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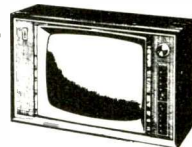
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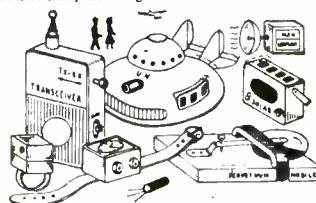
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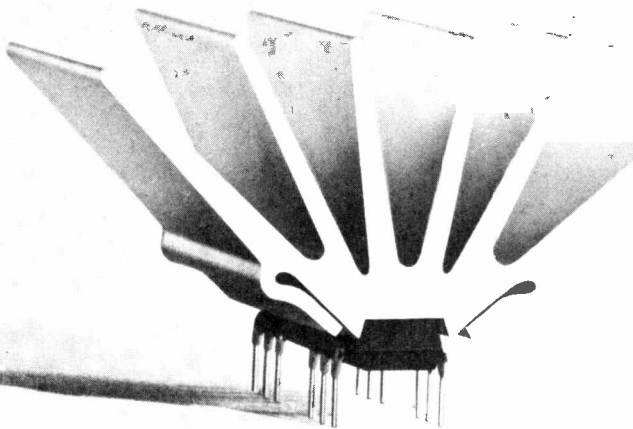
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1. Higher power.
2. Fewer external components.
3. Lower quiescent consumption.
4. Compatible with Project 60 modules.
5. Specially designed built-in heat sink. No other heat sink needed.
6. Full output into 3, 4, 5 or 8 ohms.
7. Works on any voltage from 6 to 28 volts without adjustment.
8. NEW 22 transistor circuit.

Output power 6 watts RMS continuous (12 watts peak).

Frequency Response 5 Hz to 100KHz \pm 1 dB

Total Harmonic Distortion Less than 1%. (Typical 0.1%) at all output powers and all frequencies in the audio band.

Load Impedance 3 to 15 ohms.

Input Impedance 250 Kohms nominal.

Power Gain 90dB (1,000,000,000 times) after feedback.

Supply Voltage 6 to 28 volts (Sinclair PZ-5 or PZ-6 power supplies ideal).

Quiescent current 8mA at 28 volts; low enough to make the IC.12 ideal also for battery operation.

Size 22 x 45 x 28 mm including pins and heat sink.

With the addition of only a very few external resistors and capacitors the Super IC.12 makes a complete high fidelity audio amplifier suitable for use with pick-up, F.M. tuner etc. Alternatively, for more elaborate systems, modules in the Project-60 range such as the Stereo 60 and A.F.U. may be added



FREE 44 page instruction manual now included with all units. Available free on request to present IC.12 users. Gives full circuit and wiring diagrams for many applications including car-radios, oscillators, etc.



Price, inc. **FREE** printed circuit board for mounting and manual.

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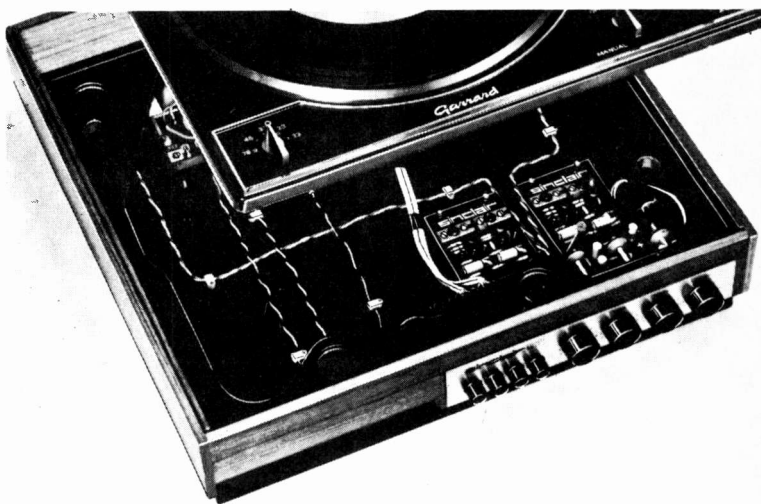
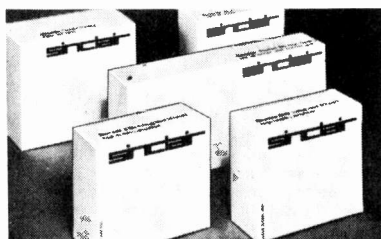
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Project 60



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Project 60 offers more advantage to the constructor and user of high fidelity equipment than any other system in the world.

Performance characteristics are so good they hold their own with any other available system irrespective of price or size.

Project 60 modules are more versatile — using them you can have anything from a simple record player or car radio amplifier to a sophisticated and powerful stereo tuner-amplifier. Either power amplifier can be used in a wide variety of applications as well as high fidelity. The Stereo 60 pre-amplifier control unit may also be used with any other power amplifier system, as can the AFU filter unit. The stereo FM tuner operates on the unique phase lock loop principle to provide the best ever standards of sensitivity and audio quality. Project 60 modules are very easily connected together by following the 48 page manual supplied free with all Project 60 equipment. The modules are great space savers too and are sold individually boxed in distinctive white and black cartons. With all these wonderful advantages, there remains the most attractive of all — price. When you choose Project 60 you know you are going to get the best high fidelity in the world, yet thanks to Sinclair's vast manufacturing resources (the largest in Europe) prices are fantastically low and everything you buy is covered by the famous Sinclair guarantee of reliability and satisfaction.

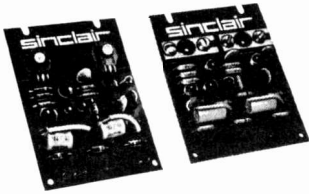
Typical Project 60 applications

System	The Units to use	together with	Cost of Units
Simple battery record player	Z.30	Crystal P.U., 12V battery volume control	£4.48
Mains powered record player	Z.30, PZ.5	Crystal or ceramic P.U. volume control etc.	£9.45
20 + 20 W. stereo amplifier for most needs	2 x Z.30s, Stereo 60, PZ.5	Crystal, ceramic or mag. P.U., F.M. Tuner, etc.	£23.90
20 + 20 W. stereo amplifier with high performance spkrs.	2 x Z.30s, Stereo 60, PZ.6	High quality ceramic or magnetic P.U., F.M. Tuner, Tape Deck, etc.	£26.90
40 + 40 W. R.M.S. de-luxe stereo amplifier	2 x Z.50s, Stereo 60 PZ.8, mains trsfrmr	As above	£34.88
Indoor P.A.	Z.50, PZ.8, mains transformer	Mic., guitar, speakers, etc., controls	£19.43

F.M. Stereo Tuner (£25) & A.F.U. Filter Unit (£5.98) may be added as required.

from a simple amplifier to a complete stereo tuner amplifier with Project 60 modules

Z.30 & Z.50 power amplifiers



The Z.30 and Z.50 are of advanced design using silicon epitaxial planar transistors to achieve unsurpassed standards of performance. Total harmonic distortion is an incredibly low 0.02% at full output and all lower outputs. Whether you use Z.30 or Z.50 amplifiers in your Project 60 system will depend on personal preference, but they are the same size and may be used with other units in the Project 60 range equally well.

SPECIFICATIONS (Z.50 units are interchangeable with Z.30s in all applications).

Power Outputs

Z.30 15 watts R.M.S. into 8 ohms using 35 volts; 20 watts R.M.S. into 3 ohms using 30 volts.
Z.50 40 watts R.M.S. into 3 ohms using 40 volts; 30 watts R.M.S. into 8 ohms using 50 volts.

Frequency response: 30 to 300,000Hz \pm 1dB.

Distortion: 0.02% into 8 ohms.

Signal to noise ratio: better than 70dB unweighted.

Input sensitivity: 250mV into 100 Kohms.

For speakers from 3 to 15 ohms impedance.

Size: 14 x 80 x 57 mm.

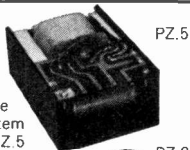
Z.30

Built, tested and guaranteed with circuits and instructions manual. **£4.48**

Z.50

Built, tested and guaranteed with circuits and instructions manual. **£5.48**

Power Supply Units



PZ.5



PZ.8

Designed special for use with the Project 60 system of your choice. Use PZ.5 for normal Z.30 assemblies and PZ.8 where a stabilised supply is essential.

PZ.5 30 volts un stabilised £4.98

PZ.6 35 volts stabilised £7.98

PZ.7 45 volts stabilised

(less mains transformer) **£7.98**

PZ.8 mains transformer £5.98

Project 60 Stereo F.M. Tuner



First in the world to use the phase lock loop principle

The phase lock loop principle was used for receiving signals from space craft because of its vastly improved signal to noise ratio. Now, Sinclair have applied the principle to an F.M. tuner with fantastically good results. Other original features include varicap diode tuning, printed circuit coils, an I.C. in the specially designed stereo decoder and squelch circuit for silent tuning between stations. Good reception is possible in difficult areas, and often a few inches of wire are enough for an aerial. In terms of a high fidelity this tuner has a lower level of distortion than any other tuner we know. Stereo broadcasts are received automatically as the tuning control is rotated, a panel indicator lighting up as the stereo signal is tuned in. This tuner can also be used to advantage with any other high fidelity system.

SPECIFICATIONS—Number of transistors: 16 plus 20 in I.C. **Tuning range:** 87.5 to 108 MHz. **Capture ratio:** 1.5dB. **Sensitivity:** 2 μ V for 30dB quieting; 7 μ V for lock-in over full deviation. **Squelch level:** 20 μ V. **A.F.C. range:** \pm 200 KHz. **Signal to noise ratio:** > 65dB. **Audio frequency response:** 10 Hz - 15 KHz (\pm 1dB). **Total harmonic distortion:** 0.15% for 30% modulation. **Stereo decoder operating level:** 2 μ V. **Cross talk:** 40dB. **Output voltage:** 2 x 150mV R.M.S. **Operating voltage:** 25-30 VDC. **Indicators:** Power on/tuning/stereo. **Size:** 93 x 40 x 207 mm.

Built and tested. Post free.

£25

Stereo 60 Pre-amp/control unit



Designed for Project 60 range but suitable for use with any high quality power amplifier. Again silicon epitaxial planar transistors are used throughout, achieving a really high signal-to-noise ratio and excellent tracking between channels. Input selection is by means of push buttons and accurate equalisation is provided for all the usual inputs.

SPECIFICATIONS—Input sensitivities: Radio - up to 3mV. Mag. p.u. 3mV: correct to R.I.A.A curve \pm 1dB; 20 to 25,000 Hz. Ceramic p.u. - up to 3mV; Aux - up to 3mV. **Output:** 250mV. **Signal to noise ratio:** better than 70dB. **Channel matching:** within 1dB. **Tone controls:** TREBLE + 15 to -15dB at 10 KHz; BASS + 15 to -15dB at 100Hz. **Front panel:** brushed aluminium with black knobs and controls. **Size:** 66 x 40 x 207mm. **£9.98**

Built, tested and guaranteed.

A.F.U. High & Low Pass Filter Unit



For use between Stereo 60 unit and two Z.30s or Z.50s, and is easily mounted. It is unique in that the cut-off frequencies are continuously variable, and as attenuation in the rejected band is rapid (12dB/octave), there is less

loss of the wanted signal than has previously been possible. Amplitude and phase distortion are negligible. The A.F.U. is suitable for use with any other amplifier system. Two filter stages - rumble (high pass) and scratch (low pass). Supply voltage - 15 to 35V. Current - 3mA. H.F. cut-off (-3dB) variable from 28KHz to 5KHz. L.F. cut-off (-3dB) variable from 25Hz to 100Hz. Distortion at 1 KHz (35V. supply) (0.02% at rated output. **Size:** 66 x 40 x 90 mm. **£5.98**

Built tested and guaranteed.

The Sinclair Guarantee

If within 3 months of purchasing Project 60 modules directly from us, you are dissatisfied with them, we will refund your money at once. Each module is guaranteed to work perfectly and should any defect arise in normal use we will service it at once and without any cost to you whatsoever provided that it is returned to us within 2 years of the purchase date. There will be a small charge for service thereafter. No charge for postage by surface mail. Air-mail charged at cost.

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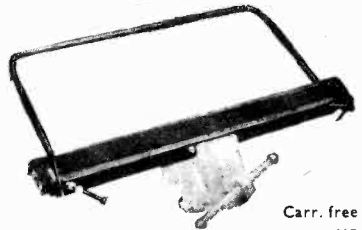
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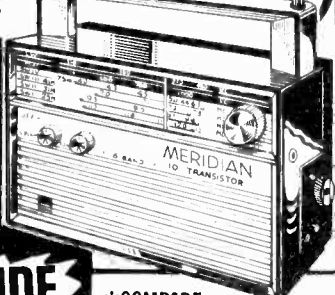
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FANTASTIC (even by our standards!) Brand new—the latest sensation in the world of sound! First class makers! Not only a fabulous VHF AM/FM Radio AND Cassette Tape Recorder and Player combined, but it also runs off standard batteries or mains (simply plug in 220/240V a.c. line cord). Now you can record and play back anything, anywhere! You can even tape direct from the Radio as you listen! **RECOMMENDED RETAIL PRICE GENUINELY £44 YET WE OFFER AT ALMOST HALF PRICE!** Just look at these wonderful features:—"Press-Button Keyboard Control panel! Or latest MASTER SWITCH CONTROL "MAGIC EYE" Visual Battery check/recording level indicator or built-in automatic leveler! *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 (24 in approx.)! Magnificently made case, with carry handle (DESIGNER VERY SLIGHTLY). Takes standard 30, 60, 90 or 120 minute Philips Cassette Tapes obtainable everywhere. But wait, the amazing built-in full circuit VHF AM/FM Radio gives you superb clarity of tone and incredible station selection—Unique rotating Station Selector Dial—get all local city and regional stations in every part of the country plus BBC National VHF. Picks up dozens of foreign stations. Also fabulous in your car! You could pay £££'s more for a Car Radio or Car Cassette Player ALONE! **ONLY £23.75** (Thurs. 1, Fri. 7). Complete with simple instructions, remote control microphone with on/off switch and earphone stand. **WITH WRITTEN GUARANTEE. BONUS OFFER—Standard Batteries and Cassette Tape 25p extra. Refund guaranteed.** Order by post to Uxbridge Road, or call at either store.

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VHF WITH SPECIAL FM MW AFC AIRCRAFT WAVEBAND

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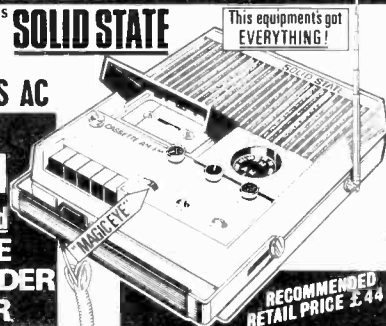
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Amazing Radio Construction set! Become a radio expert for £1.97. A complete Home Radio Course. No experience needed. Parts including simple instructions for each design. Illustrated step-by-step plans, all transistors, loudspeaker, personal phone, knobs, screws, etc., all you need. Presentation box 37p extra as illus. (if required) (parts available separately) no soldering necessary. Send £1.97 + 23p p & p.

SOOTHE YOUR NERVES RELAX WITH THIS AMAZING RELAXATRON

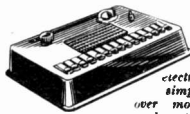
CUTS OUT NOISE POLLUTION SOOTHES YOUR NERVES! The RELAXATRON is basically a pink noise generator. Besides being able to mask out extraneous unwanted sounds, it has other very interesting properties. IF YOU WORK IN NOISY OR DISTRACTING SURROUNDINGS, IF YOU HAVE TROUBLE CONCENTRATING, IF YOU FEEL TENSED, UNABLE TO RELAX—then build this fantastic Relaxatron. Once used you will never want to be without it—TAKE IT ANYWHERE. Uses standard PP3 batteries (current used so small that battery life is almost shelf-life). CAN BE EASILY BUILT BY ANYONE OVER 12 YEARS OF AGE using our unique, step-by-step, fully illustrated plans. No soldering necessary. All parts including case, a pair of crystal phones, Components nuts, screws, wire, etc., no soldering. Send only £2.25 + 25p p. & p. (Parts available separately.)



ONLY £2.25

ELECTRONIC ORGAN

ONLY £2.75

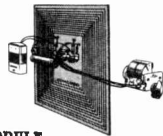


Don't confuse with ordinary electric organs that simply blow air over mouth-organ type reeds, etc. Fully transistorised. SELF-CONTAINED LOUD-SPEAKER. Fifteen separate keys span two full octaves—play the "Yellow Rose of Texas", play "Silent Night", play "Auld Lang Syne", etc. etc. You have the thrill and excitement of building it together with the pleasure of playing a real, live, portable electronic organ. NO PREVIOUS KNOWLEDGE OF ELECTRONICS NEEDED. No soldering necessary, simple as ABC to make. Anyone over nine years can build it easily in one short evening following the fully illustrated, step-by-step, simple instructions. ONLY £2.75 + 23p p & p for kit, including case, nuts, screws, simple instructions, etc. Uses standard battery (parts available separately). Have all the pleasure of making it yourself, finish with an exciting gift for someone.

READY BUILT AND TESTED TREASURE LOCATOR MODULE

ONLY £4.95

FULLY TRANSISTORISED PRINTED CIRCUIT METAL DETECTOR MODULE. Ready built and tested—just plug in a PP3 battery and 'phones and it's working. Put it in a case, screw a handle on and YOU HAVE A PORTABLE TREASURE LOCATOR EASILY WORTH ABOUT £80! EXTREMELY SENSITIVE—PENETRATES EARTH, SAND, ROCK, WATER, ETC. EASILY LOCATES COINS, GOLD, SILVER, JEWELLERY, HISTORICAL RELICS, BURIED PIPES, ETC. So sensitive it will detect certain objects buried SEVERAL FEET BELOW GROUND! GIVES CLEAR SIGNAL ON ONE COIN! 24-98 + 30p carr. etc.



Eavesdrop on the exciting world of Aircraft Communications— V.H.F. AIRCRAFT BAND CONVERTER ONLY £2.37



Listen in to AIRLINES, PRIVATE PLANES, JET-PLANES. Eavesdrop on exciting cross talk between pilots, ground approach control, airport tower. Hear for yourself the disciplined voices hiding tenseness on talk devices. Be with them when they have to take nerve ripping decisions in emergencies—Tune into the international distress frequency. Covers the aircraft frequency band including HEATHROW, GATWICK, LUTON, RINGWAY, PRESTWICK, ETC. ETC. CLEAR AS A BELL. This fantastic fully transistorised instrument can be built by anyone over nine in under two hours. No soldering necessary. Fully illustrated simple instructions take you step-by-step. Uses standard PP3 battery. All you do is extend rod aerial, place close to any ordinary medium wave radio (even tiny portables) NO CONNECTIONS WHATSOEVER NEEDED. SEND ONLY £2.37 + 23p p & p for kit including case, nuts, screws, wire, etc. etc. (Parts available separately.)

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ONLY £2.75



Do you wake up in the night and can't get off to sleep again? Would you like to be gently soothed off to satisfying sleep every night? Then build this ingenious electronic sleep inducer. It even stops by itself so you don't have to worry about it being on all night! The loudspeaker produces soothing audio-frequency sounds, continuously repeated—but as time goes on the sound gradually becomes less and less—until they eventually cease altogether, the effect it has on people is amazingly very similar to hypnosis. All transistor. No knowledge of electronics or radio needed. Step-by-step instructions. No soldering necessary. Kit includes case, nuts, wire, screws, etc. SEND £2.75 + 25p p & p (parts available separately.)

FIND BURIED TREASURE!

Transistorised Treasure Locator



ONLY £2.37

This fully portable transistorised metal locator detects and tracks down buried metal objects—it signals exact location with loud audible sound (no phones used)—uses any transistor radio which fits inside—no connections needed. FINDS GOLD, SILVER, COINS, JEWELLERY, ARCHAEOLOGICAL PIECES, ETC. ETC. Extremely sensitive, will signal presence of certain objects buried several feet below ground! No knowledge of radio or electronics required. Can be built with ease in one short evening by anybody from nine years of age upwards, with the clear, easy-to-follow, step-by-step, fully illustrated instructions—uses standard PP3 battery. No soldering necessary. Kit includes nuts, screws, wire, etc. ONLY £2.37 + 27p p & p. (Sectional handle as illustrated 78p extra.) Parts available separately. Made up looks worth £10!

SHORTWAVE TRANSISTOR RADIO

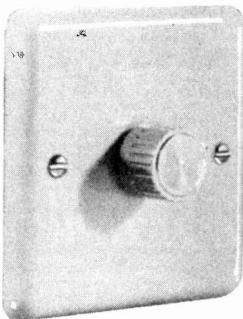
ONLY £2.25



Anyone from 9 years up can follow the step-by-step, easy as ABC, fully illustrated instructions. No soldering necessary. 76 stations logged on rod aerial in 30 mins—Russia, Africa, USA, Switzerland, etc. Experience thrills of world wide news, sport, music, etc. Eavesdrop on unusual broadcasts. Uses PP3 battery. Size only 3in x 4 1/2in x 1 1/2in. Only £2.25 + 17p p & p. Kit includes cabinet, screws, instructions, etc. (Parts available separately.)

CONCORD ELECTRONICS LTD. (P.E.12), 8 Westbourne Grove, London, W.2. Callers Welcome 9 a.m.-6 p.m. inc. Saturday

Vary the strength of your lighting with a DIMMASWITCH



The DIMMASWITCH is an attractive and efficient dimmer unit which fits in place of the normal light switch and is connected up in exactly the same way. The ivory mounting plate of the DIMMASWITCH matches modern electric fittings. Two models are available, with the bright chrome knob controlling up to 300 w or 600 w of all lights except fluorescents at mains voltages from 200-250 v, 50Hz. The DIMMASWITCH has built-in radio interference suppression:

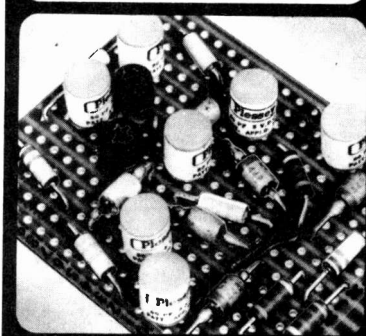
600 Wact - £3.20. Kit Form £2.70
300 Wact - £2.70. Kit Form £2.20

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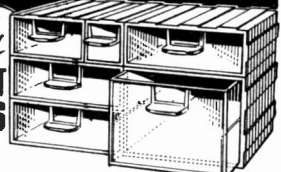


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DOUBLE TREBLE 2 draws, in one outer case (6D2), £3.65 for 8, EXTRA LARGE SIZE (6D1) £3.30 for 8.

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EMI speakers are internationally recognised—used in the highest quality sound reproduction equipment. Because of this world-wide demand, EMI matched speaker kits are available to you at a really keen price.

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combination of superb sound reproduction and good looks you'll be proud to have in your home.

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"Where can I get exclusive ROC ELECTRONICS!"



ACADEMY STEREO CASSETTE TAPE DECK, MODEL CS-2000

No hi-fi system is complete without one - hook it up to any ROC or other good quality amplifier, and the results are fantastic! The CS-2000 records and plays back. A big feature is its easy-to-use piano-key controls. Easy-to-get-at mic inputs are on top; line inputs and outputs at the rear. Dual-channel recording level meter. Pop-up cassette ejection. Stereo/Mono button. Tape counter. Pause control. Tape speed 1 1/2 ips (4.75 cms). Frequency response 100-10,000 Hz. Wow and flutter better than 0.3%. Rewind time better than 60 sec with C60 cassette. Engineered throughout to the highest electrical and mechanical standards. Size 16" wide, 4 1/2" high and 8" deep. Walnut cabinet with satin aluminium trims.

ROC PRICE
£54.95

Including two pencil microphones and all connecting leads
Normal Price £65.00



ROC PRICE
£98.50

Including connecting leads
Normal Price £115.00

REALISTIC HI-FI 36-WATT STEREO CONCERTMASTER FM-AM RECEIVER SYSTEM, MODEL 12-694

Brilliantly designed tuner/amplifier with two matching speakers. All three units in beautifully finished walnut cabinets with smart aluminium vertical trims. The tuning dial is fronted by unique black glass. Figures light up behind it in green when the unit is on. Separate easy-to-operate Left and Right volume controls. Microswitch for on/off. Programme selector. Separate bass and treble controls. Headphone socket on front panel for easy access. Single tuning knob for FM and AM. Built-in aerials, facilities for external FM aerial. Illuminated dial. Stereo broadcast indicator light. Each speaker has 6 1/2" bass and 3" treble units. Output: 9 watts r.m.s. per channel into 8 ohms. Frequency response: 30 to 20,000 Hz. FM: frequency range 80-108 MHz; sensitivity 2.5µV, stereo separation 30dB, image rejection 40dB. AM: frequency range 530-1605 kHz; sensitivity 100µV. Sizes: speakers 8" wide, 12" high and 9 1/2" deep; receiver 6" wide, 12" high and 9 1/2" deep. And their sophisticated appearance matches the excellence of the specification.

ROC PRICE
£76.50

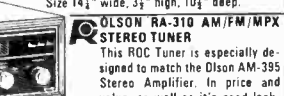
Normal Price £95.00

As reviewed in "POPULAR HI-FI" February 1972



ROC PRICE
£43.75

Normal Price £55.00



OLSON RA-310 AM/FM/MPX STEREO TUNER

This ROC Tuner is especially designed to match the Olson AM-395 Stereo Amplifier. In price and value, as well as its good looking design! But of course it's also ideal for use with any other amplifier. The RA-310 costs £10.00 less than the normal retail value, and yet it is a highly sophisticated unit, incorporating the latest solid state techniques. Operation is drift free for supreme station-holding capability. You can connect this Tuner to a stereo amplifier, to a tape deck or a tape recorder. And of course it covers all the stations in the AM and FM bands. FM: 87-108 MHz; AM: 525-1605 kHz. FM Sensitivity: FM, 3µV, AM, 250µV. Stereo separation 30dB at 1kHz. Image rejection 60dB. Size: 11 1/2" wide, 4" high, 7 1/2" deep.

ROC PRICE
£39.95

Normal Price £50.00



REALISTIC SA-100B 6-WATT STEREO AMPLIFIER

Here's fabulous, exciting value in miniature! This high quality stereo amplifier measures only 9" wide x 3" high x 5 1/2" deep. And yet it has separate ganged volume, balance and tone controls. Plus speaker in/out, mono/stereo, phono/tuner and power on/off slide switches. The ends are enameled walnut, with matching enamelled metal top. The front panel is satin aluminium and walnut-brown enamel. Frequency response is 50 to 10,000 Hz - 3dB. Output 3 watts r.m.s. per channel into 8 ohms. Inputs are 100mV for both phono and tuner.

ROC PRICE
£14.50

Normal Price £21.00



REALISTIC TM-100 AM/FM/MPX STEREO TUNER

Here's another unit that gives you fabulous value in miniature! Designed specifically to match the Realistic SA-100B in both appearance, size and performance, the TM-100 is superb value-for-money. It gives you the full FM and AM ranges - FM, 88-108 MHz; AM, 535-1605 kHz. Sensitivity: FM 5µV, AM 250µV. Image rejection 50dB.

ROC PRICE
£23.25

Normal Price £28.80

These will do justice to your amplifier - and to your pocket. At only £16.40 pair, they are real value-for-money. Each cabinet is heavily lagged and teak finished. They handle 16 watts rms (8 watts rms each). Each loudspeaker contains a large dual cone base unit, plus a separate tweeter. Frequency range: 40 to 19,000 Hz. Size 14" high, 9" wide, 6 1/2" deep.

R.446 3-WAY MATCHED SPEAKERS

These will do justice to your amplifier - and to your pocket. At only £16.40 pair, they are real value-for-money. Each cabinet is heavily lagged and teak finished. They handle 16 watts rms (8 watts rms each). Each loudspeaker contains a large dual cone base unit, plus a separate tweeter. Frequency range: 40 to 19,000 Hz. Size 14" high, 9" wide, 6 1/2" deep.

ROC PRICE
£17.80

Normal Price £25.00 per pair.

OLSON AM-357 4-WATT STEREO AMPLIFIER

Here's marvellous value for someone just starting to set themselves up in audio! At only £10.50, you get a fine amplifier in a scratch resistant metal cabinet, with a smart brushed aluminium front panel. It incorporates separate tone and volume controls for each channel. Inputs are provided for turntable (ceramic cartridge), tuner and tape deck or recorder. Frequency response: 70-20,000 Hz - 3dB. Output: 2 watts r.m.s. per channel into 8 ohms. Inputs: phono 80mV; tuner/aux 80mV. Size 8" wide, 2 1/2" high, 4 1/2" wide.



ROC PRICE
£29.00

Normal Price £39.80

buys. It takes in signals from magnetic or ceramic pick-ups, tuners (see Olson RA-310) and tape decks. And it's got outputs for tapping and for headphones. There are separate bass and treble controls, separate Left and Right channel volume controls. And a loudness switch for boosting the bass and treble notes when listening at low output levels. Frequency response: 20-20,000 Hz - 3dB. Output: 20 watts r.m.s. per channel into 8 ohms. Inputs: magnetic phono 3-0mV RIAA, crystal phono 100mV, tape 160mV. Tuner: 160mV. Size 11 1/2" wide, 4" high, 7 1/2" deep. The specification reads well - sounds even better!



25-WATT 3-WAY CHRYSLER "LIVING AUDIO" SPEAKER, MODEL CE-56

This high quality speaker has its own built-in 3-way sound response switch, giving you the ideal frequency response for hi-fi, natural or mood music listening. Its beautiful, heavy, oiled walnut cabinet incorporates two separate speaker units in an 8" woofer, and a 5" mid-range with 2" concentric tweeter. Power handling capacity: 25 watts r.m.s. into 8 ohms. Overall frequency response: 35-20,000 Hz. Cabinet size: 10 1/2" x 7 1/2" x 8 1/2". Exactly right for matching the most modern decor.

ROC PRICE
£27.25

Normal Price £39.95 each.



25-WATT 3-WAY CHRYSLER "LIVING AUDIO" SPEAKER, MODEL CE-56

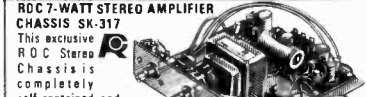
This high quality speaker has its own built-in 3-way sound response switch, giving you the ideal frequency response for hi-fi, natural or mood music listening. Its beautiful, heavy, oiled walnut cabinet incorporates two separate speaker units in an 8" woofer, and a 5" mid-range with 2" concentric tweeter. Power handling capacity: 25 watts r.m.s. into 8 ohms. Overall frequency response: 35-20,000 Hz. Cabinet size: 10 1/2" x 7 1/2" x 8 1/2". Exactly right for matching the most modern decor.

ROC PRICE
£33.20

Normal Price £42.00

PALACE AM/FM/MPX STEREO TUNER AMPLIFIER SSA-16

This is one of the lowest priced stereo tuner amplifiers on the market. It covers the full range of both AM and FM broadcast frequencies. And when you're switched to FM, an indicator lights up when a stereo signal is received - that's the time to switch to 'Stereo'! The SSA-16 has all the facilities you'd expect to find on tuners costing twice as much - separate volume, bass, treble, balance and tuning controls. Selector switch for tape, phono, AM, FM, stereo. Jack socket on front panel for stereo headphones. Frequency range: FM 88-108 MHz; AM 535-1605 kHz. Frequency response: 50-10,000 Hz ± 3dB. Power output: 4 watts total music power into two 8 ohm speakers. Size: 16" wide, 4 1/2" high, 8" deep.



7-WATT STEREO AMPLIFIER CHASSIS SK-317

This exclusive ROC Stereo Chassis is completely self-contained, and it costs £2.25 less than the normal retail value! The SK-317 is a really compact unit measuring only 5 1/2" wide, 1 1/2" high and 6 1/2" deep. It contains its own mains power supply, and has a ganged tone control and separate volume controls for each channel. Specification: frequency response 40-17,000 Hz ± 3dB; output 3.5 watts music power per channel into 8 ohms; input, phono, 600mV; signal-to-noise ratio better than 45dB.

ROC PRICE
£5.50

Normal Price £7.75



7-WATT STEREO AMPLIFIER CHASSIS SK-317

This exclusive ROC Stereo Chassis is completely self-contained, and it costs £2.25 less than the normal retail value! The SK-317 is a really compact unit measuring only 5 1/2" wide, 1 1/2" high and 6 1/2" deep. It contains its own mains power supply, and has a ganged tone control and separate volume controls for each channel. Specification: frequency response 40-17,000 Hz ± 3dB; output 3.5 watts music power per channel into 8 ohms; input, phono, 600mV; signal-to-noise ratio better than 45dB.

ROC PRICE
£18.25

Normal Price £25.20

OLSON AM-372 16-WATT STEREO AMPLIFIER

Here's a really good amplifier at a really down-to-earth price - nearly £7 less than the normal retail value! Just look at what the AM-372 will do for you - reproduce signals from ceramic or crystal cartridges, AM and FM tuners, and tape recorders. And it gives you output for two sets of speakers, headphones and tape recorders. Frequency response is 30 to 20,000 Hz ± 3dB. Output 8 watts r.m.s. per channel music power into 8 ohm speakers. Phono input 200mV. Tuner input 200mV. Size: 12 1/2" wide, 3 1/2" high, 7 1/2" deep.



ROC PRICE
£10.50

Normal Price £14.70

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Compare our prices with any other unit on the hi-fi market, and you'll find you won't beat ROC unit prices. No matter where you live, London or Land's End!

Take a good look at all these super audio equipment bargains. They're all on demonstration at our Shop from 9 to 6 p.m. Monday to Saturday, late night Thursday until 7 p.m. But don't worry if you can't get there yourself. Our Mail Order service is at your disposal. With the same exclusive ROC equipment - and at the same super value-for-money prices!

When you invest in ROC equipment, you're getting much more than an exclusive product. You're getting value for money that is literally unbeatable. ROC units are bought direct from the manufacturer, and ALL the savings ROC derive from this are passed on to you!

At ROC Electronics, we take extra care to select only the best buys. We check everything before you do - and it's fully guaranteed whether you buy at the shop or by Mail Order.



TOP VALUE • TOP QUALITY ACCESSORIES THAT EVERY HI-FI ENTHUSIAST NEEDS TO COMPLETE HIS SYSTEM

Every item shown here is the best of its kind within its price range. Buy them separately or at the same time as the other top-value audio products listed.



R.328 STEREO HEADPHONE
If you're starting in hi-fi, and you discover the need for a pair of really good stereo headphones, the R.328 is ideal. At a price you can afford. They have padded ear cushions, a 6-foot cord and jack plug. Frequency range 30-15,000 Hz. Impedance 8 ohms per channel. **ROC PRICE £2.95**



EAGLE SE-80 STUDIO STEREO HEADPHONE

Here's the ultimate in headphone design! Apart from its fantastic ability to reproduce all the frequencies from 20 to 20,000 Hz, the SE-80 has eliminated the discomfort and strain associated with traditional headphone design. Eagle have designed and produced a pair of headphones which breaks with all previous concepts. You hear all the sounds crisp and clear. In fact, the reproduction is so good, that it compares favourably with the most expensive hi-fi speaker systems. Separate slider volume control on each earpiece. Impedance: 8 ohm per channel. **ROC PRICE £14.90**



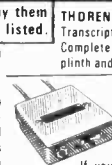
EAGLE SE-30 STEREO HEADPHONE

This model is for the more discriminating listener. For a start the frequency range extends from 30 to 16,000 Hz. And you can adjust the volume of each earpiece independently. There's also a mono/stereo switch. For maximum comfort, the ear cushions are covered in soft leathers. **ROC PRICE £7.05**



TEC HR-007 HEADPHONE RADIO

When you want to listen to the radio all by yourself. Then this will solve the problem. Separate volume and tuning controls with easy-to-use knobs. Frequency range is 535 to 1605 kHz medium wave band. Maximum output is 300 mW. Normal Price £9.45 **ROC PRICE £7.65**



THORENS TD150AB/II
Transcription Turntable
Complete with pick up arm plinth and cover. **£52.31**



R.186 STEREO HEADPHONE JUNCTION BOX

If you want easy, fingertip control of headphones and loudspeakers, here's the ideal solution to the problem. All you do is connect it to your speakers and amplifier, plug in your headphones - and you're ready to take over! At the flick of a slide switch, you can have headphones alone, or speakers alone, or both together. Input: suitable for use with amplifiers rated up to 20 watts. Size: 2 1/4" x 3 1/2" x 1 1/2". **ROC PRICE £1.50**



R.151 STEREO CAR SPEAKERS

Smart black, tough, plastic cases, each containing a high flux 110mm diameter speaker unit. Just what you need to go with the CS.8 Cartridge Player or any other car stereo system. Fitted with over three yards of connecting cable. Dimensions: 6 1/2" x 5 1/2" x 3 1/2". Impedance: 8 ohms per speaker. Rating: 5 watts max per speaker. **ROC PRICE £3.72**



R.152 STEREO CAR SPEAKERS

These sloping front speakers match the CS.8 Cartridge Player or any other car stereo system. Fitted with high flux 110mm diameter speaker unit, and over three yards of connecting cable. Dimensions: 6 1/2" x 6 1/2" x 3 1/2". Impedance: 8 ohms per speaker. Rating: 5 watts max. per speaker. **ROC PRICE £4.96**



EAGLE LC.05 STEREO MAGNETIC CARTRIDGE

For fabulous reproduction at a very low price, you'll find it hard to beat. 0.7 mil diamond stylus. Output: 6mV per channel. Frequency range: 30-18,000 Hz. Channel balance: ±1.5dB. Channel separation: 20dB. Recommended stylus pressure: 2.4 grams. Compliance: 9-10.6 cm/dyne. **ROC PRICE £4.75**



EAGLE LC.07 STEREO MOVING-MAGNET CARTRIDGE

Here's your opportunity to own a transcription cartridge for the price of a ceramic! It is specially designed to match top quality tone arms, and to get the very best from your hi-fi amplifier. 0.7 mil diamond stylus. Output: 7mV per channel. Frequency range: 20-21,000 Hz. Channel balance: ±1dB. Channel separation: 28dB. Compliance: 12-10.6 cm/dyne. **ROC PRICE £6.37**



R.088 MATCHED STEREO LOUD-SPEAKERS

Here's real value in stereo speakers! Each unit comes complete with 10-foot lead and phono plug, and looks really smart. Power handling per speaker: 4 watts rms, 8 watts peak. Frequency range: 40-16,000 Hz. Flux density: 8,500 gauss. Impedance: 8 ohms. Dimensions: 9" high, 5 1/2" wide, 4 1/2" deep. **ROC PRICE £9.50 pair**



15-FOOT STEREO HEADPHONE EXTENSION CORD R.362

Fitted with heavy duty 3-circuit stereo plug at one end and a matching stereo socket at the other. **ROC PRICE £1.30**

STEREO HEADPHONE ADAPTOR R.361 Enables you to use two sets of stereo headphones from a single socket. Fitted with male plug and two female sockets. **ROC PRICE £1.30**

EAGLE DL.67 HIGH COMPLIANCE 3-WAY TEAK SPEAKER SYSTEM

From a rich, deep, 35 Hz bass to above the limit of human hearing - this fantastic response comes from such a small size - only 10 1/2" x 6 1/2" x 6 1/2"! The DL.67 is the end product of several years' effort into the problems of full frequency response from small cabinets. The DL.67 has a dual cone high compliance bass mid range unit, and a horn tweeter. The speaker has a variable brilliance control to suit individual rooms - a feature normally only found on very expensive speaker systems. Power handling capacity: 10 watts rms, 20 watts peak. Frequency range: 35-20,000 Hz. Flux density 11,000 gauss. Impedance: 8 ohms. Dimensions: 11 1/2" high x 8" wide x 6 1/2" deep. Finish: oiled teak. **ROC PRICE £18.80 each**

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REALISTIC SA-100B SYSTEM

Realistic SA-100B Stereo Amplifier, Garrard 2025 T/C Autochanger with Stereo ceramic cartridge, plinth and cover and a pair of ROC R.446 Speakers. Matching TM-100 Stereo Tuner £23.25 extra if required. Normal Price £63.98 **ROC PRICE £47.60**



OLSON AM-395 SYSTEM

Olson AM-395 Stereo Amplifier, Garrard SP25 Mk III Record Player with Eagle LC07 Stereo Magnetic Cartridge, plinth and cover and a pair of Eagle DL.67 Speakers. Matching RA.310 Stereo Tuner £39.95 extra if required. Normal Price £106.65 **ROC PRICE £92.60**



OLSON AM-357 SYSTEM

Olson AM-357 Stereo Amplifier, Garrard 2025 T/C Autochanger with Stereo ceramic cartridge, plinth and cover and a pair of ROC R.088 4 watt Speakers. Normal Price £45.28 **ROC PRICE £36.70**



PALACE SYSTEM

Palace SSA-16 Stereo Tuner Amplifier, Garrard 2025 T/C autochanger with stereo ceramic cartridge, plinth and cover and a pair of ROC R.446 Speakers. Normal Price £84.98 **ROC PRICE £66.30**



REALISTIC SA-500 SYSTEM

Realistic SA-500 Stereo Amplifier, Garrard SP25 Mk III Single Record Player with Eagle LC.07 Stereo Magnetic Cartridge, plinth and cover and a pair of Crysler CE-5b Speakers. Normal Price £157.95 **ROC PRICE £124.00**



OLSON AM-372 SYSTEM

Olson AM-372 Stereo Amplifier, Garrard 2025 T/C Autochanger with Stereo ceramic cartridge, plinth and cover and a pair of ROC R.446 Speakers. Normal Price £68.18 **ROC PRICE £51.53**



REALISTIC 12-694 SYSTEM

Realistic 12-694 Stereo Tuner Amplifier with matching speakers and Garrard SP25 Mk III with Eagle LC.07 Stereo Magnetic Cartridge and plinth and cover. Normal Price £144.05 **ROC PRICE £124.50**



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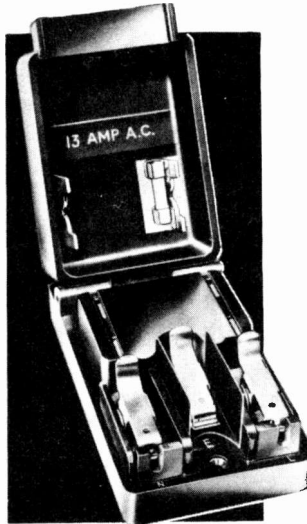
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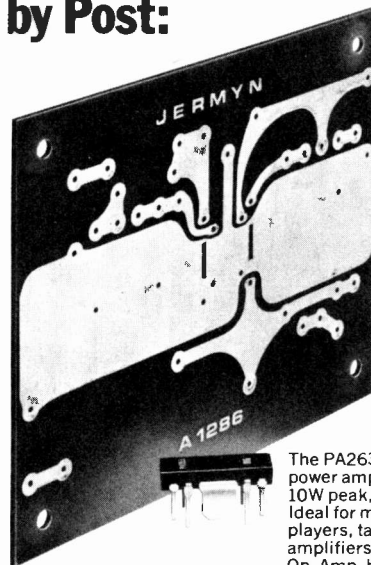
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BSY28	0-13	OC36	0-35
BSY29	0-13	OC35	0-37
BSY95A	0-15	AD149	0-30
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OC44	0-13	25034	0-25
OC45	0-13	2N3055	0-50
OC71	0-13		
OC72	0-13	Diodes	
OC81	0-13	AA42	0-10
OC81D	0-13	OA95	0-19
OC83	0-20	OA79	0-09
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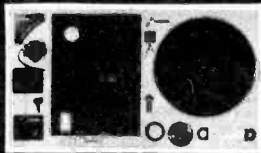


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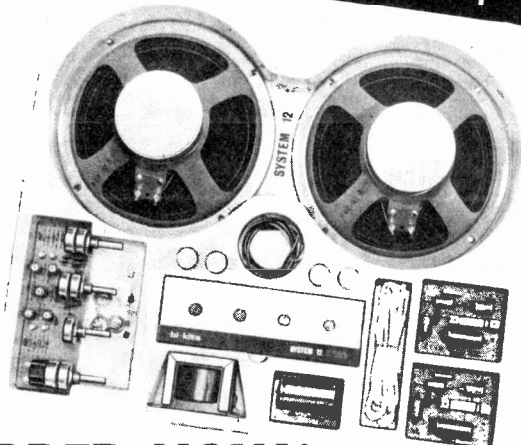
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384	-88	30FL1	-81	EBC41	-54	EY51	-33	PCL88	-65	UBF89	-32
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6F23	-83	R349	-65	ECL82	-31	PC86	-47	PY81	-25	Z77	-28
6F25	-68	B729	-62	ECL86	-35	PC88	-47	PY82	-25	Transistors	
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10P13	-58	DK32	-33	EP98	-65	PCC805	-58	U47	-84	AF127	-17
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2E14GT	-57	DY87	-24	EL93	-25	PCF807	-68	U329	-68	OC82	-12
30C1	-29	DY802	-33	EL500	-82	PCL82	-82	U801	-80	OC82D	-12
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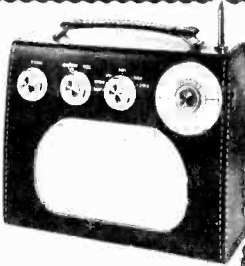
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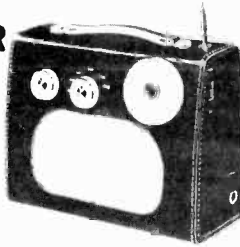
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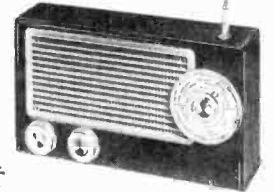
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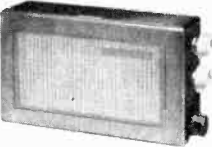
ROAMER SIX



6 TUNABLE WAVEBANDS: MW, LW, SW1, SW2, TRAWLER BAND PLUS AN EXTRA MW BAND FOR EASIER TUNING OF LUXEMBOURG, ETC. Sensitive ferrite rod aerial and telescopic aerial for short waves. 3in speaker. 8 stages—6 transistors and 2 diodes including micro-alloy R.F. transistors, etc. Attractive black case with red grille, dial and black knobs with polished metal inserts. Size 9in x 3 1/2in x 2 1/2in approx. Easy build plans and parts price list 15p (FREE with parts). Earpiece with plug and switched socket for private listening 30p extra.

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POCKET FIVE



3 TUNABLE WAVEBANDS: MW, LW, TRAWLER BAND WITH EXTENDED MW BAND FOR EASIER TUNING OF LUXEMBOURG, ETC. 7 stages—5 transistors and 2 diodes, supersensitive ferrite rod aerial, fine tone moving coil speaker. Attractive black and gold case. Size 3 1/2in x 1 1/2in x 3 1/2in. Easy build plans and parts price list 10p (FREE with parts). Earpiece with plug and switched socket for private listening 30p extra.

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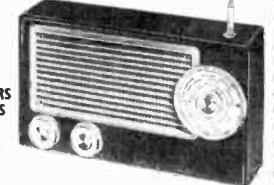


5 TRANSISTORS AND 2 DIODES

3 TUNABLE WAVE BANDS: MW, LW AND TRAWLER BAND. 7 stage 5 transistors and 2 diodes, ferrite rod aerial, tuning condenser, volume control, fine tone moving coil speaker. Attractive case with red speaker grille. Size 6 1/2in x 4 1/2in x 1 1/2in. Easy build plans and parts price list 10p (FREE with parts). Earpiece with plug and switched socket for private listening 30p extra.

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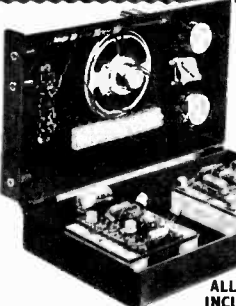
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8 TRANSISTORS AND 3 DIODES

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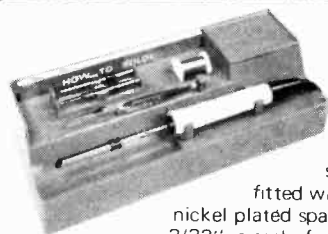
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**SK.1
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The kit contains a 15 watt 240 volts soldering iron fitted with a 3/16" bit, nickel plated spare bits of 5/32" and 3/32", a reel of solder, heat sink, cleaning pad, stand and booklet "How to Solder". Also available for 220 volts.

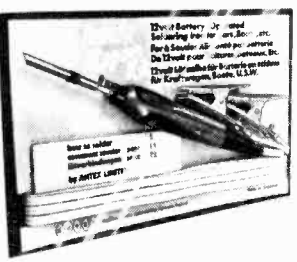
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**SK.2
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KIT**

This kit contains a 15 watt 240 volts soldering iron fitted with a 3/16" bit, nickel plated spare bits of 5/32" and 3/32", a reel of solder, Heat Sink, 1 amp fuse and booklet "How to Solder"

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JARGON

IN common usage, "jargon" appears to have become relegated to a term of disparagement. Complaints concerning the use of jargon are generally intended as motions of censure for some supposed grammatical or lingual offence. True the Concise Oxford Dictionary gives some rather unflattering definitions for jargon: "Unintelligible words . . . barbarous or debased language . . ." Other authorities assert that the much abused word jargon is a perfectly correct and proper synonym for a private or technical language. It follows, of course, that a technical language is likely to be unintelligible to those unfamiliar with the subject concerned. But who can with reason argue that technical language is improper or out of place in a technical journal, for example?

Every profession and trade, just like every branch of science and art, has its own private language, or jargon. Contrary to some beliefs jargon is not always an invention to bar or confuse the uninitiated. Usually it serves a very practical purpose: it facilitates verbal and written communication and, since it is generally succinct and incapable of misinterpretation, allows for economy in speech no less than in print.

Electronics, being a fast growing technology, has, not surprisingly, built up its own large vocabulary of technical terms. Some of these have a very homely ring about them, since they have been "borrowed" from the common language. They are well used to describe unequivocally the prevailing state of some given circuit or its mode of operation. Many terms have been specially coined, and they often create a vivid mental picture of the circuit action they describe. Yet other well known technical terms are formed from abbreviations or from the initial letters of complicated descriptions relating to materials or manufacturing processes. A custom that is quite widespread in ordinary everyday affairs, as well.

Without the use of this convenient terminology detailed explanations of circuit operation would become rambling, verbose discourses, tiresome to the reader and a strain upon his mental digestive system. This is, perhaps, nowhere better demonstrated than in the case of logic design where complex systems can be built up from a large number of basic circuit blocks interconnected in various configurations, but with much pattern repetition.

A knowledge and understanding of this special vocabulary (or call it jargon, if you will) is an indispensable part of training and education in electronics. It is the common language used and recognised by all those involved professionally, in trade and industry; it should be equally familiar to private constructors and students. It certainly should not be disparaged. F.E.B.

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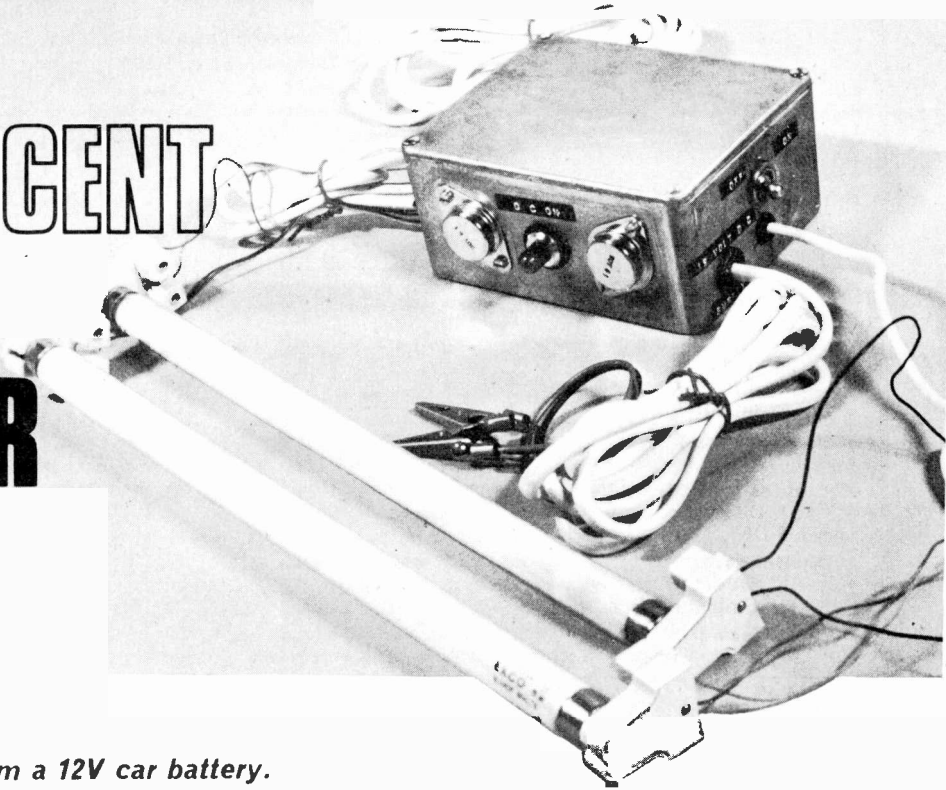
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*Our May issue will be published on
Friday, April 14.*

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DOUBLE FLUORESCENT LAMP INVERTER

BY C.J. MILLS



*Lights two 8W lamps from a 12V car battery.
Ideal for campers or for emergency lighting*

In this article designs for both a push-pull inverter to supply two 12in, 8 watt fluorescent lamps and a simpler unit to drive an 8 watt lamp will be given. Both units will operate from a 12V d.c. supply.

The use of a high frequency of oscillation for the inverters (20-30kHz) provides several advantages. It gives a more efficient operation of the lamp and it permits the use of smaller and more convenient types of transformer such as the Ferroxcube pot cores. Also, as this frequency is above the audio range, there are no annoying whistles from the units.

PUSH-PULL INVERTER

Now that high frequency planar power transistors are available at reasonable prices, the construction of high frequency power inverters becomes attractive because of the small size of transformer required.

As planar transistors are more prone to failure under reverse bias conditions than others, inverter switching circuits have to be modified to prevent this by the inclusion of high speed diodes in the bias circuit.

In Fig. 1 is shown the circuit of a 20 watt inverter suitable for driving two 8 watt fluorescent lamps or one 13 watt lamp. There is also a 230V d.c. outlet which can be used for powering a shaver.

To understand the circuit action, assume that TR1 is off and TR2 on and ignore the effect of the starting bias network. TR2 obtains its base current

from the feedback winding L1 via C6 and will stay on until this capacitor is discharged.

When the discharge current drops below the holding base current of TR2 its collector current drops and it is switched off while TR1 is switched on by transformer action. The reversed feedback voltage now holds TR1 on until the capacitor is again discharged and the cycle is completed. The timing of the on periods depends on the exponential discharge of the capacitors and therefore the CR time constant controls the frequency of operation. With this circuit a good square wave output can be obtained at frequencies up to 50kHz and the low saturation voltage of the transistors result in low dissipation and high efficiency operation.

The secondary circuit has to provide three separate heater supplies and sufficient volts to strike the fluorescent lamps. The current for the lamp LP2 is limited by the choke L6 which integrates the square wave input voltage to give a triangular wave. LP2 is supplied through a capacitor giving a differentiated wave form.

The result of these wave changes is a more efficient loading of T1.

SHAVER SUPPLY

To obtain a 250V d.c. supply for an a.c./d.c. shaver, the voltage from L5 is switched via S2 to a bridge rectifier. Small capacitors are added at the output to boost this voltage.

COMPONENTS . . .

DOUBLE LAMP INVERTER

Resistors

- R1 1k Ω
- R2 220 Ω
- R3 22 Ω
- R4 18 Ω
- R5 220 Ω
- R6 22 Ω
- R7 1k Ω
- All $\frac{1}{4}$ W, 10% carbon

Capacitors

- C1 0.047 μ F
- C2 1,000pF 300V
- C3 4,700pF 300V
- C4 0.68 μ F 300V
- C5 4,700pF 300V
- C6 0.18 μ F

Transistors

- TR1, TR2 BD123 (2 off)

Diodes

- D1, D2 IN916 (2 off)
- D3-D6 Silicon Bridge Rectifier 400V 2A

Switches

- S1 5A single pole on/off toggle
- S2 Single pole changeover

Transformer

- T1 35mm Ferroxcube type FX2242

Choke

- L6 25mm Ferroxcube type FX2240

Miscellaneous

- Diecast box $4\frac{1}{2}$ in \times $3\frac{1}{2}$ in \times 2in, LP1—miniature mains neon, LP2, LP3—8W miniature fluorescent lamps (2 off), wire (see text).

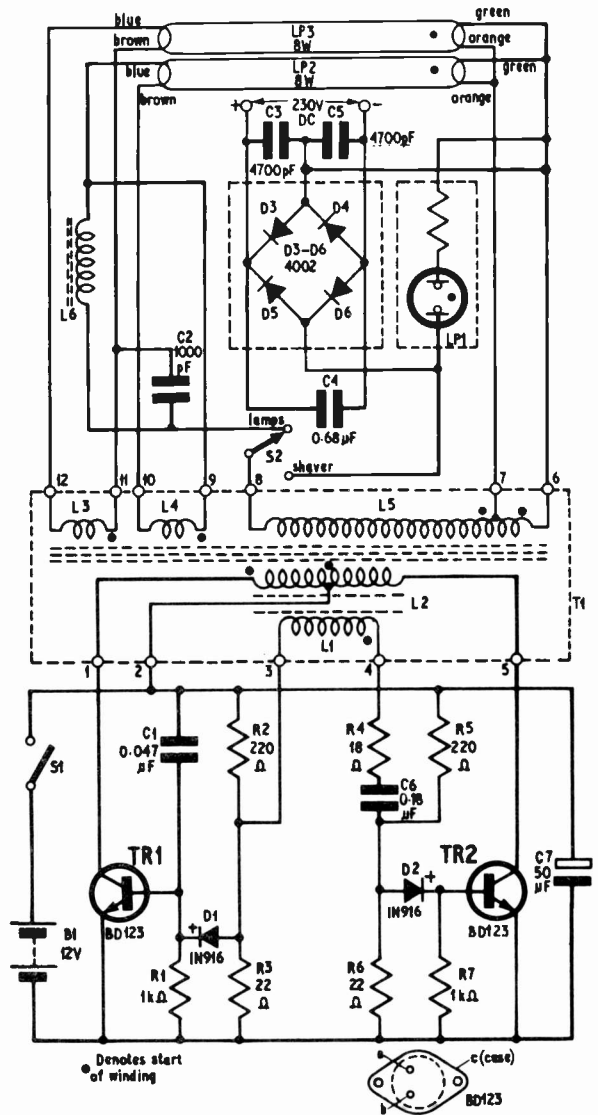


Fig. 1. Circuit diagram of 20 watt inverter

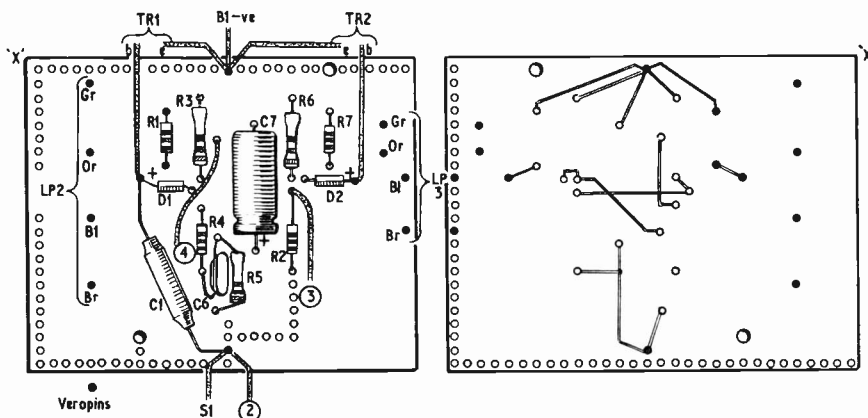


Fig. 2. Assembly and wiring details of component board

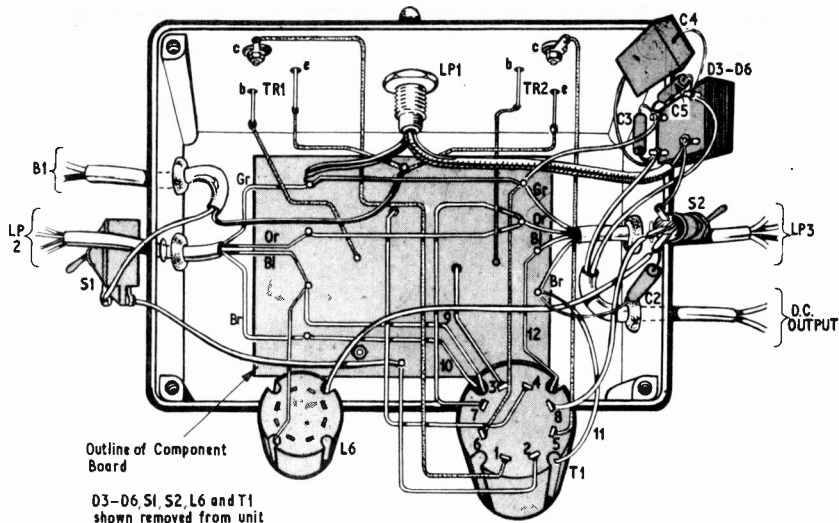


Fig. 3. Interwiring details of case mounted components and the board of Fig. 2

COIL WINDING

The transformer consists of a 35mm Ferroxcube pot core with the bobbin wound as follows.

First, about 10ft of 24 s.w.g. enamelled copper wire is doubled and wound on to the bobbin evenly until a double winding for L2 of 14 turns for each half is obtained. Next, the 15 turn feedback winding L1 is added using 30 s.w.g. wire followed by a layer of plastic insulating tape.

The main secondary winding L5 is now added, this being tapped after 10 turns and another 220 turns then put on and insulated with a layer of tape. Finally, two 10 turn heater windings (L3, L4) are put on.

Each winding should be identified by different coloured sleeving before fitting the bobbin into the pot core.

To operate a 13 watt fluorescent lamp the turns on L5 should be increased to 270 and one of the insulated heater windings omitted.

For the choke L6 a 25mm Ferroxcube FX2240 is used with 200 turns of 36 s.w.g. enamelled copper wire wound on the bobbin.

CONSTRUCTION

A suitable case for the inverter is a 2in \times 3 $\frac{1}{2}$ in \times 4 $\frac{1}{2}$ in diecast box which can be used as a heatsink for the transistors if these are mounted with mica washers and plastic bushes.

Three holes are drilled in the case and fitted with grommets for the input and output leads. Ideally all output leads should be screened to reduce capacity coupling and radio interference to a minimum.

Assembly and wiring details for the inverter are given in Figs 2 and 3. Here the circuit board should be trimmed to fit inside the case and two holes drilled to take supporting screws.

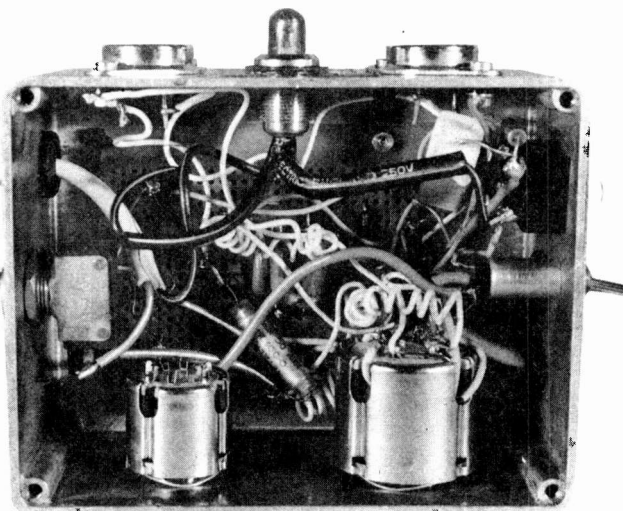
TESTS AND ADJUSTMENTS

The first test of the inverter should include some means of current limiting to prevent transistor damage under fault conditions. A series 10 watt wire wound resistor of 2 to 3 ohms is suitable and should be included in the battery line. An ammeter, if available, should be used to check the current.

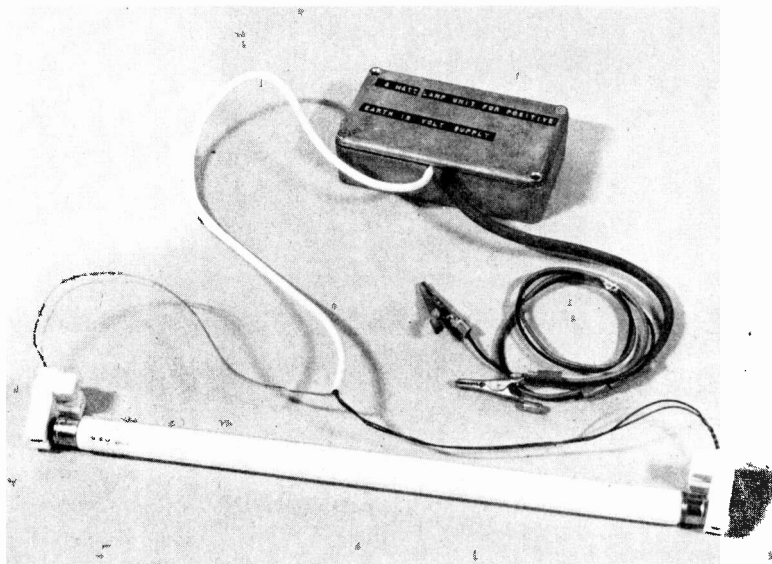
With no loads connected and S2 switched to "Shaver" the unit can be switched on for a short period. If the neon lights this proves that the inverter is oscillating; with no overheating apparent the limiting resistor can be removed and the lamps connected.

The relative brightness of the lamps can be adjusted by trimming C2 or by adjusting the frequency by trimming C6. Increasing this will reduce the frequency which will reduce the voltage drop across L6 and increase the voltage drop across C2 with both lamps alight the current drawn should be about 1.8A.

A test load resistor of between 5 and 10 kilohms should be connected across the bridge output when S2 is switched to "Shaver". The switch does not stop heater current being taken by the lamp, so to prevent excessive current being drawn the inverter should not be operated in the d.c. mode without a load (shaver) connected.



8 WATT FLUORESCENT LAMP INVERTER



SINGLE LAMP INVERTER

A circuit for driving a single 8 watt fluorescent lamp is given in Fig. 4. As can be seen this is less complex than the push-pull inverter, its working principles being based on the well known Hartley oscillator.

This particular configuration has the advantage that the collector of TR1 can be connected to the case which forms the heat sink. A disadvantage is

COMPONENTS . . .

8W LAMP INVERTER

Resistors

- R1 1k Ω
- R2 68 Ω
- All 10%, $\frac{1}{4}$ W carbon

Capacitors

- C1 0.022 μ F
- C2 0.1 μ F

Transistors

- TR1 DT3201 (Lucas) or MJE 520

Transformer

- T1 Ferroxcube pot core type LA5

Miscellaneous

- LP1—miniature 8W fluorescent lamp
- Diecast box 4 $\frac{1}{2}$ in \times 2 $\frac{1}{2}$ in \times 1 $\frac{1}{2}$ in, miniature "tombstone" two pin lampholders, s.r.b.p. board, wire (see text)

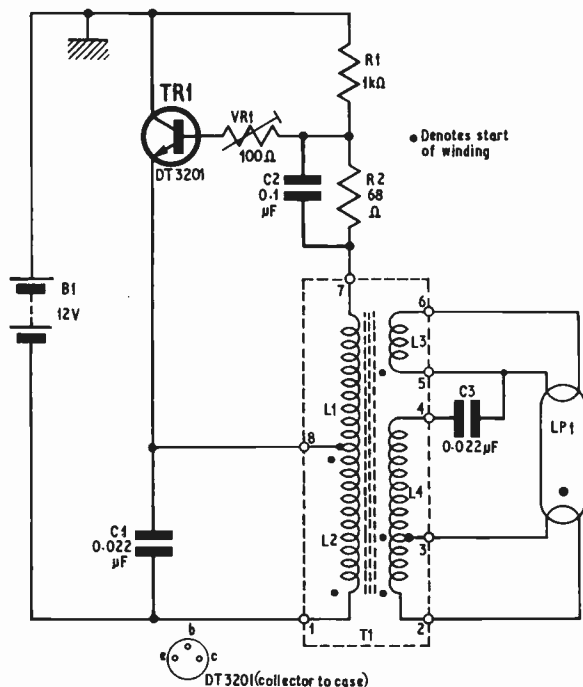


Fig. 4. Circuit diagram of single lamp inverter

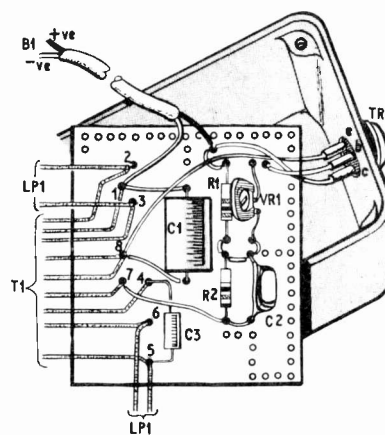
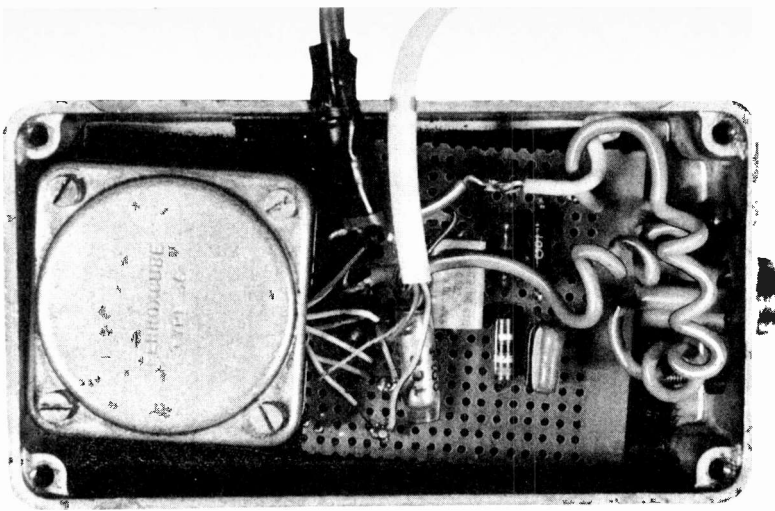


Fig. 5. Assembly and wiring details of the single lamp inverter



Interior of single lamp inverter. The components board should be insulated from the case

the risk of an excessive voltage appearing across the transistor if the unit is operated off load. Whilst there are a number of protective techniques available these were not found necessary providing the particular silicon transistor specified is used.

It is possible to strike the fluorescent lamp without the heater supply if sufficient volts are applied but this is not recommended as it shortens the life of the lamp.

No attempt was made to switch out the heaters when the lamp has struck or to switch the heaters across the battery prior to starting as the additional power consumed by the heaters is small and the extra size and complexity of the switching required was not considered worthwhile.

CURRENT LIMITING

The secondary voltage developed by the inverter must be high enough to strike the lamp and this voltage is higher than the normal running voltage. The lamp provides a negative resistance load on the inverter and a series impedance is required to limit the lamp current and drop the running voltage to the correct value.

The series impedance normally consists of a choke for higher power lamps; a small value capacitor (C3) is adequate.

TRANSFORMER

The transformer T1 consists of an LA5 pot core wound as follows. The primary winding L2 is wound on first using 26 turns of 26 s.w.g. enamelled wire. The feedback winding (L1) is then added using 10 turns of 32 s.w.g. wire and in the same direction as the primary. After identifying the ends with coloured sleeves, wrap round a layer of plastic insulating tape.

The secondary winding (L4) consisting of 350 turns of 36 s.w.g. wire is put on next, with a tapping at 18 turns for a lamp heater supply. The ends of this are identified and a layer of tape added. A final heater winding, in the same direction as before, of 20 turns of 32 s.w.g. wire (L3) completes the transformer.

UNIT CONSTRUCTION

The next stage is to mount TR1 on a 4½in × 2½in × 1in diecast box as in Fig. 5. The Ferroxcube pot core is attached to a piece of s.r.b.p. board which

approximately fits the box area. One method of doing this is to fit 6B.A. soldering tags under two adjacent screws on the pot core and to solder these tags to pins fitted on the board.

After completing the component assembly, unit operation should be checked. An a.c. meter or neon can be used to check that the unit is oscillating and producing a secondary voltage. Failure of the circuit to operate is indicated by a low input current and no secondary volts and can be due to a reversed or shorted winding or a low supply voltage.

CONNECTING THE LAMP

When the fluorescent lamp is connected and the normal supply voltage is applied, an initial glow at the tube ends will indicate that the heaters are working and the tube should strike and light up almost immediately.

To assist in starting during preliminary tests a fine wire can be stretched between the metal end caps and connected to one of the heater pins. This may be dispensed with in normal use if the tube is mounted close to a metal mounting bracket which is connected to the metal end caps and one heater winding.

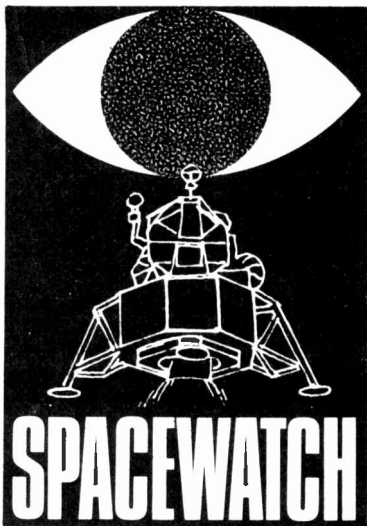
When the lamp lights, small adjustments of bias and frequency can be made to obtain the best performance. The variable resistor VR1 should be set for optimum light output with satisfactory starting under the worst conditions (a cold lamp and a low voltage battery).

The oscillator frequency can be adjusted by varying the capacity across the primary or secondary coil until it is above the audio range. If measuring facilities are available a frequency of 18 to 25kHz is suitable remembering that the capacity of the cable connecting the lamp to the inverter will have some effect.

The final power consumption of the unit should be about 0.6A at 12V. ★

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BY FRANK W. HYDE

RADIO TELESCOPE TO REACH LIMITS OF THE UNIVERSE?

A new radio telescope of very large aperture (VLA) is to be set up by the National Science Foundation under Dr W. McElroy. This is an outstanding project which will make this aerial system the most sensitive and greatest collector of radio energy from outside the earth.

No final details are at present available but the general design will be in the form of multiple dishes in a pattern 25 miles long. Situated somewhere in the mountainous area of south western America, it will take four to six years to build at a total estimated cost of 60 million dollars.

The limit of range is claimed to be between 13 and 16 thousand million light years. Hitherto, the limit of any array has been thought to be 13 thousand million light years because this is approximately the limiting factor set by the speed of light. Dr Edward David, who is science adviser to the President, has said that the project will put America in the forefront of space exploration by radio for many years to come.

Carl Sagan, one of the pioneers of listening for signals that might emanate from other civilisations, stated recently that an instrument of such gathering power would be ideal for seeking evidence of external intelligences.

GRAND TOURS CANCELLED

The proposed grand tours of space have been dropped from the new U.S. space budget funding as being too expensive when set against the scientific value of data recovered. This will be a disappointment to many astronomers engaged on studies of the solar system.

Another project that has been dropped is the Nerva programme. This project for a 75,000lb thrust, nuclear propelled rocket has been under development since 1955. It is to be replaced by a project to study small 15,000lb thrust atomic engines that can be used on unmanned missions in the 1980's. These missions will concern the outer planets. It seems that this means, in reality, only a postponement of the grand tours idea.

SKYLAB

There are three scientists among the crew for *Skylab* space laboratory. This space station will go into orbit for seven months next year.

The date for launch is April 30, 1973. A day later the first three-man crew will be launched in an *Apollo* spacecraft. They will meet and lock on to the space station, the crew will then transfer aboard and work for 28 days in *Skylab* before returning to earth.

If this first mission is successful then about a month later the second crew will journey to the space station where they will stay for 56 days. After their return and another waiting period the third crew will go to *Skylab* for another 56 days.

The work undertaken in *Skylab* will be extensive and will include observations of the sun with a large telescope attached to the station; observations of earth resources and the weather; and experiments in chemical, physical, and medical effects of weightlessness.

The nine crew members together with the six back-up crew will represent more than a third of the 44 active astronauts. Those not assigned to *Skylab* missions will be undergoing training for the space shuttle programme with the exception of the crews for *Apollo 16* and *Apollo 17* due for launch in April and December 1972.

MARINER 9

Mariner 9 has been raised in orbit a second time to compensate for Mars effect on the spacecraft. This effect is twofold; the direct effect is the gravitational field of the planet and the perigee point has been raised from 1,388km (862 miles) to 1,650km (1,025 miles). This increases the mean orbital period by some 79 seconds to 11hr. 59min. 32sec.

Originally three 20-day cycles were allocated to complete the revised mapping of the surface with a fourth period in hand as reserve. The great dust storm which raged for so long has made it necessary to complete this mapping in two 20-day cycles with a third period to cover gaps. The raising of the orbit will facilitate this.

The other reason for changing the craft's orbit is that the distance between Mars and earth is now rapidly increasing. This requires a reduction in data transmission time. The present rate is 16,200 bits/sec. Another important item is that the Golstone antenna will have to be assigned to the *Apollo 16* mission. The new orbit places the transmissions in the middle of the Golstone viewing period ensuring maximum transfer of data.

NEW VIEW OF MARS

The surface changes on Mars have always excited the imagination from the time of Schiaparelli in 1877. With the fading hopes of life on Venus it was natural to turn to Mars. Markings on Mars were translated as being due to vegetation of an elementary kind which extended with the release of moisture from melting polar caps.

Even this interpretation is now suspect. Again it is the pioneer Carl Sagan together with Peter Gierasch and Joseph Veverka who have been responsible for directing attention to other explanations. This team have shown that the *Viking* landings on Mars will face difficulties as a result of the dust storms and atmospheric disturbances.

There is a special difference between the generation of wind on the earth and on Mars. Essentially, the difference is that on Mars the vertical relief is comparable with the scale height. This is the vertical distance over which the pressure falls by half.

In the mountainous areas it means that the isotherms follow the contours of the relief. The result is that if a horizontal wind strikes a slope it runs into a steep thermal gradient. It is possible that convective relief winds could attain velocities of 250mph.

There are also global systems which are seen to be dependent on the seasonal heating and cooling of the polar regions. If local and global winds should reinforce one another then speeds nearing 400mph could arise.

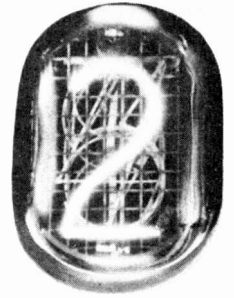
The highest velocities are found over large basins and large plateaux which are bordered by steep relief. The velocities are many times greater than the minimum required to transport the dust.

Maximum activity should come when Mars is at perihelion since the effects of uneven solar heating would ensue. It would appear then that the growth of the dark areas are due to wind activity. Radar measurements have already shown that the dark areas are zones of high elevation. An extensive study of the Syrtis Major area confirms that the changes, seasonal and secular, are in conformity with the observation of windborne dust.—Exit little green men?

ALPHA NUMERIC DISPLAYS

Part

By R.W. Coles



Decoding & Driving circuits for cold cathode tubes

WHEN it is necessary to display the contents of a memory or counter a special circuit is needed to decode the B.C.D. into a one out of ten output in order to drive a cold cathode tube. The outputs of this circuit must be able to withstand the high voltages present when driving these tubes. In this month's article some of the methods of decoding and driving are described.

DECODING AND DRIVING CIRCUITS

The simplest way of energising a numicator tube is to select the required cathode by means of a multi way switch, the pole of which is earthed. This is fine if such a simple system is compatible with the display inputs, but in most cases data will be presented to the display in coded form, requiring some method of decoding before application to the tube.

The code most used is the simple four bit (bit means binary digit) code called B.C.D. (binary coded decimal). A four bit binary group has 16 possible combinations, which by convention are equivalent to the decimal numbers 0 to 15. In the B.C.D. code only the first ten combinations are utilised to represent the numbers 0 to 9, and if the other six combinations are allowed to appear, they represent error states. With this in mind we can now look at the simplest way of decoding the B.C.D. code, and using the decoded form to drive a cold cathode tube.

Fig. 2.1 shows a circuit arrangement known as a relay decoding tree, which consists of four relays each controlled (energised or de-energised) by a particular digit in the B.C.D. group. If a digit is a logic "1" then its associated relay will be energised, and if it is a logic "0" its relay will be de-energised, each B.C.D. combination giving a unique path through the relay contacts to the appropriate cathode.

Decoding trees of this kind can be very useful in some applications, but have a number of disadvantages common to all circuits which use relays, including slow operation and short life. A solid state decoder driver circuit overcomes all of the disadvantages of the relay tree, and today tiny i.c.s are available which will decode the B.C.D. and drive the numicator cathodes directly, all for less than £1.

I.C. DECODERS

The availability of decoder/driver i.c.s at such low prices makes it most unlikely that anyone would want to go to all the trouble and expense of building this sort of circuitry with discrete diodes and transistors, and there seems little need to discuss these possibilities.

The first i.c.s produced to drive cold cathode displays were the now very common SN7441As. These i.c.s form part of the TTL range of logic types, and

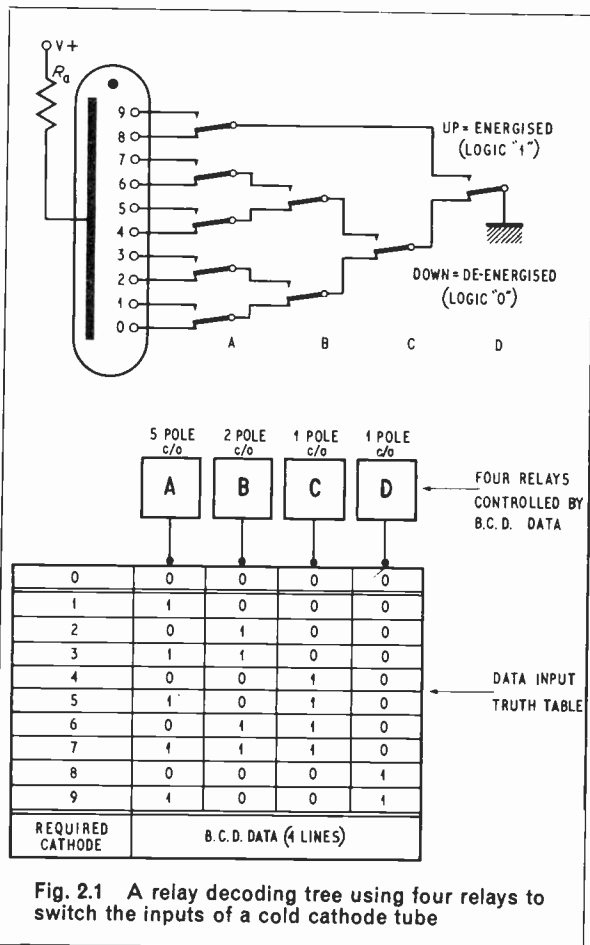


Fig. 2.1 A relay decoding tree using four relays to switch the inputs of a cold cathode tube

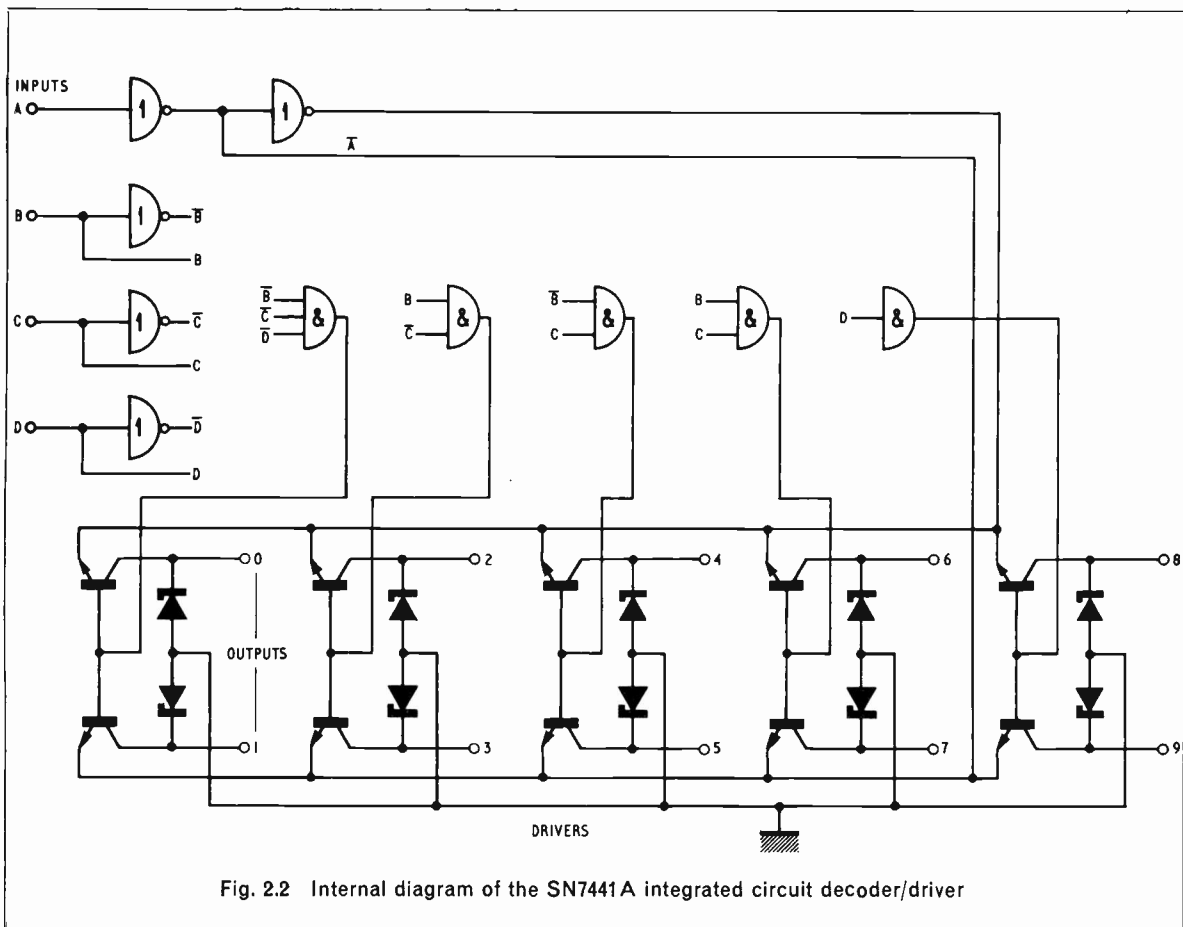


Fig. 2.2 Internal diagram of the SN7441A integrated circuit decoder/driver

because of the relatively large number of components integrated in each device, come under the sub-heading of "Medium Scale Integration" (M.S.I.).

The 7441 has four TTL logic compatible inputs, marked A, B, C, and D, and has ten outputs which will withstand at least 55 volts in the off state, and sink currents high enough to drive even large tubes.

INTERNAL CIRCUIT

The circuit of the 7441 is shown in Fig. 2.2. The inputs to the circuit are first buffered and then inverted to make available both true and complement data to the following decoding gates. Input A is used to switch on either the emitters of the odd number driver transistors, or the emitters of the even number drive transistors, thus simplifying the gating, which drives the bases of the output transistors a pair at a time.

There are five pairs of output transistors, and these are controlled by one three input gate (to decode 0 and 1), three two input gates (2 and 3, 4 and 5, 6 and 7) and the last pair by the ungated D input. This decoding uses the minimal logic, and assumes that the error states in the B.C.D. code (the binary equivalents of 10 to 15) will never occur; if they do occur, more than one of the ten outputs will be enabled. Binary 15 for example, 1111, will drive cathodes 7 and 9 at the same time, and this state of affairs must not be allowed to occur.

ZENER DIODES

Note the Zener diodes between the collectors of the drive transistors and ground, these are a modification to the original 7441 design, and account for the A suffix in the full SN7441A type number. Their purpose is to prevent voltages appearing at the collectors of the drive transistors which would exceed their collector breakdown limit, and thus force the transistors themselves to behave like Zeners. Voltage spikes of up to the full positive supply voltage can occur at the cathodes of tubes driven by transistors, and it is clearly better to limit these spikes with a Zener than to let the transistor breakdown, even temporarily.

The fact that these i.c.s will withstand only a minimum of 55 volts on their outputs may be puzzling some readers, this value seeming to bear little relation to the already discussed supply voltage range used by "Nixie" tubes. The point here is that, unlike a relay tree, the transistor merely switches a differential voltage (of at least 55V) which is sufficient to reduce the voltage across the tube to a level below its striking potential, and thus extinguish it. The 55V differential is quite small, and does mean that the lower supply voltages specified for the tubes must be used in order to be sure of extinction of "off" cathodes. The voltage usually employed with these i.c.s is of the order of 180V, 55V being a big enough proportion of this to ensure correct operation.

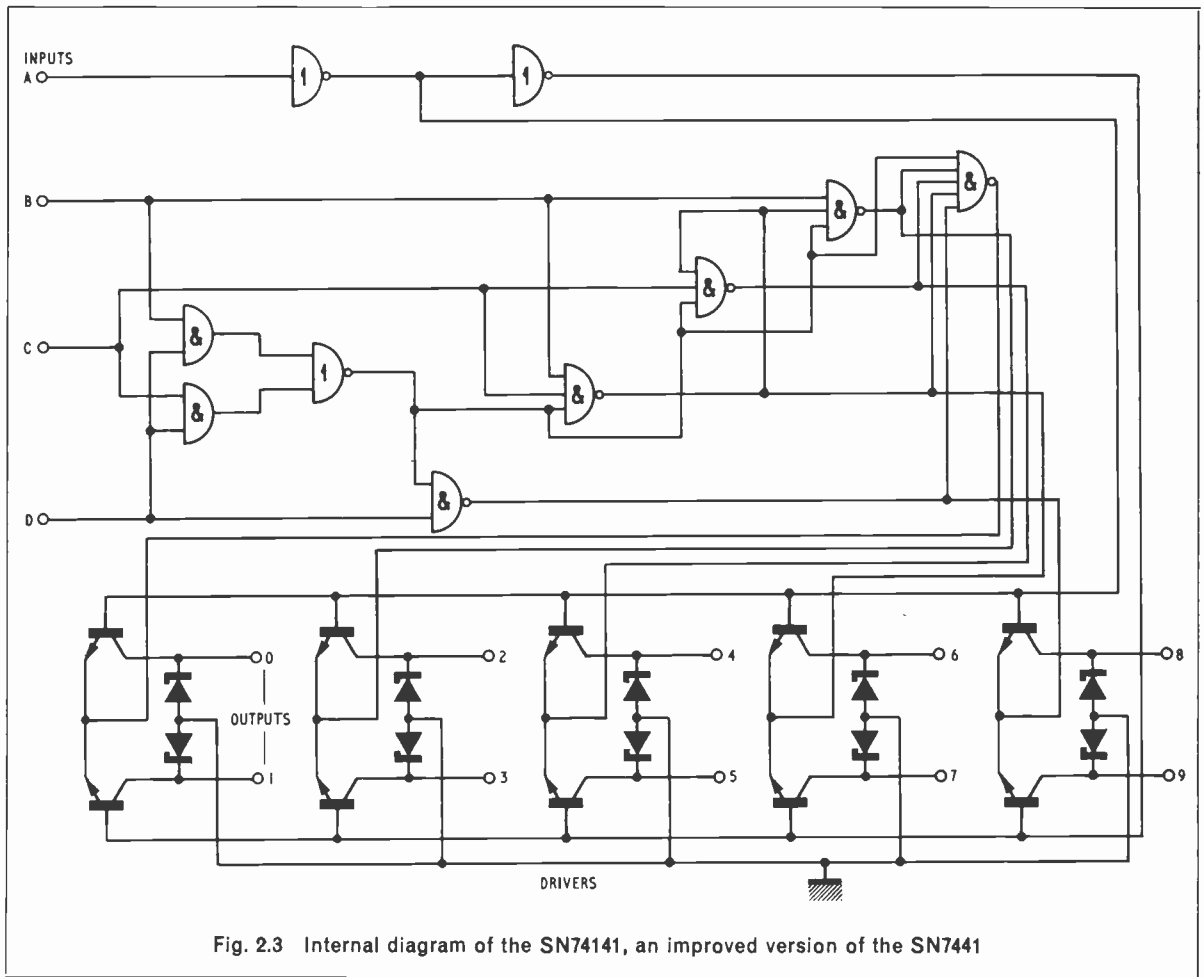


Fig. 2.3 Internal diagram of the SN74141, an improved version of the SN7441

IMPROVED PERFORMANCE

It may have become apparent during discussion of the 7441 device that there is room for improvement in some of its characteristics; having all cathodes off for error inputs would come in very handy as will be seen and an increase in the 55V level would give more freedom in supply voltage choice. These points have not escaped the i.c. manufacturers, and a new device which incorporates the improvements mentioned above and a few more besides, has recently been introduced, the SN74141.

This new device is already available through suppliers advertising in this magazine, and at the same price as the 7441. The block diagram of the 74141 is shown in Fig. 2.3 and, as can be seen, the basic principles are the same, the only difference being that the 74141 has a full decode of the input data, so that error codes will not drive any of the cathodes, and the tube will remain off.

The differential voltage switching capability has been raised to at least 65V with this device, and other circuit improvements have been incorporated to reduce switching transients and power consumption.

SUPPRESSION OF ZEROS

The invalid, or error code blanking, is useful when leading or trailing edge suppression of zeros is required in long displays. The effect of zero suppression is to blank the display tubes in a system which would normally show insignificant zeros, giving a resultant display which is very easy to read. For an example of the effects of combined leading and trailing edge zero suppression see Fig. 2.4.

The algorithm for producing the ripple blanking effect is quite simple.

FOR LEADING EDGE:

If digit one is a zero—blank it

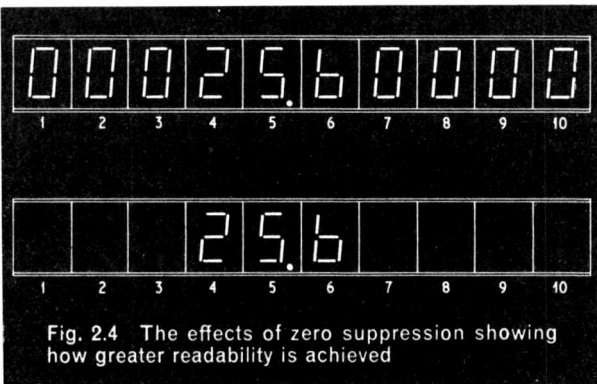


Fig. 2.4 The effects of zero suppression showing how greater readability is achieved

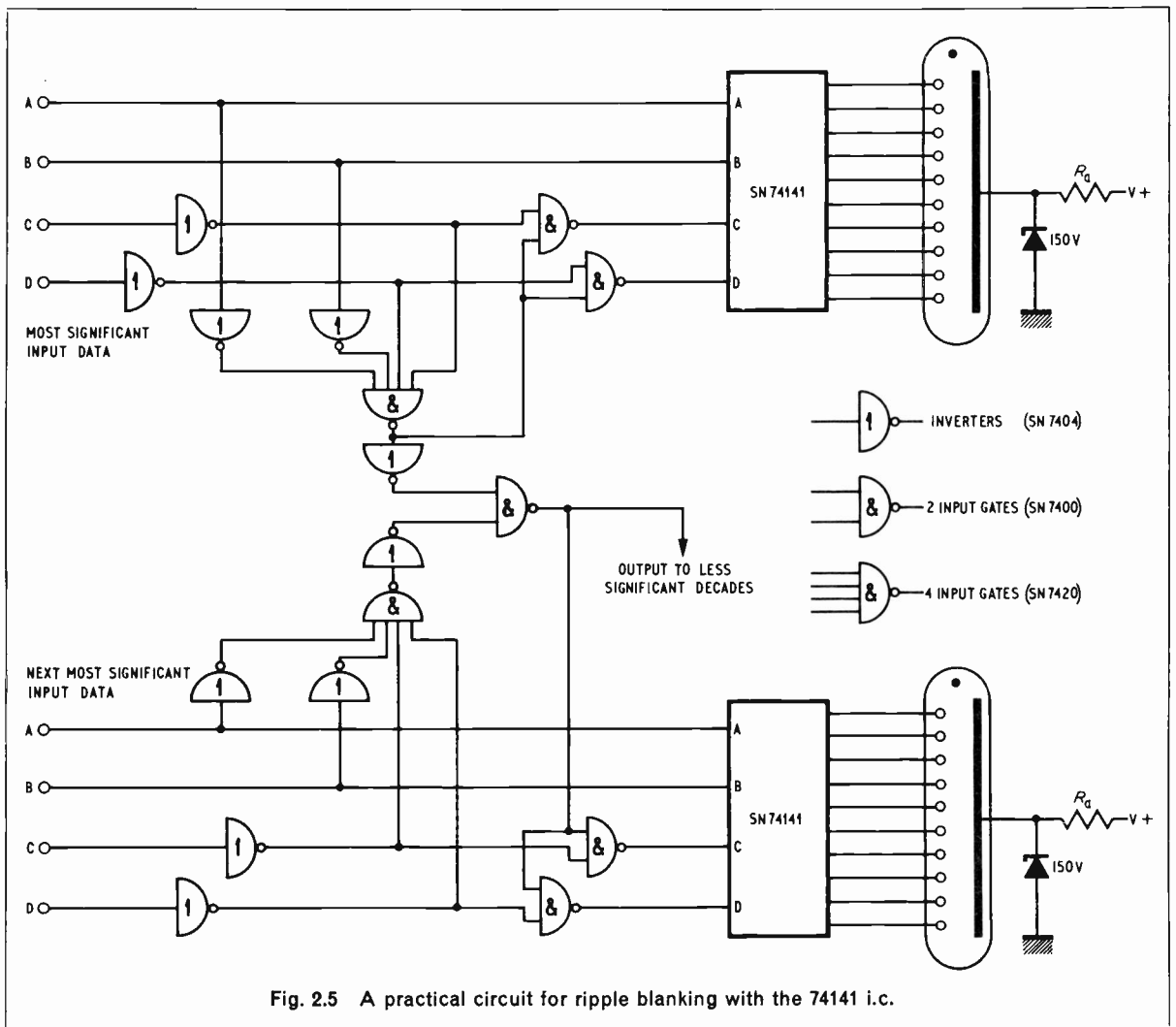


Fig. 2.5 A practical circuit for ripple blanking with the 74141 i.c.

If digit two and the digit before it are zeros—blank it

If digit three and the digits before it are zeros—blank it, and so on down the display from the left until the first integer is encountered, after which no more zero blanking is allowed.

If a decimal point is used in the display it is usual to display the zero immediately preceding the point if no integer is present, and numbers after the point are blanked if necessary by the same algorithm as used above, but this time starting from the right-hand side.

FOR TRAILING EDGE:

If digit ten is a zero—blank it

If digit nine and the digit after it are zero—blank it

If digit eight and the digits after it are zeros—blank it also.

This process continues until an integer is encountered, or until the digit after the decimal point is reached, which is displayed regardless.

If a display holds all zeros the ripple blanking will give

---- 0.0 ----

A PRACTICAL CIRCUIT

Blanking with the 74141 device is achieved by forcing its inputs into one of the invalid states when required, and part of a ripple blanking scheme with this device is shown in Fig. 2.5.

The operation of this circuit is simply that the 7420 4 input gate detects a zero in the most significant position and blanks it by forcing the 74141 inputs to binary 12. If the next most significant position also contains a zero its 7420 output is gated with the previous one to force binary 12 into its inputs also. This system can be expanded to handle any number of digits required, it can also be reversed of course, to give trailing edge blanking.

There is one point to note. It may be necessary to incorporate a Zener diode of 150V rating at the anode of each tube, as shown; this has the effect of clamping the anode voltage to 150V and is desirable to prevent partial striking of some of the cathodes when no current is being drawn by the tube during blanking.

Next month: Incandescent filament display devices.

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.

SIMPLE LAMP STROBE

THE circuit diagram in Fig. 1 may be of interest to some of your readers. It was built especially for a school production, where it was used for special stage lighting effects.

The circuit consists of a six volt power supply, using a mains transformer and a full-wave rectifier (note: no smoothing capacitors). This powers a simple multivibrator, whose frequency is governed by potentiometer VR1. This feeds the gate of thyristor SCR1 via a small isolating transformer T2, which in this case was a discarded transistor radio push-pull type.

A 1½A 400 p.i.v. SCR, fitted to a heatsink, provided excellent control for a 150 watt reflector lamp. However, if the strobe is to be used for high speed work, then low wattage bulbs (or a string of them in parallel) should be used, as thermal inertia sets up in the filaments of high wattage bulbs and light is still emitted after the current has been turned off. This may continue until the next pulse reaches the filament, therefore not producing a true strobe effect.

I. Hunt,
Lower Hutt,
New Zealand.

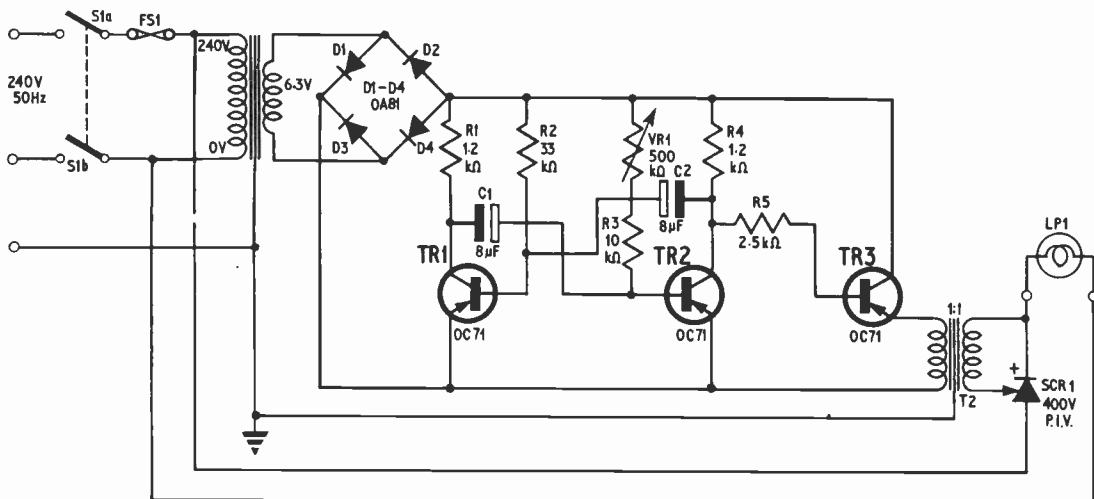


Fig. 1. Simple mains lamp strobe circuit

UJT STEP-FREQUENCY OSCILLATOR

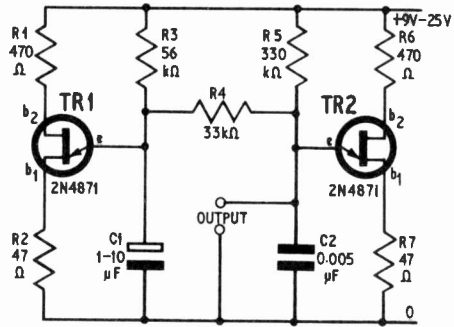


Fig. 2. Circuit diagram of unijunction oscillator

THE circuit in Fig. 2 will produce a sound of increasing frequencies until the highest one is reached and then the cycle will repeat again starting from the lowest.

The circuit is basically two unijunction transistor relaxation oscillators cross-coupled by resistor R4. When the circuit is connected to the supply, capacitors C1 and C2 start to charge up via resistors R5 and R3.

Because R5, C2 is the shorter time constant, TR2 will fire first and C2 discharge. When C2 again starts to charge there is a voltage on C1 and C2 now charges via R5, R3 and R4. This will shorten the time constant for TR2, due to C1 charging. The unijunction TR2 now fires quicker and quicker until TR1 fires. The cycle will then repeat.

The cycle length is controlled by R3 and C1 and the lowest frequency by resistor R5 and capacitor C2. A wide variation of values for these components is possible and those given in Fig. 2 are only a guide.

This circuit would make an addition to the sound effects board used in the War Games Computer. Other possible uses include door bells and audio alarms.

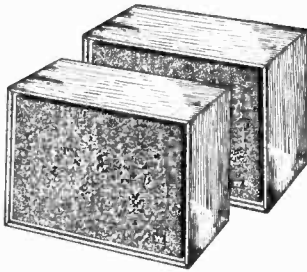
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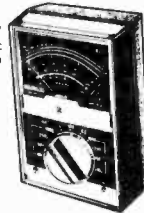
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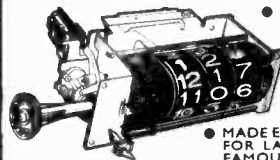
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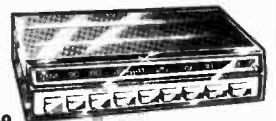
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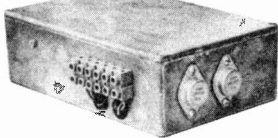
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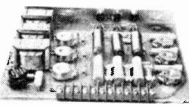


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PERHAPS the following circuit (see Fig. 3) would be of interest to your readers, and hence suitable for inclusion in the Ingenuity Unlimited section.

The circuit was designed to regulate the speed of the motor of a small capstan driven battery tape deck, a Garrard two-speed two-track transport, now out of production. The system should also prove suitable for the regulation of speed of other portable deck motors, provided that they have non-ferrous flywheels.

The pulse signal, consisting of "bursts" of sine wave from the flywheel velocity detector, is fed via C1 to the base of TR1, which is biased by potentiometer VR1 adjusted to give a collector-emitter voltage of six or seven volts. The output from TR1 passes through capacitor C2 to the base of the Schmitt trigger TR2, which is biased to near threshold by resistor R2. The output from the trigger at TR3 collector is passed to the input of the monostable TR4 and TR5 via C3. The leading edge of the monostable output waveform is sharpened by the "speed-up" capacitor C6 to give a fast switching pulse at TR5 output.

The values of C5 and R8 were chosen to give a pulse duration of about ten milliseconds, as the basic pulse repetition frequency is roughly 30Hz at a tape speed of 3½ in per second.

The monostable square wave output (of constant amplitude and duration, despite variable frequency) is fed to an integrating network consisting of R12, D1, C8 and VR2, where varying frequency causes a proportional varying d.c. voltage to appear across VR2. This potentiometer is set for the final motor speed and acts as a potential divider providing base voltage for the common collector d.c. amplifier TR6.

When the voltage at the base of TR6 exceeds the base-emitter voltage (approx. 0.6V) the transistor starts to conduct, making the anode of diode D2 less negative. When the anode-cathode voltage of D2 falls below the Zener voltage, the Darlington pair TR7 and TR8 switch off. Hence the motor power is reduced, the flywheel speed and pulse frequency fall. The centrifugal governor contacts should be connected together.

When the system is switched on, near full voltage appears across the motor, which promptly runs up to a speed where the integrating circuit voltage output causes TR6 to conduct heavily enough to decrease motor power. The motor speed then holds satisfactorily stable, although there is slight "hunting" about the mean flywheel speed set by VR2. This may be reduced by placing a 1,000µF capacitor across the motor terminals. There is also some possibility of the logic circuitry being falsely triggered by armature noise from the motor. This may be cured by decoupling the supply line and/or stabilising the power supply.

The sensor could consist of a small "button" permanent magnet ("Eclipse" type) with as much 38 s.w.g. enamelled copper wire as will fill the magnet limbs and wound over paper insulation. However, this sensor has not been tried in practice as the prototype used the magnet and coil assembly of a small magnetic earpiece. As the input voltage is not critical there is no reason why the aforementioned system should not operate.

The flywheel markers were four short pieces of 18 s.w.g. soft iron wire stuck to the flywheel circumference at equally spaced distances. The sensor was mounted close to the flywheel periphery (less than 2mm air gap) and provided triggering down to speeds of 30 r.p.m.

If dual speed operation is required potentiometer VR2 should be duplicated in parallel, with a change-over switch provided between the base of TR6 and the respective wipers of the additional potentiometers. The required speeds may then be separately set on the potentiometers, calibration being carried out using a measured length of tape and a stopwatch.

The power transistor TR8 must be mounted on a heatsink approximately 15 square inches of either copper or aluminium sheet.

J. D. Watson,
West Worthing.

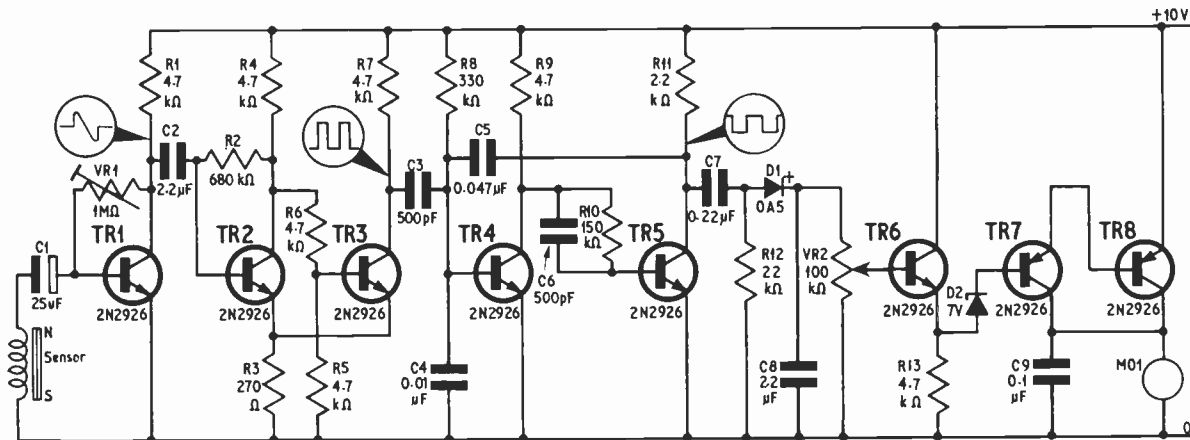


Fig. 3. Circuit diagram of the tape speed controller



CARAVAN FLASHER UNIT

I WAS recently amazed when I discovered the price of heavy duty motor car flasher units, used when a trailer or caravan is being towed. These units simply accommodate the extra indicator lamps without upsetting the timing of the indicator, and to my mind, this simple task does not justify its cost.

The circuit shown in Fig. 4 is an extremely simple modification to a car's existing indicator circuit, the only extra components being two 12V relays (single-pole change-over) which may be purchased fairly cheaply.

A further modification, at a slightly extra cost, would be to make RLA a double-pole change-over relay and wire as the other contact and a switch shown dotted in Fig. 4. If S1 is depressed and the

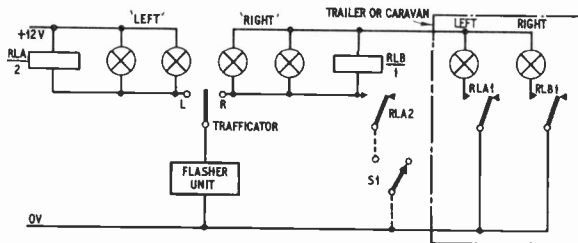


Fig. 4. Caravan or trailer flasher unit

trafficator switched to the "LEFT" position, ALL the six indicator lamps will flash on and off, constituting an emergency warning system in the event of an accident or breakdown.

L. Musworth,
Lancs.

UNISELECTOR PAPER FEEDER

THE IDEA to use a uniselector as a capstan drive for a paper recorder or seismograph was originally thought of as an alternative to the revolving disc system which had a somewhat restricted recording period. The circuit Fig. 5 provides variable paper tape speed from 2mm to 25cm per minute.

The unijunction TR1 generates positive going pulses, which are controlled by VR1. These are conveyed to TR2 by C2 which inverts the pulses and switches on TR3 for the duration of each pulse. Normally no heatsink is required for the power transistor TR3.

The uniselector used was a small 50Ω type and was marked T30338C. When all the switchgear is removed a 1.8cm shaft is revealed which can be

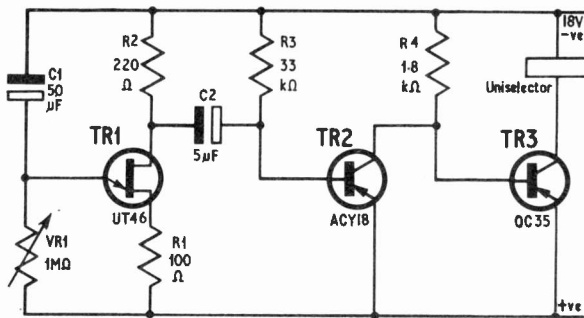


Fig. 5. Circuit diagram for paper feed controller

extended by a sleeve. This is used together with a sprung jockey wheel to feed the paper from a roll.

B. Darnton,
Sherfield English, Hampshire.

CAR ALARM TIMER

HAVING purchased a car alarm quite recently I was amazed how many times I forgot it was there and released a fearful blast from the car horns.

The circuit diagram, Fig. 6, shows a simple 4 to 12 seconds timer. The switch S1 is the trigger, it can be either the "tremor" switch supplied with burglar alarm kits or, as I have used, a pressure switch underneath the driver's seat cover.

When you leave the car you set the alarm by closing the toggle switch S2. When you get back in the car and sit down LP1 lights, this tells you that you've got about 6 seconds before the horns blast, so you open S2 and all is well.

The capacitor C2 across the relay holds the horn on if a real theft is going on. The transistors TR1 and TR2 can be any germanium general purpose types, i.e. OC71 or OC81. The lamp LP1 can be a l.e.s. 12V type (or 6V for motor cycles).

I. Davey,
Hinckley, Leicester.

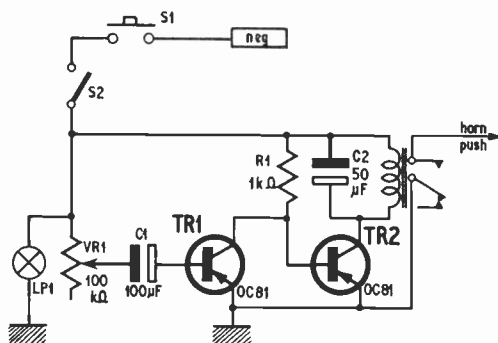


Fig. 6. Circuit diagram for a simple 4 to 12 second delay timer for a car burglar alarm

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SPECIFICATION . . .

Circuit

17 transistors, nine diodes and two integrated circuits with ceramic filters to give good selectivity and ease of alignment. Phase lock stereo decoder

Tuning Range

87-108MHz f.m. only

Sensitivity

2 μ V for 20dB quieting and 8 μ V for 40dB

Signal to noise ratio

60dB for inputs above 50 μ V

Distortion

Tuner 0.5% and stereo decoder approx. 0.3% at 1kHz, 100% modulation

Output

200mV at 100% modulation

Selectivity

6dB down at 235kHz bandwidth and 80dB down at 900kHz bandwidth

Image rejection

45dB

I.F. rejection

80dB

A.M. rejection

50dB

Stereo separation

Better than 30dB at 1kHz

Discriminator

Differential peak detector with single easily adjusted coil

Stereo decoder

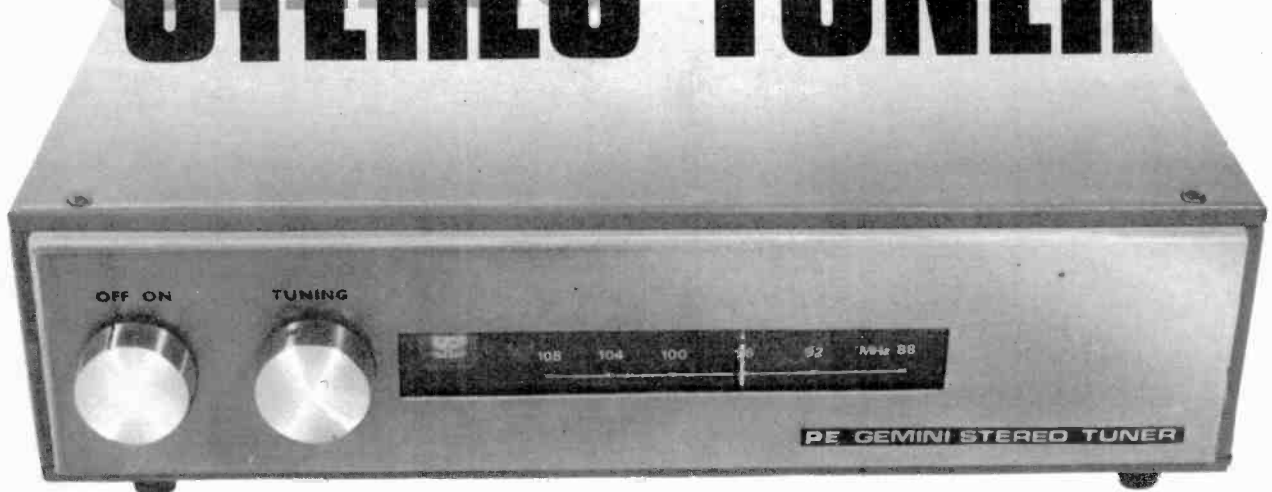
Phase lock loop type with only one easily adjusted coil

Construction

Built in case matching the P.E. Gemini pre-amplifier, with its own built-in power supply to enable it to be used with any high quality amplifier

P. E. GEMINI

STEREO TUNER



PART ONE

BY D.S.GIBBS & I.M.SHAW

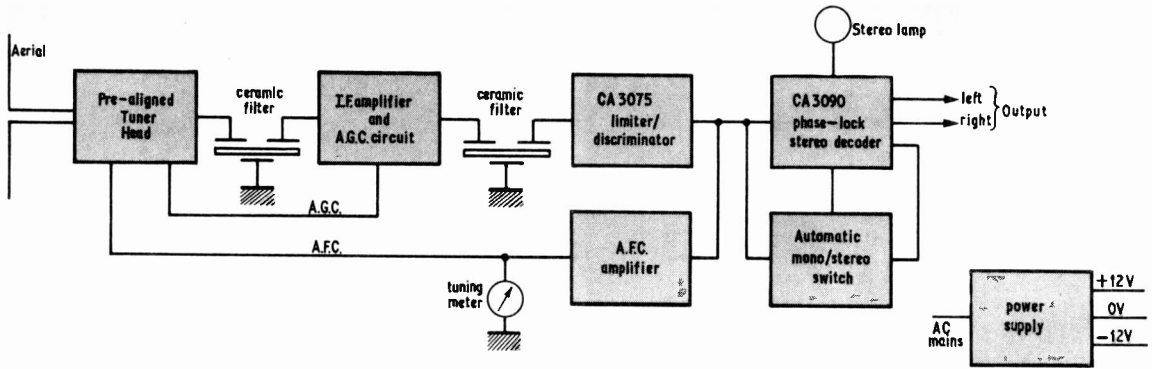


Fig. 1. Block diagram of the complete stereo tuner

THE "P.E. Gemini" Stereo Tuner is designed to give a very high standard of performance with the simplest possible alignment. In the past a high quality f.m. tuner has been a difficult project for the home constructor because of the problem of alignment, which in most cases could only be accomplished satisfactorily with the aid of a sweep generator. Pulse counter designs overcame the alignment problem, but only at the expense of poor selectivity, and spurious whistles when used with a stereo decoder.

Now all this has changed. By the use of advanced integrated circuits, ceramic filters and a pre-aligned tuner head, it is possible to build an f.m. tuner which can easily be set up by the home constructor.

The circuit can be conveniently broken down into five parts: the tuner head, the i.f. amplifier and filter, the limiter and discriminator using the CA3075 integrated circuit, the phase locked stereo decoder using the CA3090 integrated circuit, and the power supply. A block diagram is shown in Fig. 1.

TUNER HEAD

It is difficult for the home constructor to build a satisfactory tuner head since not only must lead lengths be kept to an absolute minimum and the individual stages carefully screened from each other, but the finished tuner head must be aligned and tracked to give consistent performance over the whole f.m. band. Consequently, this design makes use of a ready made and pre-aligned tuner head. The internal circuitry is shown in Fig. 2 for purely academic interest.

The tuner head used is a three transistor design with a three-gang tuning capacitor to give good selectivity. The whole tuner head is enclosed in a metal case to give good screening.

The tuner has facilities for a.f.c. (automatic frequency control) and a.g.c. (automatic gain control). The a.f.c. action, with the help of the a.f.c. amplifier, is very powerful and the tuner shows no tendency to drift. Unfortunately the strong a.f.c. causes

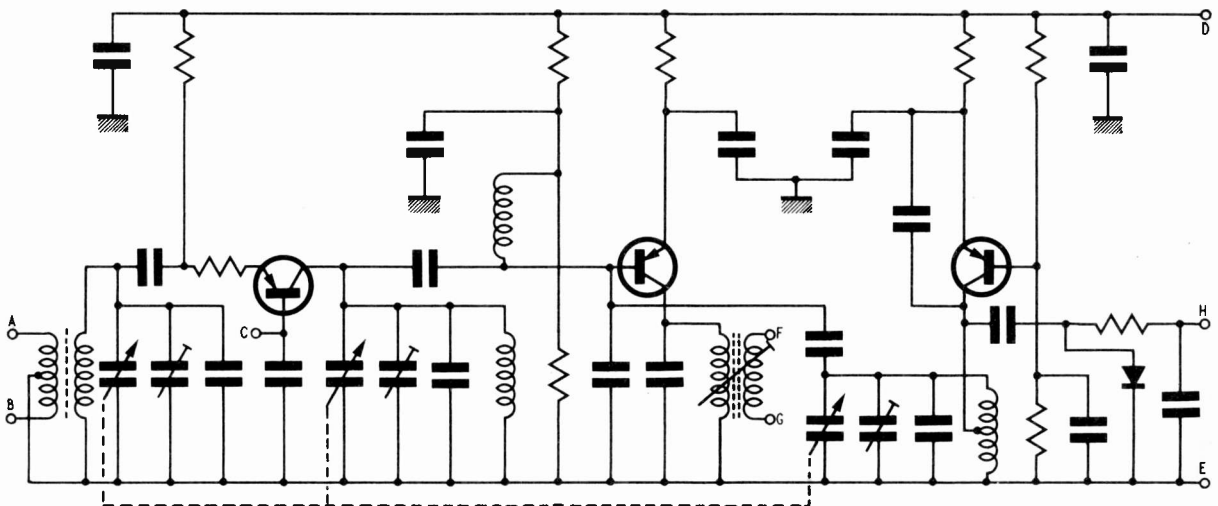


Fig. 2. Theoretical diagram of the pre-aligned f.m. tuner head

COMPONENTS . . .

Resistors

R1	1.8k Ω	R25	470k Ω
R2	330 Ω	R26	390 Ω
R3	330 Ω	R27	150 Ω
R4	47 Ω	R28	4.7k Ω
R5	330 Ω	R29	10k Ω
R6	680 Ω	R30	10k Ω
R7	100k Ω	R31	2.2k Ω
R8	22k Ω	R32	100 Ω
R9	3.3k Ω	R33	3.3k Ω
R10	330 Ω	R34	22k Ω
R11	82 Ω	R35	6.8k Ω
R12	22 Ω	R36	22k Ω
R13	1M Ω	R37	6.8k Ω
R14	100 Ω	R38	22k Ω
R15	10k Ω	R39	10k Ω
R16	390 Ω	R40	10k Ω
R17	12k Ω	R41	10k Ω
R18	6.2k Ω	R42	10k Ω
R19	10k Ω	R43	820 Ω
R20	4.7k Ω	R44	2.7k Ω
R21	47k Ω	R45	820 Ω
R22	2.2k Ω	R46	820 Ω
R23	10k Ω	R47	820 Ω
R24	10k Ω	R48	820 Ω

All $\pm 5\%$, $\frac{1}{4}$ W carbon.

Potentiometer

VR1 4.7k Ω (or 5k Ω) linear miniature moulded track preset

Capacitors

C1	4 μ F elect. 40V
C2	150pF polystyrene 125V
C3	680pF polystyrene 125V
C4	0.1 μ F disc ceramic 30V
C5	1,000pF disc ceramic
C6	1,000pF disc ceramic
C7	0.022 μ F disc ceramic 18V
C8	33pF polystyrene 125V
C9	1,000pF disc ceramic
C10	0.01 μ F disc ceramic 18V
C11	10 μ F elect. 16V
C12	1,000pF disc ceramic
C13	0.01 μ F disc ceramic 18V
C14	0.01 μ F disc ceramic 18V
C15	10pF polystyrene 125V
C16	47pF polystyrene 125V
C17	0.01 μ F disc ceramic 18V
C18	1,000pF disc ceramic
C19	220pF polystyrene 125V
C20	25 μ F elect. 25V
C21	0.22 μ F polyester
C22	25 μ F elect. 25V
C23	3,300pF polystyrene 125V
C24	1 μ F polyester 100V
C25	0.47 μ F polyester 100V
C26	1 μ F polyester 100V
C27	2.5 μ F elect. 16V
C28	6,800pF polyester
C29	6,800pF polyester
C30	4 μ F elect. 40V
C31	4 μ F elect. 40V
C32	470pF polystyrene 125V
C33	470pF polystyrene 125V
C34	0.015 μ F polyester
C35	32 μ F elect. 40V
C36	125 μ F elect. 16V
C37	250 μ F elect. 25V
C38	250 μ F elect. 25V
C39	0.0047 μ F polyester
C40	2,000 μ F elect. 25V
C41	0.1 μ F 1,000V

Transistors

TR1	ZTX311
TR2	ZTX311
TR3	ZTX311
TR4	ZTX311
TR5	ZTX108
TR6	ZTX500
TR7	ZTX500
TR8	ZTX108
TR9	ZTX108
TR10	ZTX108
TR11	ZTX108
TR12	ZTX550
TR13	ZTX500
TR14	ZTX108

Integrated Circuits

IC1	CA3075 (R.C.A.)
IC2	CA3090Q (R.C.A.) quad in-line or CA3090E dual in-line (see text)

Diodes

D1	ZS170
D2	ZS170
D3	ZS170
D4	ZS170
D5	ZS170
D6	ZS170
D7	KS110A
D8	KS120A

Filters

F1-2 Vernitron FM4 ceramic filter (2 off)

Meter

ME1 50.0-50.0 μ A centre zero f.m. tuning meter, 220-250 Ω

Transformer

T1 Mains transformer, secondary 12V-0-12V 0.5A

Inductors

L1 17 turns of 30 s.w.g. enamel on Neosid NS/E3 former
L2 2mH adjustable coil type 87135 BX 1.3mH to 2.3mH or type QL10 1.5mH to 3mH (details next month)

Lamps

LP1 6V 60mA i.e.s. indicator lamp (stereo pilot)
LP2 12V 120mA i.e.s. scale lamp
LP3 12V 120mA i.e.s. scale lamp

Switches

S1 Double pole rotary mains switch
S2 Optional single pole on-off switch for a.f.c.

Sockets and Plug

SK1 Coaxial aerial socket
SK2 DIN output socket 5-way 180
PL1 Panel mounting miniature mains connector 3-way type P429 with socket P430

Miscellaneous

Case Contil MOD-2 size G (West Hyde Developments Ltd., Ryefield Crescent, Northwood Hills, Northwood, Middlesex)
F.M. Tuner head (details next month)
FS1 Fuse 1A slow blow and fuseholder
Printed circuit board (fibreglass) 10in \times 4.5in
Satin finished brushed aluminium front panel 12 $\frac{1}{2}$ in \times 2 $\frac{1}{2}$ in
Jackson tuning dial and drive to be described in Part 2
Aluminium panel 18 s.w.g. 10in \times 2in

P.E. GEMINI STEREO F.M. TUNER CIRCUIT

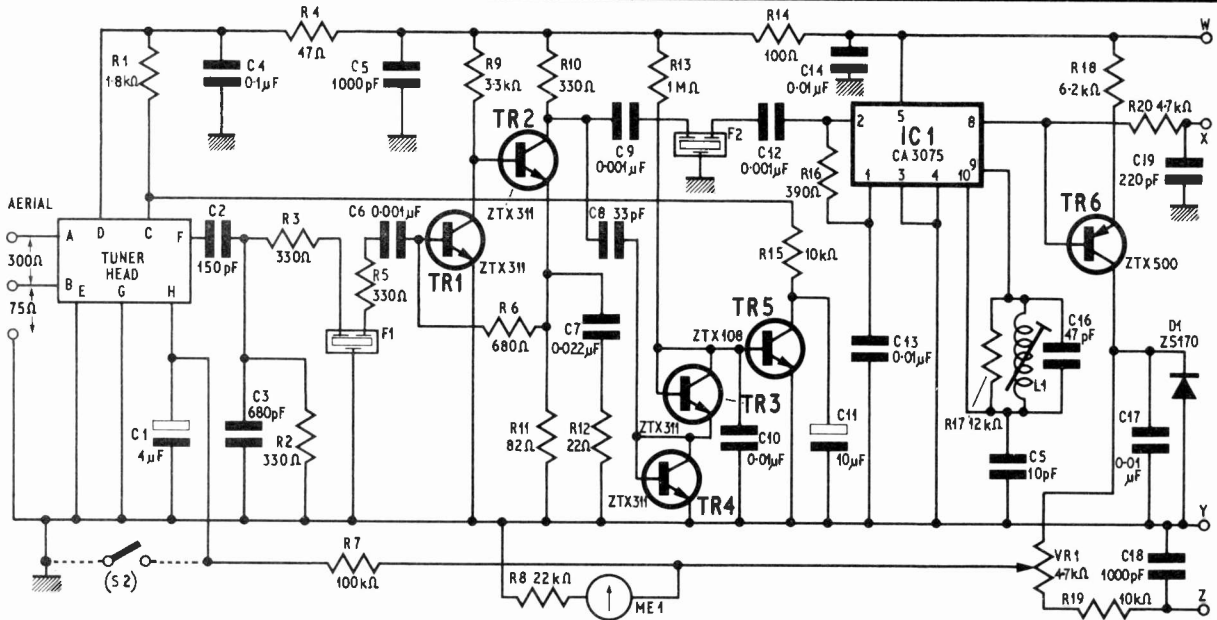


Fig. 3a. Circuit diagram of the i.f. amplifier with tuner head connections

the tuner to "jump" from one station to another as the tuning knob is turned. Commercial designs usually overcome this by providing a switch to cut out the a.f.c. whilst tuning, but in this design, such an arrangement was omitted so as not to spoil the simple and functional appearance of the front panel. However, the constructor can include an a.f.c. switch if he desires and the correct position for it is marked on the circuit diagram (Fig. 3a) as S2.

A.g.c. is a facility that is frequently omitted on f.m. tuners, on the philosophy that the signal is going to be limited anyway so why bother to control its level? If the input stages are allowed to overload, spurious sidebands can be produced and "pulling" of the logical oscillator may occur. This is clearly undesirable so an a.g.c. system has been included which effectively prevents overloading in any stage of the tuner.

I.F. AMPLIFIER

Between the tuner head and the CA3075 limiter/discriminator there is a ceramic filter i.f. section (shown in Fig. 3). TR1 and TR2 form the actual i.f. amplifier, a simple two transistor feedback pair which provides a modest amount of gain and acts as a buffer between the two ceramic filters. These filters must be operated with resistive source and load impedances of 330 ohms, which is easily provided by making the collector load resistor of TR2 330 ohms and putting a 330 ohm resistor in series with the input (R5). The input impedance of the amplifier itself is very low and can be ignored. The total gain of the i.f. amplifier is about 20dB but there is a loss of about 3dB in each of the filters, giving an overall gain for the stage of 14dB.

CERAMIC FILTERS

The ceramic tuned filters are Vernitron type FM-4. These filters give a remarkably high standard of

selectivity, each filter being approximately equivalent to two double-tuned critically coupled transformers. No adjustment is required of course so that there are no alignment problems. However, because of production tolerances the filters are graded into five frequency groups at 37.5kHz intervals around 10.7MHz and are identified by coloured dots. There is no advantage in using any particular frequency group, but you should ensure that both filters carry dots of the same colour.

The frequency response of two filters is typically 6dB down at 235kHz bandwidth and not less than 80dB down at 900kHz bandwidth. This is shown in Fig. 4. This is actually somewhat on the narrow side, since a bandwidth of 300kHz is usually considered advisable for multiplex reception.

The reason for this is that for good stereo separation a tuner must have a linear phase/frequency relationship for modulation frequencies up to 53kHz. In effect this means that the time delay through the whole tuner must be the same at all frequencies, so that all the harmonic components of a complex waveform will come out with exactly the same phase relationships as when they went in. This is important because the correct phase relationship between the pilot tone and the multiplex sidebands is essential for good stereo separation.

In fact the phase/frequency response of the ceramic filters is perfectly linear up to 53kHz, as Fig. 5 shows, and there should be no problems on this score.

But this is not the end of the story. An f.m. signal generates a very complex series of sidebands, which is unfortunately beyond the scope of this article to discuss in detail. At low modulation frequencies all the significant sidebands are contained within the ± 75 kHz deviation, and no problem arises. However, at high modulation frequencies there are significant sidebands beyond the ± 75 kHz limits and these are attenuated to some extent by the filters.

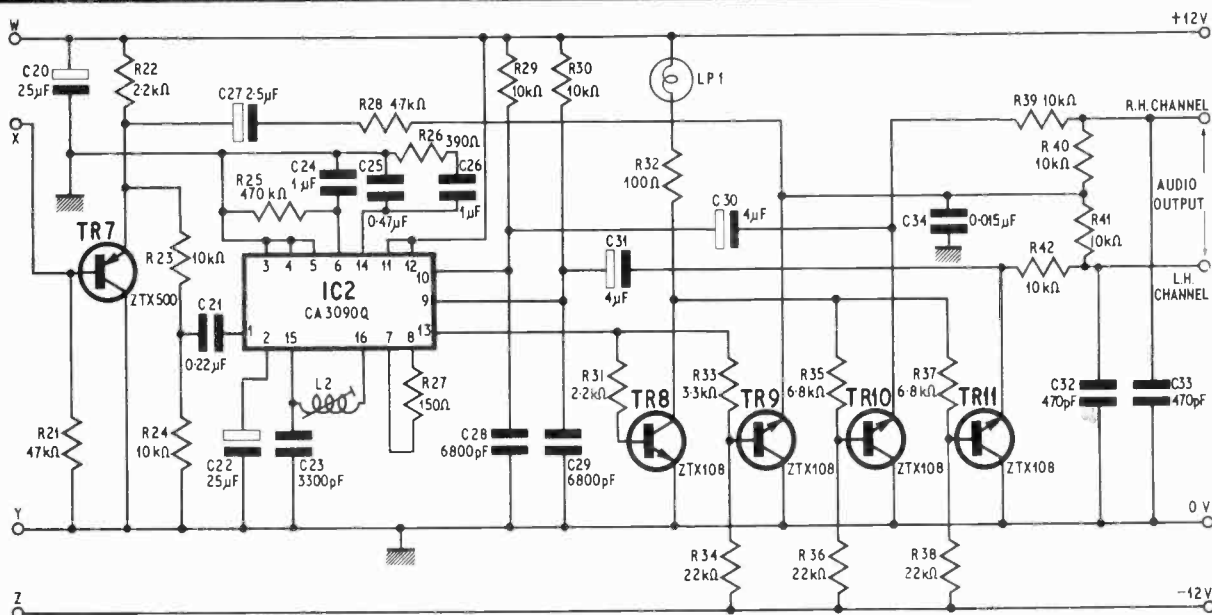


Fig. 3b. Circuit diagram of the stereo decoder

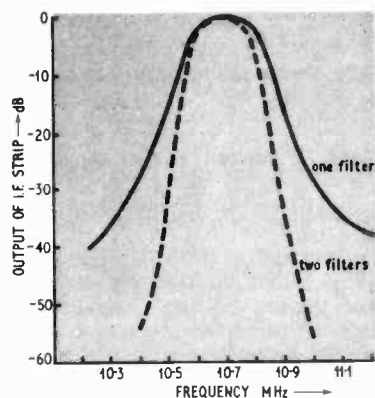


Fig. 4a. Frequency response of the i.f. amplifier and filters

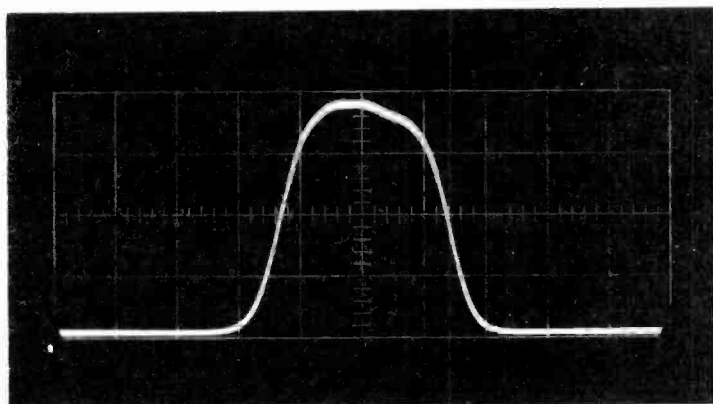


Fig. 4b. Oscilloscope, displayed by a sweep generator, of the response shown in Fig. 4a. Horizontal scale is 100kHz per division

This appears as slight distortion on the output waveform.

This distortion is not of great importance since it only appears on the L-R difference signal, which is generally of low amplitude. It is in any case a small price to pay for the convenience of the ceramic filters and the majority of new commercial designs use these filters.

A.G.C. AMPLIFIER

The output of the i.f. amplifier is peak-peak rectified by transistors TR3 and TR4, which are connected as "super diodes" and do actually cost less than conventional diodes. The rectified signal voltage is applied to the base of TR5 but, as the signal level rises, TR5 base is driven more negative, turning off TR5. This reduces the bias on the first stage of the tuner head so the gain of the tuner head falls, preventing overloading.

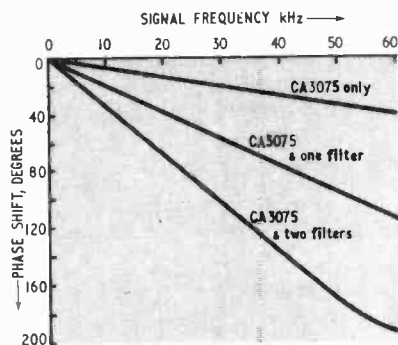


Fig. 5. Phase vs frequency characteristic of the detector and i.f. amplifier, showing very good linearity

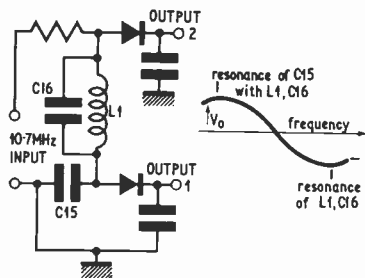


Fig. 6. Basic circuit and output waveform of the differential peak detector $V_2 = \text{output 1} - \text{output 2}$

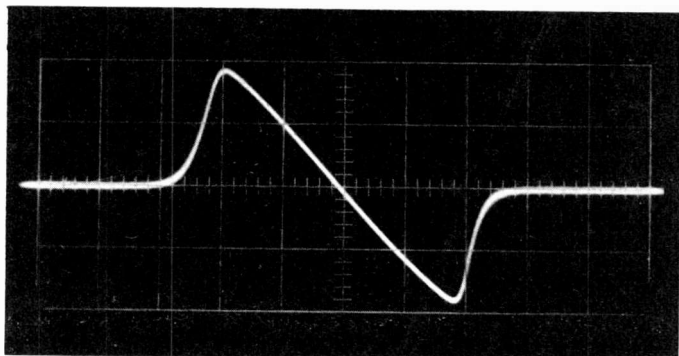


Fig. 7. Frequency response oscillogram of the CA3075 and i.f. strip together. Horizontal scale 100kHz per division; vertical scale IV per division

LIMITER AND DISCRIMINATOR

The R.C.A. type CA3075 limiter/discriminator contains three cascaded differential amplifiers which provide 60dB gain and excellent limiting. These are followed by a discriminator using what R.C.A. call a "differential peak detection circuit". This requires only a single coil and is consequently very simple to align.

The differential peak detector is novel but very simple. When the input frequency is slightly below the resonant frequency of L1 and C16 the net impedance of the L1-C16 combination is inductive. This forms a series tuned circuit with C15 and a large signal voltage is developed across C15 at this frequency. As the frequency is increased the voltage across C15 falls as it moves away from resonance but the voltage across L1-C16 increases, reaching a peak at their own resonant frequency. If we now rectify these two signals and measure the difference between them we obtain the familiar S curve (see Fig. 6).

In the CA3075 the rectification is done by four transistors which charge up two capacitors also within the i.c. The difference between these two voltages is amplified by a differential amplifier and appears at the output.

The output of the CA3075 for $\pm 75\text{kHz}$ deviation is approximately 500mV r.m.s. At this level the distortion is about 0.5 per cent. The distortion generated by the CA3075 actually remains virtually constant up to 50kHz due to the very wide bandwidth of the discriminator, but as already discussed the sideband cutting introduced by the filters increases the distortion at high frequencies.

When comparing the specification of this tuner with commercial models, remember that many manufacturers specify the distortion at 30% modulation, i.e. only $\pm 25\text{kHz}$ deviation. The distortion at 75kHz deviation is usually considerably greater. This is analogous to specifying the distortion of a 10 watt amplifier at 1 watt.

A.F.C. AMPLIFIER

The a.f.c. input of the tuner head requires a control voltage of about ± 1 volt. However, the output of the CA3075 is superimposed on a d.c. level of 5.4 volts. To overcome this difficulty TR6 acts as a level shifter, giving an output centred on zero,

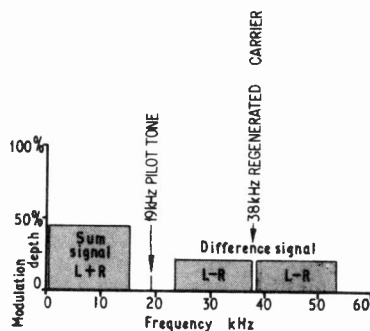


Fig. 8. Spectrum of stereo signal with equal but different signals in the left and right hand channels. The relative amplitudes of the sum and difference signals can vary according to the signals present in the left and right hand channels

and also inverts the output of the CA3075 to give the correct phase of feedback. If the feedback were of the wrong phase the a.f.c. voltage would send the tuning in the opposite direction to that required with the result that the tuner would refuse to lock onto a station.

The output of the a.f.c. amplifier is also used to operate the tuning meter.

STEREO SIGNAL

The stereo signal at the output of the discriminator has three main parts. These are shown in Fig. 8. Extending from 30kHz up to 15kHz is the normal audio signal, which in the case of a stereo transmission is the sum of the left and right hand channels (L + R). With a mono tuner this is all you ever hear. Above this there is a low level 19kHz pilot tone, and above that, extending from 23 kHz to 53kHz there are a pair of sidebands which are modulated with the difference between the left and right hand channels (L - R).

The 38kHz carrier is eliminated to economise on bandwidth and improve the signal to noise ratio and so it has to be regenerated in the receiver from the 19kHz pilot tone. This enables the (L - R) difference signal to be obtained and the left and right hand channels can be obtained by adding and subtracting.

$$\begin{aligned} \text{i.e. } (L + R) + (L - R) &= 2L \\ (L + R) - (L - R) &= 2R \end{aligned}$$

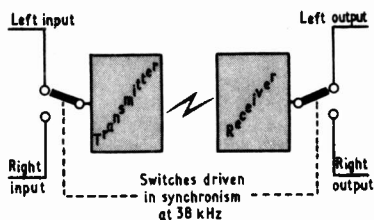


Fig. 9. Basic principles of stereo transmission system

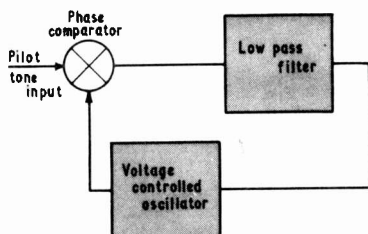


Fig. 10. Basic block diagram of the phase lock loop

A stereo decoder has a difficult job to do. It has to sort out the 19kHz pilot tone from the signals on either side of it, which may be up to nine times larger. This requires high- Q tuned circuits. It then has to double this frequency to 38kHz to replace the missing carrier in exactly the same phase as the original. A phase error between the regenerated carrier and the difference sidebands drastically reduces the stereo separation and the higher the Q of the tuned circuits the more sensitive to errors of tuning the decoder will be.

The amateur may find it difficult to understand why a phase error in the regenerated 38kHz carrier should upset the separation. One way of looking at it is to imagine a switch at the transmitter looking alternately, at 38kHz, at the left and right hand channels (see Fig. 9).

If we have a similar switch in the receiver, exactly in synchronism with the switch at the transmitter, we can reconstitute exactly the original left and right hand signals. But suppose that the receiver switch is not exactly in synchronism with the transmitter switch. When the receiver switches to the right hand channel the transmitter might still be looking at the left hand channel. Thus the left and right hand signals get mixed up and the separation is greatly reduced.

There are slight differences between the actual modulation process and the simple description above, but it is nevertheless valid and most stereo decoders work on exactly this principle.

Most commercial stereo decoders compromise between the conflicting requirements of good selectivity (i.e. high Q) and good phase stability by using three tuned circuits of moderate Q . However, such decoders are difficult for the home constructor to adjust, and may not be particularly stable once adjusted. Up to the present time one had little choice, but now integrated circuits have made it possible to use phase lock loop techniques to overcome this problem.

PHASE LOCK LOOPS

All phase lock systems contain the same basic components, and the bare bones are shown in Fig. 10. There is a voltage controlled oscillator, a phase comparator which gives an output voltage related to the phase difference between this oscillator and the input signal, and a low pass filter which removes switching transients and high frequency components from the output of the phase comparator and also determines the bandwidth of the system.

When the input signal is first applied the v.c.o. may not be running at exactly the right frequency. If this is the case the difference frequency appears at the output of the phase comparator, and if sufficiently low it passes through the low pass filter and frequency modulates the v.c.o. If the v.c.o. is now able to reach the signal frequency it will lock on to the signal. Once locked, any drift in the v.c.o. causes a phase error. This changes the output voltage of the comparator which pulls the v.c.o. back into the correct phase, enabling the v.c.o. to maintain the correct phase to within a few degrees, even when grossly misadjusted.

The v.c.o. can only lock on to signals close to its own frequency; signals beyond these limits have no effect. This gives the system good selectivity without the phase problems normally associated with high Q .

Phase lock loops are not new; they have been used in sophisticated instrumentation systems for years, but up to the present their cost and complexity has made them impracticable for consumer equipment.

STEREO DECODER

The CA3090Q stereo decoder integrated circuit is a remarkable device, containing no less than 128 transistors. It is shown in diagrammatic form in Fig. 11 but space restrictions prevent us publishing the full circuit diagram.

To describe the operation of this circuit in detail would take an article all by itself, but the following brief explanation may be of interest to the constructor.

A double balanced phase lock detector provides a d.c. output according to the phase difference between the pilot tone and the 19kHz signal generated in the circuit. This output is filtered by C25 and C26-R26 (outside the i.c.) and applied to a reactance circuit, which controls the frequency of the tuned circuit L2/C23 connected to pins 15 and 16. The actual oscillator is of the negative resistance type, the negative resistance cancels out the (positive) loss resistance of the tuned circuit and enables it to oscillate at 76kHz. This frequency varies according to the phase lock detector output voltage. The v.c.o. output is fed to a bistable, the 38kHz output driving the L-R detector.

The reason for using a bistable to generate the 38kHz waveform rather than running the oscillator at 38kHz is to ensure that the waveform is perfectly symmetrical. This assists in obtaining good stereo separation. This bistable drives two others that provide two pairs of 19kHz outputs differing in phase by 90 degrees. The first bistable drives the phase lock detector discussed above whilst the second drives the pilot presence detector which operates the pilot tone indicator.

STEREO DECODER

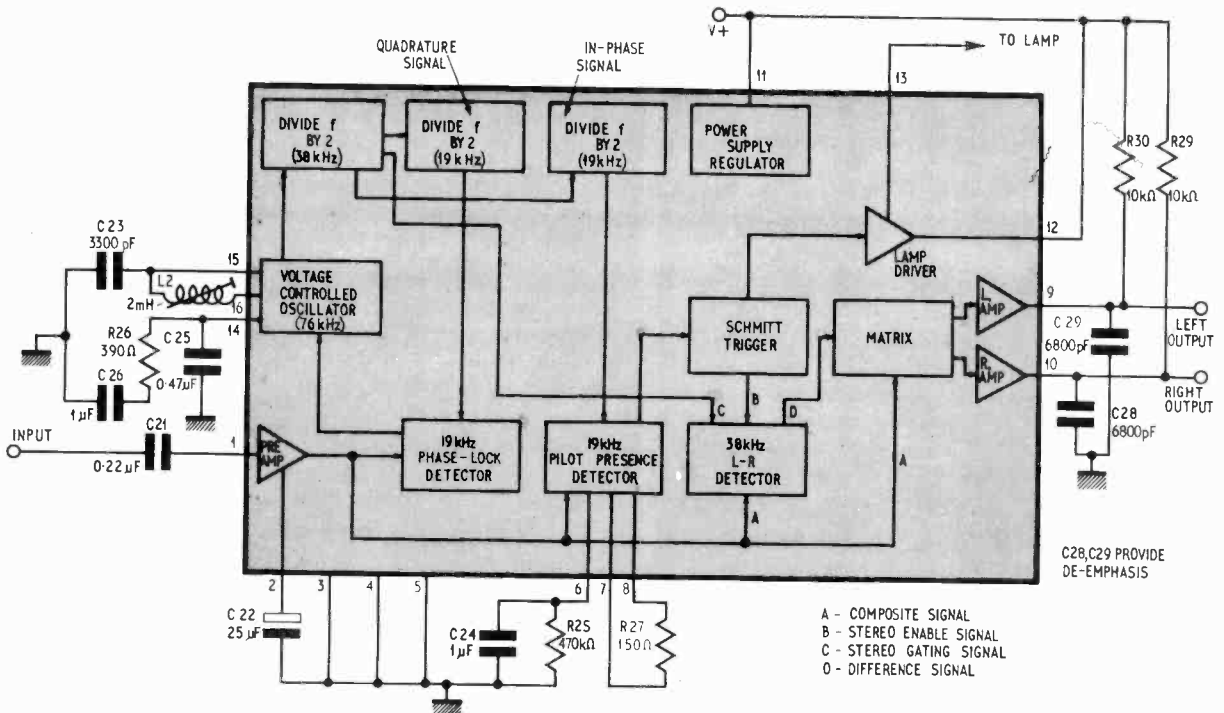


Fig. 11. Block diagram of the circuitry within the CA3090 integrated circuit

POWER SUPPLY

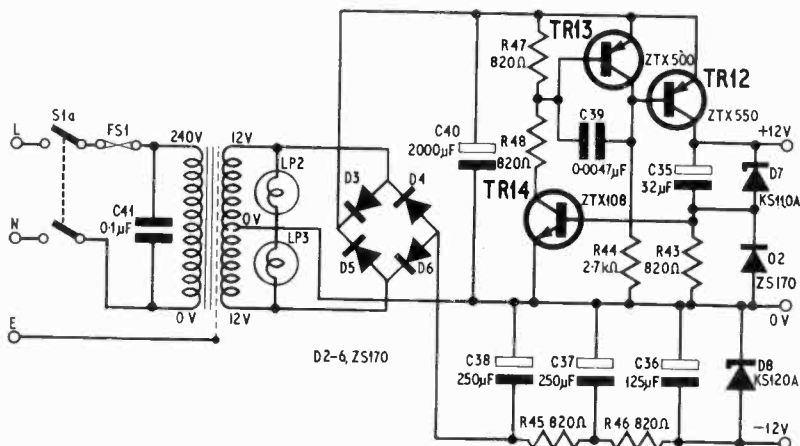


Fig. 12. Circuit diagram of the stabilised power supply

NEWS BRIEFS

A third phase sensitive detector, driven by the 38kHz bistable, separates the two channels. The left and right hand signals are mixed with a proportion of the input signal to balance out the crosstalk, which is inevitably produced by square wave demodulation, and the result is fed through the output amplifiers within the i.c.

Most of the other transistors in the i.c. perform mono/stereo switching or provide bias potentials.

The CA3090Q has quad in-line lead-out pins, i.e. alternate pins are staggered to give greater separation. The CA3090E is identical to the CA3090Q except that the pins are dual in-line. Allowance in the printed circuit pattern must be made according to which type is used.

AUTOMATIC STEREO SWITCHING

One unfortunate feature of phase lock loops is that the oscillator has to run continuously. This would not matter if the B.B.C. did not have the unfortunate habit of putting a 23kHz pilot tone on top of mono programmes. The result is that, due to stray coupling within the i.c., a low amplitude 4kHz tone appears at the output. The level is very low, but nevertheless is just sufficiently loud to be annoying, so we were obliged to include an automatic stereo/mono switch. This cuts out the decoder when a mono programme is being received and completely eliminates the whistle.

The mono/stereo switching is performed by TR9, TR10 and TR11. These three transistors are worked in inverted mode (i.e. the emitter is used as the collector) to give a very low saturation voltage.

When a mono programme is being received the output from pin 13 of the CA3075 is low, so that the lamp driver transistor TR8, and TR9 are turned off. The collector voltage of TR8 is high and this turns TR10 and TR11 hard on. These two transistors short out the left and right hand channel outputs of the i.c. TR9 however is turned off and allows the signal from the emitter follower TR7 to pass straight through to the outputs.

When a stereo programme is being received the output from pin 13 rises and turns on the lamp driver and TR9. This closes the "through path" but TR10 and TR11 have now been turned off and the two outputs of the stereo decoder are now coupled to the output.

POWER SUPPLY

The tuner requires +12 volts at about 160mA and -12 volts at only 2.5mA. The -12V is provided by a simple zener diode stabiliser (Fig. 12) although extensive decoupling is necessary to prevent hum appearing on the a.f.c. line.

The +12V is provided by a three transistor series regulator. Any tendency for the output voltage to rise causes TR14 to conduct more heavily. This increases the current in TR13, which reduces the current flowing in the regulator transistor TR12 and hence the output voltage. The purpose of C35 is to ensure that when the power supply is first switched on the +12V supply rises at the same rate as the -12V supply. This prevents the a.f.c. circuit from locking on to the wrong station.

Next month: Part 2 will give details of construction

LIGHT TOOTH

BY USING Fibre Optics your dentist may soon be able to see through your teeth without using X-rays.

This concept, known as transillumination, has not been widely used before because lights bright enough to shine through teeth usually have been too large for use inside the mouth, as well as being too hot for the patient's comfort.

The fibre optics tool inserted in the mouth is about the size of a small screwdriver and can easily be manoeuvred inside the mouth. When illuminated a healthy tooth seems to glow white, tooth decay shows up as a darkened shadow. Fillings appear as black spots or lines and hardened, crust-like accumulations of food residues and mouth secretions are clearly distinguishable.

Developed in America this new technique will soon be ready for distribution.

One possible result of transillumination could be the mass screening of children by trained dental assistants who would refer those needing treatment to dentists.

BBC COLOUR

UNDER a substantial re-equipping programme to bring full colour-broadcasting facilities to its regional television studios, the BBC has ordered further colour television broadcast cameras worth more than £100,000 from EMI Electronics Ltd.

Approximately £2 million has already been spent on EMI 2001 cameras by the BBC over the past three years and the addition of the new cameras will bring the Corporation's total to some 116 cameras. This represents over 80 per cent of the colour cameras used for studio productions and for outside broadcasting by the BBC.

The additional colour cameras will be used in BBC studios located in major cities throughout Britain including Bristol, Southampton, Leeds, Newcastle and Manchester. Several studios will be able to televise local programmes in colour for the first time, while at other locations, the EMI cameras will extend existing colour facilities. The BBC has already re-equipped a number of studios including Glasgow and Birmingham under its scheme which is expected to take about 18 months to complete.

P. E. GEMINI

REPRINTS AVAILABLE

Readers who missed the articles on the "P.E. Gemini" Dual Purpose Stereo Amplifier, published in November 1970 to March 1971, can obtain them in reprint booklet form.

The price of this 32-page booklet is 55p, including postage. Orders for copies, with P.O. or cheque made payable to IPC Magazines Ltd., should be addressed as follows:

The Receiving Cashier (P.E. Gemini)
IPC Magazines Ltd.,
Tower House,
Southampton Street,
London, W.C.2.

ELECTRONORAMA

RIDING THE MILLIMETRIC WAVES

TO ASSIST in meeting the explosive growth expected in telecommunications in the next 20 years the Post Office and the Science Research Council have begun what is probably the largest microwave-propagation study yet. This project could have a major influence in opening up the 10-100GHz range of the radio spectrum (wavelengths down to 3mm) to new microwave telecommunication system use.

The propagation study is based at the Post Office Research Station at Martlesham Heath, near Ipswich. The SRC Radio and Space Research Station is carrying out supporting research at Slough.

The Post Office needs to study the problems of transmitting radio waves at these super-high frequencies because its existing radio-relay network operating at frequencies of 2, 4 and 6GHz, is now approaching congestion and the higher frequencies offer greater message carrying capacity.

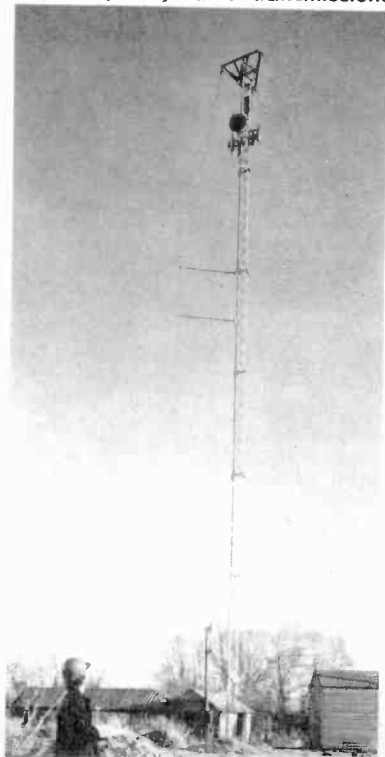
As frequencies rise above 10GHz, transmissions are increasingly affected by the weather: heavy rainfall can cause serious signal fading; and the temperature stratification that occurs on clear evenings in still air can occasionally produce multiple transmission paths that could adversely affect microwaves carrying high-speed digital signals.

A network of experimental radio transmitters has been set up in East Anglia between Martlesham and Mendlesham to find out just how radio transmissions at these millimetric wavelengths are affected by the weather and what can be done to avoid disruption of service.

View of raingauge and radio telemetry installation used in the Post Office microwave research project

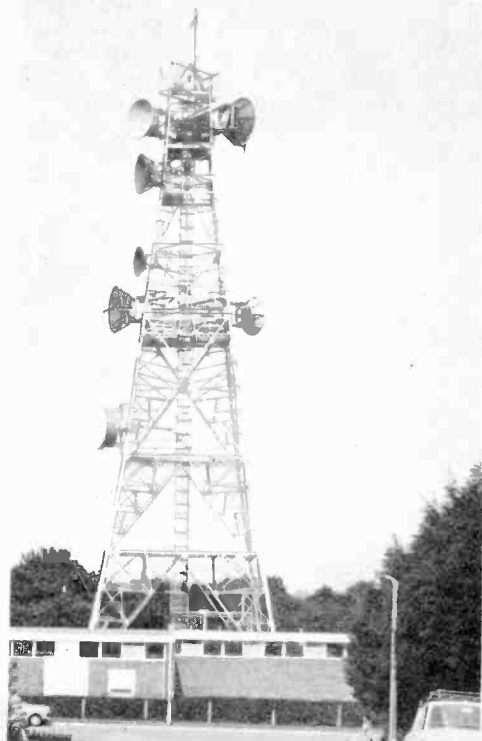


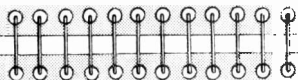
Experimental microwave station in East Anglia set up to study the effect of the weather on super-high-frequency radio transmissions



Artist's impression of the slender mast that will carry Post Office microwave equipment of the future. The masthead canopy carries all electronic equipment and the two dish antennas

Standard lattice steel microwave tower in the Post Office radio-relay network near Plymouth. The lowest dish antenna on the left-hand leg, with a protective radome, is installed for the new 11GHz link to Caradon Hill





INDUSTRY NOTEBOOK

By *Nexus*



FLY-CATCHERS

When you visit a manufacturer of high voltage power supplies you expect to see equipment for scientific applications and for general industry. I was not disappointed when visiting Brandenburg Ltd., Thornton Heath, Surrey, who specialise in high voltage work. As expected, there were units in production for use with scanning electron microscopes, electron beam machining equipment, photo-multipliers, and neat little solid state e.h.t. power packs for CRT units, the big new market for these being in computer video terminals.

But what were those peculiar devices with concentric cylindrical metal grids and a light in the middle? They were traps for flying insects. An ultra-violet light source is used as the lure to attract insects between the grids. The air is ionised between the grids and the flies, moths, gnats, bite the dust in a handy disposal tray at the bottom.

Development of this novel application for high voltage was done jointly by Brandenburg and Rentokil and the equipment is supplied by Rentokil under the trade name "Rentoflash". So far, Brandenburg has built 7,000 of these units which, I gather, are particularly effective in cow houses.

MOBILE IDEAS

To find out what's new in the mobile radio world I called on Jim Finke who has been setting up a Motorola production unit in Wiesbaden, W. Germany, to serve the European market. Motorola pioneered mobile radio in the United States, starting with a car radio as early as 1928.

The name Motorola came to company founder Paul Galvin as a flash of inspiration while shaving.

It is now world famous in both communication equipment and solid state devices. Big breakthrough for Motorola was development of first the "Handie-Talkie" and, later, the "Walkie-Talkie".

"Wasn't mobile radio getting a little 'old hat'", I asked Finke. That was enough to trigger him off. "Not a bit of it", he flashed back. "Do you realise that when a guy has a heart attack the first half hour is critical? Why not fit the ambulance with a special radio unit for transmitting the patient's electrocardiograph through to the hospital. Let the doctor diagnose the heart condition and decide the treatment while the patient is still on his way."

Well, that is only one of the Motorola ideas for expanding the market for mobile radio beyond basic two-way voice communications. Another, already in production and selling to police forces in the USA, is a tiny dashboard-mounted teleprinter which prints out messages in hard copy. Transmission from the base station is by coded audio tones over the usual f.m. mobile frequencies and eavesdropping criminals have little chance of deciphering messages unless they can find out the tone codes and get hold of the right receiving equipment. Another big advantage of this system is that police officers can leave their car unattended and find a hard print-out of all messages waiting for them when they return.

Yet another idea is a bus location system, one of which has already been installed in Chicago. With microelectronics it's amazing how many extra facilities can be squeezed into vehicles without excessive penalties on space. Digital communications between vehicles is also a growing field.

But Europe, however closely integrated economically, is completely fragmented for the mobile radio man. Each country has its own technical specifications and licence regulations. Motorola says it's a real nightmare dealing with 14 countries, each with different requirements. Which explains why those huge transcontinental lorries have no mobile radio. An installation legal in the country of origin is often illegal as soon as it crosses the border!

THE BRITISH ENGINEER

The Survey of Professional Engineers conducted by the Council of Engineering Institutions brings good news for electronic engineers. Incomes below £1,200 have all but disappeared and the great middle body of engineers' salaries now come in the range £2,400-2,599. Unemployment, at

one per cent, was well below the national average of 3.3 per cent when the survey was taken.

But there were areas of disappointment. The report, which covers 1971 and was completed last December, showed that only 19 per cent of all engineers took any courses during the period and, of these, 50 per cent were on management courses while only 33 per cent took technical updating courses. This amounts to only 7 engineers in every 100 who had technical refresher courses, hardly enough, one would think, in these days of fast moving technology.

It is debatable, too, despite improved salaries, whether the engineer is adequately paid. Lavatory attendants at British-Leyland are reported as getting £1,500 a year and I have heard of loaders at London Airport (Heathrow) getting £70 a week take-home pay. The trouble with engineers is that they are generally enthusiasts. Good for them to enjoy their work, of course, but no reason why they should undervalue their services.

A MOVE INTO THICK FILMS

Coutant Electronics, a major manufacturer of power supplies, has decided to expand into the custom-built thick film market.

This is not quite such a revolutionary decision as might at first appear because the company has had an in-house thick film capability for some years. Now, it is being made available to all.

Coutant has had an interesting history. It was the first company in the Ititech group and every previous diversification has resulted in new companies being formed. Celdis, the well-known component distributors was an early example, the name Celdis being derived from Coutant Electronics Ltd., DiStributors. Coutant's pressure transducer interests were also hived off separately as Transducers (C.E.L.) Ltd.

If the thick-film venture goes well, will it, too, be hived off into a separate concern?

BLUE STREAK — ALL SYSTEMS WERE GO!!

My recent comments on the *Europa 11* launcher failure brought a sharp reminder from a member of the Hawker Siddeley Dynamics design team that the British *Blue Streak* first stage performed perfectly and the failure was due to the inertial guidance system in the third stage when *Europa 11* was at an altitude of 17 miles.

Blue Streak, says my correspondent, maintained its 100 per cent success rate after its previous ten successful launches.

WIDE BAND SIGNAL INJECTOR

BY J.D. CROFT

Can be used for servicing

- Audio equipment
- Radio sets
- V.H.F. and U.H.F. television receivers

ONE of the most useful aids for servicing audio and high frequency equipments is undoubtedly a device which will provide a modulated signal to enable tracing the signal path through the circuit.

This injector uses one of the most common TTL integrated circuits, the SN7400N, which consists of four two input NAND gates.

Although the total component count of the circuit is 40, all but five of these are within the i.c. package so that construction is very easy.

MULTIVIBRATOR

By suitably connecting the four gates (G1-G4) in the i.c. as in Fig. 1, a multivibrator square wave generator is produced with a fundamental frequency in the audio range. Since the waveshapes produced have very short rise and fall times the harmonics generated extend up to the u.h.f. television bands, thus the generator may be used to inject signals into anything from an audio amplifier to a television set.

CIRCUIT DETAILS

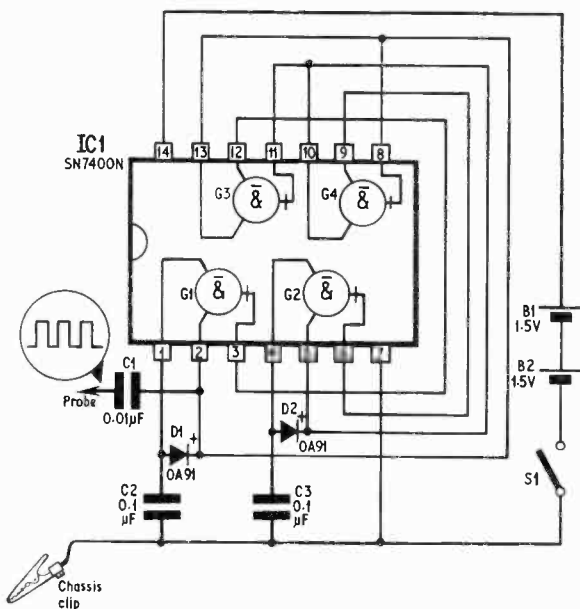


Fig. 1. Circuit diagram of signal injector

Components . . .

Capacitors

- C1 0.01µF 450V
- C2 0.1µF
- C3 0.1µF

Diodes

- D1, D2 OA91 (2 off)

Integrated Circuit

- IC1 SN7400N

Switch

- S1 Lever operated miniature microswitch

Miscellaneous

- B1, B2 HP16 (2 off), 1 crocodile clip, plastics sleeve, 4in length of screwed brass rod $\frac{1}{4}$ in diameter

CONSTRUCTION

Despite the apparent complication of the circuit, it is no more expensive to build than a conventional multivibrator using two transistors and is certainly a lot neater.

The majority of small components are built up on a piece of 0.1in matrix Veroboard measuring 1.5in x 1in as in Fig. 2. The only point to watch is the correct location of the i.c. before soldering as it is very difficult to remove all 14 pins at once if it has to be removed.

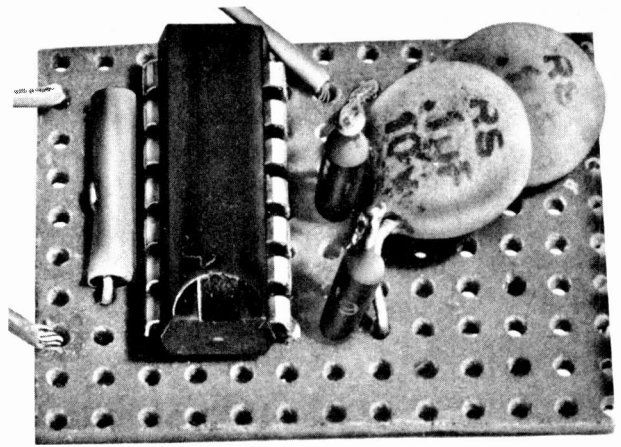
UNIT HOUSING

The actual housing was a 2.5in x 1in dia. tin with a snap-on plastics lid. As it was impossible to obtain a battery holder small enough to fit this, it was necessary to solder the battery leads directly to the battery terminals. If the constructor wishes to use a battery holder a larger tin will be found necessary.

A small microswitch is used for S1 with the lever bent as shown to protrude slightly from the lid. Adjacent to this is the probe, a 4in length of 1/16in diameter brass rod threaded at one end and covered with plastic sleeving so that only the tip is bared.

TESTING

The finished unit can be tested by connecting a pair of phones between the probe tip and chassis clip. If all is well a tone of about 3kHz should be heard.



Small component assembly on 0.1in matrix Veroboard

To check the u.h.f. properties of the generated tone, connect the output to a television receiver aerial socket which should produce an audible output from the receiver speaker.

The earth clip is not essential for use at radio frequencies but a higher output will be obtained if it is used. ★

WIRING DETAILS

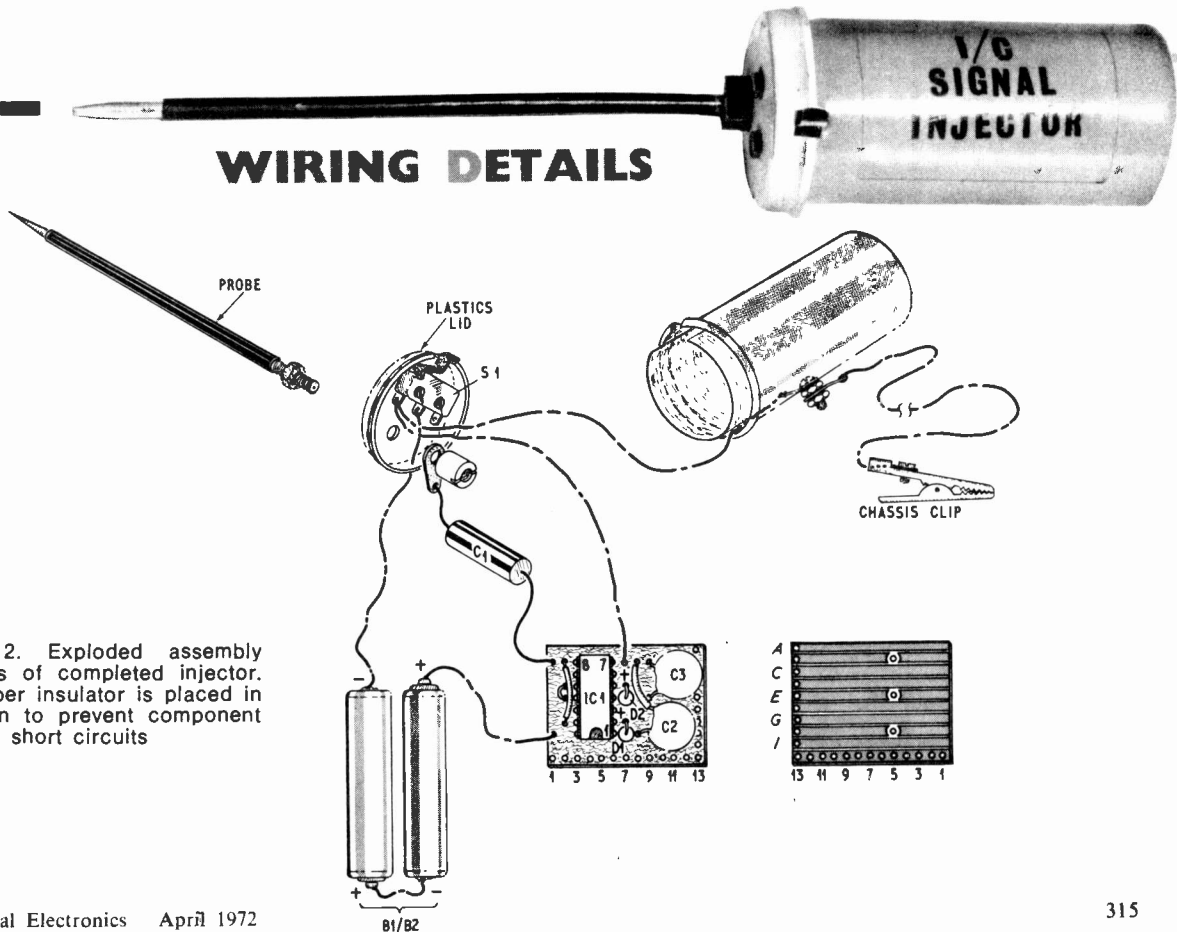


Fig. 2. Exploded assembly details of completed injector. A paper insulator is placed in the tin to prevent component board short circuits

MARKET PLACE

Items mentioned in this feature are usually available from electronic equipment and component retailers advertising in this magazine. However, where a full address is given, enquiries and orders should then be made direct to the firm concerned.

PRESSURE SENSITIVE RESISTOR

A product that should prove both versatile and also tax readers' inventive instincts is ResilistoR, a special pressure sensitive resistor announced by Logic Applications Ltd.

The "resistors" are made from cubes, slices or discs of polyurethane foam impregnated with a special graphite conductive substance. According to the amount of pressure applied the graphite granules are brought closer to each other causing a gradual reduction in resistance across the device. As soon as the applied pressure is released, the ResilistoR reverts back to its unloaded resistance and shape.

Resistances from 50 ohms to 500 kilohms are available in varying ranges. The voltage range of the device may vary from 5V to 40V a.c./d.c. according to resistance range required. Devices capable of handling 100V d.c. at 60mA and 240V a.c. at 500mA have been produced to special order.

An experimenter's pack, containing one cube, one disc and one slice is available, price £2.50 including postage and packing.

The uses of ResilistoR is obviously very numerous and some of the applications which incorporate the devices are: intruder alarm pads; motor controllers; limit switches and volume controls.

In the electronic music field they have been used in keyboards and make excellent foot controls for Waa-Waa Pedals. Aids for the disabled is one field where experiments have been carried out with some success.

Further information, experimenting kit, and resistance ranges can be obtained from Logic Applications Ltd, 47 Victoria Street, London, S.W.1.

LIGHT SOURCES

The forecast by many experts that light sources will be one of the biggest growth sections in the electronics industry this year seems to be underway. Already, devices

using varying methods of producing a light source are appearing on the market.

The solid state Ga As light indicator from West Hyde Developments uses a gallium arsenide light source and can be driven directly by a T.T.L. i.c.

The indicator will operate at 15mA at 1.6V or more. The recommended operating conditions are 40mA for brightest display (approximately 750 foot Lamberts). The device will continue to emit an adequate light down to 5mA.

Full details are available from West Hyde Developments Ltd, Ryefield Crescent, Northwood Hills, Northwood, Middx.

The use of liquid crystal cells for a light source is the latest development from RCA.

Not available generally, at the present time, the TA8032 and the TA8034 are single digit, seven segment numeric display devices.

The TA8032 is a transmissive type in which both conductive surfaces are transparent. This device is particularly suitable in applications where back or edge-lighted readouts are desirable.

The TA8034 is a reflective type and utilises a mirrored area on the inner surface of the back plate. This type is particularly useful in those applications where available front lighting is of primary importance.

These devices operate from 8V to 50V and are primarily intended for a.c. operation at frequencies from 30 to 60Hz although operation at other frequencies (400Hz) is possible. D.C. operation is not recommended.

Technical specifications and information is available from RCA, Solid State Europe, Sunbury-on-Thames, Middlesex, TW16 7HW.

Guest International have just introduced the Litronix Data-Kit 62

seven segment numeric display using gallium arsenide red light emitting diodes. The display contains approximately 56 diodes in one 14-pin dual-in-line package and the luminescence is typically 500 foot Lamberts at 20mA.

Back to the more realistic light sources, filament and neon types, Guest have also released a range of miniature neon and filament lamps with either wire-ended terminations or flanged bases.

Particulars of the Data-Kit 62 and the miniature lamps are available from Guest International Ltd, Nicholas House, Brigstock Road, Thornton Heath, Surrey, CR4 7JA.

PRINTED CIRCUIT AIDS

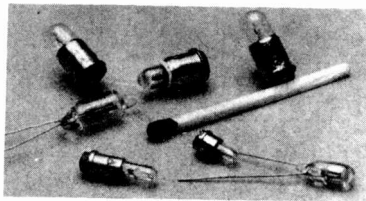
Of special interest to readers who once having proved a bench "lash-up" circuit have difficulty in translating the circuit to a printed circuit layout. Technomark are now marketing a kit for making printed circuits easily.

The Technomark printed circuit pack is known as the Ambitrack system and costs £5.35 with s.r.b.p. boards or £6.25 with epoxy based glass fibre boards.

The pack contains three 8½in x 6½in copper laminated sheets, with a 0.1 matrix scored into the copper surface; a bottle of etchant and a bottle of cleaning fluid; a pair of tweezers; magnifying glass; special grid patterned tracing sheets; and a special etchant resist pen. The case of the pack acts as a suitable etchant bath.

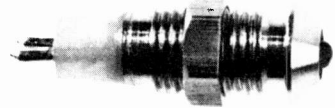
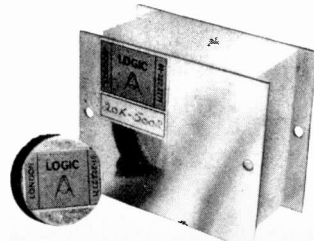
The circuit pattern is drawn onto the copper surface with the special resist pen and then immersed in the etching fluid. Alpha-numeric graduations around the edges of the boards allow for easy checking once the etching process is completed and the board cleaned.

Kits are available from Technomark, Borough Green, Sevenoaks, Kent.



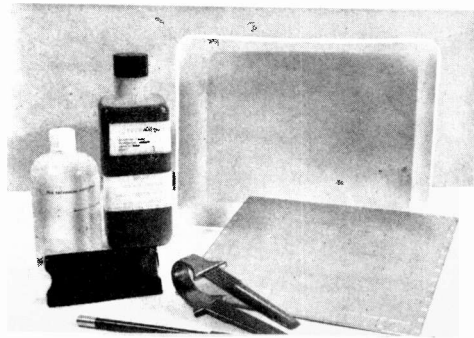
Range of miniature indicators marketed by Guest International

Two types of ResilistoR from Logic Applications



Ga As light source from West Hyde Developments

Technomark Ambitrack printed circuit kit



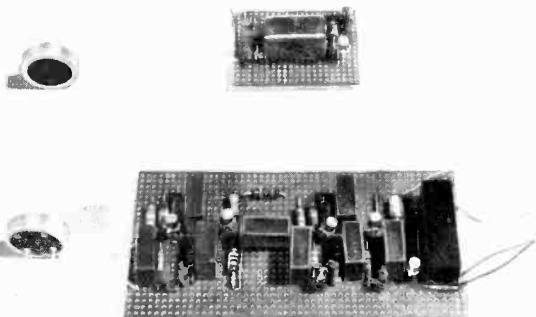
FREE!

With the **MAY** issue SEMICONDUCTOR LEAD-OUT IDENTICHART

Lists the most commonly available types of pnp, npn, field effect and unijunction transistors; thyristors and triacs; power, small signal, Zener, and tunnel diodes.
Provides rapid lead, tag, or terminal identification for these popular solid state devices.
This Wall Chart, measuring 21in x 15½in, has been specially designed for the constructor's workshop and gives vital information at a glance.
No more doubts when wiring up these devices!

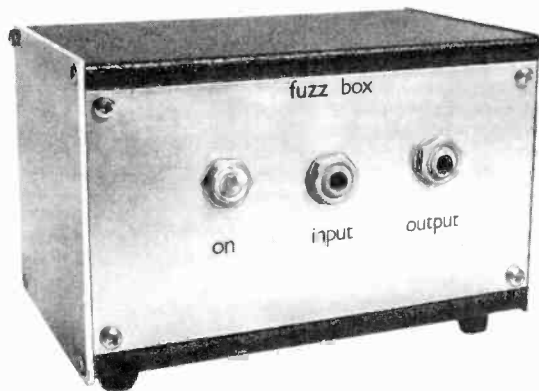
Ultrasonic Transmitter- Receiver

With a range extendible up to 100 feet, this equipment combines ease of construction with high sensitivity. Its applications range from "invisible beam" burglar alarms to remote control and signalling, and it doesn't need a transmitting licence.



FUZZ BOX

Add the wild sound of "fuzz" to your music. This is the third in the trio of sound effects units for pop group guitars and musical experimenters.



PRACTICAL ELECTRONICS

May issue on sale April 14

PATENTS REVIEW...

PRESSURE TRANSDUCER ALARMS

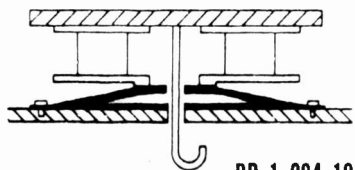


Fig. 1

BP 1 224 134

THEFT detection devices, for instance for use in museums, are legion. Usually ultrasonic or electromagnetic barriers are used although sometimes light or infrared waves are relied on. In each case movement of a foreign object in a space saturated with the radiation is sensed in one way or another.

Cerberus AG of Switzerland have patented (BP 1 244 134) what looks like a novel approach to theft detection. The object to be protected is supported on a force transducer. The transducer produces an output signal and this signal is fed to an amplifier and alarm system. When the transducer is loaded with a constant force the signal is stable, but a change in load means a change in the output signal and the alarm is triggered.

To take a simple example, a painting could be suspended by two cables, each attached to a force sensitive sensor. When the force exerted on the sensors due to the weight of the painting is changed, if an attempt is made to steal the painting, the signal from at least one sensor changes to sound the alarm. The patent also gives suggestions for suitable constructions for the sensors and circuits for converting a change of output into an alarm.

A convenient type of sensor was piezo-electric elements arranged in a cavity mounted on a vibration absorbent base (to prevent building vibrations setting off the alarm). Ideally, two elements are mounted with their axes parallel and the cord between them so as to sense not only vertical forces (due to a downward tug) but also lateral forces, such as might be caused by moving an object by sliding it sideways.

A particularly sensitive construction is a ring-shaped piezo-electric transducer with the point of application of the force situated at the ring centre.

In one example given by the inventors, sensitivity is further in-

creased by suspending the picture or the like from a hook which is mounted on a dished spring with non-linear deflection characteristics, i.e. which will flatten suddenly at a certain loading, see Fig. 1. In a normal state of loading the spring is flattened, but if only a slight change of loading takes place it will cause a dramatic arching of the spring and a sudden force to be exerted on (or taken off) the transducer. This prevents "tricking" of the alarm by relieving the load in a slow manner.

Although not suggested, devices of this type could presumably also be used in other fields, e.g. by fishermen to sense "bites" at night.

COMPANDER CIRCUIT FOR DISC RECORDING

IN the audio field it is common practice to compress sounds together in amplitude before recording them. Among other considerations this lessens the risk of overloading the disc cutter and ensures that the recorded groove does not encroach into the adjacent groove space. In sophisticated systems the audio signal is expanded over the lower range of amplitudes and compressed over the higher range. Unfortunately so-called "hush" noise is often heard when a loud noise decays rapidly. First there is a rise in background noise as the compressor gain rises and then there is a fall in background noise as the expander gain falls.

The problem is complicated and EMI Limited have patented (BP 1 245 394) a correspondingly complicated answer.

As the block diagram in Fig. 2 shows, an audio input signal is amplified and fed in parallel to both an analog divider circuit and

a logarithmic amplifier. The output of the log amplifier is rectified to provide an output signal which corresponds to the envelope of the audio signal fed from the log amplifier. The rectifier circuit also functions as a limiter and its output is fed in parallel to both a minimum selector circuit and a maximum selector circuit. Both these selector circuits are also supplied with a limiting bias voltage.

The minimum selector circuit produces an output signal which corresponds to whichever is the less—the envelope signal or the bias voltage. The output signal from this minimum selector circuit is fed to an elongator circuit which forms an expansion control signal.

The maximum selector circuit produces an output signal which corresponds to whichever is the greater—the envelope signal or the bias voltage. The output signal from this maximum selector circuit is applied to an elongator and hold circuit which produces a compression control signal.

These compression and expansion control signals are fed to a comparator, the output of which is connected to the hold circuit in the elongator of the compression control signal path. Both the compression and expansion control signals are then summed and the combined signal is applied (via an anti-log circuit) to the analog divider circuit to control the transfer factor applied to the audio signal which is passing through the analog divider.

By suitable choice of circuit parameters, the combined amplified input signal and the processed signal is held constant as the compression and expansion components decay together. As a result of this process the gain of the divider circuit remains substantially constant. Background noise thus remains equally constant with a consequent avoidance of "hush" effects.

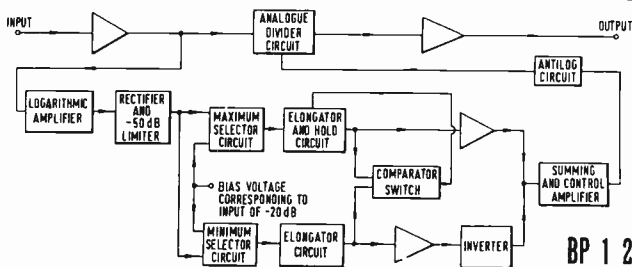


Fig. 2

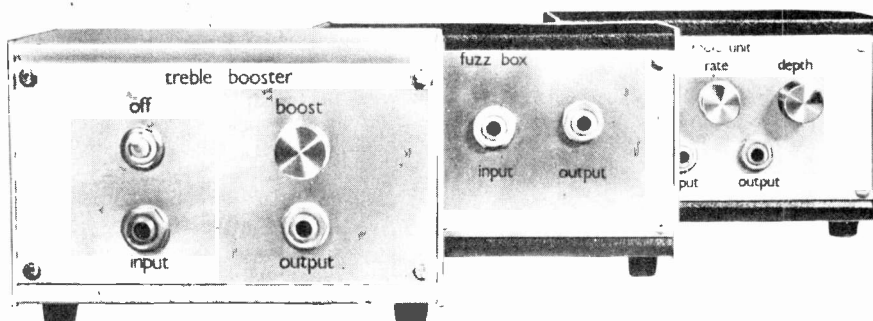
BP 1 245 394



TREBLE BOOSTER

Second of three guitar effects units

By A. Russell



A SIMPLE but effective unit for heightening the higher frequency harmonics of electric guitar sounds is a Treble Booster.

The actual sounds produced are akin to those made by the early "Rock 'n Roll" guitarists, particularly when played near to the instrument bridge.

In addition to use as an effects unit the Booster will act as a straightforward pre-amplifier if required.

HOW IT WORKS

Basically the circuit consists of a simple pre-amplifier, using a low noise, high gain transistor.

In shunt with the input (Fig. 1) is an inductor L1. The impedance of this is less to low frequency

signals and so the bass notes tend to be shunted to earth leaving the higher frequencies to be amplified and passed to the output socket JK2.

The "Boost" control VR1 is a 5 kilohm potentiometer in series with L1 and it controls the amount of bass cut applied to the incoming signal. When the wiper is rotated for maximum resistance there is almost no bass loss and all frequencies are amplified equally.

CONSTRUCTION

The prototype was built on a piece of 0.15in matrix Veroboard 1½in × 2½in as in Fig. 2. No breaks are required in the copper strips.

The primary of a small transistor output transformer is used for L1. The secondary winding and centre tap is not used and the leads from these should be cut short.

Control panel and Veroboard interwiring is straightforward (Fig. 2) and should present no difficulties. To prevent hum pick-up the input and output leads should be screened.

TESTING

With the unit completed, the wiring should be given a final check. With the battery connected you should find that the circuit will work first time since it is so simple.

A point to watch is the siting of the Booster. If it is placed near to the mains transformer of the amplifier, hum will be picked up by L1 so this should be avoided. ★

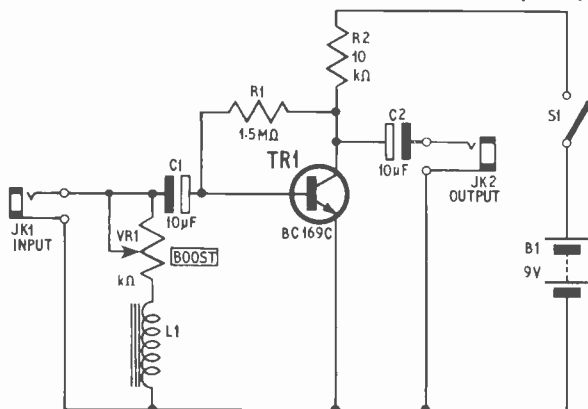


Fig. 1. Circuit diagram of Treble Booster

COMPONENTS . . .

Resistors

- R1 1.5M Ω
- R2 10k Ω
- $\frac{1}{4}$ W 10% carbon

Capacitors

- C1, C2 10 μ F elect. 25V (2 off)

Potentiometer

- VR1 5k Ω lin. carbon

Inductor

- L1 Eagle LT700 miniature output transformer

Transistor

- TR1 BC169C

Miscellaneous

- JK1, JK2 Standard jack sockets (2 off)
- S1 On/off toggle switch, B1-PP3 9V battery, Battery connectors, Control knob, Veroboard 1 $\frac{1}{2}$ in \times 2 $\frac{1}{2}$ in 0.15in matrix 2 $\frac{1}{2}$ in length of $\frac{1}{2}$ in \times $\frac{1}{2}$ in plastics angle.

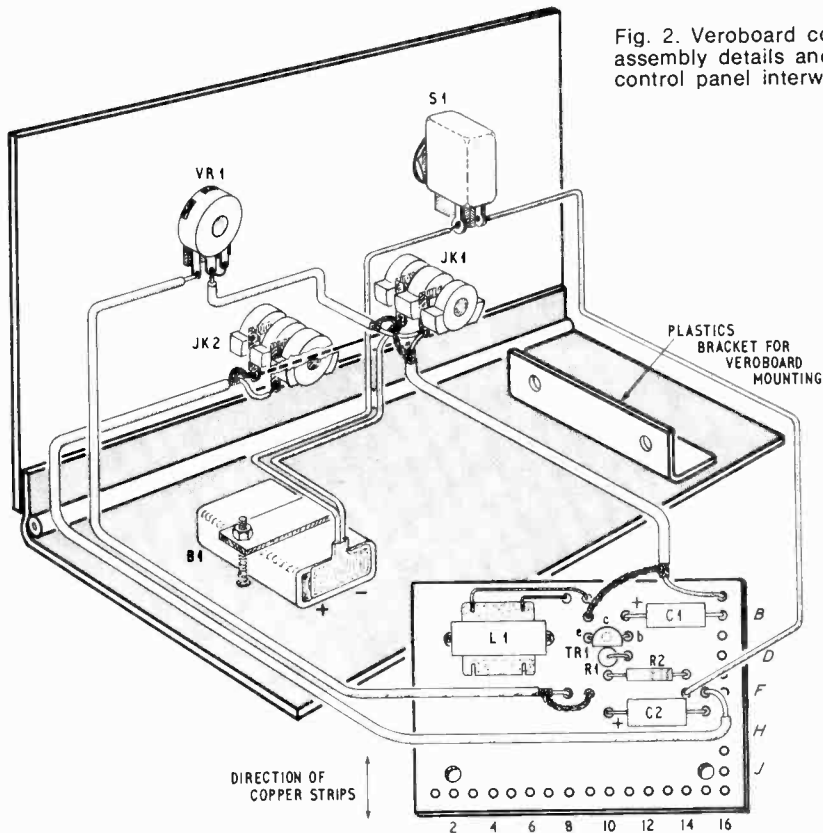
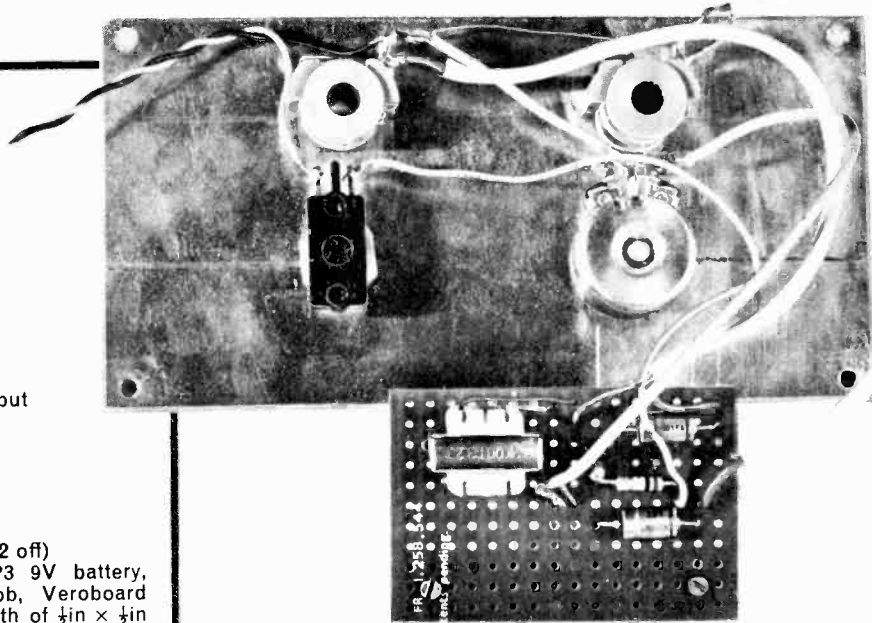


Fig. 2. Veroboard component assembly details and control panel interwiring

Silicon
Controlled
Switch

SCS COUNTING CIRCUITS

By D. Burn, Ph.D.

THE purpose of this article is to introduce a relatively little known semiconductor device, the silicon controlled switch (SCS), and to show how quite simple and inexpensive counting circuits may be constructed with it.

THE SILICON CONTROLLED SWITCH

The SCS is a four layer device, very similar to the thyristor, in which all four layers are accessible as electrodes (Fig. 1a). Unlike most thyristors, it is designed to handle only fairly small currents (up to 500mA), and may be regarded as a low power transistor combined with a "holding" circuit.

The usual symbol for the SCS is shown in Fig. 1b, which corresponds closely to the structure of Fig. 1a, and emphasises its similarity with the thyristor. On the other hand, it is much easier to understand the operation of the SCS if it is thought of as a pair of *pnp-npn* transistors connected as shown in Fig. 1c, the electrodes being named accordingly.

Suppose that a voltage is applied to the device as indicated in Fig. 1c and that the base is reverse biased by means of a resistor connected between the base and emitter. Provided that the applied voltage is less than the transistor breakdown voltage, neither transistor will conduct, since neither can obtain any base current. The device will therefore be in a stable "OFF" state.

If a positive pulse is now applied to the base, the *npn* transistor will begin to conduct and thus supply base current to the *pnp* transistor. This in turn will begin to conduct and supply more base current to the *npn* transistor, augmenting that derived from the input pulse.

The process is now self-sustaining and the current through the device rapidly increases until both the transistors are saturated. Since each transistor is providing the base current required by the other, there is no further need for the input pulse, and current will continue to flow after the input has ceased. The device is now in a stable "ON" state, with the value of the anode current being determined by the external circuitry.

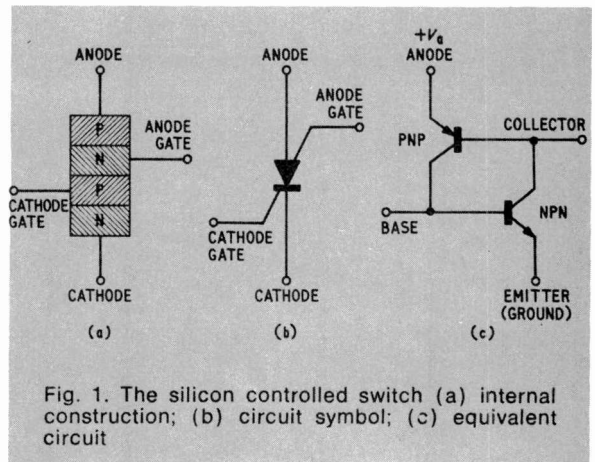


Fig. 1. The silicon controlled switch (a) internal construction; (b) circuit symbol; (c) equivalent circuit

TURNING OFF

To turn the device off again, it may be thought that it is merely necessary to reverse the turn-on procedure and apply a negative pulse to the base. Unfortunately it is not quite as simple as that.

Due to the very high gain of the device, the magnitude of such a negative pulse would almost certainly exceed the maximum permitted reverse base-emitter junction potential and thus destroy the SCS. Instead, a technique is employed analogous to that used with thyristors: reduction of the anode current to a low value.

There is a certain minimum current, known as the holding current i_H , necessary to maintain the device in the "ON" state. If the anode current is reduced below i_H , neither transistor can obtain sufficient base current to keep it conducting and so the combination rapidly turns off. This may be achieved either by applying a negative pulse to the anode, or a positive pulse to the emitter; both methods will be illustrated in the circuit to follow. Once the device has turned off, the anode potential may be restored for, as we have already seen, it can only be turned on by a pulse at its base.

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CAPACITORS

2.2pF	500V	S/M	7½p	0.0027µF	500V	S/M	15p
3.3pF	500V	S/M	7½p	0.003µF	500V	Cer.	5p
5pF	500V	S/M	7½p	0.0033µF	125V	P.S.	6p
10pF	125V	P.S.	5p	0.0033µF	500V	Poly.	6p
10pF	500V	S/M	7½p	0.0036µF	1,000V	MDC	6p
15pF	125V	P.S.	5p	0.0047µF	500V	S/M	15p
15pF	500V	Cer.	4p	0.0047µF	500V	Poly.	9p
18pF	500V	S/M	7½p	0.0047µF	500V	S/M	20p
22pF	125V	P.S.	5p	0.005µF	1,000V	MDC	6p
22pF	500V	S/M	7½p	0.005µF	100V	Mylar	3p
25pF	500V	S/M	7½p	0.0068µF	500V	Cer.	3p
27pF	500V	Cer.	4p	0.0068µF	125V	P.S.	10½p
33pF	125V	P.S.	5p	0.0068µF	500V	S/M	30p
33pF	500V	S/M	7½p	0.0068µF	500V	Poly.	6p
39pF	500V	S/M	7½p	0.0082µF	125V	P.S.	10½p
47pF	125V	P.S.	5p	0.0082µF	500V	S/M	30p
47pF	500V	Cer.	4p	0.01µF	12V	Disc	4p
50pF	500V	S/M	7½p	0.01µF	125V	P.S.	10½p
56pF	500V	S/M	7½p	0.01µF	160V	Poly.	4p
68pF	125V	P.S.	5p	0.01µF	250V	M.F.	3p
68pF	500V	S/M	7½p	0.01µF	400V	Poly	3p
75pF	500V	S/M	7½p	0.01µF	500V	Cer.	5p
82pF	500V	S/M	7½p	0.01µF	500V	S/M	30p
100pF	125V	P.S.	5p	0.01µF	500V	Paper	9p
100pF	500V	S/M	7½p	0.01µF	1,000V	MDC	6p
100pF	500V	Cer.	5p	0.015µF	1,000V	Poly.	3p
120pF	500V	S/M	7½p	0.015µF	400V	Poly.	3p
150pF	125V	P.S.	5p	0.02µF	100V	Mylar	3p
150pF	500V	S/M	7½p	0.022µF	18V	Disc	5p
150pF	500V	Cer.	5p	0.022µF	250V	M.F.	3p
180pF	500V	S/M	7½p	0.022µF	400V	Poly.	3p
200pF	500V	S/M	7½p	0.022µF	600V	MDC	7½p
220pF	125V	P.S.	5p	0.022µF	1,000V	MDC	6p
220pF	500V	Cer.	5p	0.033µF	250V	M.F.	4p
250pF	500V	S/M	8p	0.033µF	400V	Poly.	4p
270pF	500V	Cer.	8p	0.047µF	12V	Disc	6p
300pF	500V	S/M	8p	0.047µF	160V	Poly.	3p
330pF	125V	P.S.	5p	0.047µF	250V	M.F.	4p
330pF	500V	S/M	8p	0.047µF	400V	Poly.	4p
390pF	500V	S/M	8p	0.047µF	500V	Paper	8p
470pF	125V	P.S.	5p	0.047µF	1,000V	MDC	10p
470pF	750V	Disc	5p	0.1µF	30V	Disc	6p
500pF	500V	S/M	8p	0.1µF	250V	M.F.	4p
560pF	500V	S/M	8p	0.1µF	400V	Poly.	5p
680pF	125V	P.S.	5p	0.1µF	600V	MDC	10p
680pF	500V	S/M	8p	0.15µF	1,000V	MDC	13p
820pF	500V	S/M	8p	0.15µF	250V	M.F.	5p
0.001µF	100V	Mylar	3p	0.22µF	250V	M.F.	5p
0.001µF	125V	P.S.	6p	0.22µF	400V	Foil	10p
0.001µF	400V	Poly.	3p	0.22µF	1,000V	MDC	15p
0.001µF	500V	S/M	10p	0.33µF	250V	M.F.	8p
0.001µF	500V	Cer.	5p	0.47µF	250V	M.F.	8p
0.001µF	1,000V	MDC	6p	0.47µF	400V	Foil	15p
0.0015µF	400V	Poly.	3p	0.47µF	1,000V	MDC	20p
0.0015µF	500V	S/M	10p	1.0µF	250V	M.F.	15p
0.0015µF	500V	Cer.	5p				
0.0018µF	500V	S/M	10p				
0.002µF	100V	Mylar	3p				
0.002µF	500V	Cer.	5p				
0.0022µF	125V	P.S.	6p				
0.0022µF	500V	S/M	10p				
0.0022µF	1,000V	MDC	6p				

Note: S/M = silver mica 1% tol.
P.S. = polystyrene 2½% tol.
MDC = a.c. rating = 300V.
M.F. = Mullard min. foil.
Cer. = ceramic.

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CARBON
All 5%, high-stability. E12 values.
½ watt—1½p; 1 watt—4p; 2 watt—6p.

WIREWOUND
5 watt—10p; 10 watt—12p.

LOW-OHM RESISTORS

2½ watt wire-wound. 1 Ω.
1.8 Ω, 2.7 Ω, 3.3 Ω, 3.9 Ω.
4.7 Ω, 5.6 Ω, 6.8 Ω, 8.2 Ω. **11p**

CONTROLS, Log. or Lin.

Single, less switch, 15p
Single, D.P. switch, 24p
Tandem, less switch, 40p
5k Ω, 10k Ω, 25k Ω, 50k Ω, 100k Ω, 250k Ω,
500k Ω, 1M Ω, 2M Ω.

FUSES

1½in glass—2½p
60, 100, 150, 250, 500, 750mA; 1, 1.25, 1.5,
2, 2.5, 3, 5, 7.5, 10, 15 amp.

1in glass—2½p

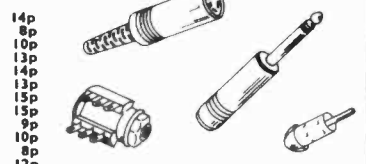
100, 250, 500mA; 1, 2.5 amp.
Anti-surge 1½in—8p
250, 500, 750, 850mA; 1, 1.5, 2, 3 amp.

Anti-surge 20mm—5p

80, 125, 200, 315, 400, 500, 630, 800mA;
1, 2 amp.

PLUGS

Car aerial
Co-axial
D.I.N. 2 pin (speaker)
D.I.N. 3 pin
D.I.N. 4 pin
D.I.N. 5 pin, 180°
D.I.N. 5 pin, 240°
D.I.N. 6 pin
Jack, 2½mm unscreened
Jack, 2½mm screened
Jack, 3½mm screened
Jack, 3½mm unscreened
Jack, ½in unscreened
Jack, ½in screened
Jack, stereo, unscreened
Jack, stereo, screened
Phono, plastic top
Phono, plated metal
Wander, red or black
Banana 4mm red or black



SOCKETS

Car aerial
Co-axial, surface
Co-axial, flush
D.I.N. 2 pin (speaker)
D.I.N. 3 pin
D.I.N. 5 pin, 180°
D.I.N. 5 pin, 240°
Jack, 2½mm
Jack, 3½mm
Jack, ½in unscreened
Jack, ½in switched
Jack, stereo, switched
Phono, single
Phono, 2 on a strip
Phono, 3 on a strip
Phono, 4 on a strip
Jack, 3½mm
Jack, ½in screened
Jack, stereo, screened
Phono, plated metal

LINE SOCKETS

Car aerial
Co-axial
D.I.N. 2 pin (speaker)
D.I.N. 3 pin
D.I.N. 5 pin, 180°
D.I.N. 5 pin, 240°
Jack, 3½mm
Jack, ½in screened
Jack, stereo, screened
Phono, plated metal

TRANSISTORS

AC127	17p	BC109	11p	BFX29	38p	5T141	23p
AC128	18p	BC147	12p	BFX84	25p	UT46	35p
AC176	22p	BC148	12p	BFY50	21p	2N696	15p
AC187	28p	BC159	15p	BFY51	21p	2N706A	12p
AC188	27p	BC158	14p	BFY52	22p	2N2926G	14p
AC199	23p	BC159	14p	MAT100	22p	2N2926Y	13p
AD149	47p	BD131	75p	MAT101	29p	2N3053	25p
AD161/162	72p	BD132	75p	MAT120	25p	2N3054	60p
ADT140	62p	BF115	25p	MAT121	29p	2N3702	15p
AF118	45p	BF178	32p	OC28	58p	2N3055	72p
AF124	22p	BF179	56p	OC35	48p	2N3702	15p
AF125	19p	BF180	30p	OC44	12p	2N3703	15p
AF126	20p	BF181	32p	OC45	12p	2N3704	15p
AF127	19p	BF184	30p	OC71	11p	2N3705	14p
AF178	67p	BF185	32p	OC72	12p	2N3706	14p
AF179	66p	BF194	14p	OC75	20p	2N3711	15p
AF180	66p	BF195	14p	OC200	27p	2N3819	35p
AF239	32p	BF196	28p	OC201	38p	2N4058	17p
BC107	11p	BF197	15p	OCPT1	60p	2N5459	60p
BC108	11p	BF197	70p	ST140	15p		

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2.5µF	64V	50µF	15V
4µF	40V	100µF	15V
5µF	64V		
8µF	15V		
8µF	40V		
10µF	15V		
16µF	40V		
25µF	25V		

7p

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OA47	7½p
OA90	7½p
OA91	7½p
OA202	10p
BY100	15p
BY127	22½p
BYZ12	22½p

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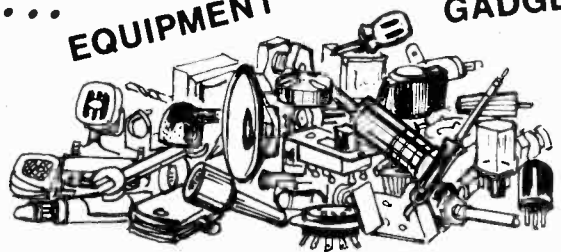


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Thus, in the SCS we have an inherently bistable device which, with the minimum of additional components, will function in the same way as a bistable circuit requiring two transistors, two diodes and several resistors and capacitors. Hence it is possible to construct counting circuits which are very much simpler, and more economical, than their transistor counterparts.

ANODE GATE

So far in this discussion, the collector, or anode gate, has not been mentioned. In fact, it is quite possible to design SCS counting circuits in which the collector is not used at all. However, where it is desired to provide a visual indication of the count, the collector forms a very convenient output electrode. Although at first sight it may appear somewhat paradoxical that the anode is used as a control electrode and the anode gate forms the output electrode, the *npn-pnp* concept of Fig. 1c does help to provide a logical explanation.

Reference to Fig. 1c will show that in the "ON" state, the collector will be very close to 0 volts (i.e. V_{CEsat} of the *nnp* transistor). In the "OFF" state, the collector will be at some positive potential determined by the external circuit.

Hence one form of read-out would be a low voltage, low current filament bulb included in the collector circuit as indicated in Fig. 2a. If, on the other hand, numerical indicator tubes are required, then another valuable feature of the SCS comes in useful, that is, it is designed to withstand high voltages. This means that the collector may be directly

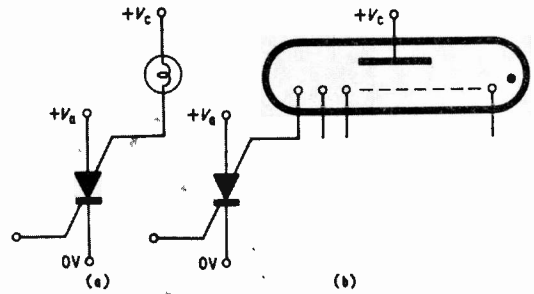


Fig. 2. (a) SCS used to drive low voltage bulb; (b) SCS driving a cold cathode tube

connected to an indicator tube cathode without the need for an intermediate, high-voltage buffer transistor (Fig. 2b).

RING COUNTER

Having discussed the SCS in some detail, the basic circuit for a ring counter with an indicator tube read-out can be introduced (Fig. 3). While it may appear rather formidable, it is, in fact, far simpler than a corresponding transistor circuit. Its operation may be explained in the following way.

To begin, assume that the RESET line is connected to the 0 volt line, and that the first SCS, CSR0, is on. Cathode 0 of the indicator tube V1 thus has direct path to 0 volt and is therefore lit.

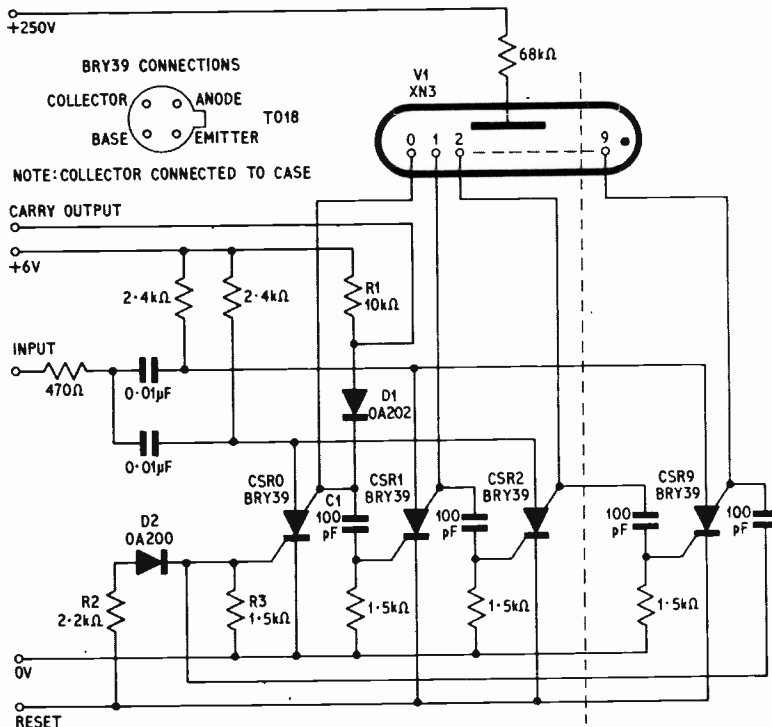


Fig. 3. An SCS ring counter

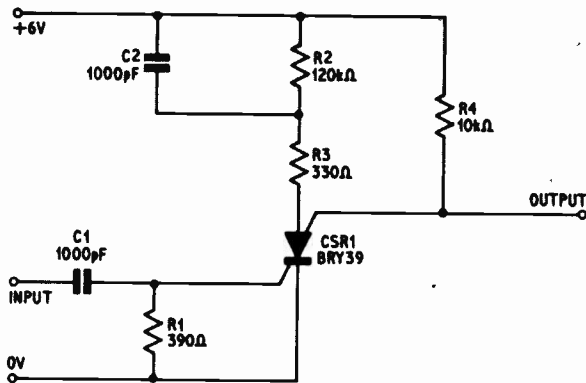


Fig. 4. An SCS pulse generator

The anode of CSR0, and of all other even numbered SCSs, will be close to 0 volt, whilst the collectors of all the other SCSs will be at potentials ranging from about +15 to +120 volts, determined mainly by the characteristics of V1.

If a negative pulse of about 6 volts amplitude is applied to the input, all SCSs will lose their anode potential so that CSR0 will turn off and cathode 0 will be extinguished. The collector of CSR0 will go positive and this positive pulse will be passed to the base of CSR1 via C1. CSR1 will therefore turn on, its collector will fall to 0 volt and cathode 1 of V1 will light. Although the negative input pulse is applied to the anodes of all SCSs, this will not prevent CSR1 from turning on. The design of the circuit is such while the anode of CSR0 goes to about -2 volts, the anode of CSR1 only falls to about +2 volts, which is just enough to allow it to turn on.

Thus the use of two anode lines is essential to the correct operation of this type of counter, and ensures that only the correct SCS can turn on with each successive input pulse. It should perhaps be emphasised that this feature means that the circuit can only be used for an even numbered count, since an odd number of stages would require two consecutive anodes to be connected to the same line.

This then is the basic ring counter circuit, requiring only a few additional refinements to turn it into a fully operational unit.

PULSE GENERATOR

First of all, we need to generate suitable input pulses, and although there are several pulse generator circuits that would do the job, a particularly simple one results from the use of another SCS, as shown in Fig. 4. The SCS is normally held off by the bias resistor R1. A positive pulse of any shape and duration applied to its base will turn it on so that the anode drops to close to 0 volts. C2 rapidly charges to 6 volts through R3 and the SCS, its charging current keeping the SCS turned on.

Once C2 is charged, this current falls to zero so that the only current that can flow becomes determined by R2. The value of this resistor is chosen so that this current is less than i_{H1} , hence the SCS turns off, and C2 discharges through R2.

The result of all this is that a negative pulse having very short rise and fall times, and the desired amplitude and duration, appears at the collector.

CARRY AND RESET

If one wishes to set up a chain of ring counters, the circuit must be arranged such that as each one completes its count, it automatically provides an output pulse suitable for stepping the next counter in the chain. This is achieved by means of diode D1 and resistor R1 in the collector circuit of CSR0 (Fig. 3). When CSR0 is off, D1 will be reverse biased so that the output line is clamped to +6 volts.

As soon as CSR0 turns on, D1 becomes forward biased and the output falls to 0 volts, thus providing the required input to the next counter.

This very simple way of obtaining a logic output from CSR0 can, of course, be applied to every SCS in the counter, thus making it possible to add, for example, pre-determining and alarm circuits to the basic counter.

The last function to be considered is the RESET facility. It may be seen that the emitters of all SCSs, except CSR0, are connected to the reset line (Fig. 3), and it was previously assumed that this line was connected to 0 volt. Suppose that the reset line is momentarily taken to +6 volts. All SCSs other than CSR0 lose their supply voltage, and the one that was on will turn off.

At the same time, this positive pulse is coupled into the base of CSR0 via R2 and D2, and since CSR0 has not lost its supply it will be turned on. The reset line also fulfils another important function. When power is first applied to the circuit, it is probable that none of SCSs will turn on. Furthermore, since the input pulses merely turn off any SCS that was conducting, there is no way of initially turning on any particular SCS. The reset line allows the circuit to start operating correctly by turning CSR0 on.

OTHER APPLICATIONS

So far, this discussion has been limited to counting circuits in which a read-out is required. However, many applications do not need a read-out and the SCS may be used just as efficiently to construct such circuits.

A ring counter having n stages, where n is an even number, will deliver one output pulse for every n input pulses, and is a very simple method of frequency division. A suitable circuit is illustrated in Fig. 5. It is virtually identical with that already described and operates in exactly the same way.

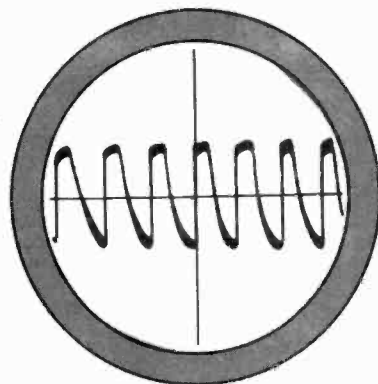
The indicator tube has been replaced by resistors which are returned to a voltage preferably higher than the anode supply. The reason for this is that under certain circumstances the collector of an SCS could go less positive than its anode. If this should happen, the SCS would be turned on since effectively the base of a pnp transistor is going negative with respect to its emitter (see Fig. 1c).

An output pulse, limited in amplitude to about 6 volts, may be obtained from the collector of any stage by means of a diode-resistor combination as shown for CSR0. Suitable input pulses may be obtained from the same type of pulse generator that was used in the counter circuit.

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RAPY

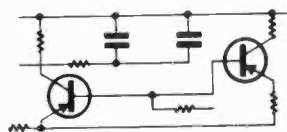
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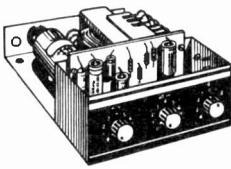
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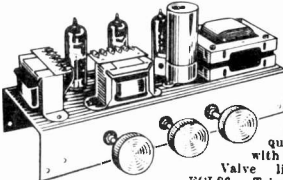
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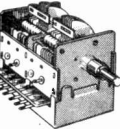
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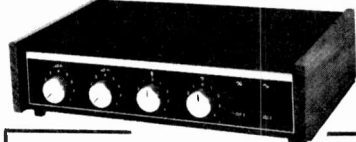
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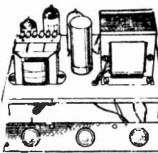


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Note: The above amplifier is suitable for feeding two mono sources into inputs (e.g. mike, radio, twin record decks, etc.) and will then provide mixing and fading facilities for medium powered Hi-Fi Discosque use, etc.



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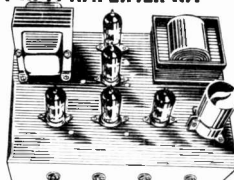
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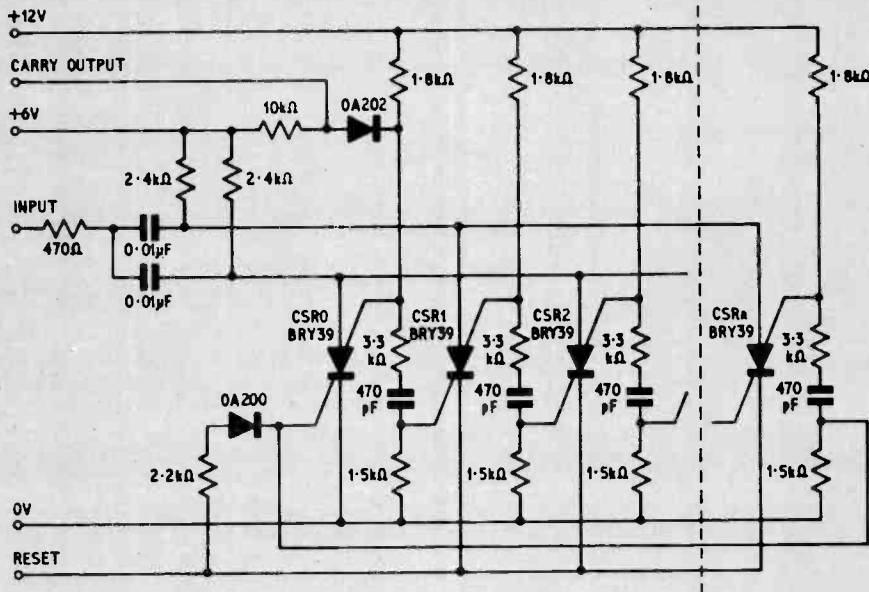


Fig. 5. An SCS frequency divider

The usual problem will arise if it is desired to produce an odd-numbered count. However, it will generally be possible to devise a gating circuit which will detect the required count and apply a reset input to the counter.

RADIO CONTROL APPLICATIONS

Some very sophisticated circuitry has been developed for modern model radio-control gear, and the final example of a counting circuit is typical of those used in the so called digital proportional equipment.

In this system, the position adopted by a servo mechanism is proportional to the duration of an input pulse supplied to it. This duration is made variable, typically between 1 and 2 milliseconds, for travel between one extreme of servo position and the other. The transmitter is therefore required to generate a string of pulses, one for each function to be controlled, whose individual durations may be varied at will, generally by means of "joy-stick" type of controls.

The appearance of such a pulse train is shown in Fig. 6, where the four pulses might control the movement of the rudder, elevator, ailerons and engine throttle. The task of the receiver is to detect these pulses and to route each one to the correct servo.

It is not intended to describe in detail the circuits of a complete system, for which the reader is referred to the numerous publications specialising in this subject. Instead, the description is limited to one aspect of the system—how does the receiver sort out the incoming pulses and know which pulse to send to which servo? This is a vitally important task, for the result of the receiver interpreting, for example, a "left rudder" command as a "down elevator" command could well be disastrous! The part of the

receiver that carries out this function is known as the decoder, and may take the form of a particularly simple SCS counter (Fig. 7).

There are several important differences between this circuit and those described earlier. In the first place, the collector (anode gate) is not used at all, the output being taken from the anode. The SCS is in fact functioning as a low current, sensitive thyristor. Secondly, the SCS is turned both on and off by means of positive and negative pulses respectively applied to its base. While this may appear to conflict with what was said earlier in this article, it is permissible here because this is a low-current, low-voltage circuit.

Finally, the circuit is not a ring counter, that is, there is no feedback from the output of the last stage to the input of the first. For reasons that will become evident later, the counter has to be told when to go back to its initial state.

DECODER OPERATION

The operation of the circuit may be followed with the aid of the waveforms shown in Fig. 8. The

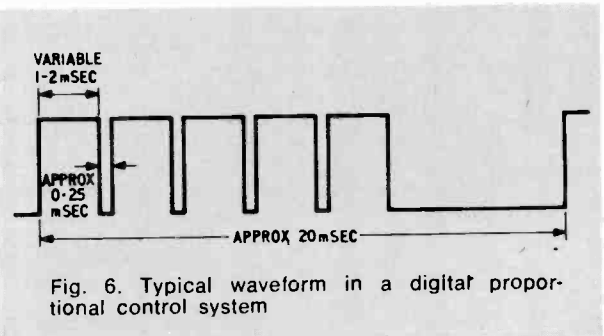


Fig. 6. Typical waveform in a digital proportional control system

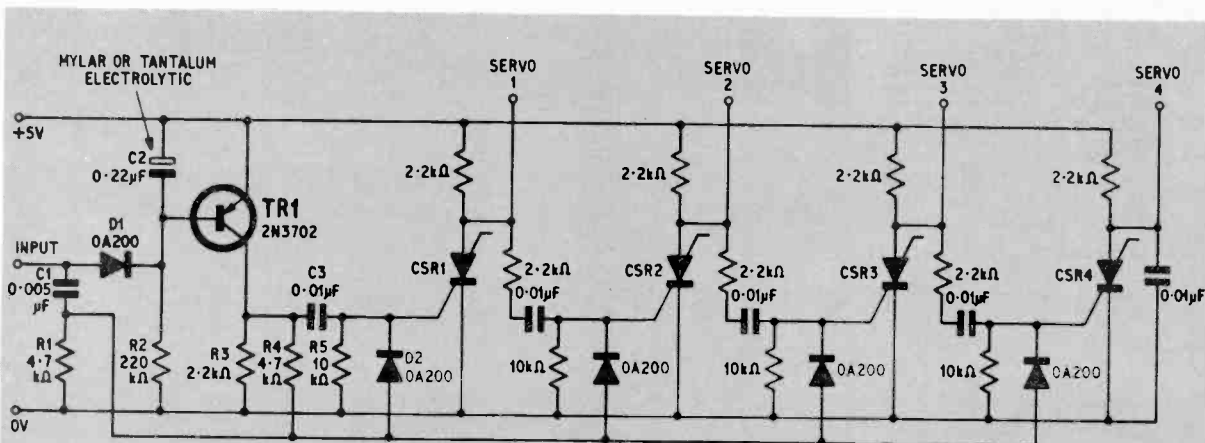


Fig. 7. An SCS digital proportional decoder

CSI-4 BRY 39

input pulses are applied to the differentiating network C1-R1 and the resulting positive spikes are passed, via diodes D1, to the bases of all the SCSs and turning them all on. (The "resting" state of the counter is that in which all the SCSs are on, so that all the outputs are at 0 volts.)

At the same time, the first positive going transition of the input will discharge C2, previously charged through R2, and thus turn TR1 off. Its collector will go negative and apply a negative-going spike, via a second differentiating network C3-R5, to the base of CSR1 and so turn it off.

There is an apparent problem here in that CSR1 has both a positive and a negative pulse applied to it at the same time. However, it will be seen from the component values that the time constant of C3-R5 is much longer than that of C1-R1 so that the negative pulse wins and CSR1 turns off. This negative pulse is prevented from reaching the bases of the other SCSs by the diodes D2.

The next input pulse will turn CSR1 on again via D1 so that its anode returns to 0 volts and terminates

the first output to servo 1. At the same time, this negative transition is passed to the base of CSR2, and once again the time constants are such that CSR2 is turned off and initiates the input to servo 2. This process continues until the final SCS has been turned off and then on again, and one pulse has been applied to each servo in turn.

RESET PERIOD

Up till now, however, there has been no way of ensuring that the correct pulse has reached the proper servo, and this is where the long gap in the train of pulses comes in. There is a third and very important time constant built into the circuit, that of C2 and R2. This is a very long one, as long as the longest possible duration of two consecutive input pulses.

The result is that once TR1 has been turned off by the first pulse in a sequence, C2 does not have time to charge up sufficiently to turn it back on again until the last pulse in that sequence has been decoded. When it finally does turn on, the resulting positive transition at its collector ensures that all the SCSs are turned on, via R4 and the diodes D2, ready for the next sequence. This explains why the counter is not a closed ring, for if the transmitter and decoder should get out of step, there will be a maximum period of less than 20ms before the counter is reset to its initial state and the correct sequence is restored.

It is hoped that these examples have given some indication of the versatility of the silicon controlled switch and may perhaps prompt some further experimentation. ★

POINTS ARISING

LOGICAL RADIO CONTROL (January 1972)

Page 51, Fig. 17a. IC1, IC2 and IC3 should read IC2, IC3 and IC4. Fig. 20. Connection pads to pins 8 and 9 on IC2 should be reversed.

I.C. AUDIO MIXER (January 1972)

Page 44, Fig. 2. An additional break should be made at 10A on the component board.

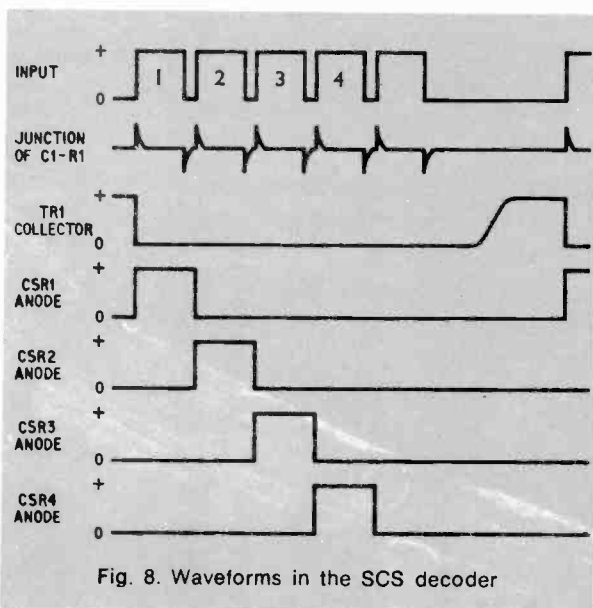


Fig. 8. Waveforms in the SCS decoder



DRILL CONTROLLER NEW 1KW MODEL

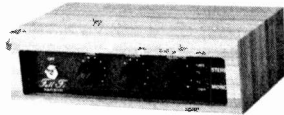
Electronically changes speed from approximately 10 revs. to maximum. Full power at all speeds by finger-tip control. Kit includes all parts, case, everything and full instructions. £1-50 plus 15p post and insurance. Made up model also available, £2-25 plus 13p post and p



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THE FULL-FI STEREO SIX



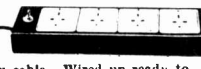
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circuit with an output power of 6W R.M.S. split over the two channels. The mains transformer and ganged volume and tone controls—also switching for Mono to Stereo, tuner or pick-up. UNREPEATABLE PRICE is £6-50 plus 20p post and insurance. Simulated Teak cabinet ready for mounting amplifier £1-95 (postage free when ordered with chassis).

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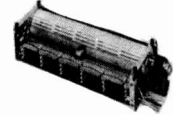
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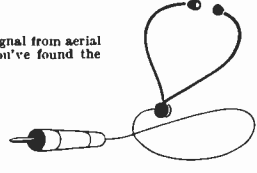
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Uses 4 transistors, and has an output of 750mW into 8 ohms speakers. Input suitable for crystal mic. or pick-up. 9V battery operated. Size 2in long x 1 1/2in wide x 1in high. SPECIAL SNIP PRICE 60p each. 10 for £5.



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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 improved and even more efficient version. Price £5-25 plus 30p post. When ordering please state whether for positive or negative systems.



TYPE 25 RELAYS

These are miniature relays. Size approx. 1 1/2in high x 1 1/2in wide x 1/2in deep. 4 changeover silver/gold contacts. Contact rating max 100V d.c. Fitted with a plastic cover. Coil operates approx. 250mW d.c. Available with the following coils: 28Ω for 1V-2.5V 45Ω for 4V-7.5V 52Ω for 4.9V-6V 90Ω for 5.5V-11.5V 130Ω for 10V-15V 530Ω for 17V-36V 1250Ω for 27V-44V 2300Ω for 31V-55V 5300Ω for 27V-44V 75p each. 10 for £6-75. Also one with 18,500 ohm coil but this has only 2 heavy duty changeover gold contacts. Price £1-45.



Veroboard. We are now stocking this in various sizes. Prices as follows:

Inches	0-1	0-15
2 1/2 x 3 1/2	85p	16p
2 1/2 x 5	94p	24p
2 1/2 x 5 1/2	94p	24p
3 1/2 x 5	87p	27p
17 x 2 1/2	76p	57p
17 x 5 (plain)	—	76p
17 x 3 1/2 (plain)	—	82p
17 x 2 1/2 (plain)	—	87p
17 x 5 (plain)	100p	76p
2 1/2 x 5 (plain)	—	171p
2 1/2 x 3 1/2 (plain)	—	15p
Pin intersection tool	47p	47p
Spot face cutter	87p	37p
Pkt. 50 pins	20p	50p

FLUORESCENT CONTROL KITS

Each kit comprises seven items—Choke, 2 tube ends, starter, holder and 2 tube clips, with wiring instructions. Suitable for normal fluorescent tubes or the new "Grolux" tubes for fish tanks and indoor plants. Chokes are super-silent, mostly resin-filled. Kit A—10-20W £1. Kit B—30-40W £1. Kit C—80W £1-20. Kit E—65W £1-20. Kit F for 8ft 125W tube £1-75. Kit MF1 is for 6in, 9in and 12in miniature tubes £1. Kit MF2 for 12in 13W miniature tube £1. Postage on Kits A and B 23p for one or two kits then 23p for each two kits ordered. Kits C, D and E 23p on first kit then 18p for each kit ordered. Kit F 33p then 23p for each kit ordered. Kit MF1 18p on first kit then 15p on each two kits ordered.

0-8 AMMETER

2in square full vision for flush mounting. Moving iron instrument. Ideal for charger. Price 45p each. 10 for £2-00.



Box Sign for Window Display, at home, office or shop, 2 1/2 wide x 1 1/2 in high x 3in deep. This is an illuminated box sign made from sheet metal hammer finish enamel with a clear plastic window. You simply have your message printed or written on poster board or thick card. (Or use stick down letters available at most stations.) You will then have a box sign normally costing anywhere between £10-15. Illumination is by a 2ft. fluorescent tube with control gear enclosed. Message card can be changed quite easily from hinged top back. Price £3 each, plus 65p post, etc.

Motivated Illuminated Box Sign. As previous item but with geared motor moving the message making it change eight times a minute. Very attention arresting. To use this for your own messages you would have to have each sign written on card then cut this up in strips which could be glued to the one supplied with the box sign. Price £4-50, plus 65p post and service.

Gearred Motor with take off socket. The gear train is driven by normal type induction motor and gives a final speed of 8 r.p.m. The motor is mounted behind a chrome plate through which the take off drive protrudes and was originally intended to drive a spit for cooking, is also ideal for driving models or for driving a colour changing disc for the local dance hall, discotheque, etc. Really well made assembly. Price £1-75 plus 25p post, etc.

Dry Film Lubricant. In aerosol can for easy application and for putting lubricant into places where the normal oil cannot reach. Home and everyday uses. We have purchased a large quantity of these from the Liquidator and are able to offer them to you at about half of the original list price. 30p per (8oz) can or 12 cans for £3 post paid. The lubricant is I.C.I. fluon L169.

REED SWITCHES

Glass encased, switches operated by external magnet—gold welded contacts. We can now offer 3 types:

Miniature. 1in long x approximately 1/2in diameter. Will make and break up to 1/2A up to 300V. Price 13p each, £1-20 dozen.

Standard. 2in long x 1/2in diameter. This will break currents of up to 1A, voltage up to 250V. Price 10p each, 90p per dozen.

Flat. Flat type, 2in long, just over 1/2in thick, flattened out, so that it can be fitted into a smaller space or a larger quantity may be packed into a square solenoid. Rating 1A 200V. Price 30p each, £3 per dozen.

Small ceramic magnets to operate these reed switches 9p each, 90p dozen.

Dry Reed Relays. Solenoids on moulded bobbins within magnetic shields printed circuit or panel mounting.

Ref.	Coil Resistance	Reed Switches	Price
71005	2 K	1 normally open	25p
81916	5 K	1 normally open,	25p
		1 normally closed	75p
05003	4 K	1 normally open	25p
62040	1500 & 500 ohms	1 normally open	25p

Multiple Reed Relay Ref. 85601. Contains 13 normally open reeds with a solenoid. Operates on 600mW. Coil resistance 9K ohms. Price £1-85 each.

Multiple Reed Relay. Ref. 031. 2 normally open 1 normally closed coil resistance 30 ohms. Price 75p.

MAINS OPERATED CONTACTOR

220/240V, 50 cycle solenoid with laminated core so very silent in operation. Closes 4 circuits each rated at 10A. Extremely well made by a German Electrical Company. Overall size 2 1/2 x 2 x 2in. £1 each.



NEED A SPECIAL SWITCH?

Double Leaf Contact. Very slight pressure closes both contacts. 6p each, 60p doz. Plastic push-out suitable for operating, 5p each, 45p doz.



AUTO-ELECTRIC CAR AERIAL

with dashboard control switch—fully extendable to 40in or fully retractable. Suitable for 12V positive or negative earth. Supplied complete with fitting instructions and ready wired dashboard switch. £5-75 plus 25p post and ins.



MICRO SWITCH

5A changeover contact, 8p each. £1 doz. 15 amp Model 10p each or £1-05 doz.



MINIATURE WAFER SWITCHES

2 pole, 2 way—4 pole, 2 way—3 pole, 3 way—4 pole, 3 way—2 pole, 4 way—3 pole, 4 way—2 pole 6 way—1 pole, 12 way. All at 20p each. £1-60 for ten, your assortment.



WATERPROOF HEATING ELEMENT

26 yards length 70W. Self-regulating temperature control. 50p post free.



BLANKET SWITCH

Double pole with neon light into side so luminous in dark. Ideal for dark room light or for use with waterproof element, new plastic case 50p each, 3 heat model 40p.



CAR ELECTRIC PLUG

Fits in place of cigarette lighter. Useful method for making a quick connection into the car electrical system. 38p each or 10 for £3-42.



TREASURE TRACER

Complete Kit (except wooden batteries) to make the metal detector as the circuit in Practical Wireless August issue. £2-95 plus 20p post and insurance.



QUICK CUPPA

Mini Immersion Heater, 350w. 200/240v. Boils full cup in about two minutes. Use any socket or lamp holder. Have at bedside for tea, baby's food, etc. £1-25, post and insurance 14p. 12v. car model also available same price. Jug heater £1-50 plus P. & P. 14p.



SNAP ACTION SLIDE SWITCH

Rated 5A 240V. Made by Arrow. Type fitted in the handles of electric drills, vacuums, etc. 5p each, 10 for 45p.



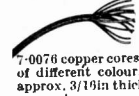
NUMICATOR TUBES

For digital instruments, counters, timers, clocks, etc. Hi-vac XN.3. Price 90p each. 10 for £9.



12 WAY SUB-MINIATURE MULTI-CORE CABLE

7-0076 copper cores, each core P.V.C. insulated and of different colour. P.V.C. covered overall and approx. 3/16in thick. Price 20p per yard.



LIGHT CELL

Almost zero resistance in sunlight increases to 10 K Ohms in dark or dull light, epoxy resin sealed. Size approx. 1in dia. by 1/2in thick. Rated at 300 MW, wire ended. 45p with circuit. Also ORP12 light cell 45p.



SOLDER GUN

A must for every busy man, gives almost instant heat also illuminates job. Dual heat 100/140 watt £3-75 plus post and ins. 20p. HIG JOB 250 watt model £4-75 plus post and ins. 40p.



Where postage is not stated then orders over £5 are post free. Below £5 add 20p. Semi-conductors add 5p post. Over £1 post free. S.A.E. with enquiries please.

J. BULL (ELECTRICAL) LTD.

(Dept. P.E.) 7 Park Street, Croydon CRO 1YD
Callers to 102/3 Tamworth Road, Croydon.

Readout —

A SELECTION FROM OUR POSTBAG

Correspondents wishing to have a reply must enclose a stamped addressed envelope. We regret we are unable to guarantee a reply on matters not relating to articles published in the magazine. Technical queries cannot be dealt with on the telephone.

Who pays?

Sir—I have just read your February Editorial and may I, with respect, be permitted to ask a question?

Who is going to pay for all these fantastically expensive schemes you are proposing? As a taxpayer, I, for one, strongly object. After all, it only needs a little less speed (i.e. to the prevailing conditions) and a little more courtesy and consideration for other road users by a very small fraction of motorists, and your problem of "Motorway Supervision" in large measures disappears.

The considerations of safety for the air do not compare with those for the road. I cannot imagine BOAC allowing a "proven-dangerous - complete - with - endorsements" driver even to enter the flight deck, let alone fly.

No, Sir, do not suggest pampering them at our expense, but sock'em hard by removing their licences at their OWN expense. I regret that this sentiment does not promote the electronic trade, as we know that is your inclination of course, but would you say me nay?

J. G. Newbury,
Ashby Parva,
Rugby.

Paradoxical stage

Sir—I am a retired teacher, having spent 41 years teaching "low level" mathematics and physics in secondary schools, and I naturally

compare the new maths with the traditional. I did have some contact with the new maths and Nuffield Science before I retired, and I followed the new maths programme on BBC schools television and have close contacts by observing my grandchildren's textbooks and their methods.

This comparison causes me much worry. I believe a blend of the old and new is the best solution, but so far as I can see, the balance is being tipped too much in favour of the new maths, and the reason put forward is that we must teach our students about computers and computer programming.

This was the reason why one of my grandsons went through junior school without learning the multiplication tables! The Headmaster said that computers do all that! Needless to say, the boy was seriously handicapped at the Comprehensive School.

But it does not end there. A careful study of his textbooks shows that the old traditional methods take about five per cent of the space.

From my own observations I know that those old fashioned initials H.C.F. and L.C.M. have key rolls in computer mathematics, and I know from experience that they teach far more about numbers than any other system, but they have absolutely no mention in the modern text book, and even comparing the value of fractions by bringing them to a common denominator has only one paragraph in a whole chapter given to that subject.

And how does this affect traditional physics? Part of the purpose of going to school is to learn to think in a logical way.

The Wheatstone Bridge is a first-class example of logical thinking yet I can find no help in the maths text book for working out

$$R_x = \frac{R_3}{R_4} \times \frac{R_2}{R_1}$$

It looks as though we are coming to the paradoxical stage when the physics department will have to teach "old fashioned" mathematics in order that the students will understand the "computer" mathematics departments who are doing all this to help in the teaching of electronics?

G. A. Cozens,
Southampton.

"Switched on"

Sir,—It may interest you to know that I am 76 years old and I became hooked on your magazine about three years ago. Your magazine has revived my old interest in these subjects of fifty or more years ago—"the cat's whisker days."

All my working life I have never been able to find the time to follow up these interests but I have now found my feet, so to speak. I like the methods used by your technical contributors in explaining the functions of the new apparatus and components. These descriptions have given me a new lease of life. They are, for the most part, brief and precise and full of technical interest.

I have been an electrical and mechanical engineer all my working life, in the heavy steel and iron industries, and felt very "switched off" when I had to retire. I can recommend your magazine to any retired gentleman who has some knowledge of these subjects and now requires a real interest in life.

H. O. Guest,
Worrall,
Sheffield.

BACK NUMBERS WANTED

Anyone who can supply the undermentioned are asked to communicate directly with the reader.

November 1969

Mr. J. Fenn, 33 Tinwell Lodge Cottages, Tinwell, Stamford, Lincolnshire.

May, June 1970

D. J. Parfitt, c/o The Duke of Richmond Hotel, Cambridge Park, St Peter Port, Guernsey, Channel Islands.

July 1970 to March 1971

Mr. S. January, 18 Hassan Assem, Zamalek, Cairo, A.R.E.

September, October, November 1971

Mr. I. M. Johnstone, 8 Hillpark Crescent, Blackhall, Edinburgh, EH4 7BG.

November 1971

Mr. J. L. Concannon, C.P.O. Mess, H.M.S. Osprey, Portland, Dorset.

February 1971

Mr P. J. Arden, 1, Hallam Grange Rise, Fulwood, Sheffield S10 4BE

May 1969 to March 1970

D1922536 Cpl. R. Larkman, "B" Flight (SAM), RAF North Luffenham, Oakham, Rutland.

January 1969

Mr A. J. Campbell, "Donegal", 9, Medina Gardens, East Oakley, Basingstoke, Hants.

We regret that back numbers of Practical Electronics can no longer be supplied. We will try to publish announcements of readers' requirements (without a guaranteed date) free of charge.

October 1970

Mr A. P. Allid, 15740, Sherman Way, Van Nuys, California, USA.

January 1967

Mr R. D. Frank, Post Office Box 88, Mt. Lawley 6050, Western Australia.

August to December 1968

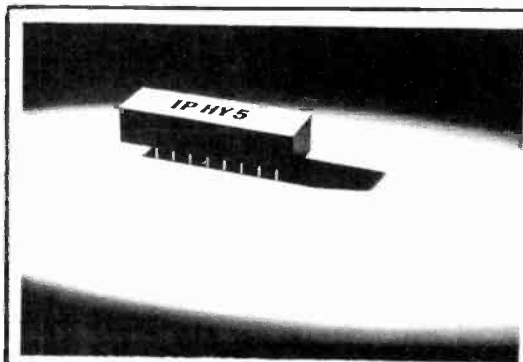
Mr B. M. Oddy, 27, Gimble Way, Pembury, Kent.

July to September 1969

Mr M. McPhee, Lowfields, 6, Enterpen, Hutton-Rudby, Yarm-on-Tees, Yorks.



I.L.P. (Electronics) Ltd



A WORLDS FIRST TO JOIN THE WORLDS BEST

The HY5 is a unique and revolutionary concept in High-Fidelity pre-amplifiers. Thanks to the latest techniques, all feedback and equalization networks are, for the first time, combined into an integrated pre-amplifier circuit.

Simply by adding volume, treble, bass potentiometers and only three stabilizing capacitors, which are supplied, your HY5 is complete and ready for use.

The HY5 provides equalization for almost every conceivable input. This years developments in equalization technique enables precise correction for both output voltage and frequency response for any crystal or ceramic cartridge. Yet another feature of the HY5 is its inbuilt stabilization circuit, allowing it to be run off any unregulated power amplifier supply.

The HY5 contains a balance circuit which, when linked by a balance control to a second HY5, forms a complete stereo preamplifier.

Specifically and critically designed to meet exacting Hi-Fi standards, the HY5 combines extremely low noise with a high overload capability. When used in conjunction with the HY40 and PSU45 forms a completely integrated system.

INPUTS

Magnetic Pick-up (within ± 1 db RIAA curve) 2mV.
Tape Replay (external components to suit head). 4mV.
Microphone (flat) 10mV.
Ceramic Pick-up (equalized and compensatable) 20 - 2000mV variable.
Tuner (flat) 250mV.
Auxiliary 1 250mV.
Auxiliary 2 2 - 20mV.

OUTPUTS

Main Pre-amp output 500mV.
Direct tape output 120mV.

ACTIVE TONE CONTROLS

Treble ± 12 db.
Bass ± 12 db.

INTERNAL STABILIZATION

Enables the HY5 to share an unregulated supply with the Power Amplifier.

SUPPLY VOLTAGE

15-25 volt.

SUPPLY CURRENT

5mA approx.

OVERLOAD CAPABILITY

better than 28db on most sensitive input infinite on tuner and auxl.

OUTPUT NOISE VOLTAGE

0.5mV.

PRICE

Mono £3-60 Stereo £7-20

HY40 IS POWER AMP PERFECTION

Lets face it — an immediate success, the HY40 is here to stay.

HY40 means Hybrid Power, power neatly locked away inside an Integrated Circuit. Power the modern way, simply mount only five additional components on a printed circuit board (all of which are supplied with the HY40). Power not only for Hi-Fi, power for Groups, for public address, for industry, power for all.

HY40 is HI-FI POWER ILP are POWER PROUD

In addition to the P.C. board and manual supplied with the HY40 we now include the five remaining components, at minimal cost, needed to complete the assembly of a High Performance Power Amplifier.

By merely combining two HY40s with a Stereo Preamplifier (2 x HY5) and simple Power Supply (PSU45), premium quality stereo may be obtained for a very modest outlay.

The free manual supplied with the HY40 gives clear, easy build instructions for Power Supply; volume, bass, treble and balance controls, together with inputs for Ceramic and Magnetic Pick-ups, Tape, Tuner and Auxiliary functions.

Internally the HY40 is based on conventional and proven circuit techniques developed over recent years.



OUTPUT POWER British Rating 40 WATTS PEAK, 20 watts RMS continuous.

LOAD IMPEDANCE 4-16 ohms

INPUT IMPEDANCE 22Kohms at 1Khz.

INPUT SENSITIVITY 300 mV for maximum output.

VOLTAGE GAIN 30db at 1KHz.

FREQUENCY RESPONSE 5Hz-60KHz ± 1 db.

TOTAL DISTORTION less than 1% (typical 0.1%) at all output powers.

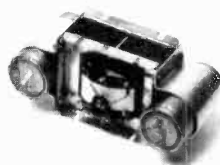
SUPPLY VOLTAGE ± 22.5 volts D.C.

SUPPLY CURRENT 0.8 amps maximum.

PRICE: including comprehensive manual, P.C. Board and FIVE EXTRA COMPONENTS:

MONO £4-40 STEREO £8-80 all post free.

POWER SUPPLY PSU45



The PSU45 is specifically designed to supply, simultaneously, your HY40 (in mono or stereo format) and one or two HY5s.

Spec.

PSU45 ± 22.5 volts, 2 amps simultaneously.

PRICE: £4-50 including Postage and Packing

CROSSLAND HOUSE · NACKINGTON · CANTERBURY · KENT
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SEW PANEL METERS

USED EXTENSIVELY BY INDUSTRY, GOVERNMENT DEPARTMENTS, EDUCATIONAL AUTHORITIES, ETC.
● LOW COST ● QUICK DELIVERY ● OVER 200 RANGES IN STOCK ● OTHER RANGES TO ORDER

NEW "SEW" DESIGNS!

CLEAR PLASTIC METERS BAKELITE PANEL METERS

TYPE SW. 100 100 x 80 mm		TYPE S-80 80 mm square fronts	
500μA	23-85	50μA	23-20
1mA	23-10	500-50μA	23-10
20V d.c.	23-10	100μA	23-75
30V d.c.	23-10	100-0-100μA	23-10
300V d.c.	23-10	300μA	23-80
1A d.c.	23-10	1mA	23-80
5A d.c.	23-10	20V d.c.	23-80
100μA	23-20	50V d.c.	23-80
100-0-100μA	23-45	300V d.c.	23-80
		VU Meter	23-87

"SEW" CLEAR PLASTIC METERS

Type MR.52P. 4 1/2in x 4 1/2in fronts.		Type MR.38P. 1 1/2in square fronts.	
50μA	23-60	50mA	21-60
50-0-50μA	23-10	100mA	21-60
100μA	23-10	300mA	21-60
100-0-100μA	23-00	500mA	21-60
200μA	23-00	750mA	21-60
300μA	23-00	1A	21-60
500-0-500μA	23-80	2A	21-60
1mA	23-80	5A	21-60
1-0-1mA	23-80	10A	21-60
5mA	23-80	30V d.c.	21-60
10mA	23-80	10V d.c.	21-60
		15V d.c.	21-60
		20V d.c.	21-60
		100V d.c.	21-60
		150V d.c.	21-60
		300V d.c.	21-60
		500V d.c.	21-60
		750V d.c.	21-60
		15V a.c.	21-70
		50V a.c.	21-70
		150V a.c.	21-70
		300V a.c.	21-70
		500V a.c.	21-70
		8 Meter	21-70
		1mA	21-70
		VU Meter	22-10

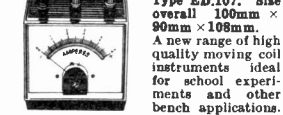
Type MR.52P. 2 1/2in square fronts.		Type MR.45P. 2in square fronts.	
50μA	22-10	50μA	22-95
50-0-50μA	22-60	10V d.c.	21-60
100μA	22-60	20V d.c.	21-60
100-0-100μA	22-50	50V d.c.	21-60
500μA	22-80	100-0-100μA	21-87
1mA	22-80	200μA	21-87
5mA	22-80	300V d.c.	21-80
10mA	22-80	500-0-500μA	21-75
		1mA	21-70
		5mA	21-70
		10mA	21-70
		50mA	21-70
		100mA	21-70
		300mA	21-70
		5A	21-70

Type MR.52P. 3 1/2in x 3 1/2in fronts.	
50μA	23-37
50-0-50μA	23-75
100μA	23-75
100-0-100μA	22-85
200μA	22-85
300μA	22-40
500-0-500μA	22-20
1mA	22-20
5mA	22-20
10mA	22-20
5A	22-20
10V d.c.	22-20

"SEW" BAKELITE PANEL METERS	
50μA	22-50
50μA	22-37
50-0-50μA	22-85
100μA	22-85
100-0-100μA	22-25
500μA	22-20
1mA	21-95
1-0-1mA	21-95
5mA	21-95
10mA	21-95
50mA	21-95
100mA	21-95
300μA	21-95
500μA	21-95
1A	21-95
5A	21-95
10A	21-95
50A	21-95
5V d.c.	22-20
10V d.c.	22-20

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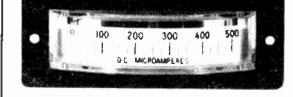


Type ED.107. Size overall 100mm x 90mm x 108mm. A new range of high quality moving coil instruments ideal for school experiments and other bench applications. 3" mirror scale. The easily accessible to working. Available in the following ranges:

50μA	24-00	20V d.c.	24-40
100μA	24-45	50V d.c.	24-40
1mA	24-40	300V d.c.	24-40
50-0-50μA	24-65	Dual range	
1-0-1mA	24-40	1A d.c.	24-40
5A d.c.	24-40	500mA/5A d.c.	24-65
10V d.c.	24-40	5V/50V d.c.	24-65

Type MR.45 3 1/2in square fronts.	
500μA	21-95
1A	21-95
2A	21-95
5A	21-95
30A	21-95
50A	21-95
5V d.c.	21-95
10V d.c.	21-95
20V d.c.	21-95
50V d.c.	21-95
150V d.c.	21-95
300V d.c.	21-95
30V a.c.	21-95
50V a.c.	21-95
150V a.c.	21-95
300V a.c.	21-95
500μA a.c.	21-95
1A a.c.	21-95
5A a.c.	21-95
10A a.c.	21-95
50A a.c.	21-95
500μA	22-95
VU meter	23-10

EDGEWISE METERS



PE.70 3 1/2in x 1 1/2in x 2 1/2in deep.

50-0-50μA	23-10	500μA	22-75
50-0-50μA	23-00	1mA	23-45
100μA	23-00	300V a.c.	23-45
100-0-100μA	23-00	VU meter	23-40
200μA	23-90		

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MODEL LT.101 1000 O.P.V. 0/10/50/250/1000 V. D.C. 0/10/50/250/1000 V. A.C. 0/1/100 M.A. 0/150 K ohms. £1-87. P. & P. 15p.

MODEL TE.300. 30,000 O.P.V. Mirror scale, overload protection 0/0-63/15/60/300/1,200V d.c. 0/6/30/120/600/1,200V 0/30μA / 5mA / 60mA / 300mA/600mA. 0/8K/80K/800K/8 meg. —20 to +63dB. £5-97½. P. & P. 15p.

TKM MODEL MD.120. Mirror scale. 20kΩ/volt d.c. 50Ω/volt a.c. 30/60/100/600/2,000V d.c. 6/120/1,200V a.c. Current 0-60μA/0-12/0-300mA. 0-60kΩ/0-6MΩ —20 to +63dB. £4-62½. P. & P. 15p.

MODEL 500. 30,000 O.P.V. with overload protection. mirror scale 0/5/2.5/10/2.5/10/250/500/1,000V d.c. 0/2.5/10/2.5/10/2.5/50/500/1,000V a.c. 0/50μA/5/50/500 mA. 12 amp. d.c. 0/60K/6 Meg. 60 Meg. £3-87½. Post paid.

TKMLABTESTER. 100,000 O.P.V. 6 1/2in scale buzzer short circuit buzzer. Sensitivity: 100,000 O.P.V. d.c. 5/Volt a.c. D.c. volts: 0.5, 2.5, 10, 50, 250, 1,000V. A.c. volts: 3, 10, 50, 250, 500, 1,000V. D.c. current: 10, 100μA, 10, 100, 500mA, 2.5, 10A. Resistance: 1K, 10K, 100K, 10 meg, 100 meg. Decibels: —10 to +80dB. Plastic case with carrying handle, size 7 1/2in x 6 1/2in x 3 1/2in. £18-90. P. & P. 25p.

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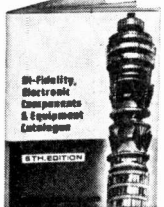
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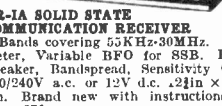
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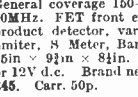
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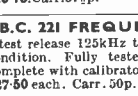
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Available complete for only £52 + £3.50 p&p

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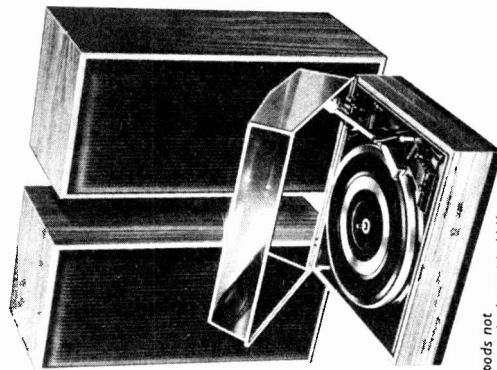
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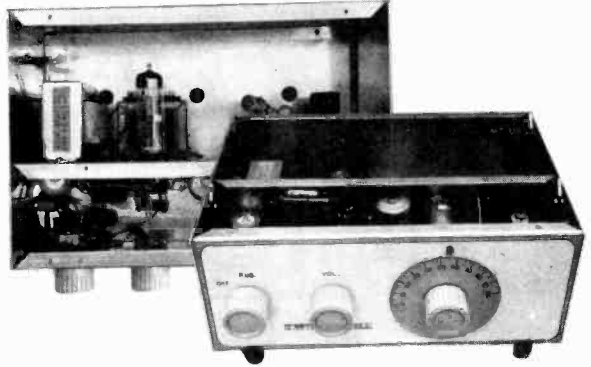
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The Reliant Mk. IV provides a high standard of sound reproduction, with full mixing facilities. Its versatility makes it suitable for: Discotheque, P.A., Home Entertainment Applications, etc.

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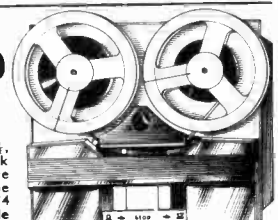
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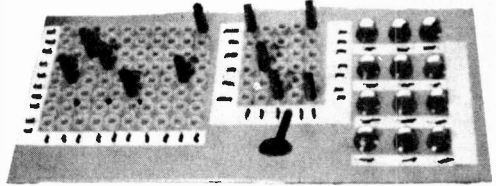


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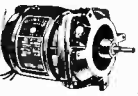
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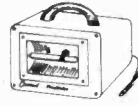


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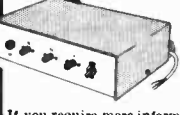
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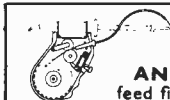
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2N3706	0-25	BCY31	0-25	GD5	0-25	0A2246	0-25
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2N3710	0-10	BCY33	0-25	GET102	0-20	0C16T	0-38
2N3711	0-10	BCY34	0-20	GET103	0-22	0C19	0-27
2N3819	0-25	BCY38	0-40	GET113	0-20	0C20	0-25
2N3820	0-20	BCY39	1-00	GET114	0-15	0C22	0-50
2N3823	0-75	BCY40	0-50	GET115	0-45	0C23	0-60
2N6027	0-25	BCY42	0-25	GET116	0-20	0C24	0-60
2N6068	0-25	BCY70	0-15	GET120	0-25	0C25	0-27
2N6065	1-25	BCY71	0-25	GET872	0-30	0C26	0-25
2N6178	0-40	BCZ10	0-25	GET875	0-25	0C26	0-25
2B301	0-60	BCZ11	0-50	GET880	0-27	0C28	0-60
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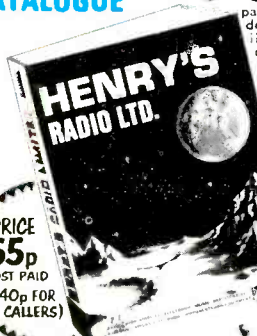
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