 W. D.C. input. **£81.10,0**

4-WAVEBAND TRANSISTORISED PORTABLE RECEIVER, Model RSW-1

This possesses Medium, Trawler and two Short-wave bands and is mid-way between the domestic broadcasting and professional general communications receiver. Ideal and inexpensive for those who wish to listen to world broadcasts, shipping and aviation communications, etc. It is not the set to buy if you wish only to enjoy domestic broadcasting. In a handsome solid leather case, it has retractable whip aerial and socket for car radio use.

£22.10.6

THE "MOHICAN" GENERAL COVERAGE RECEIVER Model GC-1U



In the forefront of design with 4 piezo-electric transfilters, variable tuned B.F.O. and Zener diode stabiliser, this is an excellent fully transistorised portable or fixed station receiver for both "Ham" and Short wave listeners. Other features include printed circuit boards, telescopic whip antenna, tuning meter and large slide-rule dial of approximately 70". Uses 10 transistors. **£38.15.0**

MONEY-SAVING "PACKAGED DEALS"

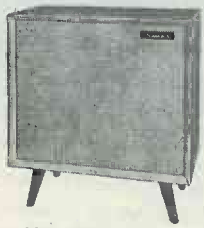
For the benefit of customers wishing to purchase several units of their Hi-Fi equipment at the same time, useful price reductions are offered. Such "Packaged Deals" may include RECORD PLAYERS and TAPE DECKS of your personal preference, not necessarily featured in our catalogue. Two money-saving examples are given below and quotations for your own special requirements will gladly be sent on request.

GL-58 Transcription Unit	£20.12.2	TA-IM	£18. 2.6
S-33 Stereo Amp.	£12. 8.6	Collaro "STUDIO"	£17.10.0
Twin SSU-1 Speakers (Bookcase Type)	£21.15.0	USC-1	£18.18.6
		MA-12	£10.19.6
	£54.15.8		£65.10.6
	Packaged £51.10.0		**Packaged £59.10.0**

PRICE OF TAPE DECK PURCHASES WITH AMPLIFIERS

	Separate	*Together*
TA-IM with Collaro **"STUDIO"**	**£35.12.6**	**£30.10.0**
TA-IS with Collaro **"STUDIO"**	**£40.16.0**	**£35.14.0**
TA-IM with **TRUVOX** Mk.6	**£54.17.6**	**£48. 5.0**
TA-IS with **TRUVOX** Mk. 6	**£60. 1.0**	**£53. 7.0**

All prices include free delivery U.K.
Deferred terms available over £10.



THE "COTSWOLD"

THE "COTSWOLD". This is an acoustically designed enclosure 26" x 23" x 15⅛" 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. Delivered complete with speakers, cross-over unit, level control, Tygan grille cloth, etc. All parts pre-cut and drilled for ease of assembly and left "in the white" for finish to personal taste. **£21.19.0**

HI-FI EQUIPMENT CABINETS

The "GLOUCESTER" (open)

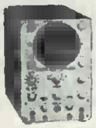
You have four different equipment cabinets designed to meet the wide variety of tastes and requirements. There is the 'CHEPSTOW', for those who have minimum floor space; the 'MALVERN' in contemporary design for the Tape and Gram. enthusiast, and the 'GLOUCESTER' Mk. I and II for those with traditional tastes. All parts pre-cut and drilled for ease of assembly and left "in the white" for finish to personal taste. Send for details of whole range. Prices from **£11.5.6** to **£17.18.6.**

Available direct from **DAYSTROM LTD** DEPT. RC9 GLOUCESTER

Easily-built Equipment Heathkit of excellent quality

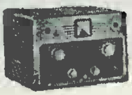
AT MUCH LOWER COST


TA-1M

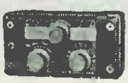

O-12U

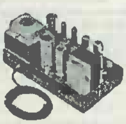

DC-1U


S-33


DX-40U


AG-9U


UJR-1


MA-12

TAPE RECORDING/REPLAY AMPLIFIERS, Models TA-1M and TA-1S. Available both monophonic (TA-1M) and stereophonic (TA-1S) and the former can be modified later to stereo with modification kit TA-1C. Special features include bias level control, thermometer type recording level indicators, press-button control. Housed in attractive metal case. TA-1M £18.2.6 TA-1S £23.6.0

GRID DIP METER, Model GD-1U. A very handy instrument for the lab., the "Ham" of Service Engineers. Complete set of plug-in coils provided covering 1.8 Mc/s to 250 Mc/s. Additional plug-in coils at 15/–. 500 micro-amp panel meter used. £10.9.6

TRANSISTORISED version of above, model XGD-1, 1.75 Mc/s to 45 Mc/s £10.8.6

5" OSCILLOSCOPE: O-12U. "Y" sensitivity 10mV/cm, 3 c/s to over 5 Mc/s. Rise time, 0.08 μsecs or less. Sweep, 10 c/s to 500 kc/s. Electronically stabilised. £36.10.0

2¾" PORTABLE SERVICE OSCILLOSCOPE: OS-1. Ideal instrument for service and portable use. Size 5" x 8" x 14". Wt. 10½lb. £19.10.0

DECADE CAPACITANCE BOX: DC 1U. Provides capacity values from 100 mmf to 0.111 mfd in 100 mmf steps. Ideal for experimental development and design work. £6.5.6

VALVE VOLTMETER: V-7A. The world's largest-selling VVM. Measures volts to 1,500 (DC & RMS) and 4,000 pk. to pk.; resistance 0.1Ω to 1,000MΩ DC. D.C. input inpedance 11 Megohms. £13.0.0

HI-FI STEREO 6 WATT AMPLIFIER: S-33. Low-priced but high quality; less than 0.3% distn. at 2½ watts per channel. £12.8.6

HI-FI STEREO 16 WATT AMPLIFIER: S-88. Superb reproduction for the man who wants the best in Hi-Fi. Only 0.1% distortion at 6 W/chnl. Many special features. £26.12.6

AMATEUR TRANSMITTER: DX-40U. 75W CW; 60W pk. c/c phone; 40W into Aerial. £32.10.0

HI-FI SPEAKER SYSTEM: SSU-1. Ideal twin speaker/ducted-reflex cabinet for stereo/mono in average room (left "in the white"). Legs £1.1.0 extra. £10.17.6

AUDIO GENERATOR: AG-9U. 10 volts, 10 c/s to 100 kc/s pure sine-wave. Switch-selected frequency and attenuator. £19.19.6

JUNIOR TRANSISTOR RADIO: UJR-1. Youngsters are not excluded from our kit programme. This special single transistor set is an excellent introduction to radio and an instructive present. £2.16.6

TRANSISTOR PORTABLE RADIO UXR-1 In elegant solid hide case, with golden relief. Six transistors, dual-wave, fine reproduction, very easy to build. £14.18.6

SINGLE CHANNEL 12 WATT HI-FI AMPLIFIER: MA-12. Ideal for stereo conversions, etc. Generous auxiliary power provided. £10.19.6

COLLARO "STUDIO" TAPE DECK. This extremely attractive and compact 3-speed monaural tape deck features digital counter, pause control and piano-key switches. £17.10.0

(Following models not illustrated)

MULTIMETER, Model MM-1U. Sensitivity 20,000 ohms per volt D.C. .5000 ohms A.C. Ranges 0-1.5, 5, 15, 50, 150, 500 and 1500V. AC and DC. Current 0-150 micro-amps to 0-15 amps in 5 ranges. Resistance ranges RX1(15 ohm centre scale) RX100 and RX10,000. 4½" 50 micro-amp meter. £11.18.6

CAPACITANCE/RESISTANCE BRIDGE: C-3U. Measures capacity 10pF to 1,000μF. Resistance 100Ω to 5MΩ; Pwr. factor. £8.6.6

VARIABLE FREQUENCY OSCILLATOR: VF-1U. 10V output; covers 10 to 160 metres. £11.2.0

AUDIO WATTMETER: AW-1U. Up to 25W continuous, 50W intermittent. £14.14.0

AUDIO VALVE-MILLIVOLTMETER: AV-3U. 1mV to 300V AC. 10 c/s to 400 kc/s. £13.18.6

ELECTRONIC SWITCH: S-3U. This extremely useful device extends your single-beam "scope" for double-beam uses. £10.15.6

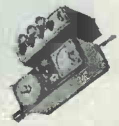
DIRECT READING CAPACITANCE METER: CM-1U. Full-scale ranges of 0-100 mmf, 1,000 mmf, 0.01 mfd and 0.1 mfd. £14.15.0

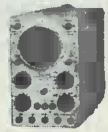
AUDIO SINE-SQUARE WAVE GENERATOR. Model AO-IU. Inexpensive generator covering 20 c/s to 150 kc/s and square waves to 50 kc/s in four ranges. Maximum output 10V., distortion less than 1 per cent. £12.18.6

R.F. SIGNAL GENERATOR, Model RF-IU. Up to 100 Mc/s fundamental and 200 Mc/s on harmonics and up to 100mV output on all bands. £11.18.0

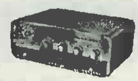
GOLDRING-LENCO TRANSCRIPTION RECORD PLAYER, Model GL-58. This four-Speed Unit is offered for those who want a domestic unit which is of transcription quality. Fitted with G60 pick-up arm it has infinitely variable speed adjustment between 33⅓ and 80 r.p.m. as well as fixed speed of 16 r.p.m. Balanced turntable (3½ lb). Unique p/u lowering device. £20.12.2

All prices include free delivery in U.K. Deferred terms available on orders above £10

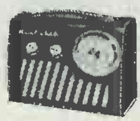

GD-1U and XGD-1

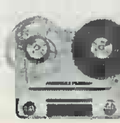

OS-1


V-7A


S-88


SSU-1


UXR-1


"STUDIO"

★ **SEND THIS COUPON NOW FOR FURTHER INFORMATION**

(Please write in BLOCK CAPITALS)

NAME ....

ADDRESS ....

....

Without obligation please send me (Tick here)

BRITISH HEATHKIT CATALOGUE ....

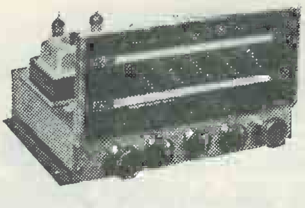
FULL DETAILS OF MODEL(S) ....

DAYSTROM LTD DEPT. RC9 GLOUCESTER . ENGLAND

A member of the Daystrom Group, manufacturers of the

WORLD'S LARGEST-SELLING ELECTRONIC KITS

ARMSTRONG AF 208 AM/FM RADIOGRAM CHASSIS



★ Full VHF Band (87–108 Mc/s,) and Medium Band, 187–570M. ★ 7 Valves ★ 5 Watts Output ★ 15dB Negative Feedback ★ Separate wide range Bass and Treble Controls ★ 2 Compensated Pick-up Inputs ★ Frequency Response 30–22,000 c.p.s. ★2dB ★ Tape Record and Playback Facilities ★ Continental Reception of Good Programme Value ★ For 3, 7½ and 15 ohm speakers. Send S.A.E. for leaflet.

Price **22 Guineas** Carr. Free

LATEST "E.M.I." 4 SPEED SINGLE RECORD PLAYER

Acos 73 Hi-Fi Pick-up for LP, and/or 78, 7", 10" and 12" records. Silent motor, heavy turntable, auto stop.

Special offer **£6. 5. 0** post free
Stereo/Monaural £6.19.6

BUILD THIS REPRODUCER BARGAIN

SPECIAL SINGLE PLAYER KIT

B.S.R. TU9 4-speed Gram Pick-up Unit	£4.5.0
Handsome portable case 13" x 11" x 6½"	£2.5.0
Ready-built 3-watt, printed circuit, amplifier with two valves and speaker	£3.12.6

or **£9. 9. 0** complete kit, post free

I.F. TRANSFORMERS 7/6 pair
465 kc/s Slug Tuning Miniature Can. 1⅜" x ⅞" x ⅞". High Q and good band width. By Pye Radio. Data sheet supplied.

New boxed VALVES 90-day Guarantee

1R5	7/6	6K8G	7/6	EA50	1/6	EZ80	7/6
1S5	7/6	6L6G	10/6	EABC80	8/6	E1148	1/6
1T4	6/–	6N7M	6/6	EB91	6/–	HABC80	12/6
2X2	3/6	6Q7G	8/6	EBC33	8/6	HVR2A	6/6
3S4	7/6	6SA7	6/–	EBC41	8/6	MU14	9/–
3V4	7/6	6SJ7M	6/6	EBF80	10/–	P61	3/6
5U4	7/6	6SN7	6/6	ECC84	9/6	PCC84	9/6
5Y3	7/6	6V6G	6/6	ECF80	9/6	PCF80	9/6
5Z4	9/6	6X4	7/6	ECH42	10/6	PCL82	11/6
6AM6	5/–	6X5	6/6	ECL80	10/6	PEN25	6/6
6B8	5/–	12A6	7/6	ECL82	10/6	PL81	12/6
6BE6	7/6	12AT7	8/–	EF39	5/6	PL82	10/6
6BH6	9/6	12AU7	8/–	EF41	9/6	PY80	7/6
6BW6	9/6	12AX7	8/–	EF50	5/6	PY81	9/6
6D6	6/–	12BE6	8/6	EF80	8/–	PY82	7/6
6F6	7/6	12K7	6/6	EF86	12/6	SP61	3/6
6H6	3/6	12Q7	6/6	EF92	5/6	UBC41	9/6
6J5	5/6	35L6	9/6	EL32	5/6	UCH42	9/6
6J6	5/6	35Z4	7/6	EL41	9/6	UF41	9/6
6J7G	6/6	80	9/6	EL84	8/6	UL41	9/6
6K6GT	6/6	807	5/6	EY51	9/6	UY41	8/–
6K7G	5/–	954	1/6	EZ40	7/6	U22	8/–

DK96, DF96, DAF96, DL96, 8/6 each or 30/– set

NEW ELECTROLYTICS FAMOUS MAKES

TUBULAR		TUBULAR		CAN TYPES	
1/350v.	2/–	50/350v.	5/6	16/450v.	5/–
2/350v.	2/3	100/25v.	3/–	32/350v.	4/–
4/450v.	2/3	250/25v.	3/–	100/270v.	5/6
8/450v.	2/3	500/12v.	3/–	2,500/3v.	4/–
8/500v.	2/9	8+8/450v.	3/6	5,000/6v.	5/–
16/450v.	3/–	8+8/500v.	5/–	32+32/350v.	5/–
16/500v.	4/–	8+16/450v.	3/9	32+32/450v.	6/–
32/450v.	3/9	8+16/500v.	5/6	32+32+32/350v.	7/–
25/25v.	1/9	16+16/450v.	4/3	50+50/350v.	7/–
50/25v.	2/–	16+16/500v.	6/–	64+120/350v.	11/6
50/50v.	2/–	32+32/350v.	4/6	100+200/275v.	12/6

C.R.T. BOOSTER TRANSFORMERS

For Cathode Ray Tubes having heater cathode short circuit and for C.R. Tubes with falling emission, full instructions supplied.

TYPE A. LOW LEAKAGE WINDINGS. OPTIONAL 25% and 50% BOOST ON SECONDARY: 2 V. OR 4 V. OR 6.3 V. OR 10.3 V. OR 13.3 V. WITH MAINS PRIMARIES. 12/6.

OUR LATEST SUPERIOR PRODUCT. MAINS INPUT TYPE A2. HIGH QUALITY LOW CAPACITY 10–15 pF. OPTIONAL BOOST 25%, 50%, 75%. 16/6 each.

TYPE B. MAINS INPUT. LOW CAPACITY. MULTI OUTPUT 2, 4, 6.3, 10 and 13 V. BOOST 25% AND 50%. THIS TRANSFORMER IS SUITABLE FOR ALL TV TUBES. 21/– each.

MAINS TRANSFORMERS 200/250 AC

STANDARD 250–0–250, 80 mA., 6.3 v. tapped 4 v. 4 a., Rectifier 6.3 v. 1 a. tapped 5 v. 2 a. and 4 v. 2 a.	22/6
Ditto 350–0–350	22/6
MINIATURE, 200 v. 20 mA., 6.3 v. 1 a.	10/6
MIDGET, 220 v. 45 mA., 6.3 v. 2 a. ...	15/6
SMALL, 220–0–220 v. 50 mA., 6.3 v. 2 a.	17/6
STANDARD, 250–0–250 65 mA., 6.3 v. 3.5 a.	17/6
HEATER TRANS., 6.3 v. 1½ a. ...	7/6
3 a.	10/6
Ditto 1.4, 2, 3, 4, 5, 6.3 v. 1½ a.	8/6
MULLARD "510" OSRAM "912", 300–0–300, 120 mA, 6.3 v. 4 a. c.t., 6.3 v. 2 a. tapped 5 v.	38/6
GENERAL PURPOSE LOW VOLTAGE. Outputs 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 24 and 30 v. at 2 a.	22/6
AUTO. TRANS. 150 w., 0, 10, 120, 200, 230, 250 v.	22/6
AUTO. TRANS. 500 w., 0, 115, 200, 230, 250 v.	82/6

O.P. TRANSFORMERS. Heavy duty 50 mA, 4/6. Miniature 3V4, etc., 4/6. Small, pentode, 4/6. Multi-ratio push-pull, 7/6. Multi-ratio push-pull 10 w., 15/6. Goodmans heavy duty 10/20 w. 6K push-pull, 30/–.

L.F. CHOKES 15/10 H. 60/65 mA, 5/–; 10 H. 85 mA, 10/6; 10 H. 120 mA, 12/6; 10 H. 150 mA, 14/–.

TELEVISION REPLACEMENTS
Line Output Transformers
from 45/- each, NEW Stock
and other timebase components
Most makes available. S.A.E. with all enquiries

FULL WAVE BRIDGE SELENIUM RECTIFIERS. 2, 6 or 12 v. 1½ a., 8/9; 2 a., 11/3; 4 a., 17/6. Free charger circuit.

CHARGER TRANSFORMERS. Tapped input 200/250 v. for charging at 2, 6 or 12 v. 1½ a., 15/6; 2 a., 17/6; 4 a., 22/6.

4 AMP. CAR BATTERY CHARGER with amp. meter Leads, Fuse Case, etc., for 6 v. or 12 v., 69/6

BOOKS

Valve and TV Tube Equivalents	9/6
TV Fault Finding	5/–
Quality Amplifiers	4/6
Radio Valve Guide. Books 1, 2, 3 or 4	each 5/–
Transistor Superhet Receivers	7/6

CRYSTAL MIKE INSERT by Acos 8/6
Precision engineered. Size only 1⅛" dia. x ⅛"

ACOS CRYSTAL MIKE 40 ... ... 25/–

BAKER SELHURST LOUDSPEAKERS

12in. Baker 15w. Stalwart, 3 or 15 ohms 90/–

12in. Baker ditto, foam suspension, 15 ohms ... £6

12in. Baker Ultra Twelve, 20 c.p.s. to 25 kc/s £17.10.0

15in. Auditorium, 35 w., £15

LOUDSPEAKERS P.M. 3 OHM. 5in. Rola, 17/6; 7in. x 4in., 18/6; 4in. Hi-Fi Tweeter, 25/–; 8in. Plessey, 19/6; 6½in. Goodmans, 18/6; 10in. R.A., 30/–; 12in. Plessey, 30/–; 10in. x 6in. R.A., 27/6; 12in. Baker 15 w. 3 ohm or 15 ohm models, 90/–; Stentorian HF1012 10in., 95/–; HF1016, £8.

CRYSTAL DIODES. G.E.C., 2/–; GEX34, 4/–; OA81, 3/–.

40 CIRCUITS FOR GERMANIUM DIODES, 3/–.

H.R. HEADPHONES, 4,000 ohms, brand new, 15/– pair. Low resistance phones, BA5, 7/6 pair.

SWITCH CLEANER FLUID, squirt spout, 4/3 tin.

TWIN GANG CONDENSERS. Miniature transistor gang 208 and 176 pF, 10/6 each; 365 pF, miniature, 1⅜in. x 1½in. x 1⅜in., 10/–; 500 pF standard with trimmers, 9/–; midget, 7/6; midget with trimmers, 9/–.

SHORT WAVE. Single 50 pF, 75 pF, 100 pF, 160 pF, 5/6 each.

TUNING AND REACTION CONDENSERS. 100 pF, 300 pF, 500 pF, 3/6 each, solid dielectric.

CONDENSERS. 0.001 mfd. 7kV T.C.C., 5/6; ditto 20 kV., 9/6; 0.1 mfd. 7 kV., 9/6; 100 pF to 500 pF Micas, 6d.; Tubular 500 v. 0.001 to 0.05, 9d.; 0.1, 1/–; 0.25, 1/6; 0.1/350 v., 9d.; 0.5/500 v., 1/9; 0.01/2,000 v., 1/9; 0.1/2,000 v., 3/6.

CERAMIC CONDENSERS. 500 v. 0.3 pF to 0.01 mfd., 9d.

SILVER MICA. 10% 5 pF to 500 pF, 1/–; 600 pF to 3,000 pF, 1/3; close tolerance (plus or minus 1 pF), 1.5 pF to 47 pF, 1/6; ditto 1% 50 pF to 815 pF, 1/9; 1,000 pF to 5,000 pF, 2/–.

465 K/s. SIGNAL GENERATOR. Total cost 15/–. Uses B.F.O. Unit ZA 30058 ready made. **POCKET SIZE** 2½in. x 4½in. x 1in. Slight modifications required, full instructions supplied. Battery 7/6 extra 69 v. + 1½ v. Details S.A.E.

WAVECHANGE SWITCHES

2 p. 2-way, 3 p. 2-way, short spindle	2/6
6 p. 4-way 2 wafer, long spindle	6/6
2 p. 6-way, 4 p. 2-way, 4 p. 3-way, long spindle	3/6
3 p. 4-way, 1 p. 2-way, long spindle	3/6

Wavechange **"MAKITS".** Wafers available: 1 p. 12 wafer, 2 p. 6 wafer, 3 p. 4 wafer, 4 p. 3 wafer, 6 p. 2 wafer. 1 wafer, 8/6; 2 wafer, 12/6; 3 wafer, 16/–. Additional wafers up to 14, 3/6 each extra.

TOGGLE SWITCHES, s.p., 2/–; d.p., 3/6; d.p.d.t. 4/–.

JASON F.M. TUNER COIL SET, 29/–. H.F. coil, aerial coil, oscillator coil, two i.f. transformers 10.7 Mc/s., detector transformer and heater choke. Circuit and component book using four 6AM6, 2/6. Complete Jason FMT1 kit, Jason chassis with calibrated dial, components and 4 valves, £6.5.0.

VALVEHOLDERS. Pax. int. oct., 4d. EA50, 6d. B12A, CRT, 1/3. Eng. and Amer. 4, 5, 6, and 7 pin, 1/–. **MOULDED MAZDA** and int. Oct., 6d.; B7G, B8A, B8G, B9A, 9d. B7G with can, 1/6. B9A with can, 1/9. Ceramic, EF50, B7G, B9A, Int. Oct., 1/–. B7G, B9A cans, 1/– each.

RADIO COMPONENT

Our written guarantee with every purchase. Buses 133 or 68 pass door. S.R. Stn. Selhu

VOLUME CONTROLS
Long spindles. Midget 5K ohms to 2 Meg.
No. sw. 3/- D.P. Sw 4/6
Linear or Log Tracks.

80 ohm CABLE Coax
Semi-air spaced ¼in. Stranded core, 6d. yd. 40 yds. 17/6; 60 yds. 25/-
Fringe Quality, Air Spaced 1/- yd.

RESISTORS. Preferred values. 10 ohms to 10 meg. ¼ w., 4d.; ½ w., 4d.; 1 w. 6d.; 1½ w. 8d.; 2 w. 1/-.
HIGH STABILITY. ½ w. 1%, 2/-. Preferred values. 10 ohms to 10 meg. Ditto 5%, 100 ohms to 5 meg. 9d.

WIRE-WOUND RESISTORS 25 ohms- 10,000 ohms.
5 watt 1/3
10 watt 1/6
15 watt 2/-
12.5K to 50K 10 w ... 3/-

WIRE-WOUND POTS. 3 WATT. Pre-set Min. TV Type. All values 10 ohms to 25K, 3/- ea.; 30K, 50K, 4/-. (Carbon 30K to 2 meg., 3/-)

WIRE-WOUND 4 WATT POTS. Long Spindle, Values, 50 ohms to 50K, 6/6; 100K, 7/6.

COAXIAL PLUGS, 1/-. **PANEL SOCKETS**, 1/-
LEAD SOCKET, 2/-. **OUTLET BOXES**, 4/6
BALANCED TWIN FEEDER, per yd. 6d., 80 ohms or 300 ohms.
TWIN SCREENED BALANCED FEEDER, 1/6 yd. 80 ohms.
TRIMMERS. Ceramic 30, 50, 70 pF. 9d.; 100 pF. 150 pF. 1/3; 250 pF. 1/6; 600 pF. 750 pF. 1/9; Philips, 30 pF. 1/- each.
BLACK CRACKLE PAINT. Air drying, 3/- tin.
NEON MAINS TESTER SCREWDRIVER, 5/-
SOLDER RADIOGRADE, 4d. yd., ¼ lb. 5/-, 1 lb. 9/-.

HIGH GAIN TV PRE-AMPLIFIERS
BAND I B.B.C.
Tuneable channels 1 to 5. Gain 18 dB. ECC84 valve. Kit price 29/6 or 49/6 with power pack. Details 6d. (PCC84 valves if preferred.)
BAND III I.T.A.—Same prices
Tuneable channels 8 to 13. Gain 17 dB.

PAXOLIN PANELS, 10in. x 8in., 1/6.
MINIATURE CONTACT COOLED RECTIFIERS. 250 v. 50 mA, 7/6; 250 v. 60 mA, 8/6; 250 v. 85 mA. 9/6.
SELENIUM RECT. 300 v. 85 mA. 1/6.
COILS. Wearite "P" type, 3/- each. Osmor Midget "Q" type, adj. dust core from 4/- each. All ranges.
TELETRON D.W.R. L. & Med. T.R.F. with reaction, 3/6.
FERRITE ROD AERIALS. M.W., 8/9; M. & L., 12/6.
FERRITE ROD AERIALS. L & M. for transistor circuits, 10/- each.
FERRITE RODS 8in. x ⅜in., 2/6.
H.F. CHOKES, 2/6.
T.R.F. COILS A/HF, 7/- pair; HAX, 3/-, DRR2, 4/-.

ALUMINIUM CHASSIS. 18 s.w.g. Plain, undrilled. 4 sides, riveted corners, lattice fixing holes, 2½in. sides. 7in. x 4in., 4/6; 9in. x 7in., 5/9; 11in. x 7in., 6/9; 13in. x 9in., 8/6; 14in. x 11in., 10/6; 15in. x 14in., 17/6; 18in. x 16in. x 3in., 16/6.
ALUMINIUM PANELS. 18 s.w.g., 12in. 12in. 4/6; 14in. x 9in., 4/-; 12in. x 8in., 3/-; 10in. x 7in., 2/3.

AUTOCHANGER ACCESSORIES
Suitable player cabinets (uncut boards). 49/6. Amplifier player cabinets with cut boards, 63/-. 2-valve amplifier and 6½ speaker for above, ready mounted on baffle, 12in. x 7in., 3in. deep, 79/6. *Wired and tested ready for use.*

QUALITY 2-STAGE HI-FI AMPPLIFIER. A.C. only, 200-250 v. Valves ECL82 and EZ80. 3 watt quality output. Mullard tone circuits, bass boost, treble and volume controls. Separate engraved Perspex front-panel with de-luxe finish. Heavy duty output transformer 3 ohm. Shrouded mains transformer. Stove enamelled chassis size 6in. x 5in. x 3in. Bargain price £4.10.0. Circuit supplied.

ALADDIN FORMERS and cores. ¼in. 8d., ⅜in. 10d.
0.3in. FORMERS 5937 or 8 and cans TV1 or 2, ⅜in. sq. x 2½in. or ⅜in. sq. x 1½in., 2/- with cores.
SLOW MOTION DRIVES. Epicyclic ratio 6-1, 2/3.
SOLON IRON, 25 w., 200 v. or 230 v. 24/-.
MAINS DROPPERS. 3in. x 1½in. With adj. sliders. 0.3A, 1,000 ohms, 4/3; 0.2A 1,000 ohms, 4/3.
LINE CORD. 0.3 A 60 ohms per foot, 0.2 A 100 ohms per foot, 2-way, 1/- per foot; 3-way 1/- per foot.
MIKE TRANS. 50:1, 3/9; 100:1 potted, 10/6.
P.V.C. CONN. WIRE, 8 colours, single or stranded, 2d. yd. Sleeving, 1.2 mm, 2d.; 4 mm, 3d.; 6 mm, 5d. yd.
SPEAKER FRET. Gold cloth, 17in. x 25in., 5/-; 25in. x 35in., 10/-. **TYGAN**, 52in. wide, 10/-; 26in. wide 5/- ft. Samples S.A.E. Expanded Metal, Gold, 12in. x 12in., 6/-.

AMERICAN BRAND "FIVE" FERRO-DYNAMICS RECORDING TAPE

Long Play	7in. reel, 1,800 ft.	35/-
	5¾in. reel, 1,200 ft.	23/6
	5in. reel, 900 ft.	18/6
Standard Play	7in. reel, 1,200 ft.	25/-
	5in. reel, 600 ft.	16/-

Double play 7in. 2,400 ft., 60/-; 5in. 1,200 ft., 37/6; Spare Reels, 3in. 1/6; 4in., 5in., 5¾in. 2/-0 7in. 2/6. "Instant" Bulk Tape Eraser and Head Defluxer, 200/250 v. a.c., 27/6. Leaflet S.A.E.

QMAX CHASSIS CUTTER

The cutter consists of three parts: a die, a punch and an Allen screw.

Sizes	Price	Key
½in.	12/9	1/-
⅝in.	12/9	1/-
¾in.	13/9	1/-
⅞in.	13/9	1/-
1in.	16/-	1/6
1⅛in.	16/-	1/6
1¼in.	16/-	1/6
1⅜in.	18/-	1/6
1½in.	18/-	1/6
1¾in.	20/6	1/6
2in.	30/-	2/3
2³⁄₃₂in.	33/6	2/3
2½in.	38/6	2/3
1in. square hole	29/-	1/6

"REGENT" 4 VALVE
"96" RANGE VALVES
Kit Price £6.6.0
carr. 4/-

PRINTED CIRCUIT BATTERY PORTABLE KIT
Medium and long wave. Powerful 7 x 4 in. high Flux Speaker. T.C.C. Printed Circuit and condensers. Components of finest quality clearly identified with assembly instructions. Osmor Ferrite Aerial Coils. Rexine covered attache case cabinet. Size 12 in x 8 in. x 4 in. Batteries used B126 (L5512) and AD35 (L5040), 10/- extra. Instructions 9d. (free with kit). Mains Unit **ready made** for above 39/6. Sold separately. Details free.

BRAND NEW & BOXED
with Cabinet, Amplifier & Speaker
£12.10.0 CARR. 5/-

RECORD PLAYER BARGAINS
4 Speed Autochangers:
BSR, U.A.14 ... £7.10.0
Collaro Autochanger ... £7.19.6
Garrard RC209 ... £9.9.0
Garrard RC 210 ... £10.10.0
4 Speed Single Players:
Garrard TA Mk. II ... £8.0.0
Garrard 4 HF Transcription ... £17.19.6
Garrard Stereo Heads £2 extra.
All Sapphire Stylii available from 6/-.

ARDENTE TRANSISTOR TRANSFORMERS
Type D3035, 7.3 CT:1 Push Pull to 3 ohms for OC72, etc., 1in. x ¾in. x ⅞in., 9/6.
Type 3034, 1.75:1 CT. Push Pull Driver for OC72, etc., 1in. x ¾in. x ⅞in., 9/6.
Type D3058, 11.5:1 Output to 3 ohms for OC72, etc., 1in. x ⅞in. x ¾in., 9/6.
Type D167, 18.2:1 Output to 3 ohms for OC72 etc., ⅝in. x ½in. x ½in., 12/-.
Type D239, 4.5:1 Driver Transformer, ⅝in. x ½in. x ½in., 10/-.
Type D240, 8.5:1 Driver Transformer, ⅝in. x ½in. x ½in., 10/-
ARDENTE TRANSISTOR VOLUME CONTROLS. Type VC1545, 5K with switch, dia. .9in., 8/-.
Type VC1760, 5K with switch, dia. .7in., 10/6.

WEYRAD
COILS AND TRANSFORMERS FOR A 2-WAVE TRANSISTOR SUPERHET WITH PRINTED CIRCUIT AND FERRITE ROD AERIAL
Long and Medium Wave Aerial—RA2W. On 6in. rod, 7/16in. diameter, 208 pF. tuning, 12/6.
Oscillator Coil P50/IAC. Medium wave. For 176 pF. tuning, 5/4.
1st and 2nd I.F. Transformer—P50/2CC. 470 kc/s, 11/16in. diameter by ¾in. high, 5/7.
3rd I.F. Transformer—P50/3CC, to feed diode detector, 6/-.
Driver Transformer—LFDT2, 1 3/16in. x ⅞in. x 1½in., 9/6.
Printed Circuit—PCAI. Size 2¾in. x 8½in. Ready drilled and printed with component positions, 9/6.
7in. x 4in., 35 ohm Speaker, 25/-.
These components are approved by transistor makers and performance is guaranteed.
Constructor's Booklet with full details, 2/-.

NEW MULLARD TRANSISTORS
Audio OC71 ... 6/- R.F. OC44 ... 10/6
OC72 ... 8/6 OC45 ... 9/6
Sub-miniature Electrolytics (15 V). 1 mfd. 2 mfd., 4 mfd., 5 mfd., 8 mfd., 25 mfd., 100 mfd., 2/6.

B.B.C. Pocket 2 Transistor. M.W. and L.W. Radio Kit, 32/6, Phones 7/6 or deaf aid earpiece, 12/6.

"PW" ROADFARER AM/FM RADIO KIT
Transistorised throughout. Advanced design, operated from internal batteries or direct from mains. **Four Sections all on printed circuit.** AM Tuner, FM Tuner, Audio Amplifier, Mains Supply Unit.
Attractive Plastic Cabinet. Ferrite Rod, Aerial for AM, Telescopic Aerial for FM. Order Order now. **Lowest price £15.**

"P.W." Pocket 6. Transistor kit. All parts, printed circuit and cabinet. Osmor Designed Kit, £8.15.0.

PECIALISTS
337 WHITEHORSE ROAD
WEST CROYDON Telephone **THO 1665**

P. charge 1/-, over £2 post free. C.O.D. 1/6. (Export welcome. Send remittance and extra postage)

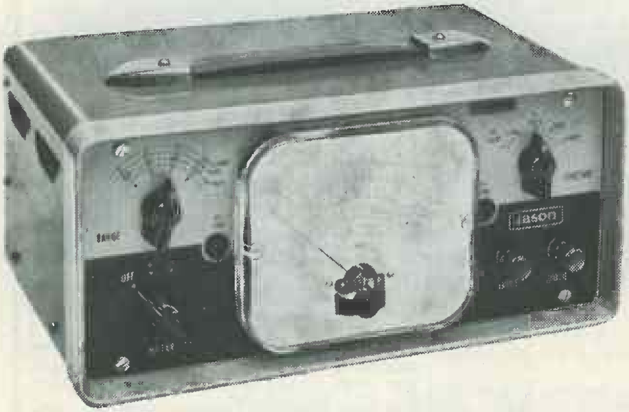
TEST EQUIPMENT
OF EXCEPTIONAL QUALITY

by

Jason

in

KIT FORM



A number of positive advantages stem out of presenting Jason Electronic Test Equipment in kit form. There is naturally a high degree of satisfaction to be obtained from building first-class equipment of this kind for yourself. You benefit too from using instruments of a standard which would otherwise cost very much more than the equivalent Jason Kit. Jason Instruments are in regular use in laboratories and test departments throughout the world. As Kits, they provide excellent opportunities for training in electronics. Built, they provide accuracy of exceptionally high order together with reliability and welcome robustness.

• TEST EQUIPMENT

● VALVE VOLTMETER (*illus.*)

4-valve Bridge Circuit. 23 ranges inc. D.C. Kit inc. valves, 4½" sq. meter and case. **£23.0.0** High voltage probes £3 extra.

● OSCILLOSCOPE OG.10 (*illus.*)

Sensitivity of 10 mV/cm. with bandwidth 2 c/s. to 2 Mc/s. Push/pull amps. on X and Y plates. With 2¾" tube, valves and case. **£22.10.0**

● AUDIO GENERATOR A.G.10

Tunes from 10 c/s to 100 Kc/s with output constant within 1dB. Square wave rise time better than 2 microseconds. With valves and case. **£15.19.0**

● AUDIO ATTENUATOR AA.10.

Nine steps by switches from 1dB to 40 dB. **£7.15.0**

● WOBBULATOR W.11

For all IF and RF alignment. Complete kit. **£14.19.0**

● CRYSTAL CONTROLLED CALIBRATOR C.C.10.

For use in 10 Kc/s to 250 Mc/s range with 0.01% basic accuracy. **£19.19.0**

Literature on all Jason items gladly sent on request.

● New Argus Transistor Radio Tuner for Recorder and Amp. £7.10.0

● NEW STEREO/MONO DE LUXE TAPE UNIT JTL

FOR RELEASE SHORTLY. DETAILS ON REQUEST.

AMPLIFIERS • TUNERS

(Built).

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The

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CONTRIBUTIONS on constructional matters are invited, especially when they describe the construction 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 hand-written or typewritten, lines should be double spaced. Diagrams need not be large or perfectly drawn, as our draughtsmen will redraw 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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TRADE NEWS. Manufacturers, publishers, etc., are invited to submit samples or information of new products for review in this section.

TECHNICAL QUERIES must be submitted in writing. 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 the equipment described in these articles.

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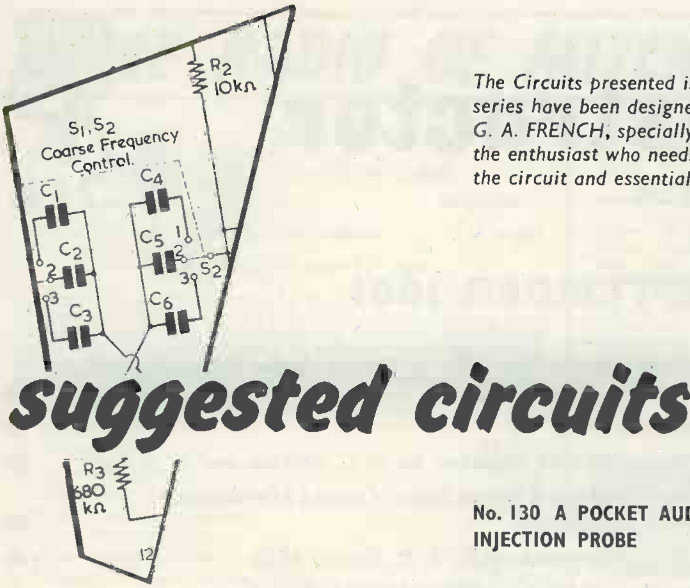


suggested circuits

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

No. 130 A POCKET AUDIO INJECTION PROBE

A SIMPLE AUDIO OSCILLATOR IS always a useful item and it may be employed for many jobs including, especially, trouble-shooting in the audio stages of faulty equipment.

This month's circuit is for an audio oscillator which employs very few components and which is intended to operate from a single 1.5 volt cell. Due to the small volume taken up by the components and cell, the oscillator is capable of being built into a completely self-contained probe, whereupon it becomes readily available for service work in the field as well as in the workshop.

The output of the probe is at high impedance, although the oscillator continues to function (with reduced output) if the probe is applied to impedances as low as 100Ω. When applied to the primary of a standard valve speaker transformer, the resultant tone in the speaker is at adequate level for fault-finding purposes. Thus, the probe may be used for trouble-shooting a.f. amplifier stages from the speaker transformer primary back.

The oscillator transformer specified in the circuit has been used in an a.f. oscillator previously described in *The Radio Constructor*[1], and the present circuit is similar in many respects to that given in the earlier issue. In this instance, however, the supply potential required is 1.5 volts only, and the output is taken from the oscillator in a different manner.

The Circuit

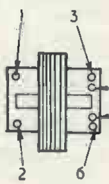
The circuit of the oscillator accompanies this article and, as may be seen, very few components are required. The collector of the transistor feeds into winding 1–2 of the transformer, feedback being applied to the base via winding 3–4. Winding 5–6 is not used, and no connection is made to its terminals. Resistors R_1 and R_2 provide bias for the transistor and also limit the a.f. current flowing in the base-emitter circuit. Condenser C_2, connected across winding 1–2, modifies the frequency of the oscillator note and reduces its tendency to squeg.

An output is taken from the collector of the transistor via the 0.01μF condenser C_1. When the probe is used for fault-finding, the flying chassis lead is clipped to the chassis of the equipment under test, whereupon the probe is applied to successive a.f. injection points as required.

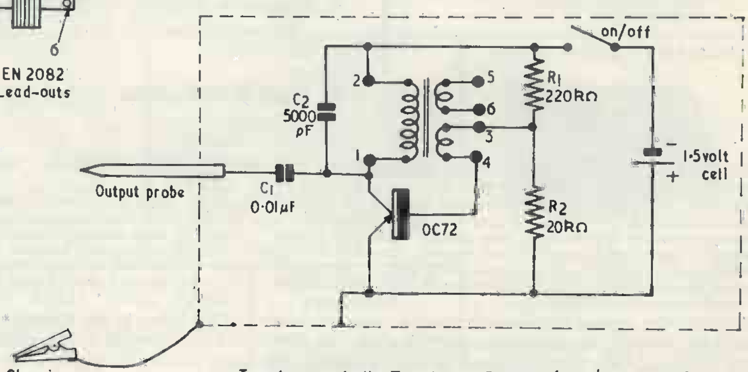
Points of Design

Most of the work on the prototype was concerned with the selection of oscillator components capable of giving a reliable a.f. output of good amplitude for the relatively low supply voltage of 1.5. The oscillator tends to squeg, and this tendency is of advantage here since it enables the transistor to offer a higher output than would be given if it were employed as a pure sine wave oscillator. In this case a compromise has been reached, condenser C_2 sufficiently reducing the tendency to squeg to enable an acceptable tone to be generated at good amplitude. Resistors R_1 and R_2 also have an effect on the quality of the tone. Apart from providing a bias circuit they reduce the a.f. level fed to the base by winding 3–4 of the transformer. R_1 and R_2 may be considered as inserting a series resistor in the base-emitter circuit, the resistor having the same value as R_1 and R_2 in parallel.

As may be gathered from the last paragraph, the quality of the tone



EN 2082 Lead-outs



Transformer: Audio Transformer EN 2082 (Henry's Radio Ltd)
Resistors ⅛ watt 20%

E112

[1] D. J. French, GRAD.I.E.E.: "A Transistor Audio Signal Generator", *The Radio Constructor*, August 1959.

generated by the oscillator is not a pure sine wave. It is, however, sufficiently acceptable in quality to be satisfactory for fault-finding and servicing work.

The frequency of the tone varies slightly with load, but this effect is not great. The supply potential has a considerable bearing on frequency, and the component values given here are applicable to supply potentials around 1.5 volts only.

A possible risk with the circuit is that if the probe is applied to an injection point carrying a high d.c. potential, a high voltage may momentarily appear across the transistor whilst C_1 charges. The transistor is, however, effectively shunted (via the 1.5 volts cell) by winding 1–2 of the transformer, the low resistance of which (approximately 150Ω) prevents damage to the transistor from this cause. Nevertheless, winding 1–2 is only connected effectively across the transistor when the oscillator is switched on, with the result that the probe should not be applied to a circuit under test when switched off. If desired, an electrolytic condenser of some 10μF or more could be connected across the supply rails after the on-off switch: such a condenser would ensure that winding 1–2 was effectively shunted across the transistor at all times, regardless of whether the oscillator were switched on or not. Similarly to protect the transistor, C_1 should be a good quality component having a high leakage resistance, and care should be taken to prevent the probe being accidentally applied to points carrying high a.c. potentials.

The transformer specified for the oscillator is a small component whose windings offer a convenient ratio for the present application. It is readily available through normal home-constructor channels.

Construction

The construction of the probe should raise few difficulties, layout not being important. When completed, the probe should be checked by connecting its output to an a.f. amplifier or to the primary of a speaker transformer. If desired, variations to the frequency and quality of the note obtained can be obtained by adjusting the value of R_1, or C_2. However, experience with the prototype did not indicate that any of the component values were so critical as to necessitate adjustment.

Results with the Prototype

It was found, with the prototype, that an audible note at adequate level was obtained when the output was applied to the primary of a valve speaker transformer. Obviously, louder tones were given when it was applied to the output and preceding grids of the associated amplifier. The oscillator continued to work reliably (at a reduced output level) when a 100Ω resistor was connected across its output.

The peak value of the output voltage, when connected to a 250kΩ load, was approximately 0.4 volts. Current consumption, for a supply voltage of 1.5, was 0.4mA.

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

Hallicrafters SX24 Receiver.—L. Orbach, 131 Clarence Gate Gardens, London, N.W.1, urgently requires the manual or circuit diagram for this receiver—will purchase if necessary.

* * *

BC348, Model JN8Q.—J. Robertson, Aukengill, Wick, Caithness, Scotland, wishes to borrow or purchase the manual.

* * *

Ex-Government Receiver Type ZC8931.—R. W. Hilton, 8 Hogshill Lane, Cobham, Surrey, is in urgent need of information and circuit details for this 1.5 metre receiver and also, if possible, modifications for 2 metre working.

* * *

T1131 or 75C Transmitter.—P. M. Beecham, 2 Fyfield Road, Enfield, Middlesex, requires to borrow or purchase the manual or circuit diagram.

* * *

RF27 Unit.—P. M. Griffiths, 5 Hulbert Street, Bury, Lancs, would like to receive details on converting this unit for use on 2 metres.

* * *

Timebase Unit No. 4 ZC24694.—D. Howdle, 52 Braithwell Road, Revenfield, Rotherham, wishes to know the actual timebase and whether suitable for an oscilloscope.

Valve Types.—A. Lee, 77 Yew Tree Lane, Manchester 23, has obtained a civilian wartime receiver and requires to know the base connections of the following valves: BVA types 273/4/5/6/7, 243 or 246, 264/5/6, 211 and 214/5/6.

* * *

Channel RC Bridge and Signal Generator.—P. D. Webb, 139 Bromyard Road, Sparkhill, Birmingham 11, would like to obtain the service manuals of these and other Channel products.

* * *

Admiralty Type Receiver R/T Pattern 4660.—J. C. Henson, North Dhuloch, By Dunfermline, Fife, wishes to acquire the service manual of this receiver (marked Model No. 850).

* * *

G.E.C. Super 10 Autogram Cat. No. BC3918H.—R. Turner, "Bowmore", Dedworth Road, Windsor, Berks, is in urgent need of the circuit, willing to purchase if necessary—this appeal is his last hope!

* * *

Marconiphone Radio, Model T32A.—A. G. Ariyoh, 19 Dempster Road, London, S.W.18, requires the service manual or circuit—or any other information available—on this receiver.

An Unusual 2-Valve Superhet

by V. C. Jackson and R. A. Ord

THE REQUIREMENT WHICH LED TO THE DESIGN OF the receiver described here was for a small radio to be used in a kitchen. Consequently, provision was only made for reception of the Medium waveband, and switched tuning provided for quick (and accurate) station selection of the Home and Light programmes. Additionally, only a very small shelf area was available, so the receiver had to fit into a fairly small cabinet. The actual cabinet dimensions were 6½ x 5½ x 4in.

Circuit Design

The circuit is shown in Fig. 1. L_1 is a ferrite rod aerial and the rest of the circuit around V_1 is of a fairly conventional mixer/oscillator stage. The i.f. output from V_1 is coupled, via L_4 and L_5, to the grid of V_2.

V_2 performs a dual function, namely i.f. amplifier and audio output stage; and its action is as follows: i.f. signals are amplified by V_2 and fed via L_6 and L_7 to the crystal detector D_1. L_6 and L_7 constitute a modified i.f. transformer. About two-thirds of the windings of L_7 are removed together with the associated tuning condenser, the remaining one-third being pushed close to the L_6 winding. The i.f. component is filtered from the audio signals by C_{11} and R_6, the detected audio signal appearing across the diode load R_7, the filtered signal appearing across the volume control R_3. From the volume control, audio signals are fed via L_5 back to the grid of V_2, which now acts as a conventional output stage.

As was to be expected in a circuit of this description, one of the most important problems to be overcome was preventing V_2 from breaking into oscillation. Due to the very high gain obtained at 465 kc/s with a high slope valve, the anode grid capacity becomes troublesome.

In Fig. 1 the circuit is stabilised by balancing the valve inter-electrode capacities in a bridge circuit. This bridge is shown in Fig. 2. Balance is achieved by feeding h.t. to the screen-grid of V_2 via the 330Ω resistor R_4, and decoupling this electrode with the 0.001μF condenser C_{14}. It is C_{14} which neutralises the circuit by balancing the bridge.

We were unable to find the anode load impedance of an EF91 when used as an audio output stage, and a suitable ratio had to be found by experiment. In the prototype, T_1 matches 15kΩ to 3Ω, and therefore has a ratio of approximately 70:1. The loudspeaker employed has a diameter of 4in.

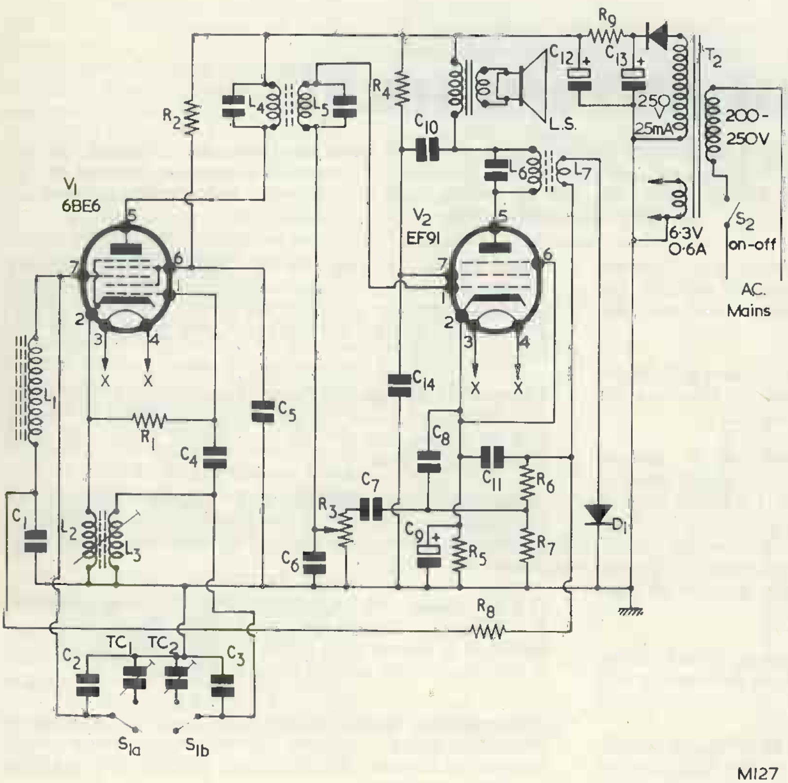


Fig. 1. Circuit diagram of the Unusual 2-Valve Superhet. $S_{1(a)}$, (b) is the station selector switch, position 1 being that of the Light programme and position 2 that of the London Home service

In the interests of safety, a transformer is fitted to provide h.t. and l.t. supplies, the type used in Band I converters being ideal for the purpose, together with a contact-cooled rectifier. The current consumption of the receiver (h.t.) is 20mA at 250V.

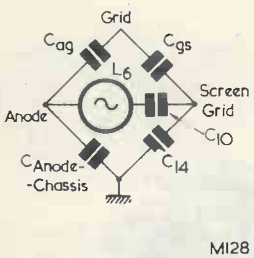


Fig. 2. Equivalent bridge circuit of V_2 interelectrode capacities

The chassis employed with the prototype measured 5 x 3 x 1in deep. Fig. 3 illustrates the layout of the major components both above and below the chassis.

Alignment

Provided that pre-aligned i.f. transformers are used, alignment will be found to be a very simple matter.

Switch to the Light programme; that is, with trimmers TC_1 and TC_2 out of circuit. Now adjust the core of L_2L_3 and the position of L_1 on the ferrite rod for maximum signal. Following this, adjust the core of L_6L_7 for optimum results.

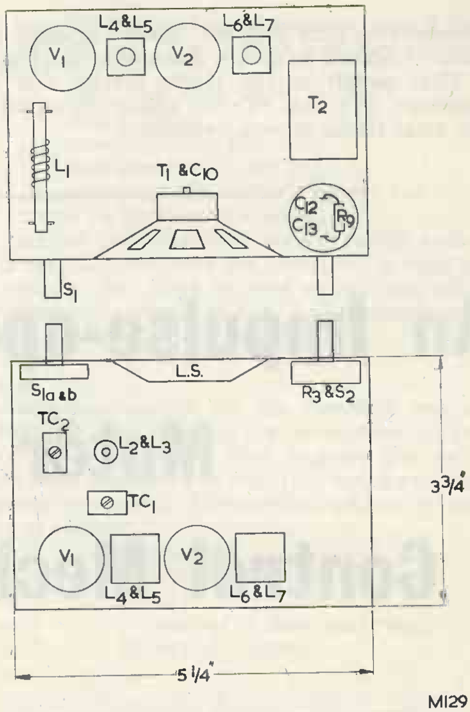


Fig. 3. Top: above-chassis main component layout; below: under-chassis main component layout

Components List

Resistors
- R_1 22kΩ ¼ watt ±20%
- R_2 22kΩ ¼ watt ±20%
- R_3 500kΩ pot, log, SPST switch
- R_4 330Ω ¼ watt ±20%
- R_5 220Ω ¼ watt ±20%
- R_6 47kΩ ¼ watt ±20%
- R_7 220kΩ ¼ watt ±20%
- R_8 1MΩ ¼ watt ±20%
- R_9 1kΩ 1 watt ±20%

Valves
- V_1 6BE6 (X77, EK90, X727)
- V_2 EF91 (Z77, 6F12, 6AM6, 8D3)

Coils
- L_1 Ferrite rod aerial (MW)
- L_2L_3 Oscillator (MW)
- L_4L_5 465 kc/s i.f.
- L_6L_7 465 kc/s i.f. modified (see text)

Transformers
- T_1 Output 70:1
- T_2 Mains: Primary 200–250V, Sec: 250V, 25mA; 6.3V, 0.6A

Condensers
- C_1 0.05μF mica
- C_2 120pF mica (see text)
- C_3 120pF mica (see text)
- C_4 100pF mica or ceramic
- C_5 0.05μF paper
- C_6 560pF mica or ceramic
- C_7 0.05μF paper
- C_8 100pF mica or ceramic
- C_9 25μF, 12V, electrolytic
- C_{10} 0.005μF paper
- C_{11} 100pF mica or ceramic
- C_{12}, C_{13} 16+16μF, 350V, electrolytic
- C_{14} 0.001μF paper
- TC_1 100pF max
- TC_2 100pF max.

Switches
- S_1 d.p.s.t. toggle or rotary
- S_2 s.p.s.t. ganged with R_3

Rectifier

Contact-cooled 250V, 25mA

Miscellaneous
- D_1 GEX34 or similar

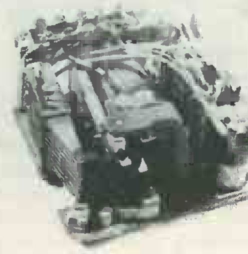
Speaker, cabinet, B7G valveholder, chassis etc.

Incidentally, note that the "inner" position of this latter is needed to ensure maximum coupling.

Next switch to the Home service and adjust trimmers TC_1 and TC_2 for maximum signal from the local Home service transmitter.

The values of TC_1, TC_2, C_2 and C_3 apply to reception of the Medium wave Light programme and London Home service. When other stations are required these components may need to be altered accordingly.

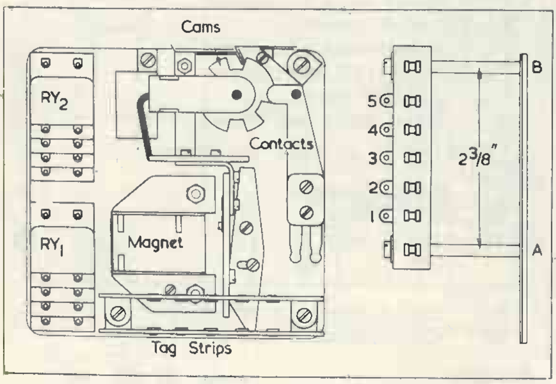
An Impulse-operated Motor Speed Control Mechanism



By R. J. HAWKINS

THIS UNIT IS A MODIFICATION OF A SURPLUS electromagnetically operated switch, Ref. 5D/609. As purchased it consists of five sets of contacts which are sequentially operated by rotating cams, these being turned by a magnetically-driven 12 tooth ratchet. A pair of contacts situated above the electromagnet allows the mechanism to motor, while the magnet winding is in two sections, one part being switched to operate the unit and the other being permanently energised. All connections are brought to a 10-way terminal block.

The suppliers of the unit recommended it for radio control as it stood, but the author decided that it was rather inflexible in its original condition, and therefore set about modifying it. The requirement was that the resulting unit should produce the following speed-sequence: full ahead, half ahead, stop, half astern, stop, half ahead. Half speed is obtained by connecting the motor field and armature in series (these being in parallel for full speed), while reversing is brought about by changing the polarity of the field supply.



M124

Fig. 1. Plan view of unit and details of tagstrip. The tags should be re-arranged if necessary by unclinching fixing lugs with pliers. Holes A and B countersunk ⅛in (B is already drilled)

When it is modified the unit is approximately 3⅝ x 3⅜ x 2½in high. The two electromagnet coils are connected in parallel, whereupon energising current is 0.7A for a 12V supply. A boat containing the equipment should be at least 2.5ft long, although this would also depend to a great extent on the size and weight of motor and power supply, as well as on the ratio of width to length. The unit could also be used in a wheeled vehicle with a length of about 1.5 to 2ft.

The unit is designed to operate with a shunt-wound motor which will consume at least 1A at full speed. In consequence the power supply would be some sort of accumulator, such as a battery of miniature lead-acid, NiFe alkaline, or silver-zinc cells. The unit itself, however, takes little power, the action of the electromagnet being practically instantaneous. Two relays, each consuming some 0.02A, are fitted to the modified unit, but these are only operational for part of the time.

The Modification

The items required for the modification are as follows:

5 $\frac{1}{16}$in Paxolin washers, ¾–⅞in dia. with $\frac{5}{16}$in hole;

2 miniature 12–24 volt relays with double-pole changeover contacts;
2 spacing pillars 1¾in long, tapped 6BA both ends;
Tagstrip, wire, sleeving, 6BA bolts.

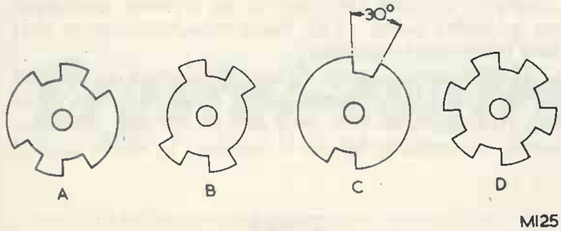


Fig. 2. Patterns of cams A, B, C, and D. Spaces must be cut to a diameter of ⅝in. (Diagram not to scale)

All wiring is removed from the magnet, motoring contacts, and terminal block, the latter two components then being removed. (A little methylated spirits may be necessary to loosen the varnish here.) To detach the motoring contacts striker arm it will be necessary to remove the magnet armature, taking care to replace the small spacing strips and to re-align the pivot correctly.

The relays are fixed to the baseplate at the point previously occupied by the terminal block, as shown in Fig. 1. Those used by the author had two 6BA holes in the base. The tagstrip is used to provide easy connection to the unit, the old terminal-block being somewhat too bulky. The tagstrip employed by the writer had every third tag supporting brackets.

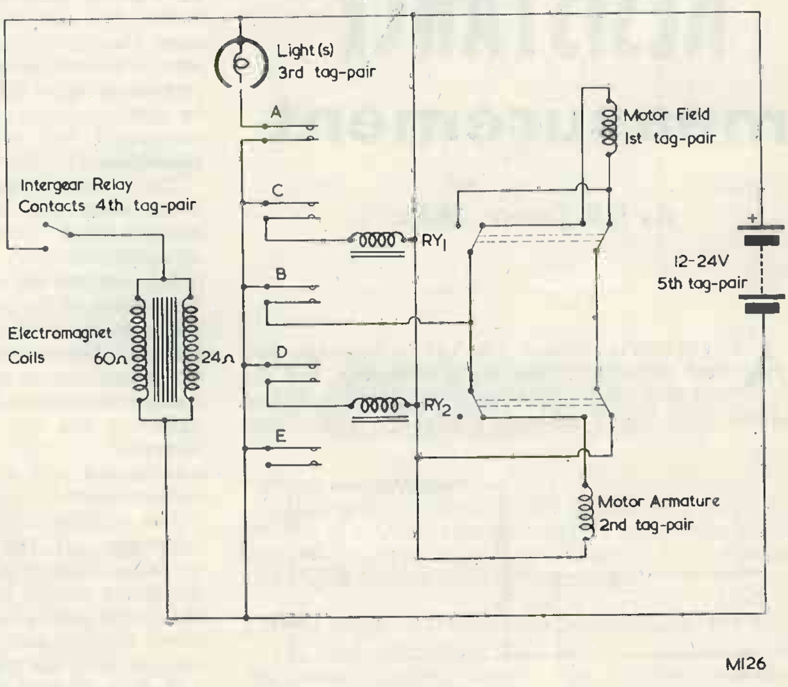


Fig. 3. Circuit diagram of the motor speed control unit. All relays are shown in the de-energised position

This tagstrip was cut and the tags rearranged (by removing with pliers and re-clinching in alternative positions) to give two strips of seven, the two end tags being inverted brackets having the parts to which the wire is soldered removed. The strips are mounted by means of the spacing pillars, as shown in Fig. 1.

The bracket which supports the cam-spindle is unscrewed and the cams removed. New cams are then made from the Paxolin washers as in Fig. 2. Cam A controls the top pair of contacts, cam B the second, and so on. The functions of the various cams are as follows:

A .. lights (on when motor is off)
B .. motor on/off.
C .. reversing relay (Ry 1).
D .. half-speed relay (Ry 2).
E .. unused in the author's model, but may be cut to suit various requirements.

The original cams have hexagonal centre holes, but it is sufficient to make the new ones a tight fit on the spindle; they must be fixed so that they take up the orientation shown in Fig. 2. This completes the mechanical part of the modification.

Wiring-up

The theoretical circuit for the complete unit is given in Fig. 3, this showing the connections to the battery, light and motor. This diagram also indicates the tags, numbered in Fig. 1 to which external connections are made. The services offered by the tags are as follows:

Pair 1 .. motor field.
Pair 2 .. motor armature.
Pair 3 .. lights.
Pair 4 .. to receiver or inter-gear relay.
Pair 5 .. 12–24V d.c. input.

Motoring Contacts

The author considered that difficulties in operation might arise if the motoring contacts were left in circuit, since it is almost impossible to judge exactly when to cut off the supply to the electromagnet.

This is particularly true when the unit is incorporated in a boat, where a change in motor revolutions is not immediately obvious from the speed of the model. Nevertheless, the circuit may be altered, if desired, to give provision for motoring. If it is found that sparking between the relay contacts gives rise to instability in the receiver it may be suppressed by connecting a 22Ω resistor in series with a 0.01μF condenser across them.

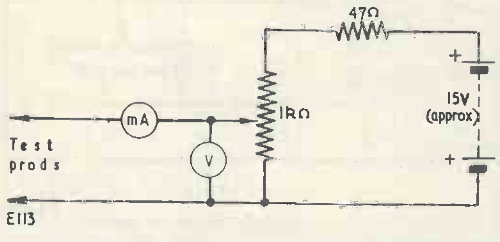
Weight and Mounting

When purchased, some units are contained in a die-cast case; removing this reduces the weight considerably. The weight of the author's unit after modification was about 20 oz. As the original fixing holes in the corners of the baseplate are no longer usable, one being used to hold the tagstrip pillar and the other being covered by a relay, it will be necessary to drill new ones. They should be about $\frac{1}{8}$ to $\frac{5}{32}$in diameter, and spaced to suit the support available.

RESISTANCE measurement

By J. B. Dance, M.Sc.

An expensive bridge circuit is perhaps the best method of measuring resistance, but the use of a multi-range meter is undoubtedly one of the most rapid methods available. Apart from



the necessity of adjusting the zero reading fairly frequently (in order to correct for any changes in the voltage or resistance of the internal battery), the multi-range meter method suffers from the disadvantage that the scale is non-linear. The resistance scale must therefore be specially calibrated and, generally, the accuracy of the instrument will not be as great as that which might be expected from methods in which a linear scale can be employed.

The circuit described (shown in the accompanying diagram) enables resistors to be quickly measured on a linear scale. The main disadvantage is that two meters are required.

The battery voltage (about 15 volts) is applied across the 1kΩ potentiometer and the portion of this voltage which is tapped off by the potentiometer is measured by the voltmeter, V, which should have a full scale deflection of between 10 and 15 volts. The milliammeter (or microammeter) measures the current passing through the resistor under test; it should have a number of ranges. The 47Ω resistor protects the battery if the test prods should be short-circuited with the full voltage across them.

TABLE

Current	Factor
100μA	10,000
1mA	1,000
10mA	100
100mA	10

Operation

The unknown resistor is connected across the test prods with the milliammeter set to its highest current range. The range is then altered until the milliammeter gives a reasonable deflection with the potentiometer set at about the centre of its range. The setting of the potentiometer is then altered until the reading is exactly 100μA, 1mA, 10mA, or 100mA. The current should be chosen from one of these four values so that it passes when there is a reasonable deflection of the voltmeter, e.g. if 100μA passes at less than 1 volt, the current should be increased to 1mA. Each measurement should be commenced with a large current range so that the milliammeter is not damaged.

The resistance is found from the reading of the voltmeter. If the current passing through the unknown resistor is 10mA, the voltage indicated by the meter should be multiplied by 100 in order to obtain the resistance value in ohms. The factors by which the voltmeter reading must be multiplied for various other currents are shown in the table.

If it is desired to make a permanent piece of equipment employing this method for measurement of resistance, it would be convenient to employ a pointer knob to operate the milliammeter range switch so that it points directly to the range factor (as shown in the table), the factors being marked on the panel around the knob.

A

Crystal-controlled Oscillator

for F.M.

by Sir John Holder, Bt.

Part 2

A DESIGN FOR A CRYSTAL CONTROLLED FRONT-END which can be adapted to any f.m. receiver appears, at first sight, to be rather a tall order. However, a little experiment indicates that the second of the two circuit applications described in Part 1 of this series was so "docile" and "pliable" that, provided the constructor fulfilled certain requirements, he could twist it round in any reasonable way and still retain an adequate chance of success. These requirements are:

Requirements

1. The circuit given in this article must be used in its entirety, together with the specified oscillator valve and coils.
2. No connecting wire carrying high frequency current must be more than 1in long. Preferably a wire should be of the order of a ¼in long.
3. The layout may be twisted and turned around in any way provided that the sequence of circuits shown in the block diagram of Fig. 1 is maintained, except that there must be no crossing over of the "flow" arrows shown in Fig. 1.
4. The relative positions of the coils is also important. L_1 must be 1½in or more away from L_2 or L_3, whilst L_2 and L_3 must be separated by exactly ¾in, this spacing giving the required mutual coupling.

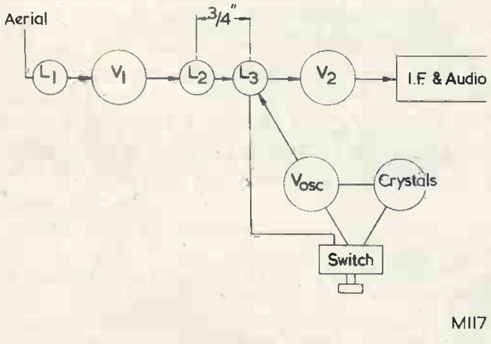


Fig. 1. Front-end block diagram

5. The crystal must be closely adjacent to the switch tags and V_{osc} must be closely adjacent to the crystal. Any undue lengthening of the wiring associated with the crystal will almost certainly cause the crystal to lose control. Further wires associated with the "switch side" of the crystals should, if possible, not be parallel to the common wire joining the crystals to the cathode of V_{osc}.

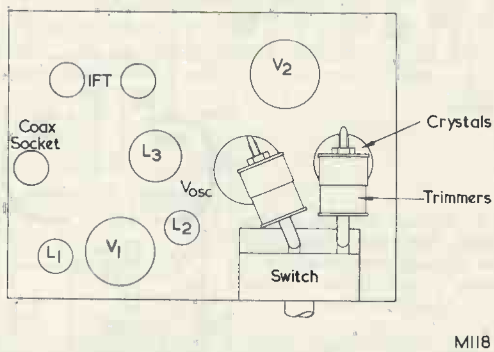


Fig. 2. The Jason "Jupiter" conversion. The existing coils, valves and switch are retained, the latter having the rear wafer removed. The trimmer side-tags should be soldered direct to the switch tags

Cutting Large Holes

Existing components on the chassis may preclude the use of a Q-Max cutter. In this case, large holes may be cut quite easily with the aid of an Arborfile (a kind of fretsaw for cutting metal).

Left to Right and Backward Arrangement

The first application tried was an adaptation of the Jason "Jupiter" tuner. For this purpose, the back wafer of the switch was removed, an oscillator valve and crystal added and the wiring altered as necessary. The original coils were retained but the top end of the ribbon coils was used as the "hot" end instead of the bottom end. The layout is shown in Fig. 2. The pentode portion of the original oscillator was retained as a mixer. All that was necessary was to ground pins 1, 9 and 8 to the chassis, the triode portion being no longer required, and connect a 220pF condenser across the primary of the mixer anode transformer, to make up for the removal of the feedback condenser.

A Complete Front End

The arrangement proved so satisfactory that it was decided to use it as the basis of a complete front end. Fig. 3 shows the circuit details, while Fig. 4 shows the dimensions.

projecting. Squeeze the end turns inwards slightly so that they grip the former. Slip the coil off and slide it on to the L_3 former. Now construct a similar coil for the tuned winding of L_2. Both coils should look like RH-thread screws.

Next construct the primary of L_2. For this, take a short length of RadioSpares stranded p.v.c. covered connecting wire (2mm overall diameter). Slip the turned winding on to the former and twist two turns of the p.v.c. covered wire round its lower

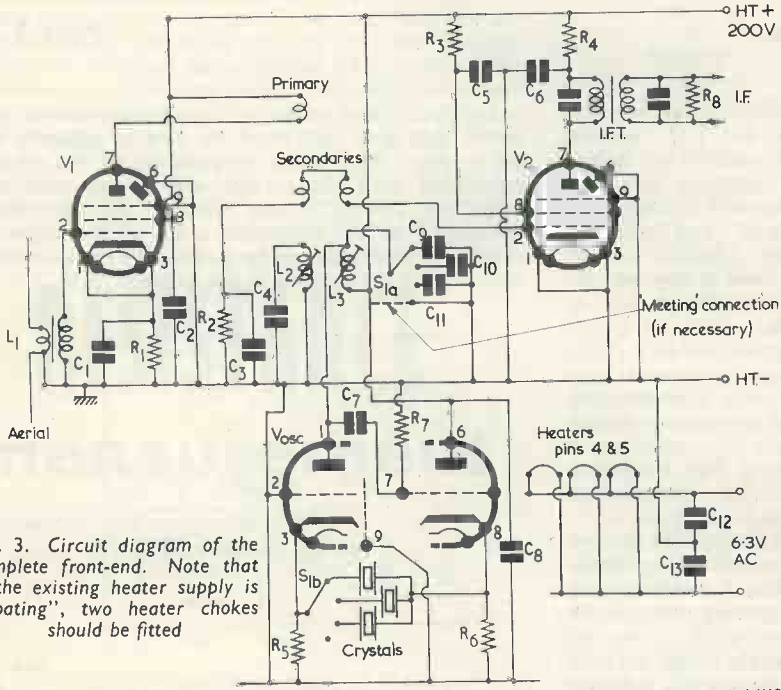


Fig. 3. Circuit diagram of the complete front-end. Note that if the existing heater supply is "floating", two heater chokes should be fitted

Components List

Resistors (all ½ watt)

R_1	160Ω
R_2	22kΩ
R_3	27kΩ
R_4	3.3kΩ
R_5	220Ω
R_6	220Ω
R_7	470kΩ
R_8	100kΩ

Valves

V_1	EF80 (Mullard)
V_2	EF80 (Mullard)
V_{osc}	ECC85 (Mullard)

Crystals

S.T.C. 4434/to suit locality

Condensers

C_1	1,000pF ceramic
C_2	5,000pF ceramic
C_3	33pF silver mica
C_4	15pF silver mica
C_5	1,000pF ceramic
C_6	1,000pF ceramic
C_7	47pF silver mica
C_8	5,000pF ceramic
C_9	8.2pF silver mica
C_{10}	15pF (max) tubular trimmer (RadioSpares)
C_{11}	15pF (max) tubular trimmer (RadioSpares)
C_{12}	5,000pF silver mica
C_{13}	5,000pF silver mica

Coils

L_1	Standard aerial coil wound on slug
L_2 }	Polystyrene formers with v.h.f. slugs.
L_3 }	Wound on 7mm diam. (see text)

Miscellaneous

S_1 Midget 4-pole, 3-way
2 B9A valveholders (nylon loaded, skirted)
1 B7G valveholder (nylon loaded, skirted)
Coaxial socket, 2-way and earth tagstrip
IF transformer
Chassis

The "Jupiter" coils are no longer obtainable. Satisfactory substitutes are as follows: L_1, use a standard f.m. aerial transformer wound on a portion of a slug. L_2 and L_3 are wound on 7mm polystyrene coil formers approximately ¾in long and have v.h.f. slugs. Although there are several windings, construction is not difficult if carried out according to the following description:

Constructing the Coils

Proceed as follows: mount L_3 former in the chassis. Hold L_2 former by the base in the left hand. Straighten a 6in length of 20 s.w.g. tinned copper wire and hold in the right hand. Lay the end across the former and place the left thumb on it. Now with the left hand, turn former and wire-end anticlockwise until four complete turns have been wound on. Extend the coil until it is ½in long. Bend ends out at right angles and cut off so that ⅛in is half. Tie the first half of a reef-knot in the ends. Offer up the former in the chassis and adjust windings so that all four ends point in the right direction. Pull the half knot tight and fix with adhesive. The tops of both the four turn coils should be nearly at the top of the formers. Mount the partially completed L_2 in the chassis. The construction of the secondaries is best left until the wiring of the unit is nearly complete. To make the secondaries, take a 6in length of the same p.v.c. covered wire and solder one end to the grid of V_2.

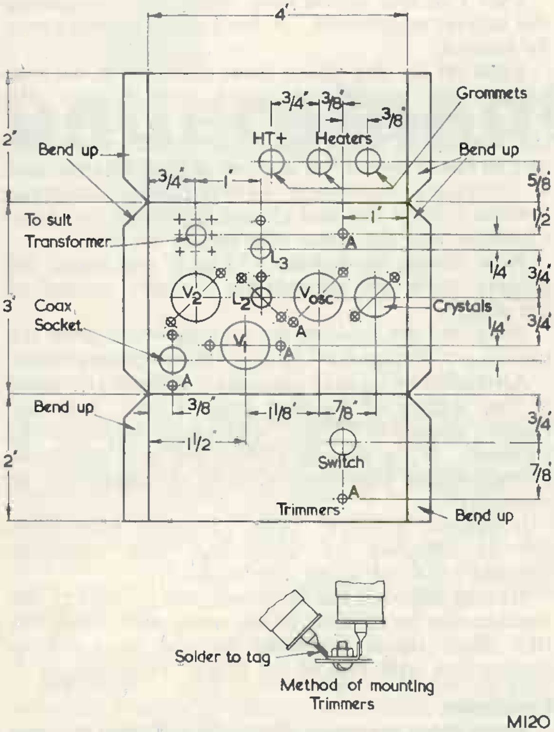


Fig. 4. Front-end chassis dimensions. Holes marked A are those to which earth tags should be fitted

Twist it anti-clockwise round L_3 once. Form a half knot and pull tight. Twist it clockwise round L_2 once. Twist the end once round the part which bridges L_2 and L_3. Pull tight round L_2 and tighten up the twist using a pair of pliers. Cut the end off short and solder to junction of R_2 and C_3.

Fix all windings in place, using adhesive.

Coupling Coils

Check that the windings are in the correct direction. L_2 and L_3 are inductively coupled. In fact, if L_3 were placed upside down on top of L_2, it would constitute one continuous coil with the "hot" ends in the centre as shown in Fig. 5. The two windings of the secondaries, however, would oppose one another.

The purpose of the primary winding of L_2 is merely to avoid having to construct a tapped coil and the 4-turn winding of L_2 can, for theoretical purposes, be regarded as the primary. With this assumption, we have L_2 primary feeding r.f. signal into the secondary and L_3 primary feeding oscillator

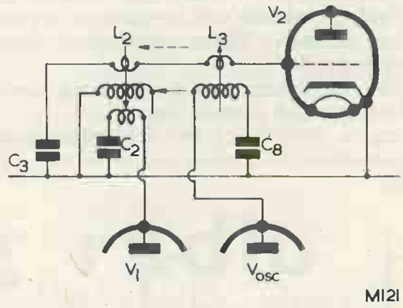


Fig. 5. The inter-valve coupling arrangement, solid arrows indicate "sense" of couplings

signal into the secondary, both of which will be applied to the grid of V_2, but the direct coupling between the two primaries is in opposition to the coupling between the two primaries via the secondaries. The net result is that there will be little if any coupling between the two primaries and we shall achieve the desirable object mentioned in Part 1, namely minimum loading of the oscillator.

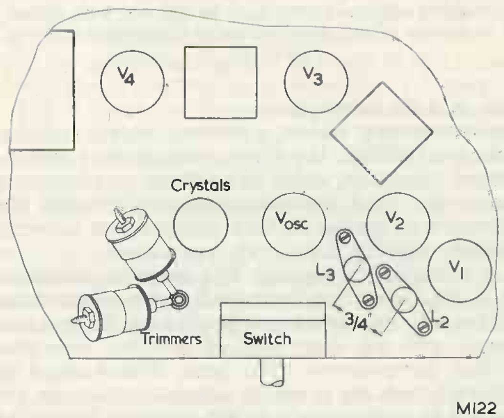


Fig. 6. Conversion of variable condenser operated tuner unit. V_{osc} and crystals added to existing valves. Note that a better arrangement would be to move the switch and trimmers ¾in to the left (existing holes in the chassis precluded this)

Construction

It is best to carry out construction of the unit in the following sequence:

(i) With switch and coil formers omitted, connect up heaters (pins 4 and 5, in the case of the ECC85) also h.t. positive wiring to pin 6 of the ECC85. Use insulated wire.

(ii) Add C_1, C_2, C_5, C_6, C_8, also R_1, R_3, R_4, R_5, R_6 and R_7, all lying flat close to the chassis.

(iii) Add R_2 and R_8.

(iv) Connect common side of crystals to pin 8 of the ECC85.

(v) Add coils and connect up. Add C_7 and C_3.

(vi) Add the switch and connect to crystals and coil former. These connections should be very short.

(vii) Fix the trimmers and remaining condensers in place and connect up.

The centre spindle of the trimmers should be rigidly connected to chassis via earth tags or thick bare wire.

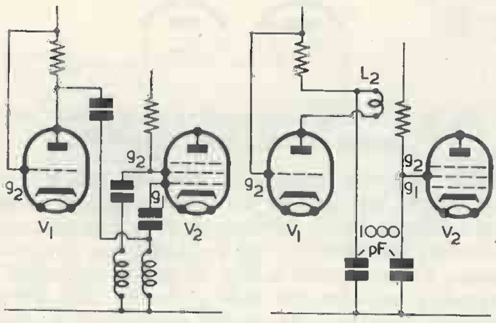


Fig. 7. Showing alterations to existing tuner unit enabling original V_1 and V_2 to be utilised. Left, before conversion; right, after conversion (inter-valve coupling as in Fig. 3)

Right to Left Arrangement

As was stated earlier, provided certain requirements are fulfilled, the whole arrangement may be changed around in order to conform to adaptation requirements and the next example illustrates the conversion to crystal control of what was formerly a vintage variable condenser type tuner.

Fig 6 shows the layout. The variable condenser and original coils were removed and a switch fitted together with the same type of coils as in the previous example and the same type of switch. Note that the new components have been interchanged as compared with the previous example. Also, as the chassis was rather shallow, the trimmer had to be mounted alongside the switch instead of above it. The original V_1 and V_2 (both Z77's) were retained.

A slight alteration to the connections of V_1 was necessary in this case. Formerly, the output from V_1 was shunt fed to V_2. In order to alter it to series feed, the anode load resistance was "lifted" from the anode pin of V_1 and the primary of L_2 interposed, the original coupling condenser being replaced by a 1,000pF condenser connected to chassis. Similarly, as V_2 formerly oscillated between screen-grid and control-grid, the back coupling condenser originally connected to the screen-grid was replaced by a 1,000pF bypass condenser to chassis. Fig. 7 shows these details "before and after".

Adjustment

Part 1 of this article gave details for recognising the correct adjustment. A few further remarks may be helpful.

First set L_2 slug about three-quarters of the way in and the programme switch to "Home". (In Fig. 3 this switches in C_9.) Screw in L_3 slug until the position is found where the Home programme can be heard over a few degrees of slug rotation and a voltmeter connected between the automatic volume control line and chassis shows no variation. Carefully find the mean slug setting for this.

Now change the switch to "Light" and repeat the process using the appropriate trimmer instead of the slug.

Next find the position for L_2 slug which gives the same a.g.c. voltage for Light and Home programmes.

Alteration of L_2 may necessitate a slight alteration of the setting of L_3 slug and "Light" trimmer. Finally, change to "Third" and adjust the remaining trimmer. If L_3 slug is altered for any reason, a corresponding alteration of both trimmers will be necessary.

If desired, a more "open" trimmer adjustment can be obtained by using 8pF max. trimmers shunted by 4.7pF fixed condensers.

Having adjusted the front-end, the i.f. part of the receiver can be checked in the usual way, using the 10.7 Mc/s signal furnished by the front-end in conjunction with one of the B.B.C. programmes.

Conclusion

These three examples should be sufficient to show the reader how to adapt the scheme to his particular needs, but for success, he *must* comply with the rules given, especially must he keep the wiring associated with the crystals and cathodes *very short*.

Indication that some part of the wiring is too long will be the hearing of one of the programmes when the switch is in the "off" position.. If the fault is not too serious it may still be possible to achieve crystal control in the proper manner, and the offending programme in the "off" position, can be silenced by connecting the open contact of $S_{1(a)}$ to pin 6 of V_{osc}.

CHANGE OF ADDRESS

Jason Electronic Designs Limited, manufacturers of high fidelity audio equipment and electronic test equipment, announce their removal from Gt. Chapel Street, Oxford Street, W.1, to Kimberley Gardens, Harringay, N.4 (*Telephone* STAmford Hill 5477).

The move has been necessitated by increasing home and export trade and the consequent need for larger factory space.

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

part 2

understanding radio

By W. G. MORLEY

IN LAST MONTH'S ISSUE WE DISCUSSED THE MOLECULE and the atom, pointing out that the latter consists of a nucleus around which one or more electrons may orbit. By applying an electromotive force, or e.m.f., to an electric conductor there is a general movement of electrons in one direction, and this constitutes an electric current. The basic unit for e.m.f. is the volt, and the basic unit of current is the ampere.

Cells and Batteries

It will be helpful at this stage to introduce some practical sources of electromotive force with which we are all familiar. A commonly encountered source of electromotive force is the *cell*. Cells are employed (usually in twos or threes) in electric torches, and may have the appearance shown in Fig. 3 (*a*). The cell shown here (known as a dry Leclanché cell) has a zinc outer container and a central carbon rod fitted with a brass cap. Both zinc and brass are conductors, and the e.m.f. given by the cell is taken from the zinc container and the brass cap, the former providing the *negative terminal* and the latter the *positive terminal*. The e.m.f. is produced by the action of the chemicals enclosed in the zinc container and, in this instance, is of the order of 1.5 volts. Often, a sleeve of specially treated cardboard or paper is passed over the zinc container to provide insulation, whereupon connection to the cell terminals may be made at the top and bottom.

It is usual to use two or more cells in an electric torch, and these are connected together *in series*, as shown in the typical example of Fig. 3 (*b*). In this diagram the brass cap (positive terminal) of the lower cell connects to the zinc container (negative terminal) of the upper cell, the e.m.f. required by the torch bulb being taken from the upper brass cap and the lower zinc container. If two 1.5 volt cells are connected together in series in this manner, the total e.m.f. at the outer terminals is 3 volts.

Fig. 3 (*c*) shows three cells connected together in series. In this case the cells are mounted side by side, and the connections from one cell to the next are made by wires soldered to the zinc containers and brass caps. Once more the total e.m.f., appearing this time across two pieces of springy brass strip, is taken from the zinc container (negative terminal) at one end of the series arrangement, and the brass cap (positive terminal) at the other end. When three 1.5 volt cells are connected together in series the e.m.f. available at the outer terminals is 4.5 volts.

A series combination of two or more cells is known as a *battery*. As has already been inferred, the total e.m.f. produced by a number of cells connected together in series is equal to the sum of the individual e.m.f.'s. If we wished to construct a battery offering an e.m.f. of 90 volts (as would be used in a portable valve receiver) we could connect together, in series, 60 cells offering 1.5 volts each.

If we wish to do so, we may also connect two or more 1.5 volt cells together in *parallel*, as in Fig. 3 (*d*). In this case all the positive terminals are connected together, as are all the negative terminals. The e.m.f. available from this parallel combination is, however, only 1.5 volts; that is, the e.m.f. offered by any of the cells so connected. Whilst the parallel combination of cells does not cause an increase in e.m.f., it can cause an increase in the current which may be drawn. Let us assume that a single 1.5 volt cell is capable, under certain conditions, of causing a current of, say, 0.1 amp to flow when it is connected to an external circuit. Two such cells, connected in parallel, could then be capable of causing 0.2 amps to flow; three could be capable of causing 0.3 amps to flow; and so on. Thus, it may be said that connecting cells in parallel causes the total current capability to be the sum of the individual current capabilities.

However, this point, which is intended to demonstrate the result of connecting cells in parallel, must not be considered as necessarily representing a sound practical technique. For reasons which will become apparent later, cells are not normally connected in parallel to increase current capability unless they are identical, or nearly identical, in electrical performance.

Another type of cell with which we are familiar is the lead-acid cell employed in car batteries. The nominal e.m.f. provided by a lead-acid cell is 2 volts, and three such cells may be connected together in series to form a 6 volt car battery, or six cells connected together in series to form a 12 volt car battery. In a car battery the series connections from one cell to the next are normally made by heavy copper straps covered with lead to provide protection against corrosion. (See Fig. 4.)

Dry Leclanché cells of the type used in electric torches are not capable of being re-charged, and are discarded when they are exhausted. Cells of the type employed in car batteries may, on the other hand, be re-charged by passing an electric current through them. Cells which cannot be re-charged are known as *primary cells*, and those which can be re-charged as *secondary cells*. A number of other cells fall into these two categories. A typical example is the mercury cell. This is a primary cell offering an e.m.f. of some 1.3 volts which, because it has a relatively long life and can be given small physical dimensions, is especially useful for hearing aids, transistor receivers and other miniaturised equipment. Alternative secondary cells are the nickel-iron NiFe cell (1.3 volts nominal and a very robust type with applications in electrically powered vehicles), the nickel-cadmium alkaline cell (1.2 volts nominal), and the Venner silver-zinc cell (1.5 volts nominal). The latter two cells may be given small dimensions and can be employed in small-size equipment and powered models or vehicles, etc.

Two points of terminology need to be mentioned before proceeding further. A term fairly commonly used in place of "in parallel" is "in shunt". Thus, the cells of Fig. 3 (*d*) are *in shunt*. If a cell is connected in parallel with a second cell, it may be described as being *shunted* across the second cell. The term *accumulator* is frequently used to describe secondary cells, or to describe batteries made up from secondary cells.

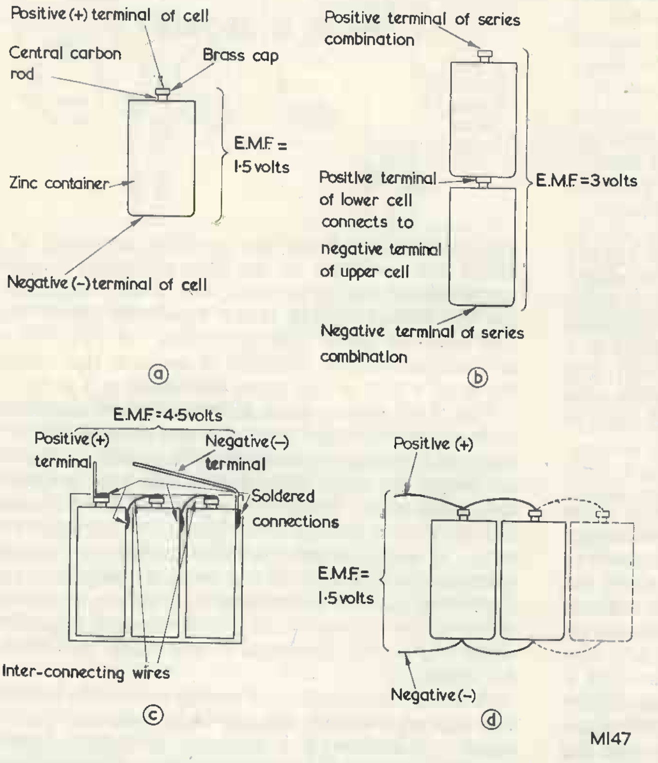


Fig. 3 (a). A dry Leclanché cell. Nominal e.m.f. is 1.5 volts, connection being made to the central brass cap and the zinc container

(b). Two dry cells in series, giving a total e.m.f. of 3 volts. An insulating cardboard sleeve may be fitted over the two cells shown here

(c). A familiar type of series cell arrangement employed in electric torches. In this instance the connections between cells are made with wire

(d). If two, or more, cells are connected in parallel, the total e.m.f. is still the same as for a single cell

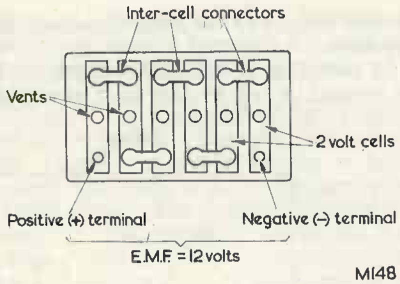


Fig. 4. A 12 volt car battery, consisting of six 2 volt cells connected in series

Circuit Symbols

It would, of course, be wasteful of time to reproduce actual cells when drawing up a circuit diagram, and so a readily recognisable symbol is employed instead. The circuit symbol for a cell is given in Fig. 5 (*a*), this consisting of a short thick line drawn parallel to a long thin line. The long line represents the positive terminal of the cell, and the short line represents the negative terminal.[1] Two cells connected in series may be represented as shown in Fig. 5 (*b*) and three cells in series as shown in Fig. 5 (*c*); but it is more usual to depict a battery (of any number of cells) in the manner shown in Fig. 5 (*d*), the total e.m.f. normally being indicated at an adjacent part of the diagram.

Potential

A very useful concept in radio and electrical engineering is that of potential difference.[2] Fig. 6 (*a*) illustrates a battery having an e.m.f. of 6 volts. It may then be said that there is a potential difference of 6 volts between the two terminals of the battery. It is usual to consider the earth as having *zero potential* and, if we connect the negative terminal of our battery to earth, as in Fig. 6 (*b*), we may then say that its positive terminal has a "positive potential of 6 volts with respect to earth". Reversing the battery, as in Fig. 6 (*c*), causes its negative terminal to have a "negative potential of 6 volts with respect to earth". The terms "above" and "below" are sometimes employed to qualify potential, and they correspond to "positive" and "negative" respectively. Thus, the positive terminal of Fig. 6 (*b*) may be described as being "6 volts above earth potential", and the negative terminal of Fig 6 (*c*) as being "6 volts below earth potential". Most electronic equipment is built on a metal chassis, and it is common to assume that the chassis has zero potential in just the same way as the earth (even though the chassis may not be connected to the earth). We may then encounter such expressions as "6 volts above chassis potential", and so on.

[1] A useful mnemonic here is to remember that a + sign (positive) has a longer "length of line" than a — sign (negative).

[2] Judging from the correspondence received when the "Understanding Television" series was published in *The Radio Constructor*, some readers have difficulty in visualising the concept of potential. In consequence, potential and potential difference are dealt with here at some length.

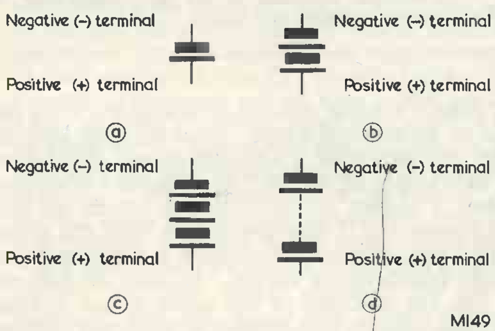


Fig. 5. Circuit symbols. That at (a) is for a single cell, and those at (b) and (c) for two and three cell batteries respectively. The symbol at (d) is for a battery with any number of cells, the total e.m.f. usually being indicated in the circuit diagram at an adjacent point

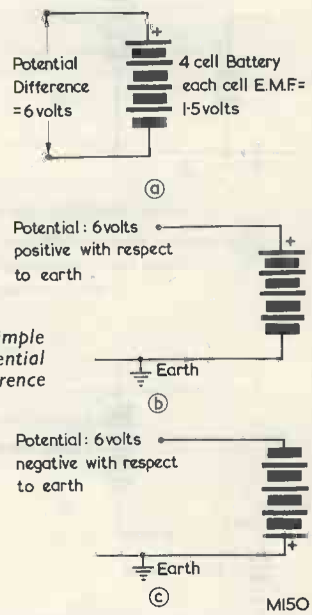
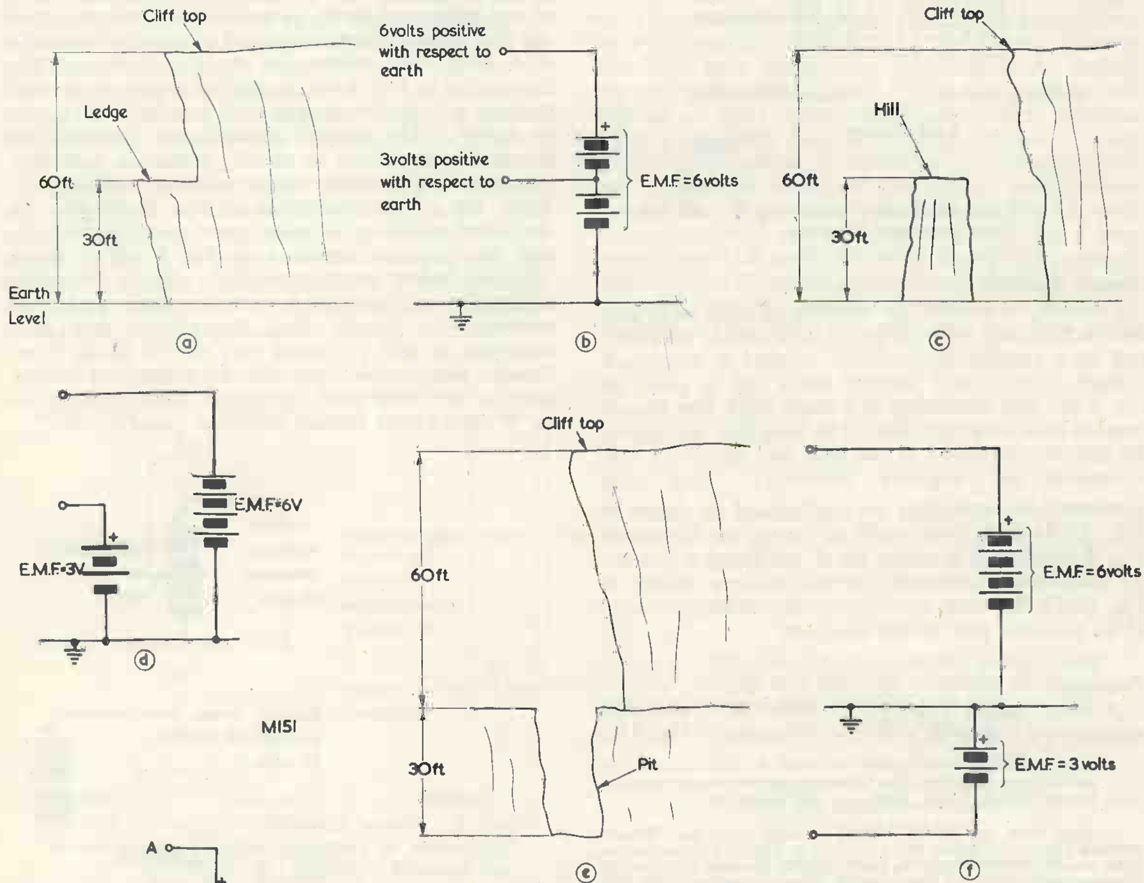


Fig. 6. Three simple illustrations of potential and potential difference

It is useful to make an analogy between potential and height. If we have a cliff 60 feet high with a ledge 30 feet below (Fig. 7 (*a*)), and there are stones on the cliff top and on the ledge, these stones possess potential energy. A stone capable of falling from the 30 feet ledge to earth level would have a potential energy which corresponded to a height of 30 feet. Similarly, a stone capable of falling from the cliff top to earth level would have a potential energy corresponding to a height of 60 feet. However, a stone on the cliff top capable of falling to the *ledge* would have a potential energy corresponding to a height of 30 feet only. Fig. 7 (*b*) shows a 6 volt battery having its negative terminal connected to earth and a connection made into it at the 3 volt terminal, *with respect to the centre terminal*, is only 3 volts positive.

Fig. 7 (*c*) shows the 60 feet cliff without the ledge. There is, instead, a hill 30 feet high alongside the



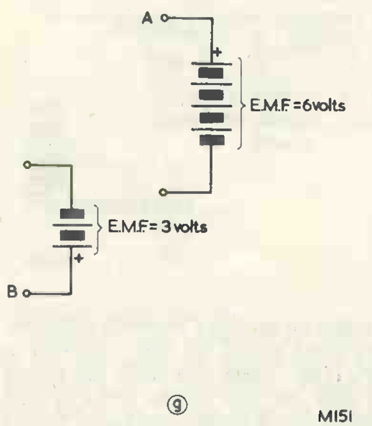


Fig. 7. Examples, discussed in the text, illustrating the analogy between potential and height

cliff edge. A stone capable of falling from the cliff edge on to this hill would, as in the case with the ledge, still only have a potential energy corresponding to a height of 30 feet. A similar set of circumstances is shown in Fig. 7 (*d*), in which we have taken away the 3 volt connection into the 6 volt battery and have added, instead, a separate 3 volt battery connected as shown. As with the cliff and the hill, the potential of the upper 6 volt terminal is 3 volts positive with respect to the upper terminal of the 3 volt battery.

Let us next add a pit 30 feet deep at the bottom of our 60 feet cliff. (Fig. 7 (*e*).) A stone capable of falling from the top of the cliff to the bottom of this pit now has a potential energy corresponding to a height of 90 feet. In Fig. 7 (*f*) we add a 3 volt

point. Just like the stones at the 30 and 60 feet levels, the potentials at the middle and top terminals are 3 and 6 volts positive respectively with respect to earth. And just like the stone which could only fall half way down the cliff, the potential of the top battery in a similar manner. The potential of the upper 6 volt battery terminal is now 9 volts positive with respect to the lower terminal of the 3 volt battery.

The exercises of Figs. 7 (*a*) to (*f*) should help to show the concept of potential and potential difference. Practical examples similar in basic principle to those described will be frequently encountered in radio work. The beginner should pay especial attention to the manner in which the 3 volt battery of Figs. 7 (*d*) and (*f*) is connected to the 6 volt battery. In Fig. 7 (*d*) its negative terminal is connected to the negative terminal of the 6 volt battery whilst, in Fig. 7 (*f*), it is its positive terminal which is so connected.

As a final example, let us examine the two batteries of Fig. 7 (*g*). What is the potential difference between terminals A and B? The answer is that no potential difference exists between these two terminals. This is because the batteries are not connected together at any point, and they become, in consequence, completely separate.

The term potential difference may be abbreviated to p.d., and it is expressed in volts in just the same manner as e.m.f. Frequently, the term is omitted altogether, whereupon the upper 6 volt battery terminal in Fig. 7 (*b*), (*d*) and (*f*) would be described as being "6 volts positive of earth". Again, the term *voltage* may be used, whereupon this terminal could be described as having "a positive voltage, above earth, of 6".[3]

We have introduced the term "earth" when discussing potential and potential difference. The fact that the earth may be considered as being at zero potential will be explained in a later article. We have also, in Figs. 6 and 7, introduced the circuit symbol for "earth".[4]

Resistance

If an e.m.f. is applied across a conductor, the current which flows will depend, amongst other things, on the material with which the conductor is made. We have seen[5] that the flow of electric current through a material is given by the flow of free electrons in the direction dictated by the *polarity* of the applied e.m.f. (Polarity refers, here, to the distinction between positive and negative terminals of the source of e.m.f.) Obviously, an infinite number of electrons cannot flow in the conductor. There must be a limiting factor, and this will in fact be given by the number of free electrons available and the ease with which they can pass through the material. Some materials allow the flow of electric current more readily than others, and they can be said to have a greater *conductance*. In radio work it is generally much easier to work with a reciprocal quality (i.e. one which decreases as the other increases, and vice versa) and so we refer to the *resistance* offered by conductors rather than to their conductance. Resistance is the opposition of a material to the flow of electric current.

The resistance of a conductor varies according to its dimensions. Let us assume that we have two equal-length wires having a square cross-section of the same area, as shown in Fig. 8 (*a*). Both wires are made of the same material and we can make connection to their ends. If we were to measure their resistance individually we would find them to be identical. In Fig. 8 (*b*) we connect the two wires in parallel.[6] If we were to measure the resistance

[3] The term voltage may also be encountered in place of e.m.f. Thus: "a battery has a voltage of 3".

[4] American terminology uses the word "ground" instead of "earth".

[5] In last month's article.

[6] In just the same way as we connected the cells of Fig. 3 (*d*) in parallel, except that there is no necessity here to consider polarity.

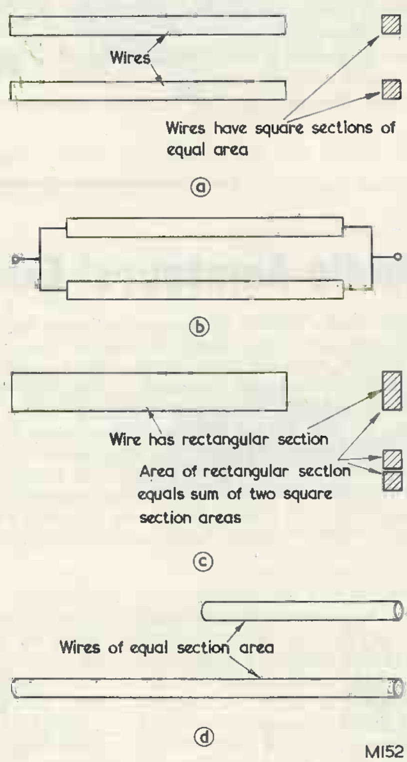


Fig. 8 (a). Two wires made of the same material, and having the same length and area of cross section. Both wires have the same resistance

(b). If the two wires are connected together in parallel, the total resistance is half that of either wire

(c). Another wire, having the same length but twice the cross-section area of the wires of (a) and (b), also has half the resistance

(d). The two wires shown here are made of the same material and have the same cross-section area. The lower wire is twice as long as the upper wire, and has twice the resistance

of this parallel combination we would find it to be exactly half that of either wire on its own. The reason for this is obvious enough: we now have, in the same length as before, twice as many free electrons to provide the current. Fig. 8 (*c*) shows a single wire having a rectangular cross section whose area is equal to the sum of the two square section areas of Fig. 8 (*a*) and (*b*). The resistance of this wire is the same as the parallel combination of Fig. 8 (b) because, once again, we have twice as many free electrons for the same length of wire. Comparing Fig. 8 (*c*) with Fig. 8 (*a*) we can see that by doubling the cross-sectional area of the wire we have halved its resistance. It could be shown by similar means that if we trebled the cross-sectional area we would reduce the resistance to a third of its original value, and so on. Summing up, it may be said that the resistance of a wire varies inversely as its cross-sectional area. For reasons of simplicity, we used wires with square cross-sections in Figs. 8 (*a*) to (*c*) but the relationship between resistance and cross-sectional area will obviously also hold true for wires with round cross-sections, or cross-sections of any other shape as well.

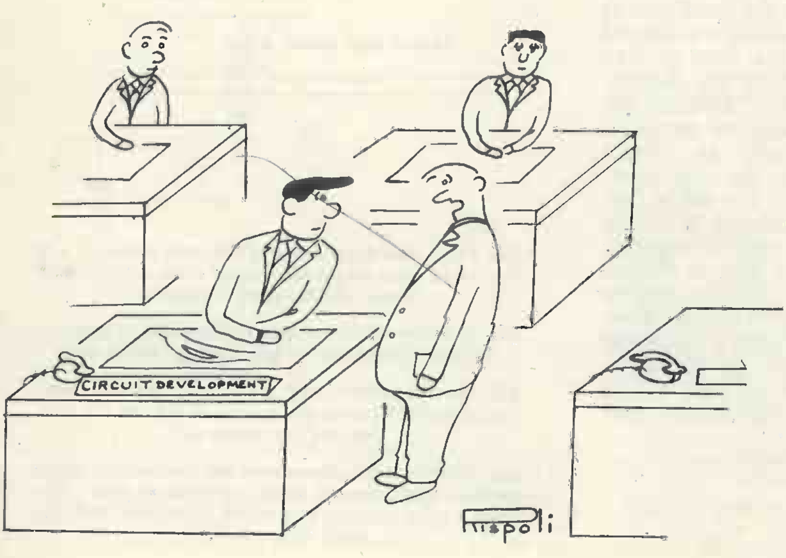
Fig. 8 (*d*) illustrates two wires of the same material and cross-sectional area. One wire, however, is twice as long as the other. Opposition to the flow of current in the longer wire will be two times greater because an e.m.f. applied to its ends will have to modify the movement of twice as many free electrons along its length. In consequence, the resistance of the longer wire will be twice that of the shorter wire. The same reasoning may be applied for other length ratios, and we can sum up by saying that, assuming constant cross-sectional area, the resistance of a conductor varies directly as its length.

Next Month

In next month's issue we shall carry on with resistance, introducing practical examples and covering Ohm's Law and power dissipation.

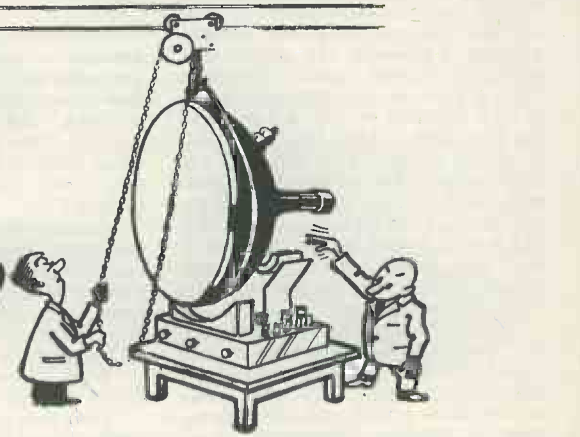
Radio Amateurs' Examination and Morse Classes

Grafton Radio Society announce that they have again made arrangements with Holloway L.C.C. Evening Institutes for official courses in the Radio Amateurs' Examination and Morse (both for beginners) to be held this winter at Montem School, Hornsey Road, Holloway, London, N.7. The classes will meet on Mondays, with repeat lectures on Tuesdays and Wednesdays, commencing Monday 25th September—R.A.E. at 7–9 p.m. (instructors S. Iles (G3BWQ) and P. Bernal (G3KQZ), followed by Morse 9–10 p.m. (instructors L. Barber and A. Ralph). The fee for either course will be 20s., or 22s. 6d. for the two. Enrolment will be at the school any evening (7–9 p.m.) Monday to Friday during the week 18th–22nd September, but application in the first instance should be made to the Grafton Radio Society Hon. Secretary, A. W. H. Wennell (G2CJN), 145 Uxendon Hill, Wembley Park, Middlesex, so that a place may be assured. Of the 30 who sat the May City & Guilds examination, 23 passed making a grand total of 157 in eight years. In addition to the above, the club meet in the same room on Friday evenings for the usual club activity, including two transmitters and a monthly SWL meeting, commencing Friday 8th September, new members and visitors being especially welcome.



"THE DEPARTMENT IS VERY INTERESTED IN CIRCUITS, JONES, BUT NOT THE ONE AT GOODWOOD!"

In your Workshop



This month Smithy the Serviceman, and his able assistant Dick, discuss a subject which has been requested by a number of readers, that of bringing old sound receivers back into service

"ISN'T IT FUNNY," REMARKED DICK, as he reached for his packet of lunch-time sandwiches, "the way the t.v. sets drop off at the end of the Summer ?"

Smithy looked round the Workshop. The racks, which normally carried a full complement of television sets in for repair now held a few only, these being interspersed with record players and transistor radios. Several venerable broadcast receivers stood sedately on one of the shelves, their sober wooden cabinets contrasting strongly against the gay and brightly coloured plastic cases of their successors.

"We've got some really *antediluvian* jobs in as well," continued Smithy's assistant. "Just look at that old-timer over there !"

Dick pointed with scorn at a battered receiver which must have seen at least two decades of service.

"I suppose," said Smithy, referring to Dick's first point, "that t.v. repairs have eased off because the Summer weather has kept the insides of the sets nice and dry. Anyway, it's time we started our lunch. Have a sandwich !"

Old A.M. Receivers

Dick looked suspiciously at the sandwich offered by Smithy.

"What sort is it ?"

"Corned beef," said Smithy heartily, "and full of vitamins."

The Serviceman glanced at Dick's lunch package, and a momentary gleam of cupidity shone in his eyes.

"I see you've got tinned salmon sandwiches today," he continued casually. "I'll swap this for one of yours !"

Very unwillingly, Dick took Smithy's sandwich and handed one of his own back in return. Smithy attacked it with great gusto.

"Why *do* we fix these old sets, anyway," queried Dick, as he bit listlessly into Smithy's corned beef sandwich. "There are quite a few service establishments which won't even look at them, you know."

"That's true enough," replied Smithy, his mouth full. "But don't forget that we don't always repair them ourselves, either. If we think the set is beyond economic repair we tell the customer accordingly."

Silence descended on the pair for a moment as they sprawled comfortably in the battered Workshop chairs and enjoyed the lunch-time lull in their labours.

"We've got an old Medium and Long wave set at home," volunteered Dick ruminatively, after a moment's deep thought. "It packed in about five years ago and we just stowed it away in the attic. I wonder if it would be worthwhile getting it out again and see if it can be repaired. After all, we could always use it as a standby set, or hitch it up in somebody's bedroom if they became ill."

"It mightn't be a bad idea," replied Smithy. "Very often all that goes wrong with these older sets is a single simple fault. But, because they've attained the dignity of years, people look upon them as being 'worn out' and just sling them away."

"So our old set at home," pursued Dick, his interest aroused, "could quite possibly have little more wrong with it than, say, a broken down condenser or something like that ?"

"That's right."

Dick digested this information.

"There must be quite a number of people," he commented, "with old radios of this type which could possibly be fixed up quite easily. How would you set about the job ?"

"Well," replied Smithy. "Before you started you would need to be quite clear in your own mind exactly what it is you want to do. A common-sense approach would be to say that if the old radio can be made good enough to bring in the Home and Light programmes reliably then it would make a useful standby set for the sickroom or, perhaps, the kitchen. Incidentally I would, personally, only tackle mains superhets and I would, even then, make certain reservations. Given an acceptable mains superhet, it shouldn't in fact be asking too much to expect fairly reasonable reception of, say, Radio Luxembourg as well as the Home and the Light. And I would suggest that some three to four hours for repairs would represent a sensible maximum time. However, that last point depends on the views of the individual carrying out the repair."

"It seems fair enough to me," said Dick, his enthusiasm mounting, "considering that you are getting a reasonable standby radio as a result of the work. What's the next step?"

"The next step," replied Smithy, "is the very important one of examining the old set and seeing whether it's worth the trouble of getting it to work again. The first thing is that, in my opinion, it's *got* to be a superhet or you're just wasting your time. Also, the i.f. should be in the range 455 to 475 kc/s. I must admit that some old supers with 126.5 kc/s are still, believe it or not, giving good service. If you feel like having a bash at any of these I wish you luck, but don't ask me where you're going to get replacement i.f. transformers !

"After ensuring that it's a superhet, check the valve line-up. Apart from the rectifier, you should have a frequency-changer, i.f. pentode, double-diode-triode, and output pentode or tetrode. Sometimes, you may get a single diode instead of the double diode, and it might just possibly be tucked away in the i.f. pentode. You might even have a Westector diode, this being normally replaceable, with advantage, by a crystal diode. If you haven't got the four amplifying valves, plus the diode or diodes, I would personally advise against proceeding further if you're interested in a quick economic repair. You just won't have the gain to play with."

"That's narrowing the field a bit, isn't it ?" queried Dick.

"Not really," replied Smithy. "Many sets produced in the late 30's had this valve line-up and so did practically all post-war sets."

"What about an r.f. stage ?"

"Not very common in this country."

"Is the valve line-up the only thing you need to check ?"

"Good heavens, no!" replied Smithy. "There are lots of other things you have to look out for as well. Valve heater voltages are the next point If these are connected in parallel they should be 6.3 volts. If they're not, I should think twice before tackling the set Incidentally, would you like another sandwich ?"

Dick, suddenly jolted from his thoughts of bringing his old receiver at home back to life again, looked at the Serviceman with suspicion.

"What is it this time ?"

"Cheese," said Smithy brightly.

"Just *cheese* ?"

"Yes," replied Smithy firmly.

"Don't say you want another of my tinned salmon ones !"

"That's a nice friendly spirit, I must say," complained Smithy. "The world's come to a pretty bad pass if two people who work together can't share their lunch in an egalitarian, comradely and unselfish spirit !"

Reluctantly, Dick handed over another of his salmon sandwiches and regarded that given him by the Serviceman with marked distaste.

"Why," he asked, attacking it gingerly, "don't you think it's worthwhile bothering with parallel-wired sets which don't have 6.3 volt heaters ?"

"Because there are no modern replacement types," replied Smithy, munching cheerfully. "If the set has a series heater string rather the same applies. An 0.3 amp string is the most attractive, followed by an 0.15 amp string."

"What about 0.2 amp strings ? Plenty of English sets had these."

"Yes, they're O.K. too," agreed Smithy, "and there are still plenty of 0.2 amp valves in the surplus market which may help out here as well.

"The next thing to check," continued Smithy, "is the valveholder type. If the valveholders are side-contact or a similar obsolete type you can take a risk that the valves currently fitted are O.K., but you must first ensure that the layout allows you to swap over to International Octal whenever you want to fit a replacement valve. That's a decision you can make yourself easily enough, of course."

Push-Button Tuning

"Anything else to keep an eye open for ?"

Smith thought for a moment.

"An important feature," he remarked, "is the tuning arrangement. If this consists of a nice simple cord reduction drive, you won't have much trouble here. On the other hand, if the tuning arrangement employs one of those fantastic combinations of cord, cogwheels and Bowden cable which used to be so popular in the old days it would probably be better to give the set a miss and return it to the cobwebs. Again, the decision is up to you. Rather the same applies if the set had push-button tuning. Before you start, you want to check the button mechanism to see that it's not worn out, and that the contacts haven't become too heavily oxydised over the years. It's just a waste of time trying to repair an old set if the push-button tuning mechanism, for which spares will not be available, is past its useful life."

"All that seems sensible enough," commented Dick. "Where do we go from there ?"

"There's nothing much else to do in the preliminary examination," said Smithy, "except to have a look at the cabinet and, also, to make certain that the set hasn't been stored in too damp a place, with the result that the chassis is a fruitful source of verdigris and plant life."

Checking Out

"I'm with this so far," said Dick. "We've dug out the old set and given it a preliminary butcher's which shows that it might be worth the trouble of putting it into working order. What's the next job ?"

"I would next get the works out," replied Smithy, "and give them a good old blow-out to clear the fluff and grime away. After which you can get down to real business. First of all, look over the chassis for obvious burn-ups. If there are any, you trace the faults causing them in the normal manner. After that, you can quickly check the h.t. positive line to chassis for shorts, apply the mains and switch on. If the set is *very* old and hasn't been used for a long time I wouldn't stand too close for the first few moments."

"Hey ?"

"I'm quite serious," grinned Smithy. "There's just a faint risk of the electrolytics going pop when they first get h.t. on them ! It's extremely improbable, incidentally, but the risk exists. After switching on you're on your own, and you follow normal servicing practice. If the valves light up you know that the heater chain or the primary and heater windings of the mains transformer, as the case may be, are O.K. Next, check to see whether there's any h.t., what sort of noise is coming out of the speaker, whether the h.t. is getting through to the anodes and screen-grids, and so on. In other words you carry out pretty well the same tests you make on any Medium and Long wave receiver which comes in for repair."

"Are there any general points to watch out for when servicing these old receivers ?" asked Dick, surreptitiously reaching for another sandwich.

"Have another of mine," said Smithy genially.

Dick examined the proffered sandwich with an expression of revulsion.

"There's a big red stain on it."

"That's because it's a jam sandwich."

"Jam ?"

"Raspberry jam," explained Smithy, coaxingly.

"You certainly go in," commented Dick, "for *grisly* lunches."

"Nonsense," said the Serviceman,

taking, with a masterful and adroit gesture, a further salmon sandwich from his protesting assistant. "It's just that I like a little variety in my food, that's all."

Dick frowned darkly at the jam sandwich which had appeared in his hand, but made no comment.

General Points

"You asked me just now," said Smithy, chewing happily, "whether there are any general points to look out for when servicing these earlier receivers. As a matter of fact, there are.

"The first thing to look out for is electrolytic condensers. I said just now that there's a very slight risk of their going pop when they first get h.t. on them. At the same time, it's much more possible for them to lose their capacity with the passage of the years. When the set is really ancient it's not a bad idea to replace the h.t. electrolytics as a matter of routine; and you may find that this automatically clears a lot of other troubles in the receiver as well. The new condensers should of course have approximately the same capacity as is marked on the case of those they replace You want to watch out for working voltage, incidentally, especially in the reservoir condenser. Some of the old sets had energised speakers (Fig. 1), the energising coil acting as an h.t smoothing choke. The resistance of such a coil is usually much greater than that of a choke, with the result that the voltage on the cathode of the rectifier and, hence, that applied to the reservoir condenser, would be quite a lot higher than that on the smoothed h.t. line. Another point is that it is inadvisable to replace reservoir condensers with new components having much larger values. The increased reservoir capacity could cause the rectifier to pass higher charging currents than it was designed for.

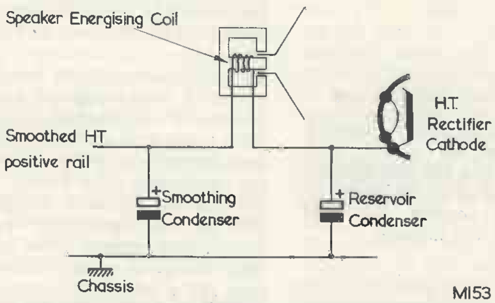


Fig. 1. In some early sound receivers the speaker energising coil also served as an h.t. smoothing choke. Because of its relatively high resistance this could necessitate a high working voltage for the reservoir condenser

"Paper condensers may also have got leaky in these old sets, and you want to keep a special look-out for leaky condensers in anode-to-grid a.f. coupling circuits. There were quite a few mica condensers in these sets as well, especially in the r.f. circuits. Sometimes, these condensers were just varnish impregnated, whereupon they became particularly susceptible to physical damage. Connection to the plates was made by rivets (Fig. 2), and you might well get an intermittent here."

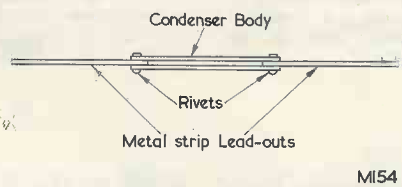


Fig. 2. In early mica condensers lead-out connections were made with the aid of rivets, as shown here. Such connections occasionally became intermittent, particularly when the condensers were varnish impregnated and had little physical protection in consequence

"What about i.f. transformers ?"

"You want to treat these with care," replied Smithy, "particularly when you're lining them up. Most of the old i.f. transformers had variable capacity trimmers with 'live' adjusting screws, some of which might connect to h.t. positive. Since the trimmer screws have to be reached through holes in the can, they should be adjusted with screwdrivers made of insulating material. If the screws are so tight you *have* to use a metal screwdriver, I should pop some sleeving over the shaft to prevent shorts to the can (Fig. 3). If the i.f. transformers had dust cores with an integral screwdriver slot you should proceed with great caution, because the cores may have become brittle over the years and any core-locking compound that was used may have hardened up. Use an insulated screwdriver that really *fits* the slots in the cores."

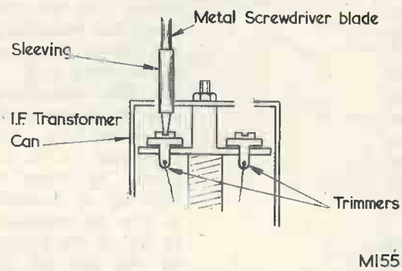


Fig. 3. I.F. transformers in old receivers had capacitive trimmers whose adjusting screws might be "live" to one end of the winding they tuned. A piece of sleeving slipped over a metal adjusting screwdriver blade prevents short-circuits to the can

"Is it worth swapping i.f. transformers on spec," asked Dick, "like the h.t. electrolytics ?"

"Oh no," replied smithy. "You only want to change i.f. transformers if they have a definite snag. Most of the transformers employed in these old sets had really high Q's."

"Are there any other things to look out for whilst lining them up ?"

"Not really," replied Smithy. "Just line them up like you would a modern receiver. There were one or two smaller receivers, however, which needed a little extra treatment. These had the tuning condenser fitted directly to the chassis without rubber mountings. If you got the i.f's. in these sets spot on frequency there was a tendency to go into audio oscillation when you tuned in a station. The reason was that the i.f. response was too sharp and you were getting feedback from the speaker back to the tuning condenser."

"I know the effect," chimed in Dick. "The sound from the speaker gets back to the tuning condenser, vibrates the vanes and frequency modulates the signal. The resultant f.m. is changed to a.m. on the skirts of the i.f. response and is applied to the speaker."

"That's the idea," confirmed Smithy. "The whole arrangement gives you a positive feedback loop. Anyway, if you get this effect after lining-up it's best to slacken off the alignment a little. You can easily rock your signal genny when you're doing this, to see if you're still getting a decent response."

Smithy took a sandwich from the packet at his side, and looked at it with interest.

"What happens if you haven't *got* a signal genny ?" asked Dick, his eyes glued to Smithy's movements.

"Tune in a station and rock the receiver tuning condenser across it," replied Smithy. "This'll give you a fair idea of what the response is like."

The R.F. Stages

"What about the r.f. circuits in these old sets ?"

"Well," replied Smithy, "these tended to be pretty complicated in some cases, with bandpass coupling and all manner of things like that. The best thing to do here is to leave them severely alone, apart from trimming, if they appear to be working reasonably well. And don't expect too much from any Short wave bands that may be fitted, because these were a bit of a joke in some receivers. In any case the whole point of the repair is to obtain a standby set capable of picking up the Home and Light programmes. Don't forget that, provided the oscillator is working, you can always get *some* sort of signal into the i.f. and a.f. stages merely by applying a short aerial to the signal grid of the frequency-changer via a 100 pF condenser (Fig. 4), and this can be jolly useful for test purposes. Since the signal grid often appeared as a top cap in early frequency-changers, the process of applying the aerial can be quite a simple operation."

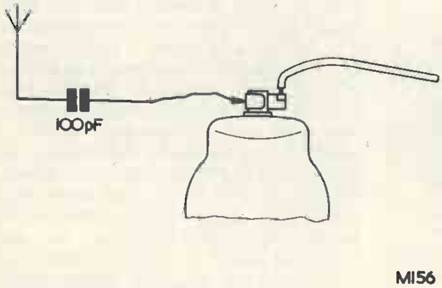


Fig. 4. Early frequency-changers usually had the signal grid brought out to a top cap connection. This enabled an aerial to be readily coupled into the receiver for test purposes

Smithy looked fondly at his sandwich, but made no attempt to eat it.

"Could r.f. instability be a problem ?" asked Dick, tearing his attention away from Smithy's actions.

"Not normally," replied the Serviceman. "But you might get quite a lot of trouble with i.f. instability. You see, it's at the intermediate frequency that most amplification in an a.m. sound receiver takes place. This holds true for modern sets as well, of course. With the old sets there was a very common cause of i.f. instability which I should tell you about. The i.f. valve was frequently covered with metallising to provide a screen, this metallising being connected to a wire wrapped around the bottom of the glass envelope. If the glass came unstuck from its base, the metallising would break away from the earth wire (Fig. 5 (a)). The cure for this was to stick the glass back into the base again and wrap tinned copper wire several times around the metallising at the bottom. You then ran a lead down the side of the valve base to the pin the metallising normally connected to, and soldered at this pin (Fig. 5 (b)). This cure earthed the metallising and cleared the i.f. instability."

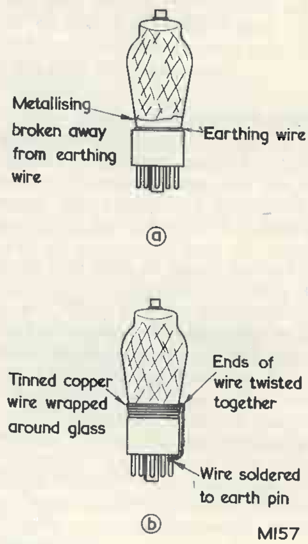


Fig. 5 (a). A common fault with metallised valves. In this diagram the metallising has broken away from the earthing wire.
(b) The metallising may be re-connected as shown here. The connection to the pin should be made as high up as possible. It may be necessary to file off the plating on the pin at the point of connection to enable a reliable solder joint to be made

Smithy paused reflectively and looked down at his hands.

"Dear me," he said, in a nostalgic tone of voice, "I wish I had as many pounds as I've cleared i.f. instability that way !"

Dick's mind, however, was not on the past but on the immediate present.

"I do wish you'd do something with that sandwich you're holding," he remarked irritably. "It's getting on my nerves your looking at it all the time."

"Ah," said Smithy, "this one's special. I want to *savour* it."

"Yes, but what's in it?"

"I would prefer not to tell you at this stage," replied Smithy equably.

Dick sighed.

"Well," he said resignedly. "I shall have to give way in the end, I suppose, if only to satisfy my curiosity. Pass it over!"

Smithy obeyed with alacrity, and two further sandwiches changed hands.

"This," remarked Dick, after an incredulous examination of Smithy's offering, "is just about the end! Until this moment I never even realised that you could *have* a dripping sandwich."

"I thought you'd like it," said Smithy. "Dripping is a very rich source of protein and carbohydrates. And it's absolutely crawling with calories."

Smithy's assistant gave a violent shudder.

"Well," he remarked, "you've wolfed all my tinned salmon sandwiches, so I suppose I'll just have to eat this horrible thing. What it will do to my stomach I hesitate to think."

"It'll do it the world of good," said Smithy, smacking his lips. "Give the old digestive juices something to *really* work on."

"Perhaps you're right," said Dick.

He thought for a moment.

"Anyway," he continued darkly, "it's better than ptomaine poisioning."

Smithy looked suspiciously at his assistant.

"What did you say?"

"Just a thought," said Dick hastily. "Anyway, let's get back to these old receivers. What about speakers, for instance? I should imagine that these would be one of the first things to replace."

Loudspeakers

"Funnily enough," replied Smithy, "that's not entirely true. If the set has been stored reasonably well you will often find that the speaker gives quite adequate reproduction. Not hi-fi, of course, but certainly good enough for a Medium and Long wave receiver which is only intended to be a standby anyway. You would be surprised, in fact, to hear how good some of those old sets sound. Should the speaker seem a bit scratchy it may need re-centring, but that isn't too hard a task if you're careful about it."

"How would you set about it yourself?"

"There are several ways of doing it," replied Smithy, "but what I've always done with cheaper speakers is to centre them by eye. You first of all place the speaker, magnet downwards, on the bench and very lightly hold the cone on either side of the centre with your two hands. (Fig. 6 (a)). You have your thumbs on the top and your fingers, passed through the gaps in the metal frame, on the back of the cone. Then you carefully raise and lower the cone, allowing its own suspension to guide it and keeping pressure exactly the same on both sides, and listen and *feel* for any interference between the coil and the pole-pieces. If there is, you loosen the centre-screw of the flexible 'spider' in the middle of the cone (Fig. 6 (b)) and carefully re-set the cone so that it looks central. Tighten up the centre-screw again and test once more for interference. It may be necessary to carry out this operation several times, because the final turn of the centre-screw sometimes shifts the 'spider' slightly. The process sounds a bit fiddling but it's pretty easy in practice once you've got the knack. The important thing is to treat the cone as gently as possible."

"It sounds a bit hit-and-miss to me," remarked Dick.

"I don't know," replied Smithy. "It's worked well for me in the past. I must add, though, that this technique is intended for old receiver loudspeakers with central 'spiders' only, and is most definitely *not* recommended for expensive high fidelity units, or anything of that order. In the latter case you must follow the manufacturer's instructions. With modern television and radio speakers, of course, no centring adjustment is normally available, as they are pre-set at the factory."

Smithy paused and lit a cigarette.

"I like a smoke after my lunch," he pronounced grandly. "By the way, what was that you said just now about poisoning?"

"I was referring to ptomaine poisoning," replied Dick carelessly. "It's a loose term for the poisoning you get from food that's gone bad. Like tinned food."

"Yes," said Smithy, thoughtfully. "I thought you mentioned something like that. But why raise the matter now?"

"Oh, it was a little thing I just remembered," said Dick, in an offhand tone. "About tins bulging."

"Bulging?"

"Before you open them. Apparently, if the ends of a tin of food bulge outwards it means that the contents have gone bad and have realeased a lot of gas. Gone putrid, in fact."

Smithy looked uncomfortable and

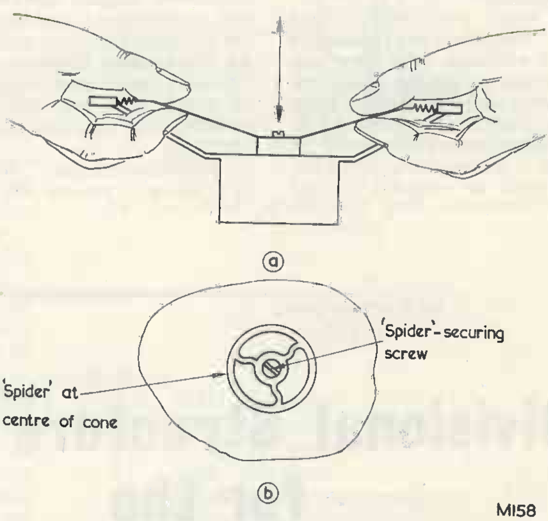


Fig. 6 (a). Part of the process of centring a loudspeaker, as described by Smithy

(b). The "spider" at the centre of the speaker cone. The spider-securing screw fits to the centre pole-piece of the magnet assembly

stubbed out his cigarette.

"It seems a funny sort of subject to bring up," he remarked eventually.

"Perhaps so," said Dick artlessly. "Anyway, we're getting off the point. I suppose you've got to replace the speaker in these old sets sometimes."

"Oh, yes," replied Smithy, returning thankfully to the subject of old receivers. "Such replacements would be most frequent in sets with small cabinets which dissipated a lot of heat. This heat could, with time, dry out the cone and voice coil former, causing them to be distorted out of shape and brittle."

"What happens if it was an energised speaker?" asked Dick. "You don't get energised speakers nowadays."

"You just replace it with an ordinary permanent magnet speaker."

"Yes," insisted Dick, "but what about the energising coil itself? You said just now that this may act as a smoothing choke. But you can't replace it with a choke directly because the latter would have a much lower resistance."

"I see what you mean," said Smithy. "Well, there are three ways out of this problem. An easy way consists of unscrewing the energising coil, complete with pole-pieces, from the speaker frame and mounting it in a convenient place in the cabinet. It will still act as a smoothing choke but it won't now be coupled to the speaker. The second way out of the trouble consists of replacing the energising coil by an ordinary choke in series with a resistor which brings the total resistance up to that of the original coil. The third method if you can get away with it, consists of simply replacing the energising coil with a resistor of the same resistance. If this results in hum you then have to try and remove it by increasing the value of the smoothing condenser—*not* the reservoir condenser—after the resistor. You should be able to get hum-free reproduction in most cases with this technique.

"You may find, by the way, that energised speakers had hum-bucking coils connected in series with the voice coil. These coils were mounted inside the energising coil assembly, and their purpose was to apply a current to the voice coil which cancelled out the small variations in magnetic field produced by the energising coil acting as a choke. You simply forget about hum-bucking coils when you fit a replacement permanent magnet speaker and connect the speaker transformer secondary direct to the voice coil."

An Unanswered Question

"And that," concluded Smithy, "is pretty well the whole story on bringing old receivers back to life again."

"Thanks, Smithy," said Dick. "I'm going to get out that old set of ours tonight and see if it's worth having a go at."

There was silence for a moment. Dick waited expectantly.

"I suppose," Smithy started, then relapsed into silence.

"Yes?" said Dick brightly.

Smithy swallowed, and tried another approach.

"Well," he remarked. "*You* had some of those tinned salmon sandwiches, didn't you?"

"I did not," replied Dick aggrievedly. "You scoffed the lot."

Smithy looked unhappy, and Dick decided to relent.

"I was just pulling your leg," he said, "about the salmon being bad."

"Thank goodness for that," said Smithy in a relieved tone. "It would have been terrible if we'd both been off sick together."

"Together?"

"Yes," said the Serviceman innocently. "Didn't you notice anything funny about that dripping."

"Oh, come off it," said Dick indignantly, "don't try the same trick on me!"

"Well," replied Smithy, shrugging his shoulders. "I only thought I'd mention it."

Dick sighed. He knew it would take a good half-hour to get Smithy to admit there was nothing wrong with the dripping. But what can you *do* with a guv'nor who insists on getting the last word?

A Divisional Structure for the Institution of Electrical Engineers

Much of the scientific work of the Institution has been for many years conducted by four Specialised Sections (Electronics and Communications, Measurement and Control, Supply, and Utilisation).

The Council have decided that it will be advantageous for the four Sections to be replaced by three Divisions, two of which will represent "Electronics" and "Power" interests, while the third, a "General" Division, will cover activities of common interest to all electrical engineers, such as basic measurement and technological education.

Each of the Divisions will comprise a number of Technical Groups designed to cover the specialisations within its field, and the scheme provides for speedy readjustment and creation of these Technical Groups which will increase the flexibility which is now more than ever necessary to reflect the rapid developments of electrical science and engineering.

In setting up a divisional structure the Council also recognise the increasing importance of electronics in electrical engineering, and the part being played by electronics engineers in the work of the Institution which has resulted in its present position as the professional home of electronics engineers.

Minor bye-law changes will be required, mainly of terminology, and these will be put to the membership at a Special General Meeting in due course.

Microphone Pre-amplifiers

Attenuators and Mixers

by F. C. JUDD, A.Inst.E.

Microphone Pre-amplifiers

A PRE-AMPLIFIER IS REALLY A *voltage* AMPLIFIER suitable for operation from very low level input sources, but with output characteristics suitable for matching to an amplifier having provision for high level input only. It is commonly used with most low level microphones and some types of gramophone pick-up in order to build up the signal from these sources to approximately 1 volt r.m.s. across a high impedance. This allows a volume control or attenuator to be placed between the pre-amplifier and the main amplifier. In some cases, however, the volume control may be included in the pre-amplifier itself and between stages if more than one valve is used. It is not good practice to have a variable attenuator at the *input* to a high gain pre-amplifier unless the input signal is very large. If the signal must be limited, it is better to incorporate a fixed attenuator in the grid circuit and use a variable attenuator *after* the first amplifier. The pre-amplifier requires the same design consideration as any other voltage amplifier and particular attention must be paid to hum pick-up, noise and microphony (ringing effects from the valves), all of which present their special problems.

Random noise includes both thermal agitation and valve noise, much of the energy of this noise being distributed uniformly over the whole of the frequency spectrum. Noise also comes from circuit components such as resistors, and this will be added to that from thermal agitation, etc. Most of the noise in a low level amplifier is due to three principal causes; noise from the anode load resistor, valve noise, and noise in the grid (input) circuit. Other, smaller, contributions may come from the screen and cathode circuits. Much of the noise may, however, be reduced by the use of high stability cracked carbon resistors and by limiting the pre-amplifier h.t. supply to between 100 and 200V.

Valve noise may be reduced somewhat by using triode valves, but at the expense of losing gain and the possible introduction of hum. Practice generally is to use a low noise pentode valve such as the Mullard EF86 which has been specially designed as a high gain, low microphony, low noise amplifier valve. There are other sources of noise; namely, leakage in the valve itself between the grid and other electrodes or from resistive paths likely to be found in poor quality valveholders and from reversed grid current.

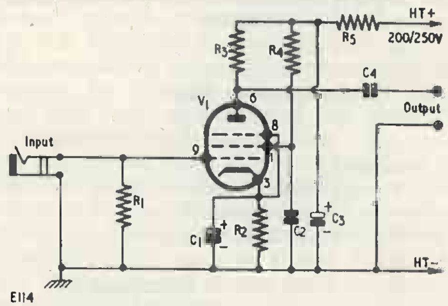


Fig. 1. Circuit of the high gain microphone pre-amplifier

Components List
(Fig. 1)

Resistors

R_1	5MΩ Hi-Stab
R_2	2.2kΩ Hi-Stab
R_3	100kΩ Hi-Stab
R_4	390kΩ Hi-Stab
R_5	47kΩ carbon (composition)

Condensers

C_1	50μF electrolytic
C_2	0.25μF paper
C_3	16μF electrolytic
C_4	0.1μF paper

Valve

V_1	EF86 Mullard

If the output source is of low impedance and coupled to the grid by means of a step-up transformer, it is not always necessary to design for minimum valve noise. In this case the input circuit should be arranged so that the microphone impedance reflected into the grid is at least twice, but better, four times that of the valve noise resistance.

This may be accomplished by using a transformer *secondary* impedance of 25 to 40KΩ in which case valve noise will have a very small effect on the total noise. This allows a more satisfactory use of high mu triodes and pentodes.

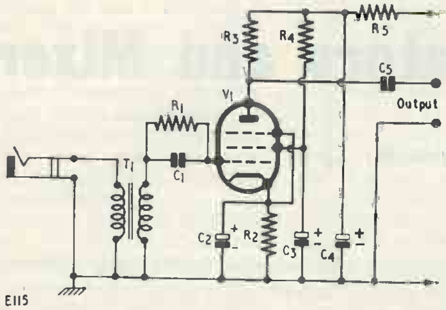


Fig. 2. Circuit of a pre-amplifier for a low impedance microphone

Components List
(Fig. 2)

Resistors

R_1	1MΩ Hi-Stab
R_2	2.2kΩ Hi-Stab
R_3	100kΩ Hi-Stab
R_4	390kΩ Hi-Stab
R_5	47kΩ carbon (composition)

Condensers

C_1	0.05μF paper
C_2	50μF electrolytic
C_3	16μF electrolytic
C_4	16μF electrolytic
C_5	0.1μF paper

Valve

V_1	EF86 Mullard

Transformer

T_1	Microphone, 100:1

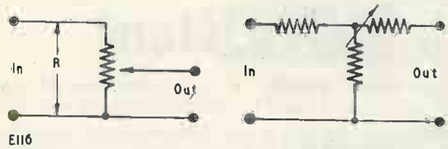


Fig. 3 (left). Continuously variable volume control (attenuator). Fig. 4. Constant impedance attenuator (T type)

Hum

In a pre-amplifier the permissible hum voltage present at the grid of the first valve depends somewhat on the maximum available signal input. If a matching transformer with a high ratio and a reflected secondary impedance of 25KΩ or more is used, the signal level will be high and an extremely low hum level is not quite so necessary. If, however, a low level microphone or pick-up is directly connected into the grid circuit without a transformer, considerable care will be needed in preventing the circulation of hum currents and their introduction into the grid itself. The following precautions should be taken when considering design and construction:

(1) The amplifier valve, associated wiring and components must be carefully screened.

(2) Matching transformers must be electro-magnetically shielded from stray 50 c/s fields. This can only be successfully accomplished by the use of mu-metal screens, orientation of the transformer and for exceptionally low level hum, by the use of hum-bucking coils.

(3) Care must be taken over all "earth" connections. Hum loops can be formed even by external cables. These loops will often induce currents into the grid and cathode circuits of the valve itself.

(4) Heater wiring should be twisted and taken by a suitable route in order to avoid coupling with other leads and components.

(5) Valves should be mounted away from mains supply transformers and electrostatically screened.

(6) If exceptionally high gain is required it may be necessary to drive the amplifier from pure d.c. supplies, e.g. batteries.

(7) D.C. h.t. supplies derived from 50 c/s mains must be well smoothed and decoupled.

In practice the limit on amplification is set by the noise level due to thermal agitation in the grid circuit of the first valve, plus some of the noise generated by the valve itself. For a bandwidth of about 15,000 c/s noise due to thermal agitation may be about −129dBm.[1] If the effective microphone level is taken as, say, −60dBm with an unloaded microphone, the maximum possible signal to noise ratio will be about 72dB. The figure would be reduced to around 68 to 69dB for a loaded microphone. In actual practice, and because of other contributing factors such as hum fields, overall noise may be considered satisfactory if it is within 10dB of the thermal noise.

When crystal microphones are used, almost the whole of the microphone noise emanates from the grid resistance, the signal to noise ratio being poorest for values around 100KΩ. Improvement is gained if the grid resistance is made smaller but this, however, will affect the frequency response of the microphone. The alternative is to make the grid resistor very much larger, a value as high as 50MΩ being indicated for very low noise. In practice, a value around 5MΩ is used and this is a good compromise for a noise voltage of 4μV or so (this equals approximately −108dBv ref: 0dB=1V). The noise resistance of a pentode is negligible by comparison

[1] dBm indicates power expressed in decibels with 0dB=1mW.

and thus permits a signal to noise ratio of at least 60dB with diaphragm and sound cell types of microphone.

A Signal Stage Microphone Pre-amplifier

The circuit of Fig. 1 shows a simple pre-amplifier, suitable for a crystal microphone of the diaphragm type with a sound pressure of around 10 dynes/cm^2. It is an amplifier suitable for recording purposes and for use in a combination mixer circuit where two or more inputs may be fed into an attenuator network like that of Fig. 6. A recommended valve is the Mullard EF86 for which the anode, grid and screen resistors should be high stability cracked carbon types.

For low impedance ribbon and moving coil microphones the circuit of Fig. 2 should be used. This employs the same valve but requires a step-up transformer to obtain a correct impedance match between the microphone and grid circuit.

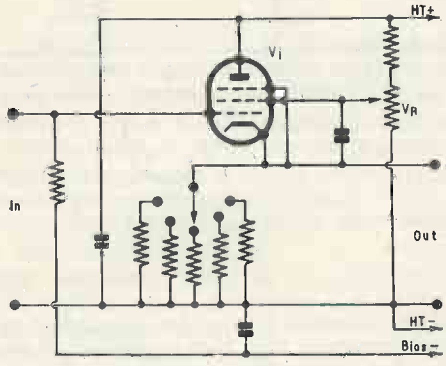


Fig. 5. Electronic attenuator (basic circuit)

Attenuators and Simple Mixers

The continuously variable volume control is commonly used in tape recorders, simple valve microphone mixers, radio receivers, and amplifiers. Its uses as an attenuator are limited because the voltage ratio is proportional to the resistance ratio only when the load at the output terminal is very much greater than the total resistance (R) of the attenuator. (See Fig. 3.) Logarithmic and linear characteristics are used, the former being adopted mainly for volume control purposes. Although this type of control has certain disadvantages as an attenuator, its low cost and otherwise reasonably noiseless operation makes it suitable for even high fidelity amplifying equipment. It would, however, be quite unsuitable for high grade studio recording equipment, which would be more likely to employ a constant impedance device for fading and mixing as shown in Fig. 4.

For some purposes an electronic attenuator may be advantageous and a possible arrangement is one utilising a cathode follower in which the screen voltage of the valve may be varied by VR, together

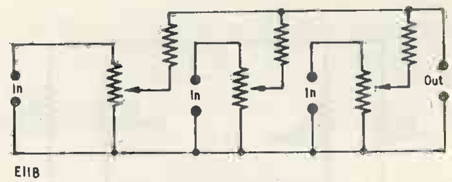


Fig. 6. Parallel mixing network

with the cathode resistors as in the circuit of Fig. 5. Any pentode type valve with a sharp cut-off is suitable although a valve with a high mutual conductance would limit the maximum attenuation.

Non-Constant Impedance Mixers

This type of mixer employs the simple "volume control" type of variable resistor which is commonly used for most domestic type amplifying equipment and radio receivers. Various combinations employing these simple controls can be used with or without valves but it must be emphasised that a combination as shown in Fig. 6 for example, is quite unsuitable for high impedance crystal microphones because of attenuation by loading, the possibility of hum pick-up, and noisy operation of the sliders. The insertion attenuation is about 10dB. The arrangement *is* suitable for direct mixing of high level signal sources such as the output from a radio receiver or gramophone pick-up. It can be combined with valve amplifiers for mixing microphones and, when used with pre-amplifiers such as those shown in the circuits of Figs. 1 and 2, provides the basis of a multi-channel mixing unit.

Another widely used mixing circuit is one employing a valve, or valves, with a common anode load as in Fig. 7. When two valves, such as a double triode, are used in this type of circuit the anode resistance of each valve acts as a shunt across the other thereby reducing the gain. With pentodes this loss of gain is negligible, however, and may be ignored.

Design for a Mixer

Combining the parallel network mixer circuit with high gain microphone pre-amplifiers, provides the

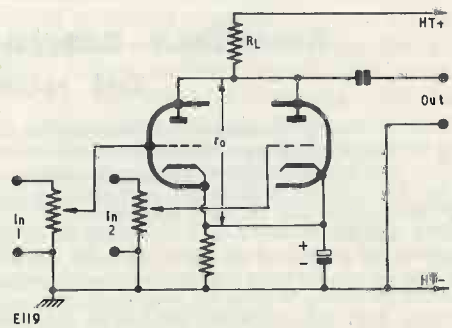


Fig. 7. Simple mixer using a twin triode with a common anode load

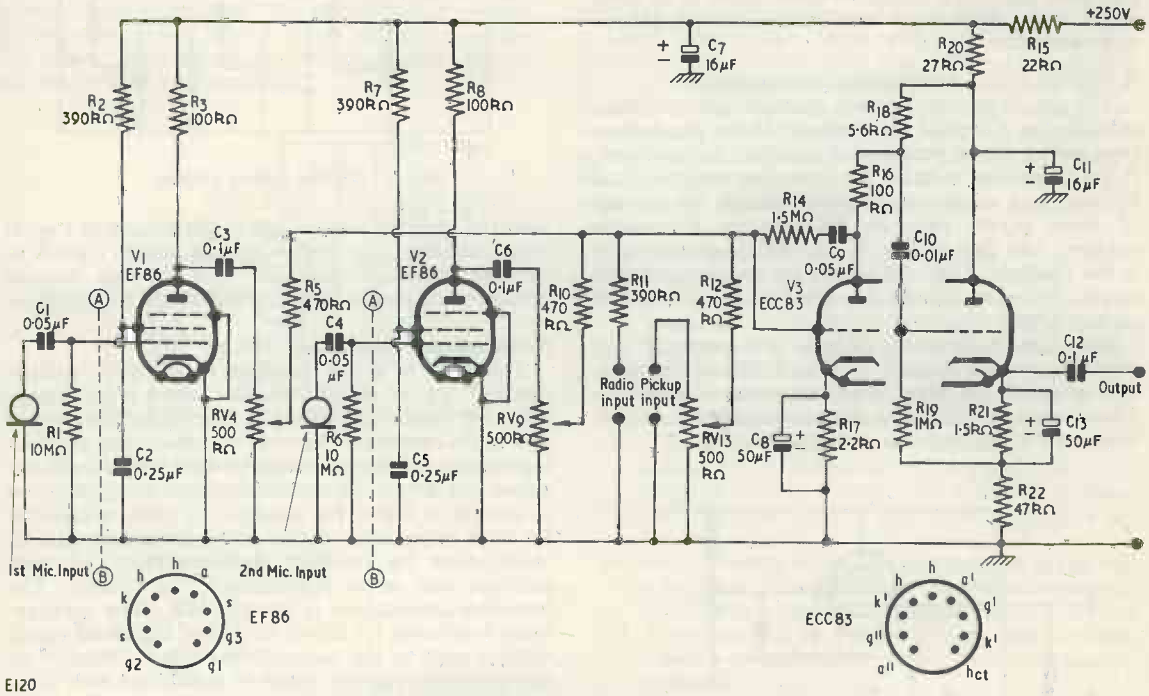


Fig. 8. Four channel signal and microphone mixer (circuit by permission of Mullard Ltd.)

basis for a very efficient multi-channel microphone and signal mixer as shown in Fig. 8, which was developed by the Mullard Research Staff.[2] The circuit employs the EF86 low noise amplifier with high value grid resistors and utilises a four channel parallel mixing network. This is followed by an intermediate amplifier with negative feedback from which the signals are taken via a cathode follower to the output terminal, which has an impedance of approximately 600 ohms. This makes the mixer suitable for connection to a high impedance input of a tape recorder or high level amplifier and allows the use of a fairly long connecting cable if so required. The frequency response of the mixer is flat from 20 to 20,000 c/s and the noise level is −50dB at full gain.

[2] The circuit given in Fig. 8 is taken from Chapter 10 of *Mullard Circuits for Audio Amplifiers*, and is reproduced by permission of Mullard Ltd.

REMOTELY CONTROLLED TELEVISION STATION ON NORWEGIAN ISLAND

The Norwegian Telegraph Administration is building a television station on the island of Bokn in Stavanger Fiord and is to operate it by remote control from the mainland by means of a v.h.f. radio link.

The transmitters selected for this purpose—two 4kW vision and two 1kW sound—are of Marconi manufacture and are suitable for unattended operation. In addition to the transmitters, Marconi's are to supply and install programme input and ancillary equipment.

The equipment will operate in Band III to 625 line C.C.I.R. standards. The two vision transmitters are to be connected for parallel working, as also will the f.m. television sound equipments. Remote control facilities over the v.h.f. link will include the independent on-off switching of all four transmitters; the control of blanking level (including the on-off switching of blanking level feedback), and the control of video and audio gain. An indication of power output at normal, high and low levels will also be provided over the link. It is intended that adjustments to the controls will be made in conjunction with a waveform display derived from a high-grade receiver and oscilloscope sited at the remote control position on the mainland.

The order was obtained through the Marconi agents in Norway, Norsk Marconikompani A/S.

Cover Feature

The JR1 Stereo Tape Recorder Unit

PART I. By G. BLUNDELL

This article outlines in detail the theoretical factors which were considered during the development of the Jason JR1 Stereo Tape Recorder Unit. Constructional details will commence in next month's issue.—Editor.

IN THIS DESCRIPTION OF A HIGH QUALITY TAPE recorder the emphasis will be on electronics, a later section showing how to obtain the optimum performance with a number of popular tape decks. The various parts of the circuit are described here so that the constructor will have an understanding of the design considerations involved.

A tape recorder requires a tape deck, playback and recording amplifier. In the cheaper type of tape recorder, the same amplifier circuit is switched to be used for record or playback, only two heads being required on the tape deck, i.e. a combined record/playback head and an erase head.

In the Jason Stereo Tape Recorder Unit three heads are used, and a typical arrangement of these is shown in Fig. 1. The tape is pulled from one reel to the other by the capstan and pinch roller, and is held accurately in line with the heads by the guides. A recording may be played back a fraction of a second later as the tape passes from the record to the playback head and the quality of the recorded signal may be immediately judged and compared with the original programme. Although this feature slightly increases the cost of the unit, it is invaluable when there is only one opportunity to make a particular recording which has to be right first time.

The circuits of the Jason tape unit are duplicated for stereo, and the switching is so arranged that the two stereo tracks may be recorded independently; thus the playing time of the tape is doubled when stereo is not required. In addition, all the measurements have been made with quarter track heads, which allow two stereo, or four single tracks on the standard ¼in tape.

No wild claims for frequency response will be made—a recent directory showed that some cheaper tape recorders claimed a wider frequency response than the professional and studio types. In practice,

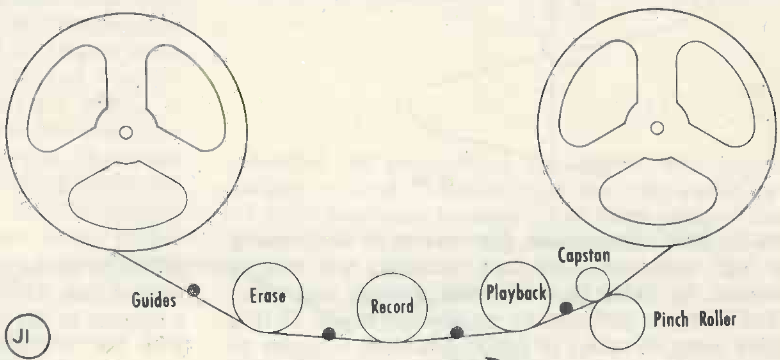


Fig. 1

careful judgment is required in relation to this question of frequency response, because distortion and background noise are also of importance and these three factors are inter-related. The technique of boosting the playback response with tuned chokes may result in an excellent frequency characteristic but it also increases background noise and transient distortion. This kind of circuit must be rejected. The aim is to produce an acceptable frequency response at 7½in per second (i.e. reasonably flat to 15 kc/s), and we can expect the quality and surface noise to be at least equal to the best gramophone records available.

To continue this point a little further, a recent 12in stereo disc is almost silent between the recorded items, the "surface noise" which then appears being in fact tape recorder noise recorded on to the disc. The gramophone disc is not dead yet and seems unlikely to become obsolete while it can be mass-produced so easily. Therefore, in saying that our tape recorder is to produce results which are as good as the best gramophone disc we are, in fact, setting a high standard. Our tape recording will not, of course, be liable to mechanical damage and wear, but it can be damaged by magnetised heads, so that care must be taken in other directions in order to preserve a good recording.

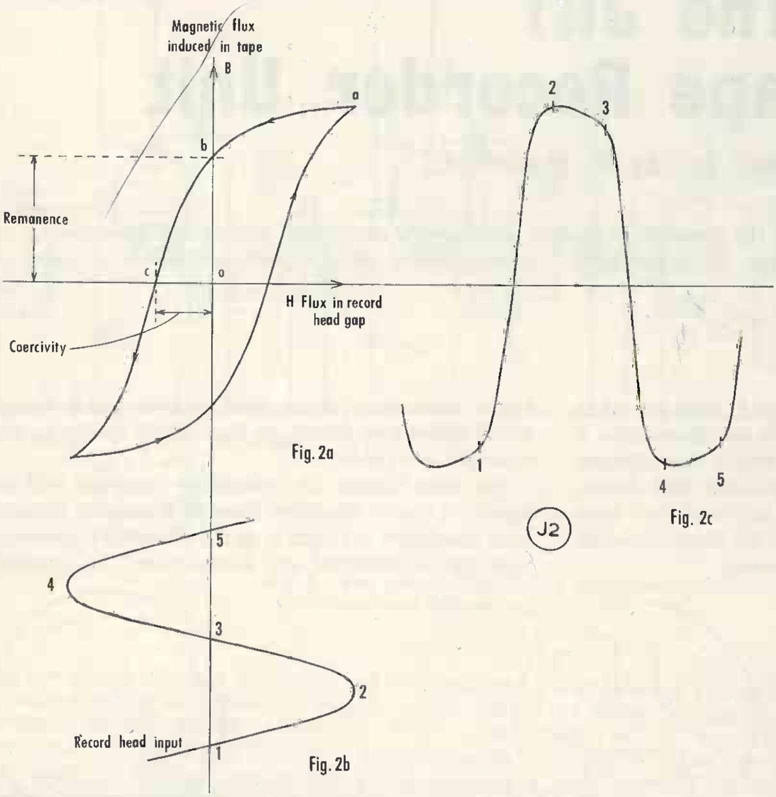


Fig. 2a

Fig. 2b

Fig. 2c

History of Tape Recording

The first magnetic recordings were made over fifty years ago, and before the war the B.B.C. were using steel tape running at 60in per second. Before the invention could become practical two further ideas were required, these being high frequency biasing (first used in 1921) and plastic based magnetic tape, which could be easily handled. During the war, the Germans developed magnetic recording to a fine art and, since then, the major advances have been improved magnetic powder on the tape, which allows better frequency response and greater output, and fine gap playback heads, which have improved the overall frequency response. At the end of the war a 10 kc/s response required the tape running at 15in per second; now we can achieve this at 3¾in per second with greater output.

Range of Frequencies to be Recorded

The character of a musical instrument is given by the overtones or harmonics and these extend in frequency out of the range of human hearing. Some people can hear frequencies up to 20 kc/s, while others, often older people, can only hear up to 10 kc/s. A good compromise is that the frequency response should be flat to 15 kc/s and then gently fall away. The piano and organ probably cover the widest ranges of frequencies, since the fundamental notes or tones extend from 25 c/s to 4,000 c/s. A violin extends from 200 c/s to 3,300 c/s, and a man's voice from 100 c/s to 200 c/s. To those fundamental notes must be added the harmonics which provide the character of the sound.

The Recording Process

The recording tape is coated with a material such as ferric oxide, which is capable of being magnetised. The behaviour of this material is shown by the hysteresis loop in Fig. 2 (*a*). From this we find that, if the tape is magnetised to point "a" by a current in the head which rises and then falls to zero, the magnetic field in the tape will fall only

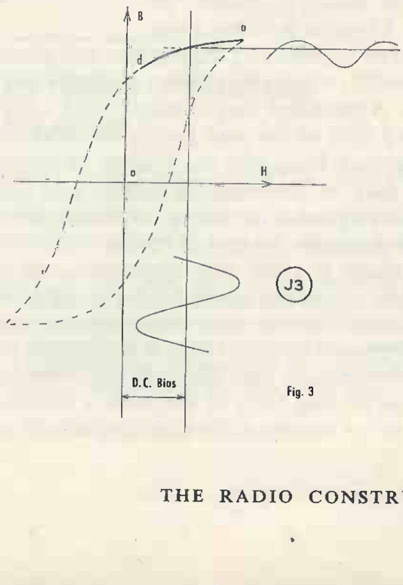


Fig. 3

to "b". This level is known as the remanance of the tape and is a measure of the strength of the signal which may be recorded on the tape. If the current is reversed, a signal amplitude OC will be required to bring the tape magnetic field to zero. This amplitude OC represents the coercivity of the tape, and offers a measure of how well and how long the tape is capable of storing a recording.

We can find from the hysteresis loop what will happen to the tape when we feed a signal (Fig. 2 (*b*)) into the record head. Fig. 2 (*c*) shows the resulting magnetic field in the tape. The figures on Fig. 2 (*b*) represent intervals of time. If we begin at 2 we can read from the hysteresis loop that the field in the tape will be as shown in Fig. 2 (*c*). At time 3 the record signal has returned to zero, but the field in the tape has not. The curve which we would see on an oscilloscope connected to the playback head would, in fact, show a steeper front and the peak at 2 would be more pronounced. The pronounced peak is due, as is explained later, to the fact that the output from the head depends on the rate of change of the field, and this has the effect of increasing the distortion. As can be seen, Fig. 2 (*c*) bears little resemblance to our initial sine wave input to the head winding and represents very considerable distortion. D.C. biasing added to the signal input was first attempted to overcome this distortion. Fig. 3 shows that, with d.c. bias, the excursions of the input signal never take the field in the tape away from the top of the hysteresis loop, and that the resulting output, as shown on the right of Fig. 3, is low. Distortion is still present but the sine wave shape is now recognisable in the output. Although this biasing is an advance, the resulting distortion and low output signal make it a suitable method only for dictation machines. Much better results are given by high frequency biasing. By adding a bias frequency of approximately 70 kc/s to the programme signal the distortion shown in Fig. 2 can be overcome. The problem in Fig. 2 is that the tape behaves as though the particles have a magnetic friction which prevents the field in the tape following the field in the head immediately. The high frequency biasing acts as a magnetic lubricant by

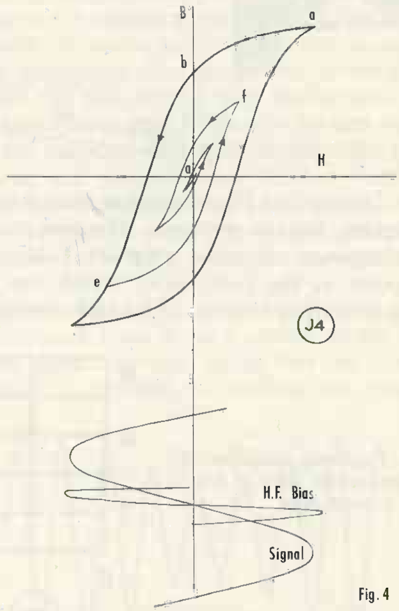


Fig. 4

subjecting the particles of the tape to very rapid changes of field. Imagine now that the signal in the head has been increased and then reduced to zero and the tape has been magnetised to the level

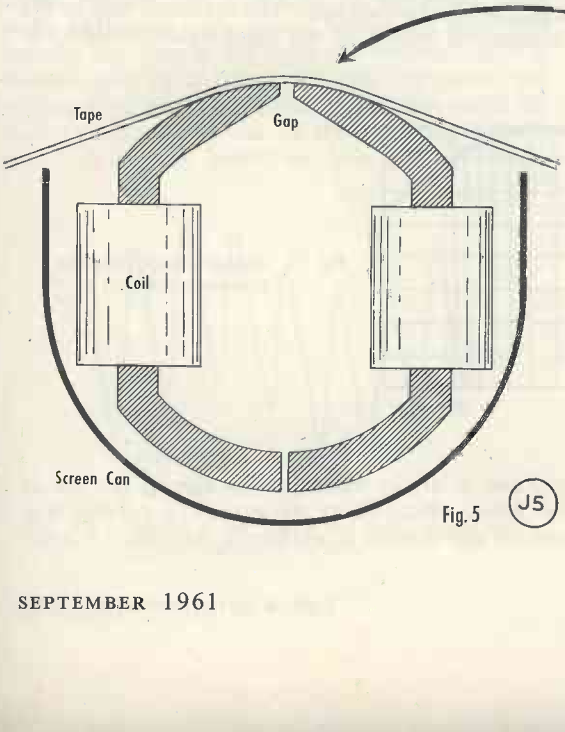


Fig. 5

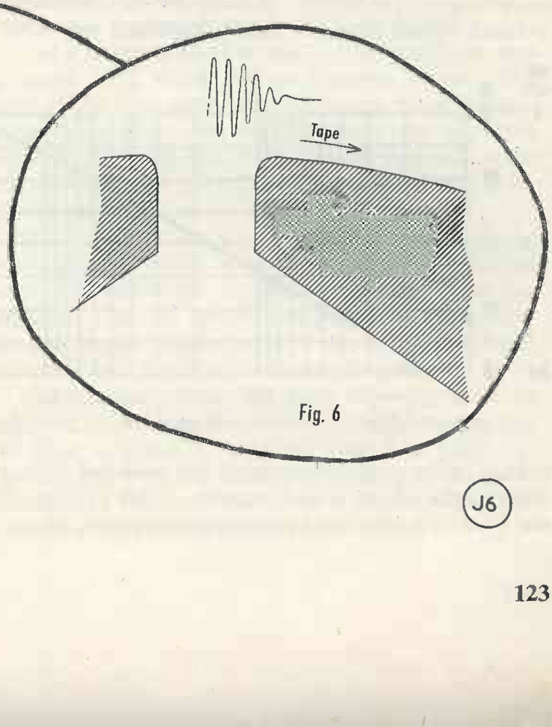
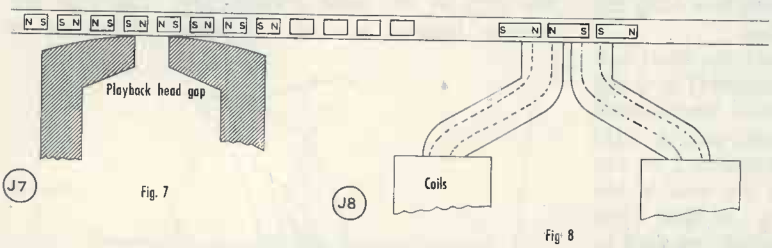


Fig. 6

Ob as shown in Fig. 4. Although the biasing frequency has been operating all this time let us now consider what is happening at the instant when the record head signal has become zero. As this particular portion of the tape is leaving the record head it is subjected to decreasing cycles of the bias



frequency. Shown on Fig. 4 is what then happens to the magnetic field in the tape. The first cycle of the bias frequency takes the magnetic field in the tape to point e, the next cycle, which has now reduced in amplitude because of the tape movement,

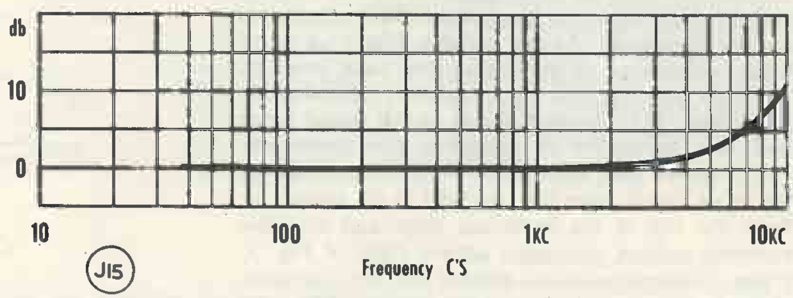


Fig. 9. Frequency response of single lamination type of playback head

brings the field to point f, and eventually the field in the tape finishes at the point o. The field in the tape has therefore been returned to zero when the recording current is zero. Because the bias frequency is much higher than the signal frequency very little

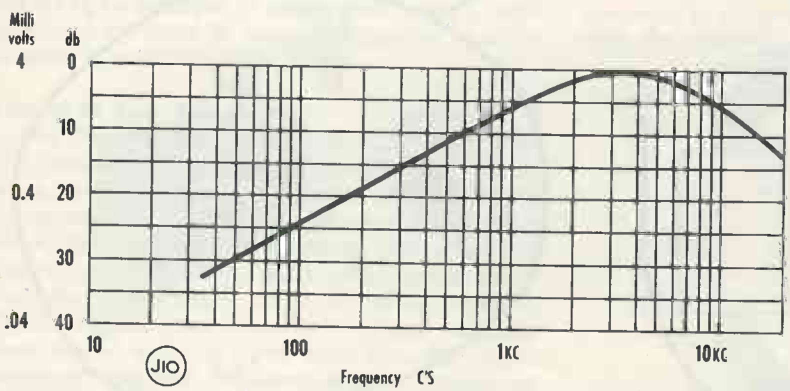


Fig. 10. Output voltage from the playback head

change in the programme signal has occurred during these cycles of the bias frequency. This cycling of the bias frequency is occurring continuously at the trailing edge of the recording head gap, as is shown in Fig. 6 and the signals to be recorded all undergo this treatment. The magnetic tape is, therefore, continuously cycled through the reducing hysteresis loops so that, at the moment of leaving the recording head, it is magnetised exactly in proportion to the programme input. The application of this idea of high frequency biasing represented a considerable step forward in the history of magnetic recording.

Wire or Tape Recording

Wire is never used now for recording except perhaps for dictation purposes because it is not very suitable. Should the wire rotate on playback, the high frequency response will vary. Also, it is difficult to join when breakage occurs and, being solid steel, h.f. biasing is not so effective in reducing distortion and increasing the output.

The Recording Head

A typical head, as shown in Fig. 5, has two sets of laminations, two coils, gaps at the front and rear, and a screening can. The magnetic field in the laminations caused by the input signal, bridges the gap and is largely wasted except for the portion at the front, which enters the tape. To prevent this loss the gap is made as shallow as possible (i.e. from front to rear), allowance being made for head wear by the tape. A reasonable compromise reduces the depth from front to rear of this gap to 10 thousandths of an inch. It follows that when the head

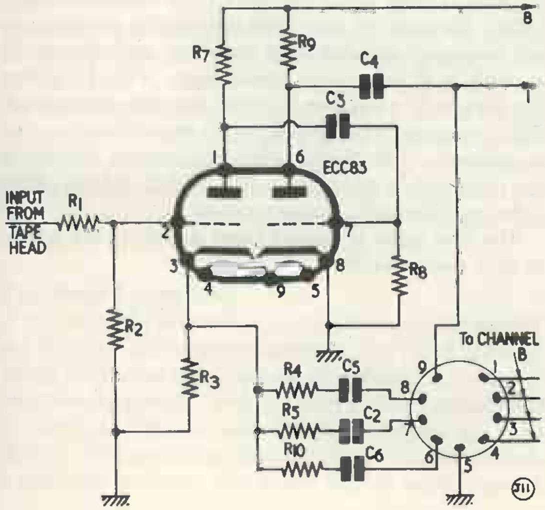


Fig. 11. The playback amplifier employed in the JR1 Stereo Unit

wears its efficiency improves. The pole pieces tips, shown enlarged in Fig. 6, have been drawn slightly rounded because magnetically this is how they behave. The wave form at the top of Fig. 6 represents the high frequency bias, which is shown falling gradually to zero because the pole piece is not magnetically sharp, and it is this variation of the magnetic field in the tape at the bias frequency which enables the recording to be made. The width of the gap in the record head is not important because the tape is left with the magnetic field it receives just as it leaves the gap. However, the trailing edge must be reasonably well defined or the high frequency response of the recording will be poor. A typical width for this gap is 0.001in

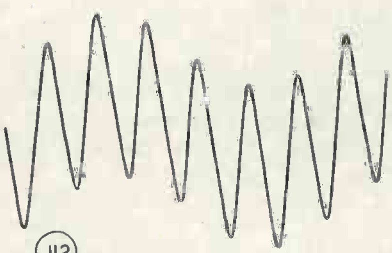


Fig. 12. Addition of the signal and bias frequencies in the recording head

although identical heads are often used for record and playback.

The Erase Head

The amplitude of high frequency voltage fed to the erase head is sufficient to magnetically saturate the tape. As the tape leaves the head this voltage decreases gradually as shown in Fig. 6 and the tape is left in a magnetically neutral state ready for re-recording. A typical gap width is 15 thousandths of an inch. A permanent magnet can be used to erase by saturating the tape in one direction, but this leaves the tape with a high background noise. The concept of magnetic friction in the tape suggests that all the particles cannot be magnetically neutral unless they are magnetised through a number of cycles of the hysteresis loop. Any particle which is out of step produces an unwanted output, and this can be heard as noise added to the output signal.

The Playback Head

The playback head is very similar to the record head, the main difference being that the front gap is as small as possible to improve the frequency

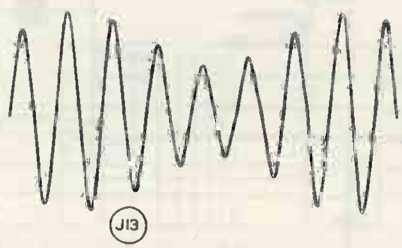


Fig. 13. Multiplication of two frequencies as occurs in the frequency-changer of a normal radio receiver

response. A typical gap width is 0.0002in, i.e. 2/10 of a thousandth of an inch. Effectively, the gap is about 20% wider due to fringing effects. The limit of the frequency response occurs when the gap width is equal to one wavelength of the recorded signal as shown in Fig. 7. Two south magnetic poles are shown at the end of the gap so that there is no flux in the head and no output from the coils.

The high frequency response will suffer if the heads are not truly vertical. Even ¼ of a degree error will halve the output at 15 kc/s. It is not sufficient that the record and playback heads have parallel gaps, the gaps must be vertical so that tapes recorded on other machines may be played.

The playback head will have as many turns as possible to achieve maximum voltage output, but the limit is about 4 millivolts output at 1,000 c/s. More turns increase both the inductance and self-capacity of the head and cause a resonance within the audio range, which must be avoided.

The screening can around the playback should be made from mu-metal, a form of magnetic steel having a very low magnetic impedance. This short-circuits any interfering a.c. fields from the motor and nearby transformers. Even steel $\frac{1}{8}$in thick is useless in comparison with $\frac{1}{32}$in mu-metal. The balanced arrangement of the laminations and coils also helps to reduce trouble from a.c. fields.

The stacked lamination type of playback head easily reproduces frequencies down to 20 c/s., whilst an alternative method of head manufacture, using a single lamination, causes a poor low frequency response below 100 c/s. The wider pole face of the lamination effectively short-circuits the immediately adjacent recording, while the narrow pole face of the single lamination, shown in Fig. 8, allows adjacent signals to increase the output at some frequencies and reduce it at others, resulting in the response shown in Fig. 9. This type of head can be recognised by the thin vertical steel pole in the centre of the head.

Pressure pads may be used to ensure good tape contact with the head although this can be achieved by wrapping tape around the head for $\frac{3}{16}$in either side of the gap as shown in Fig. 1. If this contact is not maintained the high frequency output will vary.

The Playback Amplifier

The output from the playback head is proportional to the rate of change of flux in the head. This is a nuisance because it means that the lower the frequency the lower the output from the head, as shown in Fig. 10. The playback amplifier must have the opposite characteristic, and thus the sensitivity of the amplifier at 50 c/s must be about 100 microvolts. Because of this high sensitivity precautions are necessary against hum troubles, and this point is dealt with in greater detail later. Fig. 11 shows the playback amplifier used in the full-stereo unit, this meeting the sensitivity requirements just mentioned. The 9-way plug and socket shown in this diagram is connected to a switch which offers differing playback characteristics..

The first valve is heated from d.c. to avoid heater to grid hum troubles.

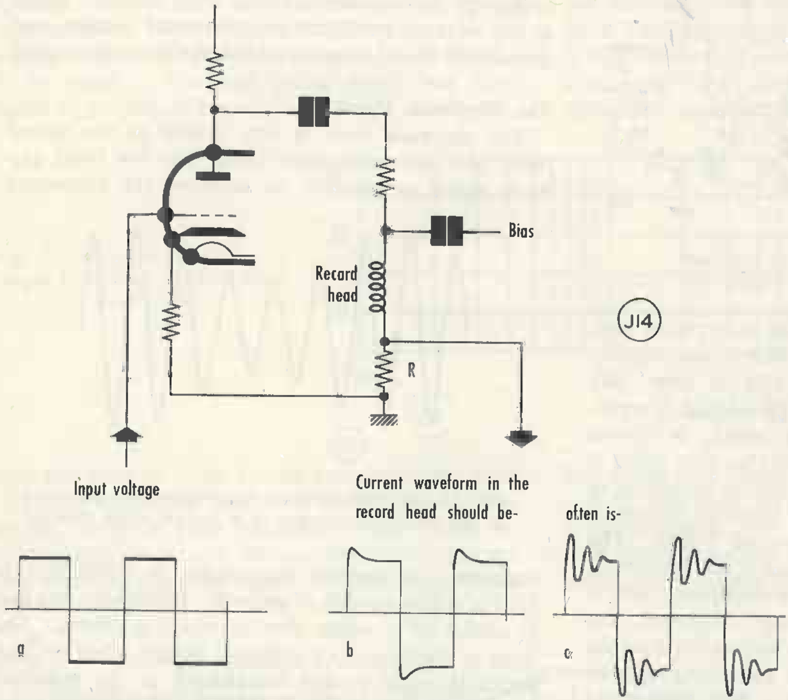


Fig. 14. Resistance R is added to the record head circuit so that the current in this head may be shown on an oscilloscope. At "a" is shown a 1 kc square wave input whilst at "b" the peaks illustrate the treble boost required to overcome the head losses. The treble boost often results in ringing ("c") and care in design of the circuit is necessary to avoid this effect

Valve noise may be a problem and therefore a triode has been chosen for the first stage. A pentode is normally used because it also embodies extra shielding to prevent heater/grid hum, but since we are using d.c. heating, this problem is avoided and we take advantage of the lower noise of the triode.

The amplifier playback response characteristic which we shall use conforms to the standard C.C.I.R. characteristic. This states that the field in the tape shall produce an output, from an ideal playback head, which is constant when the amplifier has a 100 microsecond time constant correction. Both record and playback heads have losses and therefore some treble boost will be required in both the record and playback amplifiers to compensate for these losses. In some designs all the compensation has been made in the recording amplifier. This has the advantage that less treble boost is required on playback and, therefore, the background noise is lower. However, the losses in the playback head may not be known if the tape is to be played on another machine and therefore the results would be variable. A further disadvantage is that with all the boost on the recording side there is a real danger of tape overload. The Americans have a compromise (NARTB response) whereby the top is given a small extra boost on the recording over and above that required to compensate the head losses, and this gains a few dB signal to noise ratio.

The Record Amplifier

A constant current is required through the recording head whatever the frequency. The head, through being an inductance, has an impedance which rises with the frequency. The impedance of a typical head is 100Ω at 100 c/s and 10kΩ at 10,000 c/s, and despite this variation, our amplifier has to provide a constant current. The usual way of achieving this is to insert a high resistance in series with the head so that the total load of the resistance plus head does not alter so greatly, this combination being fed from a normal amplifier. An alternative method uses the head as a load for a pentode. The current at the anode of a pentode is largely independent of the voltage and the changing voltage across the head will not, therefore, affect the current through it.

As explained earlier, high frequency biasing is added at this point and the combined signal and bias waveform is shown in Fig 12. This addition of the signals, which occurs in the recording head, should not be confused with a radio receiver frequency-changer, wherein the signals are multiplied as in Fig. 13. Minimum distortion of the recording occurs at a particular bias level. This level should be found with a distortion meter because it depends on many variables. As the amateur cannot usually perform this measurement, an alternative method is to increase the bias until the output at 10 kc/s from the playback head just begins to fall. The bias is then just beginning to erase the signal, and this sets an upper limit on bias level.

The treble boost circuit have been carefully chosen to avoid "ringing" troubles. This can be seen graphically by connecting an oscilloscope to a small resistance, R_1, in series with the recording head (see Fig. 14) when a 1 kc/s square wave is fed into the input. It is extremely difficult to achieve a current in the record head which resembles the input voltage if large amounts of treble boost are used, and this is a further argument against attempts to achieve wide frequency responses by excessive record or playback boost. The same argument also applies if the playback head gap is too wide. One has to tolerate the resulting poor top response because attempts to compensate in the circuit will result in transient distortion as shown by the "ring" on the square wave. The treble boost offered in the Jason unit is shown in Fig. 15.

The Oscillator

A push-pull oscillator (see Fig. 16) is used in the Jason unit so that the output will be balanced and free from second harmonic distortion. Any unbalance of the oscillator causes residual magnetism to be left in the heads, and this, if left in either the erase or record heads, will increase the background noise of any tape played. Distortion of the recorded signal is also increased if the bias waveform is not pure. To further lower the distortion the oscillator coil uses a ferrite core, which increases the "Q" of the circuit. This increase in "Q" can be imagined as a flywheel, which helps the waveform of the voltage output to be sinusoidal and ignore the effect of its own grid current drive, which is one of the main sources of distortion.

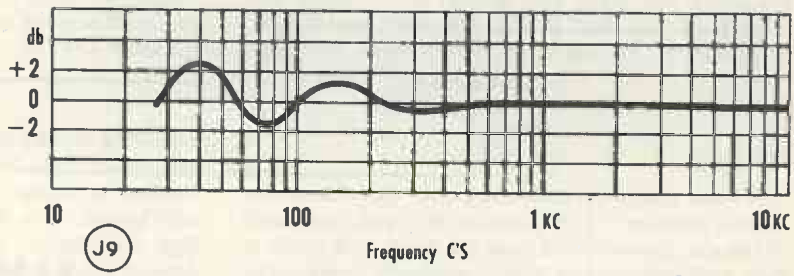


Fig. 15. Treble boost required to overcome record head losses

Demagnetisation of the Heads

Despite care with the bias waveform it is still possible to magnetise the heads and thus affect any tapes played. This can happen in a number of ways:

(1) Switching off the mains without the heads shorted.

(2) Switching a nearby transformer.
(3) Using a magnetised screwdriver when making an adjustment.

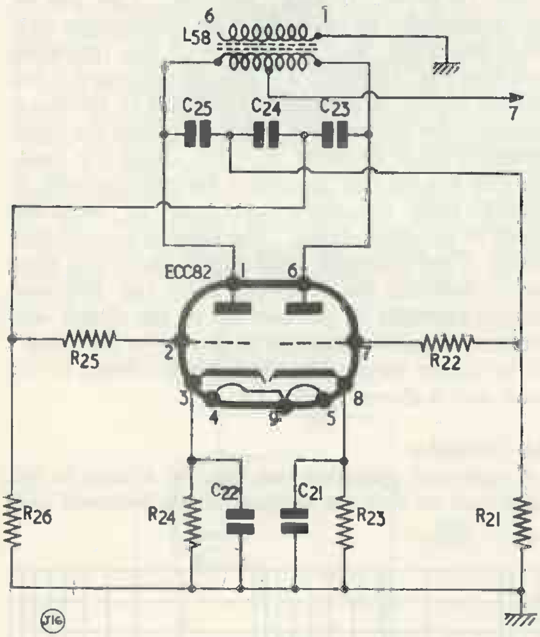


Fig. 16. The tape oscillator circuit

A keen recording enthusiast will, therefore, have a head defluxer. This consists of a coil connected to the a.c. mains placed near the head, and which is then switched on and drawn gradually away. The coil subjects the head to a number of cycles of demagnetisation in a similar way to h.f. biasing described earlier and leaves it magnetically neutral.

The Record Level Indicator

Thought was given to the record level indicator before deciding between a Magic Eye and a meter. A meter has a scale and apparently gives a more accurate indication. The question is, though—what are we expecting to read? Obviously, if the signal is rising too quickly the meter will be unable to follow and it may in fact ignore a rapidly increasing signal. A meter should be able to follow a signal with a one millisecond rise time, but, to do this, it needs to be driven by a 10 watt amplifier. The normal meter circuits fed from a triode are quite inadequate in this respect. A Magic Eye, on the other hand, has no moving parts and is capable of following rapidly rising signals. Therefore, although not so accurate to read, it will nevertheless give a reading in some circumstances which the meter will ignore. On the balance, therefore, the Magic Eye was chosen as the best compromise for the present application. Since the Jason unit is intended for stereo two Magic Eyes are employed, these being mounted side by side to enable comparisons to be made of the level in either channel.

TABLE 1

Playing Time in Minutes Per Track

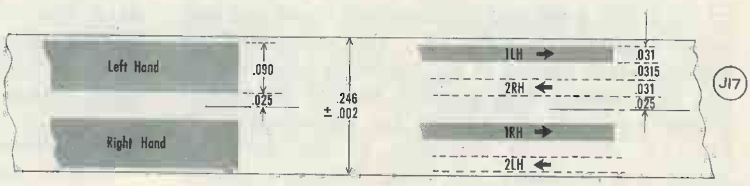
The figures should be doubled if two quarter track stereo recordings are made on one tape, or multiplied by four if four separate quarter tracks are recorded.

Tape Length	$3\frac{3}{4}$*in per second*	$7\frac{1}{2}$*in per second*
150	8	4
200	10	5
300	16	8
400	21	10
600	32	16
850	45	22
900	48	24
1,200	64	32
1,700	90	45
1,800	96	48
2,400	128	64
3,400	180	90

The Recording Tape

A recording tape should be strong enough to avoid physical damage during normal use, but not so stiff that it will not lie flat against the head. Unless intimate contact is maintained with the head, the output voltage will vary considerably, particularly at the higher frequencies. The tape which satisfies these requirements best is known as "long

Fig. 17. Standard track widths



play tape", which allows a playing time of 96 minutes, with two separate stereo recordings on a 7in reel carrying 1,800ft of tape. Tests show also that this tape suffers less from the phenomena known as "drop-out" caused by variations in the magnetic coating, and which is more prominent when the track width is narrow.

TABLE 2

Tape Length in Feet on Various Spool Sizes

Spool Size	*Standard Tape*	*Long Play*	*Double Play*
3	150	200	300
4	300	450	600
4¼	—	600	—
5	600	900	1,200
5¾	900	1,200	1,800
7	1,200	1,800	2,400
8¼	1,700	2,400	3,400

The standard tape is thicker and only 1,200ft can be accommodated on a 7in reel. The double play tape with 2,400ft on a 7in reel gives the advantage of extra playing time, but is more difficult to handle and may be stretched by the braking mechanism of some decks.

A good recording tape should have a high remanence (see Fig. 2 (*a*)), which means that it can retain a stronger magnetic field and thus give a greater output. A high coercivity, which is a measure of the ability of the tape to resist magnetisation, is also necessary. At high frequencies, the effective magnets recorded on to the tape become so short that they are able to demagnetise each other and thus result in a poor high frequency response. A further possible trouble, which is worse when the coercivity is low, is "print through". This is caused by the magnetic field of a recording impressing itself on an adjacent turn of tape and giving an unwanted echo.

Originally, only one track was recorded on a ¼in tape, but later it was found that two tracks, and then four, could be satisfactorily accommodated. To prevent interference between tracks, portions of the tape must be left unused to act as guard tracks. It is advisable also not to record to the edges of the tape, because any mechanical damage is likely to show itself there.

Fig. 17 shows the usual arrangement of recording and guard tracks, and the positions of the channels when recording stereo. The erase head is made a little longer, 0.1in for the twin track and 0.04in for the quarter track, to ensure that any tape deck alignment errors do not leave part of the recording on the tape. *(To be continued)*

Book Review . . .

FUNDAMENTALS OF RADIO RECEIVER SERVICING. By E. M. Squire. 172 pages 152 diagrams. Published by Pitman. Price 15s. net.

This is, on the whole, a well-written and useful little book, but it is first necessary to make clear, in view of its title, that it is mainly a description of the way in which a receiver and its component parts work. Many of the servicing notes are really secondary to this, and are often of a rather general nature.

Thus the home constructor, new to the field, but ambitiously building his first 7 valve all-wave receiver, will not find here instructions on how to cure the howls, whistles or plain dead silence that may at first greet his efforts. What he will find is a clear description of how the circuits ought to work, written at a fairly elementary level and in a practical way. With the servicing notes, he should then be able to apply intelligently the detailed instructions in servicing manuals.

After an introductory survey of the field, in which such basic terms as current, frequency and gain are defined, the author devotes about a third of the book to components. These chapters contain both theory and constructional details, and include an account of printed circuits and their manufacture, and material on transistors. Surprisingly, there is no discussion of component tolerances—a matter which can be of some importance in servicing. The way in which components are used in typical receiver circuits—both valve and transistor operated—is then described, including such refinements as dual-purpose circuits in a.m./f.m. sets. The chapter on power supplies is particularly comprehensive and useful, with that difficult point, the development of grid bias in battery sets, clearly explained.

After some notes on the radio-gramophone, the book concludes with two chapters on the use and care of common servicing equipment, and some advice to the novice on setting about the first servicing job.

P.R.S.

The "Finger-tip Five"

by A. S. CARPENTER

Here is an easily built little receiver capable of providing many hours of enjoyment despite its simplicity which will tune continuously from 10–2,000 metres. Although the receiver can tune the Medium and Long wavebands it has been especially designed for the Short wavebands where much of interest is transmitted.

The receiver is self-powered and is intended for use with an a.c. mains supply. The chassis is completely safe to handle due to the inclusion of an isolating mains transformer.

When headphones are plugged into the output socket a self-contained receiver results, whilst if a coaxial lead is taken from the same output socket and fed into the "gram" sockets of a broadcast receiver or to an amplifier it becomes a tuner. The unit occupies little space, its chassis measuring 8 x 4 x 2in and its front panel 8½ x 5½in. A modern triode-pentode valve is used and this ensures both space economy and efficiency.

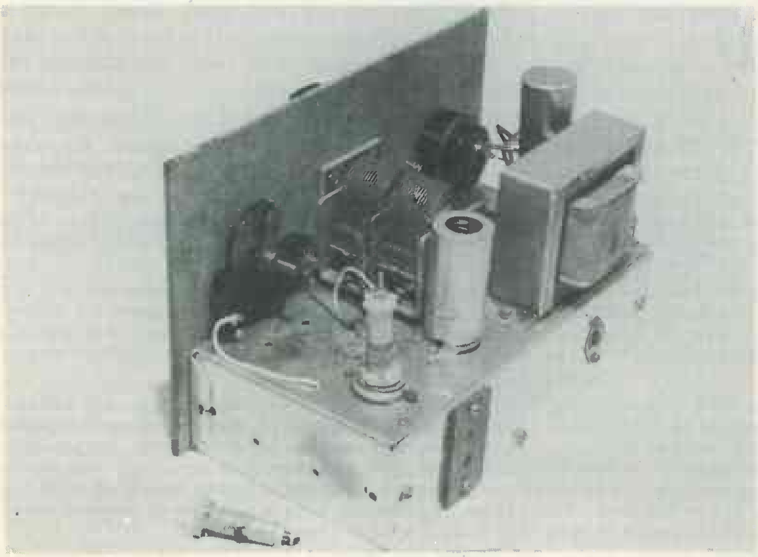
The Detector

One of the simplest and least expensive ways of exploring the Short wavebands is to use a leaky grid detector coupled to an aerial via a tuned circuit. Positive feedback, or reaction, is also required to increase sensitivity and sharpen the tuning. Whilst a great deal of fun can be obtained from simple apparatus of this nature one or two unpleasant features soon become evident, one of these being the occurrence of "dead spots", i.e. sections of the band over which it is impossible to obtain effective reaction. Such dead spots are often caused by the aerial and occur more frequently where coupling to the tuned circuit is tight. Loosening the coupling may cure the dead spots but signal pick-up may become impaired.

In an attempt to obtain optimum results with such a receiver, the aerial is some times coupled to the tuned circuit via a small value variable condenser. Although this works fairly well it means that an extra control is needed on the panel, thereby adding a further complication to the tuning of the receiver.

Another unpleasant feature of such simple receivers is their ability to radiate when reaction is too far advanced, since there is no buffer between the detector and the aerial. Even the most careful user is certain at some time or other to advance the reaction control too far and therefore cause annoyance to others.

The unpleasant features just described can be very largely avoided by employing an r.f. stage prior to the detector, and such a stage may be untuned. It might be argued that the inclusion of an untuned r.f. stage is a waste of a valve but, when it is considered that such a stage ensures that the aerial constants in no way affect either the operation or the tuning calibration plus the fact that it forms an effective buffer against radiation, most of the argument becomes void—and, after all, a certain small amount of gain is likely to result.



A rear view of the receiver

Circuit Details

Fig. 1 shows the circuit of the receiver, and it will be seen that it includes a mains transformer, and the triode and pentode sections of an ECF80. The pentode is used as the untuned r.f. stage previously referred to, whilst the triode operates as a leaky grid detector-cum-audio-amplifier, with controllable positive feedback (reaction) added for "pepping up" purposes.

Resistor R_4 serves partly to make the grid bias effective for the pentode section and partly to allow the development of sufficient r.f. for effective operation. Resistors R_1 and R_2 are merely screen-grid and anode feeds respectively for V_{1A}, whilst R_5 provides cathode bias. Condensers C_1 and C_2 are decoupling components.

R.F., amplified to some extent, appears at the pentode anode, and is conveyed to the tuned circuit and the grid of V_{1B} by condenser C_5.

At this point it should be noted that the desired waveband is obtained not by switching but by the plug-in coil method, the Denco range of miniature inductors being chosen since these conveniently fit a standard Noval (B9A) valve base. A Noval base is in fact used for this purpose and the circled figures shown on the diagram adjacent to L_1 indicate the correct tags; e.g. tag 6 on the valve base used as an inductor holder is wired to the chassis.

Note that the method of connecting the particular inductor in use permits the use of its primary winding for reaction purposes.

The triode section of the valve functions in conventional fashion, demodulating and amplifying the signal and passing the resultant audio to the output socket via C_4 and the volume control, C_9. The reaction control, C_3, is used in conjunction with the primary winding of L_1, R_6 being included to ensure successful operation.

Individual Inductor Ranges

These are given in the Table and are those published by the manufacturers, a parallel connected condenser of 310pF being assumed for tuning. As no trimming condenser is needed and as the inductors are fitted with dust iron cores which give up to 15% variation in most cases, the ranges are likely to vary a little as used here.

Some intending constructors will already possess a variable tuning condenser of 500pF and this can be used for C_7 if a 1,000pF fixed value silver-mica condenser is wired in series with it to reduce the maximum capacity. If a twin-gang condenser of good quality is to hand already this may be utilised for tuning purposes by using one section only. A twin-gang condenser was in fact used in the prototype, as can be seen from the photograph accompanying this article.

Bandspreading

Instead of fitting a bandspread condenser across C_7 a good quality slow motion drive is employed, as it is felt that this aids simplicity of operation. The drive mechanism is actually a Muirhead type and was taken from one of those excellent little RF27 ex-W.D. units. These drives are available from advertisers from time to time and, although the precise type is unimportant from the point of view of appearance, it is essential that any alternative make should be rigid in operation and permit of no backlash. An excellent

Table Showing Inductor Ranges

Range	Mc/s	Metres
1	0.150–0.400	750–2000
2	0.515–1.55	195–580
3	1.670–5.3	57–180
4	5.0–15	20–60
5	10.5–31.5	9.5–28

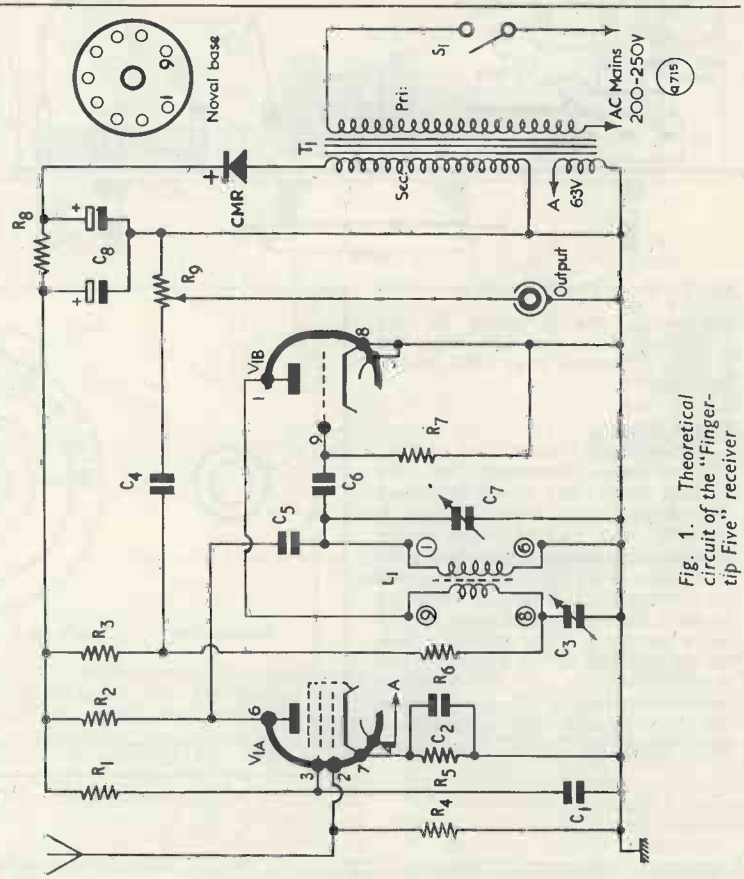


Fig. 1. Theoretical circuit of the "Finger-tip Five" receiver

Components List

Resistors
- R_1 47kΩ ¼ watt
- R_2 10kΩ ¼ watt
- R_3 68kΩ ¼ watt
- R_4 1MΩ ¼ watt
- R_5 470Ω ¼ watt
- R_6 20kΩ ¼ watt
- R_7 4.7MΩ ¼ watt
- R_8 3.3kΩ 1 watt
- R_9 250kΩ pot. and switch

Condensers
- C_1 0.01µF
- C_2 0.01µF
- C_3 500pF solid dielectric variable (reaction)
- C_4 0.01µF
- C_5 47pF
- C_6 47pF
- C_7 310pF (see text)
- C_8 16 x 16µF electrolytic, 350V working

Miscellaneous
- T_1 Mains transformer Primary—Mains input, Secondary—200–250V at 25mA, 6.3V at 0.45A min. (Elstone MT11 or similar)
- L_1 Denco Miniature Dual-purpose coils—Yellow Range (see Table)
- CMR miniature contact cooled rectifier—250V at 50mA
- $V_{1A, B}$ Mullard ECF80
- Chassis—Universal, 8 x 4 x 2in (Home Radio (Mitcham) Ltd.)
- Dial—Muirhead or Eddystone (see text)
- Two control knobs
- One coaxial plug and socket.
- Two Noval (B9A) valve bases with centre spigots
- One 5-way tagstrip (end tags earthed)
- One aerial/earth panel and sockets
- One pair headphones (2,000Ω per phone)
- Mains lead and plug, solder, wire, wood for cabinet, etc.

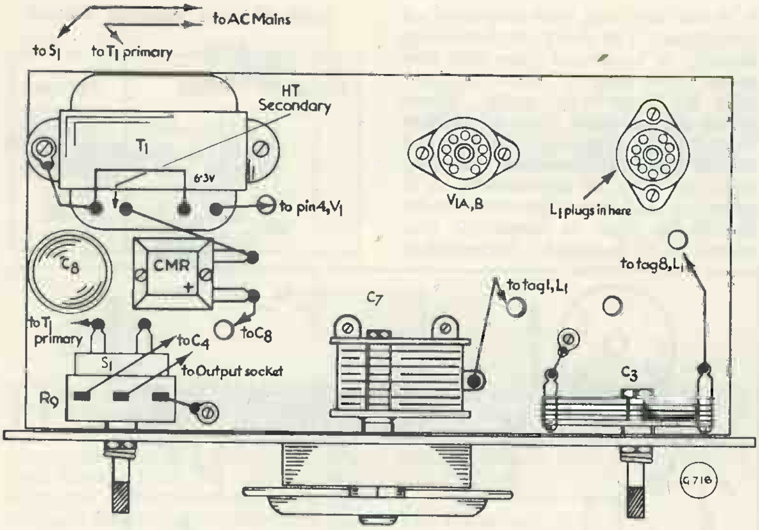


Fig. 2. Above-chassis layout and wiring

alternative choice would be the Eddystone drive type 843 which has a scale calibrated over 180° in 100 divisions.

Power Supply

The modest voltage and current requirements demanded by the ECF80 mean that a self-contained and simple power supply section is possible, and various small mains transformers designed specifically for half-wave working are obtainable very cheaply. It might be tempting to use a filament transformer for the valve heaters in order to save a little on the cost but such a method is not recommended as the chassis would necessarily become live to the mains via its h.t. circuit, this being especially dangerous when headphones were used. *A mains transformer with isolated h.t. and heater secondaries must be employed.*

Used in conjunction with the mains isolating transformer, T_1, is a midget contact cooled metal rectifier. CMR. This is approximately 1 x 1 x $\frac{1}{4}$in only in size, and it utilises the chassis as a heat sink. The a.c. supply, after being converted to d.c. by the rectifier, is smoothed by R_8 and C_8 and fed to the h.t. rail, some 180–240 volts appearing at this point.

Constructional Notes

Due to the use of a "Universal" sectional chassis, construction is greatly facilitated. The aluminium parts for these chassis are obtainable separately so that one may order a top plate and four sides, all of which bolt together to form a very rigid construction. One great advantage is that drilling is considerably eased since each piece can be handled independently of the others. Furthermore, should a particular joint be difficult to reach with the soldering iron during wiring up, then a section of the chassis can be removed!

To the front flange of the 8 x 4 x 2in chassis specified a panel $\frac{1}{8}$in thick is bolted, this being made $8\frac{1}{2}$in wide to allow a simple case made from $\frac{1}{4}$in plywood to fit snugly. (See Fig. 4.) This case will be described briefly later. For the front panel hardboard may be used as any hand-capacity effects evident during operation may easily be removed by glueing metal foil to the inside of the panel and connecting it to the chassis. Upon this panel the various

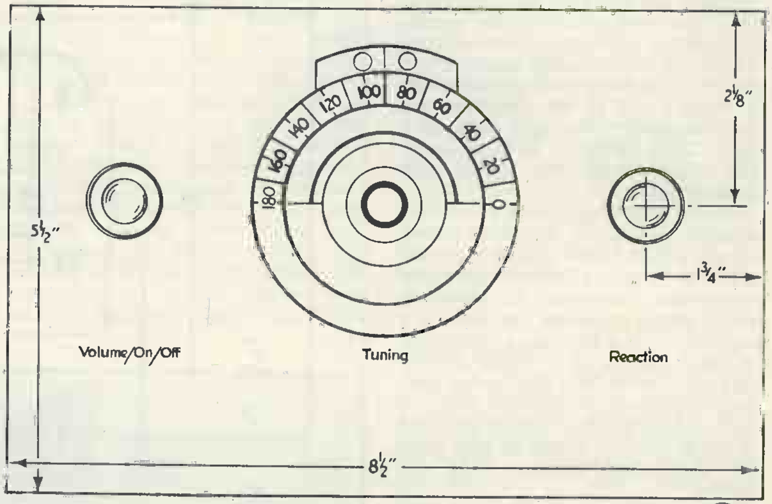


Fig. 4. Front panel details

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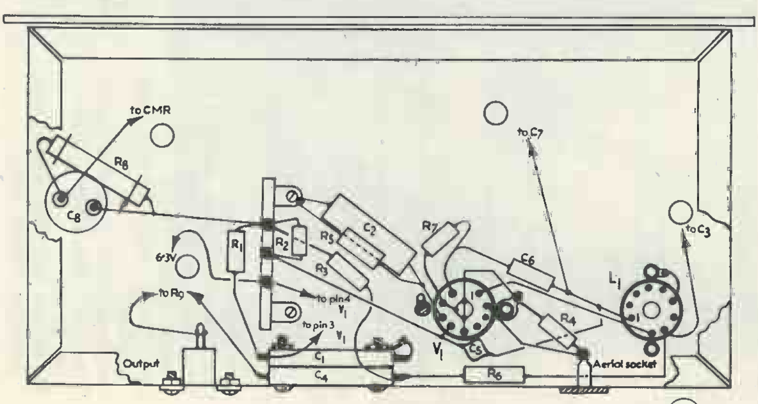


Fig. 3. Below-chassis layout and wiring

G717

controls are arranged in a neat symmetrical manner.

The rear flange of the chassis carries the aerial and earth sockets and also the coaxial output socket for the headphones. In the prototype the rear flange is also used to mount two of the fixed condensers. Full above- and below-chassis layouts with point-to-point wiring plans are given in Figs. 2 and 3, from which it will be observed that ample space exists and that no cramping occurs. A single tagstrip is sufficient to anchor the h.t. and l.t. feed points, the majority of the other small components being suspended in the wiring. Care should be taken to orient the valve bases as shown, so that short and direct wiring is made possible. A reliable connection must be made between the tuning condenser frame and chassis.

Operating the Receiver

On completion of the wiring a thorough check should be made to ensure that no short circuit exists between the h.t. rail and the chassis whereupon if all is in order an aerial may be plugged in as well as the headphones, the valve and one of the inductors. The receiver should now be switched on and an attempt made to tune in transmissions with the aid of the main tuning control, at the same time adjusting the reaction control gently to bring the valve to the verge of oscillation. Provided that the volume control is sufficiently far advanced no difficulty should be experienced in picking up signals, and the set should act in a very lively manner indeed. Should it be impossible to stop the receiver from oscillating at any setting of the reaction control, switch off and either change R_3 for a resistor slightly larger in value or, alternatively, connect a condenser of approximately 500pF from pin 1 of the valve to the chassis. But remember that the inductor core setting may affect the reaction effect to a certain extent as it can modify the coupling between the two windings.

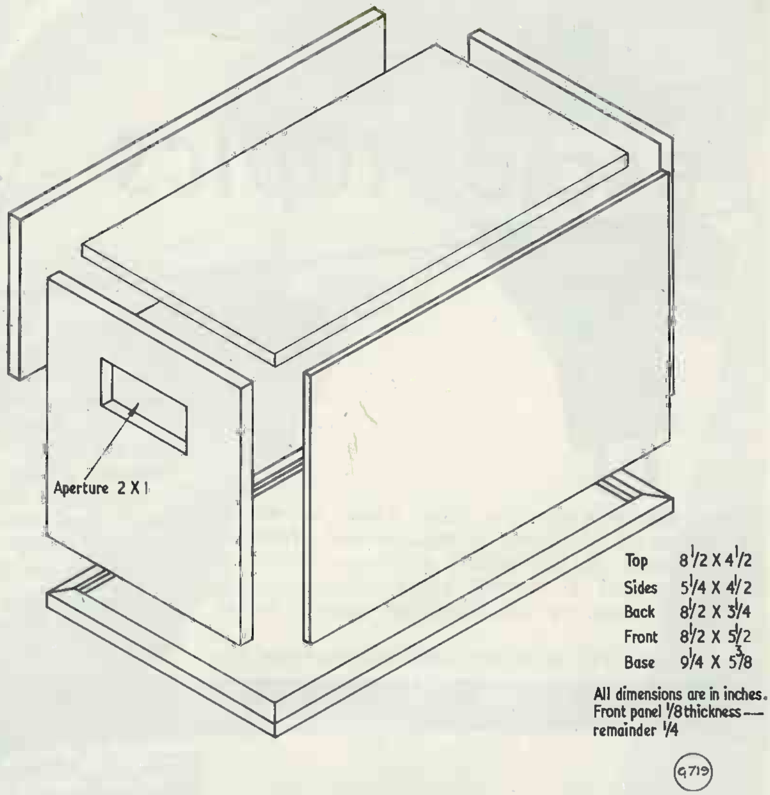


Fig. 5. Details and dimensions of the woodwork required for the suggested cabinet

The Case

A suitable housing for the receiver can be made from plywood as stated earlier. Band changing necessitates a removable type of cabinet and this can be achieved by adopting the principle shown in Fig. 5 which shows all the woodwork needed for the receiver, with the exception of reinforcement strips for holding it together without the aid of joints. Since the author professes no skill in woodworking the design is very elementary and simple, and can doubtless be improved upon considerably.

The idea is to secure the chassis and front panel to a baseboard to which is glued ⅜in moulding or quadrant as shown. Slots cut in the sides of the box assist ventilation and also permit it to be removed when it is required to change an inductor. When the case is replaced it fits into the well provided by the moulding or quadrant and is thus kept in position. Four rubber feet may be fitted to the underside of the baseboard and the whole either lacquered or French polished, or treated in whatever style is preferred.

Loudspeaker Enclosures

In the article entitled "A Small Bass Reflex Enclosure suitable for the 'Axiette' Loudspeaker" by M. J. Pitcher, B.Sc., featured on page 40 of the last issue (August), the author wrote a very clear and interesting account of the business of cabinet construction. For the benefit of readers who are interested in speaker enclosure construction and who wish to obtain still further information, we should like to point out that a free book entitled "High Fidelity Loudspeaker Manual" is available from the manufacturers of the "Axiette". In this book, details of an enclosure both for the "Axiette" and other speakers are featured. The publication is available direct from Goodmans Industries Ltd., Axiom Works, Wembley, Middlesex.

RADIO topics

By RECORDER

THE PHOTOGRAPH ON THIS PAGE SHOWS A colourful newcomer to the crowded streets of London. In this picture a driver-operator in one of the fleet of Welbeck Minicabs contacts his headquarters via the radiotelephone installed in his cab.

As readers will be aware, Minicabs may not ply for hire in the same manner as a conventional taxi-cab. They must, instead, receive their instructions via radio, and this imposes particularly stringent requirements on the equipment employed. This fact should be combined with the statement that the current Minicab system, put into service for Welbeck Motors by Pye Telecommunications Ltd., is the largest radiotelephone system in Europe. At the time of writing there are 200 Welbeck Minicabs and it is expected that these will increase to 800 by the end of the year.

Cab Installation

Welbeck Minicabs are Renault Dauphins which have been adapted for use as radio-taxis by having

their 6 volt electrical systems (the standard voltage on the Continent) converted to 12 volts. Considered overall, the cab installation is extremely simple, consisting of a self-contained simplex transmitter-receiver with self-contained speaker, and a quarter-wave whip aerial. A microphone with an integral push-to-transmit button is coupled via expanding cable to the transmitter-receiver and fits in a special clip when not required. If desired, this microphone may be replaced by a telephone handset incorporating a pressel push-to-transmit switch. The second photograph shows an engineer fitting a transmitter-receiver under the dashboard of a Minicab.

The transmitter-receiver is a Pye equipment type PTC 2007, and is known as the *Transistor Ranger*. However, apart from a transistorised h.t. power unit, all r.f. and a.f. circuits employ valves. The transmitter section has a 6BH6 crystal oscillator; 6BH6 multiplier (for 68–174 Mc/s only); QQV03–10 (6360) multiplier; and QQV03–10 (6360) power amplifier. The a.f. section of the transmitter, following a moving-coil mike, is ECC83 (12AX7) voltage amplifier; ECC83 (12AX7) phase splitter; and two EL90 (6AQ5) a.m. modulators. R.F. output is 4 to 6 watts according to operating frequency.

The receiver employs a single superhet circuit for the 25–68 Mc/s band, and a double superhet for the 68–174 Mc/s band. On 25–68 Mc/s there are three r.f. stages, an overtone oscillator mixer, three i.f. amplifier stages at 2 Mc/s, a demodulator, a.g.c. rectifier and a.f. amplifier, a noise limiter, and the a.f. output stage. On 68–174 Mc/s there are two r.f. stages followed by a crystal oscillator and multiplier, the first mixer (converting to 10.7 Mc/s), and the second mixer and crystal oscillator. After this the 2 Mc/s i.f. stages proceed as with the 68–174 Mc/s circuit. Valve line-up is two EC91 (6AQ4) r.f. amplifiers; EC91 (6AQ4) r.f. amplifier (low band) or first mixer (high band); ECF80 (6BL8) mixer (low band) or second mixer-oscillator (high band); two 6BJ6 2 Mc/s i.f. amplifiers; 6CB6 third 2 Mc/s i.f. amplifier; EBC90 (6AT6) demodulator, a.g.c. rectifier and a.f. amplifier; EL90 (6AQ5) a.f. output; 6BH6 low band overtone oscillator; ECF80 (6BL8) high band oscillator/multiplier; and OA200 silicon diode noise limiter. After a row of bottles as impressive as this some sort of noise ought to come out of the speaker. And indeed it does: typical sensitivity figures for an input of 2μV only are 1 watt a.f. output with 14dB signal to noise ratio at 72 Mc/s, and 1 watt a.f. output with 11dB signal to noise ratio at 160 Mc/s. The a.g.c. control range is similarly impressive, there being less than 8dB change in a.f. output for inputs ranging from 4μV to 20mV.

The h.t. power supply unit employs two OC35's in a multivibrator circuit running at approximately 4 kc/s, the output being rectified by a pair of silicon junction rectifiers connected as voltage doublers. An interesting feature of the power supply is that the decorative front panel also provides a radiating heat sink for the power unit transistors.

The overall unit is capable of working in the two bands 25–68 Mc/s and 68–174 Mc/s just mentioned (i.e. overall range is 25–174 Mc/s), and those fitted in the Welbeck Minicabs have six switch-selected channels. The front panel controls are On-Off, Transmitter Off/Stand-by (which switches the transmitter filaments), and a.f. volume. A squelch level control, which silences background in the absence of a signal, may also be fitted. Under an inspection cover on the front panel are controls which include transmitter aerial trimmers and receiver crystal trimmer. There is also a test meter outlet socket. The power consumption of the unit is 36 watts on Receive, 58 watts on Standby, and 105 watts on Transmit.

The Complete System

The complete Pye installation includes transmitting stations based at Hampstead and Forest Hill, and these are connected by G.P.O. land lines to the Control Room. The given radius of operation from the transmitters is 20 to 25 miles but, with good line of sight conditions, the actual range may be considerably inreased. At the Control Room, initially installed with 20 G.P.O. lines, a conveyer-belt system is fitted which can handle calls at the rate of one every two seconds.

Quite a set-up, isn't it? And something to ponder over, perhaps, if and when you next ring for a Minicab whilst in the Smoke!

Russia at Earls Court

I was able to make a flying visit to the U.S.S.R. Industrial Exhibition held in London on the 7th to the 29th July. I arrived at Earls Court to find that the familiar Exhibition Hall, on whose concrete floors I have travelled many foot-weary miles during successive radio shows, had been transformed completely by the Russians. Apart from the Fashion Theatre only the ground floor was in use; but the individual sections on that floor, which all merged one into the next, had been given very high false roofs that completely obliterated the somewhat unsightly upper section of the building. The layout seemed at first sight to be a little haphazard, but a glance at the programme soon showed that a definite route could be followed which enabled all the exhibits to be examined without re-crossing one's steps and without leaving anything out. Personally, I preferred the change from the usual geometic Exhibition layout.

Much of the emphasis was, quite frankly, on Soviet achievements; and the centrepiece of the Exhibition was contained in a circular section having a high blacked-out dome in the shape of a planetarium. A model of the world revolved slowly near the apex of this dome, being surrounded by orbits of various shapes traced out in neon tubing. This section also held models of the various Russian satellites including that in which Major Yuri Gagarin carried out his epoch-making flight into space.

Most of the purely electronic equipment on display was of a standard and solidly-made variety, and my eye was not caught, during my short visit, by any outstandingly new development. A small section was devoted to domestic radio and television receivers and my immediate reaction to the latter was that, judging by the depths of the cabinets, the Russians have not yet gone over to 110° picture tubes. The television receivers were on a closed-circuit hook-up, allowing visitors to see themselves via a camera in the centre of the stand. The radio sets were, so far as I could judge, pretty standard also, with conventional cabinet styling and not too much flashy trim.

The educational section showed some simple electronic demonstration boards employing actual components mounted in such a manner that their circuit could be easily followed. These demonstration boards included a two-triode a.f. amplifier and a two-triode balanced v.h.f. oscillator working directly into a dipole of some 3-metre wavelength. There was also a do-it-yourself kit for an electric motor in a shallow cardboard box complete with a lovely garish picture on the top of the completed job. Just the sort of thing that I used to lap up when I was a kid! A neat gadget in this section displayed a sine wave by means of a series of white buttons sliding on vertical black rods against a black background. By rotating a wheel at the rear, cords pulled the buttons to different positions, thereby changing the shape of the "wave".

I was at the Exhibition during the visit of Major Yuri Gagarin, but any hopes I may have had of seeing the astronaut were dashed because of the fantastic and enthusiastic crowds who waited for him and surrounded him as soon as he appeared.

A fond memory of the Exhibition was occasioned by a public address call for three missing schoolboys. The call asked these boys "to report to Section Four, Outer Space, immediately". This was perfectly in keeping with the idiom of the Exhibition and capped my visit very nicely.

Electroluminescent Clock Dial

Smiths Clocks and Watches Ltd. will shortly be releasing the *Callglow* electric clock. This clock, which operates from 200–250 volts a.c. synchronous mains, caused considerable comment when it was exhibited at the Tenth Electrical Engineers' Exhibition at Earls Court last March, and it is of special interest here in that it will be available with an electroluminescent dial. The light intensity of the dial is controllable and, obviously, the latter can be read very easily in the dark.

The phenomenon of electroluminescence has been the subject of research work for many years, but it is only recently that development has enabled electroluminescent light sources to become available at low manufacturing costs. Basically an electroluminescent lamp consists of a flat panel, which can be made in sizes up to 12 x 9in, containing a layer of phosphors sandwiched between two conducting layers. The back conducting layer may be opaque and the front conducting layer transparent, whereupon the application of an e.m.f. to the two causes light from the excited phosphors to pass through the front layer. As may be gathered, the light is radiated from the whole area of the panel, as opposed to the "point" light source of filament lamps and the "linear" source of fluorescent tubes.

Apart from the unique ability to radiate light from an "area" source, electroluminescent lamps have a very high efficiency. Negligible heat is dissipated, and practically all the applied electrical energy is converted directly to light. A typical lamp running from a 250 volts supply would consume a current of some 0.2 to 0.3mA per square inch only.

The Smiths *Callglow* clock will be available in illuminated and non-illuminated versions, the former having the electroluminescent dial. In this, the a.c. mains voltage is applied to the conducting layers of the electroluminescent element via a fixed limiting resistor and a variable resistor which controls the brightness. The *Callglow* clock also contains the normal alarm circuit.

Points from Letters

Last month's Radio Topics included a report of t.v. Dx reception by Mr. R. J. Ringrose of Ipswich Suffolk. Mr. Ringrose has sent me some further information, this arriving just too late to appear last month. He has now changed his receiver to negative modulation by reversing the video detector and he found that he also had to halve the value of his video output cathode resistor to obtain sufficient brightness. On his Channel 1 vertical dipole he has received Belgian and Spanish transmissions on 48.25 Mc/s, at times so strongly that contrast had to be turned fully back. He has also received the Russian test card on 49.75 Mc/s on five occasions, once so strongly that contrast had, again, to be turned fully back. Going back to positive modulation he has received Caen weakly on 52.4 Mc/s and Lille on 185.25 Mc/s, the latter being picked up at such strength that a test card was resolved with only a 10in piece of wire in the aerial socket of the receiver! Incidentally, I guessed last month that unidentified 185.25 Mc/s transmissions might be from Eiffel Tower, but it looks as though I was wrong. Both Lille and Eiffel Tower share the same channel, and both have the same power.

Mr. I. C. Beckett of Buckingham, whose feats of Dx reception formed the basis of the "Long Distance TV" article in our November 1960 issue, is still pulling them in. As of the beginning of July his total of countries received this year is 11, excluding France and Belgium. The last two must be locals to Mr. Beckett! Included in Mr. Beckett's haul is the identification card for the *Osterreichischer Rundfunk* service introduced in Austria some years ago. All Mr. Beckett's Dx is on Band I.

The way things are going, I'm expecting a report any day now on the reception of *Transatlantic* t.v.! A set successfully adapted for 625 line negative modulation shouldn't have much difficulty in resolving a 525 line signal as used in the States. The 525 line signal has a line frequency of 15,750 c/s, which is only very slightly removed from the 15,625 c/s of the 625 line signal. The field frequency is 60 per second, as opposed to 50 per cecond, but this shouldn't be beyond the capabilities of most vertical timebases.

Another letter describes the experiences of a reader, Mr. R. Goodsell of Margate, after he had inserted a request for information on an electronic metronome in the "Can Anyone Help?" column in our March issue. Mr. Goodsell writes: ". . . I received replies from Germany, Australia and New Zealand, apart from about two dozen or so from various parts of this country. I really had no idea that *The Radio Constructor* got around so much."

The "Can Anyone Help?" column certainly seems to be giving considerable assistance to those who take advantage of it. And it also proves, of course, that the old friendly spirit in the hobby of radio is still with us, and that it remains as strong as ever.

Lead Consumption Rises

Consumption of lead in batteries in the U.K. has been rising steadily in recent years and in 1960 the battery industry took some 75,000 tons of lead as metal and oxides—some 20 per cent of all lead consumed.

In order to assist in the development of this important market the Lead Development Association announces that Mr. P. C. Fryer, B.A. Cantab., has been appointed to the staff. Mr. Fryer is a metallurgist and prior to joining the L.D.A. was on the staff of the Morgan Crucible Company. He will be principally engaged in development work for the lead industry in the battery field.

A Constructor's Oscilloscope

—A Construction of the Mullard Design

Part 3

by D. NOBLE, G3MAW and D. M. PRATT, G3KEP

I. High Impedance Attenuator Probe

THE VERY SIMPLE CIRCUIT OF THIS, TOGETHER WITH constructional sketches, is shown in Figs. 7 and 8. The small trimmer is provided to balance the capacity of the coaxial lead, which should be of the specified length. In the prototype, this trimmer was made from a miniature air-spaced type with rotary moving vanes, and consisted of one fixed and one moving vane.

Construction

The probe is built around standard Neosid coil components. Firstly, the central portion of the coil former is filed away leaving a piece of semi-circular cross-section supporting the top end, in which a ⅛in hole is drilled as shown. A standard brass core is drilled through its axis to take the prod of $\frac{1}{16}$in

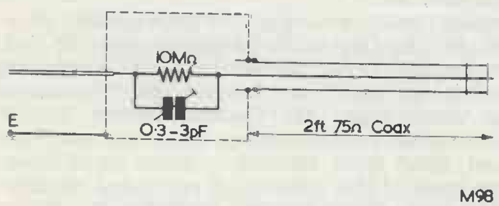


Fig. 7. High impedance attenuator probe

Components List
(High Impedance Attenuator Probe)

1 10MΩ resistor 10% ¼ watt
1 Trimmer 0.3–3pF (see text)
1 Former assembly, Neosid 5000B, complete with insulated top plate
1 Brass core (to fit former assembly)
1 Crocodile clip (Bulgin)
1 Coaxial plug (Belling-Lee L734/P)
75Ω Coaxial cable (2ft)
$\frac{1}{16}$in brass rod, screws, etc.

brass rod, which may either be sweated in or made a tight fit. A radial hole in the core is drilled and tapped 6BA such that, with the core screwed flush

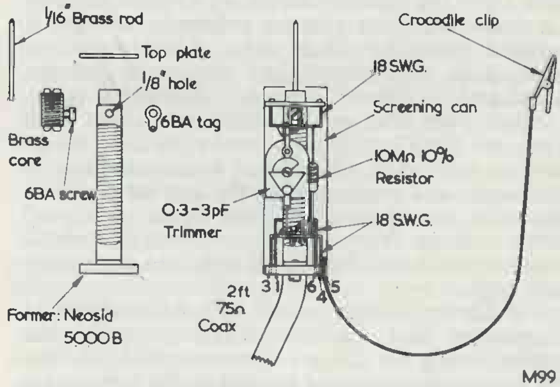
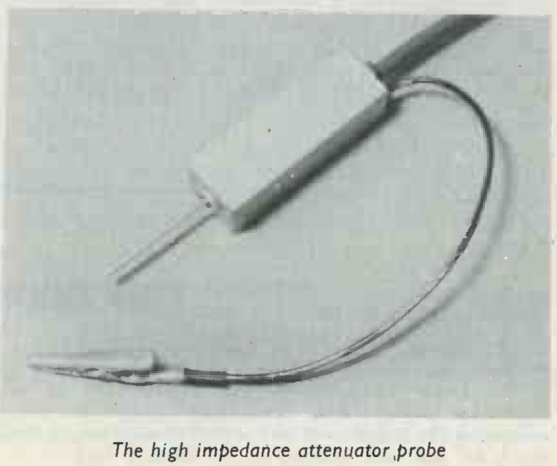


Fig. 8. Construction details of the high impedance attenuator probe (see text)

with the end of the former, a 6BA screw may be fitted through the former to retain it, a solder tag being provided for the electrical connection.

The top plate is fitted in position and three pieces of 18 s.w.g. tinned copper wire are bent and fitted into the spill holes of the top plate and base as shown.



The high impedance attenuator probe

The components may then be soldered in position. An earth lead fitted with a crocodile clip is taken from the earth spill through one of the spare spill holes. The coil can is earthed by means of a piece of copper foil, cut to a suitable shape, which is soldered to the earth spill and bent under the former base. Upon fitting the can one of the fixing lugs is clamped to the copper foil by means of its 6BA fixing screw.

As can be seen the coaxial lead is fed up the centre of the former. It will be found a tight fit, and will necessitate being tapered and screwed in. To enable the trimmer to be adjusted when the probe is assembled, a hole is drilled in the side of the can.

Components List
(High Gain Probe)

Resistors

- R_1 470kΩ ¼W 10%
- R_2 47kΩ ¼W 10%
- R_3 470kΩ ¼W 10%
- R_4 1.5kΩ ¼W 10%
- R_5 120kΩ ¼W 10%
- R_6 470kΩ ¼W 10%

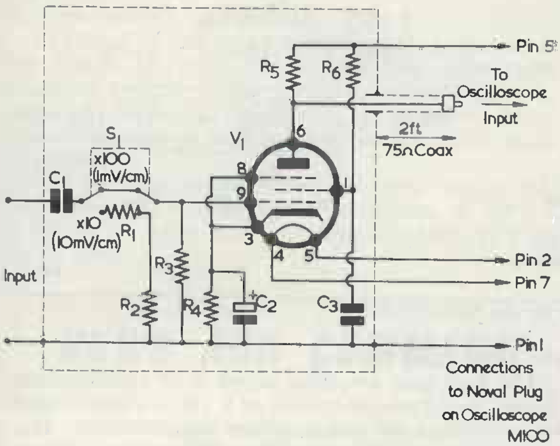


Fig. 9. Circuit diagram of the high-gain probe

Condensers

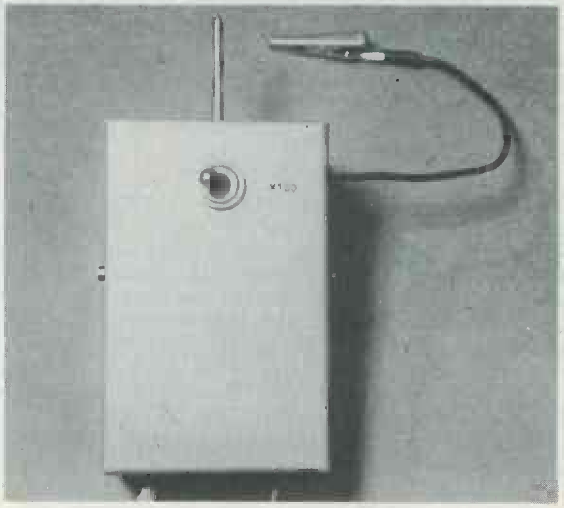
- C_1 0.1μF 350V paper
- C_2 100μF 6V electrolytic
- C_3 0.1μF 350V paper

Miscellaneous

- S_1 Double-pole changeover toggle switch, N.S.F. Type 8373/K7
- V_1 Mullard EF86

Also required—

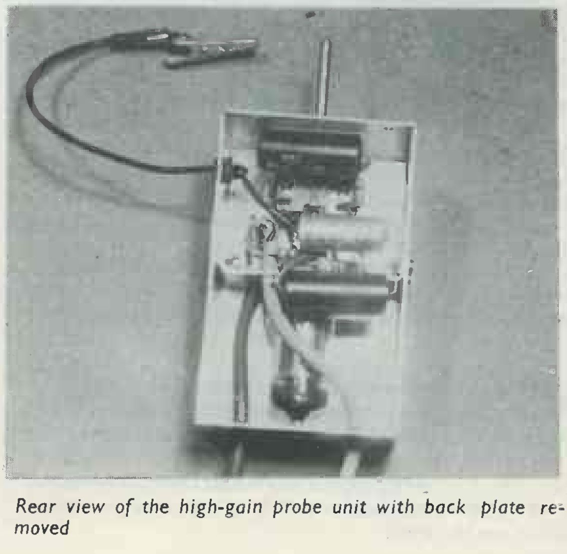
- 1 Noval valve base (McMurdo) Type BM9/U
- 1 Noval plug (McMurdo Type BLM9/USP1 with No. 22 cover)
- 2ft of 75Ω coaxial cable
- 1 Coaxial plug (Belling-Lee L.734/P)
- 2ft 4 way p.v.c. cable
- 1 crococile clip (Bulgin)
- Prod assembly (see Fig. 11)
- Chassis and box (see Fig. 10)
- 1 Tagstrip, Bulgin Type T19 with R.H. tag removed



External view of the high-gain probe

Checking

As explained earlier, the purpose of the trimmer is to make the whole circuit (including all stray capacity) aperiodic. Alignment of this condenser can be achieved by connecting the input of the high impedance attenuator probe from the oscilloscope to the cathode of the tube in a television receiver.



Rear view of the high-gain probe unit with back plate removed

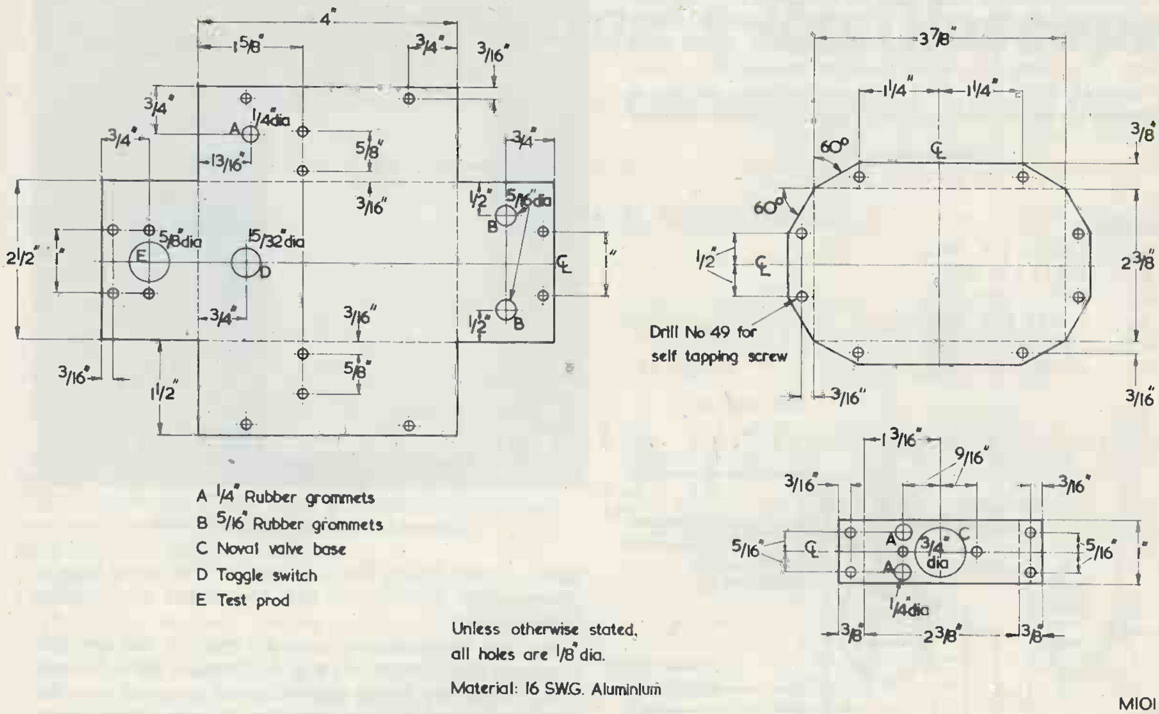


Fig. 10. Chassis drilling details for the high-gain probe

If, now, the timebase is adjusted to the line frequency, the line sync pulse should be obtained, and the trimmer adjusted until it appears as a rectangular pulse with no overshoot.

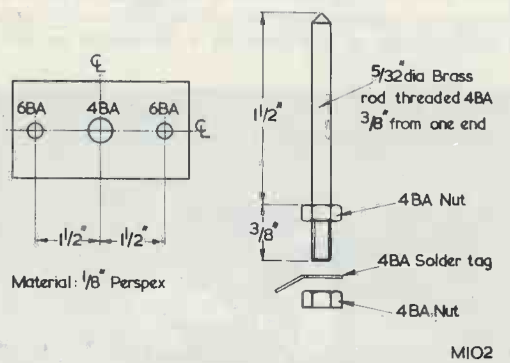


Fig. 11. Details of the prod for the high-gain probe

It must be remembered that, when checking waveforms of a.c./d.c. equipment, the oscilloscope chassis must not be earthed, but must be connected to the chassis of the a.c./d.c. equipment. This should, if possible, be connected to the neutral side of the mains in order to minimise hum pick-up and also to ensure safety to the user.

II. High Gain Probe

The high-gain amplifier probe is of conventional design giving amplifications of x 10 or x 100—these being selected by a changeover toggle switch. The circuit is given in Fig. 9. The x 100 position, with a maximum input of 300mV, gives a sensitivity of 1mV/cm., whilst, on the x 10 position, the maximum input is 3V and the sensitivity is 10mV/cm. The probe is designed primarily for a.f. amplifier work and has a bandwidth of 5 c/s to 20 kc/s.

Construction

The probe is mounted in a small box 4 x 2½ x 1½in made from 16 s.w.g. aluminium. The valve is mounted on a small bracket inside, and the prod is fitted to one end on a piece of ⅛in Perspex, an earth lead being provided through a rubber grommet at the side. The construction of this should be clear from Figs. 10 and 11.

From the opposite end to the prod, two leads leave the unit. One is the four-way power supply cable terminated by a noval plug which connects with the socket at the rear of the oscilloscope chassis. The other is the signal lead consisting of a 2ft length of ordinary 75Ω television type coaxial cable. The positions of the various components can quite readily be seen from the photograph.

Checking

The high-gain probe unit may be checked by feeding its input to a calibrated audio oscillator.

With maximum Y-gain, a display of 1 cm. amplitude should be obtained with an input of 1mV on the x 100 switch position. If the specified length of coaxial cable is used, the response should be found to be flat to within 3dB up to about 20 kc/s.

Conclusion

The writers have found this Mullard circuit to give very pleasing results in a unit which compares favourably in size with the average commercial kit, and they wish to express their appreciation and thanks to Mullard Ltd. for their kind co-operation, without which this article could not have been produced.

References

1. *Mullard Technical Communications*, Vol. 4, No. 32, "Circuit for a Simple Oscilloscope", pages 33–38. (Based on a report prepared by L. S. Brown of the Mullard Applications Research Laboratory).
2. *Scope for Service*. Mullard Publication No. TP374.

ERRATA

A Constructor's Oscilloscope—Part 1

In Part 1 of this series condenser C_1 is shown, in the circuit on page 923 of the July issue, with incorrect polarity. The condenser should have its negative terminal connected to rectifier MR_1, otherwise damage may result when the mains input is applied.

The table on page 921 did not show clearly that response, with Direct Input or "Probe X 10", is 2 c/s to 2.5 Mc/s and, with Pre-amplifier, is 5 c/s to 20 kc/s.

NEWS AND COMMENT

Interference

A correspondent to *The Times* has recently suggested, presumably not too seriously, that 4-star hotels should lose a star or two if television or radio are installed in the only comfortable lounge. Such a comment underlines the difficulty, in a heavily populated country, of how to allow freedom to one type of person without depriving another. A current difficulty is with transistor portables. Complaints of annoyance have been made when these have been used on motor bus and beach. This latter can readily be appreciated as these words are being written at a spot where normally one can only hear the sound of waves breaking on the seashore, but today some holiday-makers are listening (?) to programmes on their portable and the rest of us perforce . . .

This matter has been pinpointed by a statement issued by the Town Clerk of Eastbourne, attention being drawn to the fact that there is a bye-law which makes it an offence to operate radio sets, record players or other amplifying equipment in streets and public places. Offenders can be fined up to £5. The statement was put out after complaints of annoyance had been received from holiday-makers on the beaches and promenades. For the same reason London Transport has reminded its staff that the use of portable radios on buses contravenes regulations. A possibly more serious misuse is the monitoring of police messages by criminals to warn them of the approach of the law.

However, probably every great discovery has been misused by someone, and, when the novelty has worn off, we do not expect to hear so much about this kind of interference.

Viewing

According to figures issued by the B.B.C. in respect of the period April to June, 2 million more people watched t.v. compared with the same period a year before. It is estimated that 32 million sets are switched on during the average day! The B.B.C. compute that commercial programmes are tuned into more frequently than their own to the extent of 63% to 37%; the exception being the Saturday afternoon "Grandstand".

The number of current t.v. receiving licences issued in England and Wales is now comfortably in excess of 10 million, and in Scotland over 1 million. Taking Great Britain and Northern Ireland together the numbers are likely soon to reach 11½ million. (Sound only licences are just short of 4 million of which nearly ½ million are for car radios.)

The Home Secretary, Mr. R. A. Butler, speaking at a British Medical Association conference dinner, referred to irresponsibility among young people and mentioned, among other things, the immaturity and irresponsibility of many television programmes. One method of achieving a more responsible attitude might be to follow the somewhat facetious advice given on one of our office calendars "instead of standing them in a corner, children nowadays are best corrected by standing them with their backs to the television".

Wired Sound and Television

The chairman's statement issued with the accounts of Rediffusion Ltd., reveal the considerable overseas use of wired sound and television broadcasts. In references to a subsidiary's activities in Western Nigeria, it was stated that the majority of the world's population live in scattered communities, without power supply or radio and that anyone finding a successful means of bringing them information and entertainment will have almost limitless opportunities.

Wired sound and television was, naturally, dealt with in some detail. It was mentioned that regional agreements had been made with branches of the R.T.R.A. for co-operation with the general radio trade. It was interesting to note that Rediffusion hope to persuade manufacturers to incorporate modifications in television receivers so that viewers may receive signals from either aerial or land-line.

In Brief

● The B.B.C. estimate that an average audience of 15 million people had watched "*The Valiant Years*" each week, 10 million in the first and 5 million in the second showing. These figures were issued just before the conclusion of the series.

(continued on page 144)

Transistor Shorted Turns Tester

By M. D. ROBERTS

In our August 1960 issue, we published details of "A High Sensitivity Shorted Turns Tester" designed by M. D. Roberts. This unit employed a 12AT7 valve and required a mains h.t. and heater supply. Our contributor has now developed a self-contained transistorised version of the shorted turns tester, and this is described herewith

The transistorised shorted turns tester was designed for compactness and, since it is completely self-contained, it can be carried anywhere and used in any situation. The appearance of the unit can be seen from Fig. 1. The meter is a 0–1mA moving coil instrument, the size of this determining the size of the complete unit. The batteries are housed within the case and should have a life of many months. The case must be made of wood or other insulating material to prevent damping effects on the test probe.

There being no valves to warm up, when the tester is switched on it is ready for use immediately; therefore the unit need not be switched on until the moment it is needed, with a consequent saving in battery consumption. The core of the test probe is a piece of Ferroxcube taken from an old ferrite aerial; it is protected by being mounted in a Paxolin tube.

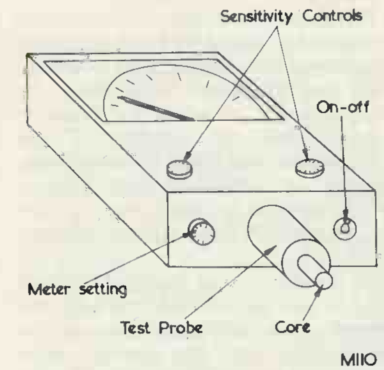


Fig. 1. The external layout of the shorted turns tester

The Circuit

The circuit, which is shown in Fig. 2, employs two Newmarket audio transistors type V10/30A. One transistor, TR_1, is used as a conventional oscillator with a nominal frequency of 1 kc, and the other, TR_2, as an amplifier controlled by the amplitude of oscillations from TR_1.

TR_1 constitutes a Colpitts oscillator in conjunction with L_1 and its associated components. R_1R_2 set up the bias conditions for the oscillator, whilst R_4 allows variation of the bias point and thereby serves as a sensitivity control. C_4 decouples the emitter to the positive supply line and prevents negative feedback in the oscillator. The oscillations built up across R_3 are passed to TR_2 via the d.c. blocking condenser C_5. The signal passed by C_5 controls the current flowing through TR_2, this current being monitored by meter M_1. R_6 controls the bias point on TR_2 and is adjusted for maximum sensitivity of this

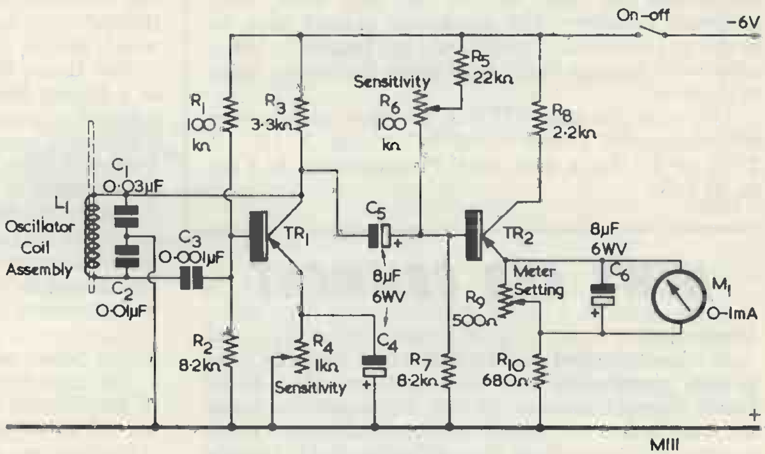


Fig. 2. Circuit diagram of the tester

Components List

Resistors
- R_1 100kΩ ⅛ watt
- R_2 8.2kΩ ⅛ watt
- R_3 3.3kΩ ⅛ watt
- R_4 1kΩ potentiometer
- R_5 22kΩ ⅛ watt
- R_6 100kΩ potentiometer
- R_7 8.2kΩ ⅛ watt
- R_8 2.2kΩ ⅛ watt
- R_9 500Ω potentiometer
- R_{10} 680Ω ⅛ watt

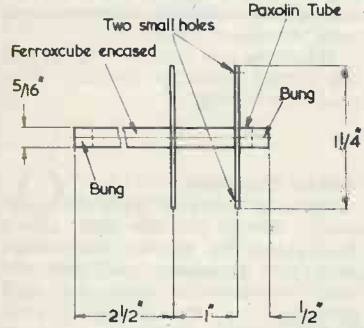
Transistors
- TR_1 V10/30A Newmarket
- TR_2 V10/30A Newmarket

Meter
- 0–1mA f.s.d.

Condensers
- C_1 0.03μF paper
- C_2 0.01μF paper
- C_3 0.001μF paper
- C_4 8μF, 6 w.v. electrolytic
- C_5 8μF, 6 w.v. electrolytic
- C_6 8μF, 6 w.v. electrolytic

Miscellaneous
- On/off switch
- 6V battery (two 3V units in series, or to suit individual requirements)
- Ferrite rod (see text)
- Paxolin tubing, etc., etc.

stage. R_9 varies the current flowing through M_1, and is set to prevent the meter being overloaded. C_6 decouples any oscillations present across the meter.



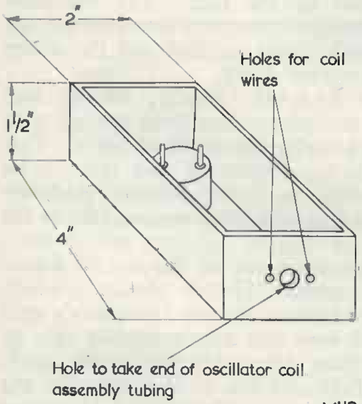
M112

Fig. 3. The manner in which the oscillator coil assembly is constructed before winding

Testing for Shorted Turns

With the aid of this unit, coils without cores can be checked to ascertain if there are any shorted turns within the winding.

Referring to Fig. 2, it will be seen that L_1 has a core which extends beyond the actual oscillator coil. If a winding with a shorted turn is passed over this core extension the oscillator coil becomes damped. The



M113

Fig. 4. The case dimensions employed in the prototype

result is a considerable reduction or, even, a complete collapse of oscillator amplitude. The reduced signal passed to TR_2 then causes this transistor to pass more current and the presence of the shorted turn is indicated by an increased reading in M_1[1]. If a coil without a shorted turn is passed over the oscillator core extension there is no increase in the M_1 reading.

Construction of the Oscillator Coil

The construction of the oscillator

Checking the transistorised shorted turns tester by passing a closed loop of wire over the oscillator core extension. This causes an increase in meter reading. (The unit illustrated here is an experimental model built to the circuit of Fig. 2 but employing a layout differing from that in Figs. 1, 4 and 5)

coil is shown in Fig. 3. Obtain a Ferroxcube rod about 3½in long and ¼in in diameter, together with a length of Paxolin tubing that is a reasonable push fit over it. Cut a length from the tubing ½in longer than the Ferroxcube rod. Make up two wooden bungs ¼in long to fit in at either end of the tubing. Put the Ferroxcube into the tube and cement the bungs in at each end so as to completely enclose the Ferroxcube and hold it rigidly in position. Make up two Paxolin discs 1¼in in diameter with a hole in the centre of each allowing them to slide over the Paxolin tube. One of the discs requires two small holes near its periphery for lead-out wires from the coil. Cement the discs into position, as shown in Fig. 3, remembering that the disc with the two small holes

[1] It should be remembered that, in the presence of oscillations from TR_1, there will be a rectifying action between the base and emitter of TR_2. This would cause C_5 to charge in such a manner that the base of TR_2 will tend to go positive, the positive excursion being limited by R_5 and R_6. Reduction of oscillation amplitude results in reduced charge in C_5, and would explain the increase in TR_2 current referred to in the text.—*Ed.*

should be nearer the end of the Ferroxcube.

Next, wind 2,000 turns of 32 s.w.g. enamelled copper wire in several layers between the two discs. Lead the two ends of the coil wire through the two small holes in the Paxolin disc and cement the coil firmly into place. The coil is now ready for assembly to the case.

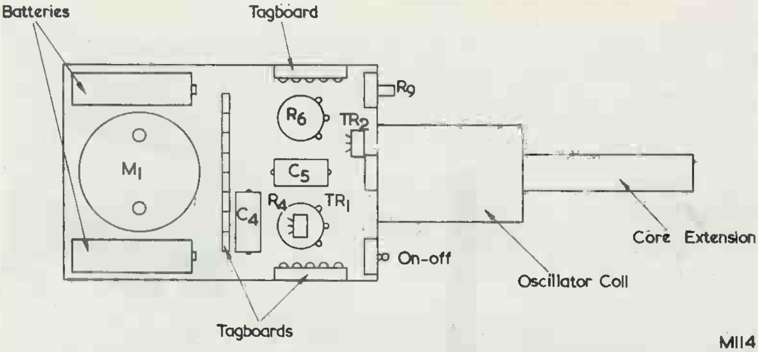


Fig. 5. Illustrating the layout of the major components

Construction of Case

The size of the case depends mainly on meter dimensions. In the writer's instance, the meter was 2 x 2 x 1¼in deep, and the dimensions of a box to house such a meter are given in Fig. 4.

Special attention is drawn to the relatively large diameter hole at the end of the case, and the two small holes on either side. The large hole takes the end of the oscillator coil tubing, and the two small holes allow the leads from the coil to be fed into the case. The rear disc on the coil can then be cemented to the end of the box with the tubing protruding through. If desired, a Paxolin sleeve 1in long and with an internal diameter of 1¼in can be glued over the coil on the two discs to completely seal the coil and make a neater unit.

After this, the layout of the components has to be decided. The layout diagram given in Fig. 5 will serve as a though guide.

The layout of components is not critical, but if the size of the unit is to be kept small, component positioning must be planned carefully. All components used in the prototype were miniature types.

When the unit has been wired, and the circuit carefully checked, it is ready for testing.

Testing Procedure

Make a 1in loop with 20 s.w.g. wire. Switch on the unit, adjust R_4,R_6 and R_9 so that they insert maximum resistance and pass the loop momentarily over the core extension of the oscillator coil. Watch the meter for results. Advance R_4 a fraction and pass the loop over the core again. Repeat this process until a position is found where the meter indicates the most deflection when the loop is passed over the core. Then proceed to R_6 and adjust this for maximum sensitivity in the same way, adjusting R_9 to prevent the meter being overloaded.

Continue minor adjustments to all three controls until the unit is at its most sensitive setting. The shorted turns tester is then ready for use.

NEWS AND COMMENT *(continued from page 141)*

● The Amateur Radio Mobile Society at their second Annual General Meeting reported an increase in membership and that they now have quite a number of members abroad. It was announced that a ruling had been obtained from the Post Office allowing separate log books to be kept for mobile contacts.

● According to the *London Evening Standard*, Mr. Charles Orr Stanley's Pye Radio and Television group is linking up with the Ling-Temco Electronics of Texas to form a new joint company to be called Pye-Ling. The new firm will market vibration test equipment which is used for testing missiles and space rockets. Initially the new firm will be comparatively small, starting with a capital of £160,000.

● In order to survey a busy intersection at Southend airport which is not visible from the control tower, a Marconi closed circuit television camera channel has been installed.

● Marconi will also be supplying underwater television cameras to be used for salvage operations by a fleet of seven Russian tugs, following an order for t.v. equipment placed by the Finnish shipbuilding firm Valmet Oy. Seven Marconi-Siebe, Gorman cameras and monitors are to be delivered to the Pansio Shipyard, Turku, for installation on board the diesel-driven salvage tugs now being built for V/O Sudoimport of Moscow. Diving equipment, and underwater cutting and electric arc welding devices, are carried by the tugs. The Marconi-Siebe, Gorman television cameras will enable salvage experts to see work being carried out by divers using pressure air-driven tools.

● An order for SARAH (Search, Rescue and Homing) marine equipment has been placed with Ultra Electronics Ltd. by the Swedish Navy. This is the first marine equipment of this type to be ordered from Sweden. An initial order for SARAH aircraft equipment has also been received from the Swedish Army.

● The first turf has been cut on the site of a new building—to be named "Elettra House"—which will house all the Marconi Marine Company's staff in the Chelmsford area and approximately fifty of the Company's East Ham central stores staff. Clearing of the three-acre site at Westway, on the Widford industrial estate, Chelmsford, has now begun and the building is expected to be ready for occupation by the end of next summer. The name of the new headquarters has a historic significance within the Marconi Group of Companies. Marchese Marconi named his famous experimental yacht *Elettra*, one of his daughters was also called *Elettra*, and the Marconi Company's present experimental yacht is named *Elettra* II.

A Magnetic Guitar Pick-up and Transistorised Tone Control Pre-amplifer

BY D. E. MAYNARD

ONE OFTEN SEES ARTICLES DESCRIBING GUITAR pick-ups, but they nearly all seem to use a crystal mike insert or similar device. Quite good results are obtainable in this way but such methods are subject to one or more of the following disadvantages:

(1) Pick-up of extraneous noises such as the rubbing of clothing on the guitar.
(2) Feedback if played too close to the loudspeaker system.
(3) High impedance output necessitating the use of considerable lengths of screened cable.

The method described here is subject to none of these disadvantages. However, it can only be used with a steel stringed guitar.

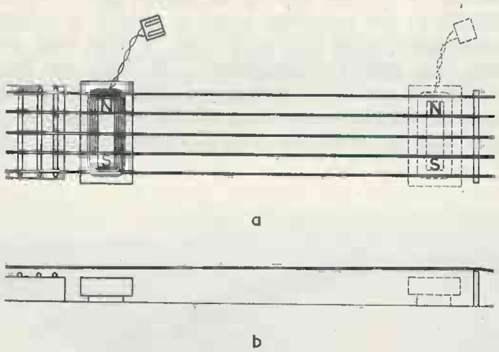


Fig. 1. Two positions for the guitar pick-up

Pick-up Construction

A bar magnet slightly shorter than the span of the strings and thin enough to pass between them and the guitar body is needed. Around this a

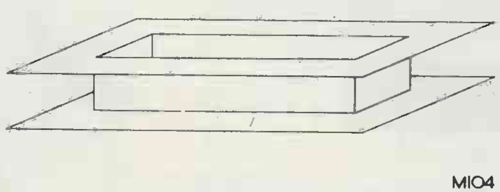


Fig. 2. The pick-up former

former of thin Paxolin or ivorine or any other stout insulating material is built up as shown in Fig. 2 so that it is a tight fit over the magnet. Then, with the magnet inserted, about 180 turns of 32 s.w.g. enamelled wire are wound on to the former and terminated in a two-pin socket which is fixed to the guitar. It should be pointed out here that the number of turns and gauge of wire required need not necessarily be the same as those just given.

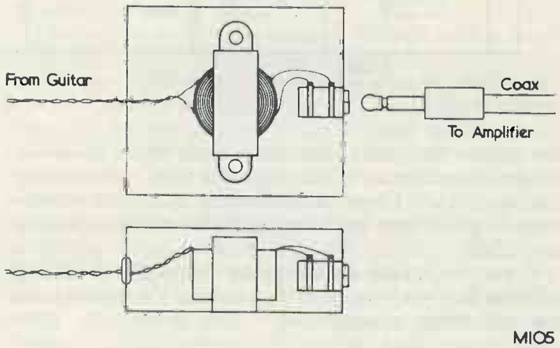


Fig. 3. Matching the pick-up to the amplifier

Experience with experimental models has shown that, whilst it is preferable to fill the former with a large number of turns of fine wire rather than a small number of turns of thick wire, the difference in output resulting is not great. A pick-up wound with 40 turns of 24 s.w.g. enamelled wire gave only slightly less output than that wound with 180 turns of 32 s.w.g. wire.

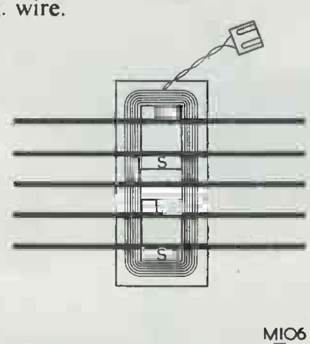


Fig. 4. An alternative method of constructing the pick-up using two magnets

The pick-up is positioned on the guitar body as in Fig. 1, it being mounted as close to the strings as is permissible after allowing for the depression of the strings on high notes. Fig. 1 shows two alternative positions for the pick-up. The steel strings of the guitar become magnetised and, when plucked, create disturbances in the magnetic field surrounding the magnet. These disturbances produce corresponding voltages in the coil which are subsequently amplified.

From the socket on the guitar up to about 20 feet of twin flex may be used to connect the pick-up to the matching transformer. The latter can conveniently be a miniature "battery pentode" output transformer mounted in a small box as shown in Fig. 3. From here, about one yard of coaxial cable is used to connect to the input of a suitable amplifier. The reason for not having the matching transformer actually at the amplifier input is that it is sensitive to magnetic fields and thus must be kept well away from the mains transformer. It may be found helpful, in order to reduce r.f. breakthrough and hum, to connect one lead of the twin flex to the outer conductor of the coaxial cable.

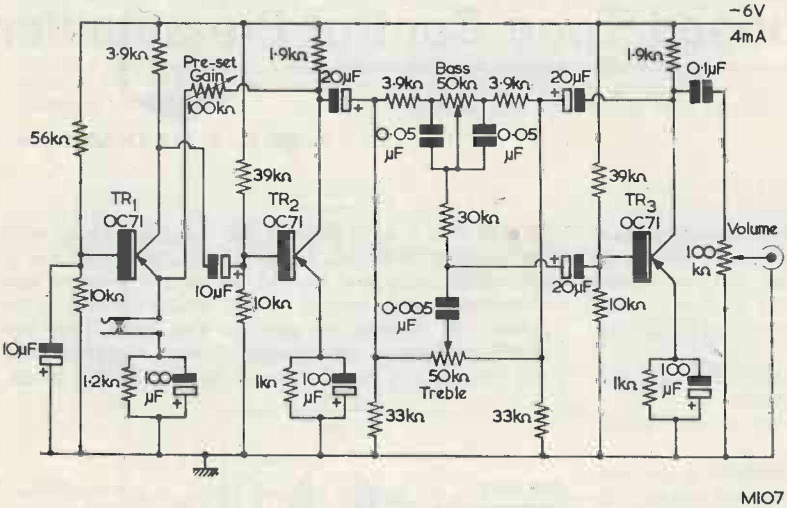
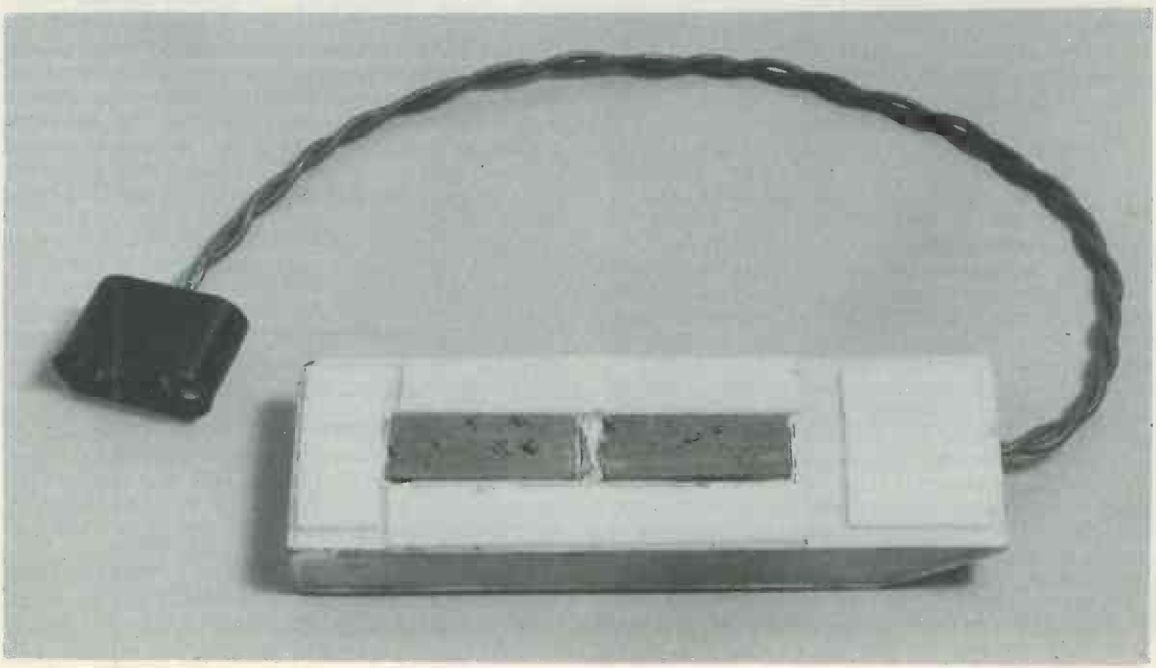


Fig. 5. A transistorised tone control pre-amplifier for the pick-up, offering a high impedance output



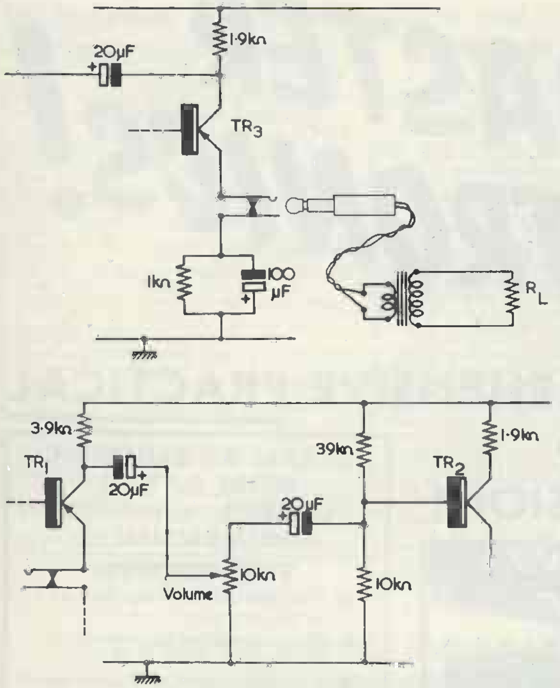


Fig. 6 (a) (above). Modifying the output stage of the pre-amplifier to low impedance
(b). The low impedance output necessitates re-positioning the volume control between TR_1 and TR_2 and deleting the pre-set gain control of Fig. 5

With the pick-up shown in Fig. 1, bass and treble boost is automatically provided; this is because the magnetic flux is more concentrated near the poles of the magnet, and consequently the outer strings produce a greater effect than the inner ones. If the constructor considers this undesirable, and cannot compensate for it in his amplifier, the effect can be greatly reduced by using two magnets as shown in Fig. 4. This arrangement provides a more even distribution of magnetic flux through the strings.

The tone of the output can be varied greatly by placing the pick-up in different positions on the guitar. If placed next to the bridge the pick-up reproduces several harmonics giving a "twangy" sound; if placed near to the finger board a more mellow sound is produced. However, the method of attaching the pick-up is best left to the constructor since guitar shapes and sizes vary so greatly.

The maximum output of the pick-up is approximately 10mV after the matching transformer.

A Tone Control Pre-amplifier

In order to provide greater flexibility, the writer has designed a pre-amplifier for use between the pick-up and the main amplifier.

The circuit of the pre-amplifier is shown in Fig. 5. As can be seen it has one grounded base stage and two common emitter stages. The pick-up used with this pre-amplifier consisted of 180 turns of 32 s.w.g. enamelled wire on a two magnet core (although, here again, the number of turns and wire gauge was not critical) and was connected directly into the emitter circuit of the first stage. About 10 feet of twin flex can be used between the pick-up and the pre-amplifier without any noticeable hum.

The first stage is a low noise amplifier providing a small amount of gain, and this is coupled to a common emitter stage TR_2, which provides the main amplification. A variable 100kΩ feedback resistor is included so that the gain of these two stages can be limited, if necessary.

The tone control circuit utilises negative feedback which is fed in with the incoming signal in varying proportions in order to provide bass and treble left and cut. It may be necessary to alter the components of the tone control circuit if the pre-amplifier is to be put to other uses, since the characteristics were chosen primarily to be of use in the frequency range of a normal guitar.

As shown, the circuit has a reasonably high output impedance and can be connected directly to a normal valve amplifier.

The output covers the range 0–800mV with a level of about 300mV for normal playing.

For use with a low impedance output, either an emitter follower stage is added or the output is taken from the emitter circuit of the present last stage as shown in Fig. 6 (*a*). In this case the output is matched at the main amplifier by means of a transformer with a suitable turns ratio. Upwards of 10 feet of twin flex can be used here without any noticeable hum pick-up. In this configuration the volume control of Fig. 5 must be discarded and one fitted between the first two stages as shown in Fig. 6 (*b*) (in which the pre-set gain control is also deleted). Alternatively, the pre-set gain control can be used as a volume control.

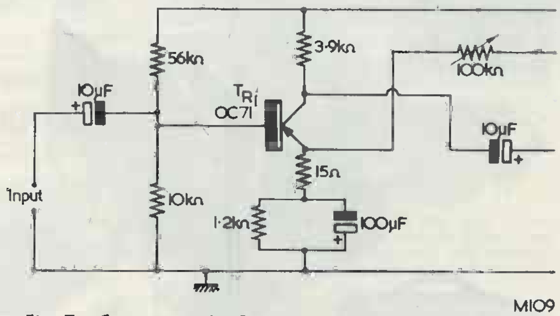


Fig. 7. Converting the first stage of the pre-amplifier to grounded emitter

If an emitter follower stage is added, the matching at the main amplifier can be effected by a grounded base transistor although this greatly increases the cost.

For use in other applications the input stage is easily converted into a grounded emitter configuration as shown in Fig. 7. The output for 1mV in is then 300mV with the tone controls in a neutral position.

The consumption of the pre-amplifier is 4mA at 6 volts.

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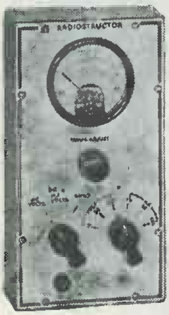

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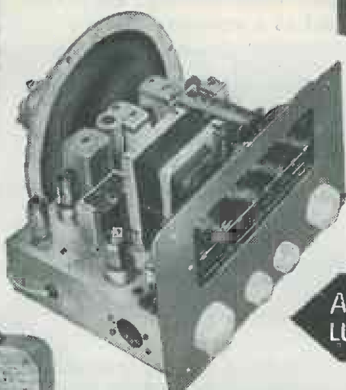

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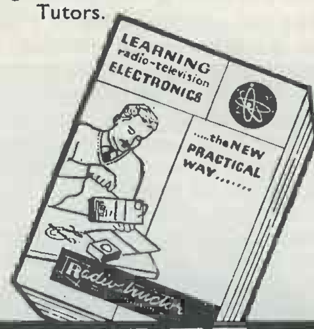

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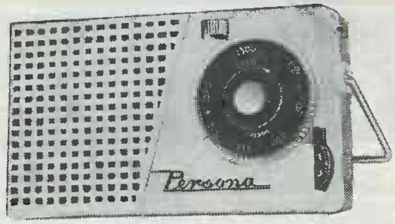

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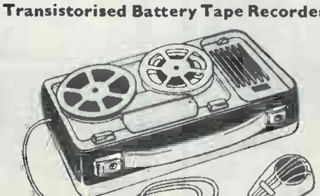

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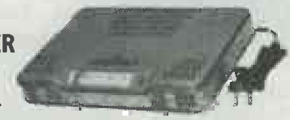

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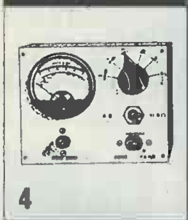
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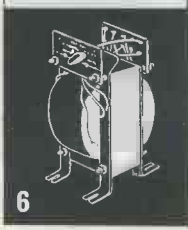
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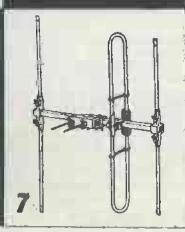
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7 **WOLSEY 3-ELEMENT FOLDED DIPOLE.** I.T.V. Aerial less mounting bracket for external use, complete with 12 yds. of coaxial cable, 15/–. P. & P. 3/6.

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10 **SIGNAL GENERATORS.** Cash £4.19.6 or 25/– deposit and 4 monthly payments of 21/6, P. & P. 5/–. Coverage 120 kc/s to 84 Mc/s. Case 10" x 6½" x 4½". Size of scale 6½" x 3½", 2 valves and rectifier. A.C. mains 230-250V. Internal modulation of 400 c.p.s. to a depth of 30 per cent modulated or unmodulated R.F. output continuously variable 100 millivolts. C.W. and mod. switch variable A.F. output and moving coil output meter. Accuracy ± 2 per cent.

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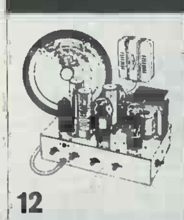
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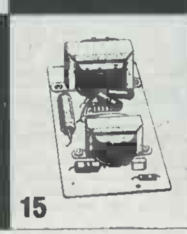
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continued on page 159

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continued from page 157

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★ Mercury Batteries: 1.3V, 2200mA/H, ⅝ x 1in dia, **2/6**; 1.3V, 5000 mA/H, 2 x ⅝in dia, **2/6**; 1.3V, 500mA/H, ⅜ x ⅝in dia., **1/3**; 1.3V, 14000mA/H, 2¼ x 1¼in dia, **5/-.**

★ Low Impedance Mic. Inserts, approx. 2000 ohms. ⅞in dia. **15/-**; ⅝ x ⅜in, **12/6** ⅜ x ⅜in, **10/-** 1¼ in diam., **15/-.** Match into Transistor Amplifiers, and hearing aids.

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WE HAVE YOUR ITEM IN STOCK. Just ask and we will quote competitive prices.

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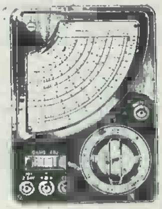

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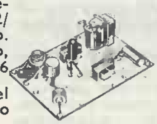

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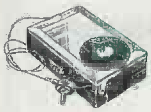
RANGER – 3



Size 4⅜" x 3" x 1¼"

No External Aerial or Earth

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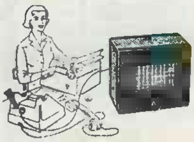

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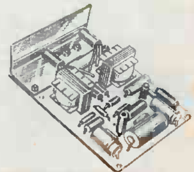

- 1 watt peak output.
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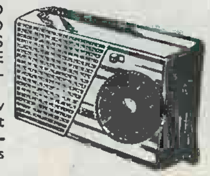

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