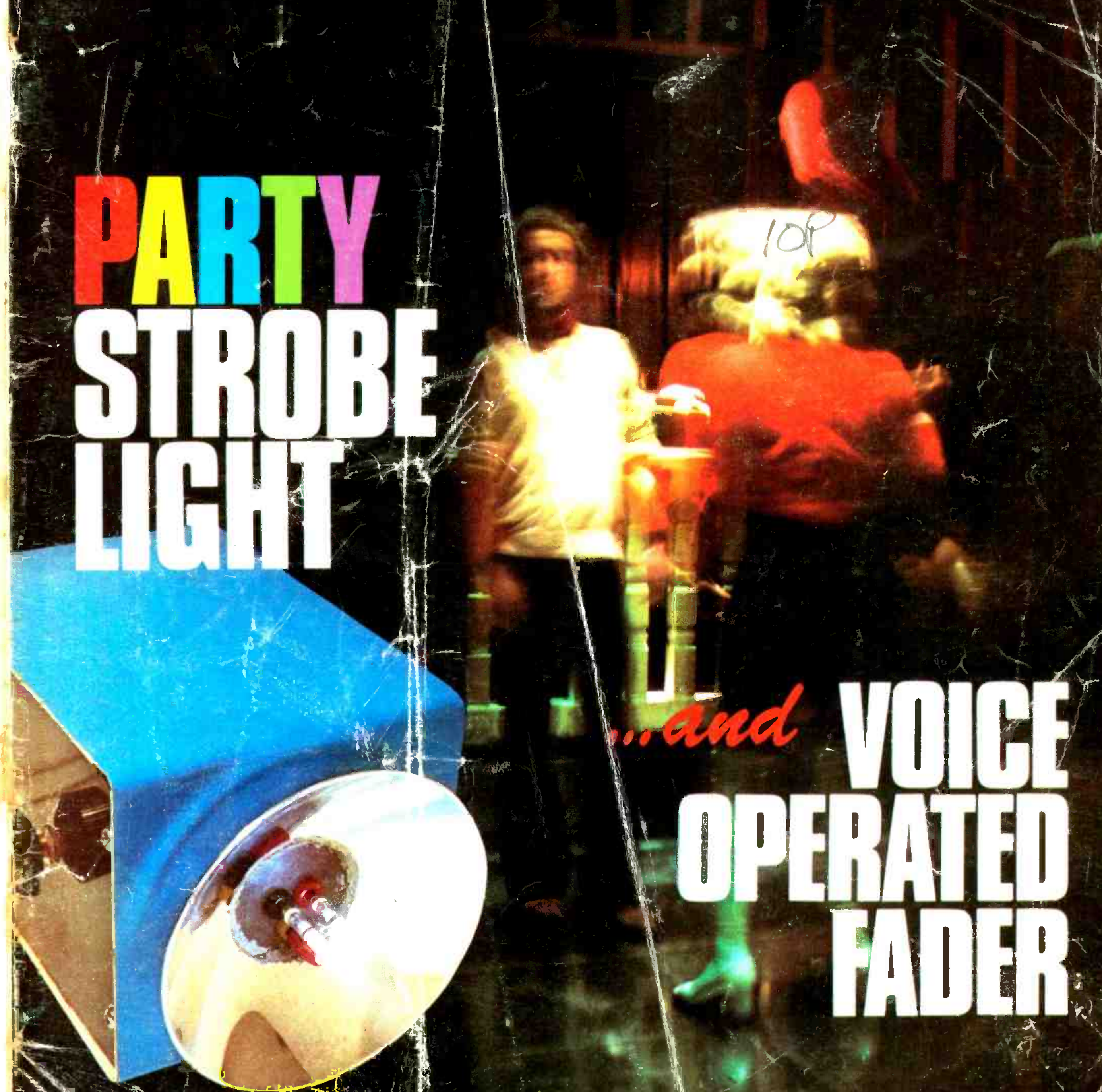
PRACTICAL

ELECTRONICS

DECEMBER 1973

20p

PARTY STROBE LIGHT



...and

VOICE OPERATED FADER

2 PROJECTS FOR PARTIES AND DISCOTHEQUES

PRACTICAL
ELECTRONICS

VOLUME 9 No. 12 DECEMBER 1973

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

NEWS AND COMMENT

Our January issue will be published on Friday, December 14, 1973

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Kit comprises EVERYTHING: Case, cables, coil connectors, Silicon grease, 8-page instruction leaflet.

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SPARKRITE

Electronic Ignition Kit only £9·35

Fascinating to build. Fantastic improvement to your car's performance. Complete Capacitive Discharge ignition system, fully proven, components fully guaranteed. Printed circuit design. All metalwork drilled ready. Fitted to car in 15 minutes when built.

• Sustained peak performance. • Up to 20% fuel saving. • Instant all-weather starting. Faster acceleration, higher top speed. • Suitable for all engines up to 8 cyls. • Longer spark plug life. • Longer battery life. • Contact breaker burn eliminated. • Purer exhaust gas emission.

A new development from the manufacturers of Gunton ignition. Price: **£9.35** inc. V.A.T. and postage. (12 volt only. State Pos. or Neg. earth). Ready built unit also available **£11.55** inc. V.A.T. and postage. **GUARANTEED 5 YEARS.**

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Please send me one SPARKRITE Kit complete. I enclose P.O./Cheque for £9·35. Or for ready built unit £11·55.

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FULL 12 MONTH AFTER SALES SERVICE ON PARTS AND LABOUR
PLEASE ASK ABOUT OUR 2 YEAR SERVICE CONTRACT

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FANTASTIC OFFER GARRARD SP25 Mk III.

Goldring G800. Teak finish, plinth and tinted cover with mains lead and DIN plug and screened lead. All fully wired. Please add £1·75 for P. & P. and Ins. **£14·95**

TURNTABLES

Please add 95p P. & P. & Ins.

BSR MP60	£9·25
Garrard SP25 Mk.III	£9·95
Garrard SL65B	£12·95
Garrard AP76	£16·65
Garrard 401	£27·50
Garrard Zero 100 (Single)	£30·95
Garrard Zero 100 (Auto)	£34·95
Goldring GL85/P P & C	£65·95
Goldring G101/P P & C	£21·95
Goldring GL72	£24·95
Goldring GL72/P	£31·95
Goldring GL75	£30·95
Goldring GL75/P	£38·95
Goldring GL75 Lid	£4·25
Thorens TD125	£60·95
Thorens TD125 AB Mk.II	£93·95
Thorens TD160 AB & C	£51·95
Thorens TD165 AB & C	£45·95
Condor Auto Cleaner (Star Value)	£1·40 P. & P. 15p

TUNERS

Please add 95p P. & P. & Ins.

Alpha Highgate FT150	£32·95
Amstrad Multiplex 3000	£23·90
Metrosound FMS 20 Mk. II	£37·75
Metrosound FMS 40	£37·75
Philips RH 621	£72·95
Rogers R/brook FET 4 (Cha)	£32·95
Rogers R/brook FET 4 (Cased)	£36·50
Sinclair cased tuner	£27·50
Teleton GT202 (N/P)	£32·95

SPEAKERS

£1·65 for P. & P. (Per Pair)

Amstrad Acoustra 1500	£26·90
Amstrad Acoustra 2500	£30·75
Celestion Ditton 15	£50·75
Celestion Ditton 44	£79·45
Goodmans D/Maxim	£40·95
Goodmans Mezo 3	£50·95
Goodmans Havant	£35·25
Keletron KS4	£13·85
Keletron KS8	£22·50
Sinclair Q16	£11·95
Sinclair Q30	£30·95
Wharfedale Denton II	£26·80

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Wharfedale Linton Kit	£16·85
Wharfedale Glendale Kit	£29·95
Wharfedale Unit 3	£16·30
Wharfedale Unit 4	£28·70
Wharfedale Dovedale Kit	£44·95

All prices correct at time of press (E. & O. E.) and are subject to alterations

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Please add 95p P. & P. & Ins.

Amstrad 8000 Mk. II	£15·85
Amstrad IC2000 Mk. II	£32·15
Amstrad Integra 4000	£23·95
Alpha Highgate FA400	£39·05
Global 10 + 10	£19·75
Global 20 + 20	£25·95
Keletron 1000	£22·95
Keletron 1500	£25·75
Metrosound ST20E Mk. II	£29·95
Metrosound ST60	£51·95
Rogers R/brook (Ch)	£41·15
Rogers R/brook Mk. III (Ca)	£44·50
Rogers R/bourne (Ch)	£54·25
Rogers R/bourne (Ca)	£56·95
Sinclair 2000	£24·90
Sinclair 3000	£31·95
Sinclair 605	£21·45
Sinclair PRO 60 2 × Z30/PZ5	£16·40
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Sinclair PRO 2 × Z50/PZ8 Trans	£25·25
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Sinclair Stereo 80 Pre-amp	P.O.A.
Sinclair Z30 Amp	£3·85
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Sinclair PZ5 Power Supp	£4·20
Sinclair PZ6 Power Supp	£6·15
Sinclair PZ8 Mains Trans	£4·95
Sinclair PZ8 Power Supp	£6·15

TUNER/AMPLIFIERS

Please add £1·10 P. & P. & Ins.

Alpha FR 3000	£61·35
Goodmans Module 80	£62·95
Goodmans Mod 80 Com	£109·95
Goodmans Mod 90	£76·95
Goodmans One-Ten	£92·95
Rogers R/brook (Cha)	£61·95
Rotel 150A	£45·25
Rotel 200A	£57·95
Status STA160	£89·95

PLINTH & COVERS

£3·35

For Garrard SP25, 2025 TC, 3000, BSR McDonald MP60 £3·08 P. & P. 71p. For AP76, SL72B, SL95B, etc. £4·85 + 71p P. & P.

CARTRIDGES

Please add 11p P. & P. & Ins.

Goldring G850	£2·75
Goldring G800	£3·50
Goldring G800E	£6·30
Goldring G800SE	£10·90
Shure M3D	£3·25
Shure M44E	£4·95
Shure M55E	£5·00
Shure 75ED Type 2	£9·25
Shure V15	£25·95
Shure M75EJ Type 2	£7·95
Sonotone 9 TAMC	£1·20
Sonotone V 200E	£8·55
Audio Technica A766	£3·15
ADC 10E Mk IV	£14·95
Ronette SM500/7	£5·25
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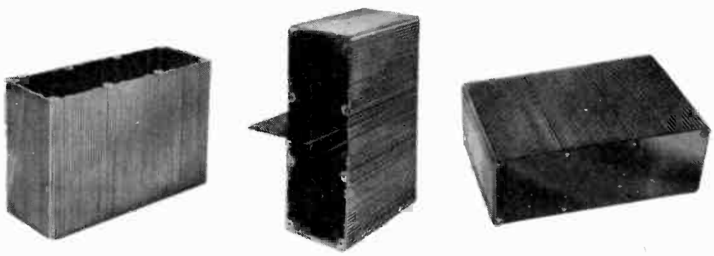

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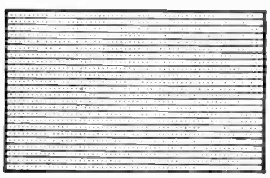
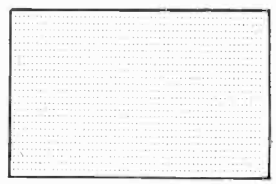
Six standard sizes of extruded box with built-in guide slots

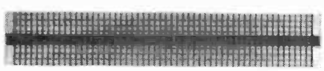


Veroboard®

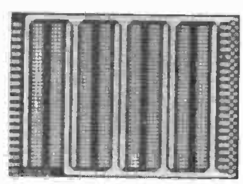
0.1" and 0.15 " pitch Single-sided, copper clad



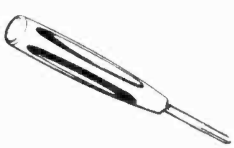
Plain boards.
0.1" and 0.15" pitch.



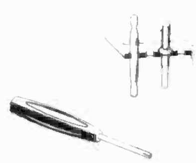
Group Boards for simple component mounting 0.1" and 0.15" pitch.



D.I.P. Breadboards are the easiest way of mounting your D.I.P's. 0.1" pitch.



Spot-face cutter to simplify cutting of copper track.



Terminal pins for 0.1" and 0.15" pitch boards together with pin insertion tool.

VERO ELECTRONICS LIMITED

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R T V C VISCOUNT III

a boost in the output.

VISCOUNT III now gives you an imposing 20 watts per channel—and the price quoted is actually INCLUSIVE OF VAT!

The money's important, of course, but not nearly so important as *value for money!* And that's something you get in abundance with VISCOUNT III. We design it . . . we make it . . . we sell it direct to you—passing on all the economies that come from cutting out middle-men! That's the only way you can get so much quality for so little money!

The unique VISCOUNT III amplifier, plus the Garrard SP25 Mk III deck, plus the magnificent Duo Type III matched speakers (or Duo Type II for a small room) give you an audio installation that will prove unbeatable for listening pleasure! On the brushed aluminium front panel of the amplifier you'll find all the facilities you need—volume, bass, treble and balance controls, plus switches for mono/stereo, on/off function and bass and treble filters. Plus headphone socket on the back. And the teak finish will harmonise and enhance virtually any style of interior decor!

The heart-stopping timbre of Tom Jones at his most virile . . . the last lingering harmonics of a solo performance by Heifetz or Menuhin . . . the pathos and the panache of Liza Minelli . . . the majestic sonorities of the brass band and the elfin subtleties of the virtuoso clavichordist—hear every nuance with a fidelity that you have *never* experienced before!

Come and hear VISCOUNT III! If it's inconvenient to travel, buy by post in the confidence that you won't be disappointed (and with a 24-carat Money-Back Guarantee to give you extra reassurance). Don't settle for second-best!

SPEAKERS: Duo Type II Size approx. 17in × 10¾in × 6¼in. Drive unit 13in × 8in with parasitic tweeter. Max. power 10 watts 8 ohms. Simulated Teak cabinet. **£14·00** a pair, £2·20 p. & p. Duo Type III Size approx. 23½in × 11½in × 9½in. Drive unit 13½in × 8½in with HF speaker. Max. power 20 watts, 8 ohms. Freq. range 20Hz to 20kHz. Teak veneer cabinet. **£32·00** a pair + £3·30 p. & p.

PRICES: SYSTEM 1

Viscount III R 102 amplifier	£24·20 + £1 p & p
2 Duo Type II speakers	£14·00 + £2·20 p & p
Garrard SP25 Mk. III with MAG. cartridge plinth & cover	£18·00 + £1·75 p & p
total	£56·20

Available complete for only £49·00 + £3·50 p. & p.

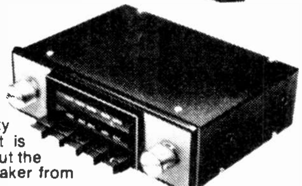
PRICES: SYSTEM 2

Viscount R 102 amplifier	£24·20 + £1 p & p
2 Duo Type III speakers	£32·00 + £3·30 p & p
Garrard SP25 Mk III with MAG. cartridge plinth & cover	£18·00 + £1·75 p & p
total	£74·20

Available complete for £65·00 + £4 p. & p.

STILL ONLY £49 COMPLETE

THE TOURIST PUSH-BUTTON CAR RADIO KIT £6·60



The Tourist PB is suitable for 12 volt working on both negative and positive earth vehicles it covers the full medium and long wave bands. It is permeability tuned and sturdily constructed. Output is a full 2·5 watts into an 8 ohms speaker. But the Tourist PB will operate into any loudspeaker from 8 to 15 ohms.

Apart from the output stage, which is an integrated circuit, the only other electronic components that need soldering are some capacitors, resistors, etc. The kit includes a pre-built RF tuner unit, and fully modulised IF stages which are pre-aligned before despatch. As well as electronic components this kit also contains 2 diamond-spun aluminium knobs, elegant matching front panel, dial, washers, screws and wire.

The Tourist PB can be mounted in any standard size dash panel and it has an illuminated tuning scale. Chassis size is: 7in wide, 2in high and 4$\frac{11}{16}$in deep.

* Circuit diagram and comprehensive instructions 55p free with parts.
* Fully retractable and lockable car aerial £1·37 post paid.

CAR RADIO KIT £6·60 p. & p. 55p

Speaker with baffle and fixing strips **£1·65**. 23p p. & p., post free if bought with the kit. Send stamped addressed envelope for leaflet.

If you can solder on printed circuit board, you can build this push-button car radio kit. It's simple—just follow the step-by-step instructions.

RELIANT Mk IV £13·50

Mono Amplifier

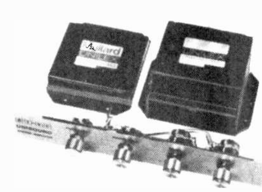
*5 Electrically Mixed Inputs. *3 Individual Mixing controls. *Separate bass and treble controls common to all 5 inputs. *Mixer employing F.E.T. (Field Effect Transistors). *Solid State Circuitry. *Attractive Styling. INPUTS 1. Crystal Mic or Guitar 9mV. 2. Moving coil Mic. or Guitar 8mV. Inputs 3, 4 & 5 are suitable for a wide range of medium output equipment (Gram. Tuner, Monitor, Organ, etc.). All 250mV sensitivity. Output 20 watts into 8 ohms (suitable for 15 ohms). Size approx. 12½ × 6 × 3½ ins.

£13·50 p. & p. 60p.

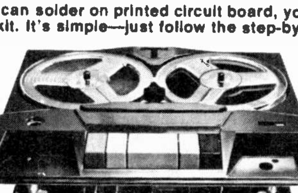
UNISOUND MODULES

ONLY £7·64 + 55p p. & p.

For the man who wants to design his own stereo—here's your chance to start, with Unisound—pre-amp, power amplifier and control panel. No soldering—just simply screw together. 4 watts per channel into 8 ohms. Inputs: 120mV (for ceramic cartridge). The heart of Unisound is high efficiency I.C. monolithic power chips which ensure very low distortion over the audio spectrum.



PE TAPE LINK CONSTRUCTORS



Suitable 3 speed tape deck, **less heads.** Caters up to 5¾ins. spools. 240V AC mains. Unused but store soiled hence no warranty.

£1 p. & p. **£4·00**

IN-CAR ENTERTAINMENT AT HOME

With this elegant stereo 8 track add on unit, audio enthusiasts now have the opportunity to extend their systems to include the playing of 8 track cartridges. Simply select your channel, by push button, four digital lamps indicate channel selected. Mains operated.

The Viscount III, the fabulous Stereo 21 and the Unisound Modules will all accept this unit, simply connect up. **£10·60** p. & p. 90p.

ALL PRICES INC. VAT

SEE OPPOSITE PAGE FOR ADDRESS DETAILS

YES, "YOU'VE GOT THE WHOLE WIDE WORLD IN YOUR HANDS"! ALMOST UNBELIEVABLE! Think of the year 1984 and what might be produced then—now get the fantastic ASTRAD 17 and SEE for yourself that the incredible Russians have done it all NOW! It's the radio perfectionist's dream come true! THIS ONE SUPERSEDES ALL EARLIER MODELS! It will probably make your present radio seem like a "crystal set"! Complete with optional battery eliminator for both battery and mains use! We're almost giving them away at only £18·50—a mere fraction of even today's Russian miracle price! We challenge you to compare performance and value with £80 radios! *Send quickly, test on mail order 7 day approval from receipt of goods, refund if not delighted. Or call. Volume controlled from a whisper to a roar that would fill a hall! Much wider band spread for absolute "pinpoint" station selection! Plus "MAGIC EYE" tuning level indicator for ultra perfect tuning sensitivity! Yes, the Russians have surpassed themselves, proving again their fantastic ability in the field of electronics and brilliantly reflecting their advanced micro-circuitry techniques in the field of spaceship and satellite communications. Yes, EVERY WAVEBAND instantly at your fingertips including Standard Long, Medium, Short and Ultra Short Waves to cover the four corners of the earth during 24 hours a day including all normal transmissions. VHF: FM/USW, AM: LW, MW, SW, gets, locally, local & new stations not yet operational, and messages from all over the world! Expensive TURRET TUNER side control waveband selection unit (as used on expensive T.V.'s!). Every waveband clicks into position giving incredible ease of station tuning! Genuine push-pull output! ON/OFF volume and separate Treble and Bass tone controls for utter perfection of reproduction and tone! Press-button dial illumination! Take it anywhere—runs economically on standard batteries (obtainable everywhere) or direct through battery eliminator from 220/240V AC mains supply. Internal ferrite rod aerial plus built-in "rotatable" telescopic aerial extending to 39 in approx. It's also a fabulous CAR RADIO. Can also be use through extension amplifier, tape recorder or public address system. SIZE 13in × 10in × 4½in overall approx. Magnificently designed, in highly polished cases. Made to give years of perfect service. Purer & sweeter tone than ever. (U.K. service facilities & spares available for years & years to come, if ever necessary!). With WRITTEN GUARANTEE, manual with simple operating instructions & circuit diagram. PLUS ultra sensitive earphone for personal listening. ONLY £18·50 (with mains/battery eliminator £2·25 extra) BOX, POST, ETC. 45p. NO MORE TO PAY! *BUT WAIT, for only 75p extra you get the sensational "COMPUTERISED" WORLD TUNING GUIDE (it enables you to zone and time in a flash for transmissions the whole world over—even a child can do it in a flash—it even lets you know when to tune into the U.K. when abroad. NO GUESSING! NO MESSING!) PLUS Standard 'longlife' batteries and Converter Plug. (Sorry—We cannot change these new radios for any earlier model already purchased.) Send quickly to Uxbridge Road address, or call at either Store. But HURRY! SHOPERTUNITIES SAVE YOU £££'s.

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1973 RUSSIAN RADIO TECHNOLOGY SHRINKS THE WORLD! *COMPUTERISED?

THIS FANTASTIC EARTH SHRINKER

YES, 24,901 miles SHRUNK TO ONLY 13 x 10 x 4½ inches approx?

BRAND NEW FABULOUS **ASTRAD 17** PORTABLE RADIO & COMMUNICATIONS RECEIVER

WORLD WIDE RECEPTION THOUSANDS OF TRANSMISSIONS & STATIONS POUR IN FROM THE FOUR CORNERS OF THE EARTH

"MAGIC EYE" tuning level indicator

28 TRANSISTORS AND DIODES! WAVEBANDS: STANDARD LONG and MEDIUM *Plus* 5 SHORT WAVEBANDS *Plus* ULTRA SHORT WAVES (V.H.F. AM. FM. MW. LW. USW.)

*MUST YOU PAY UP TO £80?

BATTERY MODEL **£18·50** BOX POST ETC. 45p

MAINS/BATTERY ELIMINATOR £2·25 extra

FIRST TIME EVER! *NOW AVAILABLE WITH fabulous "COMPUTERISED" WORLD TUNING GUIDE! NO MORE GUESSWORK – INSTANT DATA at your fingertips – enables you to ZONE & TIME IN A FLASH for transmissions the world over!

THIS OFFER ONLY FROM US!

BUY ONE FROM US! **SAVE £23·03 NOW!**

fabulous BRAND NEW **SOLID STATE** BATTERY/MAINS AC Combined V.H.F AM/FM RADIO and CASSETTE TAPE RECORDER & PLAYER

This equipment's got EVERYTHING!

WITH REMOTE CONTROL MICROPHONE

RECOMMENDED RETAIL PRICE

OUR PRICE **£20·97** CARR ETC. 50p

Shopertunities "thunder" ahead with an offer that's FANTASTIC (even by our standards!). We've snapped up 500 magnificent machines. Latest sensation in the world of-sound! First-class makers! Fabulous VHF, AM/FM Radio AND Cassette Tape Recorder & Player combined & it also runs off standard batteries or mains. (Simply plug in the 220/240V AC line cord). Record and play back anything, anywhere! IMPORTERS RECOMMENDED RETAIL PRICE £44! WE OFFER AT UNDER HALF PRICE! Wonderful features: ★ Press-button Keyboard Control Panel or latest MASTER SWITCH CONTROL! ★ "MAGIC EYE" Visual Battery check/recording level indicator or built-in automatic Leveller! ★ Separate ON/OFF and HI-LO volume controls! ★ Heavy duty built-in speaker! ★ Earphone (for personal listening or 'monitoring") and extension speaker sockets! ★ Remote control microphone! ★ Built-in swivel telescopic extension aerial (24in approx.)! Magnificently made case with carry handle. (DESIGNS VARY SLIGHTLY.) Takes standard 30, 60, 90 or 120-minute Cassette Tapes, obtainable everywhere. AND the amazing built-in full circuit VHF, AM/FM Radio gives you superb clarity of tone, incredible station selection. Unique rotating Station Selector Dial—gets, locally, local city and regional stations in every part of the country, plus B.B.C. National, VHF. Picks up dozens of foreign stations. Fabulous in your car! You could pay £££'s more for a Car Radio or Car Cassette player ALONE! £20·97, carr. etc., 50p—NO MORE TO PAY! Complete with simple instructions, remote control microphone with on/off switch and microphone stand. WITH WRITTEN GUARANTEE. Send quickly, test on mail order 7 day approval from receipt of goods, refund if not delighted. Or call.
BONUS OFFER: Batteries and Cassette Tape 28p extra if required.

FIRST TIME EVER! ***SAVE £16·02!***

BRAND NEW AC/DC BATTERY/MAINS **Cassette** TAPE RECORDER & PLAYER

With remote control microphone.

FIRST CLASS MAKERS

WE COULD CHARGE UP TO £26·97! OUR PRICE **£10·95** POST ETC. 50p

THE ONE STEP FORWARD EVERYONE HAS WAITED FOR! NOW a superb de-luxe portable BATTERY/MAINS tape recorder and player—and incredible Shopertunities bring it to you for ONLY £10·95. Due to our cut price we cannot name first-class makers—but rest assured you're getting one of the BEST! Expensive "PIANO KEYBOARD" CONTROL PANEL (or latest MASTER SWITCH control) AND AUTOMATIC LEVEL CONTROL. No fiddling with awkward tape and reels, just "slap-in" a cassette and off you go! (Takes 30, 60, or 90 minute standard cassette tapes obtainable everywhere.) Amazing performance ensures perfect tapings and superb reproduction! Remote control microphone. Rapid Rewind! Fast forward! Beautiful tone from a whisper to a roar! Complete—record anywhere, indoors or out! Runs on standard batteries AND 220/240V AC mains. Separate jacks for remote control microphone, etc. Size 9¼in × 5in × 2¼in approx. Design can vary slightly. With carry handle. WRITTEN GUARANTEE and full instructions. (Importers recommended selling price £26·97!) OUR PRICE ONLY £10·95, post, etc. 50p. NO MORE TO PAY! Send quickly, on mail order 7 day approval from receipt of goods—refund if not delighted. Or call at either of our stores. BONUS OFFER (Rationed 1 per customer)—Cassette tape. Standard batteries AND microphone stand 55p extra if required.

Order by post to Uxbridge Road address or call at either store. Bargains galore at both stores.—(COMMERCIAL TRAVELLERS PLEASE NOTE: Merchandising office at Holborn Store.)

Callers: ACCESS & BARCLAY CARDS ACCEPTED AT BOTH STORES

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AC113	20	AD162	37	BC147	11	BD116	88	BF177	39	C442	33	ST141	19	2N1308	26	2N2926(B)	11	2N4058	13
AC115	22	AD161 &		BC148	11	BD121	66	BF178	33	C444	39	TIS43	33	2N1309	26	2N3010	77	2N4059	11
AC117K	32	AD162 (MP)		BC149	13	BD123	72	BF179	33	C450	24	UT46	30	2N1613	22	2N3011	16	2N4060	13
AC122	13		61	BC150	20	BD124	76	BF180	33	MAT100	21	ZN414	£1·20	2N1711	22	2N3053	19	2N4061	13
AC125	19	ADT140	55	BC151	22	BD131	55	BF181	33	MAT101	22	2G301	21	2N1889	35	2N3054	51	2N4062	13
AC126	19	AF114	27	BC152	19	BD132	66	BF182	44	MAT120	21	2G302	21	2N1890	50	2N3055	55	2N4284	19
AC127	20	AF115	27	BC153	31	BD133	72	BF183	44	MAT121	22	2G303	21	2N1893	41	2N3391	16	2N4285	19
AC128	20	AF116	27	BC154	33	BD135	44	BF184	28	MJE2955	95	2G304	27	2N2147	79	2N3391A	18	2N4286	19
AC132	16	AF117	27	BC157	20	BD136	44	BF185	38	MJE3055	62	2G306	44	2N2148	63	2N3392	16	2N4287	19
AC134	16	AF118	39	BC158	13	BD137	50	BF187	30	MJE3440	55	2G308	39	2N2160	66	2N3393	16	2N4288	19
AC137	16	AF124	33	BC159	13	BD138	55	BF188	44	MPF102	46	2G309	39	2N2192	39	2N3394	16	2N4289	19
AC141	20	AF125	33	BC160	50	BD139	61	BF194	13	MPF104	41	2G339	22	2N2193	39	2N3395	19	2N4290	19
AC141K	32	AF126	31	BC161	55	BD140	66	BF195	13	MPF105	41	2G339A	18	2N2194	39	2N3402	23	2N4291	19
AC142	20	AF127	31	BC167	13	BD155	88	BF196	16	OC19	39	2G344	20	2N2217	24	2N3403	23	2N4292	19
AC142K	28	AF139	33	BC168	13	BD175	66	BF197	16	OC20	70	2G345	18	2N2218	22	2N3404	31	2N4293	19
AC151	17	AF178	55	BC169	13	BD176	66	BF200	50	OC22	52	2G371	18	2N2219	22	2N3405	46	2N5172	13
AC154	22	AF179	55	BC170	13	BD177	72	BF222	£1·05	OC23	54	2G371B	13	2N2220	24	2N3414	17	2N5294	60
AC155	22	AF180	55	BC171	16	BD178	72	BF257	50	OC24	62	2G373	19	2N2221	22	2N3415	17	2N5457	54
AC156	22	AF181	55	BC172	16	BD179	77	BF258	66	OC25	42	2G374	19	2N2222	22	2N3416	31	2N5458	35
AC157	22	AF186	55	BC173	16	BD180	77	BF259	94	OC26	32	2G377	33	2N2368	19	2N3417	31	2N5459	34
AC165	22	AF239	41	BC174	16	BD185	72	BF262	61	OC28	55	2G378	18	2N2369	16	2N3525	83	2N6211	75
AC166	22	AL102	72	BC175	24	BD186	72	BF263	61	OC29	55	2G381	18	2N2369A	16	2N3614	74	28301	55
AC167	22	AL103	72	BC177	21	BD187	77	BF270	39	OC35	46	2G382	18	2N2411	27	2N3615	82	28302A	46
AC168	27	ASY26	28	BC178	21	BD188	77	BF271	33	OC36	55	2G401	33	2N2412	27	2N3616	82	28302	46
AC169	16	ASY27	33	BC179	21	BD189	83	BF272	88	OC41	22	2G414	33	2N2646	52	2N3646	10	28303	61
AC176	22	ASY28	28	BC180	27	BD190	83	BF273	39	OC42	27	2G417	28	2N2711	23	2N3702	13	28304	77
AC177	27	ASY29	28	BC181	27	BD195	94	BF274	39	OC44	17	2N388	39	2N2712	23	2N3703	13	28305	86
AC178	31	ASY50	28	BC182	11	BD196	94	BFW10	66	OC45	14	2N388A	61	2N2714	23	2N3704	14	28306	86
AC178	31	ASY51	28	BC182L	11	BD197	99	BFX29	30	OC70	11	2N404	22	2N2904	19	2N3705	13	28307	86
AC180	22	ASY52	28	BC183	11	BD198	99	BFX84	24	OC71	11	2N404A	31	2N2904A	23	2N3706	13	28321	62
AC180K	32	ASY54	28	BC183L	11	BD199	£1·05	BFX85	33	OC72	16	2N524	46	2N2905	23	2N3707	14	28322	46
AC181	22	ASY55	28	BC184	13	BD200	£1·05	BFX86	24	OC74	16	2N527	54	2N2905A	23	2N3708	9	28322A	46
AC181K	32	ASY56	28	BC184L	13	BD205	88	BFX87	27	OC75	17	2N598	46	2N2906	17	2N3709	10	28323	62
AC187	24	ASY57	28	BC186	31	BD206	88	BFX88	24	OC76	17	2N599	50	2N2906A	20	2N3710	10	28324	77
AC187K	25	ASY58	28	BC187	31	BD207	£1·05	BFY50	22	OC77	28	2N696	14	2N2907	22	2N3711	10	28325	77
AC188	24	ASY73	28	BC207	12	BD208	£1·05	BFY51	22	OC81	17	2N697	15	2N2907A	24	2N3819	31	28326	77
AC188K	25	ASZ21	44	BC208	12	BDY20	£1·10	BFY52	22	OC81D	17	2N698	27	2N2923	16	2N3820	55	28327	77
ACY17	28	BC107	10	BC209	13	BF115	27	BFY53	19	OC82	17	2N699	39	2N2924	16	2N3821	39	28701	46
ACY18	22	BC108	10	BC212L	12	BF117	50	BPX25	94	OC82D	17	2N706	9	2N2925	16	2N3823	31	40361	44
ACY19	22	BC109	11	BC213L	12	BF118	77	BSX19	17	OC83	22	2N706A	10	2N2926(G)	14	2N3903	31	40362	50
ACY20	22	BC113	11	BC214L	16	BF119	77	BSX20	17	OC139	22	2N708	13	2N2926(Y)	12	2N3904	33		
ACY21	22	BC114	17	BC225	28	BF121	50	BSY25	17	OC140	22	2N711	33	2N2926(O)	11	2N3905	31		
ACY22	18	BC115	17	BC226	39	BF123	55	BSY26	17	OC169	28	2N717	39						
ACY27	20	BC116	17	BC301	30	BF125	50	BSY27	17	OC170	28	2N718	27						
ACY28	21	BC117	20	BC302	27	BF127	55	BSY28	17	OC171	28	2N718A	55						
ACY29	39	BC118	11	BC303	35	BF152	61	BSY29	17	OC200	28	2N726	31						
ACY30	31	BC119	33	BC304	40	BF153	50	BSY38	20	OC201	31	2N727	31						
ACY31	31	BC120	88	BC440	34	BF154	50	BSY39	20	OC202	31	2N743	22						
ACY34	23	BC125	18	BC460	40	BF155	77	BSY40	31	OC203	28	2N744	22						
ACY35	23	BC126	20	BCY30	27	BF156	53	BSY41	31	OC204	28	2N914	16						
ACY36	31	BC132	13	BCY31	29	BF157	61	BSY95	14	OC205	39	2N918	33						
ACY40	19	BC134	20	BCY32	33	BF158	61	BSY95A	14	OC309	44	2N929	23						
ACY41	20	BC135	13	BCY33	24	BF159	66	Bu105	£2·20	OCP71	48	2N930	23						
ACY44	39	BC136	17	BCY34	28	BF160	44	C111E	55	ORP12	48	2N1131	22						
AD130	42	BC137	17	BCY70	16	BF162	44	C400	33	ORP60	44	2N1132	24						
AD140	53	BC139	44	BCY71	22	BF163	44	C407	28	ORP61	44	2N1302	16						
AD142	53	BC140	33	BCY72	16	BF164	44	C424	28	P20	55	2N1303	16						
AD143	42	BC141	33	BCZ10	22	BF165	44	C425	55	P21	50	2N1304	19						
AD149	55	BC142	33	BCZ11	28	BF167	24	C426	39	P346A	22	2N1305	19						
		BC143	33	BCZ12	28	BF173	24	C428	22	P397	46	2N1306	23						

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AA120	0·09	BY126	0·16	BYZ19	0·31
AA129	0·09	BY127	0·17	CG62	
AAY30	0·10	BY128	0·17	(OA91 Eq.)	0·06
AAZ13	0·11	BY130	0·18		
BA100	0·11	BY133	0·23	CG651—	
BA116	0·23	BY164	0·55	(OA70–OA79)	0·07
BA126	0·24	BYX38/30	0·46	OA5	0·39
BA148	0·16				
BA154	0·13	BYZ10	0·39	OA58L	0·23
BA155	0·16	BYZ11	0·33	OA10	0·39
BA156	0·15	BYZ12	0·33	OA47	0·08
BY100	0·17	BYZ13	0·28	OA70	0·08
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7401	0·18	0·17	0·16	7453	0·18	0·17	0·16	74150	2·90	2·80	2·70
7402	0·18	0·17	0·16	7454	0·18	0·17	0·16	74151	1·10	1·05	1·00
7403	0·18	0·17	0·16	7460	0·18	0·17	0·16	74153	1·30	1·20	1·10
7404	0·18	0·17	0·16	7470	0·32	0·29	0·27	74154	1·98	1·90	1·75
7405	0·18	0·17	0·16	7472	0·32	0·29	0·27	74155	1·50	1·45	1·35
7406	0·39	0·34	0·31	7473	0·41	0·39	0·35	74156	1·50	1·45	1·35
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7410	0·18	0·17	0·16	7480	0·74	0·71	0·64	74162	4·40	4·15	3·85
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7420	0·18	0·17	0·16	7486	0·35	0·34	0·33	74175	1·75	1·65	1·55
7422	0·55	0·53	0·50	7489	4·00	3·75	3·50	74176	1·85	1·75	1·65
7423	0·55	0·53	0·50	7490	0·74	0·71	0·64	74177	1·85	1·75	1·65
7425	0·55	0·53	0·50	7491	1·10	1·05	1·00	74180	1·50	1·40	1·30
7426	0·50	0·46	0·44	7492	0·74	0·71	0·64	74181	5·00	4·50	4·00
7427	0·50	0·46	0·44	7493	0·74	0·71	0·64	74182	2·00	1·90	1·75
7428	0·55	0·53	0·50	7494	0·85	0·82	0·75	74184	3·20	3·10	3·00
7430	0·18	0·17	0·16	7495	0·85	0·82	0·75	74190	2·15	2·10	2·00
7432	0·50	0·46	0·44	7496	0·96	0·93	0·86	74191	2·15	2·10	2·00
7433	0·75	0·73	0·70	74100	1·50	1·45	1·40	74192	2·15	2·10	2·00
7437	0·70	0·68	0·65	74104	1·07	1·04	1·00	74193	2·15	2·10	2·00
7438	0·70	0·68	0·65	74105	1·07	1·04	1·00	74194	2·98	2·86	2·75
7440	0·18	0·17	0·16	74107	0·44	0·42	0·40	74195	2·00	1·95	1·90
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7444	1·20	1·15	1·10	74119	1·50	1·40	1·30	74199	5·00	4·75	4·50
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7447	1·10	1·07	1·05	74123	3·00	2·90	2·80				
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U 3	75 Germanium Gold Bonded Sub-Min. like OA5, OA47	0·55
U 4	40 Germanium Transistors like OC81, AC128	0·55
U 5	60 200mA Sub-Min. Silicon Diodes	0·55
U 6	30 Sil. Planar Trans. NPN like BSY95A, 2N706	0·55
U 7	16 Sil. Rectifiers TOP-HAT 750mA VLTG. RANGE up to 1000	0·55
U 8	50 Sil. Planar Diodes DO-7 Glass 250mA like OA200/202	0·55
U 9	20 Mixed Voltages, 1 Watt Zener Diodes	0·55
U10	20 BAY50 charge storage Diodes DO-7 Glass	0·55
U11	25 PNP Sil. Planar Trans. TO-5 like 2N1132, 2N2904	0·55
U12	12 Silicon Rectifiers Epoxy 500mA up to 800 PIV	0·55
U13	30 PNP-NPN Sil. Transistors OC200 & 2S 104	0·55
U14	150 Mixed Silicon and Germanium Diodes	0·55
U15	25 NPN Sil. Planar Trans. TO-5 like BFY51, 2N697	0·55
U16	10 3 Amp Silicon Rectifiers Stud Type up to 1000PIV	0·55
U17	30 Germanium PNP AF Transistors TO-5 like ACY 17-22	0·55
U18	8 6 Amp Silicon Rectifiers BYZ13 Type up to 600 PIV	0·55
U19	25 Silicon NPN Transistors like BC108	0·55
U20	12 1·5 Amp Silicon Rectifiers Top Hat up to 1000 PIV	0·55
U21	30 AF. Germanium Alloy Transistors 2G300 Series & OC71	0·55
U23	30 MADT's like MHz Series PNP Transistors	0·55
U24	20 Germanium 1 Amp Rectifiers GJM Series up to 300 PIV	0·55
U25	25 300MHz NPN Silicon Transistors 2N708, BSY27	0·55
U26	30 Fast Switching Silicon Diodes like IN914 Micro-Min.	0·55
U27	12 NPN Germanium AF Transistors TO-1 like AC127	0·50
U29	10 1 Amp SCR's TO-5 can, up to 600 PIV CRS1/25-600	1·15
U30	15 Plastic Silicon Planar Trans. NPN 2N2926	0·55
U31	20 Silicon Planar Plastic NPN Trans. Low Noise Amp 2N3707	0·55
U32	25 Zener Diodes 400mW DO-7 case 3–18 volts mixed	0·55
U33	15 Plastic Case 1 Amp Silicon Rectifiers IN4000 Series	0·55
U34	30 Silicon PNP Alloy Trans. TO-5 BCY26 2S302/4	0·55
U35	25 Silicon Planar Transistors PNP TO-18 2N2906	0·55
U36	25 Silicon Planar NPN Transistors TO-5 BFY50/51/52	0·55
U37	30 Silicon Alloy Transistors SO-2 PNP OC200, 2S322	0·55
U38	20 Fast Switching Silicon Trans. NPN 400MHz 2N3011	0·55
U39	30 RF. Germ. PNP Transistors 2N1303/5 TO-5	0·55
U40	10 Dual Transistors 6 lead TO-5 2N2060	0·55
U41	25 RF Germanium Transistors TO-5, OC45, NKT72	0·55
U42	10 VHF Germanium PNP Transistors TO-1 NKT667, AF117	0·55
U43	25 Sil. Trans. Plastic TO-18 A.F. BC113/114	0·55
U44	20 Sil. Trans. Plastic TO-5 BC115/NPN	0·55
U45	7 3A SCR. TO66 up to 600PIV	1·10

Code Nos. mentioned above are given as a guide to the type of device in the pak. The devices themselves are normally unmarked.

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	PIV	50 £p	100 £p	200 £p	400 £p	600 £p	800 £p
1A	TO5	0·22	0·27	0·27	0·32	0·42	0·63
3A	TO66	0·27	0·27	0·32	0·42	0·52	0·70
5A	TO66	0·39	0·52	0·54	0·59	0·75	0·88
5A	TO64	0·39	0·52	0·54	0·62	0·75	0·88
7A	TO48	0·52	0·55	0·62	0·67	0·84	0·99
10A	TO48	0·55	0·63	0·67	0·83	1·07	1·32
16A	TO48	0·58	0·62	0·67	0·77	0·97	1·50
30A	TO48	1·27	1·54	1·76	1·93	—	4·40

SIL. RECTS. TESTED

PIV	300mA DO7	750mA SO16	1A Plastic	1·5A SO16	3A SO10	10A SO10	30A TO48
50	0·05	0·06	0·05	0·08	0·15	0·21	0·60
100	0·05	0·07	0·06	0·10	0·17	0·23	0·75
200	0·06	0·10	0·07	0·12	0·22	0·25	1·00
400	0·08	0·15	0·08	0·15	0·30	0·38	1·35
600	0·09	0·17	0·10	0·18	0·36	0·46	1·90
800	0·12	0·19	0·11	0·20	0·38	0·55	2·10
1000	0·14	0·30	0·12	0·25	0·48	0·65	2·50
1200	—	0·35	—	0·30	0·58	0·75	3·00

INTEGRATED CIRCUIT PAKS

Manufacturers' "Fall Outs" which include Functional and Part-Functional Units. These are classed as 'out-of-spec' from the maker's very rigid specifications, but are ideal for learning about I.C.'s and experimental work.

Pak No.	Contents	Price	Pak No.	Contents	Price	Pak No.	Contents	Price
UIC00	12 × 7400	0·55	UIC46	5 × 7446	0·55	UIC86	5 × 7486	0·55
UIC01	12 × 7401	0·55	UIC48	5 × 7448	0·55	UIC90	5 × 7490	0·55
UIC02	12 × 7402	0·55	UIC50	12 × 7450	0·55	UIC91	5 × 7491	0·55
UIC03	12 × 7403	0·55	UIC51	12 × 7451	0·55	UIC92	5 × 7492	0·55
UIC04	12 × 7404	0·55	UIC53	12 × 7453	0·55	UIC93	5 × 7493	0·55
UIC05	12 × 7405	0·55	UIC54	12 × 7454	0·55	UIC94	5 × 7494	0·55
UIC06	8 × 7406	0·55	UIC60	12 × 7460	0·55	UIC95	5 × 7495	0·55
UIC07	8 × 7407	0·55	UIC70	8 × 7470	0·55	UIC96	5 × 7496	0·55
UIC10	12 × 7410	0·55	UIC72	8 × 7472	0·55	UIC100	5 × 74100	0·55
UIC20	12 × 7420	0·55	UIC73	8 × 7473	0·55	UIC121	5 × 74121	0·55
UIC30	12 × 7430	0·55	UIC74	8 × 7474	0·55	UIC141	5 × 74141	0·55
UIC40	12 × 7440	0·55	UIC75	8 × 7475	0·55	UIC151	5 × 74151	0·55
UIC41	5 × 7441	0·55	UIC76	8 × 7476	0·55	UIC154	5 × 74154	0·55
UIC42	5 × 7442	0·55	UIC80	5 × 7480	0·55	UIC193	5 × 74193	0·55
UIC43	5 × 7443	0·55	UIC81	5 × 7481	0·55	UIC199	5 × 74199	0·55
UIC44	5 × 7444	0·55	UIC82	5 × 7482	0·55			
UIC45	5 × 7445	0·55	UIC83	5 × 7483	0·55	UICXI	25 Assorted 74's	1·65

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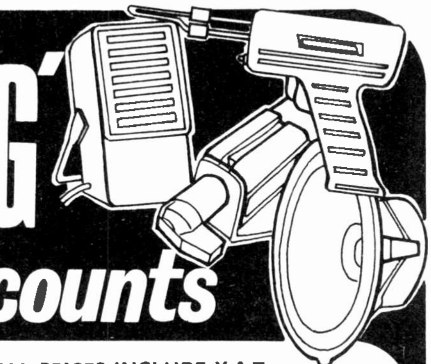

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2G371	0·40
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2N404	0·22
2N697	0·15
2N698	0·30
2N706	0·10
2N706A	0·12
2N708	0·15
2N709	0·40
2N1091	0·55
2N1131	0·25
2N1132	0·25
2N1302	0·18
2N1303	0·18
2N1304	0·22
2N1305	0·22
2N1306	0·28
2N1307	0·28
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2N2147	0·75
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2N2904A	0·25
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2N2907	0·23
2N2924	0·23
2N2925	0·15
2N2926	0·10
2N3054	0·45
2N3055	0·45
2N3702	0·11
2N3705	0·12
2N3706	0·11
2N3707	0·13
2N3709	0·10
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2N5027	0·53
2N5088	0·33
2S301	0·59
2S304	1·15
2S501	0·87
2S703	1·00
AA129	0·20
AAZ12	0·75
AAZ13	0·10
AC107	0·35
AC126	0·25
AC127	0·25
AC128	0·20
AC187	0·20
AC188	0·20
ACY17	0·35
ACY18	0·27
ACY19	0·27
ACY20	0·22
ACY21	0·22
ACY22	0·16
ACY27	0·25
ACY28	0·25
ACY39	0·65
ACY40	0·22
ACY41	0·22
ACY44	0·32
AD140	0·50
AD149	0·50
AD161	0·39
AD162	0·39
AF106	0·30
AF114	0·25
AF115	0·25
AF116	0·25
AF117	0·20
AF118	0·50
AF119	0·20
AF124	0·30
AF125	0·30
AF126	0·30
AF127	0·30
AF139	0·38
AF178	0·55
AF179	0·65
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AFZ12	1·50
ASY26	0·25
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ASY28	0·25
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ASY50	0·20
ASY51	0·40
ASY53	0·20
ASY55	0·20
ASY62	0·25
ASY66	0·33
ASZ21	1·00
ASZ23	0·75
AU101	1·50
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BC107	0·12
AC108	0·12
BC109	0·12
BC113	0·16
BC115	0·20
BC116	0·20
BC116A	0·23
BC118	0·15
BC121	0·20
BC122	0·20
BC125	0·68
BC126	0·65
BC140	0·55
BC147	0·12
BC148	0·10
BC149	0·12
BC157	0·14
BC158	0·12
BC160	0·63
BC169	0·14
BCY31	0·45
BCY32	0·85
BCY33	0·38
BCY34	0·45
BCY38	0·55
BCY39	1·00
BCY40	0·80
BCY42	0·30
BCY70	0·15
BCY71	0·20
BCZ10	0·60
BCZ11	0·65
BD121	1·00
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BD124	0·80
BDY11	1·45
BF115	0·22
BF117	0·50
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BF173	0·25
BF181	0·33
BF184	0·22
BF185	0·22
BF194	0·13
BF195	0·13
BF196	0·15
BF197	0·15
BF861	0·25
BFS98	0·25
BFX12	0·20
BFX13	0·25
BFX29	0·28
BFX30	0·28
BFX35	0·98
BFX63	0·50
BFX84	0·25
BFX85	0·28
BFX86	0·25
BFX87	0·25
BFX88	0·22
BFY10	1·00
BFY11	1·25
BFY17	0·25
BFY18	0·45
BFY19	0·55
BFY24	0·45
BFY44	1·00
BFY50	0·20
BFY51	0·20
BFY52	0·20
BFY53	0·17
BFY64	0·45
BFY90	0·75
BSX27	0·50
BSX60	0·93
BSX76	0·18
BSY26	0·18
BSY27	0·18
BSY51	0·50
BSY95A	0·12
BSY95	0·12
BT102/500R	0·75
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BY100	0·15
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BYZ10	0·45
BYZ11	0·40
BYZ12	0·40
BYZ13	0·35
BYZ15	1·25
BYZ16	0·60
BYZ88C3V3	0·10
BZY88C3V3	0·10
C111	0·55
CRS1/05	0·30
CRS1/40	0·45
CS4B	2·50
CS10B	3·13
DD000	0·15
DD003	0·15
DD006	0·18
DD007	0·40
DD008	0·38
GD3	0·33
GD4	0·10
GD5	0·33
GD8	0·25
GD12	0·10
GET102	0·50
GET103	0·40
GET113	0·35
GET114	0·30
GET115	0·75
GET116	0·85
GET120	0·50
GET872	0·30
GET875	0·40
GET880	0·55
GET881	0·25
GET882	0·35
GET885	0·35
GEX44	0·08
GEX45/1	0·45
GEX941	0·45
GJ3M	0·50
GJ4M	0·38
GJ5M	0·25
GJ7M	0·50
HG1005	0·50
HS100A	0·20
MAT100	0·20
MAT101	0·25
MAT120	0·20
MAT121	0·25
MJE520	0·65
MJE2955	1·10
MJE3055	0·75
NKT128	0·45
NKT129	0·30
NKT211	0·25
NKT213	0·25
NKT214	0·24
NKT216	0·40
NKT217	0·45
NKT218	1·13
NKT219	0·33
NKT222	0·30
NKT224	0·25
NKT251	0·24
NKT271	0·20
NKT272	0·20
NKT273	0·20
NKT274	0·20
NKT275	0·25
NKT277	0·20
NKT278	0·25
NKT301	0·85
NKT304	0·75
NKT403	0·70
NKT404	0·60
NKT678	0·30
NKT713	0·30
NKT773	0·25
NKT777	0·38
O78B	0·38
OA6	0·12
OA47	0·08
OA70	0·10
OA71	0·10
OA73	0·15
OA74	0·15
OA79	0·10
OA81	0·10
OA85	0·15
OA86	0·15
OA90	0·07
OA91	0·07
OA95	0·07
OA200	0·08
OA202	0·10
OA210	0·25
OA211	0·30
OAZ200	0·50
OAZ201	0·45
OAZ202	0·45
OAZ203	0·45
OAZ204	0·45
OAZ205	0·45
OAZ206	0·45
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OAZ208	0·40

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OAZ209	0·40
OAZ210	0·40
OAZ211	0·40
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OAZ223	0·45
OAZ224	0·45
OAZ241	0·22
OAZ242	0·23
OAZ244	0·25
OAZ246	0·23
OAZ290	0·38
OC16	0·35
OC16T	0·38
OC19	0·50
OC20	1·25
OC22	1·00
OC23	1·25
OC24	1·10
OC25	0·40
OC26	0·35
OC28	0·65
OC29	0·65
OC30	0·40
OC35	0·55
OC36	0·65
OC41	0·35
OC42	0·40
OC43	0·70
OC44	0·18
OC44M	0·17
OC45	0·18
OC45M	0·18
OC46	0·27
OC57	0·60
OC58	0·60
OC59	0·60
OC66	0·50
OC70	0·18
OC71	0·15
OC72	0·25
OC73	0·50
OC74	0·30
OC75	0·30
OC76	0·30
OC77	0·55
OC78	0·25
OC79	0·30
OC81	0·28
OC81D	0·28
OC81M	0·20
OC81DM	0·18
OC81Z	0·45
OC82	0·28
OC82D	0·25
OC83	0·25
OC84	0·25
OC114	0·38
OC122	1·00
OC123	1·10
OC139	0·40
OC140	0·65
OC141	0·80
OC169	0·20
OC170	0·25
OC171	0·30
OC200	0·55
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74154	2·30
74155	1·15
74156	1·15
74157	1·09
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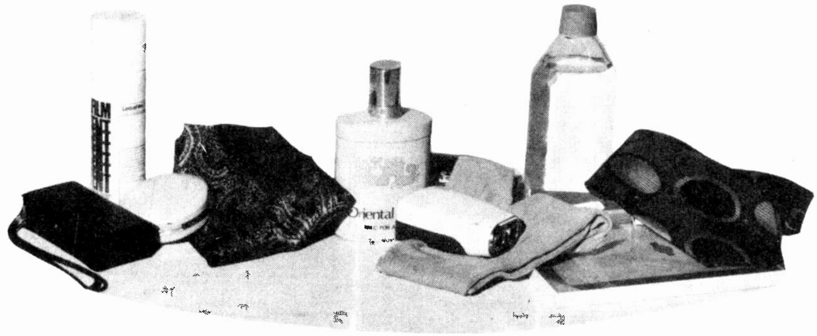

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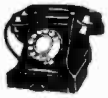

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TWENTY-FIVE YEARS ON

THE 25th year of the transistor draws to its close. A quarter century of exciting and rapid technological growth justifiably referred to as a revolution, and unlikely to be paralleled within the seeable future.

In this issue appears a final article in our special series marking this anniversary of the dawn of the new solid state era. It is written, most fittingly, by a well known contributor and dwells on those now far off days when the transistor was still much of a curiosity and just beginning to cause an upheaval in constructor circles. Established methods of building clearly had to change, but it was far from clear just how.

Much water has flowed under the bridge since then . . . but those early experiments with transistors are worth recalling, though it will all sound very strange to a fair proportion of our readers since there is now a whole generation of constructors brought up entirely on semiconductors.

Yet even our younger post-valve-era readers are not denied the excitement of being involved in great changes in technology. Right at this present moment we are witnessing a "quiet revolution." With hindsight, we know that the discrete semiconductor device represented but the opening phase of this solid state revolution; the culminating achievement has been the creation of the integrated circuit.

So let us turn now from the past and consider what the future holds for the constructor. It will be a future dominated by the i.c., that is obvious. Until, of course, another spectacular discovery leads to the obsolescence of semiconductors—a development not entirely improbable but sufficiently remote in time to be left out of any sensible prognostications at this particular moment.

The i.c. is, in circuit terms, a very large building block and is tending to become even bigger, thanks to l.s.i. This type of device influences very considerably, if it does not dominate entirely, the general pattern of any design in which it is called upon to play a part.

In the future, the drift towards more custom designed i.c.'s may well limit the total number of new devices suitable for constructor applications. Yet amongst the balance there are bound to be an abundance of types than can be usefully employed by the amateur. In this respect, particularly noteworthy at the present time are phase-locked loops. These i.c.'s are beginning to mould the pattern of many equipment designs. They are opening up new fields and revolutionising some traditional designs, especially in the radio receiver area.

Immediately following its introduction, the i.c. was thought by some to represent a threat to home construction activities. Such a pessimistic view has already been proved ill-founded. Looking ahead, there is no reason to suppose any drying up of individual enterprise and ability to extract the maximum advantage from monolithic devices yet to emerge from the microelectronics plants.

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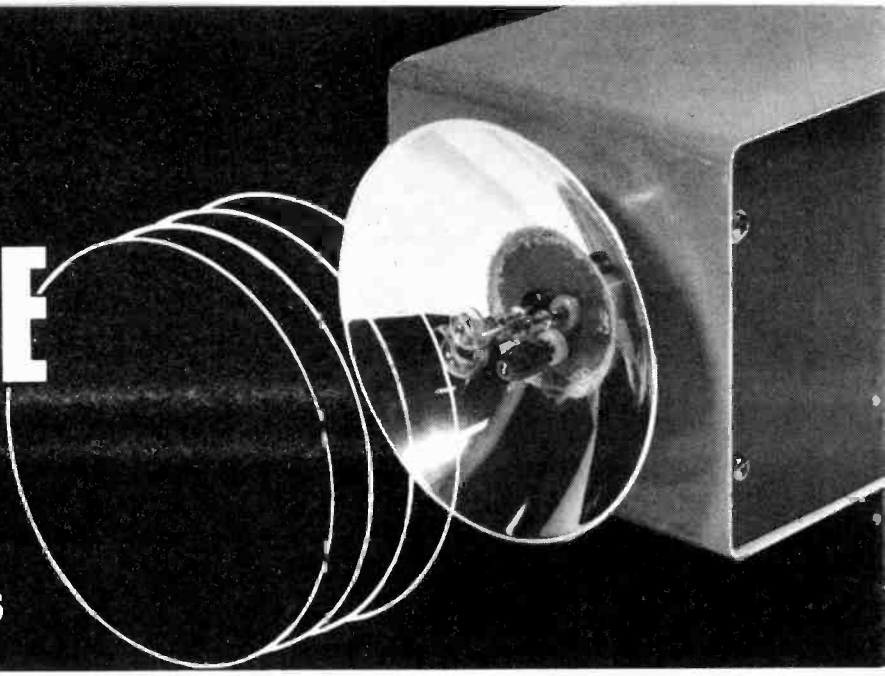
PARTY STROBE LIGHT

BY M. HUGHES



THIS stroboscope is designed primarily for use as a lighting effect for parties and discotheques. Its flashing rate is continuously variable from about 2Hz to 20Hz. It can be used—with limitations—for specialised photography but the output power (about half a joule) limits it to use with only medium to high speed black and white films at distances of a few feet. For discotheque work, however, it can be classified as of medium power.

SOME WARNINGS

Those who intend building the equipment should be fully aware at the outset of their social responsibilities in the operation of such equipment; strobing in the frequency range of 10 to 20Hz can, in some instances, produce hypnotic effects. Excessive use of the strobe should thus be avoided; however, if handled carefully and used in moderation some particularly pleasing lighting effects can be produced.

A further word of warning regarding the construction. Very high voltages are used to charge up high value capacitors—these can be lethal if mishandled. When testing it is not sufficient simply to switch off the power; the plug should be completely removed from the socket and all capacitors shorted out with an insulated handled screwdriver before any attempt is made to handle the circuitry.

OPERATION

The principle of operation is quite simple. All we have to do is apply a high voltage across a Xenon gas filled tube from a reasonably high value capacitor. This voltage is arranged to be below the breakdown voltage of the tube so initially no electrical discharge takes place. At some pre-determined time a very high voltage pulse (at low current) is applied to a third electrode fixed to the outside of the tube—this is called the trigger electrode—and we cause a localised electrical breakdown of the gas between the trigger and one of the primary electrodes. The gas in that locality becomes electrically conducting (or ionised), and the ions produced move rapidly throughout the length of the tube and cause main conduction between the primary electrodes.

For a fraction of a second the tube becomes a short circuit across the capacitor and the full charge held on the latter flows through the tube giving rise to the very bright short duration flash. As soon as the capacitor has fully discharged the tube is extinguished and a fraction of a second later the residual ions of gas revert to their non-conducting state and the tube once more becomes inert. The capacitor can now be recharged and a second trigger pulse applied for the next flash.

FLASH ENERGY

The energy of the flash is measured in joules and is equivalent to the amount of electrical energy stored in the main capacitor (C4 in Fig. 1). This energy is calculated by using the formula:—

$$\text{Energy} = \tfrac{1}{2}CV^2 \text{ joules}$$

where C is the value of the capacitor in farads and V is the voltage to which it is charged. In Fig. 1 C4 charges up through a half wave rectifier (D2) and limiting resistor, R3, direct from 250V r.m.s. mains; this means the peak voltage on the capacitor when it is fully charged is about 350V. The energy produced in each flash for the capacity used will be about 0·48 joules.

LIMITED OUTPUT

Because of the tube rating, if it is flashed too often at too high an energy it will get extremely hot. The tube specified is made of hard glass that has a

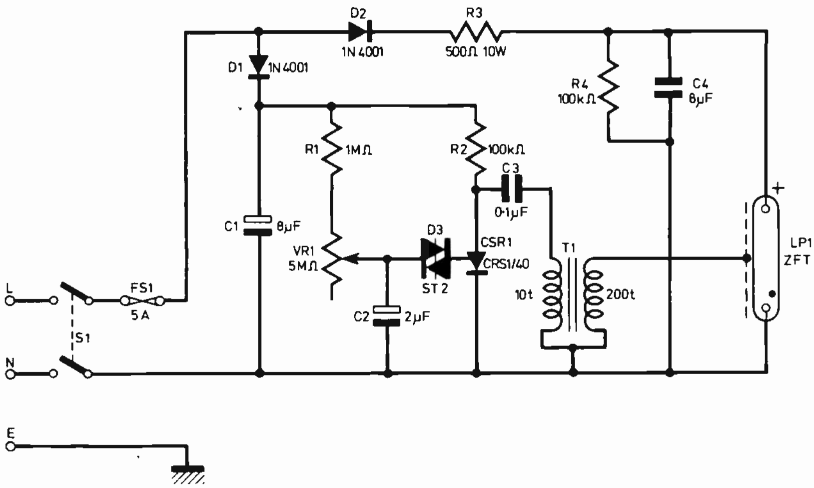


Fig. 1. Circuit diagram of the Party Stroboscope. Note that the case is connected to mains earth

maximum dissipation of 10 watts. It is possible to obtain tubes having a high permitted dissipation but these are quite expensive, particularly those made from quartz.

We can calculate dissipation by multiplying flash energy by the maximum frequency of flashing, with the stroboscope this is $0{\cdot}48 \times 20 = 9{\cdot}6$ watts.

Since this represents nearly the limit of the tube, experimenters should not try to get more light output by increasing the value of C4 without limiting the maximum flash rate proportionally.

Before describing the trigger system, which forms most of the circuitry, a word about R3. The value is reasonably important because it prevents the main capacitor charging before the discharge tube is completely de-ionised; at the same time it must be of low enough a value to ensure that C4 is fully charged before the next trigger pulse. Quite high peak currents flow through this resistor so it should be of at least 10 watts rating and even so will get quite warm in use.

TRIGGER SYSTEM

To produce the trigger pulses there must be a timing circuit that is adjustable in the range from $\frac{1}{2}$ second to $\frac{1}{20}$ second. D1 and C1 form a simple auxiliary d.c. supply of about 350V. C2 will charge up towards 350V and the rate of charge is controlled by the value of R1 and VR1—as the latter is adjustable we can vary the charging rate. In actual fact the potential across C2 will never reach 350V because as soon as it reaches about 25V the diac D3 will start to conduct and any charge held on C2 is applied to the gate electrode of the thyristor.

As soon as C2 is completely discharged the diac becomes non conducting and C2 is able to charge back up towards the 350V. This is a repetitive cycle and the timing is controlled, as we have already said, by the time constant of C2 with the charging resistors but also by the differential between the breakdown voltage of the diac and the potential towards which C2 is charging. Different diacs—particularly the cheaper ones—may have slightly different breakdown voltages so there may be some variance in timing between different assemblies. This can be compensated for in practice by increasing or decreasing the value of C2. Increase its value if you require a slower repetitive cycle and vice versa.

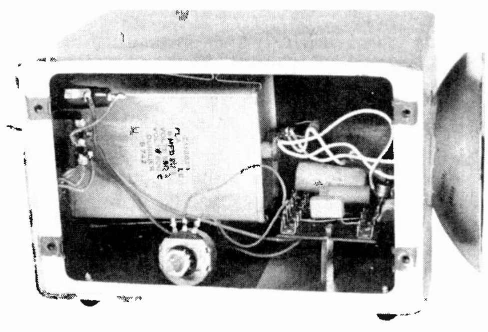
It is most important that you do not exceed a flash rate of 20Hz because you might exceed the power rating of the tube.

TURN ON

The discharge current from C2 through D3 into the gate of the thyristor causes the thyristor to turn on. C3 has been charged to 350V through R2 and when the thyristor turns on this is discharged through the circuit C3, CSR1, and the primary of T1. The instantaneous current is quite high and the rate of change of flux in the primary of T1 causes a very high voltage pulse across the secondary windings (approximately 7,000V). This pulse is fed to the trigger electrode of the discharge tube.

Component values have all been carefully chosen so that everything happens in the correct time sequence, e.g. C4 and C3 must be fully charged before the highest rate of trigger pulse is generated by C2 and the diac circuitry so do not use values other than those specified.

R4 is a bleed resistor across the main capacitor to ensure that when the unit is switched off any



The strobe unit with a panel removed showing the large paper capacitor (C4)

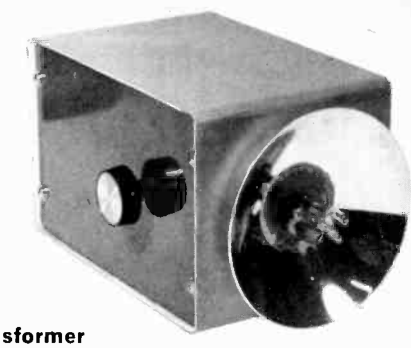
COMPONENTS . . .

Resistors
- R1 1MΩ
- R2 100kΩ
- R3 500Ω 10W wirewound
- R4 100kΩ 1W
- All 10% $\frac{1}{4}$W except where otherwise stated

Capacitors
- C1 8μF elect. 500V
- C2 2μF elect. 200V
- C3 0·1μF 400V polyester
- C4 8μF 500V paper

Diodes
- D1–D2 IN4001 (2 off)
- D3 ST2 Diac (G. W. Smith)

Xenon Tube
- LP1 Hivac ZFT2 (Townsend and Coates Ltd., Coleman Rd., Leicester)



Transformer
- T1 Primary, 10 turns 18 s.w.g. enamelled wire; secondary, 200 turns 36 s.w.g. enamelled wire both layer wound on 2in length, $\frac{1}{4}$in dia. ferrite rod

Miscellaneous
- S1 Double pole mains switch; FS1—5A fuse with panel mounted holder; group board; stand off spacers; 3 wander plug sockets; 1 wander plug

high charge stored on C4 is reduced over a short period of time. Do not, however, rely on this—it is always safer to discharge high value capacitors with a screwdriver before touching them.

C4 must be a paper dielectric capacitor rated in excess of 500V. An electrolytic must not be used in any circumstance.

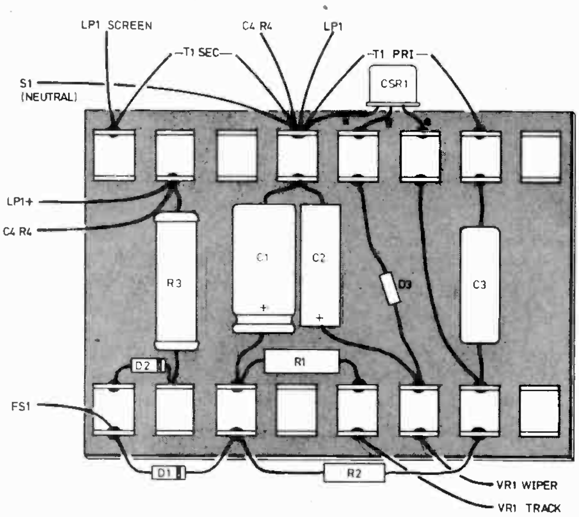


Fig. 2. Component wiring and assembly on group board. Stand-off spacers should be used when connecting to case

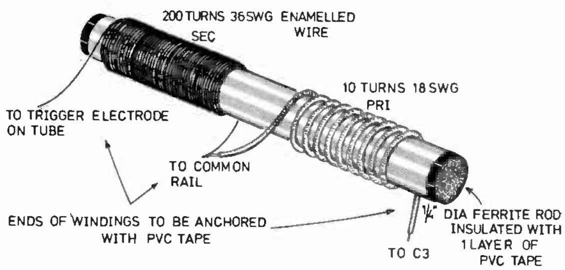


Fig. 3. Winding details of trigger transformer. Both windings are wound in the same sense

CONSTRUCTION

Nearly all the circuitry is mounted on a length of group board (Fig. 2) and the only precautions necessary in the layout are that the secondary of T1 (winding details given in Fig. 3) should not be routed too close to any other wiring and R3 should not touch any other components as it gets quite warm. As the discharge current from C4 is very high, fairly heavy gauge wire should be used to connect its terminals to the discharge tube to prevent excessive line drop.

All the components should be mounted in a metal case that can be properly earthed; this is essential as all the wiring is live to mains. Wander plug sockets form a convenient way of mounting the tube within the reflector and enable easy change of tubes which have a life expectancy of about a million flashes (this is equivalent to about 25–30 hours of operation at 10 flashes per second).

REFLECTOR

The reflector was the hardest single item to find. In the end a tour round surplus shops solved the problem where a reflector from on old projector system was found for a few pence. An old car headlight reflector (pre sealed-beam era) would be ideal.

The reflector should be bolted or stuck on the main box and the tube sockets fixed through the rear of the reflector and the case—these add extra mechanical support to the reflector. To make the unit tamper proof it would be advisable to place a clear Perspex guard in front of the tube—if different coloured lighting was required tinted Perspex could be used for this purpose. ★

THIS FADER unit was developed for use in a Discotheque console where it will automatically fade out the music being played when the D.J. makes an announcement *via* the microphone. When the announcement is finished the music is then restored to its original volume.

As the finished unit in its original form measures only 3·75 × 2·5 × 0·5in, it should fit easily into the corner of a Discotheque console.

Whilst no complicated adjustments of the console wiring are required the unit will require some form of power supply as it consumes some 7mA at 9V. This could be taken from the Discotheque supply or be provided by a battery if required.

CIRCUIT

The circuit is shown in Fig. 1 and, as can be seen, is constructed around the Motorola integrated circuit MFC 6040 which is used as an electronic attenuator. It provides zero attenuation for control voltages below 3·5V and about 90dB attenuation for a 6V control voltage. Thus to give the required control effect we have to derive a rising and falling d.c. level from the microphone signal to fade the deck signal in and out.

TR1 and its associated resistors form an emitter follower which gives the input a high impedance and thus prevents undue loading of the console pre-amplifier. TR2 forms a simple amplifier the output of which goes to the base of TR3 *via* diodes D1 and D2 and VR1. The diodes clamp and rectify the amplified microphone signal and VR1 controls the amount of signal applied to the base of TR3. Thus it controls the sensitivity of the unit.

When there is an input signal at the microphone of sufficient amplitude TR3 is turned hard on and the collector is thus at 0V. C4 prevents this voltage rising appreciably during any short breaks in speech which might occur such as between words or sentences.

Without an input signal TR4 conducts and the collector lies about 2V above earth potential. When TR3 turns on TR4 turns off and C5 charges up *via* R7, providing a rising potential at the control input of IC1.

This in turn attenuates, at a rising rate, the signal from the deck. The initial attenuation must be fairly rapid if the initial part of the announcement is not to be drowned in music.

When TR3 turns off again TR4 turns on and C5 discharges to earth through TR4 and R8 until it reaches a steady level. This gives a falling voltage level to decrease the attenuation provided by IC1.

POWER SUPPLY

As mentioned, a 9V supply giving about 7mA is needed. If such is already available within the console, all well and good. If not then it is simply a matter of dropping and stabilising the console pre-amplifier supply and this may be done simply by using the circuit of Fig. 2.

In Fig. 2, the resistor R9 drops the supply voltage from the console rail value to 9 volts at which it is clamped by the Zener D3. Capacitor C9 gives smoothing of the output. Using Ohms Law, and given a pre-amplifier voltage of V volts then:—

$R9 = \frac{(V-9)}{11}$ kΩ, where R9 is ¼ watt if V is less than 30V or otherwise ½ watt.

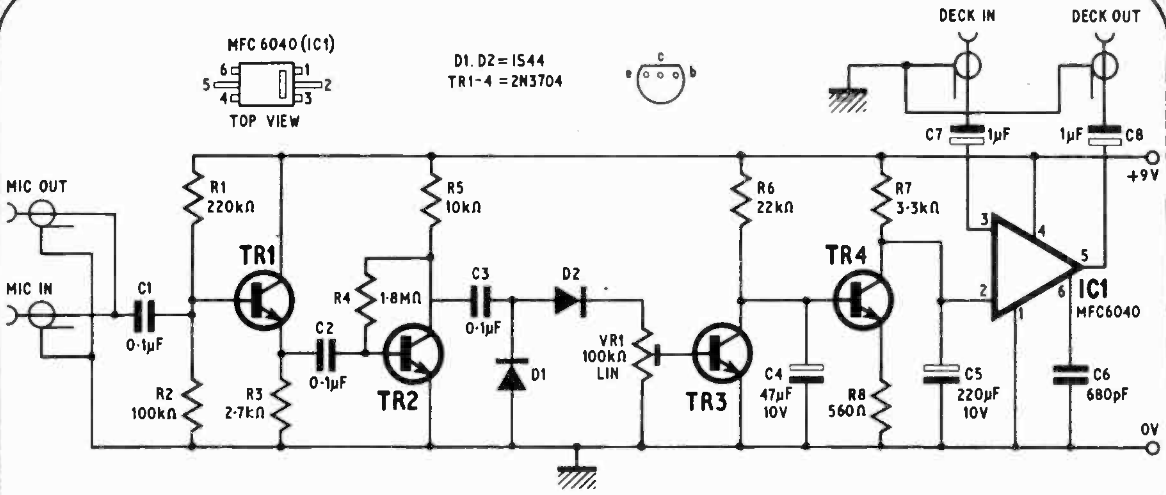


Fig. 1. Circuit diagram of the complete fader which is based on the Motorola MFC 6040 attenuator integrated circuit

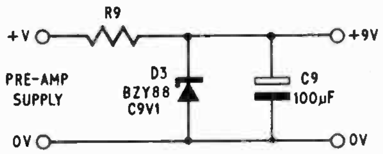


Fig. 2. Circuit of a simple power supply for use with the fader

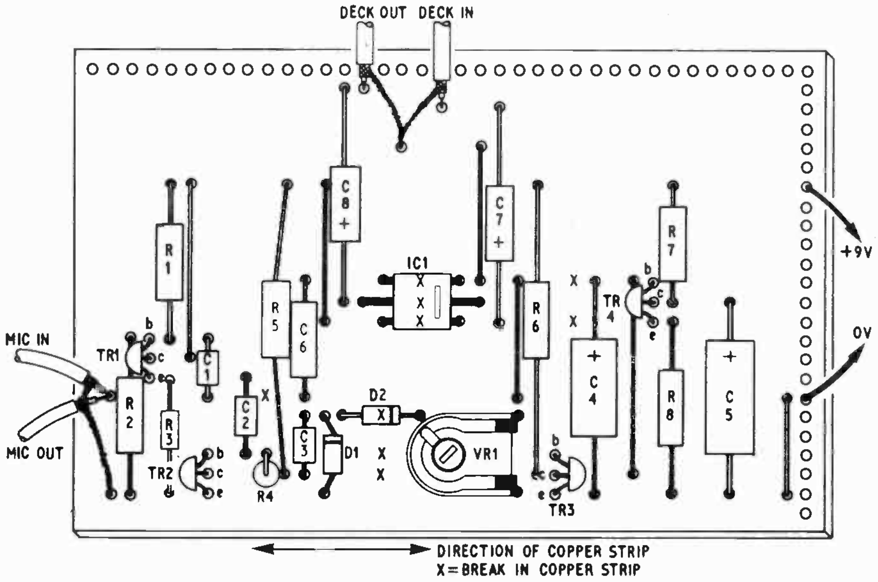


Fig. 3. Component layout and 0·1 in track Veroboard cutting details

COMPONENTS . . .

VOICE OPERATED FADER

Resistors
- R1 220kΩ
- R2 100kΩ
- R3 2·7kΩ
- R4 1·8MΩ
- R5 10kΩ
- R6 22kΩ
- R7 3·3kΩ
- R8 560Ω
- R9 See text

Capacitors
- C1–C3 0·1μF Mylar film
- C4 47μF, 10V elect.
- C5 220μF 10V elect.
- C6 680pF polystyrene
- C7, C8 1μF 16V elect.
- C9 100μF 10V elect.

Semiconductors
- TR1–TR4 2N3704
- D1, D2 1S44
- D3 BZY88 C9V1, 9·1V Zener
- IC1 MFC 6040 (Motorola). Available from Jermyn or Arrow Electronics

Potentiometers
- VR1 100kΩ linear horizontal mounting pre-set

Miscellaneous
- 0·1in Matrix Veroboard measuring 3·75in × 2·75in
- Wire and coaxial cable as needed

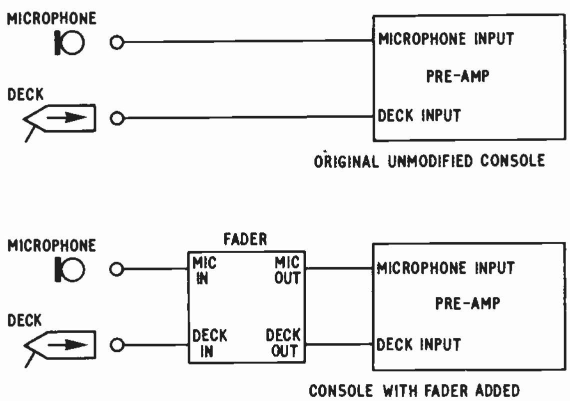


Fig. 4. Discotheque console circuit with and without voice operated fader

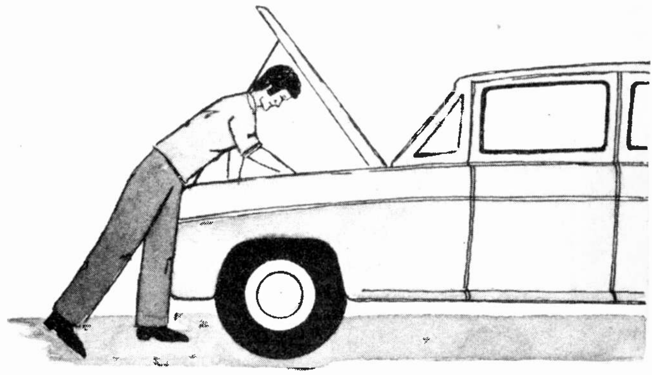
CONSTRUCTION

The unit is quite simple to construct as can be seen from Fig. 3. Using standard 0·1in matrix Veroboard 3·75 × 2·5in the layout of Fig. 3 may be followed. Coaxial cable should be used for the microphone leads to avoid hum pick-up.

Equally, circuit installation is simple as is shown in Fig. 4.

If the circuit of Fig. 2 is to be used this may be added to the board carrying the main components or simply suspended in the wiring since it consists of so few components. ★

NEXT MONTH...



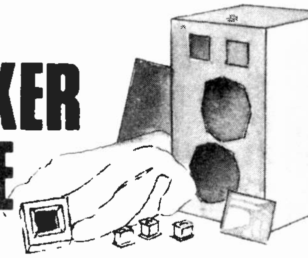
IGNITION TIMING LIGHT

By simply flashing the light from this portable unit on your car crankcase and pulley the state of ignition timing can be seen.

I.C. POWER SUPPLY

A dual power supply giving all the common voltages for linear and T.T.L. integrated circuits. Each supply gives 100mA with variable overcurrent protection.

PE RONDO LOUDSPEAKER ENCLOSURE



Construct your own Hi-Fi loudspeakers for the P.E. Rondo Quadraphonic System. (Equally suitable for use with other audio systems, of course.)
Infinite baffle enclosure, with four 8 ohm units and a six-element crossover network.
Design and constructional details given.

PRACTICAL ELECTRONICS

JANUARY ISSUE ON SALE DECEMBER 14, 1973

PART 3:
APPLICATIONS OF
PHASE LOCKED LOOP
INTEGRATED CIRCUITS

PHASE LOCKED LOOPS

BY J. B. DANCE M.Sc.

THE BASIC theory of phase locked loops has been reviewed in a non-mathematical way in the previous articles in this series. We will now consider in detail the types of phase locked loops which are currently available together with examples of the types of circuit in which they can be used.

Monolithic phase locked loops are necessarily fairly complex devices. In general the various manufacturers have evolved devices which are quite different from one another and they must therefore be considered separately.

SIGNETICS H.F. LOOPS

The Signetics International Corporation manufacture three rather similar monolithic phase locked loops which can operate at high frequencies. They are the NE560B, the NE561B and the NE562B devices.

These three phase locked loops all employ the same phase detector, the same voltage controlled oscillator and the same voltage regulator stages. The basic parameters are therefore very similar for all the three devices, but there are differences in the metallic interconnections which make some types especially suitable for certain applications.

NE560B

The NE560B can be regarded as the most fundamental of the three devices. It has the basic phase locked loop structure shown in the block diagram of Fig. 3.1. This device is suitable for high linearity f.m. demodulation, for telemetry decoding, for use in signal generators, in frequency shift keying receivers, in tracking filters, in circuits for exact frequency duplication in a high noise environment, etc.

The voltage controlled oscillator in this device provides two outputs of opposite polarity to each other.

NE561B

The NE561B contains all the circuitry of the NE560B, but also has an analogue multiplier which can be used as a quadrature detector. This allows the device to be employed for the synchronous detection of amplitude modulated signals if an external 90 degree phase shift network is added.

The NE561B can also be employed in a.m./f.m. i.f. strips, in signal generators, in telemetry decoders, in tracking filters, etc.

NE562B

The NE562B is similar to the NE560B, but the loop is broken between the voltage controlled oscillator and the phase comparator. A frequency dividing circuit can therefore be inserted in the loop at this point if it is desired that the voltage controlled oscillator shall operate at a harmonic of the input frequency.

The NE562B is therefore especially useful in frequency synthesisers and for frequency multiplication and division. In addition, it can also be used in f.m. i.f. strips and for most of the other applications for which the NE560B is suitable.

SUMMARY OF DATA

Each of these three phase locked loops can be operated over a frequency range from less than 1Hz to over 15MHz, the centre or free-running frequency being set by the value of a capacitor connected between two pins of the voltage con-

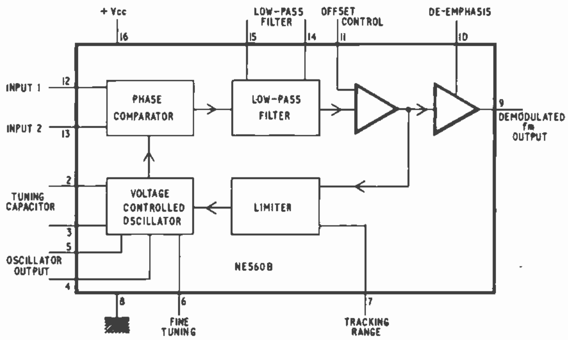


Fig. 3.1. Block diagram of the NE560B phase locked loop. The numbers refer to pins on the dual-in-line versions

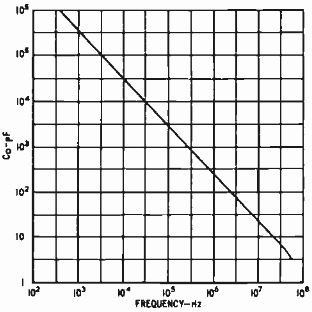


Fig. 3.2. Graph showing the relationship between the centre frequency and the value of the timing capacitor

trolled oscillator. The variation of this frequency with the value of the capacitor is shown in Fig. 3.2.

The control voltage is prevented from exceeding a preset level by a limiter between the control voltage amplifier and the voltage controlled oscillator. This range is known as the tracking range and is set by a control current into pin 7 of the i.c.

The typical operating voltage of these devices is 18V. The NE560B consumes less than 11mA, the NE561B less than 12mA and the NE562B less than 14mA.

The NE560B and the NE561B require a minimum of 100μV for locking, and can take 1V r.m.s. maximum. The corresponding figures for the NE562B are 200μV minimum and 3V r.m.s. maximum.

The maximum output voltage swing is 4V peak-to-peak.

If one applies a 1mV, 10·7MHz f.m. input signal which has a ±75kHz deviation and a 50 ohm source impedance, the demodulated output is typically 60mV in amplitude with a total harmonic distortion of 0·3% (typical).

When one of these loops is used for demodulating f.m. signals a capacitor may be connected from pin 10 to ground to provide de-emphasis.

At operating frequencies below 5MHz the low pass filter may be formed by connecting a capacitor (or capacitor and resistor in series) across the low pass filter terminals. At higher frequencies a capacitor from each terminal to ground should be used to ensure loop stability.

APPLICATIONS

In order to illustrate the usefulness of phase locked loops some circuit diagrams will be given. Whilst it is not possible to give sufficient detail for the systems to be built it is hoped that the information given will give the reader an appreciation of the practical aspects of phase locked loop i.c.s.

F.M. DEMODULATION

A phase locked loop can replace almost the whole i.f. strip, limiter and f.m. detector of a conventional receiver. A typical circuit using the NE560B as f.m. demodulator with an i.f. amplifier and limiter is shown in Fig. 3.3.

The input from the f.m. tuner unit is first amplified by the two sections of a Signetics NE510A dual high frequency differential amplifier. The low output impedance signal from the NE510A is coupled by C4 to pin 12 of the NE560B. The other input (pin 13) of the phase comparator is grounded with respect to radio frequencies by C5. The capacitors C4 and C5 may each have a value of 20pF when the signal frequency is 10·7MHz.

The frequency of the loop is set by the variable capacitor C9 which is connected between pins 2 and 3 so that the centre frequency becomes approximately equal to the signal frequency. The value of C9 may be estimated from Fig. 3.2.

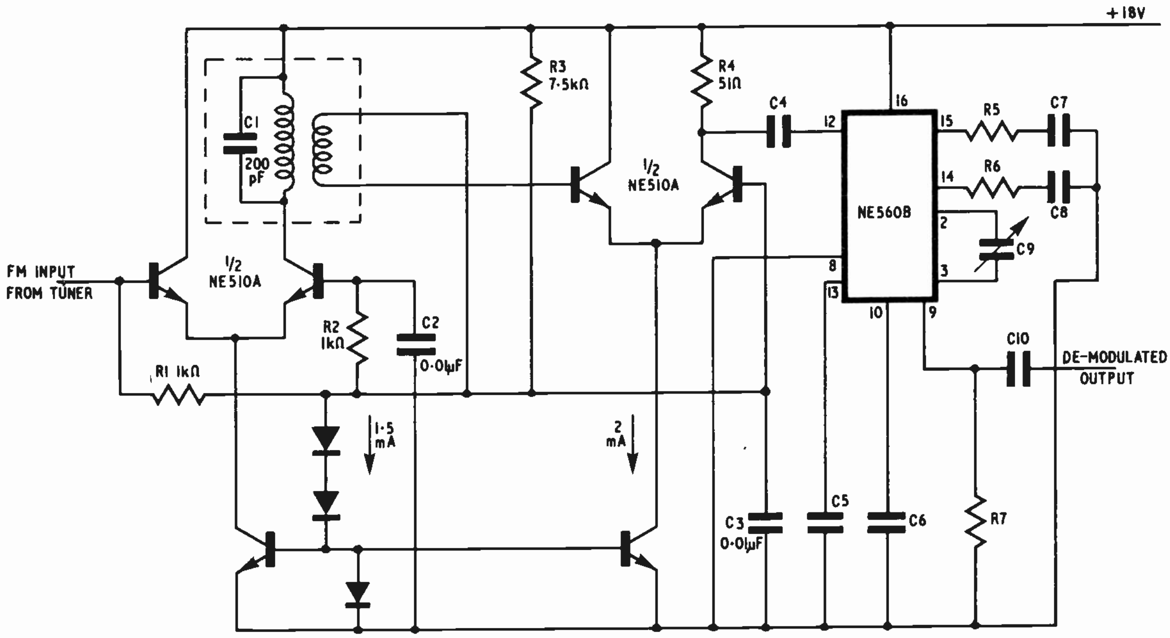


Fig. 3.3. Circuit diagram of the NE560B used in an f.m. demodulator

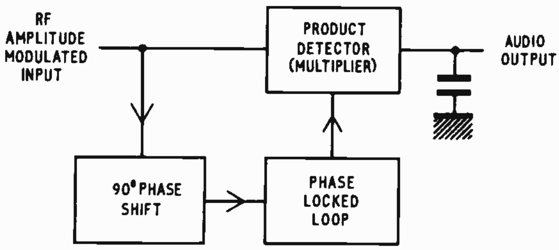


Fig. 3.4a. Block diagram showing the NE561B used as an a.m. demodulator

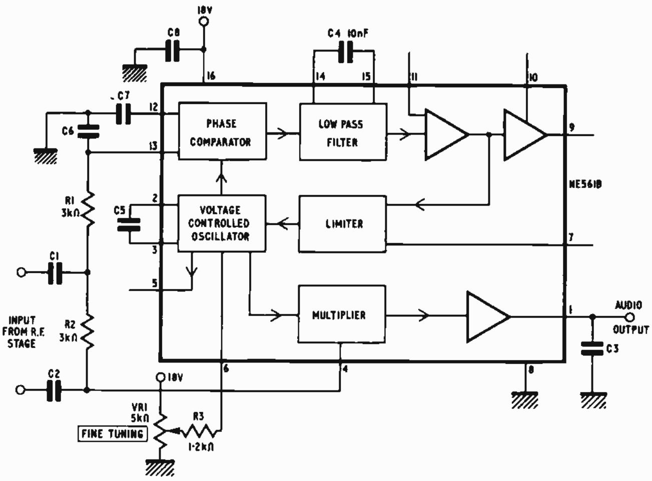


Fig. 3.4b. Practical circuit of the a.m. demodulator

Fine tuning is easily accomplished by using a variable capacitor for C9. However, a potentiometer connected between the power supply lines with the slider connected to pin 6 via a 200 ohm current limiting resistor may be employed.

Components R5, R6, C7 and C8 form the low-pass filter which controls the capture range and the selectivity. The value of the capacitors in microfarads is approximately 2660 divided by the required bandwidth in hertz.

DE-EMPHASIS

The de-emphasis is introduced by merely connecting pin 10 via a capacitor to ground. The value of this capacitor multiplied by the internal eight kilohm resistance should produce a time constant of about 50μs for the standard f.m. broadcasts in the U.K. Thus $C_6 = 50 \times 10^{-6}/8000 = 6{\cdot}25$nF, but this value is in no way critical.

THE NE561B FOR A.M. RECEPTION

The NE561B can be connected as in the block diagram of Fig. 3.4a for the detection of a.m. signals.

The 90 degree phase shift circuit changes the phase of the input signal so that the voltage controlled oscillator in the phase locked loop operates in phase with the input signal. The output from this oscillator is fed to the product detector where it provides the local oscillator signal.

A practical a.m. detector circuit using the NE561B is shown in Fig. 3.4b. It can be used over a fairly wide frequency range, but component values will be quoted for the medium wave band (550kHz to 1·6MHz).

The values of the by-pass and coupling capacitors should be chosen for a low impedance at the operating frequencies. For medium wave use C2, C7 and C8 may therefore be 0·1μF.

CAPACITOR TUNING

The value of C5 must be selected so that the voltage controlled oscillator operates at the required input signal frequency. If desired, the capacitor C5 may be a variable one, in which case the connections to pin 6 (R3 and VR1) may be omitted.

When a variable capacitor is employed for C5, its value will be approximately 300 divided by the input signal frequency in megahertz at the capacitor setting concerned. For the 550kHz to 1·6MHz range, the value of C5 should range from about 550pF to about 180pF.

RESISTOR TUNING

If the tuning is to be carried out by the variable resistor VR1, the value of C5 should be chosen so that when no current is injected or removed from pin 6, the voltage controlled oscillator operates at the geometric mean frequency of the band to be received. This geometric mean is equal to the square root of the product of the lowest and highest frequencies in the band. In the case of the 550kHz to 1·6MHz receiver, this mean frequency works out as 940kHz.

The complete medium wave band may be tuned by VR1; this potentiometer may be a ten-turn helical type to permit accurate setting. The value of R3 is selected to give the desired tuning range and will be about 1·2 kilohm when an 18V power supply is employed.

PHASE SHIFT

The component values of the phase shift circuit may be determined in the following way.

If $R_1 = R_2 = 3\text{k}\Omega$, the $C_1 = C_6 = (1{\cdot}3 \times 10^{-4}/f)$F

where f is the midband frequency. In the medium wave receiver, f is 0·94MHz and $C_1 = C_6 = 1{\cdot}35 \times 10^{-10}\text{F} = 135$pF.

LOW-PASS FILTER

The value of the low-pass filter capacitor, C4, is not at all critical, since no information is derived directly from the loop error signal. One merely requires to establish stable operation. A 10nF capacitor is suitable for C4.

TAPE RECORDER FLUTTER METER

A circuit devised by R. Blair of Houston using the NE561B in a tape recorder flutter meter is shown in Fig. 3.5. A 3kHz sinewave is fed to the recording head. The output from the replay head is fed to the phase locked loop which detects any variations in frequency from the 3kHz value.

The NE561B circuit is set to a nominal value of 3kHz using the fine tuning control. The demodulated output is capacitively coupled to an amplifier of high input impedance. The output level changes with any change in the frequency of the signal applied to the phase locked loop.

An oscilloscope may be employed to measure the peak deviations and a true r.m.s. voltmeter to make r.m.s. flutter measurements. (The waveform is complex and therefore meters which read the peak or average value will not give true readings.) The output can be filtered to study any selected bands of frequencies.

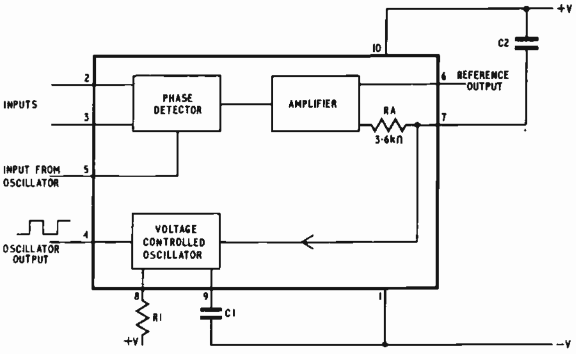


Fig. 3.6. Block diagram of the 565 low frequency phase locked loop. This is the pin numbering for the NE565A (Signetics) and the LM565CN (National Semiconductor), both 14 pin dual-in-line

THE 565

One of the best known low frequency phase locked loops is the 565 device. This is available as the Signetics NE565A device and as the National Semiconductor LM565CN device in a 14 pin dual-in-line encapsulation. The NE565K and the LM565CH are electrically equivalent devices in a TO-99 circular encapsulation.

The basic circuit for all of these devices together with the pin connections is shown in block form in Fig. 3.6.

The loop is broken between the output of the voltage controlled oscillator and the input to the phase comparator (pins 4 and 5 respectively) so that frequency divider circuits can be inserted at this point for frequency synthesis applications. The low-pass filter is formed by the internal resistor marked RA in Fig. 3.6 and the external capacitor C2.

FREQUENCY RANGE

The maximum frequency at which the voltage controlled oscillator of the 565 devices can operate is about 500kHz. The minimum practical operating frequency is set by the maximum value of the timing capacitor (C1 in Fig. 3.6) which can reasonably be used. If one decides that this maximum value is 10,000μF, one can obtain a frequency as low as 0·001Hz.

The free-running frequency of the voltage controlled oscillator is only partly determined by the value of the timing capacitor C1. The frequency can be changed over a range of at least 10:1 using a single value of C1 by varying the value of R1 in the pin 8 circuit; alternatively the value of the current fed to pin 8 may be varied.

The typical variation of the free-running frequency with the value of R1 for four values of the timing capacitor is shown in Fig. 3.7. For any given value of the timing capacitor, the free-running frequency is about an order of magnitude lower than that of the high frequency loops.

The free-running frequency of the 565 oscillator is given by the approximate equation $f = 1{\cdot}2/(4R_1C_1)$ where R1 and C1 are the timing components shown in Fig. 3.6.

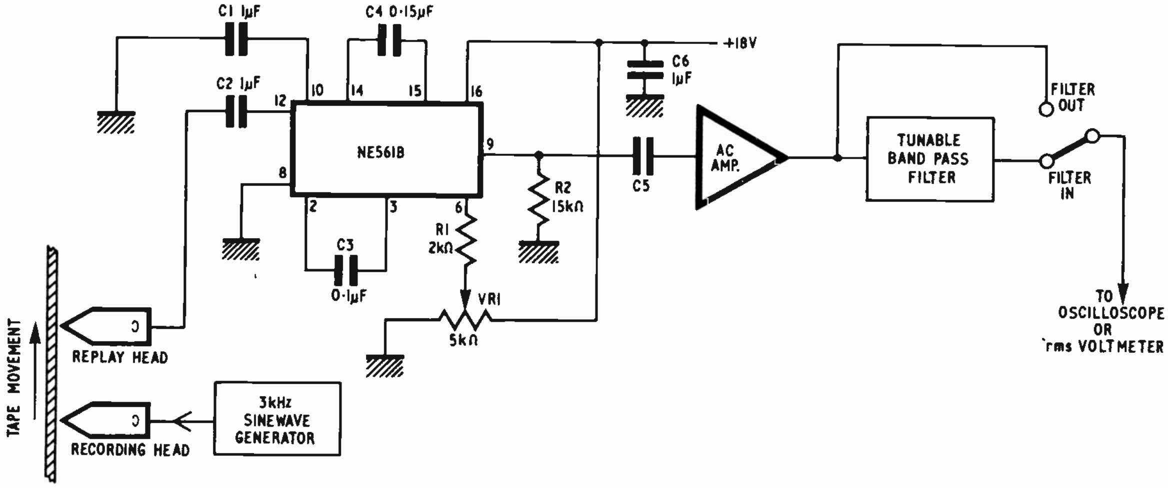


Fig. 3.5. A tape recorder flutter meter using the NE561B phase locked loop

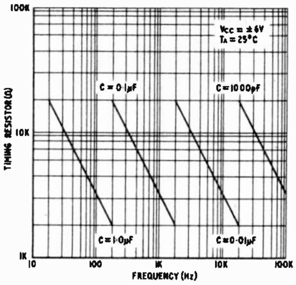


Fig. 3.7. Relationship between the centre frequency and the timing components for the 565 integrated circuit

The value of the timing capacitor C1 can vary over wide limits, but the resistor R1 should have a value of between 2kΩ and 20kΩ, the optimum being about 4kΩ.

When using power supply lines which are symmetrical with respect to ground, the range of voltages which may be employed is ±5V to ±12V. When ±6V power supplies are employed, the typical current taken is 8mA with a maximum value of 12mA. The maximum permissible power dissipation is 300mW.

THE OSCILLATOR

The voltage controlled oscillator circuit used in the 565 devices can be obtained as a separate integrated circuit type 566. It is available as the Signetics 8 pin dual-in-line device type NE566V and the similar National Semiconductor device type LM566CN. The circular TO-99 equivalents are types NE566T and LM566CH. The SE566T and LM566H are close tolerance devices.

In the 565 phase locked loops, triangular and square waves are generated by the voltage controlled oscillator, but no buffer stage is provided to give a triangular wave output as in the 566. The square wave output (about 5·4V peak-to-peak) is available at pin 4 of the 565.

The output of the low-pass filter (pin 7 of Fig. 3.6) is connected internally to the voltage control input of the oscillator. The oscillator frequency can therefore be controlled by a signal fed to the demodulated output terminal (pin 7).

LOCKING RANGE

The range of input frequencies over which the loop will remain in lock on each side of the centre frequency is given by the approximate expression $\pm 8f/V$ where f is the centre frequency and V is the total voltage between the power supply lines.

The 565 can therefore track the input frequency over a very wide range (typically ±60% of the centre frequency). Locking can be obtained over a greater fraction of the input frequency than in the case of high frequency loops.

The 565 input impedance is typically 10 kilohm (minimum 5 kilohm). The minimum input signal required to produce tracking is typically 1mV r.m.s.

The linearity of the f.m. response is very good (typically about 0·2%).

FREQUENCY MULTIPLICATION

In the circuit of Fig. 3.8, a frequency divider circuit has been inserted in the loop between pins 4 and 5. The output of the voltage controlled oscillator is divided in frequency by a certain factor and the frequency divided circuit locks with the input signal. The oscillator therefore operates at a higher frequency than the input signal.

The value of C2 should be adequate to eliminate variations in the demodulated output voltage at pin 7 in order to stabilise the voltage controlled oscillator frequency.

The square wave output frequency can be taken from pin 4.

METAL DETECTOR

Phase locked loops can be used to detect changes of frequency. Such changes can be produced when the coil of a tuned circuit approaches a piece of metal. Phase locked loops can therefore be used in metal detectors.

A circuit of this type which has been designed by J. Blecksmith of California is shown in Fig. 3.9. The 8in diameter search coil comprises 30 turns of copper wire (26 s.w.g.) and has an inductance of about 0·5mH. It is connected in the Colpitts oscillator circuit of TR1 which operates at about 100kHz.

This oscillator is coupled by C3 into the input of the 565 circuit (pin 2). A current source (TR2 and TR3) is employed to supply most of the current of about 2·5mA which passes to pin 8 and which equals the charging and discharging current of C4. The use of this current source increases the output of the loop at pin 7 to about 0·5V for a 1% frequency deviation. (This follows from the fact that the 20kΩ resistor R7 will produce a change in the current to pin 8 of 0·5/20,000 = 0·025mA for a 0·5V change. In other words a change of 0·5V produces about 1% change in the pin 8 current.)

The output voltage at pin 7 is compared with the reference voltage at pin 6 by the differential amplifier of TR4 and TR5. The output of this amplifier drives a centre reading meter which has a ±100μA scale. The meter zero is set by VR2 and the sensitivity by VR3.

When the search coil is brought near to a non-ferrous metal object, the frequency of the TR1 oscillator circuit will rise and so will the meter indication. Any object containing iron will increase the inductance of the loop and reduce the frequency of oscillation; the meter reading will therefore fall.

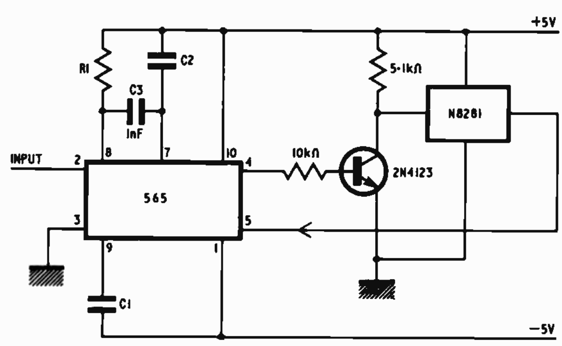


Fig. 3.8. A frequency multiplier using the 565 and a divider

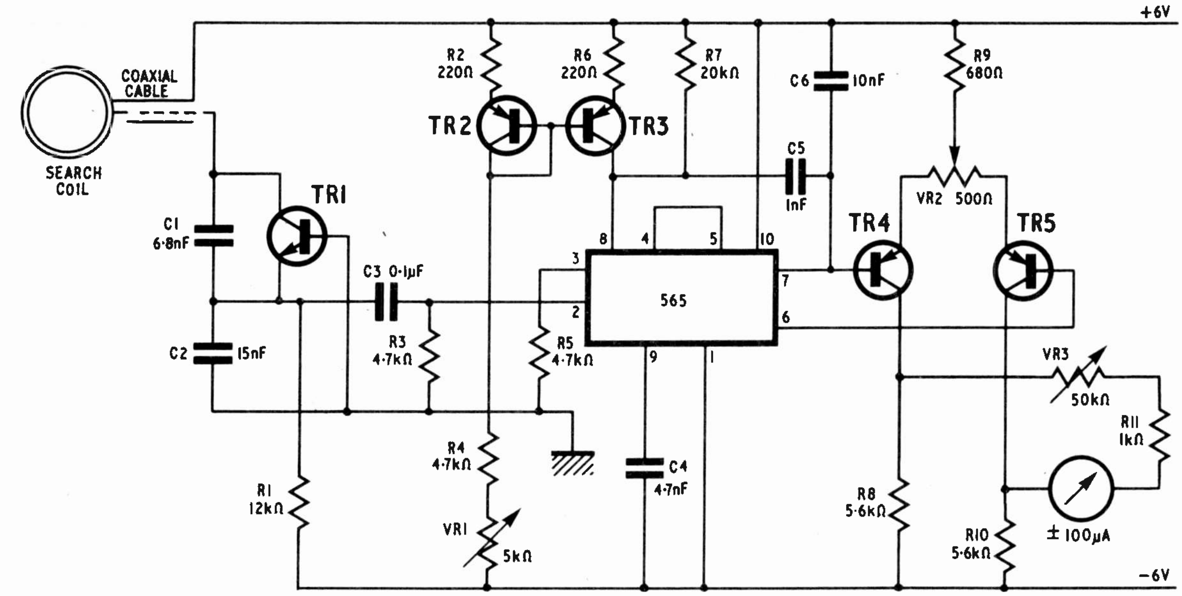


Fig. 3.9. A metal detector using the 565

WEATHER SATELLITE APPLICATION

As an example of a very different application of the 565, its use in a weather satellite picture demodulator will be outlined.

Weather satellites continually photograph the earth from a distance of typically a few hundred miles. The pictures are stored in an electrostatic Vidicon tube and are read out during the succeeding 200 seconds.

The signal is transmitted on a 137·5MHz carrier frequency modulated with a 2·4kHz sub-carrier; the latter contains the picture information. The demodulated 2·4kHz tone is normally recorded on tape at the receiving station for subsequent processing.

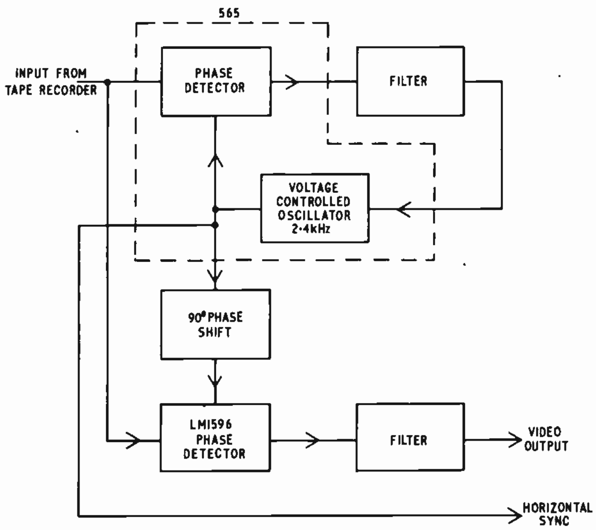


Fig. 3.10. A system for demodulating video signals from the 2·4kHz sub-carrier which is used by weather satellites

When the tape is replayed, it is desirable to reproduce the 2·4kHz sub-carrier using a phase locked loop, since the latter will effectively filter out most of the noise and will track any flutter in the magnetic tape mechanism.

The basic circuit used in this application is shown in Fig. 3.10. The loop locks at the 2·4kHz frequency. If this is also the centre frequency of the loop, the square wave output from pin 4 of the 565 will be 90 degree out of phase with the input.

However, the zero crossing times of the triangular wave across the timing capacitor may be applied to the LM1596 doubled balanced modulator so that switching occurs in phase with the 2·4kHz sub-carrier.

The picture may be reproduced on a cathode ray tube. Detailed circuit information is available in the National Semiconductor report AN-46.

AVAILABILITY

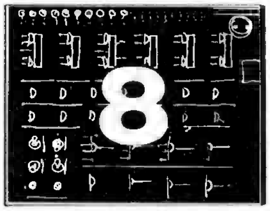
The Signetics phase locked loops are about the most widely available type at the present time and are available from many of the advertisers in Practical Electronics. The NE560B, NE561B and NE562B are available from S.D.S. Components Ltd., Portsmouth PO3 5JW at about £4·20 in small quantities. The Signetics 565, 566 and 567 are obtainable from the same source at about £4, £1·44 and £3·25 respectively.

National Semiconductor devices can be obtained from Semiconductor Specialists, Farfield Road, West Drayton.

Further information on these devices may be obtained from the Signetics Linear Integrated Circuit book and in data and applications notes from Signetics and National Semiconductors.

Next month: more applications of phase locked loop integrated circuits will be described including stereo decoding

LOGIC TUTOR EXPERIMENTS..



THE FULL ADDER

IN PRACTICE we must be able to add together two multi-digit numbers and as we saw last month the HALF ADDER does not go quite far enough to doing this. We have to design a circuit that is capable of accepting the two digits of the column (A with B) and incorporate a possible carry over from the previous (less significant) column.

TWO STAGES

The simplest way of doing this is to carry out the operation in two stages; first add together the digits that are in the higher significance column—this is done in the HALF ADDER 1 of Fig. 8.1.

If the digits were 0 and 0 we would get a partial sum of 0 and a carry of 0. If either of the digits were 1 we would get a partial sum of 1 and a carry of 0 but if both digits were 1 we would get a partial sum of 0 and a carry of 1.

We shall come back to this carry in a moment but remember that if we get a carry, at all, at the output of HALF ADDER 1 the sum output of it is *bound* to be 0.

We now take the partial sum from the first HALF ADDER and combine it with the carry digit—that might have been generated by the previous column. This is done in HALF ADDER 2. This will generate a final sum and *could* generate a carry.

If you think about it you will see that if a carry is generated at the output of HALF ADDER 1 it is not possible to get a carry from HALF ADDER 2 (because the sum from the first stage would have been bound to be 0). However, if the sum from the first stage was 1 it *might* be that there was a carry in from the previous column and these combine in the second stage to give a carry out as well as the final sum. Whatever happens it is not possible to get a carry out of both stages at the same time so there is no question of having to add two carries together.

FULL ADDER

Thus to generate a final carry out of the complete unit we only have to OR together the two possible sources of carry. This circuit is called a FULL ADDER and can be made using the building blocks we have already described in NAND form. We need two HALF ADDERS and an OR gate.

An unsimplified circuit showing the discrete stages in NAND logic appears in Fig. 8.2. Do not make this on Logic Tutor because we can simplify the circuit a little. Notice that we have double inversion on the two lines feeding the final NAND gate of the OR block. These negate each other and we are left with a complete FULL ADDER using nine NAND gates in Fig. 8.3. This you can make on Logic Tutor.

Using the switches and lamps and a piece of paper and a pencil show that the circuit truthfully follows the rules of arithmetic necessary to add the three input digits together.

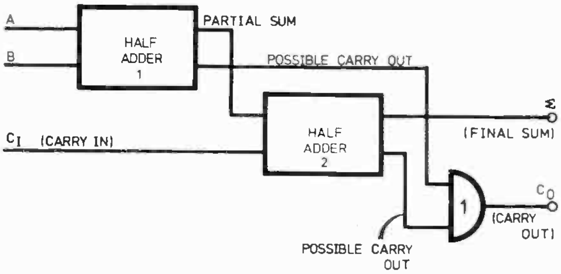


Fig. 8.1. Two HALF ADDERS are combined to form a FULL ADDER

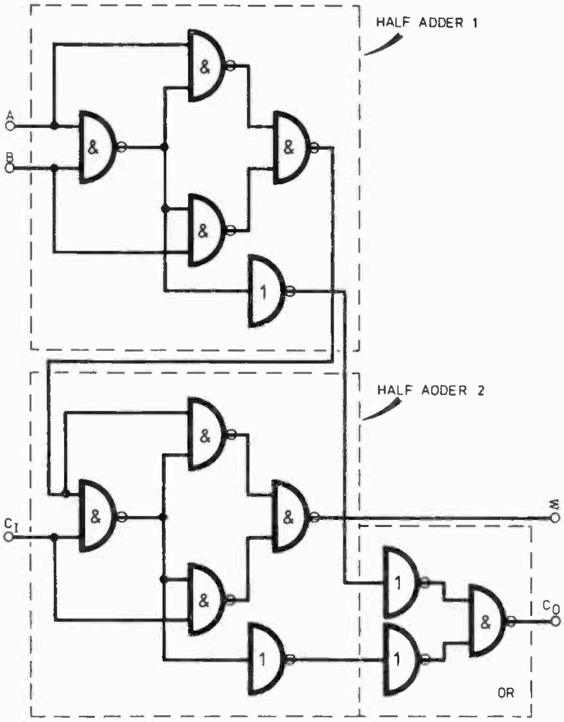


Fig. 8.2. A FULL ADDER using blocks of logic in unsimplified form. Note the two sets of double inversion before the final NAND gate in the C_0 line

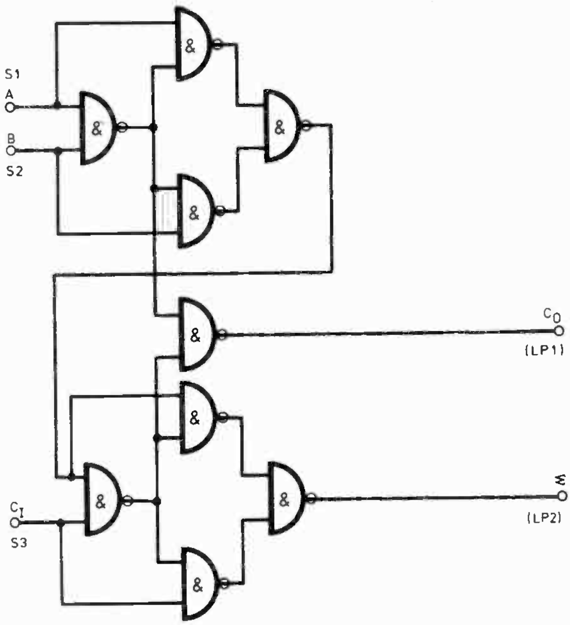


Fig. 8.3. A FULL ADDER that can be built on the Logic Tutor

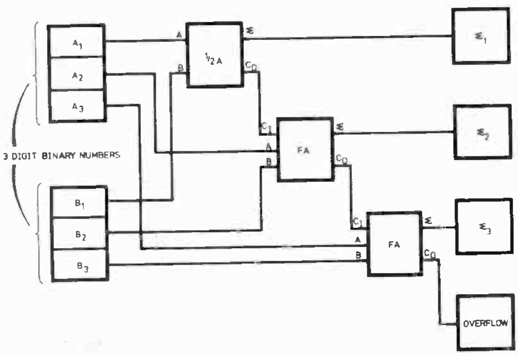


Fig. 8.4. Block diagram of a parallel adder capable of summing two, three-digit binary numbers to give a three- or four-digit answer

MULTIDIGIT NUMBERS

In practice we have to add multidigit numbers together and the simplest way of doing this is to cascade FULL ADDERS —one after the other. The carry out from the previous column is connected directly to the carry in of the next. Fig. 8.4 is a block diagram of such a summing unit.

AI and BI are the least significant digits of the respective multidigit numbers and because of this they only need a HALF ADDER to produce a true sum and carry; however, all higher order digits have to be combined in FULL ADDERS.

You would need as many adding stages as there are digits when carrying out the process in parallel form consequently a parallel adder can be quite expensive but it is very fast in operation. A cheaper form is the serial adder (not shown in this series) but there is rather more complexity in handling the carry signals. ★

by M. J. Hughes

BOOK REVIEWS

HOW TO LISTEN TO THE WORLD. 7th EDITION

By J. M. Frost
Published in the U.K. by Fountain Press
160 pages, 9in × 6in. Price £1·90

WHILST not exactly filled with "do it yourself" information on the making and using of radio receiving equipment, it does contain considerable information of general interest.

For example, how many people know the frequencies and addresses of a variety of Irish "pirate" stations currently in operation? A section of this volume provides details of a number of revolutionary stations throughout the World and gives information on their mode of operation.

On the technical side there is some interesting discussion on the use of front-end tuners for RX equipment, together with details of some the reader can make. Other chapters cover medium wave working, improving a second-hand set, working South America and a listing of the major broadcast stations.

R.D.R.

PHOTOCELL APPLICATIONS

Published by English Universities Press
52 pages, 11¾in × 8¼in. Price £1·05

AS AN introduction to electronics, photocells of various types provide an excellent starting point as they are easy to understand, they have a multitude of applications and are relatively cheap.

Only a basic knowledge of electronic principles is assumed and practical points such as resistor colour code and circuit symbols are fully covered. The projects range in complexity from a simple exposure meter to a modulated light transmitter and receiver.

Through this book the reader can obtain not only a knowledge of photocells but also other electronic components such as transistors, and thus can discover some of the fascination of electronics.

S.R.L.

IBA TECHNICAL REVIEW—DIGITAL TELEVISION

Published by the IBA
64 pages, 9in × 7¾in

IN THIS the third of the IBA's Technical Reviews ane extremely interesting account of the IBA Engineering Section and its work on digital television is presented. The book includes descriptions of the recent work of the IBA in developing digital standards converters, among them the first digital intercontinental conversion equipment (DICE) now in operational service at Independent Television News.

This book is written by members of the IBA Engineering staff and provides a valuable insight into the design techniques and philosophy behind some interesting projects.

Copies of this book may be obtained on request from: IBA Engineering Information Service, 70 Brompton Road, London, SW3 1EY.

S.R.L.

PE RONDO PART 4

MECHANICAL ASSEMBLY & INTERWIRING

BY R. A. COLE

FACIA

SURROUND

INTERWIRING & HARNESS

IN THE previous parts of the RONDO series we have discussed the construction of the main chassis member which forms a trough-like carrier for the power sections of the system. Now we come to a discussion of the general mechanical assembly and the wiring of the system.

GENERAL CONSTRUCTION

The facia of the RONDO system supports both the controls and the r.f. tuning unit, whilst the remainder of the boards are assembled in the chassis pan itself. Thus, as can be seen from Fig. 4.1 the facia consists of an aluminium framework supported on four columns which are held in the main chassis by screws.

The columns support two crossmembers (Fig. 4.1b) made from aluminium angle (½in × 1in) which in turn support two sections of aluminium extrusion made specially for the RONDO system and available from a number of kit suppliers. The two sections are separated by an inverted "U" section of brushed aluminium provided with ventilation louvres.

For those who wish to make their own facia this may be made up from sheet material bent up into the form at Fig. 4.1a, again supported on the columns and drilled so as to carry a simple aluminium facia in plain sheet. Drilling for this is identical to that for the pre-form material with the addition of master tone board mounting screw holes added.

The plain face area shown above the four input selector push-buttons on the left of the RONDO is allocated to the tuner section, yet to be described.

The final main part of the mechanical assembly is the "wrap-round" or surround which forms the sides of the RONDO. This is made from wood, veneered chipboard, or the like according to taste.

From Fig. 4.2 which shows the surround it will be seen that there are two alternative methods of fixing between the surround and the basic trough chassis. The first is to make use of the natural spring in the bent-up chassis by springing the two longer sides apart slightly such that when the surround is finally lowered over the facia to abut the two flanges on the trough, these are pushed in against the spring action. As the surround is lowered further they will then spring out to engage with the two grooves cut in the inner long surfaces of the surround.

If the constructor prefers, he may replace this method with one in which the surround is reduced in depth by the distance between the lower edge and the grooves and is supported on an extension bolted to the two trough flanges as shown in Fig. 4.2.

WIRING DETAILS

The P.E. RONDO quadraphonic system is quite complex and, if not carefully wired, will result in an untidy maze. It is therefore strongly recommended that a prefabricated wiring harness, or cableform, be made to cover the bulk of the inter-unit wiring.

This cableform is constructed by means of a simple jig illustrated in Fig. 4.3 and made from a suitable piece of wood into which a pattern of "pins" is fixed; 1½in panel pins are ideal for this purpose. They are hammered into the appropriate points as shown and the heads are then clipped off and the sharp ends smoothed.

When assembling the cableform make certain that each wire or cable is inserted in the order given in Table 4.1, since otherwise both simple mechanical and electrical problems can arise.

FACIA

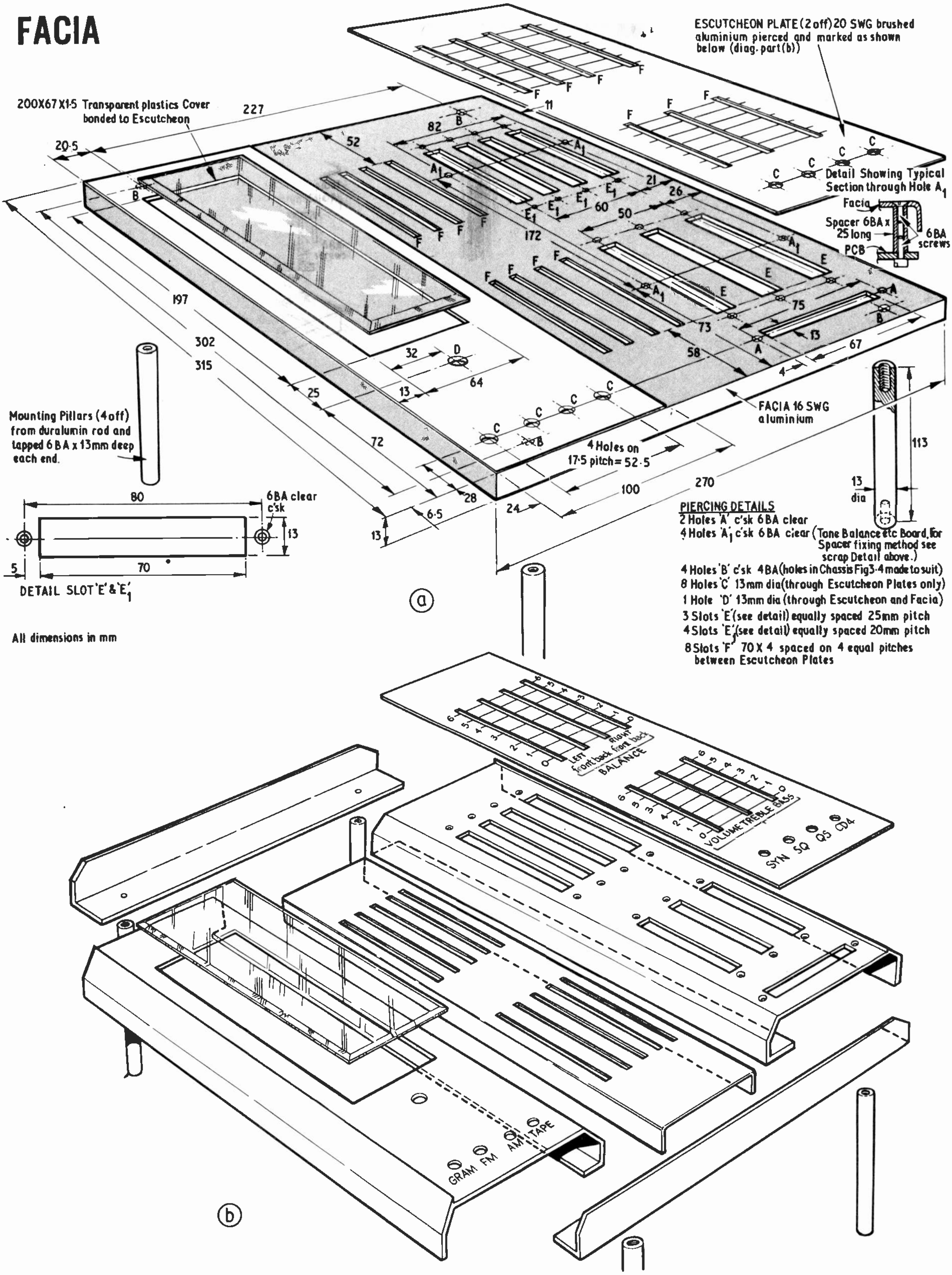


Fig. 4.1. Construction of the facia. The upper drawing (a) shows the method of assembly using "home-made" aluminium panels and the lower drawing (b) shows the method of assembly using ready-made aluminium extrusions

SURROUND & LOOM

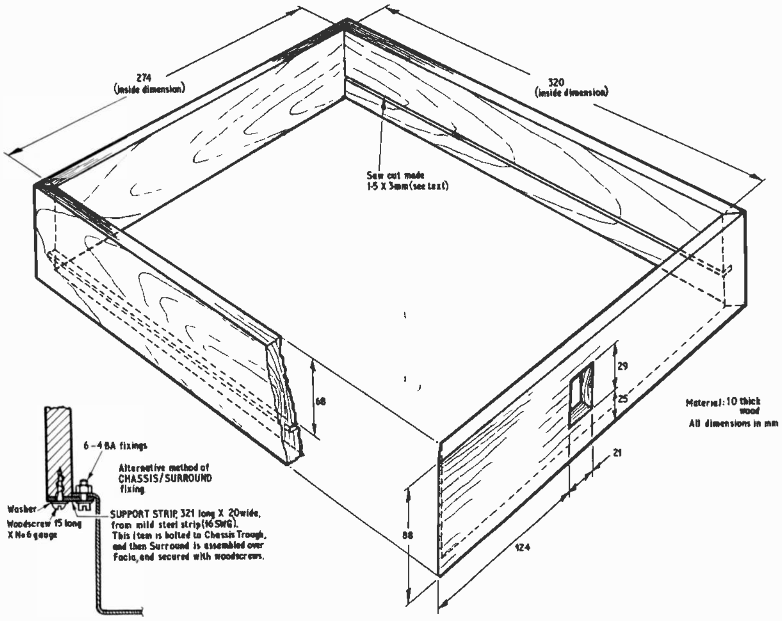


Fig. 4.2. Construction of the wooden surround with details of the two methods of fixing the trough

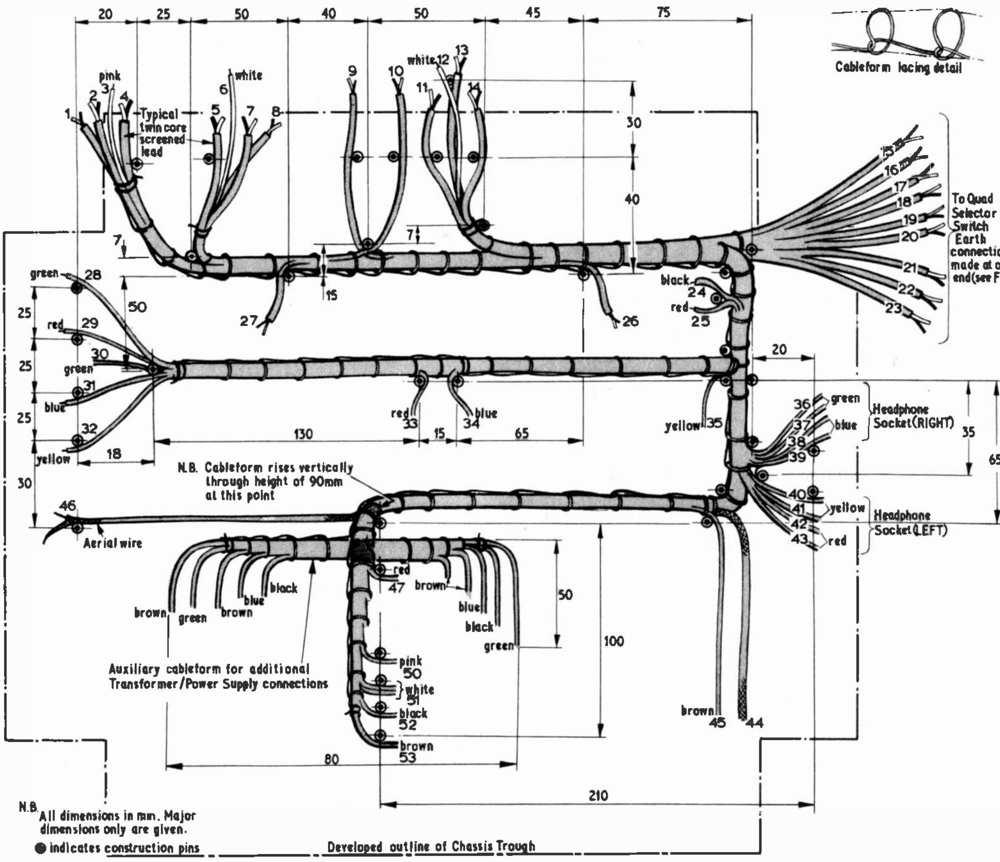


Fig. 4.3. Details of the cableform wiring harness. Interwiring between the units is greatly simplified if a cableform system is constructed as shown here

Each piece of wire is firmly secured by wrapping its start end round the first pin and then laying it along the route shown in Fig. 4.3 and the point-to-point wiring and assembly diagram of Fig. 4.4.

The intermediate pins along a route are used as guides and gentle tension is applied to each wire in order to produce a neat and tidy result. At the termination point the wire is again secured to the adjacent pin by wrapping. With the heavier wires it may be found necessary to knot the wire around the pin.

A "tail" some two to three inches long should be left at each end of each wire for later circuit connecting.

The cableform may now be "laced" up using lacing twine or, failing the availability of this, a waxed heavy thread or light nylon line. A simple form of lacing is shown in Fig. 4.3 from which it will be seen that this is merely a matter of tying the cableform into one cohesive unit by using a series of loops around the cables every ¾in or so.

After lacing, the cableform is gently eased from the pins and is now ready for positioning in the trough.

MECHANICAL ASSEMBLY

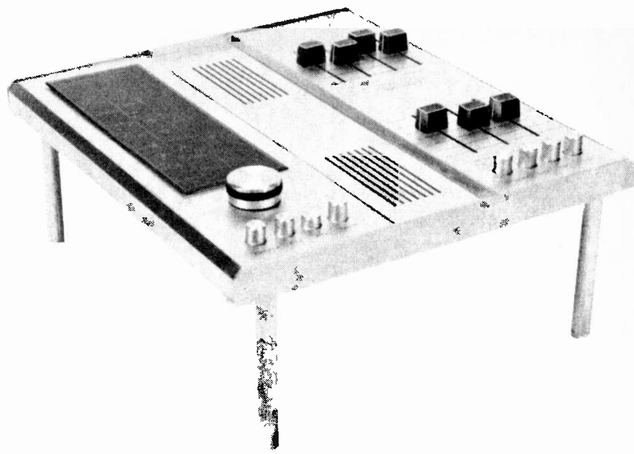
The two power amplifiers, already assembled complete with heat sinks, are laid side by side, copper side upwards on the bench. The power rails and earth rails are connected and flying leads are soldered as shown in Fig. 4.6.

The next step is to fit all sockets, rubber feet and mains lead grommet to the chassis as shown in Fig. 4.4. The wiring harness is then laid in the bottom of the main chassis as shown.

Starting at the rear of the chassis carefully identify each wire and its connecting point. Cut the wire tails to length and carefully strip the ends, wrap round and then solder. Repeat this procedure until all wires that are shown to be terminated are soldered.

Table 4.1

Start	Finish	Signal	Cable Type
1	15	CD4	Twin screened
2	16	"	
4	17	"	
5	18	SQ	
7	19	"	
8	20	"	
11	21	QS	
13	22	"	
14	23	"	
9	26	L_A I/P	
10	27	R_A I/P	
3	50	+24V Rail	14/0·0076 Pink
6	51	+20V Rail	" White
12	51	" "	" "
24	52	− 15V Rail	" Black
25	47	+15V Rail	" Red
35	40	L_F O/P	" Yellow
40	32	" "	" "
34	39	L_B O/P	" Blue
39	31	" "	" "
33	43	R_F O/P	" Red
43	29	" "	" "
30	36	R_B O/P	" Green
36	28	" "	" "
53	45	+18V Rail	" Brown
46	44	Aerial	Miniature Co-Ax



The remaining wires and their terminations are associated with the tuner unit which is to be the subject of a separate article and they will be described in detail then.

The two power amplifier boards, now joined together, are placed component side upwards in the chassis. The two right-hand limbs of the wiring harness (as seen from the front of the chassis) should be under the boards and the left-hand limb along the edge of the heat sink.

Ensure that the yellow, blue, red and green wires, in the centre limb of the harness, protrude above the boards at the appropriate outlet points. Cut, strip, wrap and solder them. Similarly treat the red and black wires in the right-hand limb, soldering them to the positive and negative 15 V rails on the power amplifier board.

The two rails are duplicated on the rear power amplifier board and the two boards are joined with short lengths of red and black wire interconnecting the rails.

HEADPHONE SOCKETS

A group of four pairs of wires, each pair of one colour, namely yellow, blue, red and green, protrudes from the front of the harness in line with the headphone sockets. These wires are connected to the headphone sockets, as shown, ensuring that the leads from the power amplifiers go to the appropriate tags on the *right* side of the headphone sockets as viewed from the front of the chassis. If these connections are not correctly made the headphones will not function correctly.

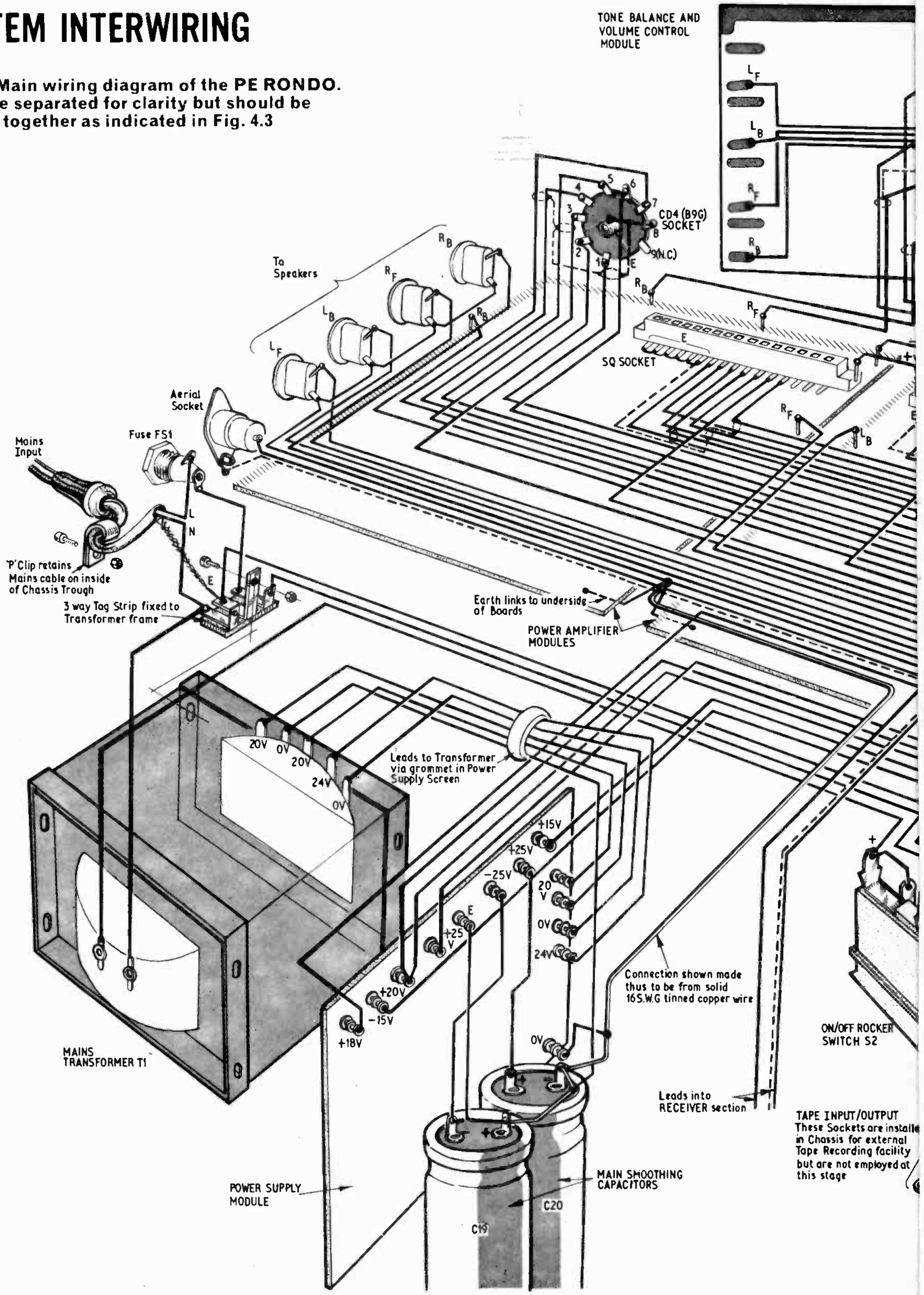
The headphone sockets shown are of the normal three-wire type which can exhibit problems with the amplifiers set to high output levels. It is possible to either damage the headphones or the eardrums if care is not taken when plugging the headset in.

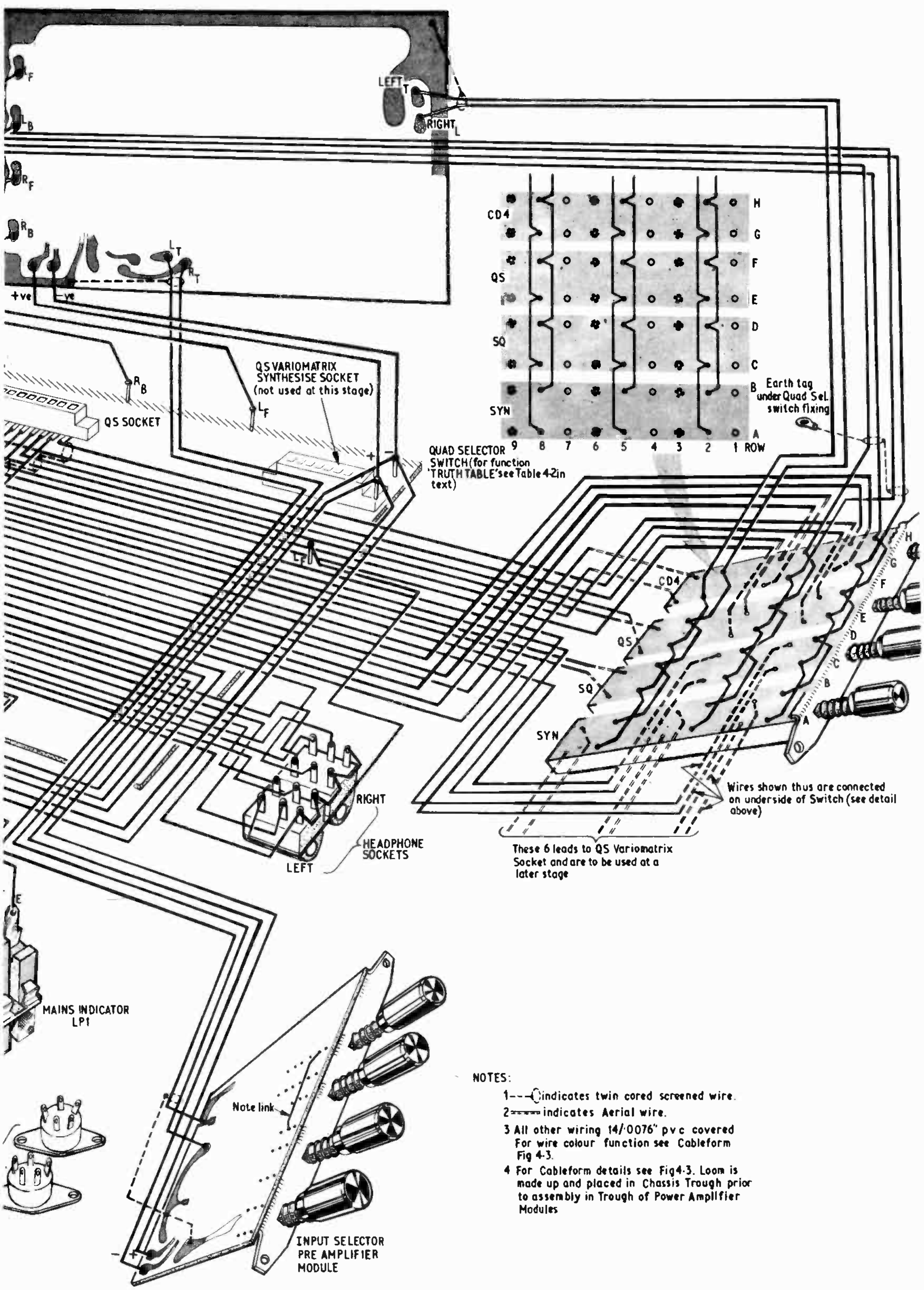
It is therefore recommended that the constructor either takes great care under these circumstances or adopts the use of a new style or socket which has just come onto the market. The new socket interposes a load in series with the headphones in order to limit the output level and current to a safe value.

Using the new sockets, a suitable load resistor for most applications is 220Ω, ½W.

SYSTEM INTERWIRING

Fig. 4.4. Main wiring diagram of the PE RONDO. Wires are separated for clarity but should be grouped together as indicated in Fig. 4.3





NOTES:

1 ---(indicates twin cored screened wire.
2 ===== indicates Aerial wire.
3 All other wiring 14/·0076" p v c covered. For wire colour function see Cableform Fig 4·3.
4 For Cableform details see Fig 4·3. Loom is made up and placed in Chassis Trough prior to assembly in Trough of Power Amplifier Modules

PE RONDO

POWER SUPPLY SUB-ASSEMBLY

Returning now to the power supply sub-assembly; fit the complete sub-assembly to the chassis with four ½in round-head 4BA screws, plain washers, lock washers and nuts. Similarly secure the power amplifiers to the chassis by means of the heat sinks. Fit the main smoothing capacitors to the chassis by means of capacitor clips.

The power supply includes transformer, power board and main smoothing capacitors and is shielded by means of two steel screens. The smaller of these screens, shown in Fig. 3.6, acts as a supporting baffle for the power supply board.

It is first fastened to one end of the mains transformer by four ½in round-head 4BA screws, each fitted with one plain washer, one lock washer and a nut. The board is then secured to this baffle by three ¾in round-head 6BA screws, washers and nuts and, in each case, a ⅜in spacer is interposed between the board and the baffle.

The larger of the two steel screens is now fitted to the chassis.

Refer to Fig. 4.4 and connect the leads to the power supply coming from the harness. Connect the mains lead and switch/pilot light as shown in Fig. 4.4.

Prepare the pre-amplifier board with flying leads for connection to the main chassis components. Similarly connect the master volume/tone/balance control board. Reference to Fig. 4.4 will give the necessary guidance.

The four-way, six-change-over, pushbutton bank is now pre-wired in accordance with Fig. 4.4 and Table 4.2.

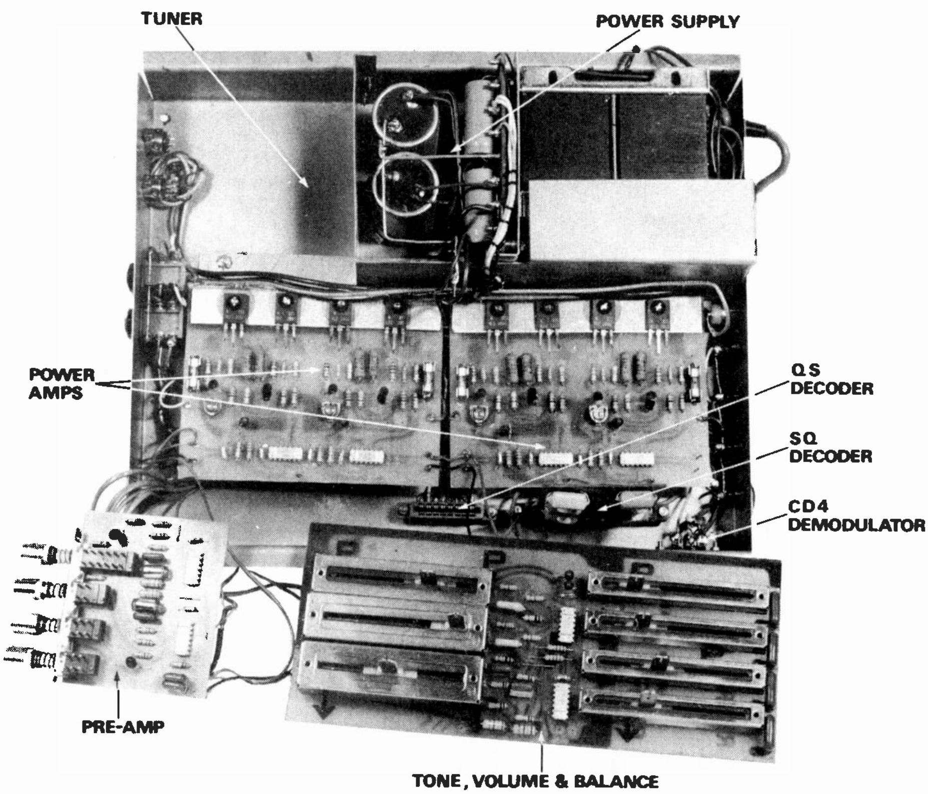
The nine pairs of screened leads protruding from the right-hand front of the wiring harness are carefully stripped and identified. Connection of these leads to the switch bank is carried out with reference to the figure.

Please note that no wiring is provided for the SYNTHESISE position on the pushbutton bank. Details of this facility will be given in a later article together with the wiring of the tape sockets.

Fuses are now inserted into the holders on the power amplifier boards and into the mains fuse holder. See components list for ratings.

AMPLIFIER CHECKING

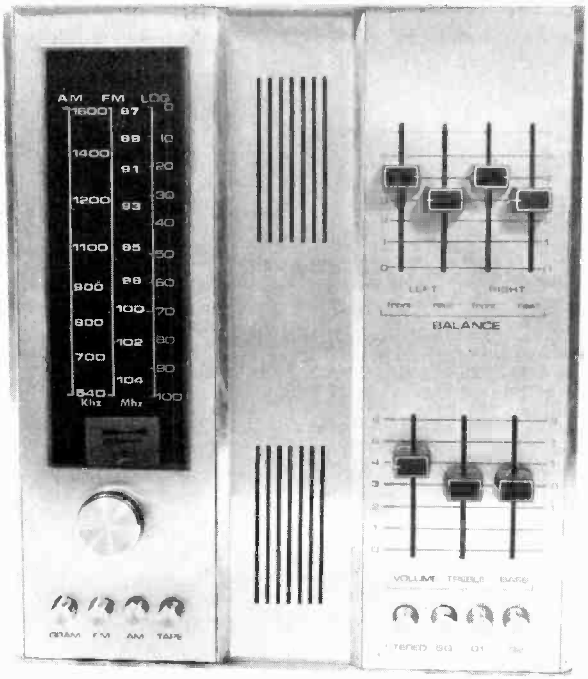
Before commencing, carefully check the accuracy and completeness of the wiring. Extra time spent here can save expensive components coming to undue harm. Ideally, a parallel check between the unit, layout drawings and theoretical circuit should be performed.



Connect the speaker outlets to dummy 8Ω loads. The dummy load may be made up from 15, 120Ω ½W carbon resistors connected in parallel. Only one load need be made as each amplifier is tested individually.

As the initial output power will be fairly low on setting up, 2W resistors are adequate. If a cheap 8Ω loudspeaker is available to monitor each channel as it is set up, so much the better. Do not, however, risk a good loudspeaker at this stage.

Turn the presets on all power amplifier channels to maximum, that is clockwise. Reduce all level and balance controls on the master board to minimum and set the tone controls mid-way.



COMPONENTS . . .

Resistors

Headphone load resistors 220Ω ½W (4 off)
Dummy load for testing 120Ω ½W (15 off)

Plugs and Sockets

Speaker sockets — 2 pin DIN (4 off)
Tape in/out sockets — 5 pin 180° DIN (2 off)
Aerial socket — Coaxial recessed
Headphone sockets — Switched stereo headphone sockets (2 off)
CD4 connector — B9G valve base
SQ edge connector — 16 way 0·15in pitch edge connector
QS Variomatrix Synthesise socket — 8 way 0·15in pitch edge connector
QS edge connector
Fuse holder — 8 way edge connector
20mm chassis type

Switches

Push button bank, 4 bank, 17·5mm spacing, with each bank
6-changeover per bank

Wiring

32ft 14/0·0076in stranded single p.v.c. (yellow 3ft, blue 3ft, red 5ft, green 5ft, white 5ft, pink 3ft, brown 6ft, black 2ft)
20ft twin screened lightweight audio wire
2ft single screened light co-ax.
8ft lacing cord
Mains lead 3-core to suit
2ft tinned copper 16 s.w.g. wire

Materials

Aluminium extrusion for facia (available from Sonax Electronics) or plain 18 gauge sheet aluminium if alternative construction method is used. Aluminium "L" or "U" form and ⅜in rod for support members for facia. Boxform surround (from Sonax) or wood to make

Miscellaneous

3-way terminal tag strip
Rubber feet (4 off)
Grommet ½in × ¼in, sleeved grommet for mains lead
½in 4BA roundhead screws (17 off)
4BA nuts, plain washers and lock washers (17 off)
⅜in 6BA roundhead bolts (16 off)
½in 6BA roundhead bolts (6 off)
⅝in 6BA roundhead bolts (3 off)
6BA nuts, plain and lock washers (25 off)

Connect a d.c. millivoltmeter across resistors R29 and R30 as shown in Fig. 4.6 on one power stage. The sum of these two resistors is approximately 1Ω. Switch on the complete system.

At this stage a variable input transformer (Variac) to adjust the mains supply slowly is very useful, but not essential.

The millivoltmeter should now read from 2 to 10mV d.c.

If the reading is more than 50mV switch off and check wiring again. If all is well, slowly rotate the preset VR8 anticlockwise until a reading of approximately 20mV is obtained. This reading corresponds to approximately 20mA quiescent current.

Disconnect the meter and repeat the procedure on all the remaining power amplifiers in turn.

The main amplifiers are now set for optimum quiescent current conditions and should not require re-setting at all.

FINAL MECHANICAL ASSEMBLY

The master volume and tone board, preamplifier board and quadraphonic selector switch are all assembled on the facia as shown in Fig. 4.1. It must be remembered that the wiring to these boards should be kept as short as possible to avoid interference and hum. However, they must be sufficiently long to allow both initial assembly and possible later dissembly.

The facia may now be attached to the trough by its pillars and 4BA screws inserted upwards from beneath the trough in the holes provided.

The surround may now be placed over the facia and dropped down to engage with the lips on the trough for either of the two fixing methods described earlier to be effected.

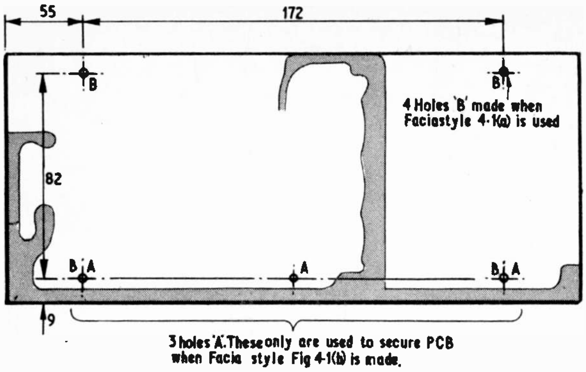


Fig. 4.5. Drilling details of the Tone/Master volume board to suit the facia of Fig. 4.4a.

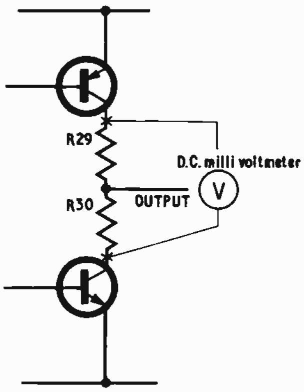


Fig. 4.6. Location of the test points for measurement of the quiescent current in the power amplifiers

Where "spring" locating method is used to retain the surround the exact fit is adjusted as required by applying a slight set to the sprung chassis sides. Be careful not to overdo the tension as this will make subsequent removal of the surround difficult.

Ideally the springing should just cause the flanges to "bite" the surround as it is lowered into position and adjustment can be made in small steps until correct setting is achieved.

To remove the surround using the same method it is simply a matter of placing the finger tips against the long sides from below and pressing lightly inwards until the lips of the flanges release from the grooves. The approach from below is important as working from above is rather difficult. Thus it is simplest to place the unit on a box or other object first so that the hands can be positioned lower than the bottom of the unit.

After releasing from the grooves a gentle upward pressure will slide the surround free for removal.

EARTHING

The use of a wiring loom reduces the problems encountered with hum and stray pickup and it is for this reason that we have described a loom here. Further steps can be taken to minimise these unwanted signals.

Firstly, ensure that both screens are electrically connected to the main chassis which must be itself

Table 4.1 WIRING OF QUAD SELECTOR SWITCH

TOP SIDE WIRING

Join A8, C8, E8, G8 = R_T input	
Join B8, D8, F8, H8 = L_T input	
Join A5, C5, E5, G5 = L_F	To Fader Inputs
Join B5, D5, F5, H5 = L_B	To Fader Inputs
Join A2, C2, E2, G2 = R_F	To Fader Inputs
Join B2, D2, F2, H2 = R_B	To Fader Inputs

UNDERSIDE WIRING

Synthesise	R_F=3A	L_F=6A	R_T=9A
	R_B=3B	L_B=6B	L_T=9B
SQ	R_F=3C	L_F=6C	R_T=9C
	R_B=3D	L_B=6D	L_T=9D
QS	R_F=3E	L_F=6E	R_T=9E
	R_B=3F	L_B=6F	L_T=9F
CD4	R_F=3G	L_F=6G	R_T=9G
	R_B=3H	L_B=6H	L_T=9H

Rows 1, 4 and 7 have no connections

connected to mains earth. Thus if there is any doubt about good conduction between the screens and chassis it is advisable to either insert a wire link or clean the adjoining faces thoroughly before assembly.

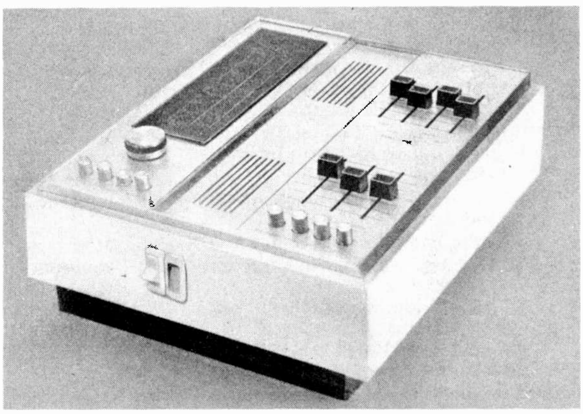
Secondly, there is a very useful technique which can be applied to the RONDO screened leads. Simply make certain that all screens are earthed at the end nearest to the signal source for that particular length of lead. With a system as complex as the RONDO this does make for complexity in deciding which end must be earthed but the results bear out the effort. The constructor may find Fig. 1.15 in the September issue of PRACTICAL ELECTRONICS useful in this context.

If hum is experienced and the circuitry in the area of the decoders is suspected it is advisable to remove the earth connections from both ends of the screened leads between the boards and the selector switch and replace each connection in turn until the hum loop is isolated. This may involve connecting from either end of a cable.

NOTE.

The output transistors in the power amplifiers should be MJE 3055K and MJE 2955K.

Next Month: Loudspeaker enclosure design and construction



RADIO STARS

In the early days of radio astronomy astronomers were constantly pointing out that there were radio sources but no known radio stars. In consequence the actual discovery on rare occasions of a radio star made headlines. Now, however, particularly over the last few months, quite a number have been added to the list. The chance discoveries have now been supplemented by those discovered as a result of a definite programme of search.

Theory suggested that an early type of star which shows emission lines and an excess of infra-red would be a candidate. It is maintained that the infra-red occurs in the surrounding dust and gas. This was the place to look for radio emission.

It is quite a neat piece of work by a team from the Algonquin Radio Observatory in Canada since a comparatively small telescope was used. The telescope operates at a wavelength of 2·8 centimetres and the dish is a mere 46 metres in diameter. Drs Feldman, Marsh and Purton have managed to secure this scoop with apparent ease.

Now, no doubt, the larger telescopes will turn their attention to the matter. Since the astronomers will now know what to look for and where to look, it is to be expected that more will be found and new data will be obtained. It could mean that a new and more successful model of infra-red stars will emerge.

ANOTHER INTERPRETATION OF THE SIBERIAN METEORITE

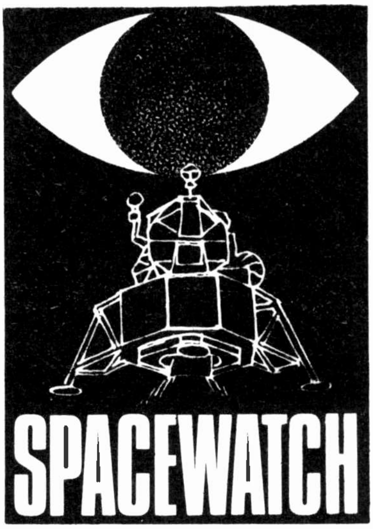
The spectacular terrestrial catastrophe that took place in Siberia in 1908, has led to much speculation. No remnants of the meteorite have ever been found so many quite bizarre explanations have been forthcoming, from a crashed space vehicle to a lump of anti-matter.

The force that produced the blast is said to have had an energy output of 0·2 to 20 megatons. The physical effect of this is observable even after many years. There is no crater as such for it is a swampy area.

Dr Stephen Hawking has suggested, in the last year or so, that if black holes do exist they would be of all sizes. Many of these could be quite tiny and may well have been formed after a "big bang" start to the universe.

Since in their travels these small units would suck into themselves matter through which they passed they may well be at the centre of stars and even galaxies. Perhaps here might be found a solution to the problem of gravitational waves.

From the University of Texas comes a suggestion by Dr A. A. Jackson and Dr M. Ryan. They put



BY FRANK W. HYDE

forward the idea that one of the small black holes moving at high speed and passing through the atmosphere would produce temperatures of the order of 10^5 degrees K.

This would cause ultraviolet radiation and a plasma column would be formed. The black hole would pass right through the Earth because of its small size but would have the mass of an asteroid. This energy would carry it onwards into space.

The plasma column would be dissipated in the surrounding area of entry. This plasma column would be of a deep blue colour. Is it perhaps significant that the many eyewitnesses described the appearance of the sighting as a "bright blue tube".

EXTRA VEHICULAR ACTIVITY

A new method of control for astronauts is under development by the RCA Company. The astronaut's voice is used to control movements.

This is a truly significant move. It means that the actual movements required can be initiated by voice commands only. There are 12 basic commands that operate the manoeuvering and propulsion system. Thus right, left, up, down, etc. can be brought to any situation. A dream come true for many applications. It is surely not far from this point to the control of vehicles in terrestrial situations.

Other activities planned for the future concern two satellites to be launched in 1975. Some of the instruments to be carried are for the determination of the immediate Earth environment. More data will be made available from the higher levels of the atmosphere particularly the thermosphere. The sort of instrumentation that is required for this work includes an electron temperature probe as well as the usual photometers and spectrometers.

The data to be gathered will be neutral particle and ion compositions, ion and the natural gas temperature, information about the air-glow and the detection of thermal electrons and photoelectrons.

The satellite will weigh about 1,300 pounds and will carry a momentum wheel for stabilisation.

SKYLAB PRELIMINARY RESULTS

So much data has been gathered on the second *Skylab* period of observation, that it will take some years to evaluate it all.

Perhaps the most consistent of the findings relate to the Sun. The better observation of the structure of the atmosphere of the Sun and in particular the great hole that has been found in the corona may unlock secrets far away from the Sun.

Recently Dr C. H. Barrow of the University of the West Indies has been trying a new correlation of micropulsations from the Sun and those observed in the radiations from Jupiter.

It could well be that the information returned from the Jupiter probe, which should be close to the planet on December 10th, will help to establish a positive result. The micropulsations have been known for some years but because of lack of data from the Sun the matter was only spasmodically reviewed.

The hypothesis involved is an important one for, though there have been a number of models evolved, all lack the sort of confirmation required to establish the facts.

COMET KOHOUTEK

Skylab will have a special mission with respect to the comet *Kohoutek*. The next mission (*Skylab 4*) is the last in the projected series and begins on November 9th.

Seven of the existing instruments will be brought to bear on the comet and the astronauts will have with them a new far-ultraviolet camera. It should be possible to photograph the neutral hydrogen cloud which is estimated to surround the comet and extend to more than six million miles.

Initially the plans are for the *Skylab* mission to be completed by January 4th. It would be a pity if this could not be extended to January 14th to allow further observation. Such a unique opportunity to study the period immediately after the perihelion passage may never come again.

The best time to view the comet for Earth-based observers is at about 12.00 to 14.00 hrs, right ascension, in the morning sky near the area of the bright star *Spica*. This will be around December 4th.

PE Sound Synthesiser 11

KEYBOARD

By G.D.SHAW

THE article this month deals with the remainder of the electronics sited within the keyboard unit and details the divider system, the analogue memory or hold circuits, modulation amplifiers, envelope shaper/v.c.a.s and mixer. The overall system has been extensively redesigned to take maximum advantage of the greater versatility of the logarithmic v.c.o.s and with the aim of improving the live performance capability of the instrument.

BLOCK SCHEMATIC

A block schematic arrangement of the keyboard unit is shown in Fig. 11.1 and the unit has been designed to accommodate a four-octave Kimber-Allen keyboard. The specified keyboard may be obtained through the Electronic Organ Constructors Society at 4 Lees Barn Road, Radcliffe-on-Trent, Nottingham NG12 2DS. The E.O.C.S are also able to supply the contact assemblies and mounting strips. The type of contact assembly required is the G.B.-2 paired contact unit, also by Kimber-Allen.

Although a four-octave keyboard is specified it should be made clear that smaller—or larger—units may be employed with no changes to the circuitry other than the adjustment to the number of divider resistors employed. With respect to the use of smaller keyboards, the E.O.C.S. have informed the author that they have a limited number of two-octave organ keyboards by Herrburger Brooks. These are full sized timber keys faced with plastic and mounted on a hardwood frame. The keys themselves are in reverse colours with black naturals and white sharps, and although they will require to be sprung by the constructor, the additional work required is reflected in the attractive pricing of £5 per keyboard.

Reverting again to Fig. 11.1 it will be seen that the keying system is divided into two channels each channel having its own electronic assemblies and signal path. Signals from both channels join together in the final circuit, a simple virtual-earth mixer. The purpose of this arrangement is to allow a rhythm accompaniment and melody line to be programmed at the same time, channel 1 programmed by the upper 31 keys and channel 2 by the remainder.

The tuning arrangement allows the transition between the two channels to be musically consecutive. Spread apart by one or more octaves or the channels juxtaposed in terms of frequency with the 31 note channel providing a bass line to a treble channel 2. Since the combined effect of the tuning controls is continuously variable there are a number of intermediate possibilities such as channel 2 dupli-

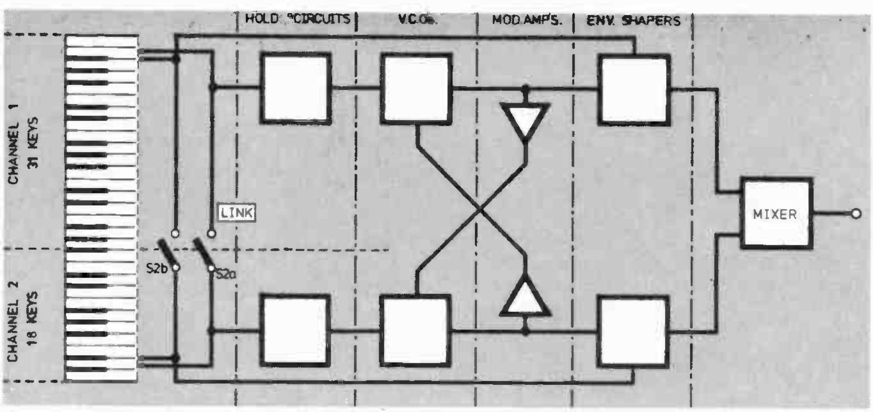


Fig. 11.1. Block schematic of keyboard unit

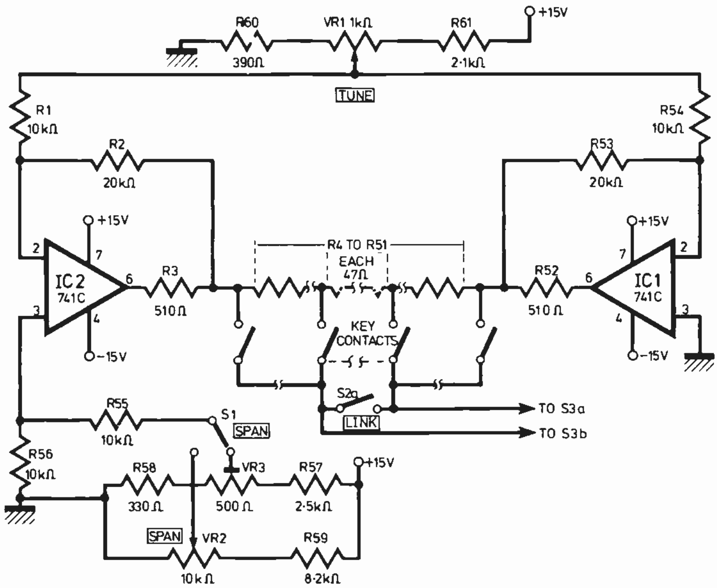


Fig. 11.2. Keyboard divider network

COMPONENTS . . .

DIVIDER

Resistors
- R1 10kΩ
- R2 20kΩ
- R3 510Ω
- R4–R51 47Ω (48 off)
- R52 510Ω
- R53 20kΩ
- R54–R56 10kΩ (3 off)
- R57 2·5kΩ
- R58 330Ω
- R59 8·2kΩ
- R60 390Ω
- R61 2·1kΩ

All 2% metal oxide

Integrated circuits
- ICI–IC2 741C (2 off)

Potentiometers
- VR1 1kΩ semi-precision wire-wound
- VR2 10kΩ midget moulded linear carbon
- VR3 500Ω cermet

Switches
- S1 s.p.c.o. miniature toggle
- S2 d.p.c.o. miniature toggle

cating sections of channel 1 or, in more bizarre terms, both channels programmed in different keys.

The programming voltage from the keyboard is led to a memory circuit which holds the last voltage entered until such time as a new voltage is programmed or until the hold circuits are grounded. The output voltage from the hold circuit is used to program its respective v.c.o. to the desired frequency which is then amplitude modulated in the envelope shaper/v.c.a. Triggering of the envelope shaper takes place each time a key is depressed in the appropriate channel and each envelope shaper is provided with separate attack and decay controls together with an additional percussive attack facility which may be switched in as desired.

Frequency modulation between oscillators may be achieved by means of the modulation amplifiers which have sufficient gain to swing the frequency of the v.c.o.s through the entire audio spectrum. Finally, a link switch is provided to enable both channels of the system to be programmed in parallel.

THE DIVIDER NETWORK

Fig. 11.2 shows the theoretical circuit of the keyboard divider network in which resistors R4–R51 inclusive form the actual divider which is "floated" between the outputs of two operational amplifiers. The output of IC1 is coupled to the high frequency end of the divider and IC2 to the low frequency end. R60, VR1 and R61 together form an adjustable divider which is coupled to the inverting inputs of both i.c.s. Thus, by means of VR1, the main tuning control, the voltage on output of the i.c.s may be swung through a range of rather more than 8 volts.

Since this latter effect will be equal at both ends of the keyboard it is necessary to apply an offset to one of the i.c.s in order that a voltage differential will exist across the divider chain. The offset is applied to the non-inverting input of IC2 through the medium of either one of two divider chains.

SPAN FACILITY

R57, VR3, R58 provide what has been termed the fixed span facility with the preset VR3 having sufficient swing to enable the V/Octave range to be adjusted between about 400mV/octave to rather more than 1V/octave. R59, VR2 provide the variable span facility which is adjustable over a range of about 8·0V. The setting of VR3 is normally adjusted so that one octave width on the keyboard spans precisely one frequency-octave. VR2 on the other hand enables the frequency spread of one keyboard-octave to be varied between a fraction of a semitone (micro-tones) to several tens of semitones (macro-tones). The actual effect, in terms of frequency range, resulting from the swing on both VR2 and VR3 will depend very much on the requirements demanded by the v.c.o. as a result of the "Law Adjust" setting.

The exact value of the divider resistors R4 to R51 is not too critical except that they should be of sufficiently low a value so that the combined loading of the v.c.o.s does not cause a measurable change in the voltage at any point on the divider. Values between 10 and 60 ohms should meet all the necessary criteria. For best results, however, it is important that, whatever the nominal value of divider resistor chosen, the individual resistors are

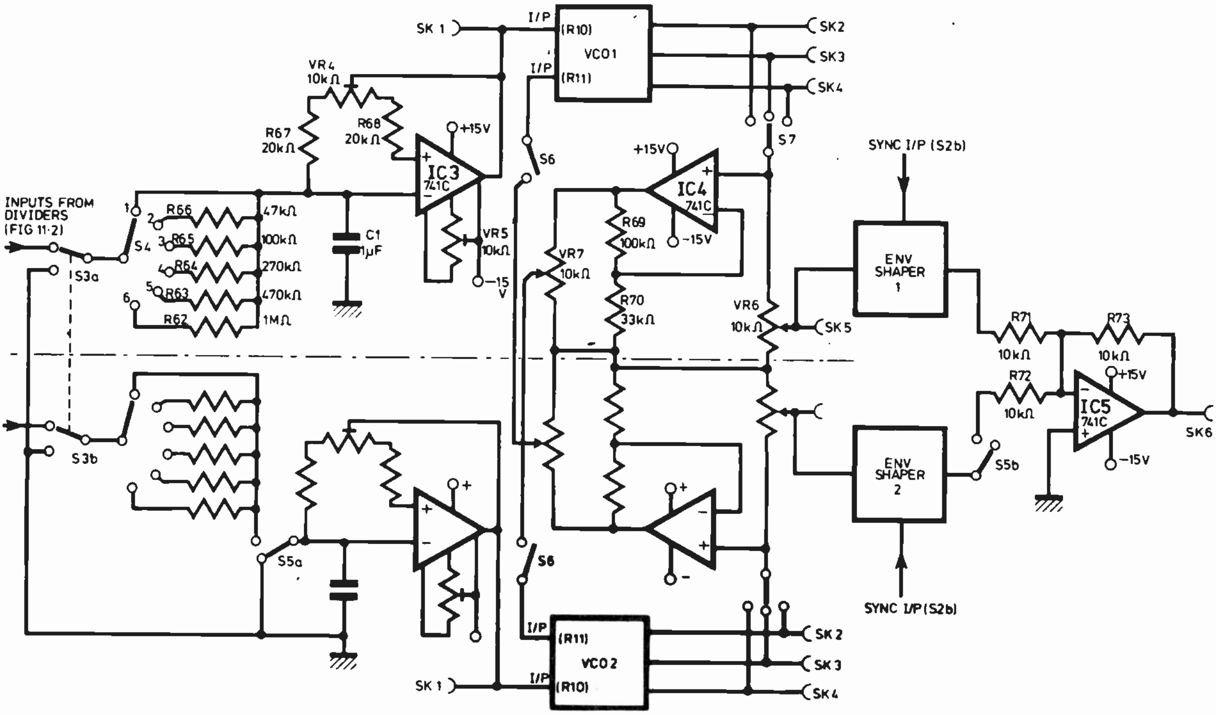


Fig. 11.3. Circuit of hold, modulation amplifier and mixer for both channels with v.c.o. interconnections. The component values for the mirrored hold and modulation amplifier circuits are identical

COMPONENTS . . .

HOLD CIRCUIT (2 off)

Resistors
R62 1MΩ 5% carbon
R63 470kΩ 5% carbon
R64 270kΩ 5% carbon
R65 100kΩ 5% carbon
R66 47kΩ 5% carbon
R67 20kΩ 2% metal oxide
R68 20kΩ 2% metal oxide

Potentiometers
VR4–VR6 10kΩ 15 turn cermet

Capacitor
C1 1μF 63V polyester

Integrated Circuits
IC3–IC4 741C

Switches
S3 2-pole 6-way
S4 d.p.c.o. toggle
S5 d.p.c.o. toggle

MODULATION AMPLIFIER (2 off)

Resistors
R69 100kΩ
R70 33kΩ

Integrated Circuit
IC4 741C

Potentiometer
VR7 10kΩ midget moulded linear carbon

Switches
S6 s.p.c.o. miniature toggle
S7 2-pole 3-way

MIXER

Resistors
R71–R73 10kΩ (3 off) 5% metal oxide

Integrated Circuit
IC5 741C

as closely matched to the nominal value as possible. It is particularly important that the ohmic value of any 12 consecutive resistors in the divider should be a close match with any other selection of 12 consecutive resistors.

The junctions between individual resistors in the divider are hard wired to the moving contact of their respective contact assemblies mounted below the keyboard, the fixed contacts being joined into two bus-bar units which can be joined by means of a link switch. A similar arrangement is employed for the second pair of contacts which serve to provide the sync pulse necessary for the envelope shapers.

ANALOGUE MEMORY

The divider voltage resulting from the depression of any particular key is routed into the analogue memory circuits via S3 and S4 as shown in Fig. 11.3. The purpose of the hold circuit is to retain the last programmed keyboard voltage for sufficient time to enable the desired tone processing to be completed. For example, with S4 in position 1, the depression of a key is sufficient to cause C1 to become charged to the value associated with that particular key. At the same time a sync-pulse is routed to the envelope shaper which, if it is set to provide a rapid attack, will turn on the v.c.a. and allow the oscillator tone to be heard. If the envelope shaper is also set to provide a long decay, the oscillator tone will immediately begin to die away.

In operation the hold circuit utilises the common-mode rejection of the 741 operational amplifier to provide a very high input impedance. Positive and negative feedback are applied by means of R67 and R68 with VR4 serving to provide a balance between the respective levels of feedback to the inverting and non-inverting inputs of the amplifier. C1 is the reservoir capacitor and is coupled directly to the non-inverting input.

The input impedance of the circuit is given by the paralleled value of R67 + part of VR4, and R68 + part of VR4 times the open loop gain of the amplifier. Thus depending on component tolerances the input impedance can be anywhere within the range 250 to 2,500 megohms and since a 1·0μF capacitor is specified the leakage time constant of the network will similarly vary between 250 and 2,500 seconds.

PORTAMENTO

When keyboard voltages are routed direct to C1 in the hold circuit the change in level of the charge on C1 is virtually instantaneous. However, if a resistance is interposed between the keyboard and C1 the rate of change of charge is inversely proportional to the value of the resistor. This provides a very convenient means of adding a portamento facility and R62–R66 are included for this purpose, being switched in as required by S4.

Portamento is the name given to the effect when the transition between two successive notes in a musical piece is accomplished in a gliding manner encompassing all the intermediate frequencies.

The nature of the hold circuit requires that the setting-up procedure be followed with great care since any output offset voltage present will inevitably cause the holding ability of the circuit to wander. With VR4 in its electrical mid position, and with the wiper grounded, a 10 megohm resistor is connected between the output and inverting input of the amplifier. With power on, VR5 is then adjusted so that the output is precisely zero when observed on the most sensitive setting of the oscilloscope. When satisfied that the initial setting up has been correctly accomplished the circuit connections may be made as generally shown in Fig. 11.3 but omitting the connections to the v.c.o. and portamento resistors. With power on again, and observing the output of IC3 on the oscilloscope, apply about −6V transiently to the junction of R67 and C1. Careful adjustment of VR4 will result in virtually negligible drift and, in the prototype, it was found that a drift of 6mV/20 minutes was quite easily attainable.

The −6V charge on C1 during the setting-up procedure is also quite an important value since it will be found that the circuit will have a much greater degree of drift if the applied voltage is significantly higher or lower than this value. For this reason S5 is provided to ground the input of the hold circuit during switch-on or when the keyboard is "idling" for any length of time thus ensuring that the v.c.o. is not over or under driven.

The output of the hold circuit is routed directly to the R10 input of the v.c.o. the three output waveforms of which are, in turn, routed to a selector switch, S7.

MODULATION AMPLIFIERS

The wiper of S7 is coupled to the v.c.o. level control VR6 and also directly to the non-inverting input of what has been termed the modulation amplifier. The output of the modulation amplifier driven by VCO1 is then routed to the R11 input of VCO2 through S6, a similar arrangement existing between VCO2 and the R11 input of VCO1.

The net result of this arrangement is that each oscillator can frequency modulate the other either separately or at the same time. Although simple in concept this system is capable of generating waveforms having very complex harmonic structures and is thus able to produce an enormously wide range of sounds and effects.

In the modulation amplifiers R69 and R70 set the gain at about 4·5 and VR7 provides a modulation depth control. S5a/b provide a means of turning VCO2 off in the sense that its input and output are isolated and its frequency controllable either by its own manual frequency control or by its associated modulation amplifier or both. The main purpose of this arrangement is to allow VCO2 to provide a vibrato modulation to VCO1.

ENVELOPE SHAPERS

From the wiper of VR6 the v.c.o. signal is routed into a v.c.a. based on the MFC6040 which is, in turn, controlled by an envelope shaper triggered by depression of any of the keys on the keyboard. The working of the circuit shown in Fig. 11.4 is as follows.

IC1–TR1 represent a current amplifier/follower with overall feedback. The output at the emitter normally is +4·5V under quiescent conditions thus

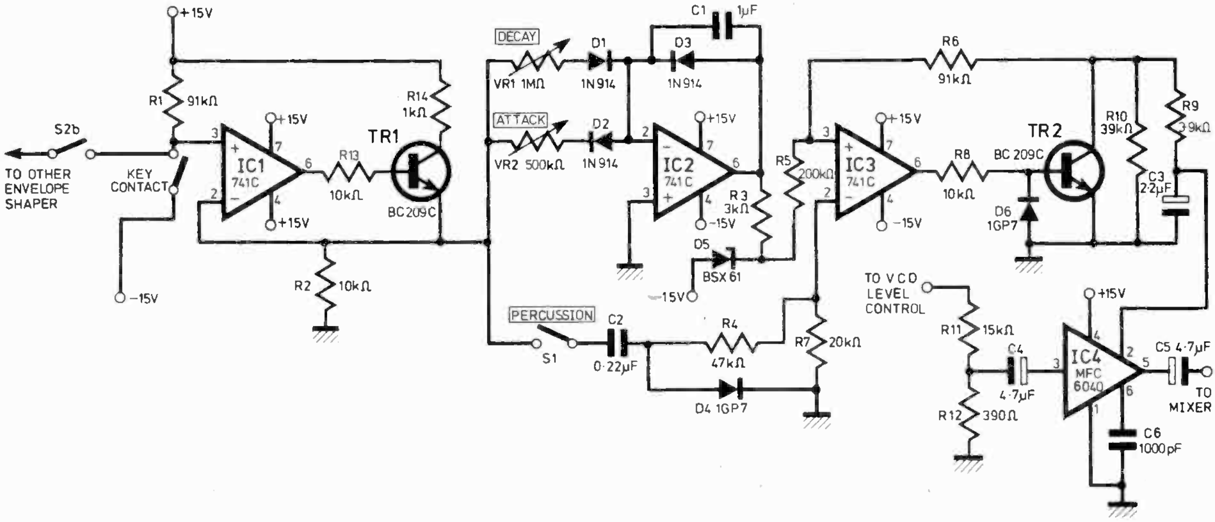


Fig. 11.4. Circuit of keyboard envelope shaper and voltage controlled amplifier

COMPONENTS . . .

ENVELOPE SHAPER (2 off)

Resistors

R1	91kΩ	R8	10kΩ
R2	10kΩ	R9	3·9kΩ
R3	3kΩ	R10	39kΩ
R4	47kΩ	R11	15kΩ
R5	200kΩ	R12	390Ω
R6	91kΩ	R13	10kΩ
R7	20kΩ	R14	1kΩ

All 5% ½W carbon

Transistors

TR1–TR2 BC209C (2 off)

Integrated Circuits

IC1–IC3 741C (3 off)
IC4 MFC6040

Diodes

D1–D3 1N914 (3 off)
D4 1GP7
D5 BZX61 V Zener
D6 1GP7

Capacitors

C1 1μF polyester
C2 0·22μF polyester
C3 2·2μF 35V tantalum
C4 4·7μF 35V tantalum
C5 4·7μF 35V tantalum
C6 1,000pF polystyrene

Miscellaneous

S5 d.p.c.o. toggle, S7–4 pole 3 way rotary (2 required), VR6–10kΩ midget moulded carbon (2 off), 2mm miniature sockets (12 off), 1–4 octave keyboard, G.B-2 pair contacts (49 off) (see text), contact locating strip.

driving IC1 hard negative, or to −12·5V as determined by the divider R3–R5. With a negative input signal to the non-inverting input of IC2 the output of this device is also negative and TR1 is turned off. With TR2 off the control input of the MFC6040 rises to +6V and thus attenuates the audio input signal by about 77dB.

The application of a negative trigger pulse to the input of IC1 causes TR1 to turn off and the output at R2 to go to −15V. C1 thus discharges via D2/VR2 and the output of IC2 rises from −12·5V to about −4V. Under these conditions the non-inverting input of IC3 becomes positively biased, its output goes positive turning on TR2 which thus effectively short circuits R10 and causes the control voltage to IC4 to fall to about +4·3V. When the trigger pulse is removed C1 charges to a level again via D1/VR1 and the original situation is positive restored.

A separate percussive attack can be obtained by differentiating the trigger pulse to the envelope shaper by means of C2. The negative differentiated trigger pulse is applied to the inverting input of IC3 with the effect previously described except that in this case the magnitude of the pulse causes the v.c.a. control voltage to fall to +3·7V corresponding to an audio signal amplification of about 12dB. The percussive attack may be used on its own by advancing the trapezoid attack control to the slowest rate and playing the keys in a staccato manner. Alternatively the percussive attack may be mixed with the normal trapezoid control waveform or it may be switched out altogether by means of S1.

The audio signal outputs of the envelope shapers are led to a simple unity gain, virtual earth mixer shown in Fig. 11.3. The level of signal from each channel is controlled directly from VR6 on each of the oscillators.

Next month: construction of the keyboard housing, wiring and tuning instructions. Details will also be given of a small p.s.u. which will enable the keyboard unit to be operated independently of the main synthesiser.

Strictly

by K. Lenton-Smith

STUDENTS of the Hammond organ can usually detect aurally which models use tone wheels and which use integrated circuits. The "Concorde", introduced over a year ago, was the first Hammond drawbar organ not to use tone wheels. Using L.S.I. techniques it is now possible to synthesise the unique sounds produced by these electro-magnetic devices.

Another novel feature of this organ is the multiple derivative divider which divides down the 12 top notes to the sub-octave frequencies giving locked tuning.

Both of these features are also found in the "Regent" cinema type organ which was released recently from the same stable. An adjunct to both instruments is the Automatic Rhythm 3 unit which is unusual in that the waltz may be selected with any other pattern for a rhythm variation (such as waltz/cha-cha!).

NOTHING NEW

There seems to be nothing radically new in the manufacture of electronic instruments at present. The various makers appear to be using integrated circuits wherever possible, having relegated the transistor to "slave" duty.

The Lowrey Venus Stereo with a.o.c. and a Genie supplying rhythm patterns

Though R/C oscillators are usually considered to be less stable than L/C oscillators, manufacturers are now using carefully designed R/C master oscillators—presumably to reduce weight and the possibility of inter-action on small printed circuit boards. The Lowrey "Genie" uses this system.

Lowrey are transistorising their automatic orchestra computer circuit, which hitherto used a diode matrix. Unless you play a Lowrey, a.o.c. will not mean much, but the sound is probably unconsciously recognised by those that enjoy light music. Harry Stoneham began to broadcast regularly some six years ago and has been featured by Sam Costa, in "Breakfast Special" and on the Pete Brady Show: more recently, he has appeared in Michael Parkinson's programme. His distinctive sound is usually produced on a Lowrey with the a.o.c. in action, though Harry also plays Hammond with equal dexterity.

A.o.c. allows the performer to play a single note melody on the upper manual (at the selected pitches) which is automatically harmonised with any chord played on the lower manual. Whilst this feature was probably designed with the beginner in mind, the experienced player can produce breathtaking runs of chords. Left hand chords must be sustained when using a.o.c. as the harmonising facility is lost when the accompaniment keys are released.

REVERBERATION

An electronic instrument played in a public hall may not need reverberation, though a crowd of people will absorb both reverberation and output power. In a small room with fitted carpets and curtains, the instrument will be dead without some reverberation. Adding echo makes the sound source seem to come from deeper within the speaker enclosure and gives a more natural effect.

Tape, delay lines or spring units may be used, the latter still being the simplest. Some commercial spring units are too small and consequently produce short delay times, often with too much "direct" signal that can only be reduced by going to work on the circuit board.

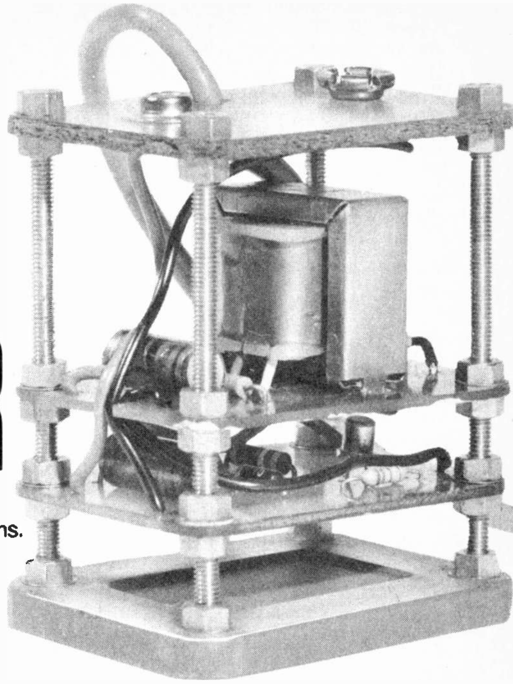
It is possible to add reverberation to an existing installation without running to the expense of a further power amplifier if some care is taken. The main amplifier loudspeaker signal is tapped off and fed to the secondary of a small output transformer. It is a good precaution to put a 100Ω resistor in series with one lead to prevent robbing, and a small 6V lamp in series with the other to act as a current limiter. The primary winding of this transformer feeds the driver coil of a magnetic unit such as the Gibbs-Hammond.

The driven coil produces only a few millivolts and requires a pre-amplifier with a gain of about 50. It is a fairly easy matter to arrange a pair of BC109 transistors, directly coupled, to recover the signal. Small capacitors should be used at both input and output of this pre-amplifier. The base of the first transistor should be biased by means of a resistor from the emitter of the second transistor.

A 50kΩ potentiometer across the pre-amp output is suggested, with a T attenuator from the slider followed by 250pF before feeding into the main amplifier at a point after the main volume/swell control. The small capacitor tends to accentuate top response. Needless to say, there is some danger of howl due to feedback and the 50kΩ variable should be kept near minimum while setting up. Ideally, the spring driver coil should be fed from a push-pull driver amplifier, but the method outlined above will probably give sufficient echo for most needs, and it has the merit of simplicity.

The Hammond Regent

9V BATTERY ELIMINATOR



BY A.M.RUDKIN B.Sc.(Eng.)Hons.

THERE are many battery operated transistor radios which are used almost entirely in the home, and with the rising cost of replacement batteries the question of a battery eliminator comes to mind. To the home constructor the thought of buying a ready-made unit goes against the grain, but it is not easy to achieve a professional finish in a home-made unit. Fortunately, the battery manufacturer provides us with an easily available case of exactly the right size. The current trend amongst manufacturers is to use a thin metal casing and a battery case of this type can be re-used quite successfully.

Most portable radios used in the home take PP9 batteries or an equivalent and this size is large enough to hold the necessary components to make the eliminator. With a component cost of about £1·50p the unit will pay for itself quite quickly and, of course, the eliminator can easily be removed whenever battery operation is required.

CIRCUIT DESCRIPTION

As can be seen from Fig. 1, the circuit of the battery eliminator is relatively simple, but despite the simplicity the unit delivers a regulated output voltage and provides protection against overloading or short circuits.

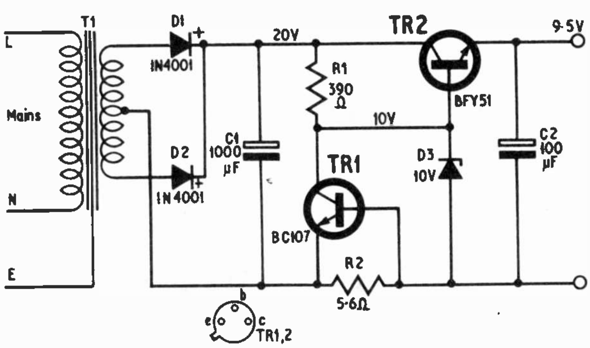


Fig. 1. Circuit diagram of the 9V Battery Eliminator

A miniature mains transformer with a centre-tapped secondary feeds a full-wave rectifier. The reservoir capacitor, C1, smooths the rectified output before it is applied to the series regulator circuit. A 10 volt Zener diode, D3, provides a fixed base voltage to transistor TR2, which in turn provides a fixed output voltage of about 9·5 volts at low impedance.

A second transistor, TR1, provides current limiting protection since its base-emitter junction is connected across a current sensing resistor, R2.

When the current flowing through the resistor exceeds 100mA the transistor begins to turn on and reduces the voltage across the Zener diode thereby reducing the output voltage so that even under short circuit conditions the current through the series regulator never exceeds a safe value.

COMPONENTS . . .

Resistors
R1 390 Ω, R2 5·6 Ω } ±10% ½W carbon

Capacitors
C1, C2 100µF 25V elect. (2 off)

Semiconductors
TR1 BC107
TR2 BFY51
D1, D2 1N4001 (2 off)
D3 10V 400mW Zener

Transformer
T1 Mains primary, 14–0–14 50mA secondary (Henry's type MT991)

Miscellaneous
Printed circuit board, 4BA studding, mains cable, nuts and washers, old PP9 battery case, interconnecting wire

The graph in Fig. 2 shows the way the output voltage varies with load current and the rapid drop in voltage as the current approaches the 120mA limit can clearly be seen.

An electronic "fuse" of this kind may seem a luxury but in fact it costs less than a fuse link and fuse holder whilst offering a high degree of protection. The simple regulator used in the battery eliminator is quite adequate for use with radio receivers and the ripple on the output is low enough not to cause any audible hum in the radio loudspeaker.

MOUNTING COMPONENTS

The electronic components are mounted on two small boards which are supported by screwed rods and it is recommended that printed circuits are used. Dimensions of the boards and the track layouts are shown full size in Fig. 3 and Fig. 5. If facilities for making printed boards are not available then as an alternative 0·1in matrix board (without copper strip) may be used with point to point wiring.

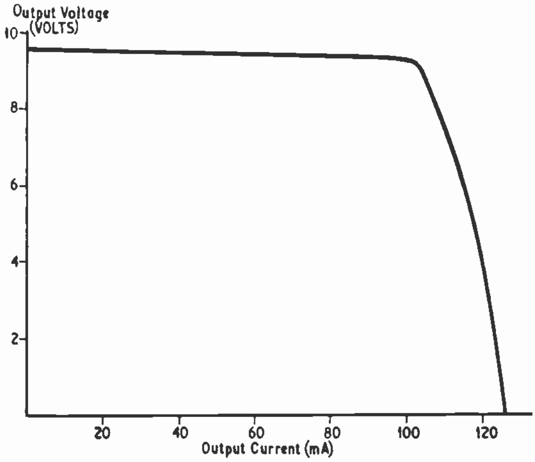
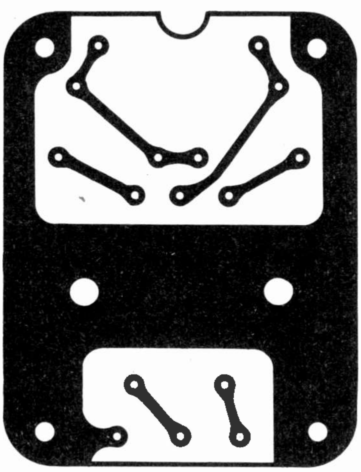


Fig. 2. Graph showing the variation of output voltage with current. The fall off at 100mA is due to the current limiting effect of TR1

BOARD 1



BOARD 2

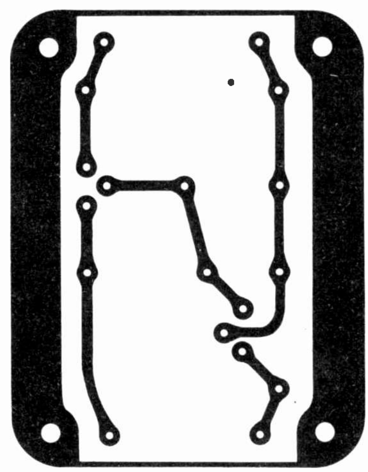
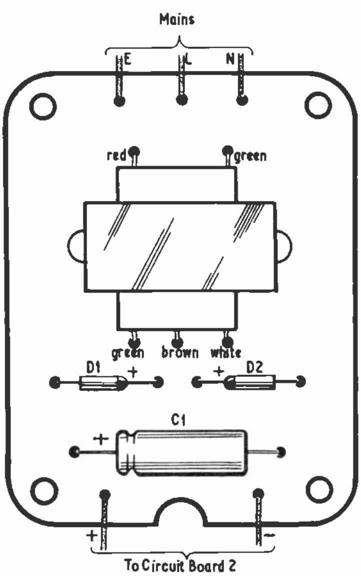


Fig. 3. The two printed circuit boards used in the Battery Eliminator. The black areas indicate copper. Both are full size



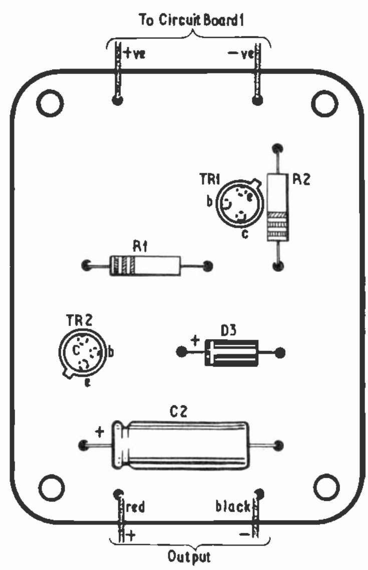


Fig. 4. Layout of the components on the two printed circuit boards and interwiring between the two

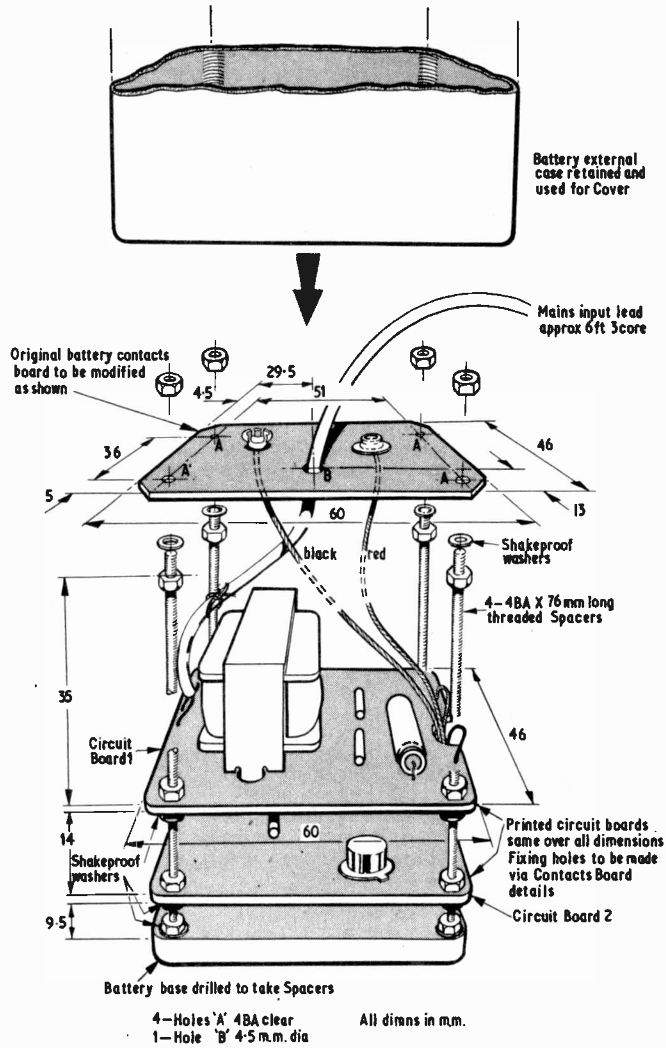


FIG. 5 EXPLODED VIEW

Before mounting the mains transformer onto the printed circuit board shorten the leads to about ¾in and strip the sleeving back to expose ¼in of the wire. Mount the transformer on the board and bend back the fixing lugs to hold it securely in place. Fit the other components and interconnect the two boards as shown in Fig. 4.

Temporarily connect a mains lead and, as a safety precaution during testing, cover the mains connections with self adhesive p.v.c. tape. Apply the mains and check that the output voltage of the regulator board is approximately 9·5 volts. A voltage very different from this value indicates a fault condition and the voltages indicated on the circuit diagram (Fig. 1) may be used to aid in fault finding.

USING AN OLD BATTERY CASE

It is quite easy to take a battery apart, but some care should be taken in order that the casing may be re-used. The battery should not be so old that the cells have started to leak or the case may be damaged.

In the battery used for the prototype the bottom plate was made of plastic and was held in place by the metal jacket which was folded over the rim of the plate. This fold was carefully straightened by bending back the metal with a small pair of pliers. After this the contents of the battery can be removed by pressing the top plate of the battery downwards.

The six cells are, of course, no longer required, but the other parts should be kept. Contact between the cells and the top plate with the "snap" connectors is by a thin piece of brass strip and a spring contact. Cut off the brass strip and remove the piece of cardboard which separated the top plate from the cells by cutting around the contacts with a knife blade.

Drill holes in the top and bottom plates in accordance with the dimensions given in Fig. 5. The hole for the mains lead is drilled in the top plate only.

ASSEMBLY

When the boards are functioning correctly they can be assembled onto the screwed rods. The distances between the boards and the plates are shown

continued on page 1097

INGENUITY UNLIMITED

A selection of readers' suggested circuits. It should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought.
This is YOUR page and any idea published will be awarded payment according to its merits.

TRACE DOUBLER FOR TTL COMPATIBLE SIGNALS

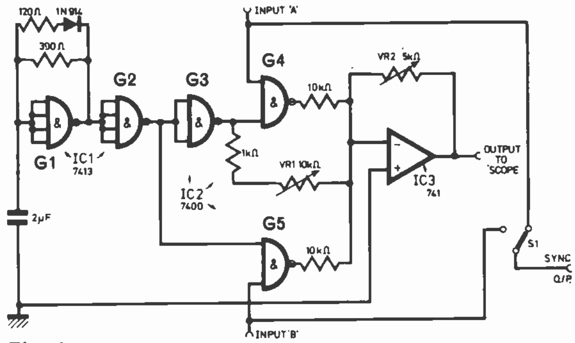


Fig. 1

THE diagram in Fig. 1 shows a circuit for a trace doubler, which displays the time relationship between two series of pulses.

Gate G1 and its associated diode plus two resistors and capacitor form a clock generator with a mark to space ratio of 1 to 1. Gate G3 provides an inverted clock waveform. One input of G4 is the signal input, "A". One input of G5 is the other signal input, "B". The other input of G4 is connected to the output of G3, the inverted clock. The other input of G5 is connected to the output of G2, the true clock.

These two clock signals are always the opposite of each other, thus gates G4 and G5 are alternately enabled or disabled. Any output from G4 or G5 is fed to the summing junction of IC3, *via* a 10kΩ potentiometer and a 1kΩ resistor. The operational amplifier combines the signals and feeds them to the oscilloscope to be displayed.

The idea behind the operation of this circuit is that any signal information from input "A" is added to a constant voltage, the inverted clock and is then displayed below the trace for input "A".

The 10kΩ potentiometer VR1 varies the separation between the traces and VR2 in the operational amplifiers feedback path controls the overall gain of the instrument.

C. Nicol, Brixton, S.W.9.

SIMPLE VARIABLE-DELAY PULSE CIRCUIT

VARIABLE delay time on a repetitive pulse is frequently required, particularly in those applications concerning transient phenomena. A simple, low cost, and easily constructed electronic circuit is described which enables continuously variable delayed times in the range 10μS to 80mS to be achieved.

The circuit, shown in Fig. 1, consists of two monostables, the first providing the controlled variable delay time and the second giving the delayed output pulse. The master pulse to be delayed is first differentiated by the R1C1 network. The negative-going spike obtained from this network is then used to turn the first monostable over. The turn-over period is given by:—

$$T = 0{\cdot}7\ VR_1 \times C_{2,\ 3,\ \text{or}\ 4}$$

The positive pulse from the collector of TR1 is fed into the second monostable *via* another differentiating network. Again the negative-going spike turns the monostable over and a rectangular pulse can be taken from the collector off TR3.

A negative output pulse could be taken from the collector of TR4, but it would be of poor shape due to capacitance C7 charging up *via* the load R8 in the collector of TR4.

By both making VR1 variable from 100Ω to 10kΩ and by selecting the C2, C3, C4 capacitors having fixed values of 0·1, 1·0 and 10μF a continuously variable delayed output pulse in the range 10μS to 80mS has been obtained.

The delayed times are measured from the negative-going edge of the master pulse. Both shorter than 10μS, and longer than 80mS can be obtained by suitable choice of the passive components VR1 and C2, C3 C4.

The minimum width of the output pulse is 2μS. This is varied using VR2 (100Ω to 10kΩ) and C7 (4000pF).

The sum of the delayed time and the pulse width must, of course, be shorter than the periodic time of the master pulse. The rise and fall times of the output pulse are respectively, 25 and 30nS.

The delay times of the present circuit have been calibrated against a standard time marker and found to be both reproducible and reliable.

Drs. R. Hackham and P. Johnston
University of Sheffield.

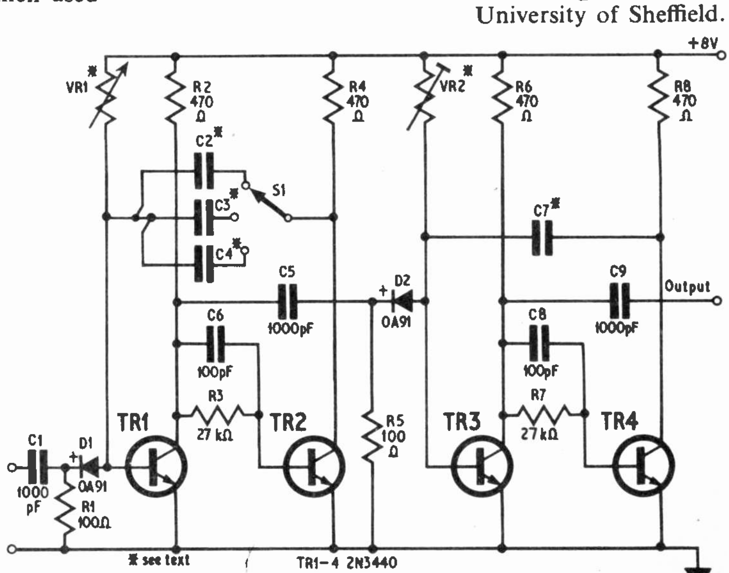
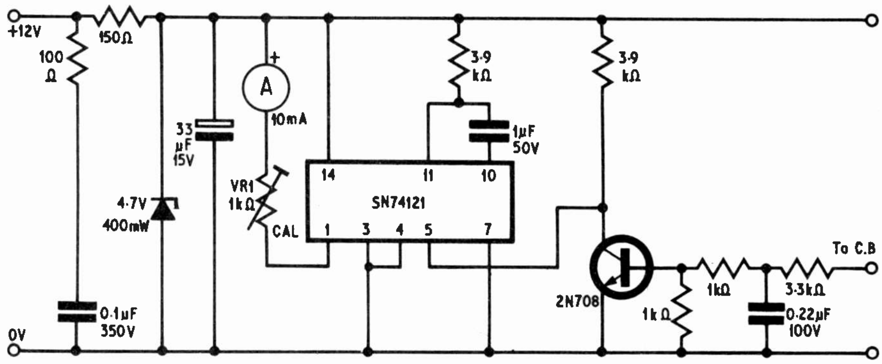


Fig. 1. Simple variable-delay pulse circuit

SIMPLE TACHOMETER



THE CIRCUIT of a tachometer shown in Fig. 1 is based on the integrated circuit SN74121. This is a monostable device available for under 50 pence.

The circuit can be adapted for a wide range of meters up to 10mA f.s.d. by simply connecting a resistor in series with the meter if required. Initially the design was made for a 12V system but providing the 150Ω series dropper is altered there should be no difficulty in adapting for other voltages.

The timing components are the 3·9kΩ resistor and 1µF capacitor connected to pins 10 and 11, and the capacitor should preferably be a reasonable quality non-electrolytic tpye.

Meter movement at very low frequencies may be countered by connecting a capacitor across the meter but a good movement should not need this.

Calibration is *via* VR1 preferably against a pulse generator of reasonable accuracy. Calibration frequencies are given in Table 1.

TABLE 1:
Calibration Frequency corresponding to 1,000 r.p.m.

No. of Cylinders	2-stroke	4-stroke
	frequency	
1	16.7Hz	8.4Hz
2	33.4Hz	16.7Hz
3	50Hz	—
4	—	33.4Hz
6	—	50Hz
8	—	67Hz

C. J. Nother,
Portsmouth, Hants.

SCREENWASHER TIMING UNIT

THE device to be described operates the electric screenwashers of a car for a period of up to 10 seconds after a single press of the switch so that one hand does not have to leave the steering wheel for more than a second or so.

Only two main components are used, a relay and a capacitor, and from Fig. 1 it can be seen that when the washer control button is pressed, C1 is immediately charged up to the full 12V battery voltage and discharges over a period of 10 to 15 seconds through the coil of RLA so closing the contacts RLA1 and operating the washer pump motor.

As C1 discharges through the relay, the current eventually falls to below the hold-in value for the relay, contacts RLA1 separate and the pump stops.

VR1 is used to set the operating time of the pump motor. By filing the copper rivet on the armature flat with the face, the hold-in time can be slightly increased and also has the advantage that the relay drops out suddenly so preventing arcing of the contacts which might occur if they separated more slowly.

The relay used is a PO 3000 type with a 1,000Ω coil with all the contacts removed except for one pair of "make" contacts to increase sensitivity, though if a second pair was fitted combined wash and wipe with "one shot" operation could be achieved.

The can of C1 should be completely insulated before mounting, using p.v.c. tape or tube and the complete unit should be mounted in a closed steel case in a dry spot away from exhaust pipes. The prototype has functioned perfectly over 1,000 miles with no maintenance being required.

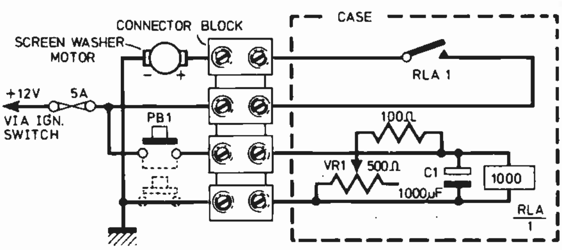


Fig. 1. Arrangement of the screenwasher unit

The circuit shown is for 12V negative earth systems. For positive earth the connections to C1 and the washer pump motor merely need to be reversed.

The dotted lines in Fig. 1 show a slight modification which is necessary where the existing switch operates the original washer circuit by shorting one side of the motor to earth, the other side being permanently live, as is often found in the horn circuit.

In both cases, connection to the supply should be *via* a 5A fuse to a "live when on" part of the ignition switch or terminal A4 on the fuse box.

A. Calder,
Leigh, Lancs.

MAINS NEON FLASHER

This is a circuit which I have developed to remind you to un-plug mains appliances as well as switch them off. The neon glows when the appliance is switched on and flashes when it is switched off until it is unplugged.

With S1 (on/off switch of the appliance) closed (see Fig. 1) the neon lights, R2 dropping the mains voltage to the firing voltage of the neon. With S1 open C1 charges *via* R1 until it reaches the firing voltage of the neon and then discharges through it, thus making it flash until S1 is closed or the appliance is unplugged.

With such devices fitted to all appliances, a quick look round the room last thing at night will tell you that they are all off and unplugged.

M. J. Maynard,
Wednesbury, Staffs.

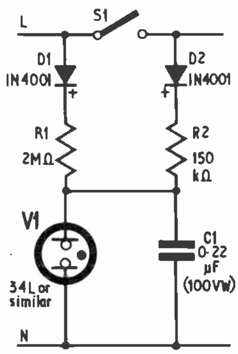


Fig. 1. Circuit diagram for the mains neon flasher

VIEWPOINT

Sir—Am I alone in thinking that quadraphony (and indeed stereo) is a "con"—or at least an attempt by the industry to create a demand?

I remember several years ago an article in this or a similar magazine, reporting a Continental idea whereby the orchestra performed in the wide end of a large exponential horn—the audience obtaining the effect of hearing a live orchestra through a metre-square hole!

Now this seems infinitely more sensible to me than quadraphony.

Surely the fact that an orchestra, or a pop-group, is ten metres wide is irrevelant. If width is necessary *per se*, why not spread the musicians out more? In fact musicians have always stood as close together as possible. Why?

A group of musicians constitutes a certain size purely because human beings are the size they are, and similarly with instruments.

"Stereo" and "quad" are NOT analogous to stereo pictures. Surely it follows that the industry should be putting the effort into improved colour, stereo pictures instead of the absurdities of "quad"! The present colour T.V. picture is on a par with a washed-out, amateur transparency viewed through a 50p lantern.

E. Wadsworth,
Huddersfield, Yorks.

9V BATTERY ELIMINATOR

continued from page 1092

in Fig. 5, although the dimension between the connector plate and the mains transformer board may need to be varied slightly to ensure a snug fit inside the battery casing.

Before fitting the connector plate pass the output leads of the regulator board through the slot in the mains transformer board and solder them to the contacts. The plain contact is positive and the castellated contact is negative (on some modern batteries the castellated contact has been replaced by a split contact).

Pass the mains lead through the hole in the connector plate and fit the plate onto the rods. Using p.v.c. lacing cord or thin p.v.c. sleeving, tie the mains lead tightly to one of the screwed rods to prevent the soldered joints being stressed.

The length of the screwed rod is 3in where the battery has a plastic bottom plate, but a slightly longer rod will be needed if a different bottom plate is fitted. The rod is normally supplied in 3ft lengths and can be sawn very easily with a "junior" hacksaw.

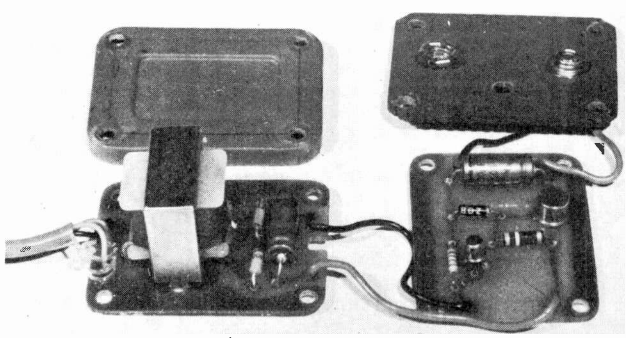
One "trick of the trade" when sawing threaded rod is to thread a nut onto the length to be sawn. After cutting and deburring with a file the nut can be removed and this will automatically re-form the thread on the cut end. This simple procedure saves a good deal of time and temper.

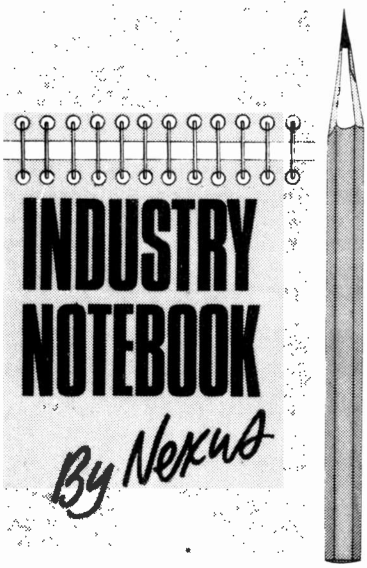
FINISHING OFF

When the power supply assembly fits the battery case satisfactorily the ends of the brass rod may be filed down level with the tops of the nuts. Finally fit the unit into the case ensuring that "+" marking on the case is closest to the plain contact and carefully re-fold the casing over the bottom plate.

The battery eliminator can then be fitted into the portable radio in place of the normal battery although a slot will need to be made in the radio casing to allow for the mains lead. On the few occasions that the radio is required as a true portable the mains unit can be removed and a battery inserted in exactly the same time as it would take to replace a flat battery. ★

Photograph showing the two component boards and the end plates of the battery before mounting on brass studding





LIGHT FINGERS

Shop-lifting by well-heeled women in London's West End has been making the headlines. Not so well publicised is the wave of petty and not-so-petty pilfering in the electronic components industry since the upsurge in world demand created a component famine.

As usual, the incidence of crime appears greatest in the United States. Few of the semiconductor manufacturers are immune and hardest hit, according to reports, is Signetics with over £40,000 of goods mysteriously disappearing. Fairchild has also been hit.

It's not only straight pilfering that's worrying the industry. Huge quantities of below - standard products have been hived off onto the market at give-away prices in recent years and many of these are now re-appearing freshly re-marked and not necessarily with the original manufacturer's name. These are being bought in good faith and equipment manufacturers have found performance not up to scratch. Motorola has been one company receiving back for replacement falsely marked semiconductors. Over in the States, the police have been sleuthing away and some arrests have been made.

The racketeers have not confined activities to the USA. The very nature of semiconductor devices with their small size, light weight and high intrinsic value makes them a natural for shipping round the world and Bill Richardson, Chairman of Britain's Association of Franchised Distributors of Electronic Components (AFDEC) has warned the industry against dishonest brokers.

Members of AFDEC are bound by constitution to guarantee all products they sell and this is the best protection. Richardson quotes a case where a UK manufacturer disposed of a bulk quantity of sub-standard products 12 years ago which have recently re-appeared on the UK market through sources which can be traced back through Tel Aviv and Geneva. Buyers beware!

DEFENCE BOOM

The Royal Navy Equipment Exhibition at Greenwich showed defence equipment manufacturers in good shape, technically and economically. Defence exports have been booming and climbing in value every year. In 1968-69 exports were £150 million, in 1972-73 they had climbed to £345 million and this year will top £400 million, about 40 per cent of all defence equipment manufactured in the UK.

The sales success of recent years owes much to the pioneer work of Sir Raymond Brown who resigned his Chairmanship and business interests in Racal Electronics to become the first Head of Defence Sales in 1966. Present Head of Defence Sales is Sir Lester Suffield.

The sales organisation does market research, organises exhibitions, assists industry with advice and generally smooths the path between initial enquiry and final sale. Even Royal Fleet Auxiliary vessels are pressed into use as floating exhibition centres. For the past three months RFA *Tarbatness* has been touring the Middle East and Far East on just such a mission.

FIFTY YEARS ON

This has been a great year for Golden Jubilees marking the 50th anniversary of broadcasting and of many of the pioneering companies that sprang into existence to serve the needs of what was to become an industry in its own right. Of all the celebrations one of the cosiest, if not the biggest, was the informal party given by Eddystone Radio.

Although the company is now part of the giant GEC-Marconi complex, Eddystone's managing director Dick Carroll has managed to preserve the family atmosphere—perhaps not too difficult with so many of the staff having been around for more years than they care to remember.

Enough of the past. How is Eddystone shaping up to the future? Today's sets are all solid-state, modular, up-to-the-minute and selling well. Eddystone profits are buried deep in the corporate accounts of the parent group but I can reveal that they are healthy in every way. Watch out for new models and an expanded component line in 1974.

COMPUTERISED METROLOGY

Herbert Controls and Instruments Ltd. was formed in 1969 from three companies in the Alfred Herbert Group and started life with a 50-year background in measurement techniques stretching back to Sigma gas gauges, modern versions of which are still sold to the gas industry. But more recently HCIL moved into the field of mechanical inspection equipment and rapidly established a world reputation for solving difficult problems.

One of HCIL's most remarkable machines is the Sigmatrace designed specifically for inspection of the aerofoil profile of gas and steam turbine compressor blades. This was traditionally a skilled job which took a lot of time and involved lengthy written records which were passed to a blade polisher to iron out humps and hollows and get each blade right. The inspector would compare the workpiece under inspection with a perfect master.

Sigmatrace does the whole job in a minute, complete with a printed record of deviation. Moreover, no master blade is required because all the master profile information is fed into a computer store direct from the drawings. HCIL is 'doing a roaring trade world wide with this sort of electronic-based metrology and supplies most major automotive and aerospace manufacturers.

The chief engineer of HCIL, Dr. Colin Gaskell, sees computer-controlled gauging becoming really significant in engineering shops where more than 30 measurements are needed on a workpiece. When you get up to 80 measurements a computer is practically a necessity.

DUCKS AND GROUSE

Mallard is dead—long live Ptarmigan. They are the code names for the army's trunk communications systems. Mallard died after endless discussion. Now Plessey has been appointed prime contractor for the new system, Ptarmigan, with Marconi and STC as sub-contractors. Initial contracts are worth £17 million but the project could lead to £100 million of business over the years.

I marvel at the wit of those who invent code-names. Mallard always seemed a dead duck. And if Ptarmigan doesn't come up to scratch, we'll have something to grouse about.

RECORD PLAYBACK HEADS (TRUVOX)

Individual prices of these are:—
2 track record playback heads **50p** each.
4 track record playback heads **72p** each.
Erase heads are also available separately—2 track **33p**—4 track **55p**.
MV metal mounting shields **39p** each.
2 track-heads already fixed on heavy mounting plate with shield **£1·22**.

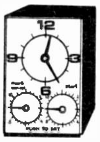
DRILL CONTROLLER

NEW IKW MODEL

Electronically changes speed from approximately 10 revs. to maximum. Full power at all speeds by finger-tip control. Kit includes all parts, case, everything and full instructions. **£1·95.** 13p post and p. Made up model also available. **£2·95.**

MIGHTY MIDGET

Probably the finest possible radio, as described in *Practical Wireless*, January 73. All electronic parts **£2·20** post paid.



TIME SWITCH

Smith's mains driven clock with 15 amp switch, also notes showing how you can wake up with music playing, kettle boiling or come home to a warm house, warn off burglars, keep pets warm, halve your heating bills, etc. **£1·95.**

I CHIP RADIO

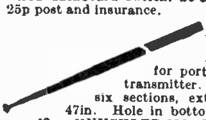
Ferranti's latest device ZN414 gives results better than superhet. Supplied complete with technical notes and circuits. **£1·38** each. 10 for **£11·11.**

HI-Q TUNER COMPONENTS

For experimenting with the ZN414.
KIT NO. 1. Plessey Miniature Tuning Condenser with built-in LW switch and 3in Ferrite slab and litz wound MW coil, **72p.**
KIT NO. 2. Air spaced tuning condenser 6in ferrite rod litz wound MW and LW coils, **94p.**
KIT NO. 3. Air spaced TC with slow motion drive 8in ferrite rod, with litz wound LW and MW coils, **£1·10.**
KIT No. 4. Permeability tuner with fast and slow motion drive and LW loading coils, **50p.**

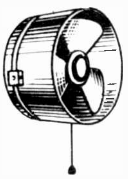
AUTO—ELECTRIC CAR AERIAL

with dashboard control switch—fully extendable to 40in or fully retractable. Suitable for 12V positive or negative earth. Supplied complete when fitting instructions and ready wired dashboard switch. **£6·35** plus 25p post and insurance.



TELESCOPIC AERIAL

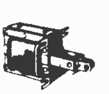
for portable, car radio or transmitter. Chrome plated—six sections, extends from 7¼ to 47in. Hole in bottom for 6BA screw. **42p.** KNUCKLED MODEL FOR F.M. **55p.**



EXTRACTOR FAN

Cleans the air at the rate of 10,000 cubic ft. per hour. Suitable for kitchens, bathrooms, factories, changing rooms, etc. it's so quiet it can hardly be heard. Compact, 5¼in casing with 5½in fan blades. Kit comprises motor, fan blades, sheet steel casing, pull switch, mains connector, and fixing brackets. **£2·75** + 20p P. & P.

MAINS OPERATED SOLENOIDS



Model 772 — small but powerful 1in pull—approx. size 1¼ × 1¼ × 1¼in **68p.**
Model 4001/—½in. pull. Size 2¼ × 2 × 1¼in. **83p.**
Model TT1—1¼in pull. Size 3 × 2½ × 2in **£1·98**
plus 20p post and insurance.

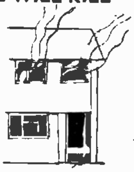
MAINS TRANSISTOR POWER PACK

Designed to operate transistor sets and amplifiers. Adjustable output 6v., 9v., 12 volts for up to 500mA (class B working). Takes the place of any of the following batteries: PP1, PP3, PP4, PP6, PP7, PP9, and others. Kit comprises: mains transformer rectifier, smoothing and load resistor condensers and instructions. Real snip at only **£1·10.** Plus 20p postage.

DESK TELEPHONES

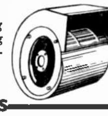
Ex G.P.O. Black standard model with dialing dial but no internal bell. Supplied with connection diagram **£1** each. Ditto, with bell but without dialing dial **£1·25.** Model as illustrated with bell and dial **£1·50** each plus 50p post for single then 65p per pair.

SMOKE WILL KILL—GAS WILL KILL—FIRE WILL KILL



But, if you install SAGA (our smoke and gas alarm) your family will have the latest electronic protection, against these killers. Saga uses a fantastic electronic sensor which " smells " smoke and gas and sounds the alarm immediately, in a neat case measuring approx. 5in × 3¼in × 2¼in, it has its own internal alarm, also a connector for additional bells. You just plug it in to the mains and hang it near the ceiling. Saga uses so little electricity that it will hardly move the meter, leave it on always to give night and day protection. One year's guarantee, also 7-day cash return offer, (or kit of parts **£5·99.** Battery model kit only **£4·99**), **£6·99** plus 30p post and service.

CENTRIFUGAL FAN



Mains operated, turbo blower type. Pressed steel housing contains motor and impeller. Motor is 1/10th h.p. giving considerable air flows but virtually no noise. Approx. dimensions 10½in wide × 12in dia. outlet into trunking 10½ × 4¼in. **£6·55** plus £1 post and insurance.

STANDARD WAFER SWITCHES

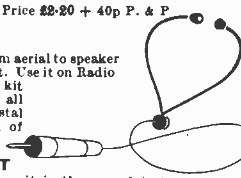
Standard size 1¼in wafer—silver-plated 5 amp contact, standard ¼in spindle 2in long—with locking washer and nut.

No. of Poles	2way	3way	4way	5way	6way	8way	9way	10way	12way
1 pole	44p	44p	44p	44p	44p	44p	44p	44p	44p
2 poles	44p	44p	44p	44p	44p	44p	44p	77p	77p
3 poles	44p	44p	44p	44p	77p	77p	77p	£1·04	£1·04
4 poles	44p	44p	44p	77p	77p	77p	77p	£1·32	£1·32
5 poles	44p	44p	77p	77p	£1·04	£1·04	£1·04	£1·60	£1·60
6 poles	44p	77p	77p	77p	£1·04	£1·04	£1·04	£1·87	£1·87
7 poles	77p	77p	77p	£1·04	£1·32	£1·32	£1·32	£2·15	£2·15
8 poles	77p	77p	77p	£1·04	£1·32	£1·32	£1·32	£2·42	£2·42
9 poles	77p	77p	£1·04	£1·04	£1·60	£1·60	£1·60	£2·70	£2·70
10 poles	77p	77p	£1·04	£1·32	£1·60	£1·60	£1·60	£3·00	£3·00
11 poles	77p	£1·04	£1·04	£1·32	£1·87	£1·87	£1·87	£3·25	£3·25
12 poles	77p	£1·04	£1·04	£1·32	£1·87	£1·87	£1·87	£3·52	£3·52

THE TWENTYLITE

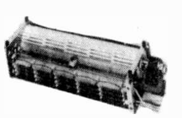
Fluorescent lighting units with polyester choke and finished white enamel. 2ft. model, ideal kitchen, bedroom, hallway, porch, lift, etc., with tube. Assembled ready to install. Price **£2·20** + 40p P. & P.

RADIO STETHOSCOPE



Easiest way to fault find—traces signal from aerial to speaker—when signal stops you've found the fault. Use it on Radio TV, amplifier, anything—complete kit comprises two special transistors and all parts including probe tube and crystal earpiece. **£2·20**—twin stethoset instead of earpiece **83p** extra—post and ins. 20p.

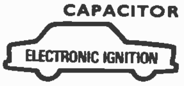
TANGENTIAL HEATER UNIT



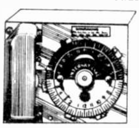
This heater unit is the very latest type, most efficient, and quiet running. Is as fitted in Hoover and blower heaters costing £15 and more. We have a few only. Comprises motor, impeller, 2kW element and 1kW element allowing switching 1, 2 and 3kW and with thermal safety cut-out. Can be fitted into any metal line case or cabinet. Only needs control switch. **£3·85.** 2kW Model as above except 2kW **£2·75.** Don't miss this. Control Switch **44p.** P. & P. 40p.

Room Thermostat made by the famous Smith's Company. 15 amp at 250V Elegant white and beige case, size 4½in long by 1¾in square approx. Adjustment is by slider (lockable), adjusts through range 30°–90°F. Special Snip price **£1·65.**

CAPACITOR DISCHARGE CAR IGNITION



This system which has proved to be amazingly efficient and reliable was first described in the *Wireless World* about a year ago. We can supply kit of parts for an improved and even more efficient version (*Practical Wireless*, June). Price **£6·55** plus 20p post. When ordering please state whether for positive or negative systems. De-luxe model including printed circuit board, etc. **£7·95.**



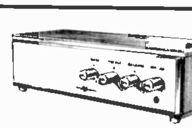
24-HOUR TIME SWITCH

Made by Smiths, these are A.C. mains operated, NOT CLOCKWORK. Ideal for mounting on rack or shelf or can be built into box with 13A socket. Two completely adjustable time periods per 24 hours, 5A changeover contacts will switch circuit on or off during these periods. **£2·75** post and ins. 25p. Additional time contacts **55p** pair.

PHOTO ELECTRIC KIT

Contains photo cell, relay, transistor and all parts to make light operated switch. **£1·75** plus 20p post and ins.

MULLARD UNILEX STEREO AMPLIFIER



We demonstrate these daily and almost always a sale results; it really is a cracking amplifier. Only Mullard with their know-how could have made it possible at this low price. SPEC.: Mains operated. 4 watts music or speech per channel. Double wired power supply eliminates cross talk. Harmonic distortion less than 2%. Frequency response 50Hz-15kHz. Input suitable for pick up tuner or microphone. 6-month guarantee. Only **£11·30** post paid. Optional extras—Cabinet **£2·20.** Extra front plate **£1.** Pair of 15 ohm speakers **£3·30.**

NEW ITEMS THIS MONTH

White Rocker Switches. Four types available, all snap in fixing through oblong hole approx 1in × ⅝in, all rated at 10A a.c. All have white rocker except S3, which is amber. Our ref RS S1, push to make, spring return, **14p.** Our ref RS S2, push to break, spring return to on, **14p.** Our ref RS S3, change over contacts, luminous rocker, **28p.** Our ref RS S4, changeover contacts, normal rocker, **16p.**
Rocker Switches. 15A Pritmac panel mounting, hole size 1¼in × ⅜in. Our ref RS S5 price **11p** each. 5A made by Mem, their type ref 1600, our ref RS S6, price **11p** each.
Miniature Hand Microphone. Dynamic, for tape recorders but equally suitable for amplifiers, good quality with lead and plug, price **£1·37.**
Open Coil Relays. All with 10A change over contacts, all brand new. Our ref REL S1, 12 volt d.c. coil, double pole, **44p.** Our ref REL S2, 110 volt a.c. coil, treble pole, **44p.** Our ref REL S3, 240 volt a.c. coil, treble pole, **55p.**
Photo Transistor Bargain. First class maker but slightly reject, covered, however, by our normal six month guarantee, these respond to light or infra red. Will work a burglar alarm system, make detector counter, etc. Price **22p** complete with three circuits.
Mains Flex. Padded, circularcotton covered, overall. Six A (23–36) 100 yard coils. Price **£2·75** plus 50p post.
Mains Contactor. This serves the same purpose as a treble pole relay but owing to the more robust construction and more positive action it is much more reliable and very suitable for heavy duty mains circuits, for example, where a thermostat has to control a large number of heaters. The contactor has four switches each in its own compartment separate from the others and each able to make and break 10A with complete safety. German made, these measure approx. 2¼in × 2in × 2in, price **£2·20.**

GOOD COMPANION I.C. VERSION

We can now offer these again in I.C. version using Ferranti ZN414 and Mullard AF Module 1172. Cabinet size approx. 11in wide × 8in high × 3in deep. Complete assembly instruction—Excellent tone wood cabinet **£5·75** plus 25p post and insurance.

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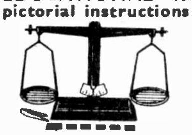
EDUCATIONAL KITS — all with pictorial instructions



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Transistors & Constructors

By D. Bollen

The start of a great revolution in home construction is recalled by a well-known contributor in this article, which brings to a conclusion our special series commemorating the invention of the transistor

IN THE TYPICAL home electronics workshop of twenty-five years ago the enthusiast would be surrounded by machines for bending, punching, drilling, and rending asunder sheet metal. Constructional techniques were based upon the chassis, a box-like structure full of holes into which were inserted spindles, screws, valveholders, grommets, and trapped fingers.

Sometimes, when the burden of bashing metal became tiresome, a piece of easily punctured Bakelite might be pressed into service as a breadboard, but this was considered very unprofessional, a throwback to the days of coil winding, capacitor building, and generally doing it yourself.

Components came from two main sources; sturdy ex-government equipment which was cannibalised, sometimes with the aid of a hammer and cold chisel, and the "junk box" where reposed an amorphous heap of very second-hand items, ranging from a leaking electrolytic capacitor dated 1941 to a speaker grille woven to depict a scene of nymphs and satyrs dancing in a woodland setting. These were the lean years just after the war, with no oriental imports, kits of parts or regular sources of "bits".

Into this man's world of hot cathodes and 100 watt soldering irons was born the sub-midget transistor, and the wonder is that it managed to survive at all, let alone replace valves, which everyone said it would never do.

A TOUGH TIME

Transistor manufacturers were having a tough time trying to fabricate the new device, probably because they were ham-fisted too. In any event, if you were fortunate enough to get hold of a sample in the early fifties it was likely to be one that everybody else had rejected, with a leakage current of two or three milliamps, a current gain of five, and dying from slow contamination.

Compared with a valve this was a pathetic thing indeed!

Assume that you were the proud possessor of a device no bigger than a resistor with three wires sticking out of it. Where did you go from there? Published information was scanty and far from standardised. Maximum ratings were mere hearsay. At the devaluation equivalent of £2 to £4 each, the safest policy was to power the device at the lowest voltage and current at which it was capable of supplying useful work.

As far as circuits went, which was not very far, there was a limited choice between the upside down, thread-in-a-maze American sort, or the UK variety which favoured the powering of each transistor in a multi-stage circuit by its own personal 1·5V cell.

Apart from earth symbols and batteries floating all over the page, there was also a general tendency for transistor symbols to be shown doing a base-down nose dive into the earth rail, this being the only way they could be made to function above 10kHz.

GREAT DIFFICULTIES

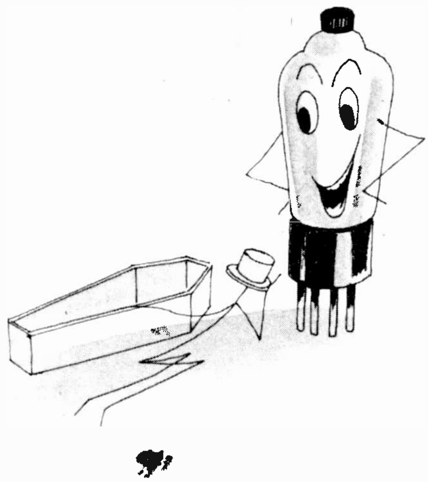
So, in the face of great difficulties you managed first of all to identify the leads on your transistor with an ohmmeter and then to find, or rashly devise a transistor circuit.

Were you supposed to solder the thing to a tag-strip, and mount the resulting assembly on the customary two acres of sheet aluminium? After all, we were here dealing with impedances of a very low order, for which electrolytic capacitors the size of milk bottles would have to be accommodated for coupling and decoupling purposes.

DELICATELY SOLDERED

The delicately soldered transistor clings to its tag-strip. The scope (ex-government of course) displays a straight line on its axis. Several meters are linked to those parts of the circuit where a voltage or current might conceivably occur.

After inserting the power supply plug into the lowest voltage tap of a grid-bias battery . . . yes, we have oscillation!



True, it is but a crude imitation of what would normally pass as a sine wave from a valve circuit, but it is early days yet. A few more volts perhaps? Why is that meter reading creeping higher and higher? Should the transistor run hot? It has stopped oscillating.

"Grrr! They will never replace valves."

AVAILABLE TO AMERICAN

The transistor was available to American enthusiasts for about $18 in 1953. Over here, the ubiquitous OC71 and "red spot" transistors (the latter a polite name for manufacturer's reject) came on the scene in 1956 priced at 24/- and 10/- respectively. Full praise must be given to those suppliers who struggled to bring us the amplifying crystal less than eight years after its invention.

The silicon transistor also took only eight years to reach the home after being first manufactured in 1952.

More than one enterprising magazine contributor of the period went one better and gave full instructions for making a point-contact transistor from an old crystal diode, but the problem here was that an excess of audio signal or marital strife in the home could dislodge the triple catswhisker and thus degraded performance.

Another bright spark discovered that when the paint was scraped off the glass encapsulated OC71 it responded to light in the manner of a phototransistor. The manufacturers quickly countered this cunning move by filling their transistors with opaque blue putty, labelling the clear putty variety OCP71 and charging more for it.

NEST OF SNAKES

An innovation of the middle fifties was the transistor radio, which incorporated the new "nest of snakes" unrepairable printed circuit and the fragile ferrite rod aerial. Also at this point in time, the word "transistor" was press-ganged into common English usage to signify a radio receiver which could be employed to annoy people on beaches, and also render the user deaf in one ear by means of a simple unhygienic earphone.

The printed circuit defied all former rules of construction.

Components were held in position by solder alone, a practice which previously would have been considered very naughty. With the passing of the chassis, there was no longer anywhere to mount controls, and this caused quite a few headaches in constructional circles.

Eventually, it was tacitly agreed that serious projects would have their controls mounted on smart metal front panels, while silly projects could use sheet plastic or even wood. Alas, these attempts at standardisation failed miserably.

One breakaway group defiantly insisted on using metal tobacco tins for all projects, while another sect mounted their controls on the printed circuit itself! The latest trend seems to be to bung everything inside a transparent plastic cube or sphere and hope for the best, so confusion still persists.

ADVANCED STAGE

Valve audio amplifiers had reached an advanced stage of development prior to the introduction of the "jump-a-groove" long-playing record in 1950, but with the coming of the difficult-to-tune f.m. radio in 1955, hi-fi purists were at last able to take time off to just sit and listen to the music, without having to bother about all that nasty distortion of former years.

Unfortunately, this idyllic state lasted only until 1961, when the easy-to-blow power transistor started to appear in output stages, accompanied by something called "the transistor sound".

This unusual effect was characterised by a rattling buzz from loudspeakers when gain controls were turned low. After a good deal of concentrated sleuthing, it transpired that transistor audio amplifiers were subject to crossover distortion, so the purists had to climb out of their armchairs and set about exorcising the demon with cabbalistic circuitry.

Since then there has been no further opportunity to listen to music. Elimination of the output transformer led to severe difficulties in trying to match the then extant 15 ohm loudspeakers to amplifiers requiring a four to eight ohm load, and all problems were multiplied by two when stereo came along.

Now they are about to be multiplied by four.

SURVIVE THE TRANSITION

What has the future in store for those who have managed to survive the transition from valve to transistor? Clearly, the introduction of a new device is often accompanied by unpleasant side-effects. For example, with i.c.s. we have already experienced circuits which are best understood if held upside down in front of a mirror, and the use of postal codes for device numbering is to be deprecated.

Above all, one thing is patently clear. A new device seems to take eight years to mature to amateur status. Furthermore, all information concerning a new device is automatically witheld for five years, or until it becomes obsolete, whichever period is shorter. So it follows that there is no need to get too agitated when a new device comes along, because the threat to one's peace of mind is not immediate.

NOTE: This last point is not quite true since it is the avowed object of PRACTICAL ELECTRONICS to ensure that the reader is informed of interesting developments as soon as possible. Indeed, the problem nowadays would be to avoid doing so—ED.

★

PATENTS REVIEW...

FUEL MONITOR

BP 1 320 039

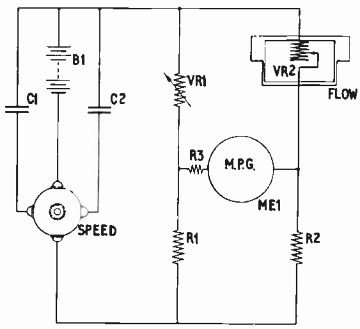


Fig. 1

With petrol likely to be very scarce or more expensive or both in future, devices for accurately measuring vehicle fuel consumption will become more popular.

In BP 1 320 039 Alan Westwood, Peter Davidson and Brian Dean describe and claim just such a device. The circuit Fig. 1 shows a vehicle speed measuring device, a flow meter to measure fuel rate of flow (and thus proportional rate of consumption) and an ammeter for reading m.p.g.

The meter is connected between opposite junctions of a Wheatstone bridge comprising VR2 (which forms part of the flow meter), R2, R1 and VR1 for pre-setting bridge balance. The use of R3 in series with the meter is only necessary with certain meters.

The opposite corners of the bridge are connected together by the vehicle speed measuring device. This includes a rotor geared to the vehicle transmission with brushes which alternately connect capacitors C1, C2 across the vehicle battery and discharge them through the bridge. The capacitors C1, C2 thus charge and discharge alternately to give a signal representative of the vehicle speed.

The flow meter will generally be in the form of a chamber with inlet and fuel outlet pipes and a bellows-type diaphragm. Fuel passing to the engine flows through the chamber to compress the diaphragm in dependence upon fuel flow rate. As the diaphragm is compressed, the value of VR2 resistance is varied by movement of the slider over its track. The value of VR2 resistance is in practice an inverse function of the fuel flow rate.

The reading given on the meter is approximately proportional to an arithmetical relationship between the two signals controlled respectively by the flowmeter and the speed measuring device, being approximately proportional to the current received from the rotor of the speed measuring device multiplied by the imbalance of the bridge circuit due to the flow meter. This reading represents an indication of distance travelled by the vehicle per unit of fuel consumed and the meter ME1 can be calibrated to provide direct readout in miles per gallon.

NEW APPROACH TO TONE CONTROL

In BP 1 304 774 Wilfred Palmer of Dagenham, Essex, describes a three part tone control circuit for an audio amplifier. By way of example he gives a list of specific values for all the components, see Fig. 1.

The variable potentiometer VR1 and d.c. blocking capacitor C1 form a normal volume control. The slider of VR1 acts as a common input line to the three sections of the tone control, shown dotted.

The bass circuit includes R1 and R2 in series with VR2. The slider of VR2 is in series with R3 which feeds the output terminal.

The mid-range circuit has R4 and R5 in series with VR3, and the slider is also connected to the output via R6 and C2.

The high frequency circuit comprises VR4, the slider being connected to the output via C3.

The resistor R7 between C2 and C3 is intended to isolate the infinite variations of time constant of the treble circuit from the infinite variations of time constant of the mid-range circuit. Also, the resistor acts as an impedance to high frequencies from the bass and mid-range circuits. The inventor suggests that in this way the signals from the middle and treble circuits are cleanly and fully mixed.

The bass circuit presents a high impedance to high frequencies, thereby attenuating them but passing low and mid-range frequencies. This is due to the presence of resistors R1 and R2. The inventor points out that any resistor can be represented by a pure resistance in parallel with the self capacitance across the resistor terminals and there is thus attenuation of high frequency signals by the changes of self capacitance with increasing frequency. By using the resistors in series, total self capacitance is lowered.

The treble circuit presents an increasing impedance as the frequency decreases, thus attenuating low frequencies but passing the high and part of the mid-range frequencies.

The inventor claims that the circuit eliminates the need for attenuators in crossover units and allows infinite variations of the signal fed to loudspeakers over the whole audio spectrum.

BP 1 304 774

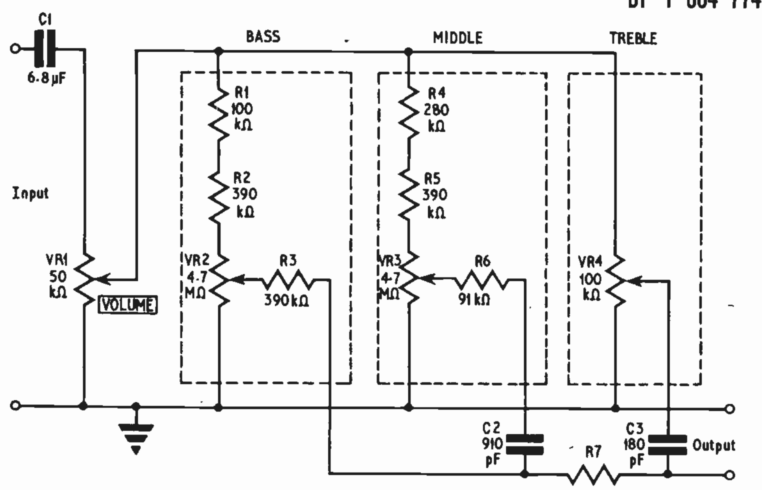


Fig. 1

parts for PRACTICAL ELECTRONICS projects.

"One Source" buying makes sense—saves you time, money and postage.

After many requests, Electro Spares are now supplying lists of components for ALL the projects featured in "Practical Electronics" commencing July 1973 issue. Just forward a S.A.E. (preferably 9" × 4" minimum) stating which project is of interest to you—we will forward an individually priced list of components required. No need to buy a full kit—you need only purchase the parts you require at any one time. All Electro Spares supplied components are new, branded products of reputable manufacturers and carry full makers' guarantee. We regret we cannot supply lists for projects published before July 1973 issue.

"P.E. RONDO" QUADRAPHONIC SOUND SYSTEM

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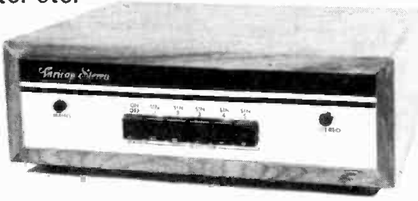

"P.E." F.M. VARICAP STEREO TUNER

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BFX86	40	50MHz	17p
BFY53	30	50MHz	10p
BSX19	40	500MHz	10p
BSX67	30	200MHz	12p
2N697	60	40MHz	12p
2N709	15	900MHz	30p
2N718	60	60MHz	12p
2N753	25	250MHz	12p
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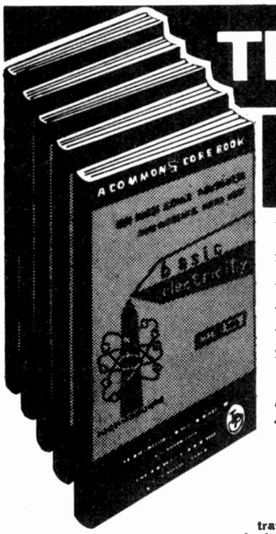

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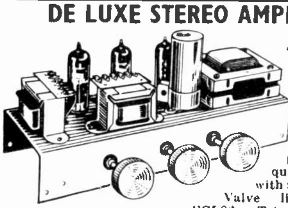
PRICE £11·60 P. & P. 40p.

DE LUXE STEREO AMPLIFIER



A.c. mains 200–240 volts. Using heavy duty fully isolated mains transformer with full wave rectification giving adequate smoothing with negligible hum. Valve line up:—2 × ECL86 Triode Pentodes. 1 × EZ80 as rectifier. Two dual potentiometers are provided for bass and treble control, giving bass and treble boost and cut. A dual volume control is used. Balance of the left and right hand channels can be adjusted by means of a separate "balance" control fitted at the rear of the chassis. Input sensitivity is approximately 300mV for full peak output of 4 watts per channel (8 watts mono), into 3 ohm speakers. Full negative feedback in a carefully calculated circuit, allows high volume levels to be used with negligible distortion. Supplied complete with knobs, chassis size 11in. w × 4in. x. Overall height including valves 5in. Ready built and tested to a high standard. **Price £9·90.** P. & P. 50p.

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200/240V A.C. input. Four switched fully smoothed D.C. outputs giving 6V and 7½V and 9V and 12V at 1 amp continuous (1½ amp intermittent).
Fitted insulated output terminals and pilot lamp indicator. Hammer finish metal case, overall size 6" × 3¾" × 2¼". Suitable for Transistor Radios, Tape Recorders, Amplifiers, etc., etc. Ready built and tested.

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GENERAL PURPOSE HIGH STABILITY TRANSISTOR PRE-AMPLIFIER. For P.U. Tape, Mike, Guitar, etc., and suitable for use with valve or transistor equipment. 9–18V. Battery or from H.T. line 200/300V. Frequency response 15Hz–25KHz. Gain 26dB. Solid encapsulation size 1¾ × 1¼ × ½in. Brand new — complete with instructions. Price **£1.** P. & P. 15p.

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LATEST RONETTE T/O Mono Compatible Cartridge for EP/LP/78 mono/stereo records on mono equipment **£1·50.** P. & P. 15p.

QUALITY RECORD PLAYER AMPLIFIER MK II
A top-quality record player amplifier employing heavy duty double wound mains transformer, ECC83, EL84, and rectifier. Separate Bass, Treble and Volume controls. Complete with output transformer matched for 3 ohm speaker. Size 7in. w. × 3 d. × 6 h. Ready built and tested. PRICE **£4·40.** P. & P. 50p. ALSO AVAILABLE mounted on board with output transformer and speaker. PRICE **£5·85.** P. & P. 60p.

SPECIAL OFFER!!

HI-FI LOUDSPEAKER SYSTEM

Beautifully made teak finish enclosure with most attractive Tygan-Vynair front. Size 16in high × 10¼in wide × 6in deep. Fitted with E.M.I. Ceramic Magnet 13in × 8in bass unit, two H.F. tweeter units and crossover. Max. power handling 10W. Available 3, 8 or 15 ohm impedance.

Our Price £9·25 Carr. 75p.

CABINET AVAIL. SEPARATELY **£4·95.** Carr. 65p. Also available in 8 ohm with EMI 13in × 8in. bass speaker with parasitic tweeter. **£7·15.** Carr. 75p.

HARVERSON'S SUPER MONO AMPLIFIER

A super quality gram amplifier using a double wound fully isolated mains transformer, rectifier and ECL82 triode pentode valve as audio amplifier and power output stage. Impedance 3 ohms. Output approx. 3·5 watts. Volume and tone controls. Chassis size only 7in. wide × 3in. deep × 6in. high overall. AC mains 200/240V. Supplied absolutely Brand New, completely wired and tested with good quality output transformer.

OUR ROCK BOTTOM BARGAIN PRICE £3·30 P. & P. 40p

LOUDSPEAKER BARGAINS
5in 3 ohm **£1·05,** P. & P. 15p. 7 × 4in 3 ohm **£1·15,** P. & P. 20p. 10 × 6in 3 or 15 ohm **£1·90,** P. & P. 30p. E.M.I. 8 × 5in 3 ohm with high flux magnet **£1·62,** P. & P. 20p. E.M.I. 13½ × 8in with high flux ceramic magnet with parasitic tweeter 3, 8, or 15 ohm **£3·50.** P. & P. 30p. E.M.I. 13 × 8in, 3 or 8 or 15 ohm with two inbuilt tweeters and crossover network **£4·65.** P. & P. 30p.
EMI CERAMIC MAGNET HEAVY DUTY TWEETER. pprox. 3¼in. Av. 3 or 8 or 15 ohms. **£1·25** plus 20p p. & p.
BRAND NEW. 12in 15w H/D Speakers, 3 or 15 ohm. Current production by well-known British maker. Now with Hiflux ceramic ferrobar magnet assembly **£7·50.** Guitar models: 25w **£7·50.** 35w **£9·35.** P. & P. 45p each.

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LIMITED NUMBER OF BRAND NEW ELAC 10" TWIN CONE LOUDSPEAKERS. With large ceramic magnet and plasticised cone surround. 8 ohm impedance.

£2·70. P. & P. 35p.

Also available specification as above but size 10" × 6" **£2·70** and size 8" round **£2·60** P. & P. 35p.

LIMITED NUMBER EMI 2½" 8 ohm Tweeters. Mounted on flat bracket, size 2½" wide × 7¼" long. **70p** per pair plus 15p P. & P. Ex equipment but new and tested. **70p** per pair plus 15p P. & P.

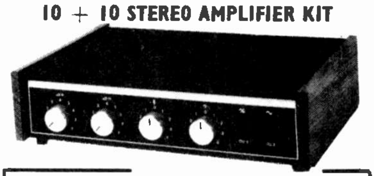
12in "RA" TWIN CONE LOUDSPEAKER
10 watts peak handling. 3, 8 or 15 ohm, **£2·45.** P. & P. 36p.
35 ohm SPEAKERS 3". ONLY **70p.** P. & P. 25p.

"POLY PLANAR" WAFER-TYPE, WIDE RANGE ELECTRO-DYNAMIC SPEAKER
Size 11¾in × 14¾in × 1⁷⁄₁₆in deep. Weight 19oz. Power handling 20W r.m.s. (40W peak). Impedance 8 ohm only. Response 40Hz–20kHz. Can be mounted on ceilings, walls, doors, under tables, etc., and used with or without baffle. Send S.A.E. for full details. Only **£6·55** each. P. & P. 34p.

HI-FI STEREO HEADPHONES

Adjustable headband with comfortable flexifoam ear-muffs. Wired and fitted with standard stereo ¼in jack plug. Frequency response 30–15,000Hz. Matching impedance 8–16 ohms. Easily converted for mono. PRICE **£3·30.** P. & P. 25p.

HAVERSONIC SUPER SOUND 10 + 10 STEREO AMPLIFIER KIT



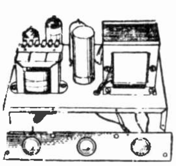
NEW FURTHER IMPROVED MODEL WITH HIGHER OUTPUT AND INCORPORATING HIGH QUALITY READY DRILLED PRINTED CIRCUIT BOARD WITH COMPONENT IDENTIFICATION CLEARLY MARKED FOR EASIER CONSTRUCTION

A really first-class Hi-Fi Stereo Amplifier Kit. Uses 14 transistors including Silicon Transistors in the first five stages on each channel resulting in even lower noise level with improved sensitivity. Integrated pre-amp with Bass, Treble and two Volume Controls. Suitable for use with Ceramic or Crystal cartridges. (Very simple to modify to suit magnetic cartridge—instructions included). Output stage for any speakers from 5 to 15 ohms. Compact design, all parts supplied including drilled metal work, high quality ready drilled printed circuit board, smart brushed anodised aluminium front panel with matching knobs, wire, solder, nuts, bolts—no extras to buy. Simple step by step instructions enable any constructor to build an amplifier to be proud of. Brief specification: Power output 14W r.m.s. per channel into 5 ohms. Frequency response ±3dB 12–30,000Hz. Sensitivity better than 80mV into 1MΩ. Full power bandwidth ±3dB 12–15,000Hz. Bass boost approx. to ±12dB. Treble cut approx. to −16dB. Negative feedback 18dB over main amp. Power requirements 35V at 1·0 amp. Overall size—12" wide × 8" deep × 2¾" high.
Fully detailed 7-page construction manual and parts list free with kit or send 18p plus large S.A.E.

PRICES AMPLIFIER KIT,	**£11·55**	P. & P. 25p.
(Magnetic input components 33p extra)		
POWER PACK KIT,	**£3·30**	P. & P. 35p.
CABINET,	**£3·30**	P. & P. 35p.

(Post Free if all units purchased at same time). Full after sales service. Also available ready built and tested, **£23·10.** Post Free.
Note: The above amplifier is suitable for feeding two mono sources into inputs (e.g. mike, radio, twin record decks, etc.) and will then provide mixing and fading facilities for medium powered Hi-Fi Discotheque use, etc.

3-VALVE AUDIO AMP. HA34 MK II



Designed for Hi-Fi reproduction of records. A.C. Mains operation. Ready built on plated heavy gauge metal chassis, size 7¾in w. × 4in. d. × 4¾in. h. Incorporates ECC83, EL84, EZ80 valves. Heavy duty, double wound mains transformer and output transformer matched for 3 ohm speaker. Separate volume control and now with improved wide range tone controls giving bass and treble lift and cut. Negative feedback line. Output 4½ watts. Front panel can be detached and leads extended for remote mounting of controls. Complete with knobs, valves, etc., wired and tested for only **£5·50.** P. & P. 45p.

HSL "FOUR" AMPLIFIER KIT. Similar in appearance to HA34 above but employs entirely different and advanced circuitry. Complete set of parts, etc. **£4·50.** P. & P. 45p.

10/14 WATT HI-FI AMPLIFIER KIT

A stylishly finished monaural amplifier with an output of 14 watts from 2 EL84s in push-pull. Super reproduction of both music and speech, with negligible hum. Separate inputs for mike and gram allow records and announcements to follow each other. Fully shrouded section wound output transformer to match 3–15Ω speaker and 2 independent volume controls, and separate bass and treble controls are provided giving good lift and cut. Valve line-up 2 EL84s, ECC83, EF86 and EZ80 rectifier. Simple instruction booklet **15p** plus S.A.E. (Free with parts). **All parts sold separately.** ONLY **£8·80.** P. & P. 60p. Also available ready built and tested **£12·10.** P. & P. 70p.

VYNAIR & REXINE SPEAKERS & CABINET FABRICS app. 54 in. wide. **Our price 85p yd.** length. P. & P. 25p per yd. (min. 1 yd.). S.A.E. for samples.

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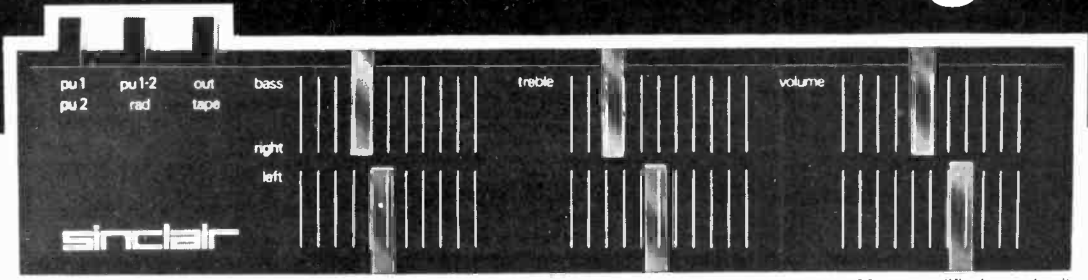
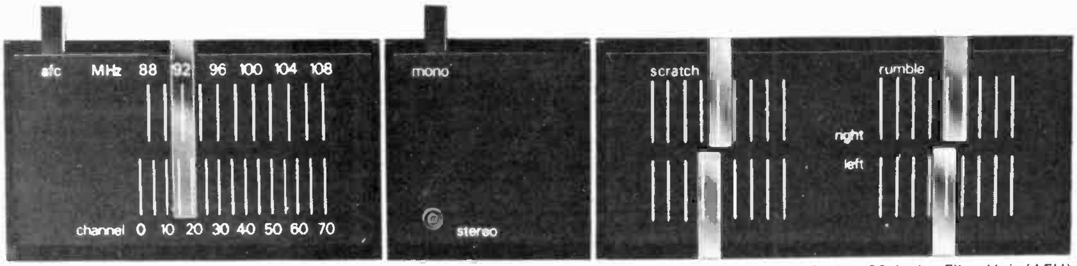
now...

Project 80

... exciting new thinking in modular hi-fi design

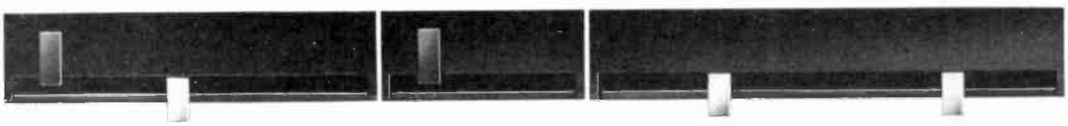


Stereo 80 pre-amplifier/control unit



Project 80 tuner   Stereo decoder   Project 80 Active Filter Unit (AFU)

the slimmest, most elegant hi-fi modules ever made



Living with hi-fi takes on new meaning now that Project 80 is here. These amazing new modules mark a brilliant technical advance all round; their size and presentation bring exciting new opportunities to install systems in ways hitherto only dreamed about but never before made practical. You can build a Project 80 system virtually anywhere and it is unbelievably simple to install and connect up. Everything that could possibly be wanted in a top quality do-it-yourself domestic hi-fi system will be found in Project 80 – compactness, elegantly ultra-modern styling, ease of fixing and operation, new control methods, and above all superb performance. New as well as popular established ideas on installation are featured on page four of this announcement to provide just a few examples of the system's fantastic versatility.

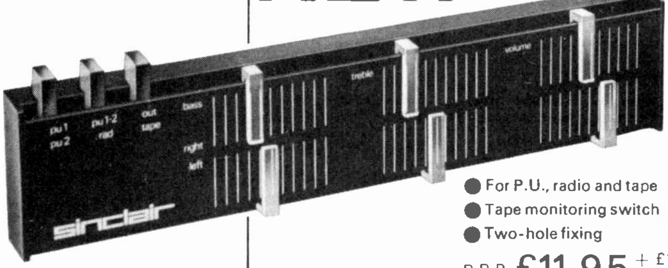
sinclair

Project 80 new modules

Stereo 80 pre-amplifier and control unit

As with other Project 80 units, the Stereo 80 is mounted by means of two bolts fixed at the rear which pass through holes drilled in the wood or plastic on which modules are to be mounted. *All the electronics are contained within the ¾" deep front panel!* Connecting leads are taken away similarly out of sight. Each channel in the Stereo 80 has its own independent tone and volume controls operated by sliders. This enables exceptionally good environmental matching to be obtained. Provision is made for magnetic and ceramic pick-ups, radio and tape in and out. A virtual earth input stage forms part of the up-dated circuitry of the Stereo 80 to ensure the finest possible quality from all signal sources. Generous overload margins are allowed on all inputs. Clear instructions with template are supplied.

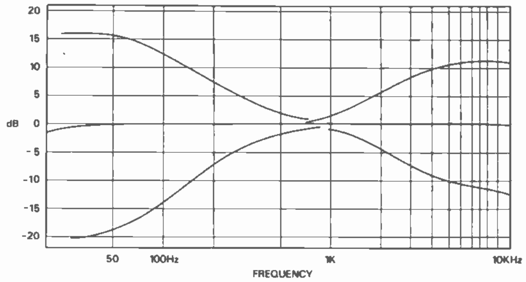
NEW



- For P.U., radio and tape
- Tape monitoring switch
- Two-hole fixing

R.R.P. £11.95 + £1·19 V.A.T.

TECHNICAL SPECIFICATIONS
Size – 260 × 50 × 20mm (10¼ × 2 × ¾ins)
Finish – Black, with white markings
Inputs – Mag. P.U. 3mV RIAA corrected; Ceramic P.U. 300 mV
Radio 300 mV, Tape 30 mV
S/N ratio – 60db
Frequency range – 20Hz to 15KHz ±1dB; 10Hz to 25KHz ± 3dB
Power requirements – 20 to 35 volts
Outputs – 100mV + AB monitoring for tape
Controls – Press button for tape, radio and P.U. selection Volume.
Bass + 12dB to – 14dB at 100Hz, Treble + 11dB to – 12dB at 10KHz

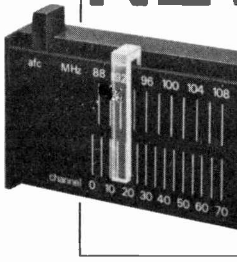


Project 80 FM tuner smaller, more efficient

A truly remarkable tuner in every way – its unbelievably compact size – its original circuitry – its dependable performance – all this in a boldly designed modern case measuring 85 × 50 × 20mm (3½ × 2 × ¾ins). Greater adaptability (and possibly financial convenience) results from the tuner and stereo decoder section being made available separately.

TECHNICAL SPECIFICATIONS
Size – 85 × 50 × 20mm (approx. 3½ × 2 × ¾ins)
Tuning range – 87 to 108 MHz
Detector – I.C. balanced coincidence, for good A.M. rejection
AFC – Switchable, with thermistor control to prevent from drift
One 26 transistor I.C.
Twin dual varicap tuning
Distortion – 0.3% at 1KHz for 75KHz deviation
Ceramic filter in I.F. section
Aerial impedance – 75 Ω or 240-300 Ω
Sensitivity – 4 microvolts for 30dB quieting
Power requirements – 12 to 45 volts

NEW



- AFC switch
- Twin dual varicap tuning
- 4-hole ceramic filter
- Slider tuning

R.R.P £11.95 + £1.19 V.A.T.

Project 80 stereo decoder

Making the Project 80 decoder separate from the F.M. tuner gives the constructor a wider choice of systems as well as saving money in cases where stereo reception may not be required. This unit gives a 40dB channel separation with an output of 150mV per channel. The gallium arsenide light emitting beacon automatically lights up to show when a stereo transmission is tuned in. Designed essentially as an integral part of Project 80 systems, this multiplex stereo demodulator may be used in many cases with existing single channel frequency modulated tuners to provide stereo reception.
Size – 47 × 50 × 20mm (1⅞ × 2 × ¾ins)
One 19 transistor I.C.

NEW

- Solid-state stereo indicating beacon
- Readily adaptable for use with other tuners

R.R.P. £7.45 + 0·74p V.A.T.

new constructional techniques

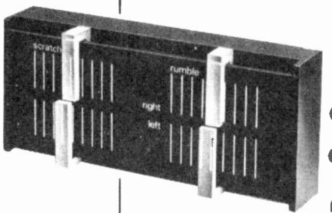
. . .and again Sinclair leads the world

1962 Micro-miniature power amp small enough to stand on a 10p. piece. Slimline pocket receiver smaller than a 20 cigarette pack
1963 Micro-6 receiver, smaller than a matchbox
1964 Pocket F.M. receiver; PWM amp.
1965 Z.12 power amplifier module; PZ.3 power supply
1966 Stereo 25 pre-amp/control unit
1967 Micromatic; Q.14 loudspeaker; the first Neoteric
1968 IC.10, the first ever integrated circuit for constructors' use
1969 Q.16 – improved version of Q.14 Systems 2000 and 3000: Project 60 launched
1970 IC.12 Project 605
1971 Project 60 stereo FM tuner Z.50; PZ.8
1972 Improvements to Project 60 with Z.50 MK.2 and PZ.8 Mk.3 The Executive Calculator; Digital multi-meter. Q.30 speaker
1973 Cambridge Calculator
PROJECT 80 LAUNCHED
. . . and next ?

Project 80 active filter unit

This efficiently designed unit makes a highly desirable part of any worthwhile system where inputs may be from record, radio or tape As with Stereo 80, separate controls are applied to each channel thereby making it easier to obtain ideal stereo balance in any kind of indoor environment.

TECHNICAL SPECIFICATIONS
Size – 108 × 50 × 20mm ($4\frac{1}{4}$ × 2 × $\frac{3}{4}$ins)
Voltage gain – minus 0 2dB
Frequency response – 36Hz to 22KHz, controls minimum
Distortion – at 1KHz – 0 03% using 30V supply
HF cut off (scratch) – 22KHz to 5 5KHz, 12dB/oct slope
L.F. cut off (rumble) – 28dB at 20Hz, 9dB/oct. slope



NEW

- For scratch and rumble control
- Transistorised active circuitry

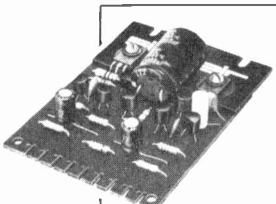
R.R.P. £6.95 + 0 69p VAT

Z.40 & Z.60 power amplifiers
totally short-circuit proof

Either of these entirely new power amplifiers is intended for use in Project 80 installations although, of course, they are readily adaptable to an even wider range of applications Both Z.40 and Z.60 incorporate built-in protection against shortcircuiting and risk of damage arising from mis-use is greatly reduced. Comprehensive instructions are supplied with each of the modules.

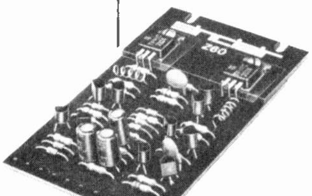
Z.40 Technical Specifications
Size – 55 × 80 × 20mm
($2\frac{1}{8}$ × $3\frac{1}{8}$ × $\frac{3}{4}$ins) 9 transistors
Input sensitivity – 100mV
Output – 15 watts RMS continuous into 8 Ω (35V). 30 watts music power into 4 Ω (30V)
Frequency response – 10Hz–100KHz ± 1dB
Signal to noise ratio – 64dB
Distortion – at 10 watts into 8 Ω less than 0 1%
Power requirements – 12-35 volts

Z 60 Technical Specifications
Size – 55 × 98 × 20mm
($2\frac{1}{8}$ × $3\frac{7}{8}$ × $\frac{3}{4}$ins) 12 transistors
Input sensitivity – 100-250mV
Output – 25 watts RMS into 8 Ω (45V). 50 watts music power into 4 Ω (50V)
Distortion – typically 0 03%
Frequency response – 10Hz to more than 200KHz ± 1dB
Signal to noise ratio – better than 70dB
Built-in protection against transient overload and short circuit
Load impedance – 4Ω min; max safe on open circuit



NEW

Z.40
RRP £5.45 + 0·54p V.A T

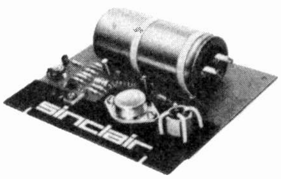


Z.60
RRP £6.95 + 0 69p V.A.T.

Sinclair power supply units PZ.8

the worlds most advanced unit in its class

Stabilised power supply unit. Re-entrant current limiting makes damage from overload or even direct shorting impossible, a principle never before inporated in a commercially available constructor module. Normal working voltage (adjustable) 45V
R.R.P. £7.98 + 0.79p V.A.T.
Without mains transformer
PZ.5 30V unstabilised
R.R.P. £4.98 + 0.49p V.A.T.
PZ.6 35V. stabilised
R.R P. £7.98 + 0 79p V A.T.



Recommended Project 80 applications

System	The Units to use	Units cost
Simple battery record player	Z.40	£5.45 +54p V A T
Mains powered record player	Z.40, PZ.5	£10.43 +£1 04 V A T.
30W. RMS continuous sine wave stereo amp.	2 × Z.40s, Stereo 80; PZ.6	£30.83 +£3 08 V A.T.
50W (8 Ω) RMS continuous sine wave de luxe stereo amplifier	2 × Z.60s, Stereo 80; PZ.8	£33.83 +£3 38 V A.T.
Indoor P.A.	Z.60, PZ.8	£14.93 +£1.49 V A.T.
Car Radio	F.M. tuner, Z.40	£16.40 +£1 64 V A.T.

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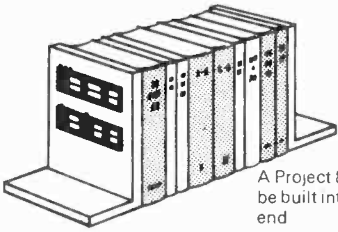
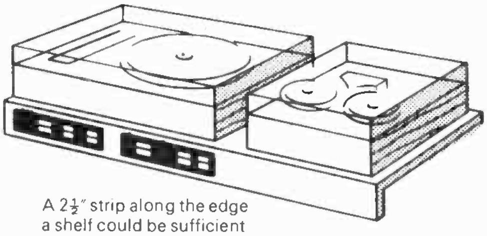
From Sinclair
the worlds most advanced hi-fi modules

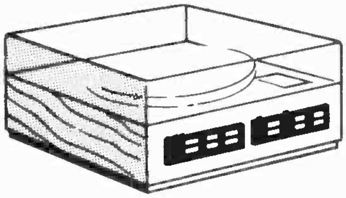
Sinclair Project 80 the ultra-modern non-obtrusive hi-fi



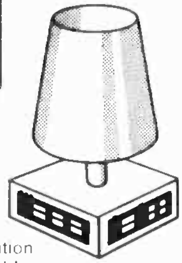
A Project 80 system could be built into a book-shelf end



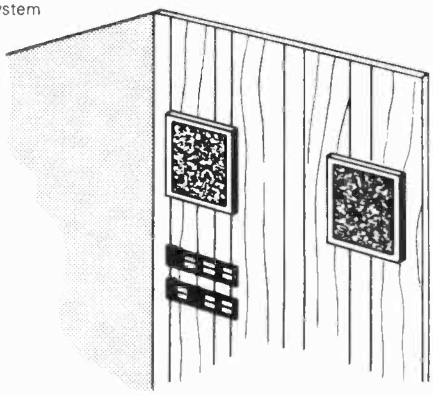
A $2\frac{1}{2}''$ strip along the edge a shelf could be sufficient to contain a complete system



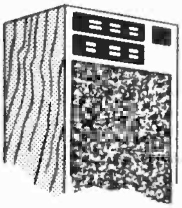
The modules mount very easily onto a playing plinth



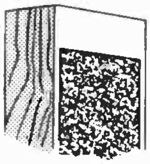
A novel application would be to build around the base of a lampshade



Two Sinclair Q.16 loudspeakers suitably positioned together with Project 80 could be mounted on to a false wall.



Project 80 could be easily mounted onto a loudspeaker cabinet



When you have seen for yourself how fantastically slim and cleverly designed these modules are, further ways will suggest themselves in which they can become a pleasing part of your particular domestic environment.

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RT.3KVA 1·5 turns per V. **£19·00.** Post £1.

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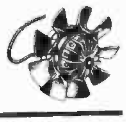

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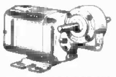

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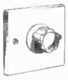

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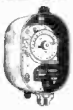

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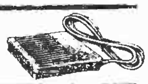

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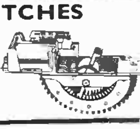

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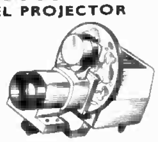

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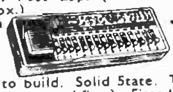

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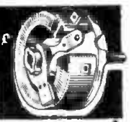

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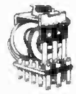

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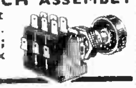

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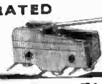

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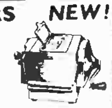

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The applicant should not be less than 24 years of age and have a good working knowledge of the above equipment. Salary will be negotiable depending on qualifications and experience. Three weeks holiday, contributory pension and life assurance scheme.

Please send all relevant personal history stating how the above requirements are met, and quoting reference GEA335, to:

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Personnel Manager
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2N3571	1·12
2N3572	0·97
2N3702	0·11
2N3703	0·10
2N3704	0·14
2N3705	0·10
2N3706	0·09
2N3707	0·13
2N3708	0·07
2N3709	0·09
2N3710	0·12
2N3711	0·09
2N3712	0·96
2N3713	1·95
2N3714	2·29
2N3715	1·23
2N3716	3·00
2N3773	3·96
2N3779	3·15
2N3790	4·21
2N3794	2·06
2N3791	2·06
2N3792	2·20
2N3794	0·10
2N3819	0·32
2N3820	0·47
2N3823	1·42
2N3824	1·33
2N3826	0·23
2N3854	0·18
2N3854A	0·19
2N3855	0·19
2N3855A	0·20
2N3856	0·19
2N3856A	0·20
2N3858	0·17
2N3858A	0·19
2N3859	0·16
2N3859A	0·19
2N3860	0·20
2N3866	1·69
2N3877	0·25
2N3877A	0·26
2N3900	0·20
2N3900A	0·21
2N3901	0·32
2N3903	0·24
2N3904	0·27
2N3905	0·24
2N3906	0·27
2N4036	0·46
2N4037	0·40
2N4058	0·16
2N4059	0·09
2N4060	0·11
2N4061	0·11
2N4062	0·11
2N4302	0·25
2N4303	0·47
2N4916	0·20
2N4917	0·17
2N4918	0·73
2N4919	0·84
2N4920	0·99
2N4921	0·73
2N4922	0·84
2N4923	0·83
2N5172	0·12
2N5174	0·22
2N5175	0·26
2N5176	0·32
2N5190	0·92
2N5191	0·96
2N5192	1·24
2N5193	1·01
2N5194	1·10
2N5195	1·46
2N5245	0·43
2N5457	0·49
2N5458	0·46
2N5459	0·49
3N128	0·73
3N138	1·65
3N139	1·42
3N140	0·92
3N141	0·81
3N142	0·58
3N143	0·75
3N152	0·92
3N153	0·81
3N154	0·84
3N159	1·17
3N187	1·55
3N200	2·49
3N201	1·05
40050	0·78
40251	0·81
40309	0·30
40310	0·50
40313	0·92

40316	0·50
40318	0·92
40360	0·46
40361	0·43
40362	0·45
40363	0·81
40389	0·46
40394	0·56
40395	0·65
40406	0·44
40407	0·33
40408	0·50
40409	0·52
40410	0·53
40411	2·25
40414	3·55
40467A	0·69
40468A	0·44
40600	0·69
40601	0·67
40602	0·46
40603	0·58
40604	0·56
40636	1·10
40673	0·70
AC107	0·35
AC113	0·16
AC115	0·16
AC117	0·20
AC121	0·13
AC126	0·25
AC127	0·25
AC128	0·25
AC141K	0·30
AC142K	0·25
AC151V	0·14
AC152V	0·17
AC153	0·22
AC153K	0·25
AC154	0·20
AC176	0·18
AC187K	0·20
AC188K	0·26
ACY17	0·35
ACY18	0·24
ACY19	0·27
ACY20	0·22
ACY21	0·26
ACY22	0·16
ACY28	0·20
ACY30	0·42
ACY39	0·65
ACY40	0·17
ACY41	0·17
ACY44	0·31
AD136V	0·96
AD140	0·55
AD142	0·50
AD143	0·45
AD149V	0·66
AD150	0·63
AD161	0·45
AD162	0·45
AD161 } AD162 }	1·05
AF109R	0·40
AF114	0·25
AF115	0·24
AF116	0·25
AF117	0·20
AF118	0·50
AF121	0·22
AF124	0·24
AF125	0·20
AF126	0·19
AF127	0·20
AF139	0·38
AF170	0·25
AF172	0·25
AF178	0·55
AF179	0·65
AF180	0·50
AF186	0·40
AF200	0·35
AF239	0·41
AF240	0·72
AF279	0·54
AF280	0·54
AFY42	0·74
AF211	0·55
AL102	0·75
AL103	0·70
ASY26	0·30
ASY27	0·36
ASY28	0·28
ASY29	0·30
ASY50	0·20
ASY55	0·35
BC107	0·16
BC108	0·15
BC109	0·19
BC113	0·13
BC114	0·12
BC115	0·15
BC116	0·15
BC116A	0·18
BC117	0·21
BC118	0·11
BC119	0·27
BC121	0·23

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BC302	0·27
BC303	0·54
BC307	0·10
BC307A	0·10
BC308	0·09
BC308A	0·09
BC308B	0·09
BC309	0·10
BC309A	0·10
BC309B	0·10
BC327	0·24
BC328	0·22
BC337	0·19
BC338	0·19
BCY30	0·43
BCY31	0·51
BCY32	1·15
BCY33	0·34
BCY34	0·35
BCY38	0·53
BCY39	1·05
BCY40	0·81
BCY42	0·15
BCY43	0·15
BCY58	0·21
BCY59	0·22
BCY70	0·17
BCY71	0·22
BCY72	0·13
BCY87	3·47
BCY88	2·40
BCY89	0·97
BCZ10	0·35
BCZ11	0·50
BD115	0·75
BD116	0·50
BD121	0·75
BD123	0·82
BD124	0·67
BD130	0·57
BD131	0·40
BD132	0·50
BD135	0·43
BD136	0·49
BD137	0·55
BD138	0·68
BD139	0·71
BD140	0·83
BDY10	1·25
BDY11	1·50
BDY17	1·50
BDY18	1·75
BYD19	1·97

BFS21A	2·30
BFS28	0·92
BFS61	0·27
BFS98	0·28
BFW10	0·61
BFW11	0·61
BFX13	0·23
BFX29	0·30
BFX30	0·25
BFX37	0·30
BFX44	0·33
BFX63	2·48
BFX68	0·68
BFX84	0·24
BFX85	0·29
BFX86	0·24
BFX87	0·28
BFX88	0·25
BFX89	0·45
BFY10	0·35
BFY11	0·45
BFY17	0·90
BFY18	0·35
BFY19	0·35
BFY20	0·50
BFY29	0·40
BFY37	0·20
BFY41	0·43
BFY43	0·65
BFY50	0·22
BFY51	0·18
BFY52	0·20
BFY53	0·15
BFY56	0·34
BFY64	0·41
BFY76	0·22
BFY77	0·24
BFY78	0·36
BFY90	0·60
BRY39	0·38
BSX19	0·13
BSX20	0·14
BSX21	0·20
BSX26	0·49
BSX27	0·84
BSX28	0·25
BSX29	0·47
BSX60	0·54
BSX61	0·42
BSX76	0·15
BSX77	0·20
ASX78	0·25
BSW70	0·28
BSY24	0·20
BSY25	0·15

MJ421	0·88
MJ430	0·75
MJ440	0·71
MJ480	0·75
MJ481	0·85
MJ490	0·94
MJ491	1·10
MJ802	4·12
MJ901	2·65
MJ1001	2·34
MJ1800	1·88
MJ2500	2·92
MJ2501	3·25
MJ2955	1·00
MJ3000	2·47
MJ3001	2·79
MJ3701	0·93
MJ4502	4·44
MJE340	0·47
MJE370	0·73
MJE371	0·80
MJE520	0·59
MJE521	0·73
MJE1092	1·93
MJE1102	1·57
MJE2801	1·19
MJE2901	1·56
MJE2955	1·65
MJE3055	0·83
MM1613	0·43
MM1711	0·49
MM1712	0·64
MM2712	0·64
MPF102	0·51
MP8111	0·32
MP8112	0·40
MP8113	0·47
MPSA05	0·25
MPSA06	0·20
MPSA12	0·40
MPSA14	0·24
MPSA55	0·30
MPSA56	0·28
MPSA65	0·25
MPSA66	0·28
MPSU01	0·44
MPSU05	0·48

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SN74118	1·00	SN74155	1·55	SN74181	7·00
SN74119	1·92	SN74157	1·80	SN74190	1·95
SN74121	0·60	SN74160	2·60	SN74191	1·95
SN74122	1·35	SN74161	2·60	SN74192	1·90
SN74123	1·35	SN74164	2·26	SN74173	1·90
SN74141	0·90	SN74165	4·00	SN74196	1·60
SN74145	1·50	SN74167	6·25	SN74198	4·60
SN74150	3·35	SN74174	2·00	SN74199	4·00
SN74151	1·10	SN74175	1·35		

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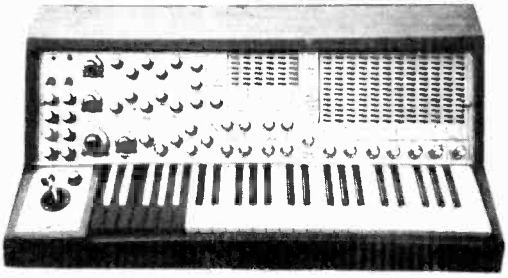

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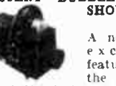

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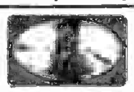

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Top quality cassettes at unbeatable prices (complete with standard storage case): C60 **28p,** C90 **38p,** C120 **48p** plus 5p P. & P.

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Three Channel: Bass—Middle—Treble. Each channel has its own sensitivity control. Just connect the input of this unit to the loudspeaker terminals of an amplifier, and connect three 250V up to 500W lamps to the output terminals of the unit, and you produce a fascinating sound-light display. (All guaranteed)
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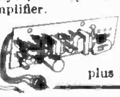
If you require more information please send S.A.E.

"CRESCENT BEAT BRITE"

SINGLE CHANNEL SOUND TO LIGHT UNIT
This fantastic little box approx. 4" × 3" × 2½" when connected to the output of a sound source from 1 to 100 watts produces a psychedelic light display of up to 1000 watts.
Complete with a sensitive level control the unit is fused and cannot harm your amplifier.
A Bargain at £7·50 plus 10p.

LOW VOLTAGE AMPLIFIER
5 transistor amplifier complete with volume control, is suitable for 9V d.c. and a.c. supplies. Will give about 1W at 8 ohm output.
With high IMP input this amplifier will work as a record player, baby alarm, etc., amplifier.



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plus 13p P. & P.

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A top quality speaker ideal where small size is important. Manufactured by E.M.I. for a well-known hi-fi set maker. Size: 7in × 4in. Impedance: 8 ohms. Flux: 38,000. Max. Free range: 90Hz to 12kHz. Power handling: 5W. Unbeatable. Price: £1·60. Free postage on this item.

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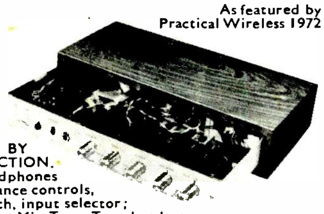
BUILD THE TEXAN

20 + 20 WATT IC STEREO AMPLIFIER

As featured by Practical Wireless 1972



Now built and used by thousands of satisfied customers. **FEATURES:** slim design, overall size in cabinet 15¼in × 2¾in × 6¼in 6-IC's, 10 transistors, stabilisers, Gardeners low field transformer, Fibre Glass PC Panel, complete chassis work. Now available built and tested as well as in kit form.

HIGH QUALITY & STABILITY ARE PREDOMINATE FEATURES—DEVELOPED TEXAS ENGINEERS FOR PERFORMANCE, BY RELIABILITY AND EASE OF CONSTRUCTION. **FACILITIES.** On/off switch indicator, headphones socket, separate treble, bass, volume and balance controls, scratch and rumble filters, mono/stereo switch, input selector; Mag. P.U., Radio Tuner, Aux. Can be altered for Mic, Tape, Tape-head, etc. Constructional details Ref. No. 21, 30p. Distributed by Henry's throughout UK.

FREE Teak cabinet with complete kit.

KIT PRICE **£28·50** (+ VAT + 50p carr/packing) or

built and tested **£35·00** (+ VAT + 50p carr/packing) as illustrated

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100 watt amplifier for above	£42·50
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SDL1 (rotary controls):	£49·50
SDL11 (slider controls):	£58·50
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Disco anti-feedback microphone	£11·95
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PLUS Price Savings

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SYSTEM 25 (list approx. £109) **£79·50**

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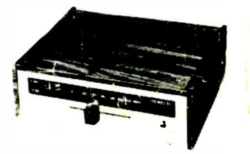
NEW FM TUNER	£11·95
STEREO DECODER	£7·45

All items post paid—Best price on request.

BUILD THE NEW HENELEC STEREO FM TUNER



A completely new high stability stereo FM tuner. Features variable capacity diode tuning, stabiliser power supply, IC Decoder, high gain low noise. IF stages. LED indicators, Tuning meter, AFC. Easy to construct and use. Mains operated. Slim modern design with fibre glass PC, teak cabinet, etc. Available as a kit to build or ready built. Overall size: 8in × 2¼in × 6½in. Produced to give high performance with a realistic price. (Parts list and constructional details Ref. No. 5, 30p.) Henry's are sole distributors UK and Europe.

Kit Price **£21·00** (+ VAT)

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Quantity and trade enquiries invited.

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* Polished wood cabinet £4·60, post 35p.

8 ohms full range (post 20p)
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BUILD YOURSELF A POCKET CALCULATOR

A complete kit, packaged in a polystyrene container and taking about 3 hours to assemble—that's the Sinclair Cambridge pocket calculator from Henry's. Some of the many features include interface chip, thick-film resistor pack, printed circuit board, electronic components pack. Size: 4⅓in long × 2in wide × 11/16in deep.
Free of charge with the kit for the more advanced technologist is a 32-page booklet explaining how to calculate Logs, Tangents, Sines, etc.

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Also assembled ready to use **£27·22** (+ VAT)

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