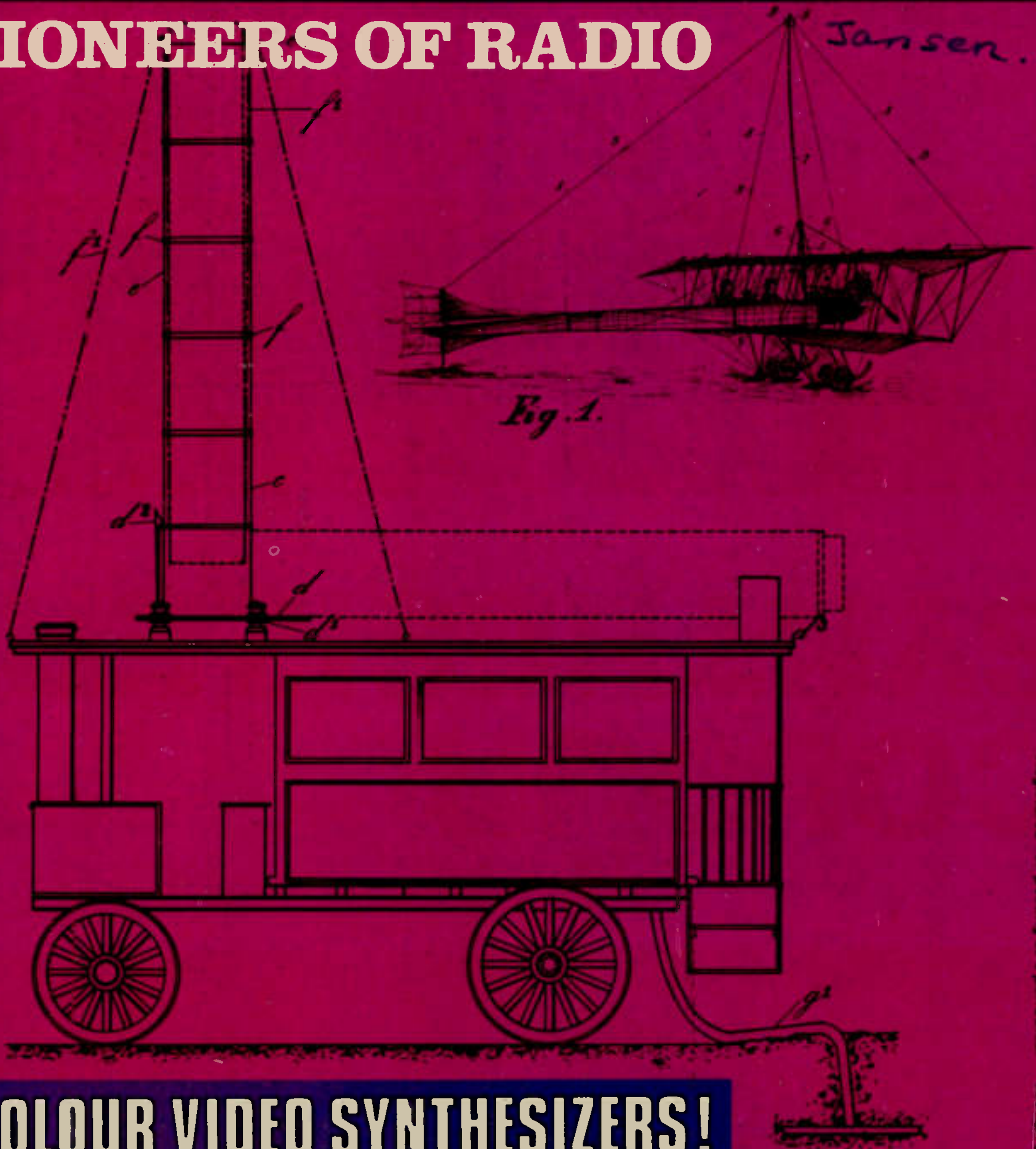
MARCH, 1975
75c*

electronics TODAY INTERNATIONAL

HI-FI

PIONEERS OF RADIO

Jansen.



Registered for posting as a periodical — Category C.

COLOUR VIDEO SYNTHESIZERS!

7 GREAT PROJECTS

- LINE AMP FOR MICROPHONES — 16-8 CHANNEL MIXER
- SELF CHARGER FOR CALCULATOR — IMPEDANCE METER
- SOUND/LIGHT OPERATED FLASH — 3600 SYNTHESIZER
- ELECTRONIC SPEEDO FOR BICYCLES

KILL THE HISS

keep the music

Until now tape hiss and other irritating noises prevented true high fidelity reproduction, so JVC invented ANRS (automatic noise reduction system) and incorporated this exclusive feature in the 1667U stereo cassette deck.

ANRS (automatic noise reduction system) as the name implies, ensures absence of tape hiss without sacrificing fidelity and musical reproduction and is claimed to be the world's best system by independent authorities.

Additionally the 1667U features the 'cronios heads' developed by JVC, that have a life ten times longer than ordinary heads. Naturally CrO_2/Normal tape selector switch, electrically governed DC motor, automatic stop mechanism and tape counter are all included.

For maximum recording ease the 1667U features two large VU meters, separate sliding volume controls and convenient push buttons. All this helps the 1667U boast of a frequency response of 30-16000Hz (±3dB) and a low wow and flutter of 0.15% RMS.

A 'must' for any serious stereo enthusiast, the 1667U stereo cassette deck, from JVC.

JVC

IF YOU'RE SERIOUS ABOUT SOUND

ANRS
Automatic Noise Reduction System

WT.GD54J.

electronics TODAY INTERNATIONAL

MARCH, 1975 Vol 5, No 3.

main features

projects

reviews

news & information

COVER: Extracts from British patent specifications; car radio about 1900, aircraft radio 1913. Definitive history of radio's early days begins page 22 this issue.

NEXT MONTH

SPECIAL PROJECT BUILDING ISSUE

Here's everything a beginner needs to know.

AT LAST! HOW AMBISONICS WORK

ETI's Technical Editor disects the Fellgett patents!

VOLTAGE MULTIPLIERS

Thousands of volts from a few diodes and capacitors.

BUILD YOUR OWN FM ANTENNA !

The feature articles listed above are included amongst those currently scheduled for our April issue. However, unforseeable circumstances, such as highly topical news or developments may affect the final issue content.

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INTERSTATE advertising — Melbourne: Clarrie Levy. Suite 23, 553 St. Kilda Rd., (51-9836). Adelaide: Ad Media Group of South Australia, 12-20 O'Connell Street, North Adelaide, S.A. 5006. (67-1129). Brisbane: David Wood, Anday Agency, 11-14 Buchanan St., West End (44-3485). OVERSEAS — United Kingdom: Modern Magazines (Holdings) Ltd., Ludgate House, 107 Fleet Street, London EC4, U.S.A.: A.C.P. Room 2102, 444 Madison Avenue, New York 10022. Printed in 1974 by Conpress Printing Ltd., 65 O'Riordan St., Alexandria N.S.W.
Distributors: Australian Consolidated Press. (*Recommended and maximum price only).

news digest

OUTDOOR LIQUID CRYSTAL DISPLAYS

A liquid crystal display that can be read in bright light – even outdoors – has been developed by Tekelec (Oxnard, California).

The displays are field-effect devices with both transmissive and reflective properties. A small globe is used to assist readability when ambient lighting is poor.

MICRO TV CAMERA

A colour TV camera less than four millimeters in diameter has been developed by Philips!

The camera has been produced for medical use and is so tiny that it can be threaded through human veins. It can even obtain pictures from inside the brain.

Within the camera a 3.5mm diameter synchronous motor drives a mirror and prism/lens combination. This rotating assembly scans the target area.

The target area is illuminated via glass fibre leads. Similar glass fibre connectors pick up the scanned data and feed it out to associated photomultipliers.

The camera is not just a state-of-the-art prototype – pre-production units have been built by Philips' Laboratoires d' Electronique et de Physique Aplique and satisfactorily tested in hospitals in France. As a result the cameras may soon be commercially available.

LOW-PRICE SCIENTIFIC CALCULATOR FROM H.P.

The HP-21 scientific calculator, the first of a new generation of Hewlett-Packard pocket calculators, was introduced on February 10th. It is priced at $119.00 (sales tax exempt), and $133.28 (sales tax paid).

The 400 gram HP-21 is the smallest and lowest priced model in HP's line. It is designed primarily for scientists, engineers and students. Scientific calculators like the HP-21 also are finding increasing use in marine and aircraft navigation, surveying, medicine and education.

While introducing the HP-21, Hewlett-Packard also reduced prices of the HP-35 and the HP-45 model to $180 and $225, respectively, (sales tax exempt prices).

The new HP-21 has all of the trigonometric and logarithmic functions of the HP-35. In addition, the user can calculate in either degrees or radians; convert from polar to rectangular co-ordinates and vice versa; format and round the display in either fixed or scientific notation; and perform register arithmetic (+,–,x,÷) with the contents of its single addressable memory.

"Because of technological advances, fewer logic chips are required in the HP-21 than in other HP pocket calculators," said Dick Warmington, Intercontinental Regional Marketing Manager for HP's Calculator line. "The new model uses only two rechargeable batteries instead of three. Reduced power requirements of the new design permit up to five hours of continuous operation, the same as with other HP pocket models.

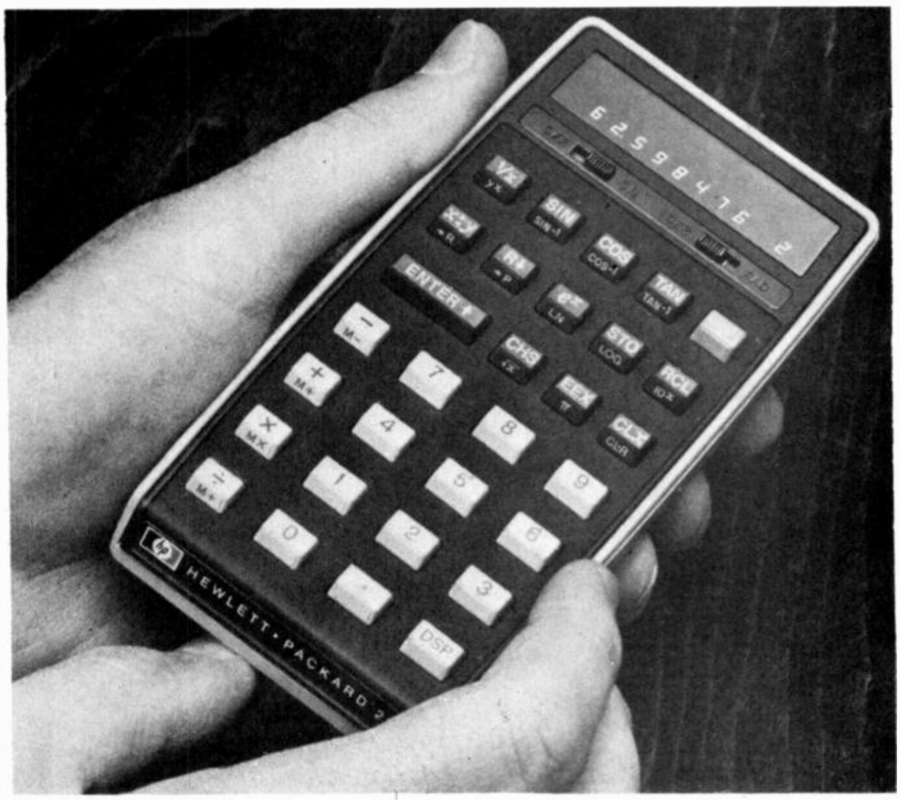
"These features allow more efficient internal packaging that has resulted in a much smaller and lighter calculator – also, one that can be produced at significantly less cost than previous models."

The new calculator also has five fewer keys (30) than other HP pocket models. However, since several keys serve dual functions, the HP-21 is able to perform more functions and operations than the HP-35.

"Although we are introducing a new generation of HP pocket calculators, we will continue to market and develop our current line, more than 500,000 of which are now in use," Warmington said. This current line includes two preprogrammed scientific models, two models for business and finance and two programmable models.

"The new generation of smaller, lower-priced units will embody many of the most popular features of our other calculators, but will not be function-for-function copies. We will continue to provide innovative products at the upper end of the capability scale to fill the needs of the most demanding professionals," Warmington said.

Like other HP pocket calculators, the HP-21 features the company's Reverse Polish Notation (RPN) logic system with a four-memory stack that holds intermediate answers and automatically brings them back when needed in a calculation.



news digest

TYPEWRITER FOR HANDICAPPED

A revolutionary system enabling severely handicapped people to use a conventional electric typewriter, is attracting considerable interest in Europe, the USA, and Canada.

Basically the system (developed by Palmstienas Mekaniska Verkstad AB of Stockholm, Sweden), consists of a specially designed keyboard which replaces the conventional typewriter keyboard and a solenoid unit which acts as an interface between the typewriter keys and PMV keyboard. The company, which has been developing specialised products such as this typewriter system since 1938, has produced several different keyboards which can be operated by any part of the body.

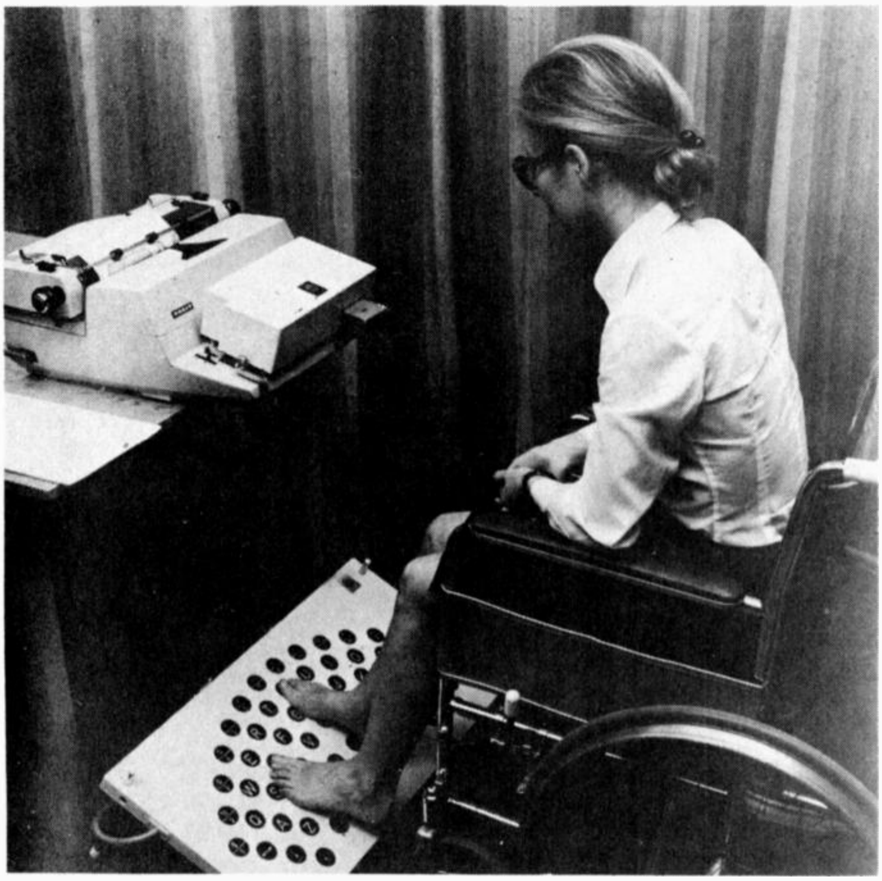
The keyboards are enlarged, modified versions of the standard Qwerty key — the largest measuring 770 mm by 495 mm. Pushbutton switches are mounted on a single printed circuit board which links the switch terminals to a multiway cable that plugs into the solenoid unit.

The solenoid unit is mounted over the keyboard of a typewriter by means of a simple clamp. For each key on the typewriter a solenoid is aligned in such a way that when activated it pushes down the relevant key. The solenoid pins are provided with a protective moulding so that typewriter key wear is kept to a minimum.

Operator controls are provided on a single three-way switch mounted on the solenoid unit. Position one is an on/off switch, position two allows typing to be performed at virtually any speed, and position three only allows typing at approximately two second intervals. This is incorporated to prevent typing errors. The time period can be adjusted by varying a resistor in the time delay circuit.

The PMV system called for solenoids that were small, yet provided a short high-force stroke. A typical PMV system keyboard requires about 57 solenoids to be mounted in a module no larger than a conventional typewriter keyboard so miniature components which could be closely packed was a prime consideration. The short high force stroke requirement also helps to keep down size but is important on electric typewriters which need little downward movement of keys to operate. The action must, however, be well defined and consistent.

The solenoids used by PMV are Magnetic Devices type 429, which, apart from the special plastic moulding to save typewriter wear, are supplied in standard form. The PMV System is just one example of the many ways conventional electro-mechanical components are finding new applications in all walks of life.



TEXAS INSTRUMENTS CLAIM JAPANESE ROYALTIES

America's Texas Instruments are demanding retrospective royalty payments from Japanese calculator manufacturers.

The claims relate to the one-chip MOS ICs that most calculators now use.

Industry observers are puzzled by the claim, for whilst Texas Instruments have patented the process in the USA, as far as is known, it has no such patents in Japan.

DISTORTION-FREE AMPLIFIERS

Negative feedback has long since been used to reduce distortion in amplifiers — effective but tending to initiate oscillation under certain conditions.

A new approach to reducing amplifier distortion is currently being researched by the Research Dept of Britain's Royal College of Surgeons.

The technique involves two amplifiers — in the first the output is subtracted from the input. The noise and distortion signal is amplified in a second unit and again subtracted from the output from the first. The resultant output is virtually noise and distortion free.

NEW SUPERCONDUCTOR

A new superconductor that has zero electrical resistance at cryogenic temperatures and retains this ability in intense magnetic fields has been developed by scientists at Massachusetts Institute of Technology's Magnet Laboratory.

A combination of one part lead, five and one-tenth parts molybdenum, and six parts sulphur remained superconducting in a magnetic field of 510 000 gauss at liquid helium temperature (-268°C). At absolute zero, MIT scientists say, the material might withstand a field of 600 000 gauss.

RAUDIVE PHENOMENON

Would any readers who have experimented or who are interested in the 'Raudive' effect (the phenomenon of voices appearing on otherwise blank tape) please contact Mr. George Ingram on (Sydney) 467-1936.

Continued on Page 11


music

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KITSETS

KIT'S KOLUMN

Expense-account called me into his office the other week. He had that sort of look on his face like the ashtray on his Lamborghini was full.
"Close the door and come over here," he said, "this won't take long."
Knowing him, that meant one of two things, and as I already had a drawer full of genuine simulated pearl necklaces made in Hong Kong and 1-day wonder wristwatches, I was about to feign an attack of the vapours when he held up his little golden key. A tingle of excitement ran down my spine and a sigh of relief escaped from somewhere under my nose. Kitsets Intelligence section was back in business. (No funny jokes, thank you.)
My mission: unlock the security store with the key. Don my special Mata Hari outfit, complete with chiffon dress, picture hat, and stick-on moustache. (You have to look inconspicuous on a job like this, and these days, everybody but Alfred E. Neuman has a moustache.)
I was to investigate the operations of a certain store which had opened near us. We'd given them the code name of "Mom". Were they really a CIA front? Did they really sell special pre-erased tapes? How much, if any, of their equipment were rejects from pinball machines? I first staked-out the place from the TAB opposite, and seeing no heavies in there (or customers for that matter) I sauntered over, and spent an hour or two looking like a prospective customer. (Which is a bit difficult wearing a Kitsets I.O. badge, but Expense account won't relax the rule.)
Anyhow, I found out some fascinating things. It certainly appears we've been undercharging for component parts. Mom for instance has ½W resistors going for around $4.95 a pack of 100. Trouble is, we've been charging only $2 a 100 for ¼W and ½W. Anyhow, Expense account got all upset and said we'd have to get in line with Mom's prices.
So now we're offering ¼W and ½W resistors at 200 for $3. It's just for orders postmarked this month. Next month we'll be back to our usual underpriced figures.
More about Mom next month. Things like how to convert a 5-cell flashlight to a 2-cell which costs less to operate and shines as bright. Also: how to read assortment packs and find out you could be buying bits salvaged from equipment.
And by the way — you can still buy one of any component part you need at Kitsets.
Keep your iron hot,

Kit

U-BUILD STEREO AMP HUGE 50 WATT PER CHANNEL $115

Hang on to your house when you build this beauty. Superb ET circuit gives genuine 50W RMS per channel with both channels driven into 8 ohms at typically less than 0.2% distortion. Ideal for nerve-shattering jokes on your mother-in-law. If you can whack a crystal set together, this should be a snack for you. Complete with real teak cabinet. P&P $3.

FOIL BURGLARS ELECTRONICALLY

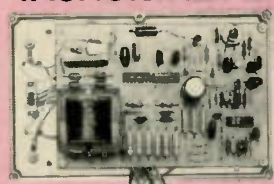
$20

ETI's sensational intruder alarm (Jan 75) — now in an easy-to-build kit form. We supply everything you need except the bell or siren. System works by micro or reed switches fitted to doors, windows, wife's side of bed, or wherever you want to put them. Has special "silent entry" facility that delays alarm 30 seconds on front door to allow you to enter and turn off or turn on and leave. Locks on when tripped — only master switch can turn it off. A little beauty — especially at this price. All instructions and diagrams provided. P&P $1.50.

CASSETTES GALORE!

Glad to announce we've managed to get supplies of Certron (blank) cassettes. Genuine screw type — not welded. Pro C60: $1.25. Pro C90: $1.50. Gamma C60: $1.75. Gamma C90: $2.25. P&P on each is 50c which is a bit steep, but we don't run the Post Office. To save, buy any 4 cassettes and pay 60c P&P, or any 10 and pay $1 P&P.

ELECTRONIC IGNITION, TACHO. & REV LIMITER KIT



$53·50

This is the 3-in-one unit that outdates all others. Overcomes serious failings of lesser types, gives same benefits like extra long point and plug life, plus handy protection against over-rev blow-ups. Our kit comes complete with sheaves of instructions and diagrams, the critical recommended capacitors (no makeshift substitutes) all screws, nuts, plugs, sockets and so on as well as the required meter for tacho operation. All you supply is one 12V negative earth car. This is a fairly advanced project, so if you're not beyond xtal sets yet, better get a cluey friend to help. P&P $2.50.

THE QUESTION: IS COLOUR TV BETTER THAN COLOUR HI-FI?

Colour Hi-Fi? Well who said Hi-Fi had to be brown woodgrain, anyway? (Not everybody has brown woodgrain furnishings.) And that's what L&G Hi-Fi equipment is all about . . . . colour. And it looks as great as it sounds. It's pointless showing you here the tuners, amps, turntables, speakers, and so on because we don't have full colour. But you can call into any Kitsets showroom in Australia and see for yourself why we're so sold on L&G. Even just on a performance/price basis it's superb. If there's no way you can make it in to see L&G in the flesh, drop us a line with a long SAE and we'll send you a colour brochure free.

Low priced Valves

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TYPE	LIST PRICE	PRICE EACH FOR MIX OF	
	NORMAL PRICE	1 – 50	50 – 100
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6AL3	$2.00	$1.20	$1.10
6BL8	$2.00	$1.20	$1.10
6MB8	$2.10	$1.20	$1.10
6CM5	$2.90	$1.90	$1.80
12AV7	$1.92	$1.20	$1.10

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HOW TO ORDER:

MAIL ORDERS: PRINT all details clearly. Include phone no. for quick checking if any problems. Send cheque or postal order (NOT cash) to Kitsets (Aust.) Pty. Limited, PO Box 176 Dee Why 2099. For urgent queries or PMG/COD ring us on 982 7500, Area code 02. (24 hour open line service).

JMcA2156FP

news digest

Continued from Page 6

SAM'S NOT WHAT IT SEEMS

Prerecorded cassettes in the style of well known recording artists' may soon be on sale in Australia.

The cassettes are produced in the USA by SAM (Sound Alike Music), and they are low-priced 'copies' of the real thing. They are copies in the sense that the labels are virtually identical to the original product except for the legend 'a tribute to' followed by a warning in small print that the recording has not been made by the recording artist/s then named on the label. In almost every other respect though it is impossible to tell the difference between the original and the SAM product.

Among the artists not recorded by SAM are Helen Reddy, Roberta Flack, Cat Stevens, Ray Charles and Johnny Cash.

Seems to be legal in America and the UK — but whether or not they contravene our Trade Practices Act has yet to be seen.

ENZYME-POWERED BATTERIES SOON?

An enzyme battery for cardiac pacemaker implants appears to be in the offing, according to one of its developers, Dominic C. Avampato of South Central Connecticut Community College, New Haven (USA). The enzymic process produces a seven-micro-ampere current from 5 grams of maleic acid and five-micrograms of NAD malate dehydrogenase.

SCRAMBLER DEVICE GIVES TELEPHONE SECURITY

When confidential information is passed by telephone there is always the risk — accidental or otherwise — of the conversation being overheard.

A new British device, the 'Privateer' in fixed or portable versions, 'scrambles' conversation by converting speech frequencies and producing a jumbled sound that is unintelligible along the line. Only those using the device, which both scrambles and unscrambles, can hear what is actually being said.

In an executive style briefcase which looks completely conventional externally, the portable version (pictured here) weighs only 4.3 kg. The case contains the transistorised circuitry, a simple two switch control console and a telephone handset which the speaker uses. Conversation passes though the circuitry and into regular handsets which are positioned in cushioned sockets in each briefcase. External and internal telephone lines can thus be used without interference from existing installations and equipment.

Power is supplied from internationally available dry batteries and, should the case be closed with the device switched on, an automatic switch-off circuit operates.

Presumably APO permission would be required for the units to be used in Australia.

(Details from EMI Sound & Vision Ltd, 252 Blyth Road, Hayes, Middx UK.)

Continued on Page 14

Continued from Page 11

AUSTRALIANS – SPECIAL COMMENOATIONS

A special commendation in an international competition has been made to Mr John Howlett, Technical Sales Manager, Dunlop Batteries Australia for the development of a new battery to provide high power for a short duration.

The award was announced in Paris at the 5th International Lead Conference.

The new battery was developed to meet a need for the Australian Post Office for a battery to power the no-break supply in solid-state telephone exchanges. The battery had to provide 1000 amps during the few milliseconds which elapse between loss of normal power and the point at which the main station battery comes in on its regulator circuit.

Cell design is based on a standard 200 ampere/hour cell with pasted pure-lead grids with internal components developed to allow delivery of extremely high currents. The new cell exceeds design expectations in being able to remain above 1.9 volts per cell for tens of milliseconds at 1000 amps.

The competition judges noted particularly the description 'electrochemical flywheel' used to describe this type of peak-lopping service which they thought very apt.

(Further information: Dunlop Batteries Australia, 27 George Street, Sandringham, Vic.)

A further special commendation was awarded to the Melbourne firm of Dawe and Jack for the development of a compact fluorescent emergency lighting unit using a new inverter/power circuit and small sealed lead batteries.

The company's principal objective in design was the provision of realistic light levels and operating times using compact components powered by small, relatively inexpensive sealed lead batteries.

The lighting units are self contained and can be installed easily and economically in any desired location without expensive wiring alterations. As a result installation can be made in stages to provide for progressive occupation of buildings and units are readily relocated to accommodate later extensions or alterations.

Changeover to battery power on mains failure is automatic and the hot strike is virtually instantaneous. Normally light output is set to give an hour or more of bright light followed by a longer period of 'moon light'. Complete recharging takes 24 hours, but in practice power failures do not last long enough to completely discharge the batteries. Batteries last three to four years and reliability is said to be outstanding.

(Further information: Dawe & Jack, 87 Albert Avenue, Boronia, Vic.)

DIGITIZED TV VIA FIBRE OPTIC LINK

Digitized TV pictures have been successfully transmitted via a 4 km fibre-optic link. The experiment was conducted by West Germany's Heinrich-Hertz Institute using equipment developed by Siemens AG.

The TV picture was conventional PAL 625-line, 5 MHz bandwidth. It was converted to binary-difference pulse-code modulation (24 megabits/second) and transmitted via multimode fibre by a special light emitting diode.

The receiver was an avalanche diode connected to the monitor via a pulse decoder.

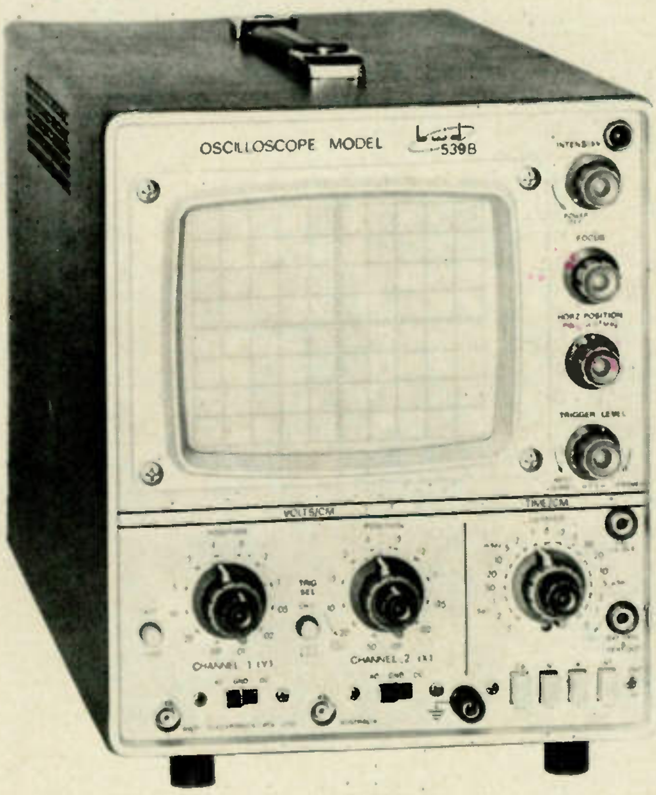
ERRATA

Electronic Ignition System
January 1975.
page 56, add to parts list, diode D8, IN914.
page 57, Table I. Second heading should read 'REV LIMIT – value of C14' not 'C15' as published.

DC~16 MHz Dual Trace oscilloscope The New BWD 539B

With These Outstanding Features

- Amplifiers:
  DC to 16MHz-3db) Both
  20nSec Rise Time) Channels
  10mV to 50V/cm)
  3Hz to 30kHz) Single Channel
  at <500μV/cm) Cascaded
- Time Base:
  100nSec to 2.5s/cm time range
  1Hz to >25MHz Auto Triggering
  TV line and frame trigger.
- X Amplifier:
  Identical X-Y operation
  DC to 2MHz-3db
  10 mV to 50V/cm
  1° Phase shift from DC to >100kHz.



PLUS

- 5% calibration Y,X & T.B. including a 10% line voltage change.
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- 3.3KV EHT and an 8x10cm display.
- Push button operation simplicity and AC-GND-DC amplifier switching.
- 3cm of deflection at 30MHz and a time base that locks solidly to it.
- Vertical amplifier and time base outputs.
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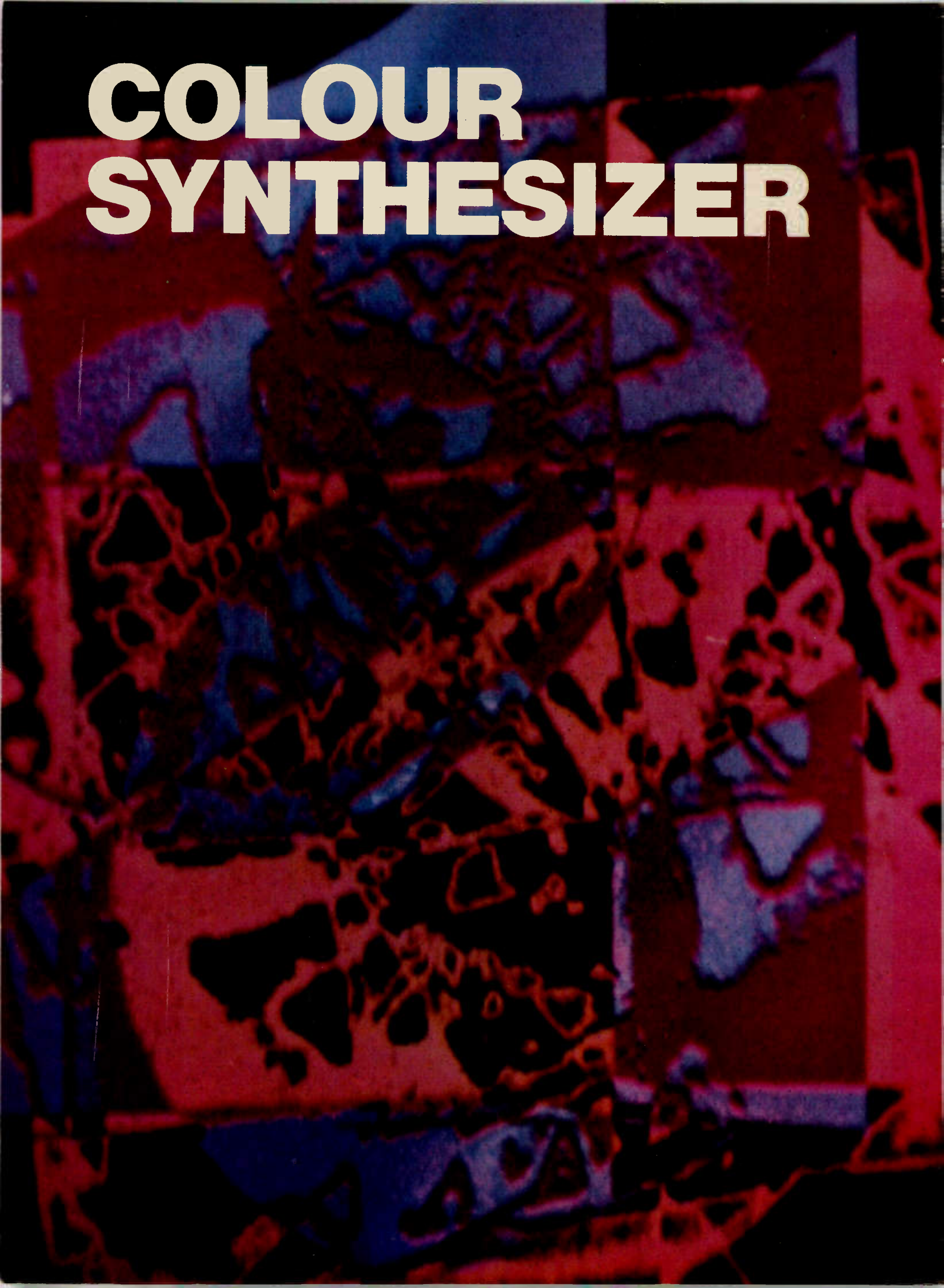
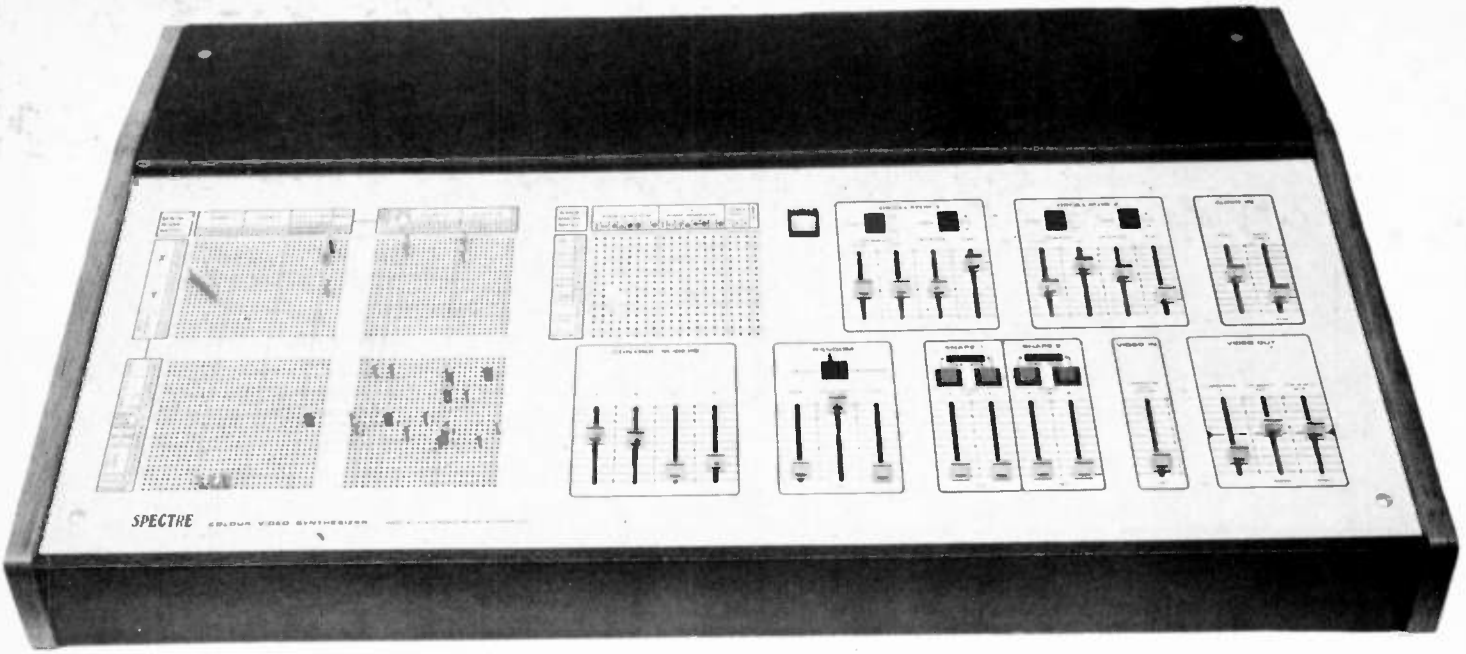
COLOUR SYNTHESIZER





The EMS graphic colour synthesizer (note unit is now called 'Spectrum' not 'Spectre' as seen here).

A vast repertoire of static or moving colour effects — displayed on a 625-line PAL TV screen, Terry Mendoza reports

ELECTRONIC music synthesizers are such incredibly versatile devices that, around the world, a number of people are investigating their use in another art-form: that of visual display.

Now, in London, EMS have produced a commercial visual synthesizer called Spectrum.

In common with its audio counterpart, Spectrum utilizes a small number of modules to create a vast repertoire of static or moving colour effects for display on a conventional 625 PAL video screen. Apart from obvious applications in the special effects sector of video work and TV broadcasting, its designer Richard Monkhouse envisages it being applied to X-ray recognition — it is particularly suited to this application for it can accept an external video input and split its grey scale into seven discrete bands, each of which may then be coloured differently.

Matrix patching (common to all EMS synthesizers) has been retained — inputs to modifiers and outputs that produce the final image are sited at the top of the board, and outputs from the modifiers and all video sources are at the side of the board. However, due to noise and crosstalk difficulties encountered with analogue video-frequency signals, the direct picture signals are in digital form. This adds greatly to flexibility; a 'form-specifying' digital signal only governs shape and area — texture, hue, brightness and apparent position are controlled by further digital signals combined with the first. There now follows a survey of the various modules incorporated in Spectrum.

X AND Y COUNTERS

The X counter produces vertical bars and the Y counter horizontal bars, the width of the bars and the spacing between them are variable and dependent on which outputs of the binary counters have been patched to the AND gates which sum them.

The bars or, when simultaneously used, the chequerboard, can be modified by the superimposition of the outputs from an analogue generator — of which more later. Each of the counters has nine different outputs, the bar-width going down by a factor of two between each pair of adjacent outputs. Any, or all, of the outputs may be phase-inverted by grounding its 'invert' input.

OVERLAY GATES

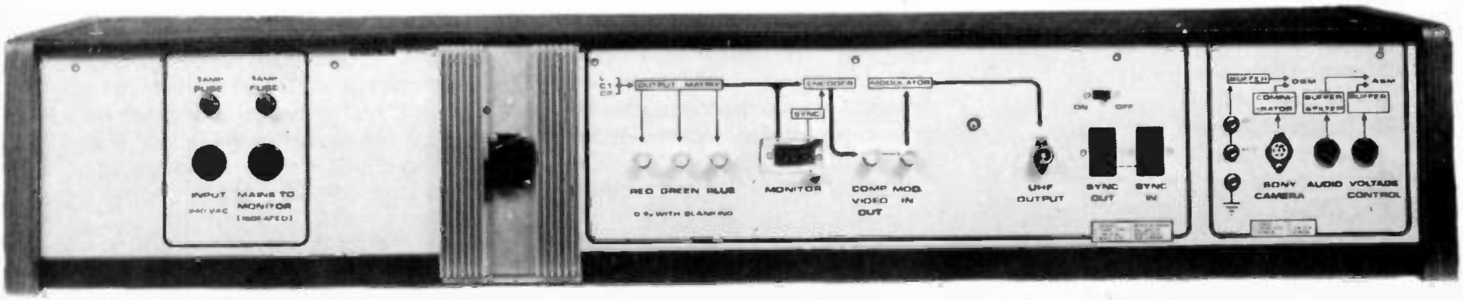
There are four overlay gates which can overlay one moving (or static) pattern with another. The signal representing the background of the video 'scene' is patched into the 'sig' input and the signal intended for the foreground is fed to the 'dis' (disable) input; only when this input is not pulled low will the background signal be gated through.

SHAPE GENERATORS

There are two shape generators, each of which produces two outputs, which may themselves be preselected from sixteen possible design shapes. The two generators both have four LED displays to indicate, in binary form, which shape has been selected i.e. all indicators off indicates 0000 = circle shape; 0010 = 'gear' shape (see illustration 2).

The shape can be selected by manual switching or can be allowed to cycle through its 'catalogue' at a predetermined rate. Ovoids and triangles are generated by dual-ramp generators, with the intersection of two voltages producing a visible low.

Any shape or pattern may be fed to an inverter in order to be able to utilise the background of the shape for modification rather than the shape



COLOUR SYNTHESIZER

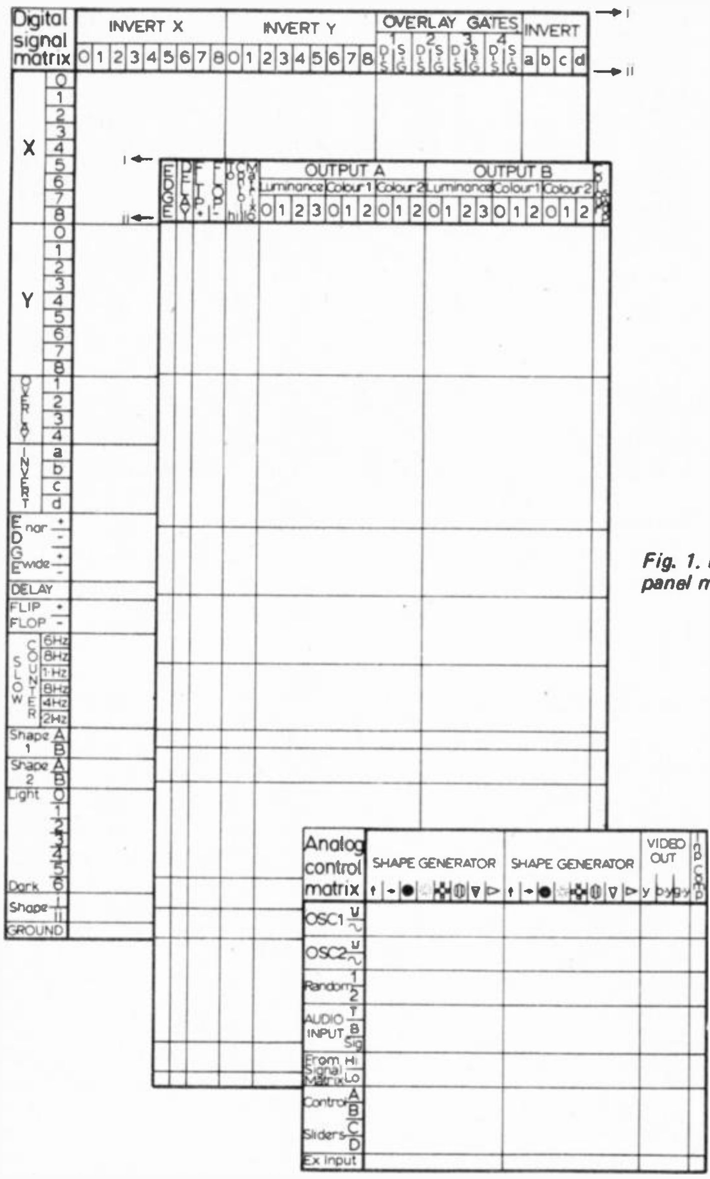


Fig. 1. Layout of front panel matrix boards.

itself (see Fig. 3). Thus a circle and moving pattern fed to the overlay gate will give rise to a blank circle in the foreground with the pattern moving around and 'behind' it. Inverting the circle before patching it to the gate will completely alter the effect – the pattern will only appear within the confines of the circle which will lay on a blank background.

A mini analogue – synthesizer panel (Fig.1) feeds each shape generator to allow controlled distortion to be imparted to the chosen shape.

The shape-generator parameters fed by the analogue controls are as follows:

1. horizontal position
2. vertical position
3. horizontal zoom
4. vertical zoom
5. circle size
6. 'gear' size
7. 'frizz' size
8. 'lantern' size

It can be seen that inputs 5-8 are, to use the physiological term, species specific and will only affect the shape indicated. Hence a circle shape will only be influenced by parameters 1, 2 and 5.

The following analogue controls are available:

a. Two sine/square wave generators with a wide highly – stable range between 0.1 Hz and 30 kHz which can be very finely controlled. When the controlling signal forms a harmonic of the line frequency very beautiful patterns result and these control generators have been designed to lock onto these integer frequencies to make full use of this effect.

b. A random voltage generator with Gaussian distribution, two independent outputs and a slew rate control. It also has a switch to recycle the sixteen most recent events.

c. Four slider-fader control voltage inputs.

d. A buffered audio signal input together with another input which is split to give treble and bass envelope following.

e. Two output lines are provided, with different time constants, direct from the digital signal matrix.

f. A buffered external control voltage input.

As well as influencing the shape generators, these analogue modules may also be used to bias the two colour parameters, the picture brightness and the step spacing of the video comparator. This latter is the device that takes a black and white camera input signal and splits it into a seven-level grey scale feeding to seven output rows on the digital control patchboard.

A certain brightness level at the input will activate one output row, causing it to go 'low' and this may then be patched to a combination of luminance and colour outputs to give a particular hue and brightness each time the same brightness is encountered at the input. It is this that could provide the medical application mentioned earlier. The output row need not only be patched to relate grey-scale brightness to colour but in conjunction with the overlay gates, could be used to produce a chequered pattern each time a chosen brightness level is reached – quite a startling effect when used, for instance, on the human face.

SLOW COUNTER

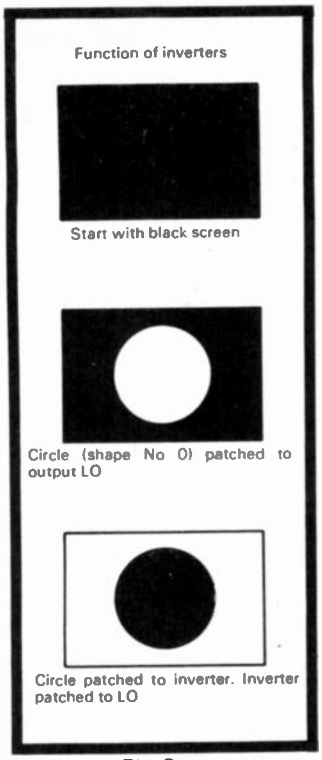
This is another source on the digital signal matrix giving six outputs consisting of binary multiples of frequency from 6 Hz to 0.15 Hz. It is synchronized so that it only changes state during the frame fly-back and is used to give sudden rapid changes and movements.

EDGE GENERATOR

This is an interesting device which synthesises an apparent three-dimensional edge to a pattern or shape. It is described by the designer as a "cut out of plywood" effect (see Fig. 2). There are four outputs from this module giving either a narrow or wide edge which is situated to the left or the right of the pattern.

A delay module, which causes 0.6μS signal retardation, can be used to generate a different variety of edge effect and a type of feedback which produces an 'echo oscillation' (Fig. 4).

The digital matrix is completed by a flip-flop device which halves the



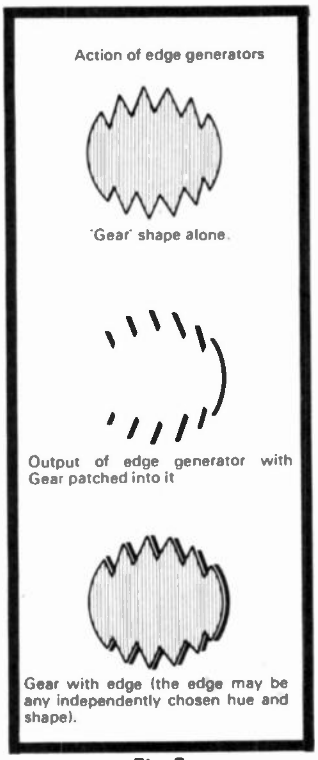
Function of inverters

Start with black screen

Circle (shape No 0) patched to output LO

Circle patched to inverter. Inverter patched to LO

Fig. 2



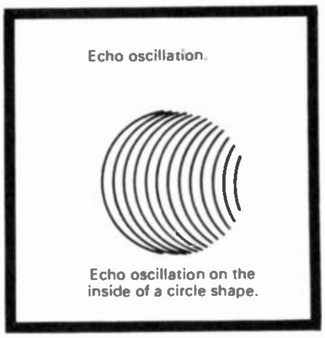
Action of edge generators

'Gear' shape alone.

Output of edge generator with Gear patched into it

Gear with edge (the edge may be any independently chosen hue and shape).

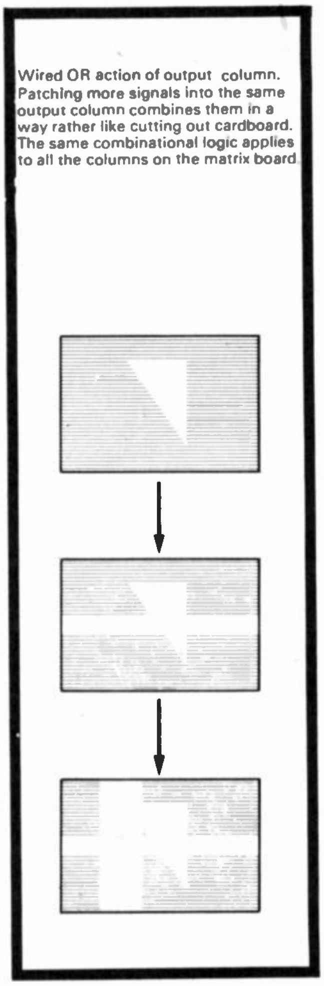
Fig. 3



Echo oscillation.

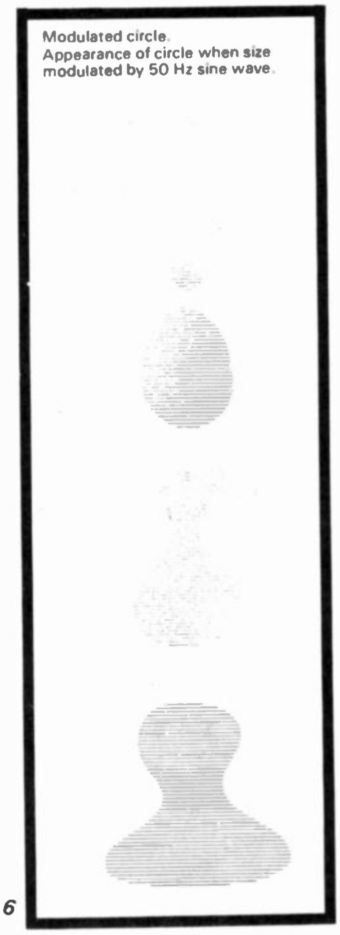
Echo oscillation on the inside of a circle shape.

Fig. 4



Wired OR action of output column. Patching more signals into the same output column combines them in a way rather like cutting out cardboard. The same combinational logic applies to all the columns on the matrix board.

Fig. 5



Modulated circle.
Appearance of circle when size modulated by 50 Hz sine wave.

Fig. 6

horizontal spatial frequency of patterns patched to it, and may also be used to fill out shapes that start as outlines or to divide the width of the 'echo oscillation' mentioned above.

There are two output channels which are identical in every respect. Each has four luminance channels, three 'colour 1' (controlling red intensity) and three 'colour 2' (controlling blue intensity). Binary combinations of outputs produce a graduated scale of brightness and colour i.e. for brightness the following sixteen-step scale is used:

	L0	L1	L2	L3
1 Black				
2				X
3			X	
4			X	X
5		X		
6		X		X
7		X	X	
8		X	X	X
9	X			
10	X			X
11	X		X	
12	X		X	X
13	X	X		
14	X	X		X
15	X	X	X	
16 White	X	X	X	X

In the same binary fashion, each three-column colour channel can be made to produce an eight-step scale of saturation. The value of the digital system can now be seen. At its simplest, patching different outputs of the slow counter to a combination of colour and brightness outputs will produce a rhythmically flashing screen in different colours and brightness.

Special circuitry ensures that increasing the luminance will not result in a reduction in perceived colour saturation.

Incidentally all the output columns have a wired OR action which means they will go low if a signal patched into them goes low, and only one signal patched in needs to go low to produce this effect. In terms of the visible end effect, feeding more signals into the same output column is, to quote the designer, "like carving away a piece of black card to expose a white surface behind — one can never add a new area of black" (see Fig.6).

Though Spectrum is thorough and capable of high complexity, EMS are adamant that maximum potential can only be realized if the system is used in conjunction with camera feedback — focussing the camera on the screen of the monitor. This results in a moving pattern with the modification of the image each time the signal travels around the loop.

EMS are producing a complete package incorporating a Sony black and white camera and modified Sony monitor, priced at £4000. The Spectrum alone is available for £3000 and for this price, despite its versatility it may still suffer the same fate as the audio synthesizer — the majority of operators will find themselves generating the same hackneyed patterns that could probably be realized by much simpler circuitry.

It will be left to a talented few to use the device to the limits of its capabilities and to develop video graphics into a new art form. ●

RADIO -the true pioneers

A definitive history of the early days — by Peter Sydenham M.E., Ph.D., M.Inst. M.C.

FOR REASONS OF SIMPLICITY, maturity in a subject usually leads to its existence being attributed to a single inventor. The other players in the chase are swallowed up by the march of time.

In actuality many pioneers steadfastly struggled on to pacify their desire to crystalize a feeling about a phenomenon that existed in their mind as an almost but not quite, expressible idea. Often life-long toil is needed to bring out an idea and this can often turn out to be a minor, but vital, link in a long chain of events that eventually produces something that drastically alters our way of life.

Certain people are gifted with a flair to combine seemingly unrelated concepts and inventions in a way that creates a new system of great value. These people need not be, and indeed are often not, ingenious in the mind; their ability is to push an idea into commercial practice where it may become a household word. Edison, the father of electricity; Bell the inventor of the telephone; Marconi the inventor of radio — they did not invent the discipline in the strict sense but rightly earn a place in technological history because of the impact they produced by utilizing the many ideas of the less far-sighted and more conservative minds.

Here we are concerned with one such story; early radio. This is an account of the events that preceded the era of crystal sets and valves.

Over a century of effort was expended to create the mood and conditions that allowed the Marconi developments to blossom around 1900. This is not intended to be a new case for who invented radio but a description of the real facts that led eventually to the rapid development of the concept. You will see that numerous people — and many more have been omitted for reasons of brevity — each played an unwitting part in the development of the everyday radio system that we use today.

The essential concepts of a workable radio system

To appreciate the history it is important that those who are unskilled in radio technique be given a basic idea of the operation of the radio system. A deep understanding is not required for the concepts of early radio are simple to comprehend.

Basically, see Fig. 1, a radio (or wireless as it is also called) system comprises a unit that can send out signals into a communicating space as 'coded' electrical energy. This is the transmitter. To receive and understand the signals a second unit, somewhat different from the transmitter but not greatly so, is used to convert desired electric signals received from the communicating space back into the appropriate physical form, be it the marked tape of a telegraph or the aural sounds of the radio.

The transmitting end consists of a source of communicating signal that can be modified with time in some way in order to take on the information presented by the input device. Modulation, as the input modification process is called, can be achieved with a simple on-off mechanism (the morse key) or a more complicated arrangement — a microphone — which can send continuous information signals, examples being voice or music. The now modulated carrier signal is then coupled to the transfer medium by an appropriate circuit that sends off a reasonable proportion of the energy

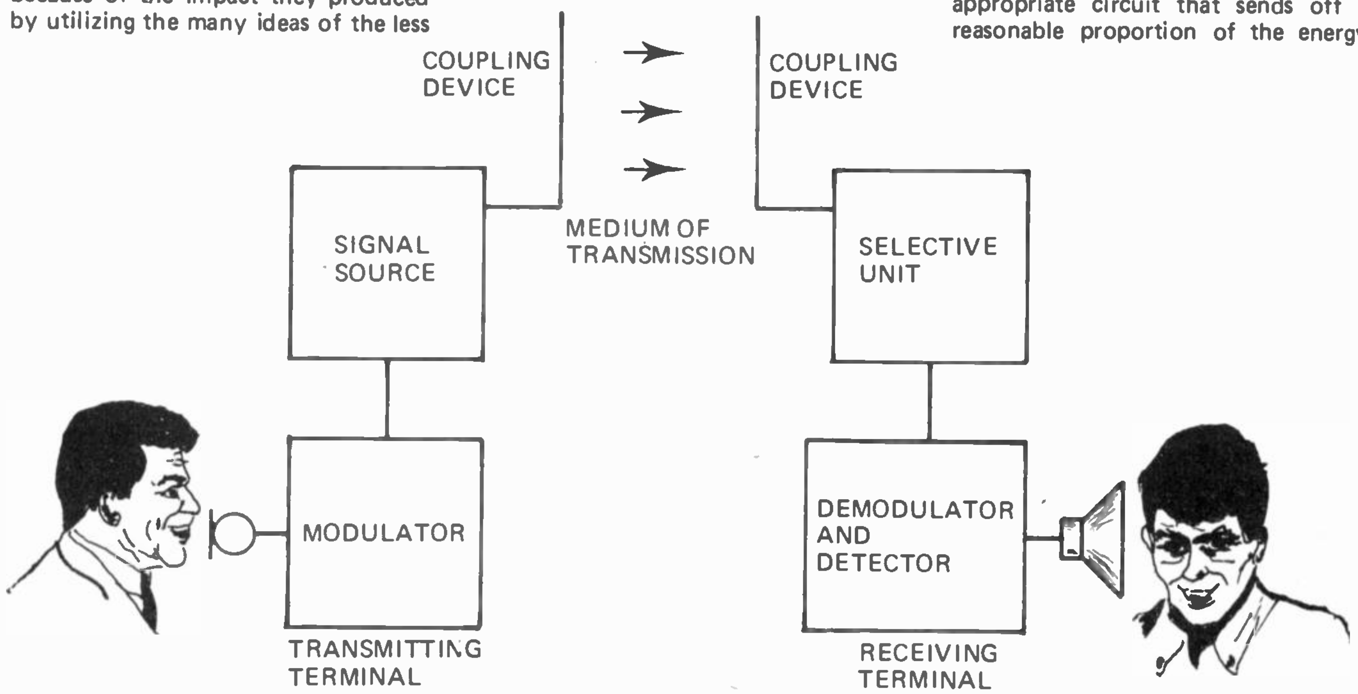


Fig. 1. Schematic of a system of communication that does not use wires to connect two locations.

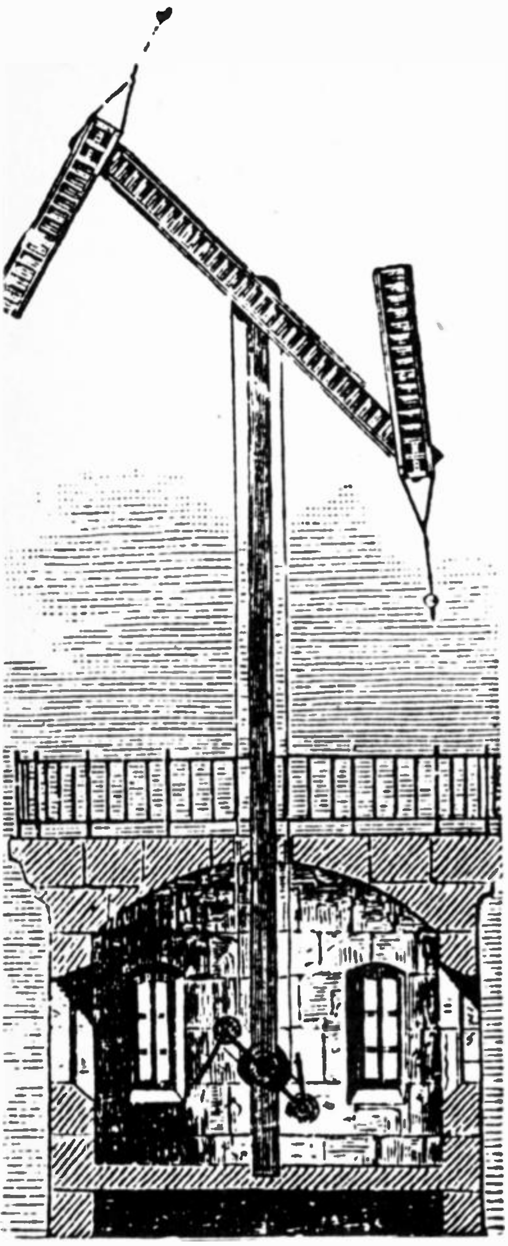


Fig.2. Chappe's telegraph of 1750-1790 provided wire-less communication when visibility allowed.

generated in the desired direction.

To achieve wire-less transmission (used in the literal sense — without wires) use may be made of the earth, the water of rivers or the sea and the air space above. Each possibility was investigated in the nineteenth century as we will see later.

The receiving end also needs a coupling device that will accept a reasonable amount of the transmitted signal arriving in its vicinity. This is followed by a means of discriminating between one signal transmission and another, for only one is needed at a time. Finally, the selected signal is converted back to a suitable form.

The key elements of a system communicating without wires are, therefore, a generator of the basic signal that can be modulated; coupling mechanisms; a conveyance medium; a selector; a detector cum demodulator and an output device.

Today we regard the term "radio" as the wire-less form of transmission that uses electro-magnetic EM waves. These radiate through space without the need for any form of medium having substance. Early pioneers sought to exploit any means that could be used to send signals over considerable distances without having to go to the expense of laying cables.

Three dominant themes of wire-less link were investigated; use of the ground or water as the communicatig path; use of induction effects between wires (placed relatively close together by EM radio standards) and, eventually the use of EM waves that are 'launched' away from the transmitter as escaping radiation energy. (The latter is our current method). The three ideas (plus others such as acoustic and ultra-violet links to a lesser degree) were in vogue simultaneously until around 1910. At that time it was becoming quite clear that the EM method was dominant due to the simple economic reason that it costs considerably less to send signals over long distances by that means than by any other alternative.

Before we start discussion of the many interesting historical events that culminated with commercial radio at the end of the nineteenth century it must be pointed out that the people concerned in the development did not necessarily know of their counterparts' progress. To what extent they were familiar is not accurately assessable. Looking back it is easy to conjecture that the various outcomes were obvious or that certain courses of action were pointless. Time was needed for ideas to gell and for suitable circumstances to occur for ideas to be accepted. To a large extent the reader must draw his or her own conclusions as to who really invented radio, bearing in mind that the full history can never be recorded in less time than it took to happen and that the facts are often not available after the event. Perhaps, one day,more information will be uncovered to further modify the story. In preparing this historical review, contemporary books and accounts were consulted. These, plus knowledge about actual apparatus still existing in collections across the world, have been used to create this historical account.

A chronological list of events has been compiled from these sources. Happily there is general agreement on the various dates giving us some confidence in the order of events. The chronology is included — it can be followed as the sequence unfolds.

Where did the idea begin?

Obviously the need to communicate at a distance arose as far back as mans' genesis because of the limited range of mans' vocal and hearing powers. This shortcoming was overcome with best means available: Alexander the Great used chains of bonfires to carry simple messages. More sophisticated methods gradually evolved, resulting in the Chappe brothers sytem of semaphore (1792) where poles and arms, see Fig. 2, were placed in various inclined positions to represent prearranged letters, number and codes.

Optical methods such as Chappe's semaphore often lacked the range needed and reliability in all atmospheric conditions was low. Security of signals was another reason for inventing new ideas. Optical methods, however, had to be used until the eighteen century — there was no satisfactory alternative. It needed electrical method to further the concept but this was not established in the Chappe Brothers time.

Our story, therefore, really begins to unfold when science started to yield knowledge about permanent magnetism, about electro-statics and, finally, about electro-magnetism.

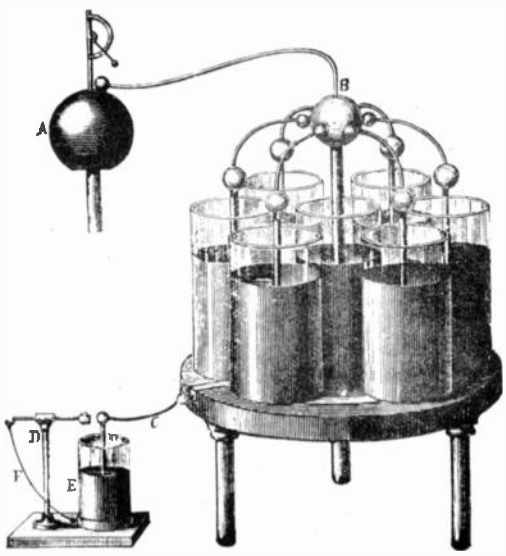


Fig. 3. Bank of Leyden jars used contemporarily in 18th century (and on) to store charge produced by frictional and influence electrostatic generators.

RADIO-the true pioneers

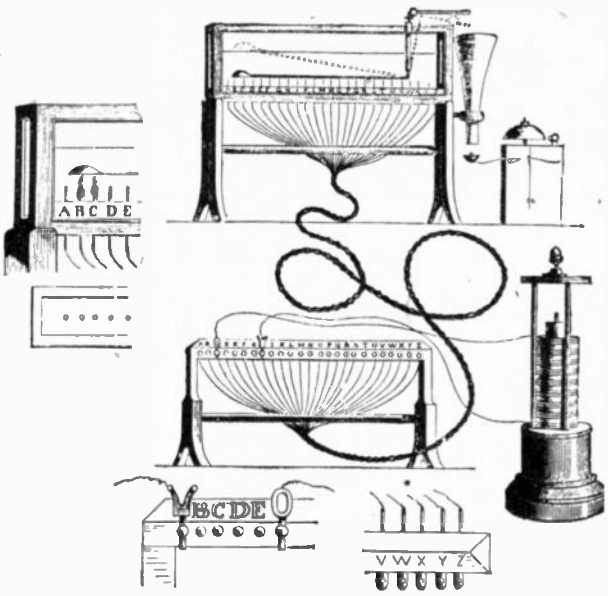


Fig. 4. Sommering built this telegraphy system around 1809. The right-hand column is a Voltaic pile – a method that provided steady current for circuits from 1800.

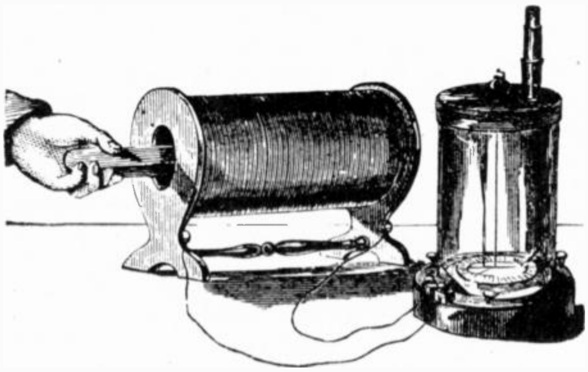


Fig. 5. This simple experiment was used by Faraday in 1851 to prove that moving a bar magnet inside a coil generated electricity. The simple galvanometer available to him at the time consisted of a magnetised needle, that rotated on a torsion fibre when the coil surrounding it was energised.

In the sixteenth, seventeenth and eighteenth centuries many suggestions were made that related to using the influence of permanent magnets on each other as a means of long distance signalling. The earliest traceable account seems to be that of Baptista Porta, a Neapolitan, who published a book in 1558 in which he said

"owing to the convenience afforded by the magnet, persons can converse together through long distances".

As his ideas matured he later wrote

"I do not fear but that with a long absent friend, even though he be confined by prison walls, we can communicate what we wish by means of two compass needles circumscribed with an alphabet".

The concept involved is clear enough but the practice was somewhat fanciful. Real experiments were not made or else statements like that made later by Strada (1617), referring to such an idea for travellers to use, would not have appeared –

"And thus by several motions of the needle to the letters (inscribed on the compass dial) they may easily make up words and sense which they have a mind to express".

This idea could not be taken seriously until electro-magnetism was discovered in the nineteenth century for the range of permanent magnet forces is very limited.

Turning to static electricity we can see that a more promising method was available to the late eighteenth century inventors because currents flow in wires and also through the ground without wires. But when did the concept of a current carrying wire appear?

Electrostatics started simply, yet basically, with Thales (600 BC) who wrote of the charging of amber by rubbing it. It was, however, not until 1730 that the natural philosophers (the scientists of the day) learned, because of the observation of one Steven Gray, that some types of lines conducted charge if supported on insulators (silk threads). Dr. Fay, after this event, managed to transmit charges over many hundreds of metres of dampened thread.

It is recorded that Winkler, of Leipzig, discharged Leyden jars (the first capacitors – made from foil coated glass and inverted jars) using an insulated wire. This was in 1746. What is interesting to a theme of wire-less communication history is that he used the River Pleisse to form the return circuit and, later, an earth return path. Distances of five kilometres were used. Thus a start was made toward true wireless communication by the elimination of one wire.

Further evidence in this period of wire-less transmission by conduction via water exists in a letter written by Benjamin Franklin in 1748.

"Chagrined a little that we have hitherto been able to produce nothing in this way of use to mankind, and the hot weather coming on, when electrical experiments are not so agreeable, 'tis proposed to put an end to them for this season, somewhat humorously, in a party of pleasure on

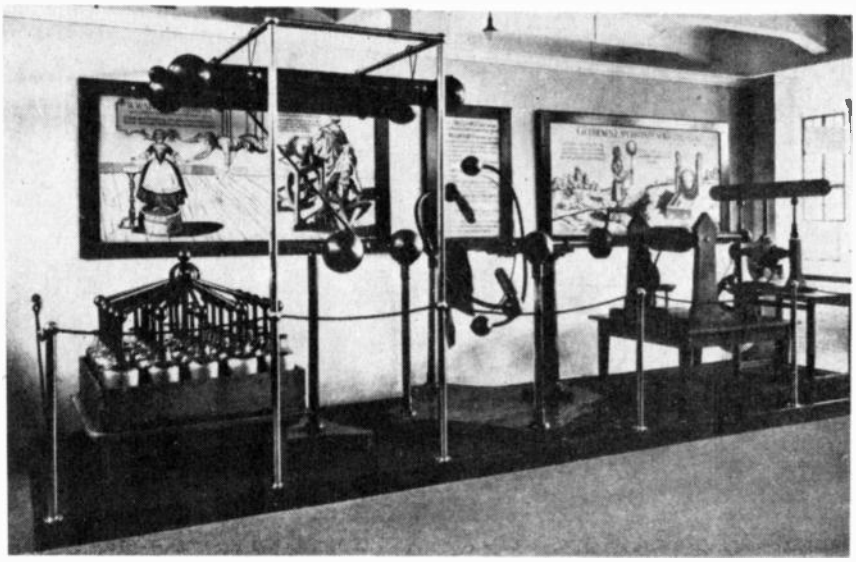


Fig. 6. In Ohm's time, about 1830, well equipped electrical laboratories used apparatus like his shown here. On the left is a bank of Leyden jars, on the right are frictional generators and, in the centre, various discharge arrangements for transferring and discharging static electricity.

the banks of the Skuylkil. Spirits at the same time are to be fixed by a spark sent from side to side through the river, without any other conductor than the water — an experiment which we some time since have performed, to the amazement of many . . ".

Franklin is known for his famous lightning conduction experiment of 1752 in which he drew a spark from a key that was electrically connected into a storm cloud by a kite supported on a silk ribbon. Scientists of that era considered their own senses as quite all right to use as sensing devices: at least

CHRONOLOGY OF EVENTS PRECEDING COMMERCIAL RADIO

1558 Baptista Porta quoted use of magnetic influence.
1730 S. Gray discovered the use of wires to convey static electrical charges.
1745 Leyden jar devised by Kleist, Muschenbrok or Cuneus — the first capacitor.
1746 Winkler discharges Leyden jar using water return circuit.
1747 Watson transmitted static electricity in water and wire circuit.
1788 Barthelemy suggested use of influencing magnet in a work of fiction.
1795 Salva's paper presented on application of electricity to telegraphy — predicts telegraph.
1800 Volta's primary battery invented.
1803 Aldini used wire supported on a boat and water return path to communicate between Calais and Fort Rouge.
1809 Sommering built a working 26 line galvanic telegraph using wires.
1819 Oested discovered current in a wire deflects the needle of a compass.
1825 Sturgeon made first electro-magnet.
1827 Ohm announced his law relating current, voltage and resistance.
1831 Lindsay telegraphed via ground and water circuits (probable date).
1831 Faraday discovered laws of induction.
1832 Schillings five wire telegraph
1837 Anon. report appeared in "The Mechanical Magazine" on use of earth return.
1837 Cooke and Wheatstone five needle telegraph patented. Immediate use on Great Western Railway.
1837 Morse built first reported relay (contested claim).
1838 Steinheil of Munich worked on railway lines as 'cable' paths leading to use of earth itself.
1838 Munck discovered metallic filings reduce in resistance when electrical discharge flows through them.
1842 Morse's celebrated cross-river wireless link using grounded plates.
1843 Wheatstone's bridge circuit published.
1845 Brett referred to possibility of oceanic telegraph without cables.
1845 Wilkins proposed communicating between England and France using terminals dipped in earth and water at each end (1849 is more usual date quoted).
1850 Guitard noticed electrified air causes dust to cohere.
1851 Cross-channel telegraph cable laid (the first long underwater cable).
1852 Hightons started 20 years of work on wireless communication by conduction.
1852 Kelvin related L, C in resonant circuits to natural resonant frequency.
1853 Kelvin published paper "Oscillatory discharge of a Leyden jar".
1854 Lindsay was granted patent on his cross-river method by conduction.
1856 Varley discovered coherer principle.
1858 Transatlantic cable laid.
1858 Kelvin's sensitive mirror galvanometer used on Atlantic cable.
1859 Lindsay addressed British Association on ways to improve conduction method of wireless.
1861 Feddersen's work experimentally proved oscillatory nature of discharge.
1862 Patents issued on use of induction and leakage currents for system of telegraphy.
1863 Clerk Maxwell suggested EM waves exist-using theory only.
1866 Usually acredited date for Varley's discovery of coherer.
1866 Sorensen (Danish) signals ship from shore by conduction.
1867 Clerk Maxwell produced formulae describing EM waves.
1867 Kelvin's syphon recorder devised and built.
1870 Barbouse system of conduction wireless readied for communication with besieged Paris.
1873 Clerk Maxwell published treatise "Electricity and magnetism"
1874 Proposals begin to talk of induction as well as conduction wireless.
1875 Edison talked of etheric force as basis of wireless communication.
1877 "Journal of Telegraphy" article ridiculed proposals for a 'radiation' wireless by Loomis.
1878 Hughes emperimented with metallic coherer and probably detected electric waves from a spark discharge.
1879 Berlin Academy of Science offered prize concerned with nature of Maxwell's theory of EM waves.
1879 Hughes observed EM waves over 600 m range.
1879 Hughes noticed coherer effect with carbon rods resting on steel plate.
1879 Patent Brit. 3132 described use of induction communication between cables at sea to a lightship.
1880 Trowbridge extended Gott's idea of earth return and started on transmission without wires by a systematic study of induction effects between wires.
1880 Trowbridge induced signals in parallel wires at 2 km.
1881 Smith's induction link for telephony to railcars in motion.
1882 Preece completed experiments on conduction wireless between the Isle of Wight and Mainland.
1883 Dolbear placed one wire of induction link in air as antenna.
1883 Lodge rediscovered coherer principle.
1883 Patent (Brit. 4220) replaced one conductor with air-path requiring "moist air to complete circuit".
1883 Edison noticed rectifying effect in lamp (described in an 1884 patent).
1884 Dolbear demonstrated signalling with antenna.
1884 Phelps railway induction link.
1884 Preece began radio experiments including induction between wires.
1885 Preece experimented with induction wires.
1885 Edison patented wire-less train telegraph using electrostatic induction.
1886 Hertz obtained EM induction with close coils and Leyden jars.
1888 Hertz demonstrated existence of EM waves.
1890 Branly's imporved coherer (based on Calzecchi-Onesti and Varley).
1891 Anon. writer in Electrician suggested 200000 MHz waves could be used to communicate through walls.
1891 Trowbridge suggested aerials for ships.
1892 Brit. patent 10161 described shore to lightship communication via induction between cables.
1892 Crookes predicted use of focussed waves in "Fortnightly Review".
1894 Preece summarised his past ten years of work on wireless.
1894 Hertz died.
1894 Lodge demonstrated etheric wireless to Royal Institution and British Association using Hertzian oscillator and Branly Oscillator over 120 m.
1894 Marconi's personal claim to first recorded message through space by EM waves.
1894 Preece addressed Royal Society of Arts.
1894 Michel's ground telegraph.
1894 Gavey's Loch Ness experiments on conduction wireless telegraphy.
1894 Marconi system using Righi design of oscillator.
1894 Editorial in "The Electrican" predicted use of radio waves to detect storms.
1895 Russo d'Asars, acoustic, ship wire-less telegraphy experiment achieved 100 km range (date approximate).
1895 Popoff worked on electrical storm detection using Branly coherer and lightning conductor; incorporated de-coherer device.
1895 Rutherford realised principles later used in magnetic detector.
1895 Preece made temporary link across 12 km range using induction.
1897 Wilson and Evans detector (similar to Rutherford's)
1897 Slaby began radio experiments at Charlottenburg after working with Marconi. Co-worker Count Arco.
1897 Marconi's own claim for first telegraphy between ships in motion (20 km range).
1898 Marconi devised means to electrically isolate coherer from sky rod thus introducing transformer coupling — the jigger.
1898 Lodge's system released.
1898 Braun used tuned circuits as coupled resonance.
1898 Tesla's patent for controlling route of a distant ship by radio.
1898 Zickler reported ultra-violet link over 1.3 km.
1898 Lodge and Muirhead magnetic decoherer.
1898 Preece delivered lecture to Royal Institution supporting Marconi's claims.
1899 J.J. Thomson explained the Edison effect of 1883.
1900 Popoff's patent of improved coherer.
1900 Dudell's patent on singing-arc continuous wave production.
1900 Car radio patented.
1902 R.A. Fessenden of Pittsburgh sent voice over 2 km.
1902 Marconi patented magnetic detector.
1903 Poulson's patent for using Dudell method to generate radio waves.
1903 Electrolytic detector patented.
1904 Nussbaumer's musical transmission system.
1904 Hueslmeyer's radar using radio waves reflected from ships.
1905 Prize offered by International Congress of Aeronautical Navigation for 300 m range transmission of 1/10 HP by electrical waves.
1905 Lieben's valve work (patented in 1906 as a relay) using magnetic field control of internal current.
1906 Dunwoody discovered crystal detector.
1907 Fessenden patented heterodyne detection — well before its time.
1907 Lee de Forest patented triode valve.
1908 Wien's quenched spark-gap.
1910 Lieben built valve amplifier.
1913 First USA musical transmission.
1922 British Broadcasting Company came into existence.

RADIO-the true pioneers

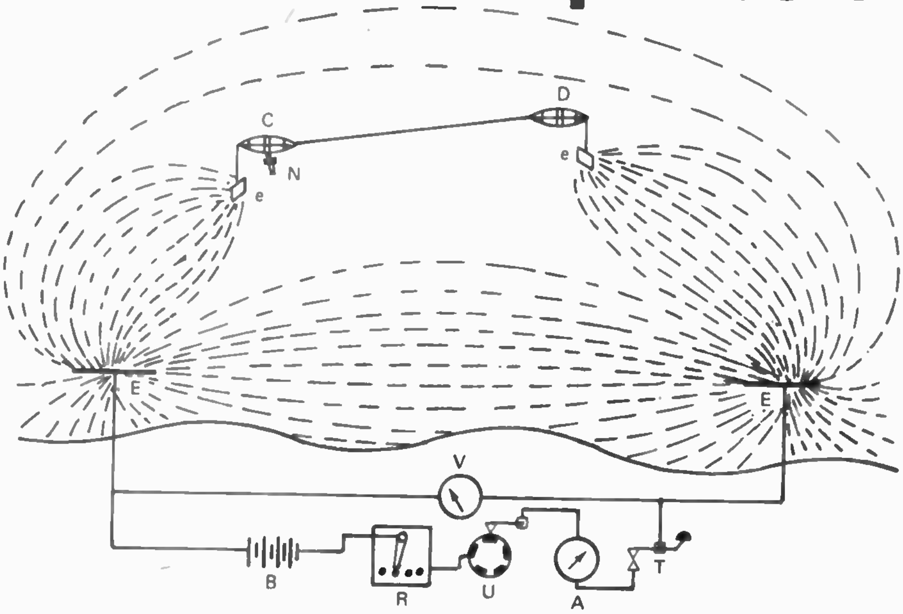


Fig. 7. The first truly wire-less systems made use of conduction in water or on the ground. Mazzotto, in 1906, used this diagram to show how the two current lines remain isolated provided the electrodes E and e are correctly spaced.

until fatalities happened in the course of such dangerous actions rose in number. It eventually became obvious that lightning was dangerous to play with.

The Leyden jar, pictured as a bank in Fig. 3, (named after a place, not a person), crudely insulated wires, detectors — such as personal discomfort to shocks, or the electroscope, and the fictional generating machines became common place play-things of the scientists of the eighteenth century. Numerous experiments were conducted to learn the properties of electricity for both scientific and amusement reasons.

Writers continued to suggest in vague terms how communications could be extended: Barthelemy, in a fictional work published in 1789 wrote of the use of influencing magnets, thus carrying on the same theme started generations before. Some time was yet to pass before the basic elements of electrical technique were to be combined for signalling purposes.

Lightning was a dominant theme in the minds of men — a Hebrew writer in the book of Job implied its potential for communication

"Canst thou send lightnings, that they may go, and say unto thee, Here we are".

We will see later at least one wireless pioneer (Popoff) was inspired to look to lightning as a source of electro-magnetic signals.

These times (the end of the eighteenth century), therefore, saw the expenditure of considerable mental and experimental effort upon ways of providing communication. The main method was the use of wires combined with single on-off sending of charge. We now call this cable telegraphy.

In 1753 there appeared a letter in "Scot's Magazine" proposing telegraphy via multiple wires, one for each letter of the alphabet, along which charges were to be sent as required. They were to be detected at the receiving end by watching the attraction of marked pieces of paper that rose to a pith ball hanging on the end of each wire. The letter was signed just C.M. and to this day the method is known by that name (one writer in antiquity has named C.M. as Charles Marshall!).

Other suggestions like C.M.'s continued to appear in print — Bozolus 1767, anonymous 1782, Le Sage 1782. Eventually in 1787, Lamond constructed one of the proposed schemes. In 1795 Salva, a Spanish physicist, built the first known long line telegraph having receiving sensors capable of data transfer. This led him, in 1798, to build a 50 km line using a grounded return.

Cable telegraphy flourished rapidly from then on. Many people placed their energies on devising useful systems and to learning more about the nature of the electric "substance". Paramount was the need to explore how fast it travelled through wires; one of many of such experiments by Aldini, in 1803, used a circuit between Calais Harbour and Fort Rouge made with a wire supported on the mast of a boat and the 70 m of intervening water as the return circuit.

The following year (1804) Salva read a paper "Galvanism applied to telegraphy" in which he outlined a cable telegraphy system. It used the, then newly available, Volta pile (the first primary battery) to send currents along wires in order to produce, by electrolysis, bubbles of hydrogen and oxygen in jars into which each wire was placed. The jars that bubbled indicated the letter of the alphabet being sent by code. A single common return was used. As history will sometimes have it, Salva's claim to fame was largely forgotten with the credit for such a system going to Sommering who built a working arrangement along these lines in 1809. The original apparatus which is to be seen in the Deutsches Museum in Munich, is illustrated in Fig. 4.

Enter electro-magnetism

As far back as 1630 Gassendi has observed that ferrous bodies (those with iron content) became magnetised

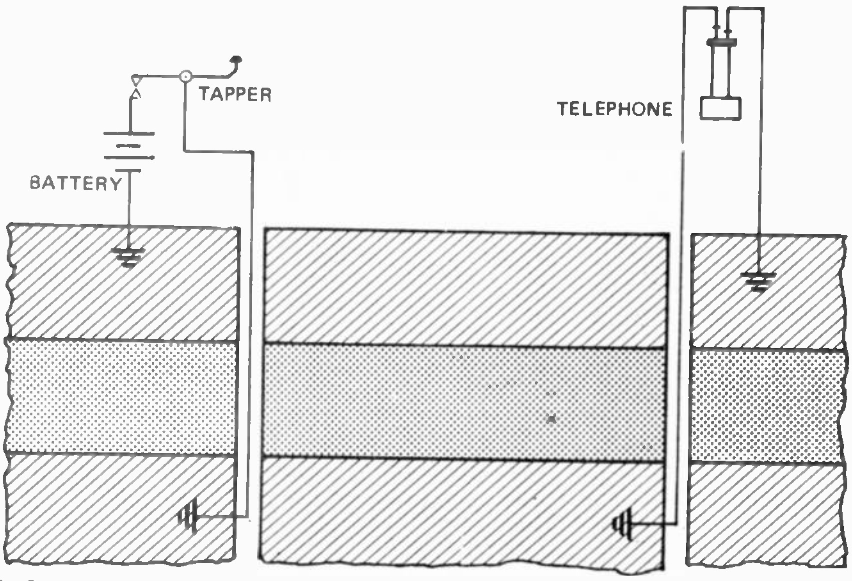


Fig. 8. Interest in conductive systems of wireless continued into this century. Michel, in 1894, made use of the stratified ground to telegraph over a kilometre — other schemes realised 30 km but only with input currents of 20 amperes or more.

by lightning. Phenomena such as this led scientists to suspect that electricity and magnetism were related. But *how* was the important question? Many great names made casual observations as the years moved on. Newton, in 1716 wrote about the magnetisation of a needle by frictional electricity; Swedenborg (1730) argued that such a relationship existed; Franklin established the polarity laws for Leyden jar discharges through a knitting needle. In 1758 Beccaria proposed a theory that the earth's magnetic field is due to internally circulating electric currents, a view still held today.

The problem, felt intuitatively by many, was eventually summed up in 1774 when the Electoral Academy of Bavaria set up a prize essay competition on the theme: "Is there a real and physical analogy between electric and magnetic forces . . . "

Even though a number of experiments came close to answering this basic idea, the final breakthrough came much later in 1819 when Oersted found that voltaic electricity passing current in a wire visibly deflected a magnet held near the wire. He established the laws of current directions and magnetic polarity. There is, by the way, a reasonable claim that his discovery was predated by the work of one Romagnesi, of Trent because an essay by Aldini, written in 1804, and a book by Izarn of 1805 both refer to this gentleman as having discovered that

"Galvanism causes the magnetic needle to deviate".

This new experimental fact opened up the way to a whole host of new, more sensitive detectors of electric current and enabled cable telegraphy to literally leap ahead in practical and economic utility. Cable communication was in extensive use within thirty years of Oersted's discovery. The electromagnetic principle enabled relays and sensitive galvanometers to be devised thus clearing the way for a new era in electrical science. Signals could be amplified enabling man to probe a little deeper into electrical phenomena.

Although the development of telegraphy is a tale of itself it is necessary to mention these early days in order to portray the hardware available to the pioneers who contributed towards wire-less transmission.

Static and dynamic electro-magnetic effects

Having grown up with permanent magnets only it is understandable that scientists of the early 19th century failed to realise that yet more electro-magnetic effects existed when the field was moving in a dynamic state. It was common knowledge in the 1820's that a dc current passed through a coil surrounding a magnetised needle caused the needle to diverge one way or the other according to the direction of the current. If electricity can produce magnetism does not the reverse apply? This was the problem that occupied Faraday (and others) in the years 1822-31. Moving the needle by hand and holding it there did not produce a steady current in the coil so, due to the lack of sensitive detection devices, the truth lay hidden for a decade or more.

Eventually, in 1831, Faraday founded that the important fact relating magnetism and current was that current was produced by *changing* not *static* magnetic conditions — the now famous Faraday law of induction was thus formulated. In the course of several weeks of intense experiments following his discovery he built the first transformer, a component that became important in radio from 1898 onward. Figure 5 shows a neatened version of Faraday's experiment to prove induction with a magnet provides electricity.

So, by 1831, we now find scientists have some knowledge of the physics of capacitors, inductors and resistors as individual components. Ohm had just related resistance to voltage and current in 1827 using equipment shown in Fig. 6. Two more decades were, however, to pass before the oscillating effect of capacitance and inductance was formulated.

Grounded systems continue

Whilst the 'static' form of electro-magnetics was booming in cable telegraphy and clearly showing great commercial return on investment, many more experiments tried to produce true wire-less links in order to gain cost savings. By the 1830's the use of an earth return must have been common knowledge but without sensitive current detectors available it is doubtful if any experiments attempting to replace both wires with the ground or water would have been successful enough to have supported serious further work. From 1820 onward, the date of Schweigger's galvanometer (the first really sensitive detector) experimenters now had in their stock of tools far greater detection capability. Schweigger's contributions were to realise that the magnetic force of a current could be "multiplied" by using many turns of wire around the swinging magnetised needle and that a steady current in a second, suitably placed, coil could be used to balance out the earth's magnetic field thus enhancing the ease to which the needle deflected with the unknown current being monitored. (This is now known as the astatic principle.)

There were plenty of contenders for the conductive form of wireless telegraphy in 1830's. An anonymous report in "The Mechanical Magazine" of 1837 discussed the use of earth returns.

In 1831 there is reason to believe that the Scotsman, James Lindsay, telegraphed across the 2 km wide River Tay completely without wires. The scheme used shown, in Fig. 7, relies on connection electrodes to provide the two wire-less paths by conduction. Lindsay was eventually granted a patent on the method in 1854 but most accounts of early telegraphy gives the credit for this idea to Morse (of subsequent Morse code fame) who did a similar thing in 1852. Regardless of whether Morse preceded Lindsay or not both appear to have been beaten to it by Franklin! By 1838 the problem of conductive wireless telegraphy was well exploited by C.A. Steinheil who made tests proving that the conductive method worker in practice provided a sensitive enough galvanometer was available and certain rules about electrode plate separation were obeyed.

Interest in conduction systems of practical use continued right up to the start of this century, as Fig. 8 shows, but we can dismiss their usefulness as limited, for the range is restricted unless enormous input power is used.

From time to time various people proposed grandiose systems for trans-oceanic communications by this method. Henry Highton said the following in 1872:

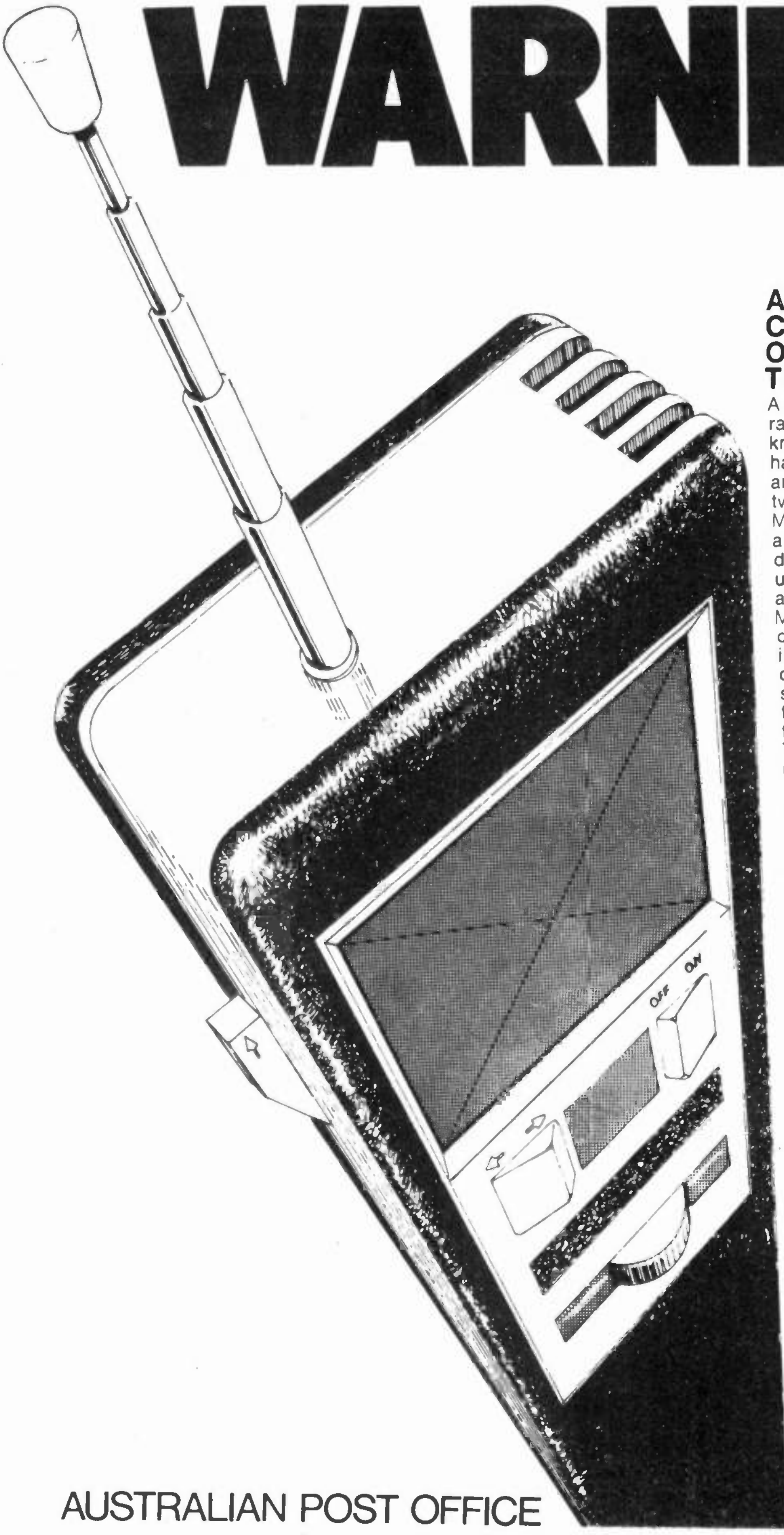
". . . it is possible, by erecting a very thick line wire from the Hebrides to Cornwall, by the use of enormous plates at each extremity, and by an enormous amount of battery, to transmit a current that would be sensibly perceived in a similar line of very thick wire, with very large plates on the other side of the Atlantic . . . "

(this could be used to describe the modern submarine communication proposals!) Wilkins had proposed a similar grand scheme to link England with France as early as 1745.

Highton's statement is somewhat ambiguous for around this time a second wire-less method was realised — that of 'near'-field' induction between wires. Did his passage refer to this method or to conduction?

We will look at induction and radiation wire-less communication in another part on this subject. Although conduction methods did not provide a worthwhile solution to avoid cables it did get people thinking on the right lines.

WARNING!



AN IMPORTANT NOTICE CONCERNING THE USE OF WALKIE-TALKIE TRANSCEIVERS

A number of low powered, short range radio telephone units — commonly known as walkie-talkies or handphones — have been imported and sold in Australia during the last twelve months.

Many of them are technically inferior and cannot be licensed because they do not meet the standards laid down under the Wireless Telegraphy Act and Regulations.

Many of them are designed to operate on a frequency which causes interference both to essential service communication concerned with the safety of life and property — and to the reception of normal radio and television broadcasting.

The use of such unlicensed (or unlicensable) sets is in contravention of the Wireless Telegraphy Act. The penalty for using radio equipment for the transmission and reception of messages without a licence is imprisonment for six months, or a fine of up to $100.

People contemplating purchase of radio telephone units should first check with the Regulatory & Licensing Section of the Post Office to ascertain whether licences would be granted to use the units for the purpose they have in mind.

Importers: Please note that only radio telephone units which meet Australian Post Office approval may be licensed in this country. Claims by overseas manufacturers that licences are not necessary should be disregarded. Embarrassment to importers, retailers and purchasers will be avoided if licensing eligibility is ascertained before import orders are placed. Such information may be obtained from the Superintendent, Regulatory & Licensing at Post Office headquarters in any state.

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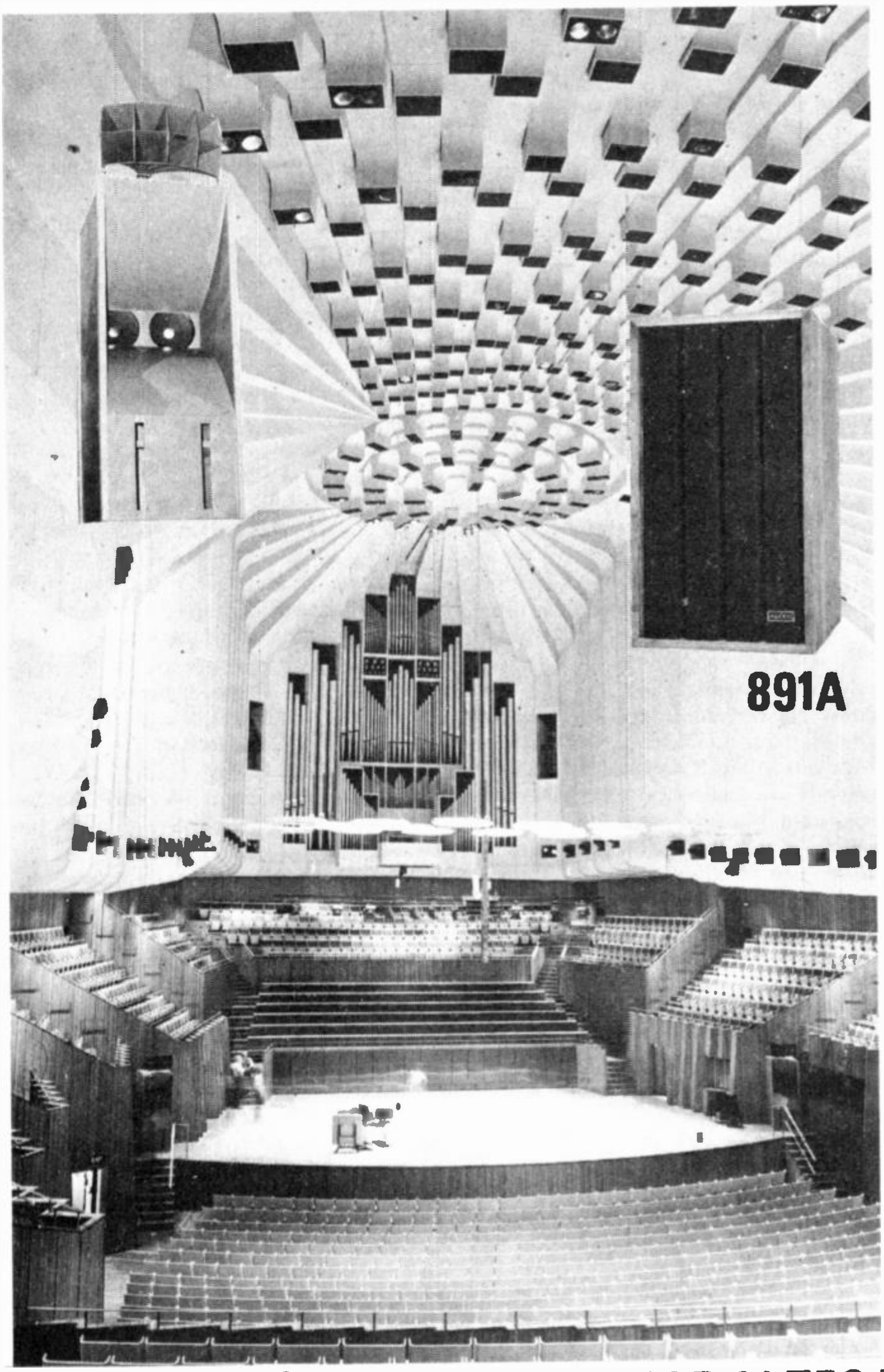

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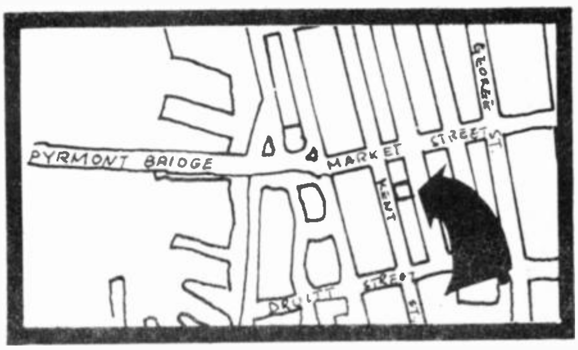

BETTER STEREO SOUND

Conventional quadraphonic systems leave much to be desired says Dr. Farrimond, here is a better way.

Dr. Farrimond is Reader in Psychology University of Waikato, Hamilton, New Zealand.

OPINIONS differ on the relative merits of omnidirectional versus directional loudspeakers. Sound which retains its directional properties retains the ability to provide a good stereo image; however omnidirectional types of loudspeaker are very easy to listen to since the dispersion of sound results in a non-fatiguing acoustic.

If the desired aim of loudspeaker reproduction is to provide dispersed sound, whilst at the same time retaining a stabilised stereo image, there appear to be tangible benefits in increasing the number of speakers.

Possibly the complete solution would be not only to increase the number of speakers being driven by two separate channels but also to increase the number of separate channels; this would provide dispersion, in addition to an increased facility for localization of the sound source. Unfortunately quadraphonic recording and playback techniques are not used in this way although they have *potential* ability to solve this problem. In any case present day quadraphonic recording has its own problems of quality which must first be overcome.

Some moving-coil loudspeaker manufacturers have used groups of speaker units to act upon larger amounts of air. Such an example is the Bose loudspeaker in which eight units face the rear and are driven in unison to provide a diffusion of sound-energy — one speaker faces the listener so producing a sense of direction.

IS FOUR-CHANNEL WORTHWHILE?

After lengthy experimentation with 'conventional' four-channel sound the author decided that the disadvantages outweighed the advantages.

Apart from the gimmicky nature of some recordings, resulting in sounds emanating from unexpected sources (see ETI, March 1974, P.52), the quadraphonic system left much to be desired in terms of low distortion, extended frequency response and signal to noise ratio, — this is a criticism of the CD-4 demodulator used and also of the records.

Nevertheless, experience with four-channel sound had shown that it was worthwhile researching other than conventional two-speaker stereo, so the author investigated the possibility of better stereophonic sound dispersion using six speakers rather than two.

It was decided that "double" full-range electrostatics would be used to provide the frontal sound source and that Acoustic Research LST-1's would be used as rear mounted speakers to provide dispersion and some low and high frequency boost. This particular combination was chosen since the LST's can be driven hard, are omnidirectional, cover a wide frequency range, are compact (although heavy at 42 kg) and are a good tonal match to the modified Quads.

No decoding of any sort is used — in effect the speakers on each side of the room are driven in parallel.

The directional characteristics of stereo are retained since the speakers on the left hand side of the room (both front and rear) reproduce the left channel signal and the speakers on the right hand side reproduce the right channel signal. The advantage of using moving-coil speakers in combination with electrostatics is that they augment the acoustic output of the electrostatics below 45 Hz where the level is about five decibels down relative to the higher frequencies.

SERIES OR PARALLEL

During the initial experiments, the LST's were driven in series with the Quads. This arrangement was used so that the blocking capacitor of the LST's kept direct current and low frequencies from the Quads. The results were good, but normally a parallel arrangement is preferable since this does not raise the load impedance, with a consequent reduction in amplifier damping factor.

The impedance curve of the LST's using switch position number six, is in general, complementary to that of the Quads: a rise in one system being counteracted by a fall in the other. The fall in impedance of the Quads above 8 kHz is partially counteracted by a constant impedance of 12 ohms for the LST's when the selector switch is in position 6. The net result, particularly for series connection, is a flattening of the impedance curve for the six speaker assembly with excellent acoustic results. Nevertheless the parallel arrangement was preferred overall.

The Quads were positioned at the front of the room well away from the wall. The LST's were located high up on a rear wall so as to increase the distance of the sound path to the listener. The tonal matching of the electrostatics and the LST's was very good, since LST's have very little bass overhang and it was possible for the listener to move from one set of speakers to the other without noticing any great variation in overall tonal quality.

Currently the amplifier load has been spread a little, so that now in the final installation, the Amcron D-60 has only the Quads to cope with whereas the LST's are driven by a Harman Kardon Citation 12 amplifier. Both power amplifiers are fed by the same stereo signal from the double output sockets of a Harman Kardon Citation 11 preamplifier. Any residual discrepancy between the LST and the Quads is compensated for quite easily, since the preamplifier has slider frequency controls which can boost or cut the signal up to 12 decibels at hinge points of 60 Hz, 320 Hz, 5 kHz and 12 kHz. The overall frequency spectrum of the LST's may also be varied by adjusting the six position impedance control switch on the speaker. By manipulation of both sets of "frequency" controls, a satisfactory acoustic match is possible.

Loudness balancing is readily accomplished, since the D-60 amplifier has variable gain controls which makes it possible to balance the gains of the two amplifiers. It would have been even easier if the Citation 12 amplifier also had gain controls, but unfortunately it has not. This is a design feature which would be welcomed on all separate power amplifiers.

Low frequency directionality is good as the output is omnidirectional and therefore the source of the sound is difficult to localize. For the high frequencies, which do provide directional cues, it is important to adjust the high frequency output levels of the LST's to just *below* the point at which the source of sound can be identified. This was found to be best at settings between 4 and 6 on the LST's. The net result is to bring the transients of triangles and cymbals forward, to a point apparently between the listener and the speakers. The stereo image does not suffer since the effect is fore and aft displacement rather than a lateral displacement.

The stereo image is largely dictated by the Quads and is, subjectively, relatively free from major disruption as the listener changes position laterally. The energy gradient within the room is fairly uniform. There is little apparent fall off in acoustic energy as one moves up and down the room.

Presumably it is because of Haas Effect (in which both precedence effect and loudness, influence the apparent source of the sound) that the sound still appears to originate from the speakers at the front. This, as stated previously, is helped by the position of the LST's near the ceiling on the rear wall, so that even though at the listening position they may be producing a volume of sound which is equal to that of the Quads, the greater distance and unusual angle of the LST's does not enable them to obtain "precedence" over the Quads — unless the listener moves nearer to the LST's. The changeover point occurs at a distance from the LST's of one third of the total horizontal distance separating the two systems.

The three-dimensional quality of the reproduction produces a closer approximation to the sound of live music. In subjective terms it may only be described as warmer, more rounded and less fatiguing, and whatever may be registered objectively by a meter, it is the subjective result after all which is the more important.

Other loudspeaker combinations will probably give similar results if they are chosen carefully, so readers with other speaker preferences may care to experiment along similar lines in pursuit of the elusive "ultimate sound".

Four speaker stereo was found to confer a greater element of realism or three dimensional quality when compared with the two speaker stereo. The sound is brought towards the listener and seems to come from just in front of the speakers rather than from inside them. The best effect is achieved by locating the rear speakers as far behind the listener as the forward speakers are in front of the listener. This may be a problem in some rooms, but it is worth the effort if circumstances permit. The relative volume levels between front and rear speakers should be adjusted by trial and error until the listener is *only aware of sound coming from the front pair.*

The result is a warm surround-sound, which is non-tiring and is a step nearer to the reproduction of the characteristics of live music. ●

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OVERCOMING P.A. PROBLEMS

Avoid pitfalls and improve system layout for optimum P.A. performance.

THE PURPOSE of public address and sound reinforcement systems is to enable an audience to hear participants in a function-programme, intelligibly and clearly.

Contrary to the practice in some quarters it is not just to make a loud sound. If the information, whether speech or music, is not heard and understood without strain, the system has failed its purpose.

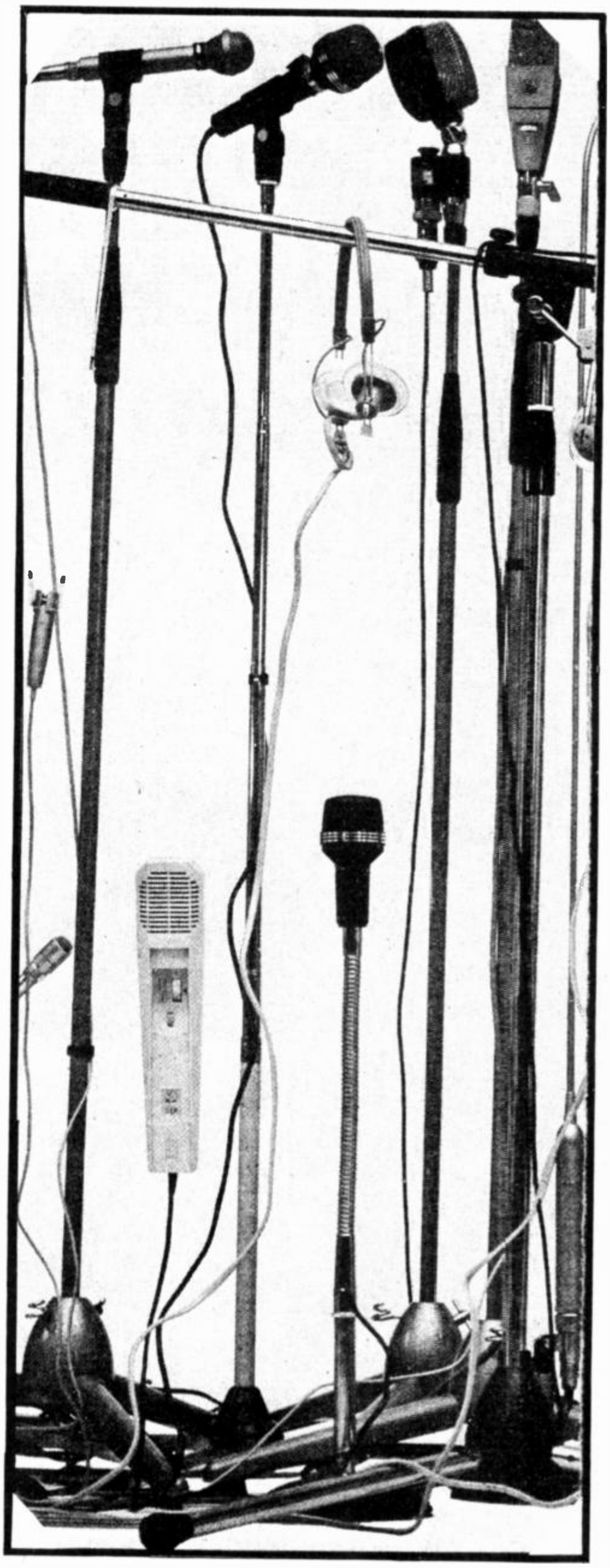
The ideal is for the audience not to be aware that a p.a. system is in actual use, only that they can hear comfortably with adequate volume, but otherwise as though the speaker was just using his natural voice.

Practical installations pose many problems, both of a temporary and permanent kind.

One of the biggest problems is acoustical feedback, often called "threshold howl". Sound from the loudspeaker is picked up by the microphones, amplified, reproduced by the speakers and picked up again. This cycle is repeated until it builds up into a massive howl limited only by the power output capabilities of the amplifier. The frequency of the signal is governed by the main resonance in the feedback loop, usually that of the microphone, and the whole process takes little more than a second.

Feedback will occur when the gain of the system exceeds a certain critical level. The microphone must of course be live, but does not have to be receiving for speech or music. Ambient noise or electrical noise in the amplifier is sufficient to trigger it off. If the system gain is just below the critical level, we can have *incipient* feedback, where every word uttered by the speaker is followed by a decaying ringing sound.

The critical level depends on many factors, but where it is low due to poor acoustics, inferior equipment or inexpert installation, the amount of volume which can be used may well be restricted to a level below that required for reasonable audience audibility. They will have to strain to hear, and non-technical members may protest that the volume should be turned up more, or a bigger amplifier used.



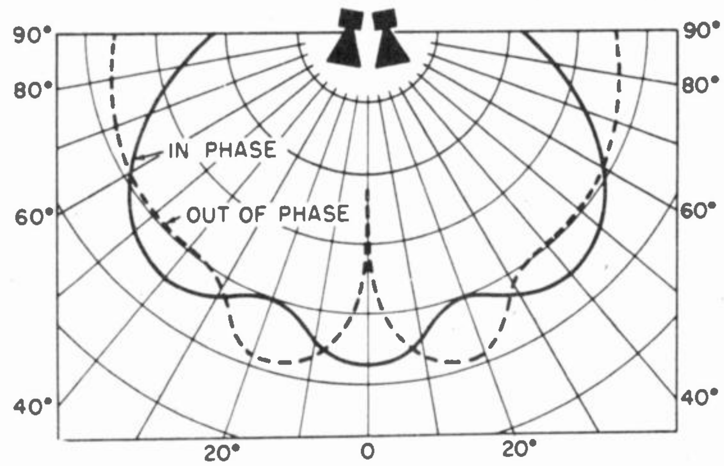
Photograph courtesy AKG.

In order to get as high a volume level as possible, the p.a. operator may turn the gain up to as near the critical level as he dare go. The resulting ringing, considerably reduces intelligibility and so makes matters worse; and of course there is the real danger that the system may "go over the top" at any moment. It is always better to operate with a safety margin well below critical feedback level to achieve maximum intelligibility, even though the volume may be rather less than desired.

HOW TO REDUCE ACOUSTIC FEEDBACK

The design and installation of a p.a. system should have, as a major consideration, the reduction of feedback and raising of the critical level to as high a value as possible. Where microphones and loudspeakers are working in the same volume of air, the problem can never be completely eliminated, there will always be a critical gain beyond which feedback will take place. Much can be done though to reduce the acoustical microphone/loudspeaker coupling, and hence the degree of feedback.

Single-unit loudspeakers radiate sound forward in all directions in the shape of a cone (Fig. 1). The first basic principle then, is to avoid positioning any loudspeaker so that it directly faces into a microphone. Loudspeakers should never be placed at the back of the speaker's platform with the microphone(s) in front of them. They should be placed at the sides and slightly forward. Any loudspeakers placed in the auditorium should likewise not face back toward the platform. Unless the rear of the loudspeaker cabinet is completely sealed, there will be some radiation



If two or more loudspeakers are used close together it is essential that they are in phase, otherwise 'blind spot's will occur — especially in the area between the main axes of the speakers.

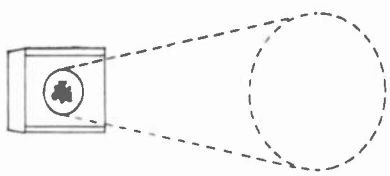


Fig.1. Conical sound distribution pattern of single-unit loudspeaker.

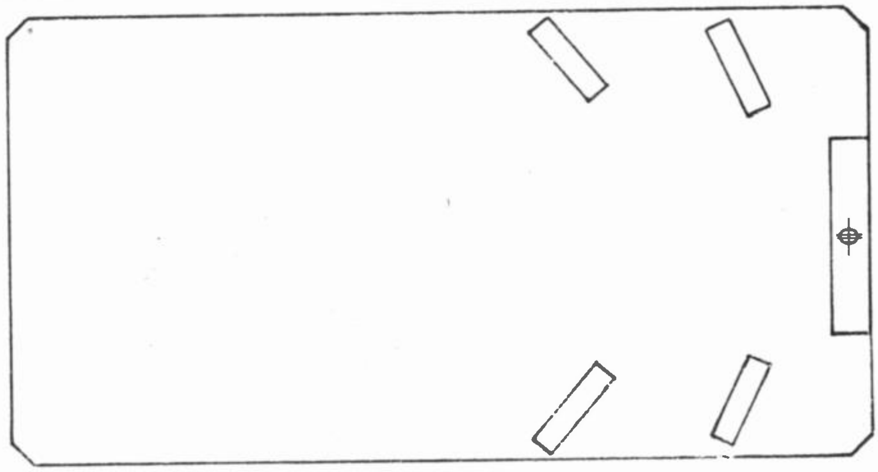


Fig.2. Loudspeakers mounted with their sides facing the microphone give the minimum direct feedback.

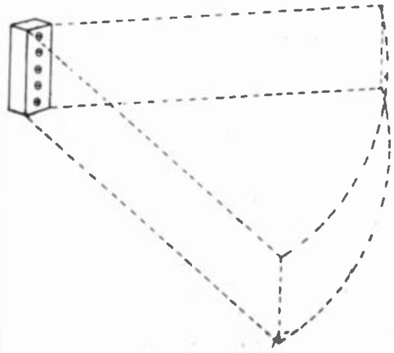


Fig.3. Distribution pattern (simplified) of column loudspeaker. Note flat top and bottom.

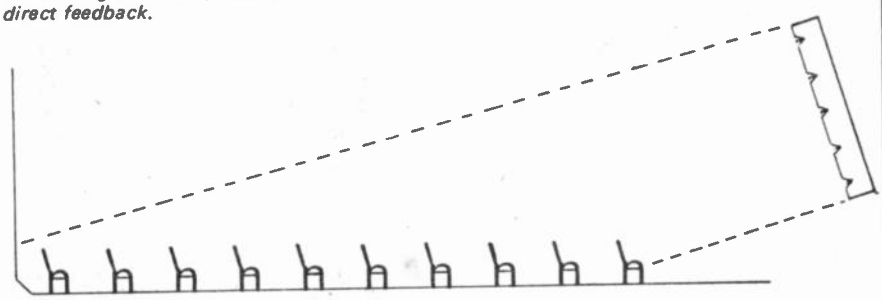


Fig.4. Column loudspeaker angled to cover whole audience yet give minimum rear-wall reflection.

OVERCOMING P.A. PROBLEMS

from the back, so unsealed backs should also not face toward the microphone. The ideal position is to angle them so that they are sideways-on to the microphone (Fig. 2).

Directly radiated sound is by no means the whole problem. Sound will be reflected from various objects in the auditorium, especially the rear wall. If this surface is hard and reflective such as unpapered plaster, with no absorbent areas such as curtains, wooden panels or doors, feedback may well cause difficulties. The platform wall is also important as a reflector, because sound from the auditorium will bounce from the wall behind the platform right into the front of the microphones. Very often though, this wall is covered with drapes or otherwise decorated with absorbent material over all or part of its surface, so its effect is reduced. Where both walls are bare and hard, the p.a. engineer may be in real trouble!

The ceiling can also prove troublesome – especially if arched or domed. Sound rising to such a structure will be reflected in all directions, much of it coming back to the platform.

Of recent years, the single-unit loudspeaker has given way to the column or line-source speaker. This has many decided advantages. The sound radiation pattern from a column is shown in Fig. 3 (in simplified form), omitting minor secondary lobes. The outputs from the line of drive-units all reinforce each other in the forward direction in the same plane. Above and below, the sound field is minimal.

If positioned and angled correctly, this cheese-shaped radiation pattern can be used greatly to reduce unwanted reflections. To start with, very little sound is directed to the ceiling, that which does arrive there is as a result of reflections from the floor and seating. Arched and domed ceilings are nowhere near the bogeys they can be when using single-unit speakers.

The elevation and angle of a column loudspeaker should be such that the sound beam is directed along the heads of the audience in a gradually descending path, (Fig. 4). It can be seen that when finally reaching the rear wall, only a small area at the bottom will be affected. Thus there will be minimal reflection.

All too often installations are seen where the column is vertical, and mounted too high. In this position the sound beam is directed over the heads of the audience, straight at the rear wall, about the worst possible condition. A further aid is to turn the columns inward to some degree, by this means any sound reaching the rear wall does so at an angle and thereby is not bounced directly back, but must be reflected by other surfaces (being attenuated each time), before finally arriving at the platform. Such an inward turn is obtained by the sideways-on positioning relative to the microphones (Fig. 2). And so a dual benefit is obtained. Also, the audience in the front-centre of the auditorium who may otherwise be missed with a straight-to-the-back speaker position, are well served. Where the floor rises toward the back as it does in many theatres, vertical-mounted columns will achieve the desired angle with the audience, so in this case tilting forward is not necessary.

Some columns are designed to stand on the floor, using tripods or other means of support. These are convenient to erect and position for temporary jobs, but one possibility must not be overlooked. Feedback can take place through the floor from speaker to microphone. If the critical feedback level is much lower than would be expected from experience, lift the microphone stand off the floor. If there is an improvement, then the feedback is indeed structural rather than airborne, and absorbent pads should be placed under the microphone and loudspeaker stands. In most cases, the loudspeaker will be suspended from some convenient wall support.

A major factor in the control of feedback is the choice of microphone. Some microphones are omni-directional, they pick up from all directions, others have a figure-8 polar diagram, these pickup from front and back but not at the sides. Still others

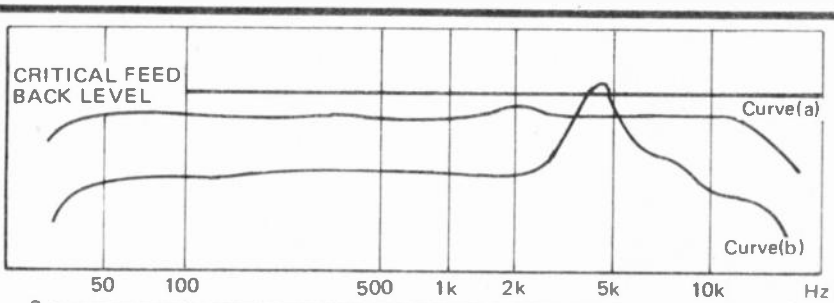


Fig.6. A microphone with a bad resonant peak (curve b) will initiate feedback because peak tip is over the critical feedback level. A flat-response microphone (a), can operate at a much higher gain level without crossing the critical point. (most good-quality moving coil microphones would have a much less pronounced peak, a bad case is here shown to illustrate the principle. However all peaks reduce the usable gain level by the peak amplitude plus a safety margin).

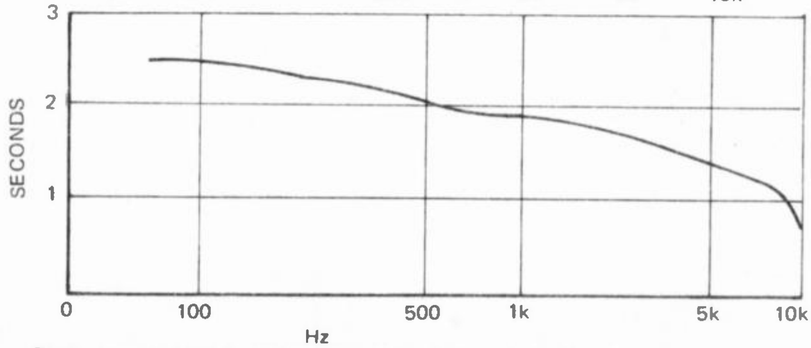


Fig.7. A typical public hall reverberation characteristic. Note how the reverberation time increases at low frequencies which are therefore responsible for most of the reverberation. Judicious bass-cut can greatly improve matters.

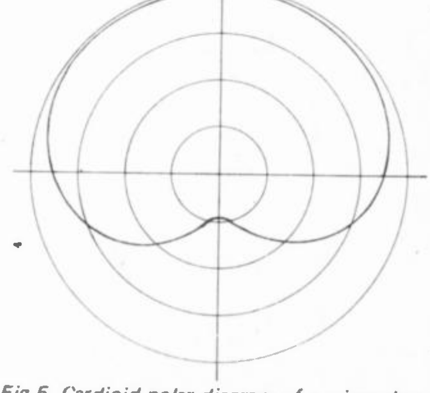


Fig.5. Cardioid polar diagram of a microphone showing sensitivity variations with direction.

have a polar diagram that has a large lobe at the front which decreases around the sides to form two small lobes to back left and right, with minimal pickup at back centre. The diagram resembles a heart-shape, hence its name, cardioid. Some that have still greater front-to-back ratio, are termed super or hypercardioid.

Super, or hypercardioid microphones can assist in controlling feedback because of the rejection of sounds coming from the rear. However, their advantage is lost if the microphone position is moved such as when hand-held to give the speaker mobility. There are also the reflections from the platform wall which enter the front of the microphone. These can be more significant than those entering the rear. Although cardioid microphones are strongly recommended in some quarters for feedback prevention, the advantage is slight and overstated.

A far more important characteristic, is the frequency response of the microphone. Microphones with a flat response are generally considered to be unnecessary and wasteful for p.a. work. Although good quality sound is to be aimed for, high-fidelity is not expected or possible under the usual conditions, especially as speech is generally the main signal source. Hence it is felt that the use of expensive high-class microphones is not really justified for p.a. use.

But this is not really true.

All cheaper microphones, and many dearer ones of the moving-coil type, exhibit a resonance to a greater or lesser degree somewhere in their response curve. This is due to a basic cone resonance and although the better units have this resonance damped to a certain extent, it cannot be eliminated.

If this peak on the response curve causes the gain of the system to reach the critical feedback level at that frequency, feedback will result, even though the rest of the curve lies well below (see Fig. 6). Thus the maximum volume at most frequencies will be much lower than the critical level. A microphone with a flat response, such as a ribbon or condenser type, is also shown; this has a higher usable gain level, and yet will not run into feedback because no part of the curve is over the critical line. Furthermore a 'peaky' microphone is very unstable, it needs only the small amount of energy encompassed within the frequency band of the peak to take it 'over the top', and it will feed back at the slightest provocation even when the gain is well down. On the other hand, a flat-response microphone is much more docile. Even when operating near the critical level, it is slow to feed back because a large amount of energy over a much broader band is required to make it do so. A microphone such as the ribbon Beyer M260, has a response completely free from peaks and has proved its worth in difficult feed back conditions.

REVERBERATION

From acoustical feedback we will turn to another p.a. problem — that of reverberation.

Reverberation is caused by reflections of the sound from one surface to another over multiple paths. Each introduces a time delay, so that from one single original sound, the listener hears a whole series separated by minute fractions of a second. Concert halls have designed reverberation. This is measured at various frequencies and defined as the time taken for a sound to die away to a millionth of its original level.

While reverberation in moderation is essential for music, for it imparts depth and richness, it tends to obscure speech and reduce intelligibility.

The observations made regarding loudspeaker siting and angling to reduce feedback will also help to reduce reverberation. The clothed human body is very sound absorbent, and directing the sound beam from column speakers into the audience, will lessen the amount that will be free to bounce about the walls and furnishings. The relative freedom from roof and ceiling reflections which result from the use of column speakers is a big help.

Unfortunately the measures adopted for reducing feedback, while helpful, are not always *completely* effective in controlling reverberation. In dealing with feedback we try to prevent reflected sounds from the auditorium from reaching the platform. In inhibiting reverberation, we try to stop the sounds bouncing around in the auditorium itself, a rather more difficult undertaking.

Some situations, such as underneath balconies, can be particularly prone to high reverberation. Higher frequencies are more readily absorbed than lower ones, so it is usually those at the lower end of the spectrum that tend to continue being reflected, and so contribute most toward the reverberation. Considerable improvement can often be made therefore, by cutting the bass response of the amplifier, thereby reducing the level of the bass frequencies.

It may be noted in passing that some p.a. operators try to reduce feedback by cutting the treble response. This can help if the microphones are 'peaky' because the resonance peak usually occurs between 2-5 kHz, and so can be reduced in this way. It also can be effective where the loudspeakers are not properly angled, and are directed into hard wall-surfaces that reflect high frequencies. However, it also cuts those speech frequencies and transients that make speech intelligible and so defeats the main object of a p.a. system. It is far better to use good microphones and take care with the loudspeaker mounting.

When cutting the bass to reduce reverberation, do not give maximum cut, as some p.a. operators do, unless this proves to be absolutely necessary. Some bass is necessary to preserve naturalness of the reproduction, if cut too far the result sounds thin and strangled, and can be tiring to listen to. What with top cut, and excessive bass cut leaving only the emaciated middle frequencies, it is little wonder that "p.a. sound" has had such a bad name in the past.

An effect akin to reverberation, though from a different cause, is where sound from several different loudspeakers all at different distances from the listener, arrives at different times. Due to Haas effect, all the sound appears to come from the nearest one, but even so, the different time delays can reduce the level of intelligibility; the effect is especially pronounced where the speakers are more than 50 feet apart. This used to be a problem when large numbers of single-unit speakers were used in an installation, but with columns and their much greater range, far fewer are required. This reduces mutual interference. Furthermore, because the sound field from columns can be controlled and directed to specific parts of the audience, although there may be overlap between adjacent ones, there will not be multiple fields from several speakers in the same area.

BLIND-SPOTS

Blind-spots can sometimes be found in an auditorium; everywhere else in the auditorium sound coverage is good, but in one spot, often just affecting three or four seats, it is very poor.

The most likely cause is overlap between two speakers that are out of phase. This is why it often occurs near the centre of an auditorium which is served from speakers on either side. If speakers are connected out of phase, so that the cones in one column are moving forward while those of another are moving backward, the sound waves produced by both will cancel when they meet. Prevention is better than cure, so the polarity of every speaker should be marked on its terminals, and two-colour wire used to connect them up so that correct phasing of the whole system is maintained. If there are no speaker polarity indications,

OVERCOMING P.A. PROBLEMS

they can be determined by using a small dry battery such as a 4.5 or 6-volt lantern type. Connect the battery across the terminals momentarily, and observe whether the loudspeaker cones moved forward or backward. The terminals should be marked indicating the battery polarity that produced forward cone-motion.

Another cause of blind-spots is just lack of coverage from any loudspeaker, the intended one may be angled too high or low thus missing the affected area. Care in installing the speakers should prevent this from the start. Roof-supporting pillars in the auditorium can cause blind-spots by producing a sound-shadow. Usually this affects only those seated close to the pillar, as the sound converges around it at a greater distance. Loudspeakers should be so positioned that the sound-shadow from one is filled in by another not-too-far-distant speaker. It is often an advantage to mount the columns on the pillars rather than the side walls.

EQUIPMENT BREAKDOWN

Perhaps the biggest problem that can face the p.a. operator is a breakdown, especially if the function is a large one that could not continue without the p.a. Here again, prevention is the keyword, even if the trouble can be traced and put right, it will mean a considerable interruption and delay in the programme.

The most prolific cause of breakdowns is a cable fault. Loudspeaker feeders should be run where they can come to no harm. Wherever possible they should be mounted high and out of reach, never across exit doors or through doorways unless there is clearance to allow for the door to be closed. They should always be supported at frequent intervals; never just hung in a long loop across any open space, or even along a side-wall without any intermediate support. They should not be bridged across a corner, but run into the corner and supported. Connections should be carefully made with particular attention to odd whiskers of wire that could stray to an adjacent terminal. Cables should never be run along the floor with the one exception of microphone cables on the platform or stage, as these are usually under the surveillance and control of the p.a. operator.

Cable-breaks usually occur due to fatigue, within an inch or so of the connector or plug (with the exception of those accidentally or otherwise damaged). Cables in frequent use will sooner or later break at this point, so it is a good preventive practice to occasionally cut off three inches from the ends of all cables and re-fit the plugs. It may seem rather a chore, but the improvement in reliability is well worth the effort.

Loudspeakers rarely give trouble unless damaged, and even if one did develop a fault, it would only mean a partial breakdown. None-the-less, many p.a. installers like to have a spare column with them on any important job. Several microphones are often needed at many functions, so there will always be a spare available. These too are generally trouble-free unless dropped, or in the case of ribbons, blown-into as a test. (To test a microphone never knock it or blow into it, speech is the best test, but if one wants to surreptitiously test a mike while the programme is in progress, gently scratch the end).

The amplifier is usually the most vulnerable item, and a spare, even if of lower output, should be available. It is a recommended practice to have two or more amplifiers feeding separate sets of speakers so that volume levels can be independently adjusted. If this is done then a spare will be already connected and ready for immediate substitution in the event of a failure.

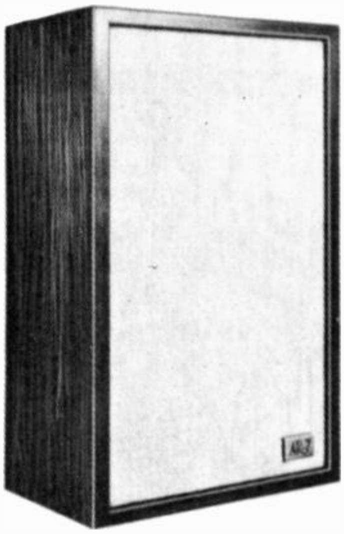
Faults can occur in mixers although they are not so common. A spare can be carried though, even if of a more modest specification but if the worst comes to the worst, a microphone can be plugged directly into the microphone socket of the amplifier and so by-pass the defective mixer.

The final problem that we shall deal with in this article is that arising from the way in which microphones are used. Microphone output is proportional to the square of the distance from the sound source. Doubling the distance from the speaker's mouth, reduces the output to a quarter. If the critical feedback level is rather low, the gain cannot be turned up far enough to compensate before encountering feedback, hence it is necessary to keep the microphones close to the speakers. But if they are *too* close, explosive consonants such as "P" and "B", will produce shattering effects from the loudspeakers. About nine inches to a foot is a good average microphone/speaker distance, so if the rostrum or speaker's desk is deep, a boom-arm or swan-neck is a useful accessory.

The microphone should not be positioned level with the speaker's mouth because not only will this obscure him from the view of the audience, but this is not where maximum sound pickup from the human voice is obtained. Sound tends to be reflected downward from the palate, and this can be further accentuated by the speaker looking downward from the platform to a seated audience. The most satisfactory angle is with the microphone positioned about 45° from the horizontal.

Speakers should be instructed, in advance, of the optimum microphone distance, as some like to step back and ignore the microphone completely, while others lean so close that they appear as if they are going to swallow the thing. An extended hand-span is a good rough measure of the optimum distance, and one that is reasonably easy to estimate by the speaker. It would be as well to warn him not to measure the distance literally by this means while speaking, as the audience may misinterpret the gesture!

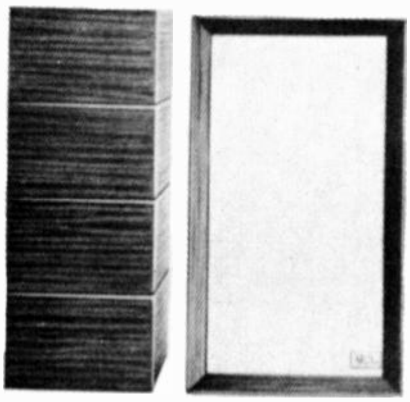
It can be seen that there are many pitfalls, and installing p.a. (even a temporary system) is not just a case of connecting up a few speakers, an amplifier and microphone. But attention to the points here described should enable one to avoid some of the worse problems. ●



AR-7

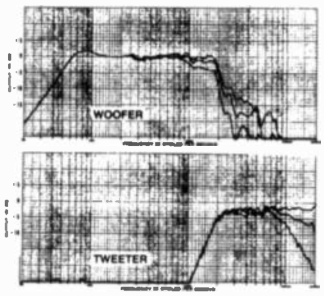
a new standard of excellence in a speaker of small size

The AR-7 is the smallest speaker system Acoustic Research has ever designed. It is purposely small.
Recognizing the space demands imposed by four channel stereo music systems, AR decided to develop a small speaker to permit installation in areas where our larger speakers are not appropriate. At the same time, this speaker must offer the extended range usually associated with speakers of much larger dimensions.
That the AR-7 has achieved both design objectives is clearly evident.



The size (9¾ x 15¾ x 6¼) is such that 4 AR-7's occupy less cubic volume than a single AR-3a.

The accuracy of the sound is such that we show these power response curves and guarantee each AR-7 speaker to match the curves within ± 2dB. Such accurate, full frequency range performance from an enclosure of this size did not come easily. It required years of development and state-of-the-art technology.



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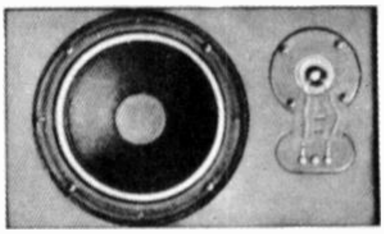
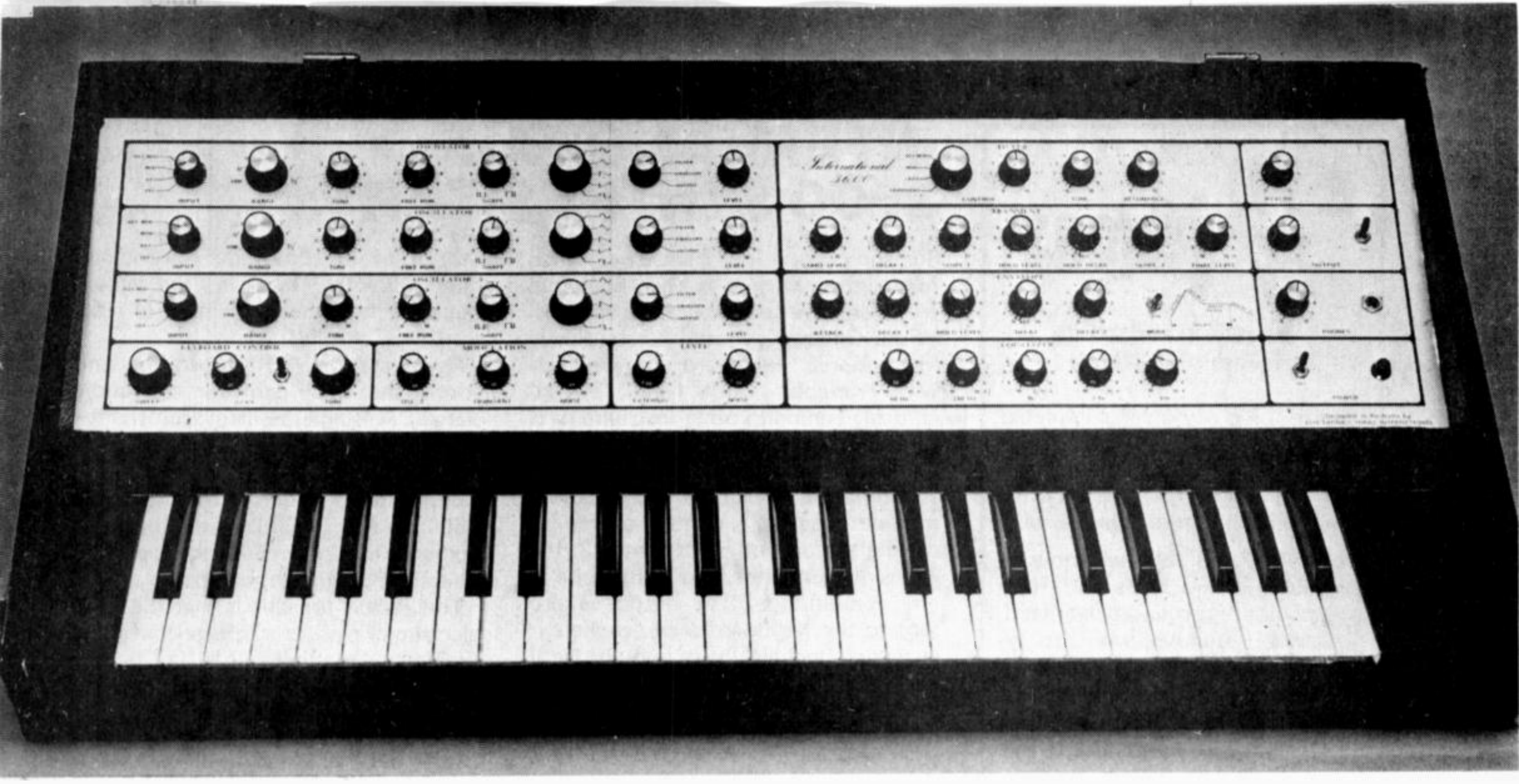


The woofer of the AR-7 uses such advanced design and manufacturing techniques that its low frequency response extends substantially below that of competitive speakers of far greater size.
The tweeter of the AR-7 is similar to the tweeter used in the highly acclaimed AR-6. It produces smooth, wide dispersion sound. Both the woofer and the tweeter use high temperature voice coils, permitting higher power handling capability.
Though the AR-7 was designed primarily with four channel stereo installations in mind, its accurate wide frequency response makes it a wise choice for high quality two channel stereo systems.
AR-7, priced at $199 a pair*. Compare the superb sound of the modestly priced AR-7, AR 4xa and the AR-6. Even to the most critical ear, the difference is subtle.

*Recommended retail price

2559



INTERNATIONAL 3600 SYNTHESIZER

THE International Voltage Controlled Synthesizers have been developed as "state of the art" systems. Extensive use has been made of digital techniques and CMOS has been used as the primary logic family.

This article introduces the construction of the second of our two music synthesizers – the International 3600. The larger International 4600 was described in a series commencing October 1973.

The 3600 is a relatively inexpensive model that is basically designed as a portable, limited capability instrument for stage work. It does however offer a performance superior to most small synthesizers at present on the market.

The larger 4600 is a full scale unit. It uses the same electronics but has more modules, a programming patchboard and many additional features which make it more suitable for studio use.

The flexibility of both units, in particular the larger, allows individual constructors to tailor an instrument to their own requirements.

In the larger 4600 unit no compromises were made that would hinder expansion of the system. Construction could pace the ingenuity or finances of its builder. The unit had a 22 x 22 way patchboard to facilitate the rapid selection of various module configurations.

The 3600 offers the most popular features of our larger 4600 synthesizer but is simpler.

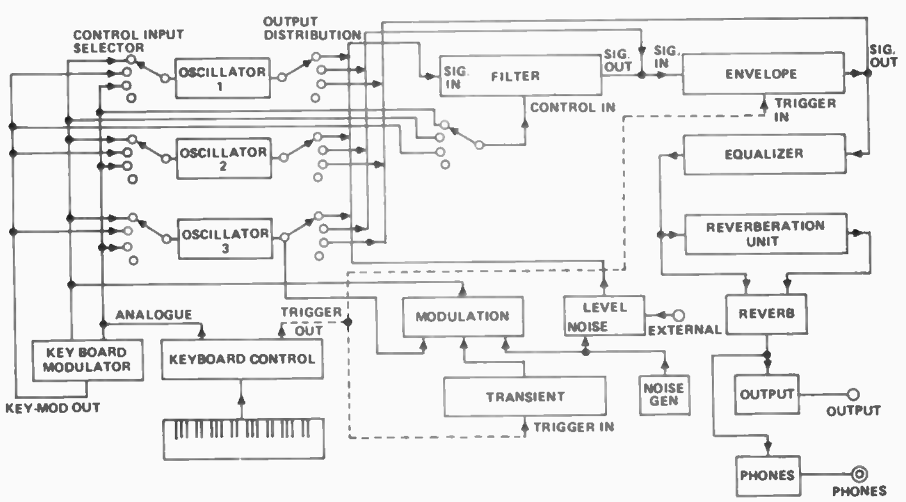
It is faster to operate as it has a switch patching system rather than the matrix patchboard of the larger unit.

The 3600 is particularly suitable for live performance and portable use, being completely enclosed in a rugged carrying case with detachable lid, the lid is large enough to house a monitor loudspeaker which can be driven by the headphone amplifier.

3600 FORMAT

Three Oscillators:

Three indentical Voltage controlled Oscillators give Sine, Triangular, Sawtooth, Inverted Sawtooth (Ramp) and Rectangular waveforms. Each oscillator is switchable over seven (precisely tuned) octaves, plus a



Block schematic of 3600 unit. Note this will be shown larger next month. (Copyright Electronics Today International ©).

INTERNATIONAL 3600 SYNTHESIZER

Sub-sonic (very low frequency) range for control purposes. The oscillators are insensitive to temperature changes.

Four Octave Keyboard A four-octave monophonic keyboard is provided with variable 'Glide' and 'Sweep' control. Tuning to other instruments is done using the 'Tune' control located on the 'keyboard control' module.

Modulation Mixer A 'Modulation' module provides a control source by mixing the output of Oscillator 3, the Transient generator, and white noise in any combination. The output is also sent to the Keyboard module where it is mixed (technically it is multiplied) with the keyboard voltage and a 'key mod' output is obtained i.e. the modulation modules' output tracks the keyboard.

External Input An external input signal such as guitar or voice can be sent directly to the filter by a continuously variable gain control located in the 'Level' module. A white noise control in the same module sends noise directly to the filter input.

New Low-Pass Filters A low-pass Voltage controlled filter selects its' control from the 'Transient', 'Keyboard', 'Modulation', Module or 'Key Mod' outputs. The depth of control is continuously variable by a control next to the selector switch. A 'Tune' control determines the filters' starting point (pitch) and a 'Resonance' control provides variable resonant peak at the (voltage controlled) cut-off point. This filter is *not* the same as the original filters in the 4600 Synthesizer.

Unique Transient Generators A transient generator, intended primarily to control the filter, is triggered whenever a key is pressed on the keyboard and provides a programmed control voltage. It has two slopes, either of which can be rising or falling depending on the 'Start'. 'Hold' and 'Final' level setting.

Initiation of the transient can be delayed until some time (variable) after a key is depressed on the keyboard. The hold level can be sustained until the key is released, or it will hold only for the duration of a preset (variable) period regardless of the key being lifted prior to, or after the set period.

Envelope Generator with 'Hold delay'. The output of the filter goes directly to the Envelope Control (Loudness contour) which has three slopes and an adjustable Hold Level. A hold delay similar to that in the transient generator is also incorporated. This can be overridden for manual hold on the keyboard.

Five Section Tone Equalizer The output of the Envelope control unit goes directly into a five-section equalizer for finer refinement of tonal quality.

Reverberation A Reverberation unit forms the final path for the audio signal. A single control adjusts the amount of reverberation from zero to full.

Super-stable A special feature of the 3600 (and 4600) is that an 'exponential' control voltage is derived directly from the keyboard.

The reason for this is that the basic electronics of a voltage-controlled oscillator requires that a 'linear' voltage change at its input will provide a 'linear' pitch change at its output. However, our twelve-semitone musical scale works exponentially rather than linearly, and so a synthesizer keyboard must ultimately proyide an 'exponential' voltage scale if the oscillators are to provide an exponential pitch scale.

It is relatively easy to obtain a 'linear' voltage scale from a keyboard by simply having resistors in a chain, all the same value. Voltages are tapped along the chain as a key is depressed. This 'linear' voltage scale is then converted to an exponential scale electronically, by an 'exponential converter' sometimes called an 'oscillator controller'.

Exponential convertors are particularly susceptible to temperature, and most instruments based on such techniques have to be frequently retuned to overcome the inherent drift in pitch caused by temperature changes. Some synthesizers use only one or two exponential converters to control banks of oscillators, whilst others have a separate converter for each oscillator.

To overcome this very common problem, the 3600 (and 4600) derive an exponential voltage directly from the keyboard by a unique matrixed voltage selection system which is not sensitive to temperature change. This technique also allows more accurate keyboard tuning than the 1% tolerance resistor chain found in most other synthesizers.

Constructional details of the 3600 synthesizer will commence next month. The 3600 uses many modules which are common to the 4600.

Both models are available from Jaycar Pty Ltd in kitset or built up form. The International 4600 completely assembled is $1590. The price of the 3600 is not yet known but is expected to be around $1000. (Both units are of course, substantially cheaper in kit form — about 50% less).●

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Fantastic F.M. Tuner

"Very good value indeed" Neville Williams, Electronics Australia, Feb. 75

Only $75

Don't take our word for it, see the review in Feb. E.A. The Echosound Tuner is incredible value for money. Has separate AM and FM front ends. 10 transistors and 14 diodes. Covers FM 88 to 108 MHz AFC, 60db S/N, 35 db sepn. 600mV output AM 535 to 1605kHz, ferrite rod antenna. Features multiplex adaptor complete with built-in stereo indicator. 240V operation. Complete in Walnut case. Guaranteed for 12 months. Such has been the demand that we are air-freighting them in. Don't miss out at only $75.00 (P & P Free).

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Manufactured by Hills (need we say more?) 3 element $12.05. Long range 7 element $29.55 (Both road freight on).

FM splitter.

This one is a beauty. Splits incoming 300 ohm TV aerial lead giving outlet for FM tuner. In fact 3 outputs TV VHF, TV UHF and FM. Fits on back of TV set. Great value at $3.50

'600' Regulated power supply

delivers 3A (5A peak) at 12V. Ideal for running car radios etc. off domestic power. On-off switch, neon indicator, 7mV rms ripple etc. Great value at only $32.00.

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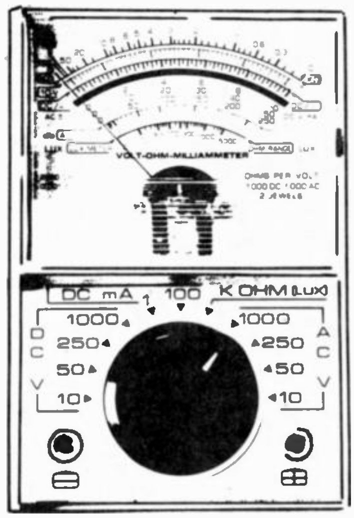
TK700 Cube speakers

handle 10W with a response that has to be heard to be believed. Has 8 ohm full range 5" speaker with 1½" voice coil throw!! Response from 45 to 18kHz thanks to huge 3" magnet yet measures only 6" cube. Available in red, black or white (specify). Ideal extension or 4 channel rear unit or for budget hi-fi. Only $14.95 each (P & P freight on).

MINI·MULTI·LIGHTMETER $8.50

This is a great idea. You get a basic multimeter with a scale marked in lux. Simply spend an extra $6.00 on the special lux probe and you have a light meter measuring from 10 to 5000 lux (midscale 300lux). Normal ranges: Vdc 10, 50, 250, 1000; Vac 10, 50, 250, 1000; Adc 1mA, 100mA Ohms 150k. Basic instrument offers 1000 ohm/V, mirror scale, 11 ranges. Highly recommended but hurry orders for lux probe as only 50 available.



AM+FM DIGITAL CLOCK RADIO $45.00

Makes an excellent gift. Clock will switch on the 10 transistor, 9 diode radio at any time, switch off at any time up to 60 minutes after setting 'sleep' switch (how lazy can you get?). You can wake up to music or buzzer then press snooze button for an extra forty winks. Covers AM 530 to 1630 kHz; FM 88-108MHz Sankyo clock movement. (P & P $2.00).

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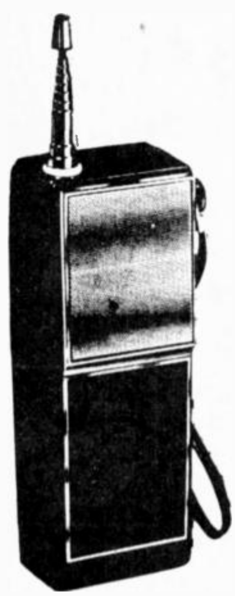

TREMENDOUS LOW PRICE WALKIE TALKIE OFFER CONTACT CT10

Remember the famous Midland 13700 units in our last year's catalogue? We sold thousands of these units (and no wonder when you read the spec). The Midland is no longer available but we have located an absolutely IDENTICAL Unit. ONLY THE NAME HAS CHANGED. Check these features:

Provision for 2 channels (27.240MHz or 27.880 MHz). Tuned RF stage. One microvolt sensitivity. Mute control. Calling tone. Heavy duty aerial. Maximum power allowable. PMG APPROVED (licence required). Transmitter effectively converts its 1W output power into a high ratio output power by high level push-pull class B modulation. Rugged case. Supplied with one set of crystals (specify frequency). Other frequency available at $4.50 pair.

Range:	up to 10 miles depending on terrain up to 50 miles over water
Frequency:	27.240 or 27.880 MHz
Freq. Stab:	0.005%
Tx:	Crystal controlled 1W
Rx:	Crystal locked superhet
Antenna:	13 section telescopic
Power:	8 x 1.5V UM3 cells
Size:	8¾ x 3¼ x 1¾"
Weight:	25 oz

$39.95

We have the Contact CT10 at the same, YES SAME price as our old catalogue. It must be the cheapest, 1 Watt, fully approved unit in Australia at ONLY $39.95. Buy 5 or more and save $2.00 on each unit at only $37.95 (P & P $2.00 per unit).

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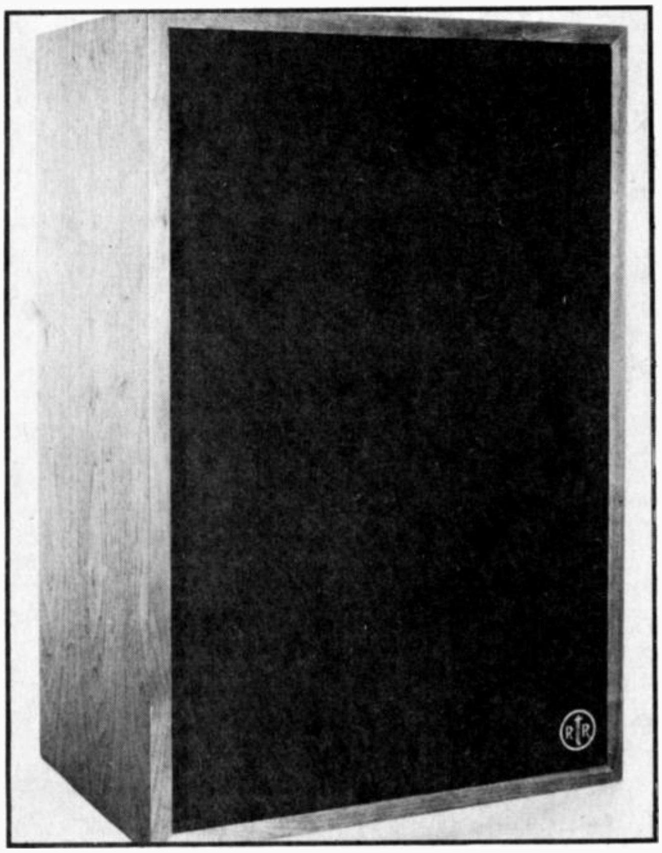
RTR 400E Loudspeaker

ETI PRODUCT TEST



Electrostatic mid-range drivers result in ultra-low distortion

Recommended retail price $770 pair.

SPEAKER components manufactured by California's RTR Industries have been used in other manufacturers' enclosures for many years. In fact many well known and respected American speaker enclosures are designed around dynamic and electrostatic drive units from RTR.

In the past few years, RTR, like several other companies in this field, decided that if their components were good enough for other manufacturers, then they might just as well make complete units too. Amongst a very wide range of speakers since produced, the 400E's are perhaps the most interesting.

The first and most noticeable feature is that whilst the 400E's have electrostatic drivers, these are used as mid-range drivers instead of being used as tweeters, as we have come to expect in the majority of speakers. Four of these drivers are used in two arrays set in both sides of the face of the cabinet neatly flanking a ceramic horn tweeter at the top of the cabinet.

The low frequency driver is a 250 mm diameter woofer mounted in a fully sealed enclosure with a volume of 60 litres. Each of the four electrostatic mid-range drivers is 140 mm x 140 mm. Unusually, for such units, these mid-frequency drivers are rear vented – via a resistive glass fibre material.

The manufacturers have gone to extreme lengths to protect the electrostatic drivers against overloading. A circuit breaker as well as fuses has been included to safeguard against the inadvertant abuse which all such speakers have to cope with sooner or later. The circuit breaker is reset by a push button on a panel at the rear of the enclosure. This panel also has two controls for adjusting the sensitivity of the mid-range and tweeter, together with the mains connection, and polarised terminals for connecting to the amplifier.

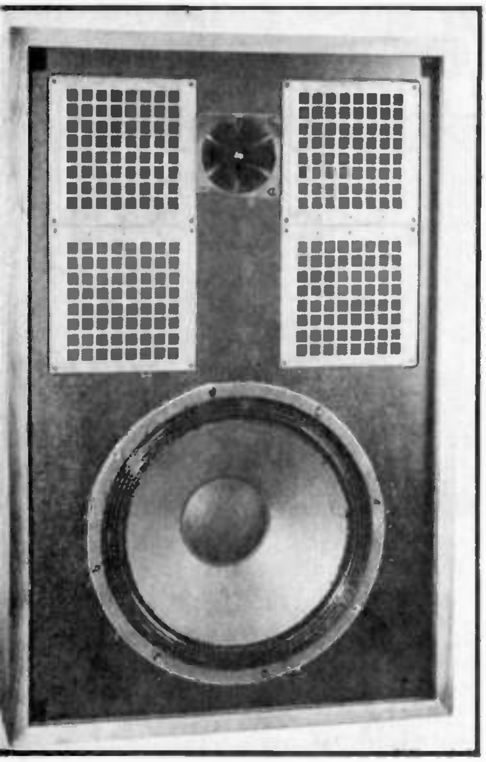
The electrostatic drivers have an overload point which is sharp, well defined, and readily achievable. However just below the overload point there is a buzzing sound, which was quite noticeable during sine wave testing. Once this level is exceeded the circuit breaker automatically cuts the power input.

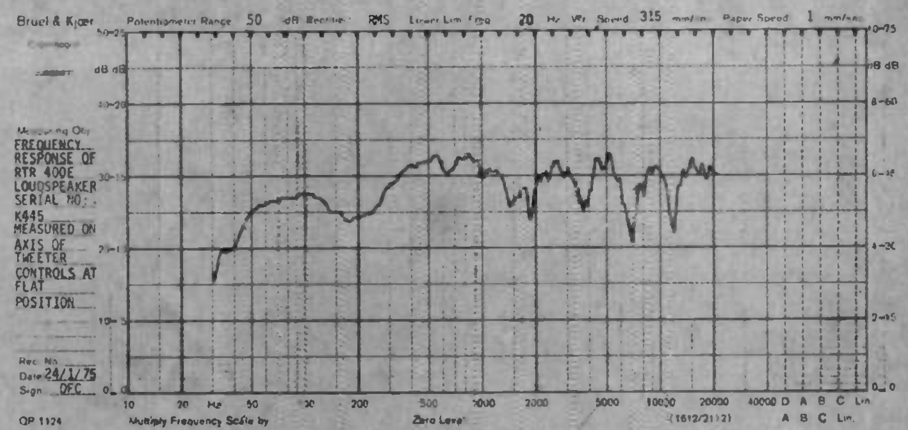
FREQUENCY RESPONSE

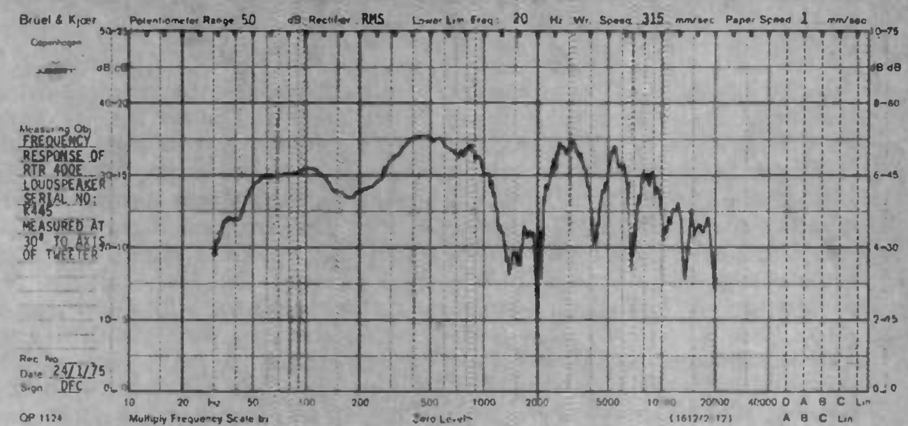
Frequency response of the 400E speakers is reasonably good on axis although the cross-over notches are

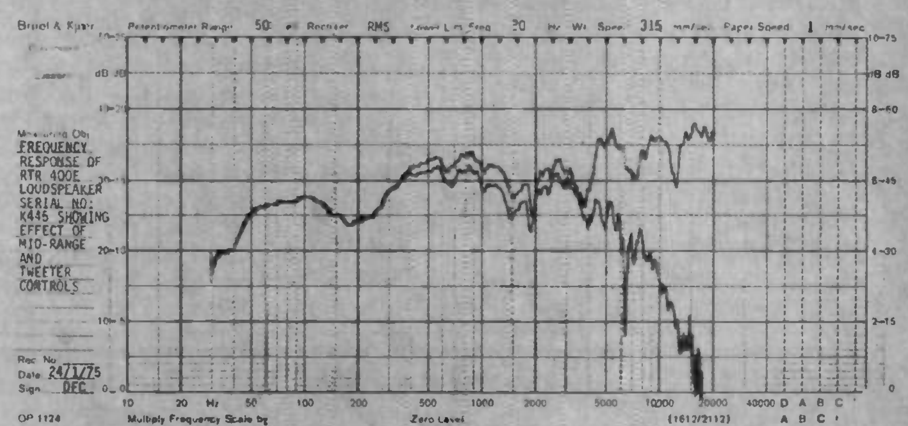
MEASURED PERFORMANCE OF RTR 400E SPEAKER SERIAL NO: K445

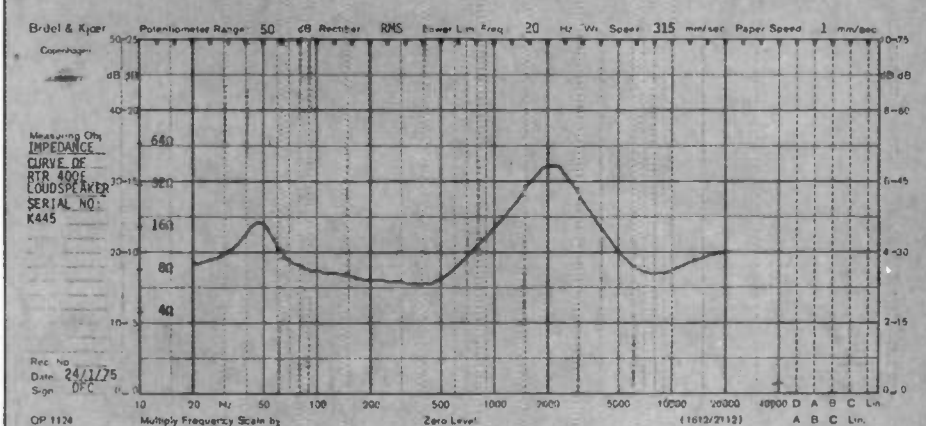
Frequency Response:	+3 −5 dB	50 Hz	20 kHz
Total Harmonic Distortion: 90 dB at 2 metres on axis	100 Hz 0.45%	1 kHz 0.57%	6.3 kHz 0.32%
Electro-Acoustic Efficiency: 90 dB at 2 metres on axis	14 watts		
Measured Impedance:	100 Hz 8Ω	1 kHz 16Ω	6.3 kHz 8Ω
	(but see also impedance curve)		
Cross-over frequencies	470 Hz – 7800 Hz		
Weight:	25 kg		
Dimensions:	700 x 458 x 303 mm		









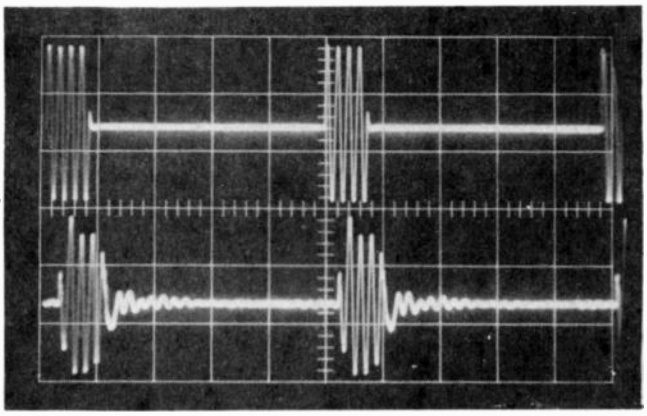


readily apparent. At 30° to the main axis, interference effects between the two arrays of mid-frequency electrostatic units are quite pronounced and causes an effect which we have not seen in any other speaker for quite a while. Depending on where one listened or took measurements it was possible to achieve substantial interaction between the two arrays. This resulted in a series of lobes on the polar plot due to the phase addition and phase cancellation between the two vertical arrays of electrostatic tweeters. This shows up particularly well on our frequency response measured at 30° to the main axis where a typical 12-15 decibel peak to null ratio results. (See relevant graph). The effect contrasts noticeably with the particularly smooth response directly on the main axis of the speaker. The notch, which can be seen on the response at 30° to the main axis at 2 kHz, is real and highly unusual.

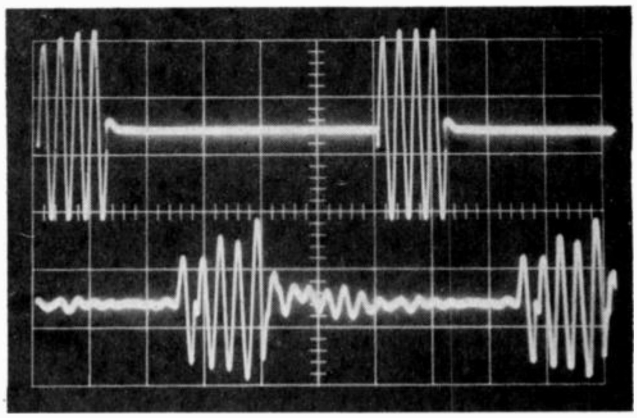
Whilst the frequency response and resulting colouration are not outstanding, the lack of distortion that these electrostatic drivers achieve is unusually good being almost the lowest that we have ever recorded in their class.

The impedance characteristics show a pronounced high-frequency rise which we have come to expect from the majority of electrostatic speakers, reaching a level of 42 ohms at 2kHz, but by and large this won't cause the average amplifier any great problems. It is significant that changing the level controls, which have a marked effect

RTR 400E Loudspeaker



Tone-burst 1 kHz



Tone-burst 6.3 kHz

on the output of the highest frequencies of the speaker, had virtually no effect on the impedance.

The ceramic tweeter used in the unit is unusually good, and whilst it exhibits a small notch at 12 kHz, the array of drivers chosen do have one of the smoothest *on-axis* responses that we have had the pleasure to measure.

The tone burst responses were extremely interesting. Depending on where one placed the microphone with relationship to the speaker it was again possible to observe highly unusual interactions between the two arrays of mid-frequency drivers. A minor example of this is illustrated in the tone burst response at 6.3 kHz. However, apart from this interaction the tone bursts are reasonably clean — but we did manage to pick up that ubiquitous extra cycle at high frequencies!

ULTRA-LOW DISTORTION

As far as distortion is concerned the RTR 400E really excels. The distortion figures that we measured on this speaker (below the maximum recommended power input) were certainly the lowest that we have yet seen in any speaker even twice their price. They are extraordinarily low.

If our measured results may seem discouraging we may change the picture somewhat with our subjective evaluations. We evaluated the performance of the speaker with a wide range of classical, pop and contemporary music ranging from pipe organ pieces through to violins, guitars, and vocalists.

Performance of this speaker system was outstanding on violin, classical music, and guitar pieces — the purity of the mid-range, and excellence of the tweeter would be hard to beat. The lack of distortion and the generally good transient performance was particularly noticeable, and the violins had that feeling of realism which can only be achieved by a speaker system of exemplary characteristics.

The RTR 400E is an unusual speaker, it combines very fine attributes and significant limitations in one and the same unit!

The interaction between the two mid-frequency arrays can readily be measured and heard in anechoic or semi-anechoic rooms — but it is not nearly so apparent in the average listening room where reflections 'smooth out' the dips and bumps. The same is true of transient response.

The RTR 400E is probably intended for the musical purist. It offers the lover of classical music an unusual complement of drive units which have exceptionally low distortion, excellent transient response, and a realism of sound hard to better in the majority of medium and high priced speakers on the market today.

In our opinion these units would not be satisfactory for rock or pop enthusiasts who listen at high levels — but for the classical music lover they have a very great deal to offer. ●

BICYCLE SPEEDOMETER

PROJECT 235

Be the first to have an electronic speedo on your bicycle! — an A.J. Lowe project.

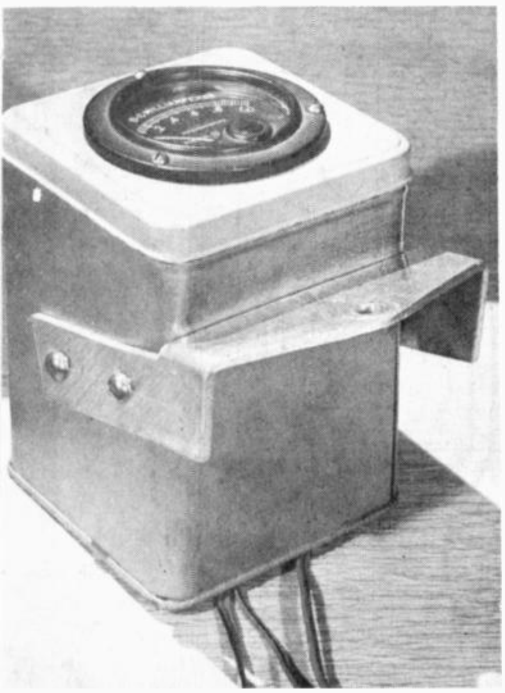
BE THE FIRST to have an electronic speedometer on your, or your son's bicycle — calibrated in km/h too! The advantage of an electronic speedometer is that it doesn't take extra muscle power to drive it — as do those mechanical ones. The small amount of energy needed comes from a battery which is switched on only when a speed reading is required — this is obtained by pressing a bicycle horn button.mounted on the handlebats.

This project was developed around a stripped down bicycle, hence the photographs show bare elements only.

The indicator part of the speedometer is a 1 mA meter mounted in the lid of a suitably sized tin can, see Fig. 1. This is attached to the handlebar pinch bolt by means of a bracket fashioned from aluminium as can be seen in the photo.

The electronics are in four connected sections the indicating section (Fig. 1); the switch, which is a push button mounted on the handlebar — a bicycle horn button is ideal; the photo transistor and resistor R2; and the lamp.

Fig. 1. The meter section may be attached to the handlebars by a bracket held by the handlebar pinch bolt. (meter dial is seen here before re-calibration).



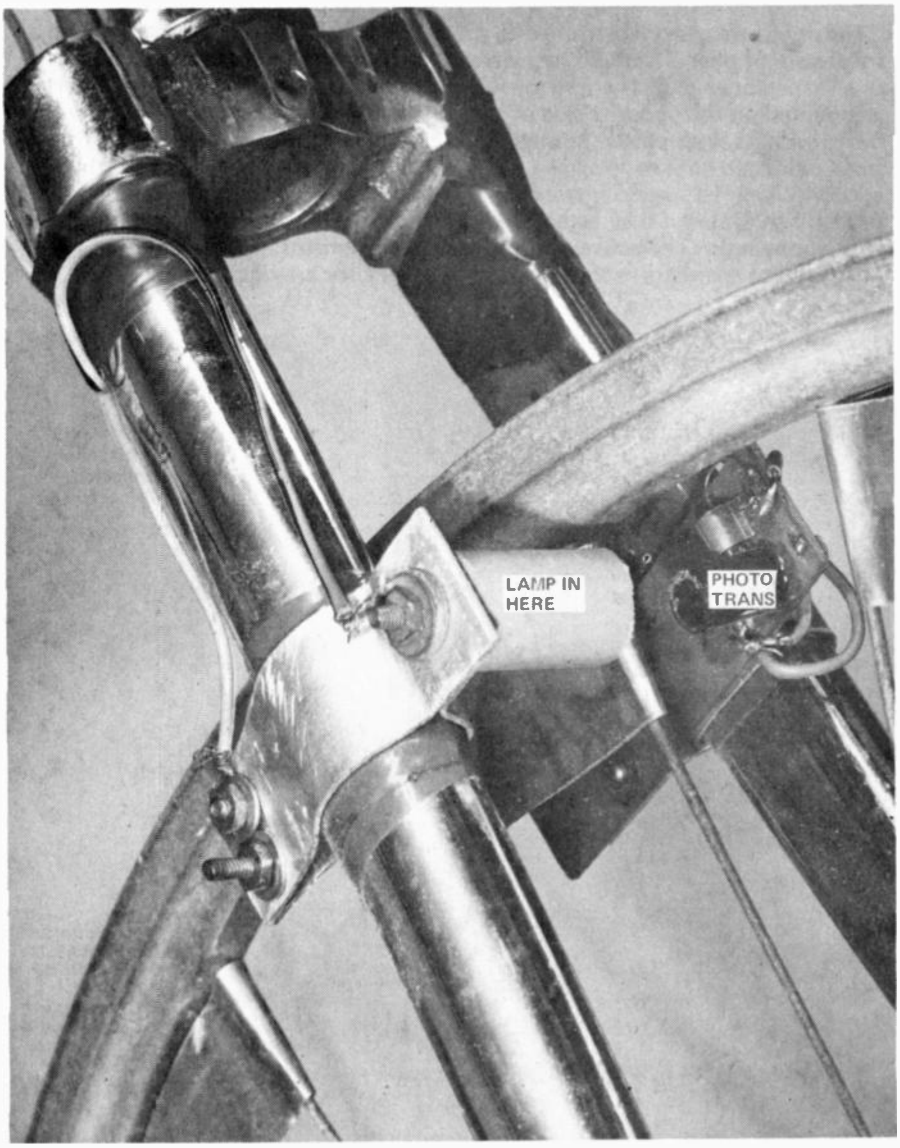
INOICATING SECTION

The components of the indicating section are mounted on a very simple printed circuit board, shown full size in Fig.4. This is attached by bent brass strips to the meter terminals. Veroboard or tagboard enthusiasts can use their favoured technique and save themselves the trouble of making a board if they wish.

The battery, comprising six AA cells, is contained in a battery case also inside the tin box. Note that an extra wire has to be soldered to a connection of the battery case to provide the tap at the 6 volt point as shown.

LAMP ANO PHOTOTRANSISTOR

These items are mounted on the insides of the front forks of the bicycle. If this location is not available,



BICYCLE SPEEDOMETER

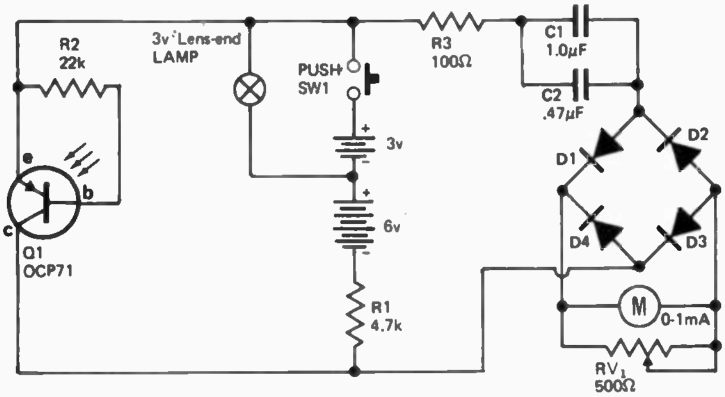


Fig.2. Circuit diagram of complete unit.

due to the existence of brakes for example, then the rear forks or seat stay may be used as an alternative position. Whatever position is used it is important that the mounting brackets are attached securely so that they will not allow the parts to tangle with the spokes.

The photo transistor is attached to a small strip of phenolic board by means of a shaped brass clip. The resistor R2 is mounted on the opposite side of the board with its leads passed through small holes and bent to form an anchor. When the speedo is working properly this resistor may be covered with epoxy resin. The active portion of the photo transistor is shrouded from unwanted light by a short length of black plastic tubing, cut from an empty ball pen, epoxied on to the board.

Directly opposite the transistor is a lens-end bulb (pen torch variety) in a lamp holder mounted on a suitable bracket. The bulb is shrouded with a piece of plastic conduit — mainly to keep dirt away. It is very important that the bulb selected should have its filament on the bulb axis — so that the bright spot formed by the bulb is in line with the bulb and can be directed on to the transistor. These two elements must be adjusted so that they are rigidly aligned.

CONNECTION

Light twin flex such as speaker lead is suitable for connecting the various elements together

BARRIERS

The barriers on the prototype were pieces of aluminium about 90mm x 25 mm, actually cut from the aluminium plates used on office offset printers. Simply bending the ends of the strips around the spokes and pinching them is sufficient to keep them in place.

Constructors who can't obtain similar aluminium could use old

HOW IT WORKS

The speedo is essentially a very simple tachometer which measures the frequency of pulses caused by interrupting a light beam shining on a photo transistor. Fig. 2 shows the circuit. The transistor and lamp are mounted on opposite sides of one of the bicycle wheels and the light from the lamp is interrupted by barriers between alternate pairs of spokes. Pulses of current flowing in the transistor circuit cause a pulsating voltage across the battery and load resistor R1. These pulses are fed to the 1 mA meter through a bridge rectifier circuit D1 – D4 in series with a capacitor (actually C1 and C2 in parallel). The rectified meter current is directly proportional to the size of the capacitor and pulse frequency. The variable resistor RV1 provides calibration adjustment.

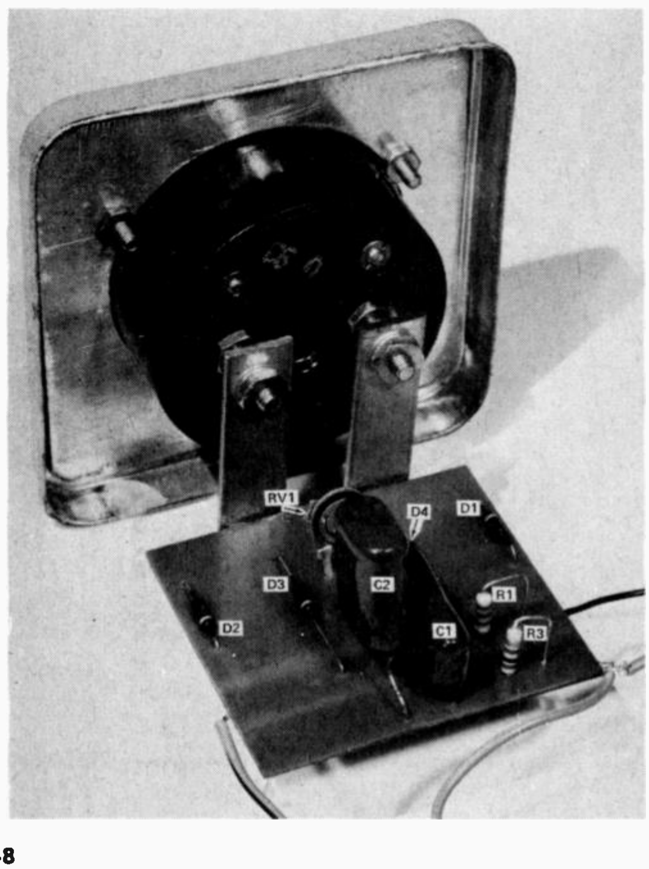
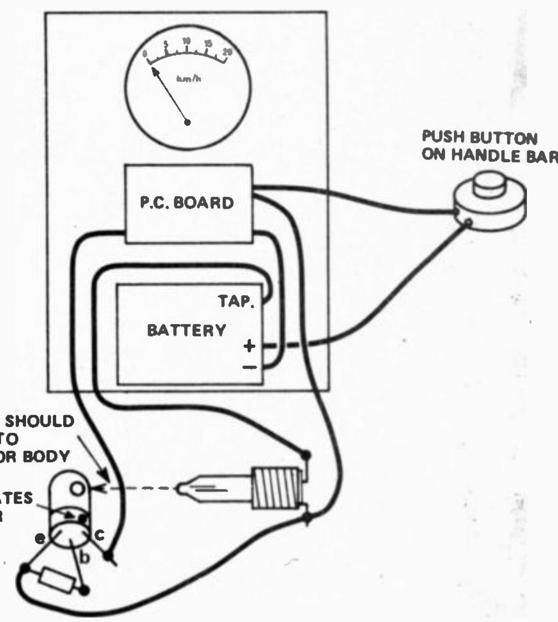


Fig.3. This schematic drawing shows how the various bits are interconnected.



aluminium or tin cans flattened out and perhaps painted.

CALIBRATION

A fairly accurate calibration may be made by attaching a piece of cardboard to the spokes so that it acts as a clicker as it passes the forks. Aim for a light click on one fork only so that the wheel is not slowed down too rapidly

Then, spinning the wheel, counting clicks over say 30 seconds and reading the meter at the same time, provides enough data to work out speeds and calibrate. (Something to do with your new calculator!)

The meter should be adjusted by the calibrating pot RV1 so that it reads full scale at some convenient speed such as 45 km/h. It may be hard to spin the wheel at this speed by hand, but the problem is overcome by driving it by a rope drive from a pulley fitted in the chuck of a drill. This works very well.

As the meter reads linearly, settings below full scale should be accurate enough using the divisions on the original meter scale.

Another possibility for calibration is for the bicycle to be paced by a car with a speedo of known accuracy, (remember that only a maximum full scale reading is required).

The meter scale should be fitted with fresh numbers — Letraset figures stuck on white Contact background are ideal.

NOTES ON COMPONENTS

The prototype used an OCP71 photo transistor which was on hand. These are becoming harder to find so the more readily available ones may be easily substituted, with suitable changes in connections if an NPN rather than PNP type is selected.

If there is any problem with getting a full scale reading the most likely causes are:— incorrect alignment of lamp and photo transistor, and a lamp which spreads out the light too much instead of concentrating it.

FINISHING TOUCHES

When all is in working order the battery case should be taped up and then 'nested' in plastic foam inside the tin box. The tin box should be sealed against weather with plastic tape, and the lamp should be lightly soldered to the lamp holder to prevent its being loosened by vibration. ●

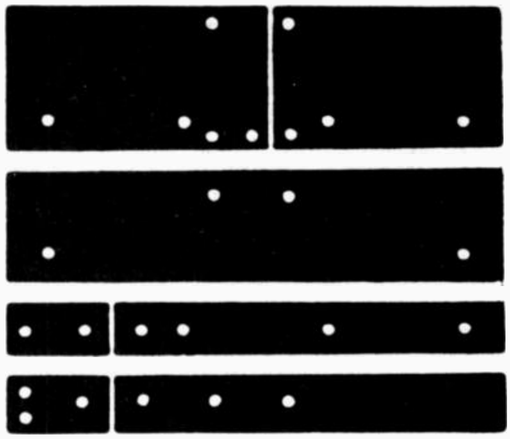


Fig.4. Printed circuit board (shown full size).

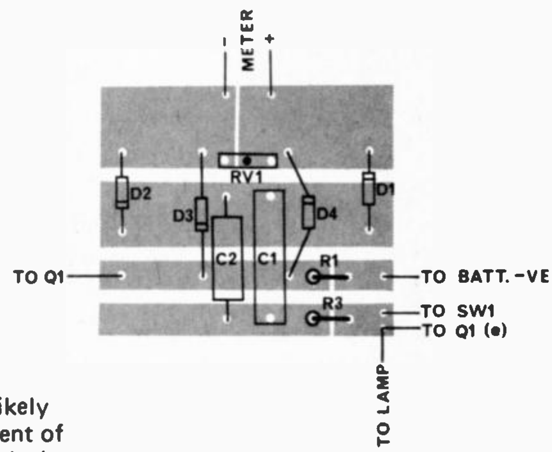


Fig. 5. How the components are mounted on the printed circuit board. The completed board may be fixed rigidly to the meter terminals by two copper straps.

PARTS LIST ETI 235

R1 Resistor 4.7k ¼ watt
R2 Resistor 22k ¼ watt
R3 Resistor 100 ¼ watt
Rv1 potentiometer 500 ohm
C1 capacitor 1.0 µF plastic
C2 Capacitor 0.47 µF plastic
D1-D4 diode OA200 or similar silicon diodes
Q1 photo transistor OCP71 or similar
S1 push button switch normally open — bike horn type
M 0-1mA meter
Lamp 3 volt lens end type as used in pen torches
Battery — 6 AA cells in case
Aluminium for barriers
Aluminium or light steel for brackets
Tin box

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Gives excellent noise reduction with tapes and eliminates most surface noise from records, (see E.A. Sept '73). Input voltage required is about 300 mV, overall gain is unity. Operates from 12 V D.C. Kits include 1 P.C.B., 5 transistors, 1 I.C., all resistors and capacitors, switch etc., per channel. Save $3 to $5. Post 50c each.

BASIC TUNER KIT

Cheapest and best $13.50., post 75c Save $1.00

Features reliable permeability tuning (suit car radio). high sensitivity, easy construction. Supply 6 to 12V D.C. at 5 mA. Uses external aerial.

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DE-LUXE 3 WAY $15.50.
Features mid-range and tweeter level controls, mounted on attractive panel for fitting to front or rear of cabinet. Crossover 2 kHz, 7 kHz impedance 8 ohms, handles up to 50 Watts. Post $1.00.

2 WAY CROSSOVER KIT
Model CN-1. $5.90., Post 70c. Crossover frequency 4 kHz, 8 ohms, handles 30W R.M.S.

3 WAY CROSSOVER KIT
Model CN-3. $8.90., Post $1.00. Crossover frequencies 500 Hz, 4 kHz, 8 ohms, handles 30W R.M.S.

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High output – fully adjustable to "freeze" even fast moving objects.

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CONVERT 2 CHANNEL to 4 CHANNEL with 4 CHANNEL QUAD SYNTHESIZER.

$19.50. Post 50c

The kit includes individual L and R volume controls and phasing switches for the rear channels.

Specifications: Noise level –92 dB below 1V. Dist – 0.05% or less at 1V rms out. Gain of + 6 dB on the two front channels, controllable from –7 to +6 dB on the two new channels, and freq. resp. of + 0.5 dB from 20 Hz to 20 kHz.

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- Ultra low noise.
- LM381 I.C.
- 32V 10 mA supply
- Size only 3" x 2"
- Round of slider pots incl.

Specifications – freq. response 10Hz – 100kHz, T.H.D. 0.1% at 1KHz, Channel separation 60 dB, less than 1μV total input noise. Input sensitivity 3 mV, for 200 mV out, compensated or flat equalization. Input Imp 100K ohms, single supply only.

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- Modern Attractive Style
- Loudness/scratch filter.

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Highly recommended by music lovers.

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- Loudness/Noise filter
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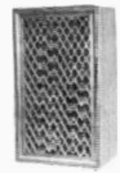
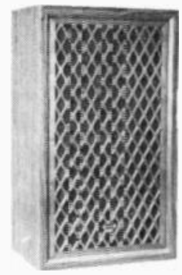


Frequency response 30 Hz — 20 kHz. Amazing sound quality from a box only 49 x 30 x 20 cms. Walnut styled cabinet would enhance the decor of any lounge-room. Speaker complement, 8" woofer, 5" mid-range, 3" tweeter with 3 way crossover network.

NS250 — 10"

3 WAY SPEAKER SYSTEM 50 WATT

$84.90 EA Pack/Post $3

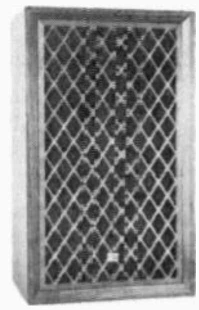


This 4 speaker system uses a 10" woofer for smooth bass sound, a 5" mid-range for clarity and two 3" tweeters for crystal-clear "highs." Walnut styled cabinet is 56 x 33 x 27 cms. Uses 3 way L-C Crossover network to achieve minimal distortion, frequency response is in the range 20 Hz — 25 kHz.

NS300 — 12"

4 WAY SPEAKER SYSTEM 60 WATT

$115 EA Pack/Post $4

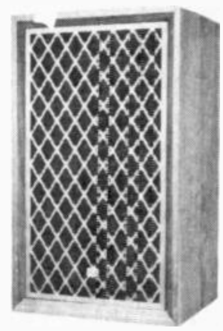


A very compact 12" speaker system able to handle 60 watts music power. This system features a "super-tweeter" (horn), a 3½" tweeter, a 6½" mid-range and the 12" bass driver, a total of 4 speakers with a 4 way L-C Crossover network. The sound result is almost as realistic as a "live" performance, as tests have shown a frequency response of 15 Hz to 30 kHz. The cabinet, of walnut colour, measures 64 x 38 x 29 cms.

NS800 — 12"

4 WAY SPEAKER SYSTEM 80 WATT

$149 EA Pack/Post $4



The first speaker in the range of continental styled speaker systems is this 12" 5 speaker system, including a 2" horn "super-tweeter", two 3" tweeters, a 6½" mid-range and a 12" bass driver. A 4 way crossover network complements these speakers, and the overall performance covers 15 Hz to 30 kHz at up to 80 watts rating. Like the smaller systems, the walnut colour and the styling is both modern and decorative and this quality of looks and performance could never come cheaply.

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A low-priced turntable which includes base and cover, mains lead, output leads and ceramic cartridge in one, neat package. Recommended price is $71.95., you save $6.95.

GARRARD 6-200

Ready to play STEREO CHANGER **$69**

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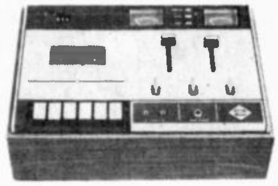

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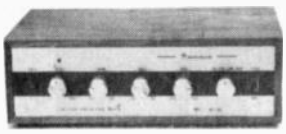

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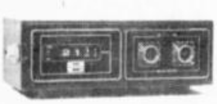

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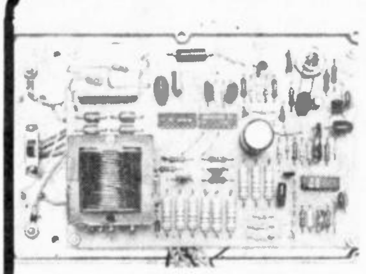

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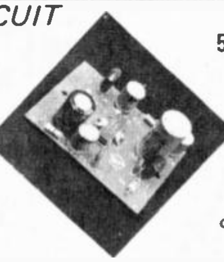

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5.5W in 4Ω at 14.4V
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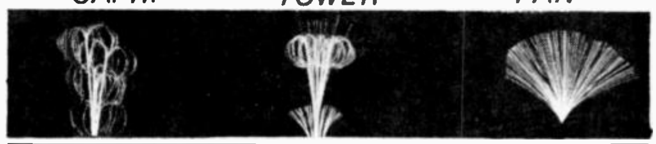

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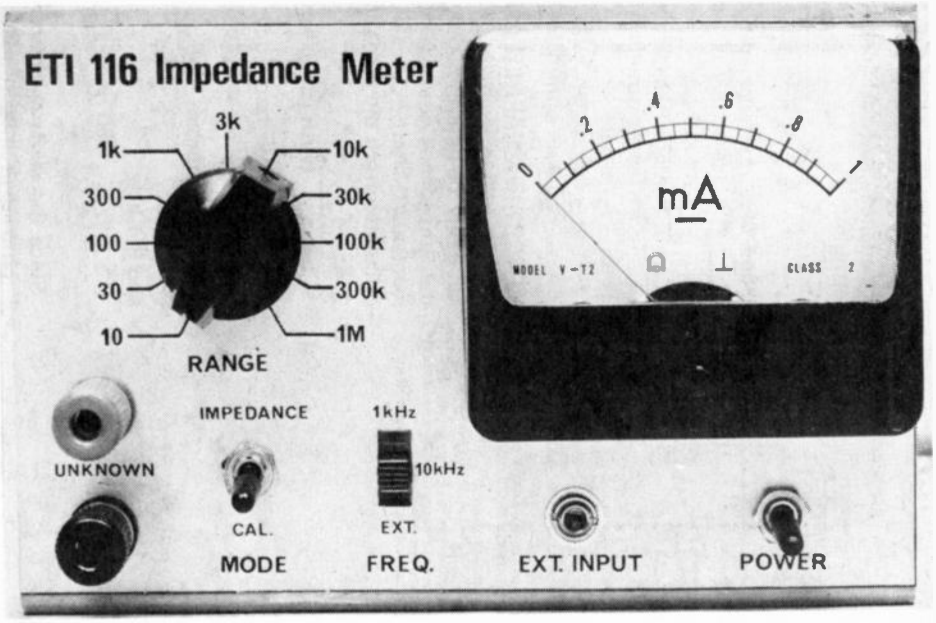
IMPEDANCE METER

Measure impedance directly with ETI's new impedance meter — checks capacitance and inductance too!



THIS IS an unusual project — in that we started out designing one thing and finished up developing another!

We had intended to design an RLC bridge which is a very useful instrument and perhaps the next most commonly used after the multimeter, signal generator and scope.

But whilst it is useful to be able to measure the value of an individual component, on many occasions we are more concerned with the magnitude of the impedance than we are with the actual value of C or L.

For example assume that we require to know how the impedance of a speaker varies with frequency. Due to the effects of the crossover network it will not be known whether the speaker is inductive or capacitive in the crossover region. Additionally a speaker goes capacitive below its natural resonant frequency. Hence the use of an RLC bridge to plot impedance would be very tedious indeed. We would have to determine whether the speaker was capacitive or inductive, measure the actual value and then calculate the impedance for each point to be plotted.

With the ETI impedance meter impedance can be read *directly* as a function of frequency as shown in Fig. 7.

This is just one example of the many possible applications. In addition the meter may be used to measure component values by simply referring to a reactance chart or doing a simple calculation as detailed below.

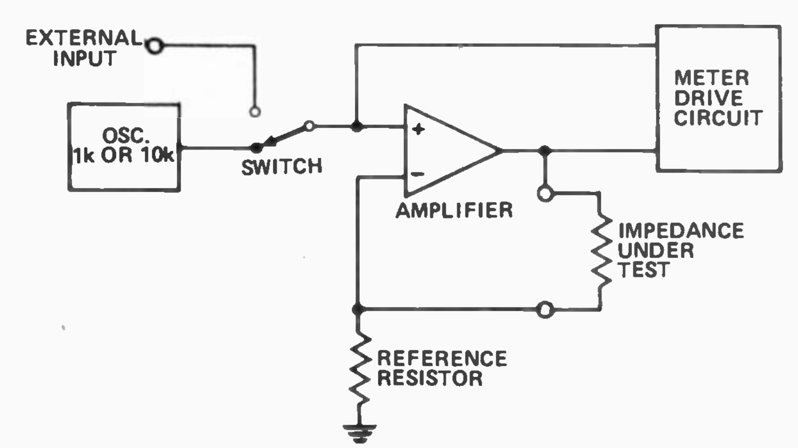
Other applications include measuring the impedances of microphones, filters, transformers and amplifier inputs etc. All can be measured as easily as one would measure a resistor using an ohmmeter. Simply by connecting the device to the input terminals of the meter and making the measurement as detailed in the "How To Use" section.

In most practical applications we require to know the magnitude of the impedance — we do not care whether the device is predominantly inductive or capacitive.

On the rare occasions that we do require to know reactance we can

Fig. 1. Block diagram of the impedance meter shows that it consists of an oscillator an amplifier and a meter circuit. ▼

PROJECT 116



SPECIFICATION

Impedance measuring range	1Ω – 1 Meg Ω	
Frequency of test	20 Hz – 20 kHz 1 kHz or 10 kHz	external internal
Range of inductance	10μH – 1000 H 20μH – 100 H	external internal
Range of capacitance	100 pF – 1000μF 100 pF – 100μF	external internal
Accuracy ± 5%		

Voltage applied to unknown, max 1 V rms

When measuring items which are connected to the mains earth either the item, or the meter, must have the earth removed.

IMPEDANCE METER

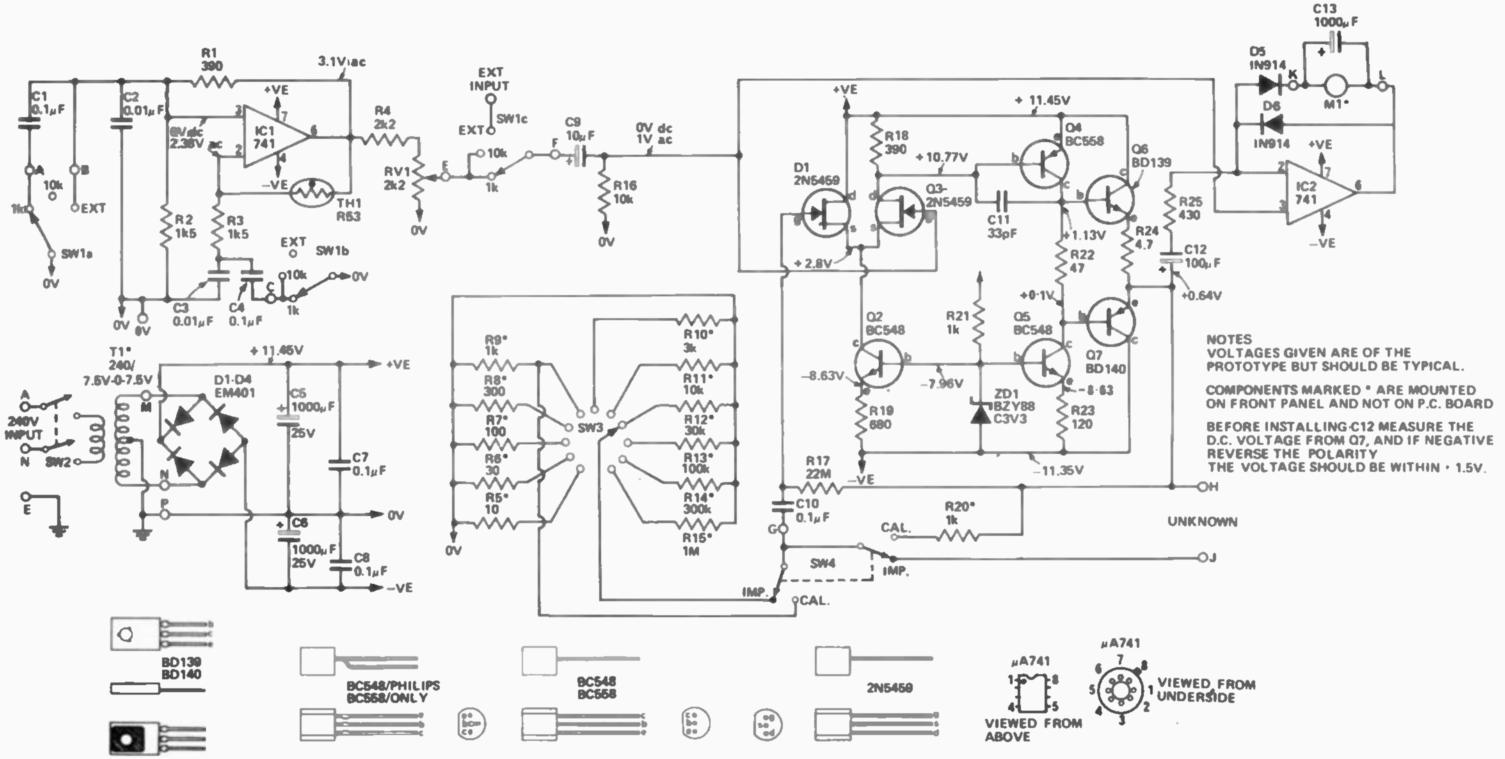


Fig. 2. Circuit diagram of the complete impedance meter.

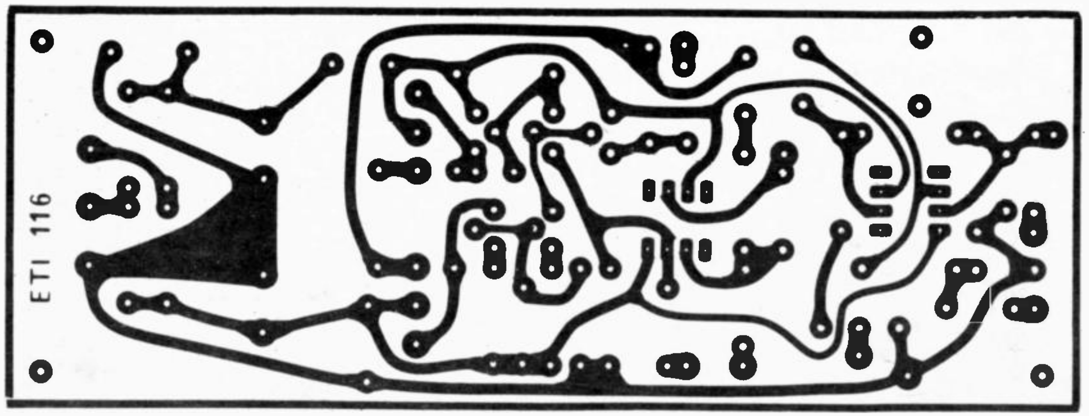


Fig. 3. Printed circuit board layout. Full size. 140 x 62 mm.

measure the dc resistance as well as the impedance and calculate from the formula

$$X = \sqrt{Z^2 - R^2}$$

where X = reactance inductive or capacitive at the frequency used

Z = magnitude of impedance (as measured on impedance meter)

R = dc resistance (as measured by an ohmmeter).

MEASURING CAPACITANCE

The value of an unknown capacitor can easily be determined by measuring the impedance and then using the reactance chart. Or, it may be calculated from the formula

$$C = \frac{1}{2\pi F X_c} \text{ (with capacitors } X_c = Z_c\text{)}$$

If the 10 kHz frequency is used this may be simplified to

$$C \text{ in microfarads} = \frac{16}{Z_c} \text{ (} Z_c \text{ in ohms)}$$

and if 1 kHz

$$C\mu F = \frac{160}{Z_c} \text{ (} Z_c \text{ in ohms)}$$

Since the meter can resolve the range 1 ohm to 1 megohm this implies a capacitance range of 16 pF o 160μF. But as explained elsewhere stray capacitance limits the lowest capacitance that can be resolved to about 100pF.

MEASURING INDUCTANCE

To determine the value of an unknown inductance the impedance is again measured and the value read off the reactance chart. Alternately the value may be calculated from

$$L = \frac{X_L}{2\pi F} \text{ high Q coils} \quad X_L = Z_L$$

or

$$L = \frac{\sqrt{Z_L{}^2 - R^2}}{2\pi F} \text{ (low Q coils)}$$

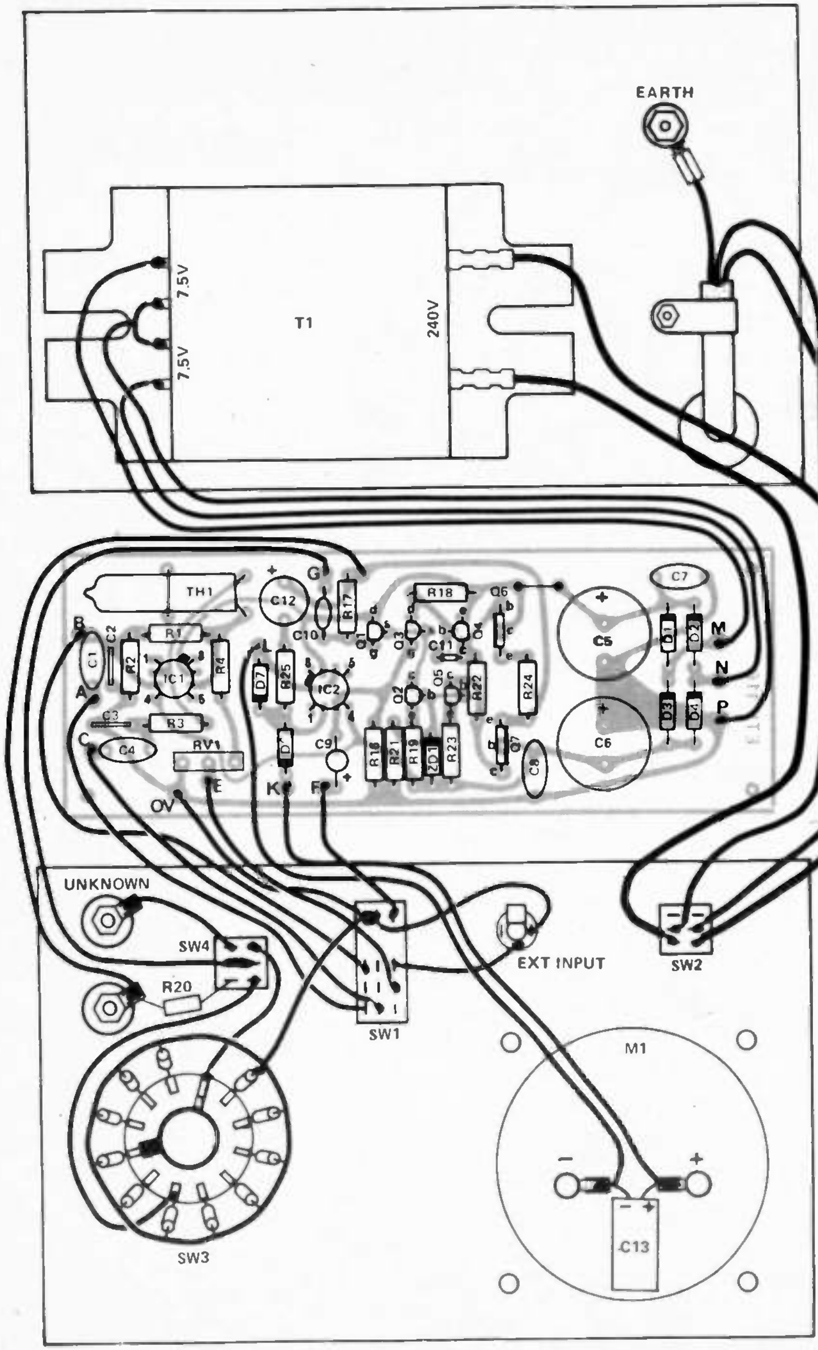


Fig. 4. Component overlay and wiring diagram for the impedance meter.

HOW IT WORKS ETI-116

The basic format of the impedance meter may be seen from the block diagram Fig.1. Firstly, we have an oscillator which may be switched to provide either 1 kHz or 10 kHz. Then we have a differential amplifier with a high input impedance, and lastly a meter drive circuit.

Either output of the oscillator, or an external frequency, as required, is passed to the non-inverting input of the amplifier. The amplifier gain is set by the ratio of the unknown impedance, Z, to the reference resistance, R. Due to feedback, the voltage across R is always equal to the input voltage and, as the amplifier requires no input current, the current through R must also flow through the unknown impedance, Z. The voltage across Z is therefore proportional to its impedance.

The meter circuit measures the output voltage by using the input voltage as a reference. Since the input voltage is equal to the voltage across R, we are effectively measuring the voltage across Z.

Refer now to the main circuit diagram Fig.2. The oscillator is of the Wein bridge type and uses a 741 IC as the amplifier and an R53 thermistor as the stabilizing element. The circuit oscillates at the frequency where the impedance of C2 and C3 is equal to the resistance of R2 and R3 respectively. Therefore, to change frequency, we simply change the values of C2 and C3. The output of the oscillator is attenuated by R4 and RV1 to approximately one volt.

The amplifier has a very high input impedance, can supply about 200 mA into a load, has an open-loop gain of 50 dB and can work into any load including a short circuit (unity gain).

An integrated circuit operational amplifier having the above characteristics (at reasonable cost) is not available, hence, a discrete seven transistor design was used. To obtain the high impedance input a pair of FETs, Q1 and Q3, used as a differential pair, operate with a constant current (4 mA) supplied by Q2. Transistor Q4 is supplied with a constant current of 22 mA by Q5, and Q4, in conjunction with the input pair, supplies the necessary overall gain. Transistors Q6 and Q7 buffer the output of Q4 and Q5 to provide the necessary current drive. The dc bias for the amplifier is provided by R17 such that an output voltage within ±1.5 volts of zero is always obtained.

The meter drive circuitry consists of a 741 IC with a meter, and half wave rectifier in series, connected in the feedback path. A second diode is used to prevent the IC being saturated on the opposite-polarity swing.

The current in the meter is half the current through R25 and, since this is proportional to the difference between input and output voltages of the amplifier, is proportional to the voltage across the unknown impedance. The meter scale is linear and the IC effectively compensates for the diode drop. Capacitor C3 provides the smoothing necessary when working at frequencies less than 40 Hz.

As previously stated the gain of the amplifier is set by the ratio of the unknown impedance 'Z' and the reference resistor 'R', and is equal to

$$\frac{Z + R}{R}$$ (where Z may be complex)

The value of R is switch selectable from 10 ohms to 1 megohm in eleven ranges. In the calibrate mode a 1 k resistor, R20, is substituted for the unknown impedance and the 1 k range selected. This provides a gain of two and thus with one volt in we have two volts out and hence 1 volt into the meter circuitry.

Thus, on calibrate, the output of the oscillator (or the external oscillator level) should be adjusted by RV1 to obtain full scale deflection on the meter. The calibrate position should also be selected before changing the unknown impedance, as an open circuit may damage the meter by driving it well beyond full scale.

IMPEDANCE METER

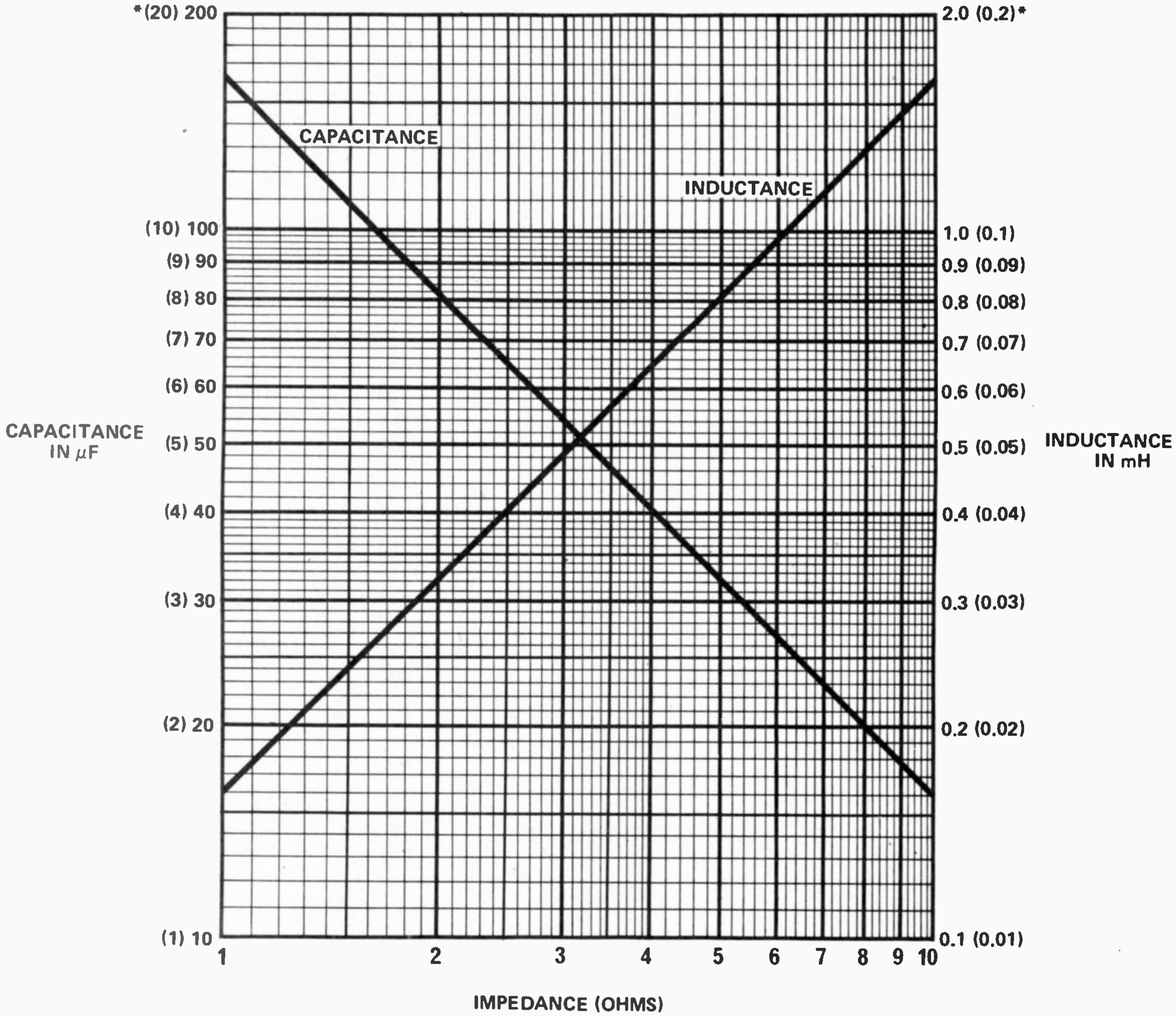
It should be borne in mind that we are determining impedances by using audio frequencies in this instrument hence components such as RF coils may well have a different impedance at RF frequencies (due to skin effect etc) than they do at audio. Additionally iron-cored coils have an inductance dependant upon the measuring frequency and upon dc current flowing. Hence such coils should be measured under conditions as close as possible to those when in circuit. Further the inductance value, as measured, will only be accurate on coils having a Q greater than 10.

If the dc resistance is greater than one tenth of the measured impedance the second formula should be used.

TURNS RATIO

To measure the turns ratio of an unknown transformer simply load the secondary with a value of resistance, R, which causes the impedance Zp (looking into the primary) to drop by 50% from the unloaded value. The turns ratio may then be calculated from

$$\frac{N_1}{N_2} = \sqrt{\frac{Z_p}{R}} \quad \text{(N = number of turns)}$$



FOR IMPEDANCES GREATER THAN 10Ω DIVIDE CAPACITANCE SCALE BY THE SCALING FACTOR AND MULTIPLY THE INDUCTANCE SCALES BY THIS FACTOR. e.g. A CAPACITOR WHOSE IMPEDANCE IS 6000 OHMS (SCALING FACTOR x 1000) AT 1 kHz VALUE IS 27/1000 = 0.027µF

*FIGURES IN BRACKETS ARE FOR 10 kHz

Fig. 5. Reactance chart for determining values of L or C from measured impedance at 1 kHz (10 kHz in brackets).

This calculation is based on the fact that an impedance in the secondary is transformed to an impedance in the primary that is proportional to the square of the turns ratio.

Many other applications can be devised for an impedance meter and the few mentioned here are indicative of the usefulness of such an instrument.

CONSTRUCTION

Any accepted construction method may be used but the use of a printed circuit board will greatly simplify the procedure.

Components should be assembled onto the printed circuit board, with the aid of the component overlay Fig 4, making sure that all polarized components are orientated correctly. Capacitor C12 should not be fitted initially as the required polarity must be determined as follows.

Temporarily connect the transformer to the otherwize completed board and switch on the power. Measure the voltage from the amplifier at point H. This should be within ± 1.5 volts of zero. If this voltage is negative reverse the polarity of C12 to that shown on the overlay. If the voltage is positive use the polarity shown. This variation of voltage at point H is due to differences in the FET transistors Q1 and Q3.

Attach wires to all output cohnections of the printed circuit board allowing sufficient length to terminate them in their respective positions. Instal the board in position using 12 mm long spacers and countersunk screws. Countersunk screws are necessary as they will be covered by the lid of the box. Instal the power transformer and power lead, on the rear panel, together with the power-cord clamp and earth lug. Mount the slide switch to the front panel using countersunk screws.

Resistors R5 to R14 should be mounted on the rotary switch SW3 before mounting it on the front panel. If the 30, 300, 3k etc resistors are not available they may be replaced by a parallel combination; eg 30 ohms is obtained from 33 ohm and 330 ohms in parallel and 3 k from 3.3 k and 33 k in parallel.

The rest of the front panel components, except the meter, (for ease of wiring) should now be mounted together with the escutcheon. The wiring can now be completed and the meter installed and connected.

USING THE METER

The meter should be used in the following manner:–

1. Switch the cal/impedance switch to cal.

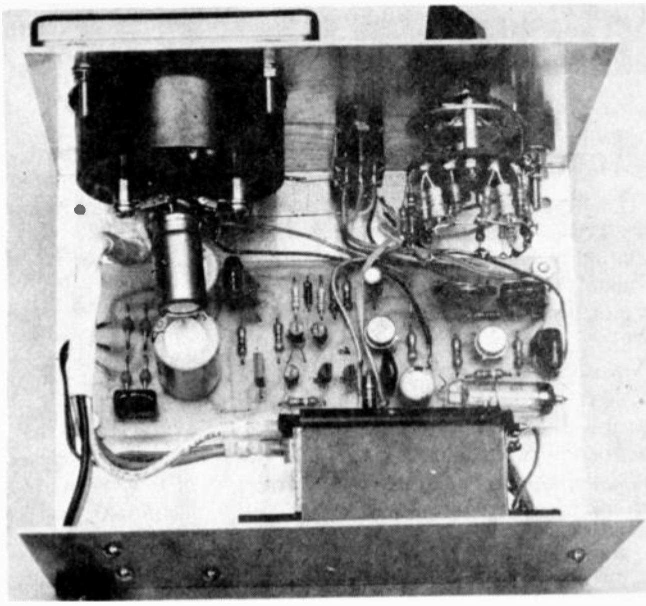


Fig. 4. Internal view of the meter shows how the board and other components are positioned.

2. Switch on power.

3. Select the required test frequency. The meter should read full scale, if not, adjust RV1.

4. If an external oscillator is used set the frequency and adjust oscillator output level to obtain full scale reading.

5. Connect the impedance to be measured.

6. Select the one megohm range.

7. Switch the cal/impedance switch to impedance.

8. Reduce the range, if necessary, to obtain a readable deflection. This reading is the required impedance; eg 0.6 on the 10 k range is an impedance of 6 k.

9. If desired the external frequency may be varied to obtain a plot of impedance versus frequency.

10. Switch back to 'Cal' before removing the impedance being measured.

TABLE 1

Error	Resistance (R2/R3)	Capacitor (C1,C4)	Capacitor (C2,C3)
1%	150k	0.001μF	100 pF
2%	68k	0.0022μF	220 pF
3%	47k	0.0033μF	330 pF
4%	39k	0.0039μF	390 pF
5%	27k	0.0056μF	560 pF
6%	22k	0.0068μF	680 pF
7%	18k	0.0082μF	820 pF
8%	18k	0.0082μF	820 pF
9%	15k	0.01μF	1000 pF
10%	13k	0.01μF	1000 pF

PARTS LIST – ETI 116

R24	Resistor	4.7 ohm ½W 5%
R5	"	10 " " "
R6	"	30 " " "
R22	"	47 " " "
R7	"	100 " " "
R23	"	120 " " "
R8	"	300 " " "
R1,18	"	390 " " "
R25	"	430 " " "
R19	"	680 " " "
R9,20,21	"	1k " "
R2,3	"	1k5 " "
R4	"	2k2 " "
R10	"	3k " "
R11,16	"	10k " "
R12	"	30k " "
R13	"	100k " "
R14	"	300k " "
R15	"	1M " "
R17	"	22M " 10%
RV1	Potentiometer	2k2 Trim type
TH1	Thermistor	type R53
C11	Capacitor	33pF ceramic
C2,3	"	0.01μF polyester
C1,4,7	"	0.1μF "
C8,10	"	0.1μF "
C9	"	10μF 16V electrolytic
C12	"	100μF 6.3V electrolytic
C13	"	1000μF 6.3V electrolytic
C5,6	"	1000μF 25V electrolytic
Q1,3	Transistor	2N5459 or similar
Q2,5	"	BC548 "
Q4	"	BC558 "
Q6	"	BD137, BD139
Q7	"	BD138, BD140
IC1, 2	Integrated Circuit	μA741C mini dip or T05
D1-D4	Diodes	EM401 or similar
D5, 6	"	IN914 "
ZD1	Zener Diode	BZY88 C3V3 or similar
T1	Transformer	240V/7.5-0-7.5V @ 1A PL 1.5-18/20VA, PL 15/20VA
M1	Meter	0-1ma FSD. 75 x 65 mm
SW1	Switch	three pole three position slide switch
SW2	"	DPDT 240V toggle switch
SW3	"	one pole eleven position rotary switch
SW4	"	DPDT toggle switch

PC board ETI-116, Metal box Dick Smith type LMB 564, Front panel, small phone socket, pointer knob, 3 core flex and plug, rubber grommet and cable clamp, four 12 mm long spacers, two terminals, nuts & bolts etc.

FREQUENCY CALIBRATION

The frequency should be within 10% of nominal if specified components are used. However, if a frequency meter is available the network can be trimmed to give the correct readings.

Measure both the 1 kHz and the 10 kHz and calculate the percentage errors. If either or both are low in frequency the resistors R2 and R3 can be paralleled with additional resistors to increase the frequency. Since this will affect both ranges choose the one with the greatest error. Table 1 gives the correct resistance to use.

Re-measure the frequencies. One frequency should now be right and the other high. The capacitors C1 and C4 or C2 and C3 can be paralleled by the appropriate capacitors as selected from Table 1.

LIMITATIONS

Due to stray capacitance, (about 15 pF) associated with the front panel terminals and the switches, the 1 megohm range is useful only up to about 4 kHz. The 300 k range is useful to about 10 kHz.

When measuring series LCR networks (where the impedance rises greatly off resonance) it is usually necessary to parallel a resistor across the network to stabilize it. Once at resonance, the resistor may be removed for the actual impedance measurement. The frequency can now be altered provided that the meter is not allowed to go off scale. The resistor used should be not more than 10 times the value of the network impedance at resonance. ●

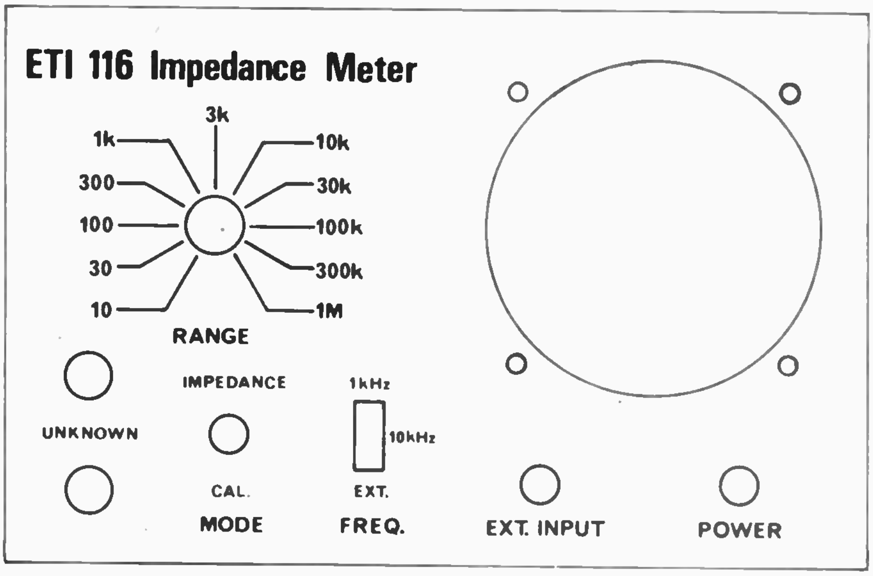


Fig. 6. Layout of front panel. Full size is 152 x 98 mm.

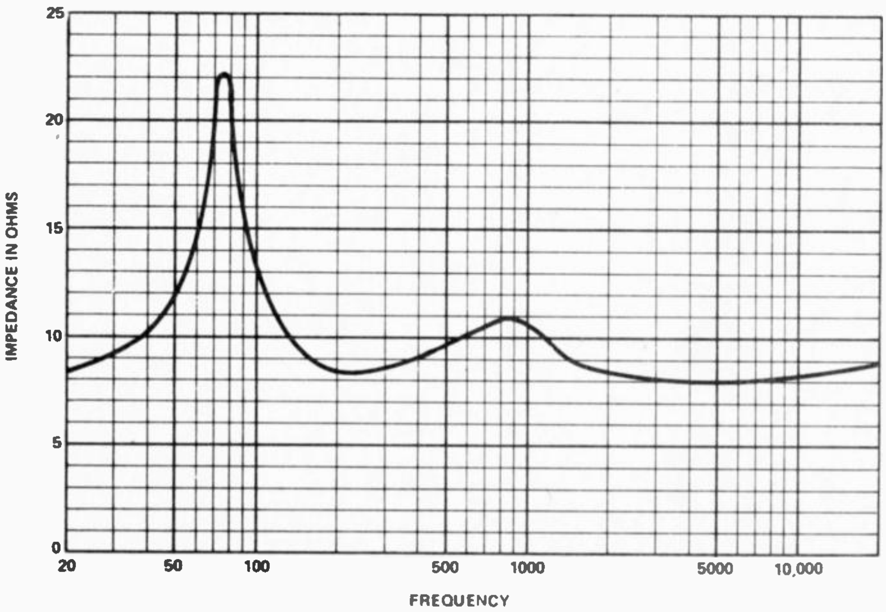


Fig. 7. Impedance-versus-frequency plot for a two-way speaker box. Note the combined speaker/box resonance is 75 Hz. The crossover frequency was 2 kHz. A plot such as this would be extremely difficult to generate using a conventional LCR bridge, but is very simply done using the ETI 116 impedance meter.

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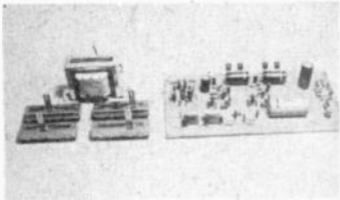

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Amazing offer for "hi-fi-ers" — Stereo amplifier kit, giving 15W RMS in 4 ohms, 10W rms in 8 ohms (per channel) with 5 mV magnetic cartridge input VOLUME, BALANCE, BASS and TREBLE controls supplied — latest integrated circuit pre-amp and driver stages, complementary "flat-pack" output transistors — all on one P.C. Board for easy assembly. Hi-Fi performance with 20Hz to 50kHz response, low distortion and low hum level ensure compatibility and the best turntables and speakers.

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2¼" 25 Ohm	$1.00	5" x 4" 15 Ohm	$2.75
3" 3.5 Ohm	$2.50	6" x 4" 15 OHm	$2.90
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☐ **$1.00 ea or 10 for $9.00.**

Popular replacement speaker for local and imported transistor radios. Model 225A, 300 Hz to 5 kHz.

5 inch T.V. TUBE

Brand new, sealed in manufacturer's carton

SPECIAL PRICE **$11.95.**

Ideal for servicemen, amateurs and experimenters. Specifications:— Electromagnetic deflection, 70 deg. angle, filament 12 Volt 70mA, Anode voltage 8KV at 50μA, 2nd grid voltage 300V, 1st grid cut-off voltage —25V, electrostatic focusing, size 5½" x 4" x 7" long.

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A limited quantity of yokes is available to suit above T.V. tube. **Price $7.50**

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A high sensitivity 4 transistor AM tuner with tuned RF amplifier and two IF stages for extra selectivity and sensitivity. The Module is ready assembled and operates from 9V OC at approximately 3MA. A permeability type tuner and push-button On-Off switch are supplied together with circuit and application diagrams. As the module may be used with a ferrite road type aerial OR an external wire type antenna, it is ideally suited to car, portable or home use. Size 5½" long x 1½" wide x 7/8" deep. Ferrite rod aerial $1.25ea. **$12.99** ☐

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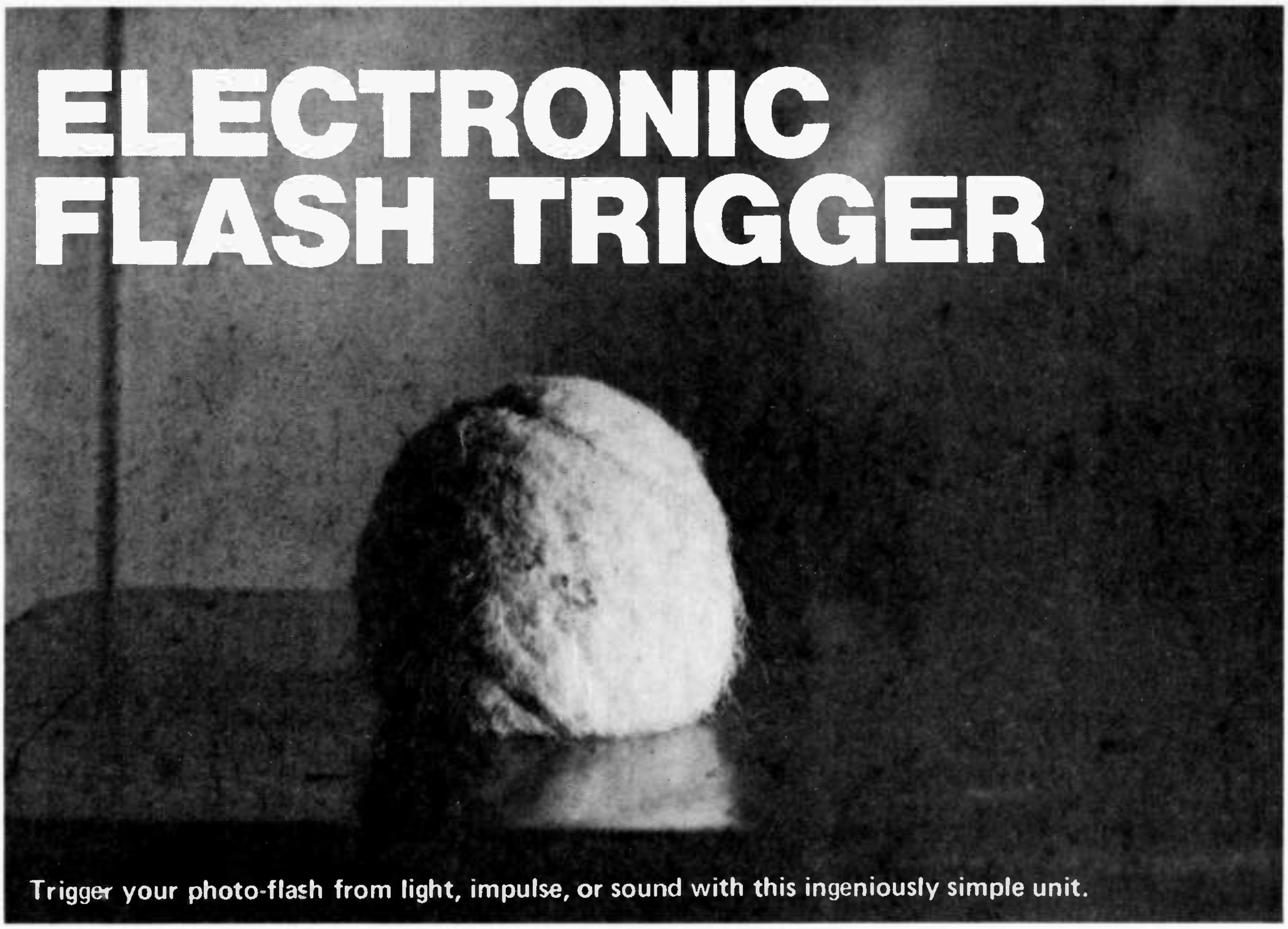
A complete, easy-to-assemble kit ready to install in your own cabinet. All top quality fully branded, full spec. parts incl. Printed Circuit Board, Mullard Display Tubes, transformer, I.C.'s, resistors, capacitors etc.

VHF TRANSISTOR T.V. TUNER

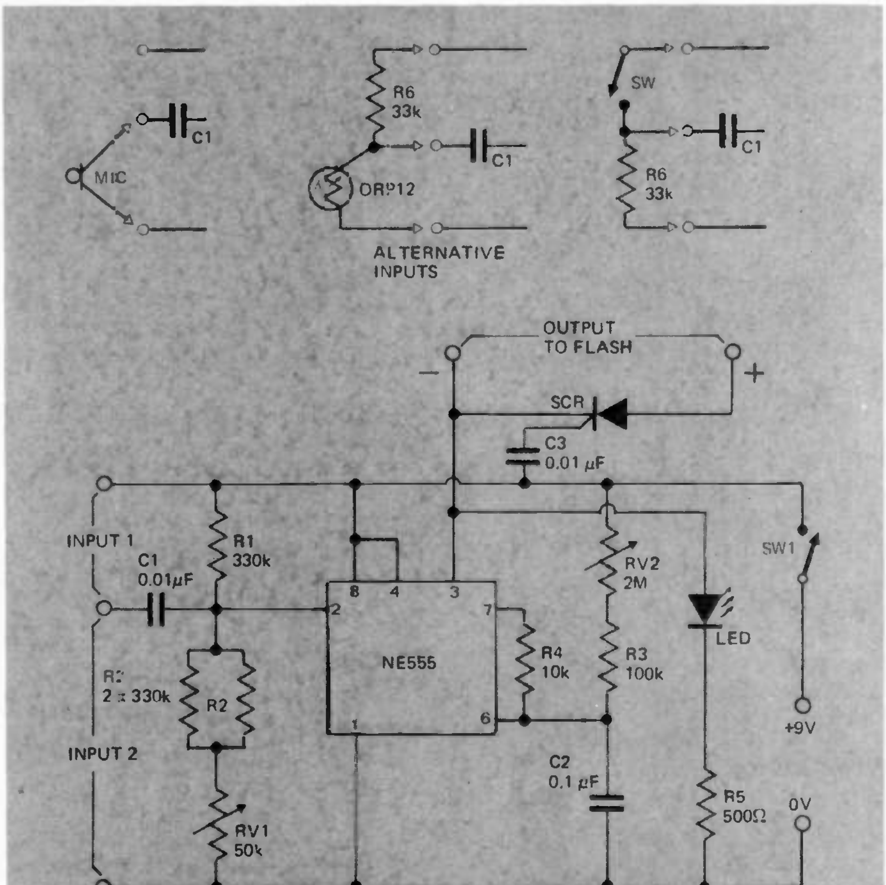
$7.50 12 Channels

A high sensitivity transistorized T.V. tuner suit Australian Stations. Operates from 12 V D.C. and output goes to IF section. Suit hobbyists, amateurs, T.V. servicemen etc. **$8.50 ea.** ☐

ELECTRONIC FLASH TRIGGER



Trigger your photo-flash from light, impulse, or sound with this ingenious simple unit.



CIRCUIT DIAGRAM

MANY sound-operated flash trigger circuits have been published, some of which can be adapted to accept other means of triggering.

This one, designed by Dick Smith/ETI Design Contest entrant, A.T. Torrens of Hornsby, NSW will trigger from virtually any energy source. All that is required is a sound, light flash or other effect that can provide a sudden voltage change.

The unit also incorporates a variable time delay between the trigger input and the flash triggering.

It has been based on the NE 555 timer IC — this has a very sensitive input, the ability to provide the required variable time delay and an output of sufficient energy to trigger an SCR.

CONSTRUCTION

The prototype unit was constructed on Veroboard, taking care not to apply too much heat to either the components or the board.

The most critical part of the circuit is around pin 2 of the IC. The triggering current needed is only 0.5 microamps and with pin 1 being the negative supply line and pin 3 the output, leakage currents across a dirty board can easily cause continuous triggering. To prevent this the strip to which pin 2 is attached should be as short as possible. It is also a good idea to clean off any excess flux with methylated spirits on completion of soldering.

Input is via two miniature phone plugs mounted on an insulating strip. The outside connection goes to the positive and negative lines respectively with the centre connection of both plugs going to the input.

The only problem likely to be experienced is continuous triggering. This is caused by a dirty board. The slightest trace of dampness around pin 2 on the board may cause this trouble.

USING THE UNIT

Sound trigger. The unit may be triggered by a crystal microphone insert or by a loudspeaker used as a microphone. The input can be to input 1 or 2. When the sensitivity is turned up to maximum, (RV1 at minimum) the unit may trigger continuously. To avoid this, simply turn the control back until the LED goes out, but flashes when the required sound is made. The photo of the tennis ball hitting a stool was made in this way with the time delay at minimum (about 4 milliseconds).

Light trigger. The resistance change of a cadmium sulphide cell may be used to trigger the unit when the light level falling on the cell varies. If the intensity of light increases, the resistance drops rapidly, while if the intensity falls, the resistance increases – but much more slowly. Triggering is thus best done by increasing the light level. Connect the CdS cell to input 2 via a 33 k resistor across input 1. A sudden increase in the light level will then fire the flash. If the time is set at a minimum this can be used as a slave flash unit as it only responds to sudden changes.

The photos of the fluid drop falling into the beaker of water were taken by having the drops interrupt a light beam falling onto a cadmium sulphide cell. The cell is in the tube in the top left of the large photo. The drops were indian ink to be certain they would block out the light beam. The time delay was about 250 milliseconds.

Switch triggering. With a switch connected to input 1 and a resistor to input 2 (33 k), the unit will fire when the switch is opened. If the position of the switch and resistor are interchanged the unit will fire as the switch is closed.

For simplicity in use the inputs have been devised using miniature phone sockets with a resistor connected to a plug – so by simply changing the plugs the input can be changed. ●

HOW IT WORKS

A negative pulse at the input is fed via capacitor C1 to the input pin (2) of the IC. Pin 2 is held slightly above its triggering voltage of 1/3 V_{CC} by the voltage divider comprising R1, R2, and RV1. The negative pulse triggers the IC and the output (pin 3) goes high for a time period controlled by RV2, R3 and C2. When the output goes low again at the end of the time interval capacitor C3 charges through the gate cathode circuit of the SCR switching it on and firing the flash.

Capacitor C1 isolates the input from the voltage divider so that the unit isn't sensitive to the dc level at the input. RV1 acts as a sensitivity control by allowing the voltage to be adjusted to a suitable level so that the input signal will trigger the IC. Resistor R4 limits the discharge current from C2 at the end of the timing cycle so protecting the IC. The LED and its protective resistor R5 act as an indicator to show that the unit has triggered, so simplifying the setting up process and minimising the number of times the flash has to be fired. This means that the flashgun needn't be fired until a photo is to be taken.

PARTS LIST

SEMICONDUCTORS
IC NE 555.
SCR C106 D1 or similar with a 400 volt rating
LED Miniature red.

RESISTORS (10%0
R1 330 k
R2 165 k (2x330 k in parallel)
R3 100 k
R4 10 k
R5 560 ohm
R6 33 k (optional depending on input)

CAPACITORS
C1 0.01 µF
C2 0.1 µF
C3 0.01µF

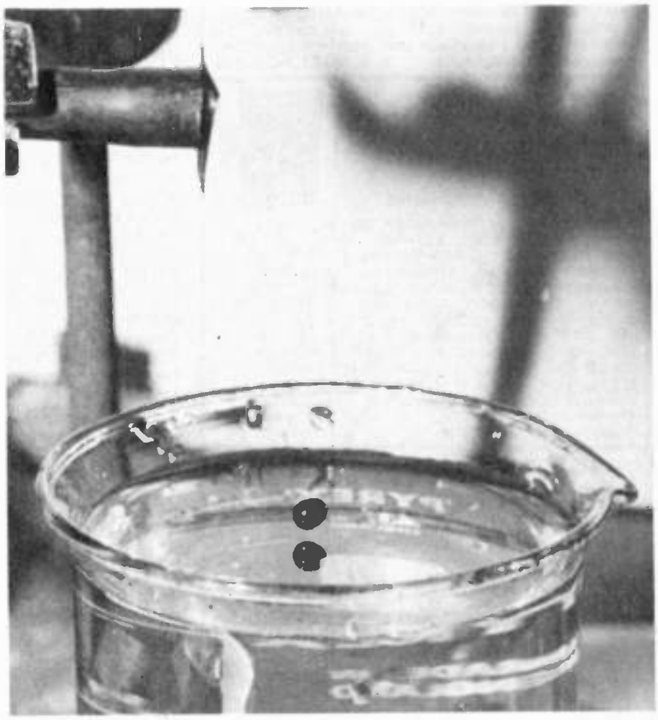
SWITCH
Any SPST switch suitable

POTENTIOMETER
RV2 2 Meg linear
RV1 50 k linear

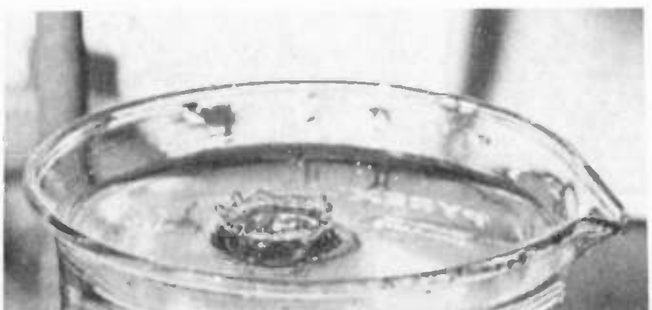
INPUT DEVICE
CdS cell (ORP 12)
Crystal mike insert etc.

OUTPUT DEVICE
Electronic flashgun, preferably computer type as these give a much shorter flash duration at close range.

OTHER PARTS
Metal case (58 x 58 x 100 mm)
Veroboard (40 x 80 mm)
Input sockets minute phone.
Output to suit flash unit being used
Knobs 2 for pots.
Battery Connector.



Drops of Indian ink are 'caught' here splashing into a beaker.



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1. AM 535 to 1600 kHz, 2. Marine 1-5 to 4 MHz, 3 & 4. combined SW 4 to 12 MHz, 5. 30 to 50 MHz, 6. 88 to 108 MHz, 7, 8 & 9 combined VHF Aircraft 145 MHz-174 MHz incorporating weather band.

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AM/FM/AIR-PB-WB SOLID STATE **$39.00**

VHF MONITOR

battery operated.

SPECIFICATIONS

Transistor: 12 Transistor, & 8 Diode; Frequency: FM 88-108 MHz, AM 540-1600 kHz, AIR-PB108-174 MHz; Power Output: Maximum 500 mW, Undistorted 280 mW; Speaker: 3" 8 ohms; Earphone: Magnetic 8 ohms; Power Source: DC 6V UM-2 x 4 pcs. or AC 230 Volt; Antenna: Ferrite bar for AM, Rod antenna for FM/AIR-PB-WB; Controls: Volume (w/on-off switch); Selector (AM/FM/AIR-PB-WB); Accessories: Earphone & batteries; Dimensions: 3 3/8" x 6¾" x 9¾"; Weight: Approx. 3 lb.

MODEL NC-310 DE LUXE 1 WATT 3 CHANNEL C.B. TRANSCEIVER

- WITH CALL SYSTEM
- EXTERNAL AERIAL CONNECTION

SPECIFICATIONS, NC-310

Transistors: 13
Channel Number: 3, 27.24 OMHz Citz. Band
Transmitter Frequency Tolerance: ±0.005%
RF Input Power: 1 Watt
Tone Call Frequency: 2000 Hz
Receiver type: Superheterodyne
Receiver Sensitivity: 0.7μV at 10 dB S/N
Selectivity: 45 dB at ±10 kHz
IF Frequency: 455 kHz
Audio Output: 500 mW to External Speaker Jack
Power Supply: 8 UM-3 (penlite battery)
Current Drain: Transmitter: 120-220mA
Receiver: 20-130mA.
Price $49.50 per unit or $99.00 pair

SCOOP PURCHASE!

Latest military design multi-band radio, 30 transistors and diodes. With exclusive (LED) light emitting diode tuning indicator for positive station selection.
Battery and electric covers all popular AM and FM bands. **$59**

SPECIAL INTRODUCTORY PRICE

SPECIFICATIONS

CIRCUIT: 16 transistors, 15 diodes, 1 varistor and 2 rectifiers. FREQUENCY RANGE: AM 535-1605 KHz, FM 88-108 MHz, TV1 56-108 MHz, TV2 174-217 MHz, AIR/PB2 110-174 MHz and WB 162.5 MHz. POWER SOURCE: DC 6 Volts. POWER OUTPUT: 350 mW (Maximum) 250 mW (Undistorted). DIMENSION: 9 3/8" x 3 3/4" x 8". WEIGHT: 4 1/4 Lbs. (approx). SUPPLIED ACCESSORIES: Earphone, Batteries (4 size D).

KENWOOD/TRIO TS 520 5 BAND SSB TRANSCEIVER

SP520 — TS520 — VF0520

Specifications

Frequency Range: 80 meter band — 3.50 to 4.00 MHz; 40 meter band — 7.00 to 7.30 MHz; 20 meter band — 14.00 to 14.35 MHz; 15 meter band — 21.00 to 21.45 MHz; 10 meter band — 28.00 to 28.50 MHz, 28.50 to 29.10 MHz, 29.10 to 29.70 MHz; WWV — 10.00 MHz.

Mode (Receive only) USB, LSB, CW.

Input Power: 160 watts on 80 to 15 meter band, 140 watts on 10 meter band.

Antenna Impedance: 50 to 75 ohms, unbalanced.

Carrier Suppression: 40 dB.

Unwanted Sideband Suppression: 40 dB.

Harmonic Radiation — 40 dB.

AF Response: 400 to 2,600 Hz (—6 dB).

Audio Input Sensitivity: High impedance (50kΩ) 0.5 μV for 10 dB (S+N)/N on 80 to 15 meter band. 1.0 μV for 10 dB (S+N)/N on 10 meter band.

Selectivity: SSB: 2.4 kHz (—6 dB), 4.4 kHz (—60 dB), CW: 0.5 kHz (—6 dB), 1.5 kHz (—60 dB), (with optional CW filter).

Frequency Stability: 100 Hz per 30 minutes after warm-up.

Image Ratio: 50 dB.

IF Rejection: 50 dB.

AF Output Power: 1 watt (with 8 ohms load and 10% H.D.)

AF Output Impedance: 4 to 16 ohms (Speaker or Headphone).

Tube and Semiconductor Complement: 3 tubes (2 x S2001, 12BY7A), 1 IC, 18 FET's, 44 transistors, 84 Diodes.

Power Requirements: 120/220VAC, 50/60 Hz; Transmit: 280 watts; Receive: 26 watts (with heater-off) or 13.8 VDC; Transmit: 15 Amp; Receive: 0.6 Amp.

Dimensions: 333 (13.11) wide x 150 (5.91) high x 335 (13.19) deep mm (inch).

Weight: 16 kg (35.2 lbs).

Nett. amateur prices

TS 520 $550.00, VFO 520 $95.00, SP 520 $25.00.

Also available

Trio QR666 general coverage communications receiver solid state 550 kHz — 30 MHz 6 bands.

Price $330

Trio TR72009 144 MHz band car transceiver 12volt. P.O.A. Please send S.A.E. for information on above items.

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Magnavox 8-30 speakers $14.95

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Popular Gakken and Scienceland Electronic Kits, ideal for beginners, Completely safe, no soldering, learn electronics with each project.

Crystal Set Kit	$5.50
10 Project Kit	$10.90
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100 Project Kit	$27.95
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P & P extra

1 watt 2 channel transceiver with call system. 27.240 MHz. 12 transistor. PMG approved type.

SPECIFICATIONS: Transmitter — Crystal Controlled: 1 Watt input power to RF stage. Receiver Crystal-controlled superheterodyne circuit with 455 Kc IF. Antenna — Built-in 60" telescopic whip antenna. Audio Output — 0.8 Watt maximum. Power supply required — 12 volts DC (Eight 1.5 volt DC battery cells). Loudspeaker — 2¼" PM type (built-in) function as microphone on transmit.

$39.95 each

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MODEL OL-64D/P MULTIMETER $21.95

20,000 ohms per volt. DC volts: 0.025, 1, 10, 50, 250, 500, 1000 (at 20K o.p.v.), 5000 (at 10K o.p.v.). AV volts: 0-10, 50, 250, 1000 (at 8K o.p.v.). DC current: 50uA, 1mA, 50 mA, 500 mA, 10 amps. Resistance: 0-4K, 400K, 4M, 40 megohms. DB scale — 20 to plus 36 dB. Capacitance: 250pF to 0.02uF. Inductance: 0-5000 H. Size: 5¾ x 4-1/6 x 1¾ in.

A-10/P $55 p.p. $1

Giant 6½" Meter, inbuilt signal injector. Overload Protected. AC/V: 2.5V, 10V, 50V, 250V, 500V, 1000V, (10,000Ω/V). DC/V: 0.5V, 2.5V, 10V, 50V, 250V, 500V, 1000V at (30,000Ω/V) 5000V (10,000Ω/V). DC/A: 50μA, 1mA, 50mA, 250mA, 1A, 10A. OHMS: 10kΩ, 100kΩ 1MΩ 100MΩ db: —20 to +62dB

Signal Injector: Blocking oscillator circuit with a 2SA102 transistor.

Approx. size: 6-2/5" x 7-1/5" x 3-3/5".

200-H. $13.50, p.p. 75c

90° quadrant meter. Pocket size.

AC/V: 10V, 50V, 100V, 500V, 1000V (10,000Ω/V). **DC/V:** 5V, 25V 50V 250V, 500V, 2500V (20,000Ω/V).

DC/A: 50μA, 2.5mA, 250mA

OHM: 60kΩ, 6MΩ

Capacitance: 100pF to .01-μF, .001μF to .1μF.

db: -20db to + 22dB.

Audio Output: 10V, 50V, 120V, 1000V Ac.

Approx. size: 4½" x 3¼" x 1-1/8"

LINE AMPLIFIER

PROJECT 430

Boost microphone output with this low noise amplifier.

The completed line amplifier. Note the use of Cannon plugs and the gain switch on the side.

MODERN high quality microphones are low impedance units having a very low output voltage. To minimize noise, picked up on long leads, it is usually necessary to use special balanced and screened leads together with balancing transformers. An alternative approach is to use a low noise amplifier to boost the signal *before* passing it down the cable. The ETI 430 line amplifier, described here, is intended for this purpose.

Such a unit, when used with the ETI Master Mixer (described in February, March, April and May 1973) provides either 20 or 40 dB of gain prior to the mixer. This allows the mixer to be used on the low-sensitivity range. Thus the larger signal now available, effectively over-rides the inherent noise of the first amplifier in the mixer.

The overall effect of using such an amplifier is to vastly improve the signal-to-noise ratio of the particular microphone channel and to eliminate the need for an expensive balanced and screened cable and balancing transformer.

To reduce the possibility of mains – hum pickup we have used a small nine volt battery to power the unit. Since the current drawn is a mere 0.5 mA, the batterv should last about three to

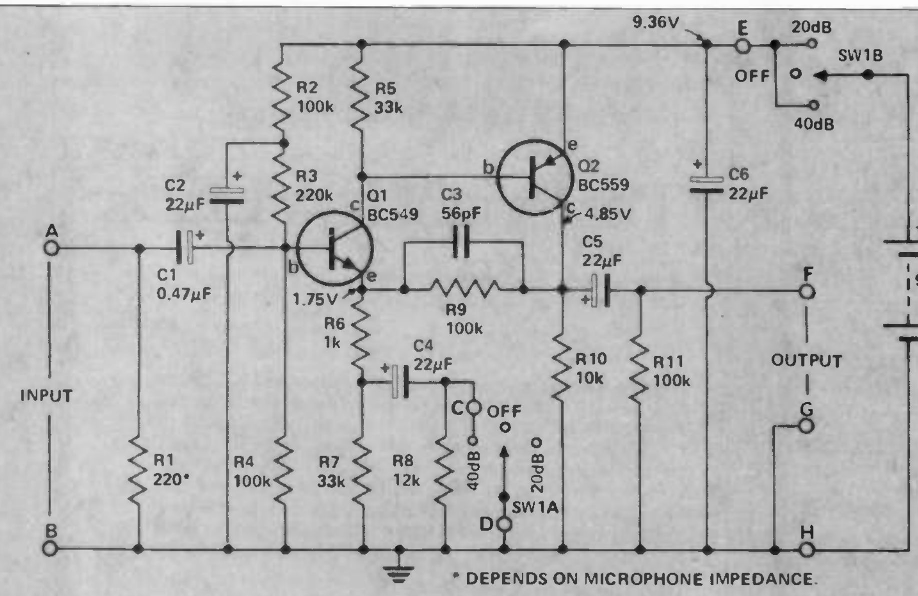
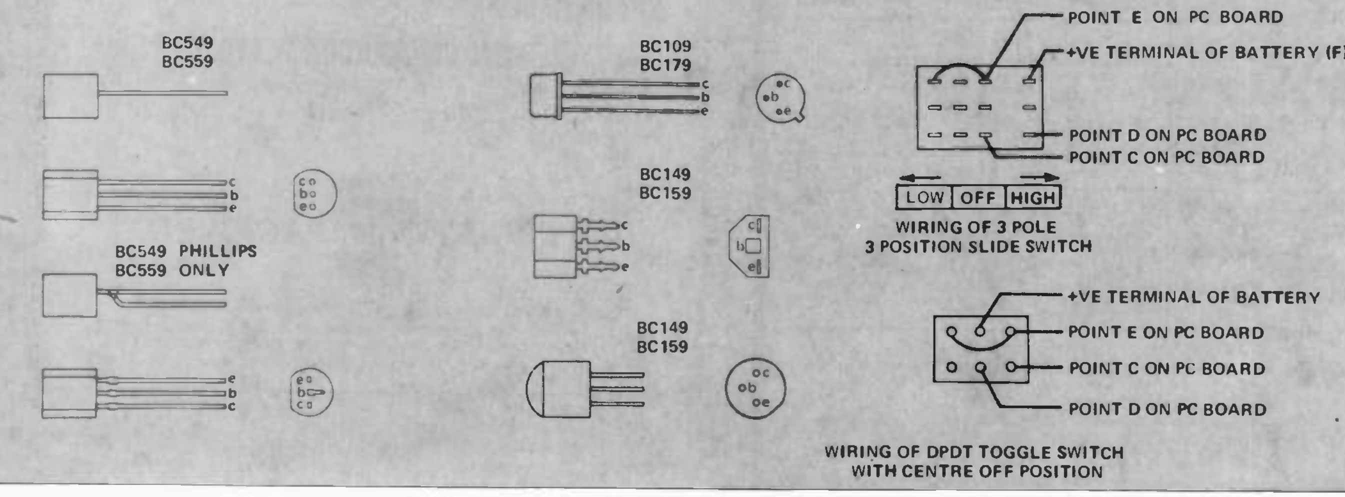
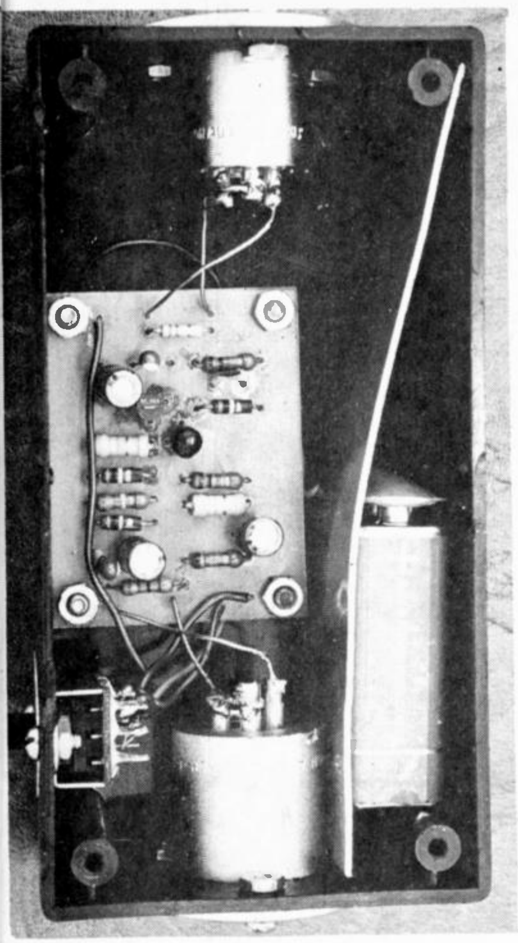


Fig. 1. Circuit diagram of the microphone line amplifier. Voltages shown are typical and as measured on our prototype.





Internal layout of the line amplifier.

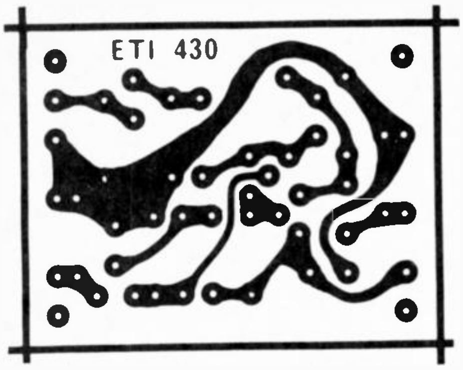


Fig.2. Printed circuit board layout for the amplifier. Full size 55 x 42 mm.

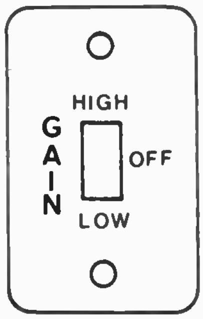


Fig.3. Artwork for the gain switch label. (Shown full size).

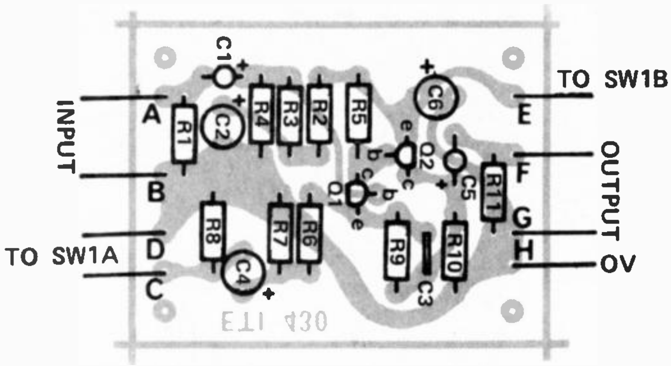


Fig.3. Component overlay. Note particularly the orientation of the transistors and electrolytic capacitors.

four hundred hours before replacement is required.

The ETI line amplifier can of course be used to great advantage with any recording equipment where low noise operation is necessary. When used with the Master Mixer the low impedance input should be used but the terminating resistor (fitted across the mixer input socket) should be removed so that a 4.7 k input impedance is obtained.

CONSTRUCTION

The circuit is not critical in any way hence, practically any construction method may be used. However, the use of the printed circuit board specified will considerably simplify construction.

We used an unbreakable plastic box (polycarbonate) to house our unit but if the unit is to be used in the proximity of power cables etc it would be advisable to mount the unit in a metal box (diecast or similar). This is especially so if an input impedance above 1 k is to be used as the higher the impedance the more likely is hum pickup.

If Cannon plugs are used, as in our prototype, pins 1 and 2 should be linked and used as the earth line. Pin 3 is then used as the active line.

(Continued next page)

MEASURED PERFORMANCE

IMPEDANCE			
Input			selectable up to 68k max
Output			≈ 1.5k
GAIN			
High			40 dB
Low			20 dB
OUTPUT VOLTAGE			
Maximum			3 volts
INPUT VOLTAGE			
Maximum (high range)			30 mV
Maximum (low range)			300 mV
FREQUENCY RESPONSE			
10 Hz – 30 kHz			+0 – 3 dB
EQUIVALENT INPUT NOISE			
(referred to 1 mW into 600Ω)			
High Range			–110 dBm
Low Range			– 102 dBm
DISTORTION			
Output Voltage	100 Hz	1 kHz	6.3 kHz
300 mV	<0.1%	<0.1%	<0.1%
1 V	0.17%	0.2%	0.17%
2 V	0.5%	0.5%	0.5%
3 V	1.75%	1.8%	1.7%

LINE AMPLIFIER

HOW IT WORKS – ETI 430

The line amplifier is basically a two transistor amplifier having a selectable gain of either 20 dB (x10) or 40 dB (x 100).

The input impedance of the amplifier (referring to Fig. 1) is determined by the combined values of R1, R3 and R4 – all in parallel. The parallel impedance of R3 and R4 is 68 k and this is therefore the upper limit of input impedance (R = ∞).

For impedances less than 5 k the values of R3 and R4 may be ignored and R1 is set to the same value as the desired input impedance. Hence the circuit as shown matches microphones having 200 ohm output impedance.

Resistor R2, in conjunction with R3 and R4 determines the dc bias for transistor Q3 whilst capacitor C2 decouples the input bias network from any supply rail noise. The output of Q2 is fed back to the emitter of Q1 thus providing negative feedback which as well as supplying a dc bias. sets the ac gain of the stage.

The gain of the amplifier may be calculated using the following formula (assuming ideal transistors).

$$\text{Gain} = \frac{R9 + R6 + (R7//R8)}{R6 + (R7//R8)}$$

Thus for R8 = 12 k the gain is 11.2 or 21 dB. For R8 = 0 the gain is 101 or 40 dB. The actual gain obtained is slightly lower than this due to the finite betas of the transistors used.

The value of capacitor C3 determines the upper 3 dB point of 30 kHz whilst capacitors C1, C4 and C5 all give individual break points at the low end of 5 Hz, 7 Hz and 1.5 Hz respectively.

PARTS LIST – ETI 430

R1	resistor	selected to suit input impedance
R2,4, 9,11	"	100 k ¼W 5%
R3	"	220 k " "
R5,R7	"	33 k " "
R6	"	1 k " "
R8	"	12 k " "
R10	"	10 k " "
C1	Capacitor	0.47µF 25V TAG
C2,4,5,6	"	22µF 16V electrolytic
C3	"	56pF ceramic
Q1	Transistor	Bc109, BC149, BC549,
Q2	"	BC179, BC159, BC559
SW1	Switch	2 pole 3 position slide or 2 pole centre off toggle

PC board ETI-430

Cannon sockets = XLP-3-13 female
= XLP-3-14 male.

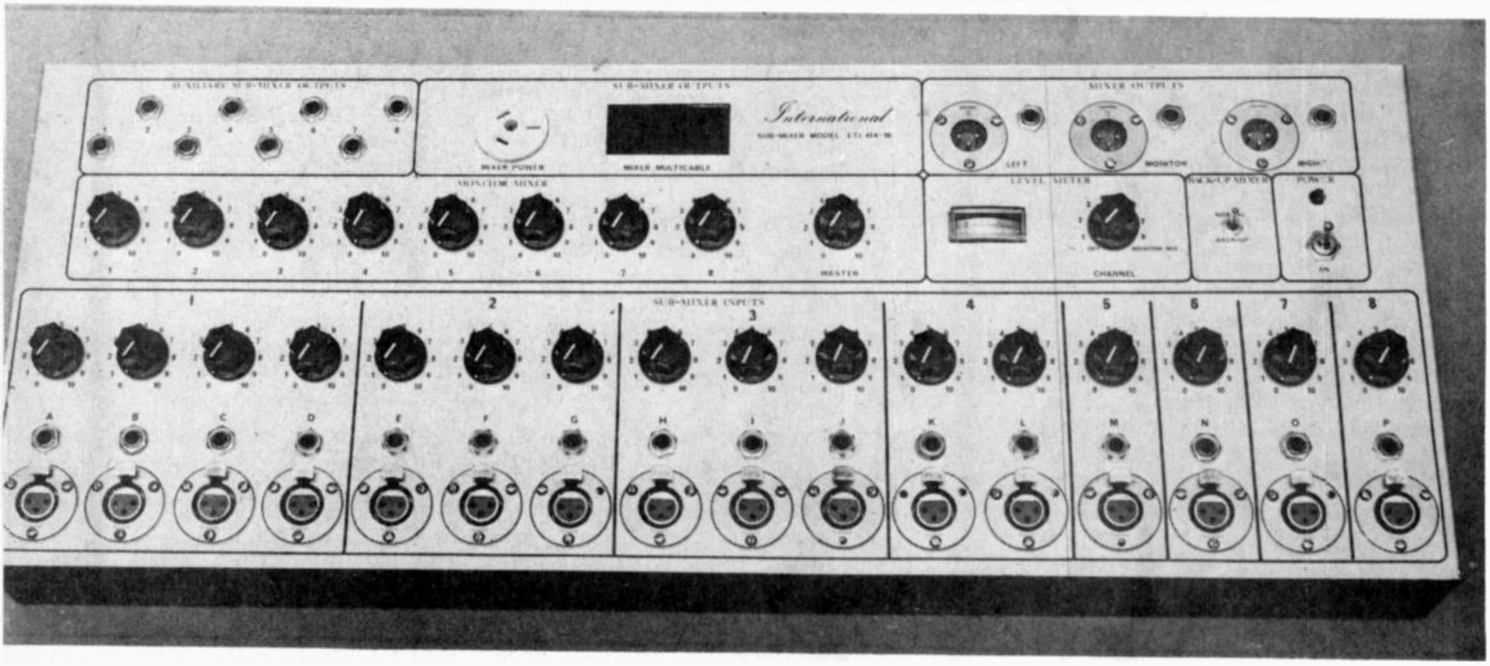
Cord plugs = XLP-3-11 female
= XLP-3-12 male.

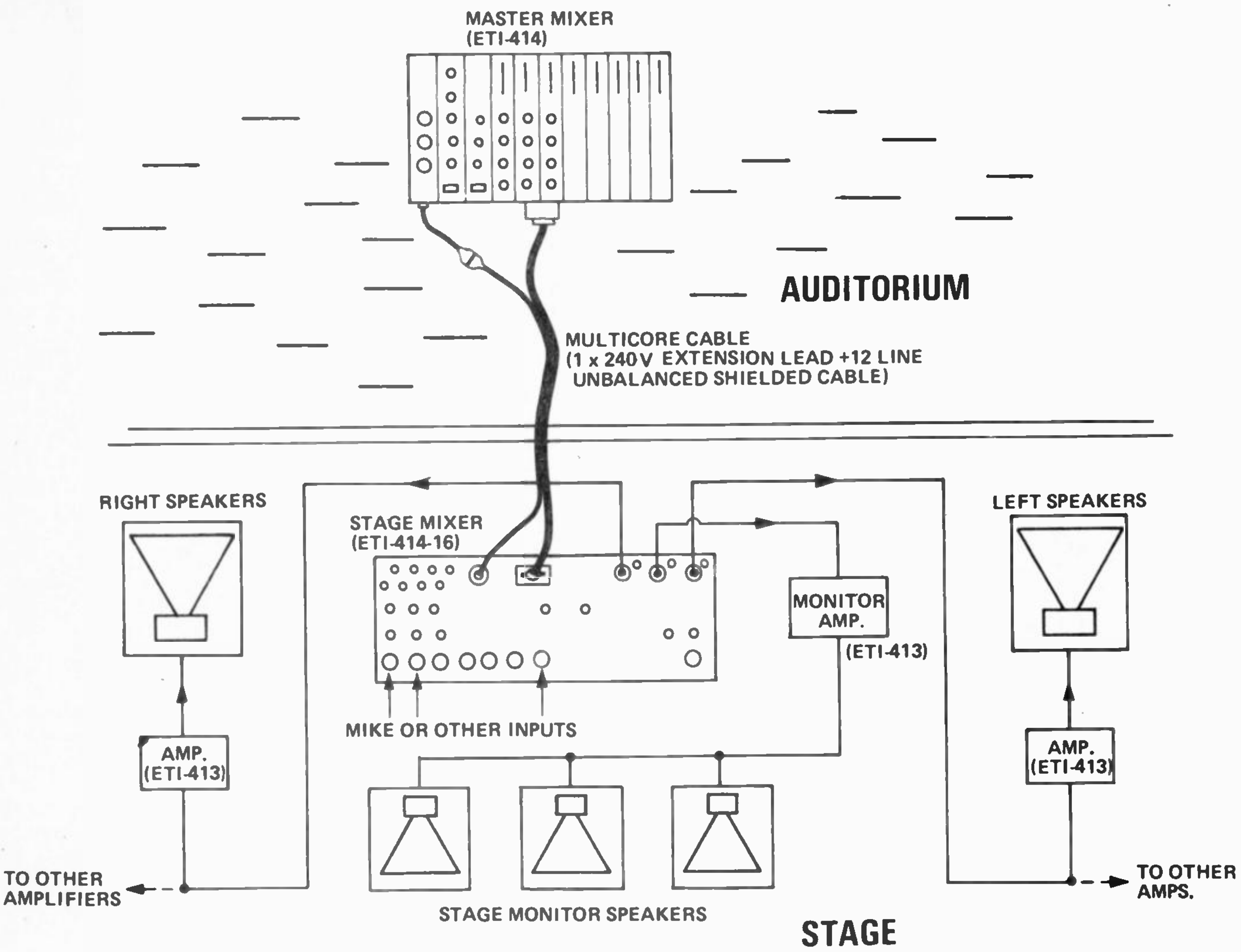
Box to suit (preferable metal), 9 V battery and clip input and output sockets etc.

eti PROJECT 414 STAGE MIXER

Sixteen amplifiers sub-mixed to eight channels – plus monitor

SEVERAL hundred of our master mixers (described February, March, April and May of 1973) have been built and are in use by groups and recording studios throughout Australia. Whilst this mixer has been enormously successful, there are several areas in which improvements can be made which will still further improve the flexibility and usefulness of this instrument especially for on-stage performances.





This is the way that the ETI Stage Mixer would be used for a live performance.

LONG-LINE WORKING

For most live performances the master mixer is best located in the listening area so that the mix can be continuously monitored, and controlled, for best effect. Whilst such operation is possible with the ETI master mixer, the inputs are not designed for long line work, especially with low-output, or unbalanced high impedance microphones. This deficiency may be overcome by using a line amplifier for each input.

THE NEED FOR SUB MIXERS

The next obvious deficiency in stage applications is that several microphones are often needed to mike

SPECIFICATION

NO OF INPUTS	16
NO OF OUTPUTS	8 normal + 1 monitor
NOMINAL INPUT maximum gain	10 mV
NOMINAL OUTPUT maximum	8 volts
nominal	3 volts
INPUT IMPEDANCE selectable	< 68 k
SIGNAL TO NOISE re 10 mV single channel input	74 dB
MAXIMUM INPUT on maximum gain	30 mV
on minimum gain	1 V
GAIN maximum	50 dB
variation possible	36 dB

Any number of inputs can be connected to any submixer. However no input may be connected to more than one sub-mixer. The VU metering is switchable to any one output channel.

TABLE 1
Selection value of R11 (or 21, 31 etc)

Input Impedance	R11
200Ω	220Ω
600Ω	680Ω
47 k	150 k

STAGE MIXER

the drums, or the several speakers of an organ etc. This requires the use of separate mixers, in front of the main mixer, to avoid wasting the 8-channel master mixer's capability. To overcome both these disadvantages we have incorporated 16 line amplifiers and eight sub-mixers into a common unit such that the 16 channels may be grouped in any desired combination to the eight master mixer channels. The grouping shown for our prototype stage mixer (in the block diagram Fig. 1) is 4,3,3,2 plus 4 individual channels. This may of course be varied to suit individual requirements.

THE STAGE MIXER

Thus the unit described here is a 16 channel to eight channel sub-mixer which is specifically designed for use on stage. It accepts high or low impedance microphone inputs, which may be balanced or unbalanced. The unit provides eight high-level outputs for transmission to the master mixer.

The inputs may be made by either Cannon connectors or by standard tip-and-sleeve jacks. We strongly recommend that Cannon connectors be used for on-stage work because of their ruggedness. The input impedance of each channel may be tailored to suit the individual microphone (or other source) by selecting one resistor.

The gain of each line amplifier is adjustable from unity to 63 (36 dB) and the sub-mixer adds a further (14 dB), that is, a total of 50 dB gain is available.

The output level of each channel (even from a low output microphone) will be of the order of 1 volt and may be as high as 22 volts peak-to-peak without overload distortion occuring. Thus an extremely wide dynamic range may be accommodated by this mixer and the same dynamic range will also be accommodated by the master mixer. The master mixer, when used with the stage mixer may be used switched to the low sensitivity input position and such operation greatly improves the signal-to-noise ratio.

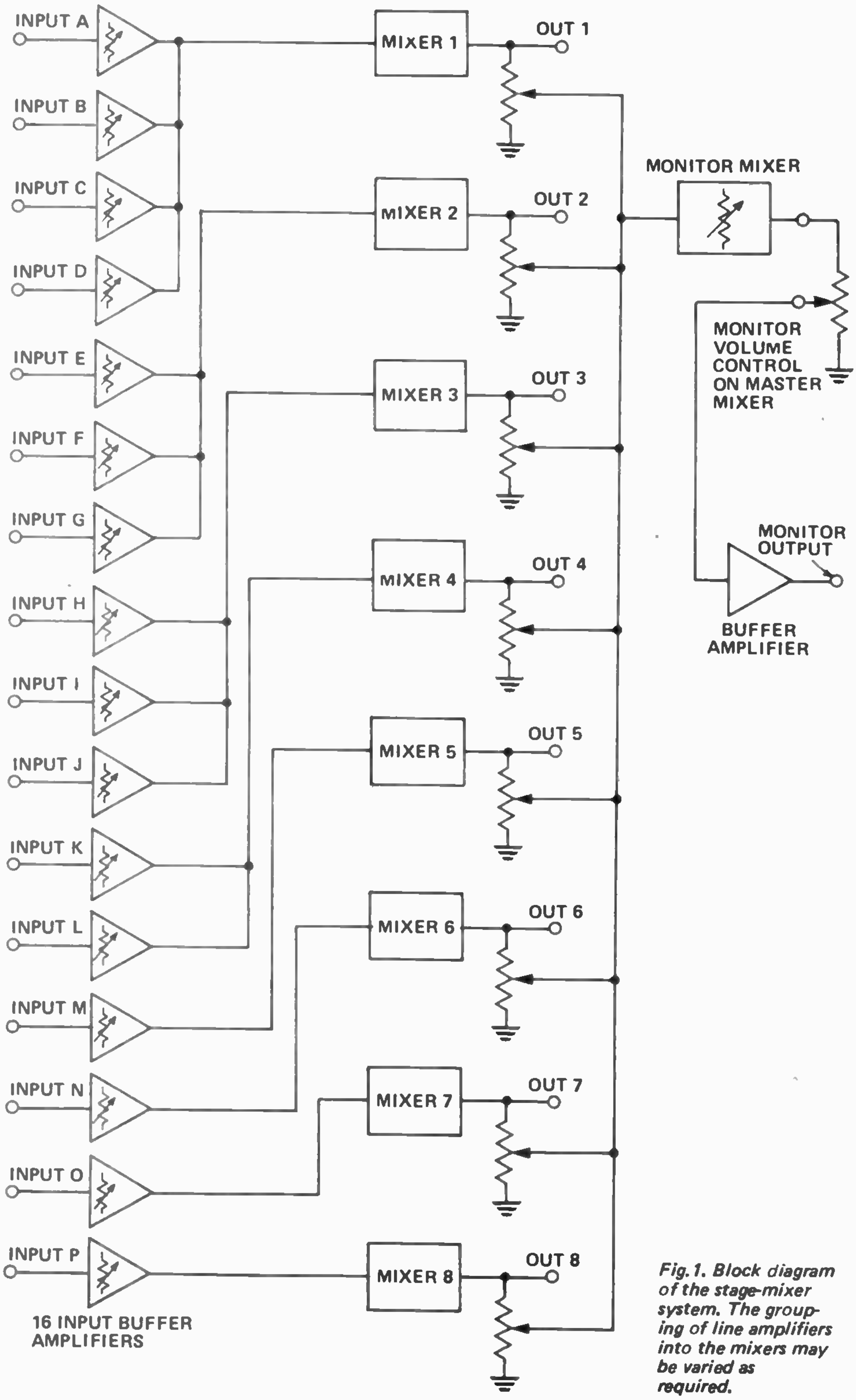


Fig. 1. Block diagram of the stage-mixer system. The grouping of line amplifiers into the mixers may be varied as required.

MONITOR FACILITIES

The original master mixer does not incorporate any monitor facilities. It is possible to use the echo-mix channel for monitoring but the level controls for each channel will also affect the monitor output. This is undesirable as if a louder level is required in the auditorium the monitor will also become louder – introducing a danger of acoustic feedback occuring.

Within the stage mixer we have incorporated a special monitor mixer which has its own level control followed by a buffer amplifier. A second 'Master' monitor volume control is physically located on the main mixer so that it can be adjusted should acoustic feedback occur.

BACK UP MONITOR

Facilities are provided such that should the master mixer fail, or the cables between the two mixers be damaged etc, the stage mixer may be switched to provide an output direct to the PA system.

In this mode a 'Back up' switch takes the output from the monitor mixer and transmits it direct to both channels of the PA system. The monitor signal is still transmitted to the monitor amplifier when the mixer is in this mode. In normal use the 'back up' switch must be at 'normal'.

When the stage mixer is in 'back up' mode the master monitor level control, located on the master mixer, is by-passed (full volume) regardless of whether the master mixer is connected or not.

FINAL OUTPUTS

The master mixer outputs (i.e. left and right stereo plus monitor mix) are returned to the stage as part of the multicore cable and terminated on the 'stage mixer' with both 'Cannon' and standard 'Jack' type connectors.

METERING

A VU meter is provided on the stage mixer which can be used to monitor the output of any of the eight (sub) mixers or the stage monitor output. This meter will be useful for initial level settings on each sub-mixer.

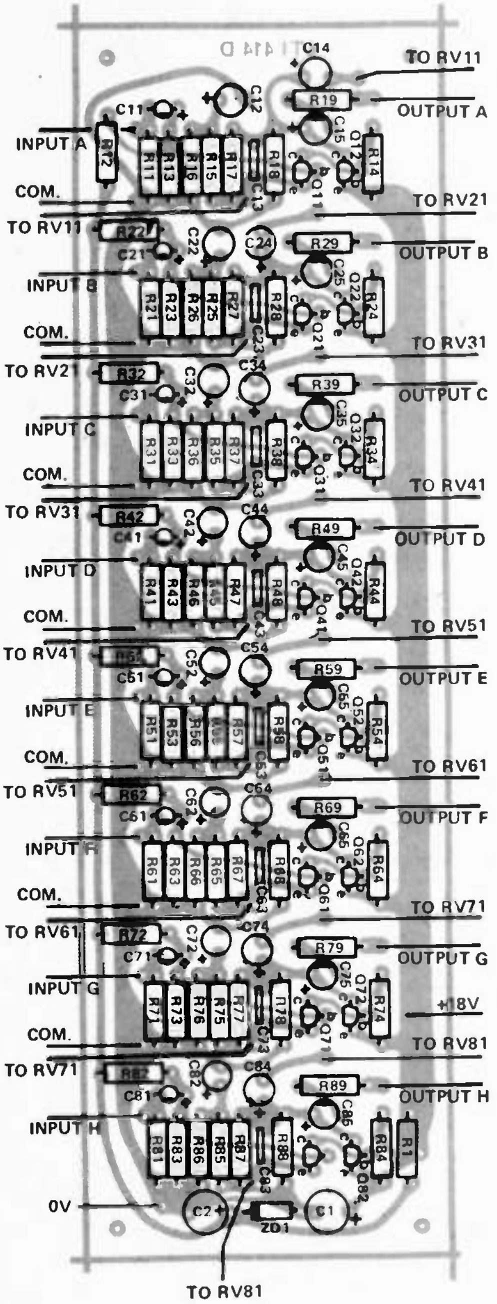


Fig.2. Component overlay for the preamplifier board.

POWER OUTLET

A switched, 240 volt power outlet is provided on the stage mixer. This is intended to provide power for the master mixer via an extension cable. Thus the power cable and the multicore cable are the only ones required between the two mixers.

HOW IT WORKS – ETI 414

LINE AMPLIFIER

The line amplifier used is similar to the ETI 430 line amplifier except that the gain is variable from unity to 40 dB (actually 36 dB in a practical circuit).

The input impedance of the amplifier (referring to Fig. 2) is determined by the combined value of R11, R12 and R13 – all in parallel. The parallel impedance of R12 and R13 is 68 k and this is therefore the upper limit of input impedance ($R = \infty$).

For impedances less than 5 k the values of R12 and R13 may be ignored and R11 is set to the same value as the desired input impedance. Hence the circuit as shown matches microphones having 200 ohm output impedance.

The output of Q12 is fed back to the emitter of Q11. This path via R17 in parallel with RV11 and C14 provides negative feedback as well as supplying a dc bias which sets the overall gain of the stage.

The gain of the amplifier may be calculated using the following formula (assuming ideal transistors).

$$\text{Gain} = \frac{(R17//RV11) + R15}{R15}$$

When the gain control is at maximum the gain is 102 or 40 dB (in practice 36 dB), and when the gain control is at minimum R17//RV11 is zero and the gain is therefore unity.

The signals from any number of line amplifiers may be summed by one of the sub mixers (eight per board IC1-IC8) the output from each mixer is taken directly to output socket to the master mixer, and via a 22 k level. control to the monitor mixer, IC9.

The output of the monitor mixer is taken to the master-monitor, level control on the master mixer and then returned to a buffer amplifier in the stage mixer, IC10.

In an emergency (main mixer faulty) SW2 disconnects the outputs from the master mixer and connects the output of the monitor amplifier to the PA channels.

Power for the Stage mixer is provided by a conventional supply which provides plus and minus 15 volts for the mixer amplifiers and plus 19.6 volts for the line amplifiers.

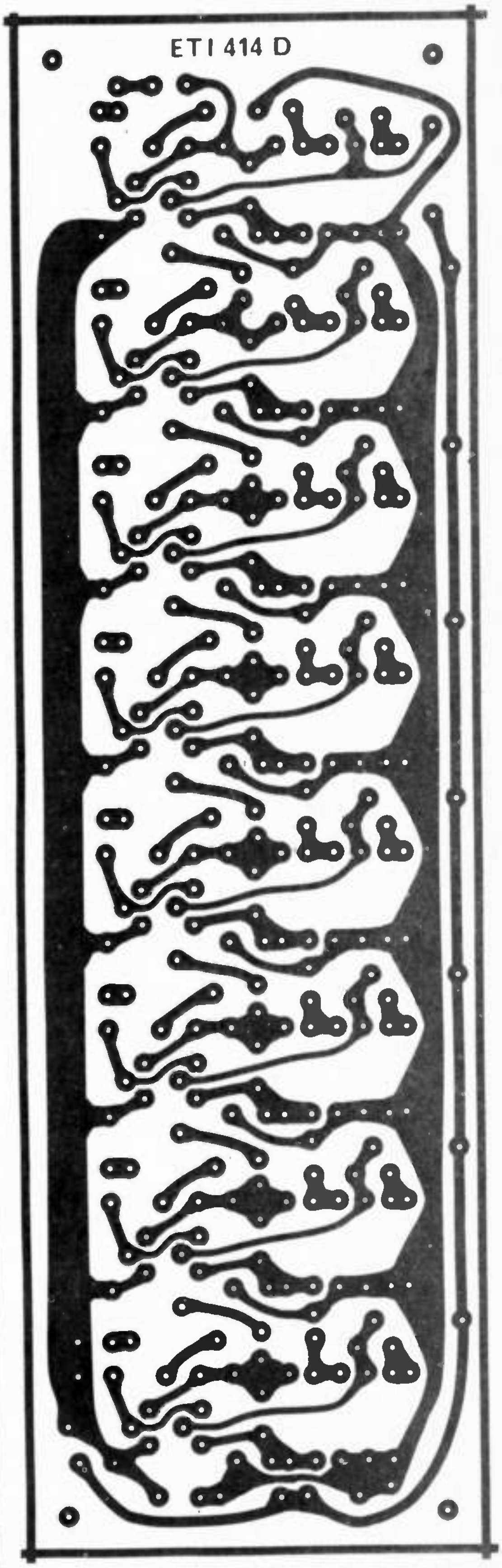
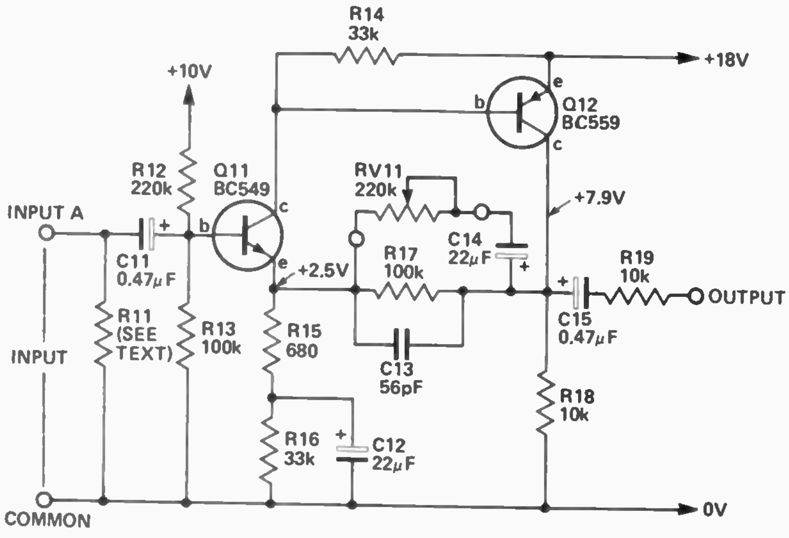
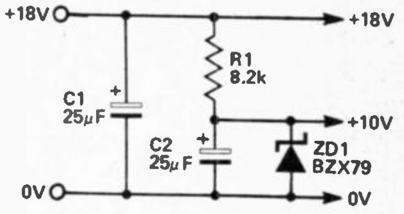


Fig.3. Printed circuit board layout for the preamplifiers (two required for 16 channels). Full size 223 x 63 mm.

STAGE MIXER





NOTE
ONE AMPLIFIER ONLY SHOWN. PC BOARD ETI-414D CONTAINS 8 AMPLIFIERS. COMPONENT NUMBERING OF SECOND AMPLIFIER STARTS AT 21, THE THIRD AMPLIFIER AT 31, ETC. COMPONENTS R1, C1, C2 AND ZD1 ARE COMMON TO ALL AMPLIFIERS.

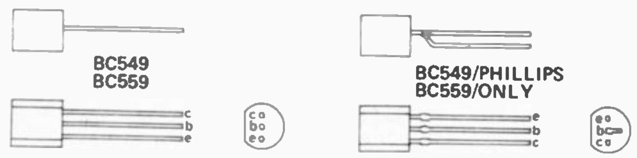


Fig.4. Circuit diagram of the line amplifier (eight per board).

CONSTRUCTION

Full constructional details will be provided next month. In the meantime the mixer as described may be partially built by assembling two line amplifier boards (eight channels each), as described in this article. Of course the unit could be extended by adding an additional line amplifier board without other modification (i.e. 24 channels mixed down to eight) however further amplifier boards may not be added without modification, but a second mixer board may be used if further extension is required.

When assembling boards take particular care with orientation of ICs, transistors diodes and electrolytic capacitors. ●

To be continued next month . . .

STAGE MIXER PARTS LIST

PARTS LIST GENERAL

Chassis
Box
Escutcheon
16 Cannon sockets XLP-3-13
3 Cannon plugs XLP-3-14
27 Phone jacks — mono— 6.4mm
1 LED and panel holder
1 11 position 1 pole rotary switch
1 VU meter
1 240V power outlet HPM type 55 or similar
1 21 pin socket John Carr KA/213
26 Knobs
12 1" spacers
nuts, bolts, 3 core flex & plug etc.

SUB-MIXERS, POWER SUPPLY

R2,5,8,11 resistor 100Ω ¼w 5%
R14,17,20 " 100Ω ¼w 5%
R23,25,28 " 100Ω " "
R29,30,31 " 390Ω ½w "
R1,4,7,10 " 47 k ¼w "
R13,16,19,22 " 47 k " "
R3,6,9,12 " 100 k " "
R15,18,21 " 100 k " "
R24,26,27 " 100 k " "

RV1,2,3,4 potentiometer 22k rotary log
RV5,6,7,8 potentiometer 22k rotary log
RV9 potentiometer 470k rotary log

C4,5,6 capacitor 0.1μF polyester
C1,2,3 capacitor 470μF 25V electrolytic

IC1-IC10 integrated circuit μA741C
Mini dip or TO5

D1-D4 diode EM401 or similar
ZD1,2 Zener diode BZX79C15

T1 transformer 240V/15-0-15V PL30/20VA
PC Board ETI-414E
SW1 switch DPDT toggle 240V rated
SW2 switch 4PDT toggle

INPUT AMPLIFIERS

16 off are required for all components below

R11 resistor see text
R15 resistor 680Ω ¼w 5%
R18, 19 resistor 10k ¼w 5%
R14,16 resistor 33k ¼w 5%
R13 resistor 100k ¼w 5%
R12 resistor 220k ¼w 5%

RV11 potentiometer 220 k rotary log.

C13 capacitor 56pF ceramic
C11, 15 capacitor 0.47μF TAG Tantalum
C12 capacitor 22μF 16V electrolytic

Q11 transistor BC549 or similar
Q12 transistor BC559 or similar

2 off are required for all components below —

R1 resistor 8k2 ¼w 5%

C1, 2 capacitor 25μF 25V electrolytic

ZD1 Zener diode BZX79C10

PC Board ETI-414D

FANE

HI-FI LOUDSPEAKERS FROM ENGLAND

10" The model B101/10LR is a 10" loudspeaker with a 2" voice coil working within a 10,000 guass magnet structure, total flux 100,000 maxwells. The free air-resonance of the loudspeaker is 25Hz thus making it suitable for a small sealed cabinet of between 1½ and 2 cu.ft.
Efficiency is higher than might be expected from a sealed cabinet and power handling is 20-25 watts r.m.s. **$34.50**

12" The model B122/10LR is a 12" bass speaker featuring a rubber suspension which allows a fundamental resonance of 17Hz in free air. This low-resonance, combined with a 2" voice coil working within a carefully selected magnet structure makes the speaker ideal for a sealed cabinet of about 2 cu.ft. capacity. Efficiency of the B122/10LR is surprisingly high for this type of loading and the speaker is ideal for amplifiers with an output of 20-25watts r.m.s. per channel at 8ohms. **$39.50**

12" The model B122/12LR, like the B122/10LR described above, is also suitable for sealed cabinets but because of its more powerful magnet structure a volume of about 3 cu.ft. is required to ensure the speaker gives its optimum performance. **$49.50**

15" The Fane model B152/12LR is a 15" bass driver with a fundamental resonance of 15Hz in free-air. Once again a sealed cabinet provides ideal loading for this unit and the volume can be varied from 3 to 5 cu.ft. The performance in 5 cu.ft. is particularly outstanding as the resonance is kept in the region of 30Hz. This results in firm, non-resonant bass without any of the "boxiness" often associated with conventional speakers. Efficiency is reasonably high and power-handling is up to 30watts r.m.s. at 8ohms. **$59**

5" The Fane 505 x 5" mid-range loudspeaker employs a special cone material which is doped to remove any irregularities in response. Useful frequency range is 400-4,000Hz and sound quality is very neutral. **$24.50**

1" The Fane 1" Dome Tweeter DD1 is a newly developed soft-dome tweeter with a useful frequency response from 4,000Hz to 20,000Hz. Efficiency is medium to high. **$23.50**

PUBLIC ADDRESS & MUSICAL INSTRUMENT UNITS

12" CRESCENDO 12A — Super High Efficiency, Wide Frequency Response and 100 Watt r.m.s. power handling. This beautifully finished loudspeaker is particularly suitable for lead guitar, organ and public address work. VOICE COIL DIAMETER: 2", FLUX DENSITY: 20,000 Guass, IMPEDANCE: 8 ohms. **$79.00**

15" CRESCENDO 15/100 BASS. Specially designed for high power, high efficiency bass performance. This magnificent unit is rated at 100 watts r.m.s. and has a resonant frequency of 40Hz. VOICE COIL DIAMETER: 3", FLUX DENSITY: 15,000 Guass, IMPEDANCE: 8 ohms. **$99.00**

920 HORN UNIT. This unit has just been released on the Australian market and features super high efficiency of 109 dB and power handling of 100 Watts r.m.s. above 600 Hz. VOICE COIL DIAMETER: 2", FLUX DENSITY: 20,000 Guass, IMPEDANCE: 8 ohms. **$149.00**

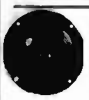
12" POP 50. A general purpose 50 watt r.m.s. loudspeaker of high efficiency, but economically priced. VOICE COIL DIAMETER: 2", FLUX DENSITY: 13,000 Guass, IMPEDANCE: 8 ohms. **$39.50**

18" POP 100 An outstanding 18" bass loudspeaker for musical instruments, the POP 100 handles 100 watts r.m.s. at high efficiency. Resonant frequency is 55 Hz. VOICE COIL DIAMETER: 3", FLUX DENSITY 14,000 Guass, IMPEDANCE: 8 ohms. **$79.00**

NEW 3-WAY SPEAKER SYSTEMS OF EXCEPTIONAL QUALITY

Developed by exhaustive and thorough testing, this new 3-way speaker system combines wide, flat frequency response with genuine high power capability. (Available in Kit form or completely assembled.)

CHALLENGE SYSTEM 1



CHALLENGE H-22 DOME TWEETER
The development of dome tweeters has been a major project of most loudspeaker manufacturers of recent years. The H-22 dome is one of the latest designs. The 1" diaphragm is made of carefully selected metallized polyester material which is of very small mass to allow maximum efficiency. **$8.50**

SPECIAL MID-RANGE SPEAKER
An outstanding 5" mid-range loudspeaker developed by one of Germany's leading loudspeaker manufacturers. It employs carefully selected cone material and a special cone termination to ensure flat response and high efficiency. A protective cover is fitted to the rear of the loudspeaker to prevent interference from air pressure developed within the cabinet by the bass speaker. **$15.90**

CHALLENGE 10L-24 WOOFER
This robust 10" unit features a 4 layer wound 1½" voice coil which allows it to handle 30 watt r.m.s. comfortably. The combination of extremely rigid cone and low-fundamental resonance of 35 Hz in free-air ensures deep, positive bass when used in the recommended enclosure sizes. **$16.90**

CHALLENGE HP 1 HIGH-POWER CROSSOVER NETWORK
features 4 inductors including a high-efficiency air-wound 3.55 Mh choke in series with the bass speaker. 3 crossover capacitors are also used. Crossover points are 500 Hz and 4 000 Hz and the rate of roll off is 12dB/oct. **$14.50**

The **CHALLENGE SYSTEM 1** can be purchased as components only as above or completely assembled and tested in 2 cu.ft. walnut veneered cabinets at **$179 pair**

NEW CHALLENGE TURNTABLE SEMI-AUTOMATIC BELT-DRIVE

$99.50

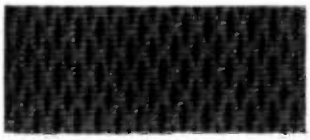
- The automatic arm return is achieved by a very simple and effective mechanism which ensures years of trouble free operation.
- Oil damped cueing lever permits instant selection of any record track without having to reject the tone arm.
- Heavy cast platter, belt-driven by a syncronous motor, reduces rumble, wow and flutter to negligable proportions.
- Tone arm features anti-skate, lateral balance and removeable headshell fitted with magnetic cartridge. Fully adjustable counter balance weight with independent scale allows easy adjustment of stylus pressure.
- All connecting cables and plugs are fitted to the turntable.
- 12 month guarantee.
- Walnut base and tinted perspex cover with hinges available as for $27.50.

CROSSOVER CAPACITORS

Our wide range includes 2.2 mfd mylar film **$1.20** each, 3.3 mfd mylar film **$1.40** each, 5 mfd NP Electrolytics 40c each, 10 mfd NP Electrolytics 45c each, 16 mfd NP Electrolytics 50c each, 30 mfd NP Electrolytics 60c each and 60 mfd NP Electrolytics 90c each.

SPEAKER GRILLE CLOTH

An attractive selection of speaker grille cloths are available ex stock at very reasonable prices. Free sample pieces are available on request and will be forwarded per post anywhere in Australia together with our price list.



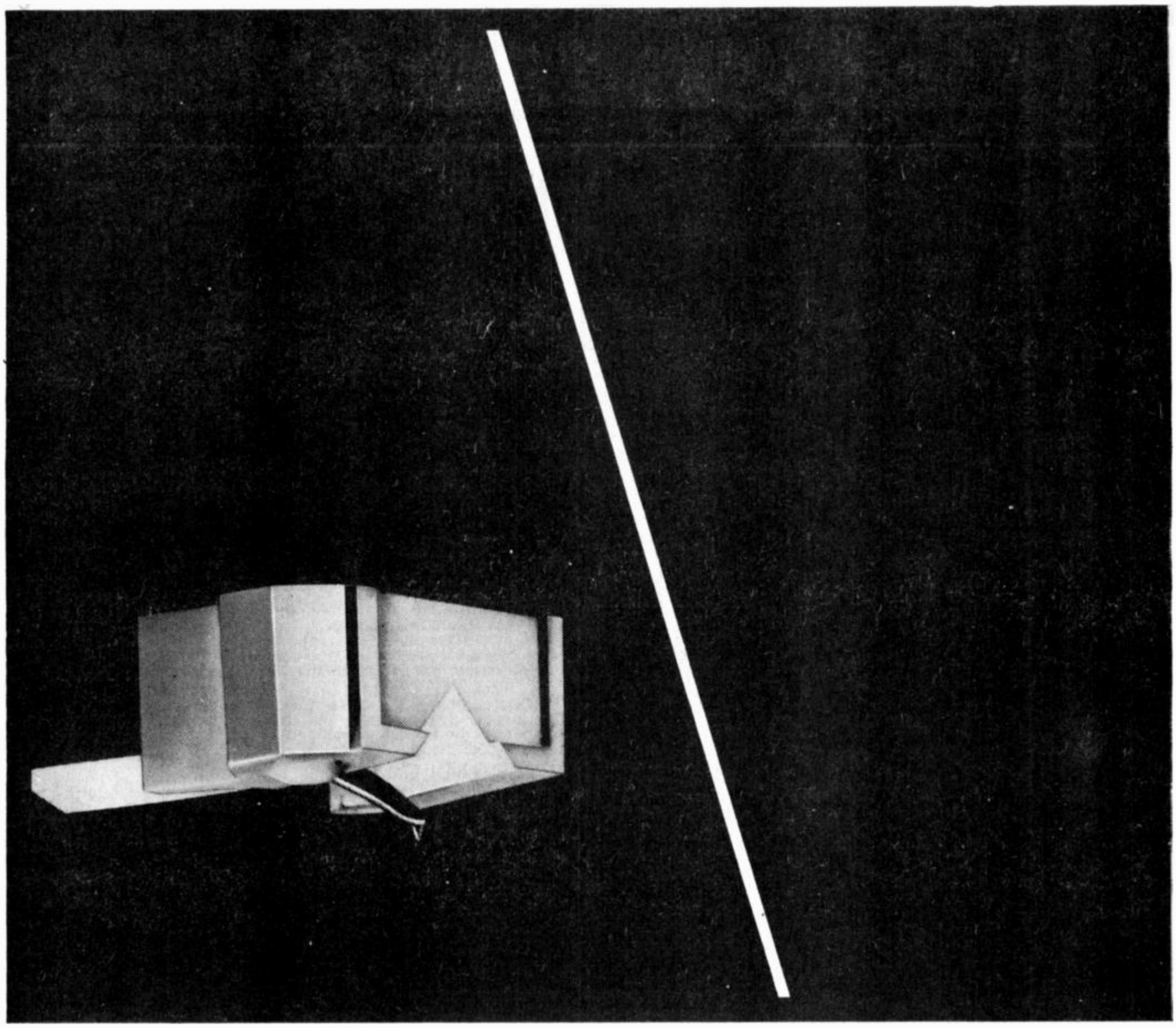
CROSSOVER CHOKES

A comprehensive range is now available of high power, high efficiency inductors in the following values, 0.25 Mh, 0.35 Mh, 0.5 Mh, 0.75 Mh, 2.2 Mh and 3.55 Mh. Prices range from **$1.00** to **$5.00** each.

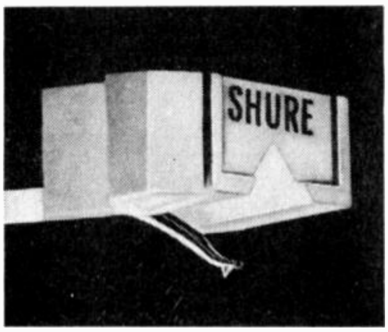
Challenge

HI-FI STEREO PTY LTD

**96 PIRIE ST.
ADELAIDE
STH. AUST. 5000
PHONE: 223 3599**



Are you "Shure" of your Stylus?



The stylus shown above is phony. It's represented as a replacement stylus for a Shure cartridge, and although it looks somewhat authentic, it is, in fact, a shoddy imitation. It can fool the eye, but the critical ear? Never! The fact is that the Shure Quality Control Specialists have examined many of these imposters and found them, at best, to be woefully lacking in uniform performance — and at worst, to be outright failures that simply do not perform even to minimal trackability specifications. Remember that the performance of your Shure cartridge *depends* upon the stylus, so insist on the real thing. Look for the name SHURE on the stylus grip (as shown in the photo, left) and the words, "This Stereo Dynetic® Stylus is precision manufactured by Shure Brothers Inc." on the box.

Write Audio Engineers Pty. Ltd., 342 Kent St., Sydney, NSW 2000.

SHURE

AE082/FP

AUDIO ENGINEERS P/L
342 Kent Street,
SYDNEY 2000 N.S.W.

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THORNBURY 3071 Vic.

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ATHOL M. HILL P/L
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AUDIO ENGINEERS (S.A.)
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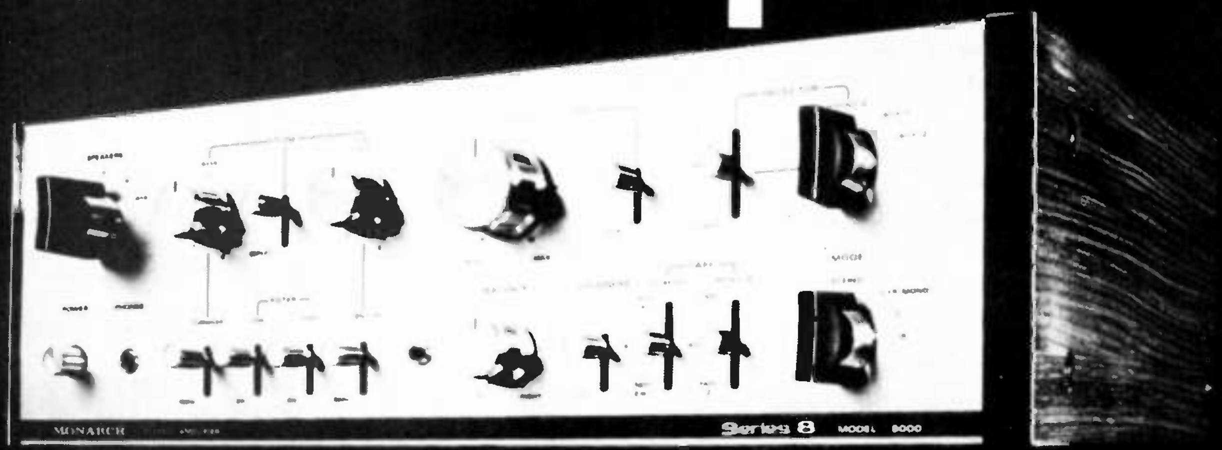
ADELAIDE 5000 S.A.

The compliment we like best about the new Monarch Series 8:

"It's no surprise!"



When people already think of one name as the best value for money, they naturally expect every new model to maintain the same high standards — or improve on them. So, Monarch's brilliant new Series 8 amplifiers will come as no great surprise.

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COLOUR TV STANDARDS

Many engineers and hobbyists involved with Colour TV have asked us to publish definitions of the technical standards laid down by the Broadcasting Control Board.

Here they are then — prepared by S.L. Cachia, B.Sc., C.Eng., M.I.E.E., M.I.E.R.E., M.I.E. Aust.

1. CHANNEL FREQUENCIES

Each television channel occupies a bandwidth of 7 MHz. The allocated vision carrier frequency and frequency limits of the channels in the Australian TV service are given below.

Channel	Vision Carrier Frequency MHz	Sound Carrier Frequency MHz	Frequency Limits MHz
0	46.25	51.7496	45–52
1	57.25	62.7496	56–63
2	64.25	69.7496	63–70
3	86.25	91.7496	85–92
4	95.25	100.7496	94–101
5	102.25	107.7496	101–108
5A	138.25	143.7496	137–144
6	175.25	180.7496	174–181
7	182.25	187.7496	181–188
8	189.25	194.7496	188–195
9	196.25	201.7496	195–202
10	209.25	214.7496	208–215
11	216.25	221.7496	215–222

It should be noted that the nominal vision carrier frequency is 1.25 MHz above the lower frequency limit of the channel and the sound carrier frequency is 5.4996 MHz above the vision carrier of the channel.

The vision carrier frequency may be offset from the nominal in certain instances.

2. MODULATION

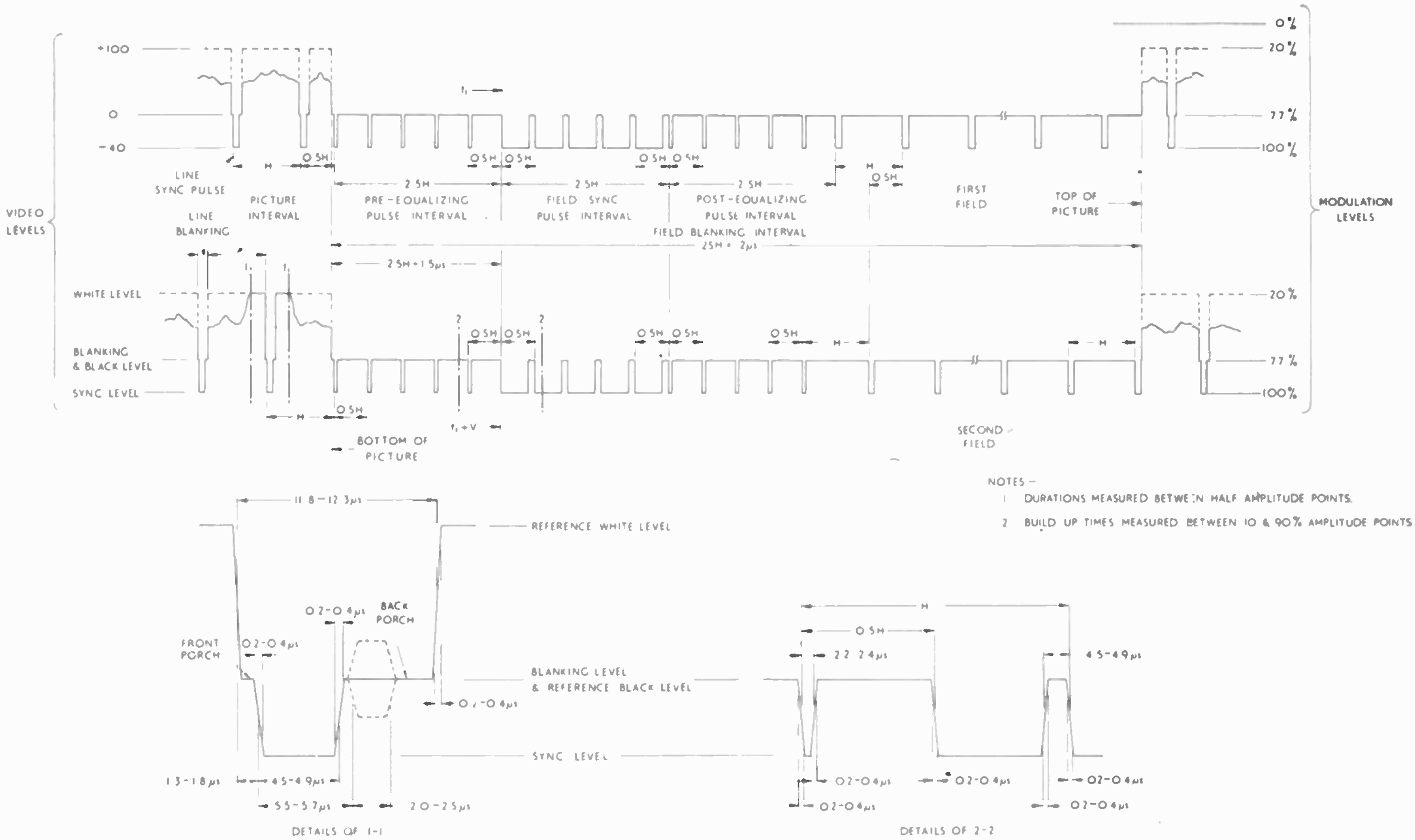
2.1 Vision Carrier

The amplitude of the vision carrie· is negatively modulated so that it decreases as the video signal amplitude increases.

(a) White corresponds to 20% of peak vision carrier amplitude.

(b) Black corresponds to 77% of peak vision carrier amplitude.

(c) Blanking level also corresponds to 77% of peak vision carrier amplitude.



VIDEO SIGNAL

(1) VIDEO SIGNAL CORRESPONDING TO FULLY SATURATED COLOURS

2.2 Sound Carrier

The frequency of the sound carrier is modulated to a maximum deviation of ± 50 kHz.

3. DISPLAY

3.1 Picture Details

Aspect ratio, vertical to horizontal:	3:4
Picture Frequency:	25
Field Frequency:	50
Number of scanned lines per picture	625
Interlacing:	The lines are interlaced 2 to 1.

The line frequency (FH) is related to the colour sub carrier frequency (fsc) by the expression

$$FH = Fsc/(1135 + 4/625)$$

3.2 Primary Colours

The colour picture tube should have phosphors balanced for a white chromaticity of CIE Illuminant D_{6500} and exhibiting the CIE chromaticity co-ordinates as shown below.

	CIE	Co-ordinator
	x	y
Red Phosphor	0.64	0.33
Green Phosphor	0.29	0.60
Blue Phosphor	0.15	0.06
Illuminant D_{6500}	0.313	0.329

The spectral responses of the colour signal generation section should complement the transfer characteristics of the picture tube so as to produce a colour picture of optimum fidelity.

4. VIDEO SIGNAL

4.1 Sub Carrier Frequency

The colour sub-carrier frequency is 4.43361875 MHz ± 5 Hz.

4.2 Composite Signal

The video composite signal is shown in Fig. 1.

Timing intervals are given below

Field period (V)	2000 μS*
Line period (H)	64
Line blanking interval	11.8–12.3
Front porch interval	1.3–1.8
Line synchronizing pulse interval	4.5–4.9
Field blanking interval	25H–12
Duration of field synchronizing pulse sequence	2.5H
Duration of pre-equalizing pulse sequence	2.5H
Duration of post-equalizing pulse sequence	2.5H
Equalizing pulse interval	2.2–2.4
Interval between field synchronizing pulse	4.5–4.9
Colour sub-carrier burst; start from leading edge of line synchronizing pulse	
edge of line synchronizing pulse	5.5–5.7
duration (nominally 10 cycles)	2.0–2.5
duration of burst blanking pulse per field	9H
Build-up time;	
blanking pulses	0.2–0.4Δ
synchronizing signals	0.2–0.4

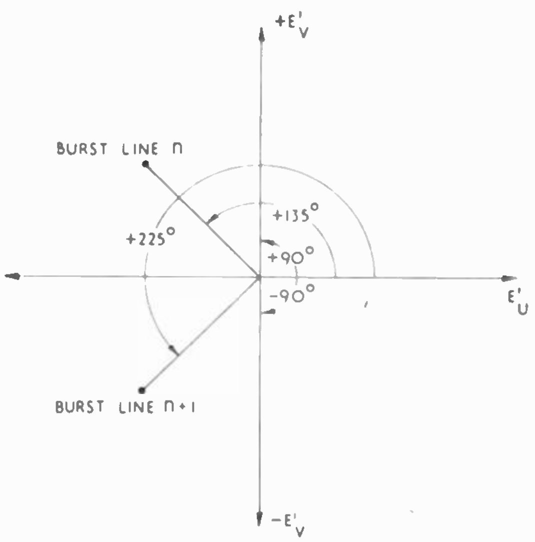
* All figures are half amplitude durations in microseconds except for build-up times, which are,
Δ from 10% to 90% amplitude.

COLOUR SUB-CARRIER AMPLITUDES & PHASES FOR FULLY SATURATED PRIMARY & COMPLEMENTARY COLOURS

COLOUR	LUMINANCE E'_Y	PEAK TO PEAK CHROMINANCE			CHROMINANCE ANGLE (2)	
		$2E'_U$	$2E'_V$	2S (1)	LINE n (3)	LINE n+1
REFERENCE WHITE	100·0					
YELLOW	88·6	87·4	20·0	89·6	167·0°	193·0°
CYAN	70·1	29·5	123·0	126·4	283·5°	76·5°
GREEN	58·7	58·0	103·0	118·1	240·7°	119·3°
MAGENTA	41·3	58·0	103·0	118·1	60·7°	299·3°
RED	29·9	29·5	123·0	126·4	103·5°	256·5°
BLUE	11·4	87·4	20·0	89·6	347·0°	13·0°
BURST	0	28·3	28·3	40·0	135·0°	225·0°
REFERENCE BLACK	0					

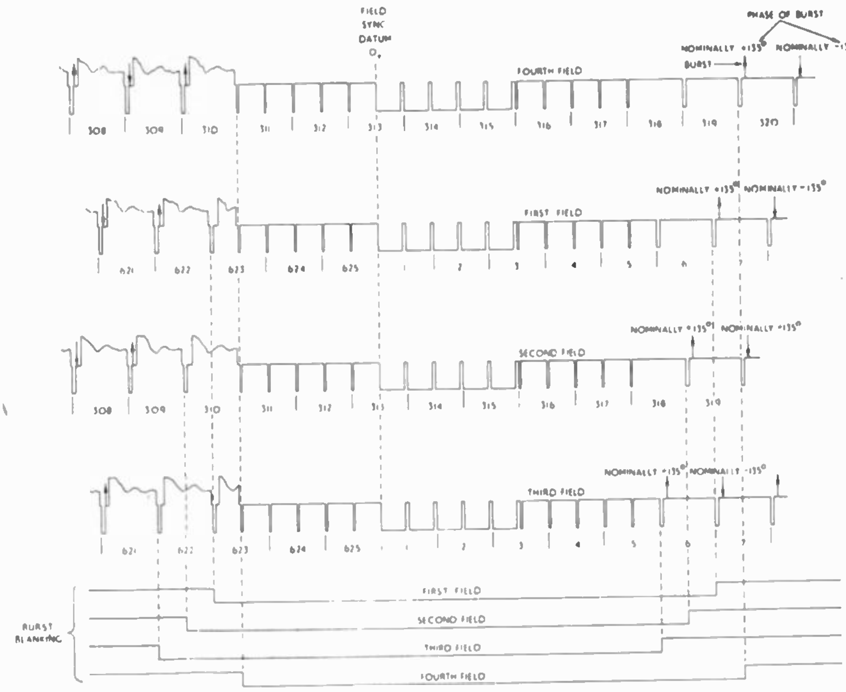
NOTES.-

1. $S = \left(E'^2_U + E'^2_V\right)^{\frac{1}{2}}$
2. THE CHROMINANCE ANGLES ARE MEASURED ANTI-CLOCKWISE FROM THE E'_U AXIS
3. LINE n CORRESPONDS TO THE ODD NUMBERED LINES OF THE FIRST & SECOND FIELDS & THE EVEN NUMBERED LINES OF THE THIRD & FOURTH FIELDS



(2) PHASES OF BURST, E'_U & E'_V SIGNALS.

COLOUR TV STANDARDS



FOUR FIELD SEQUENCE OF BURST BLANKING

4.3 Colour Picture Signal

Composition of the colour information is in accordance with the Phase Alternation (on each succession) line system, and the colour picture signal, E_M, is expressed by

$$E_M = E'_Y + E'_U \sin 2\pi \text{ fsct} \pm E'_V \cos 2\pi \text{ fsct}$$

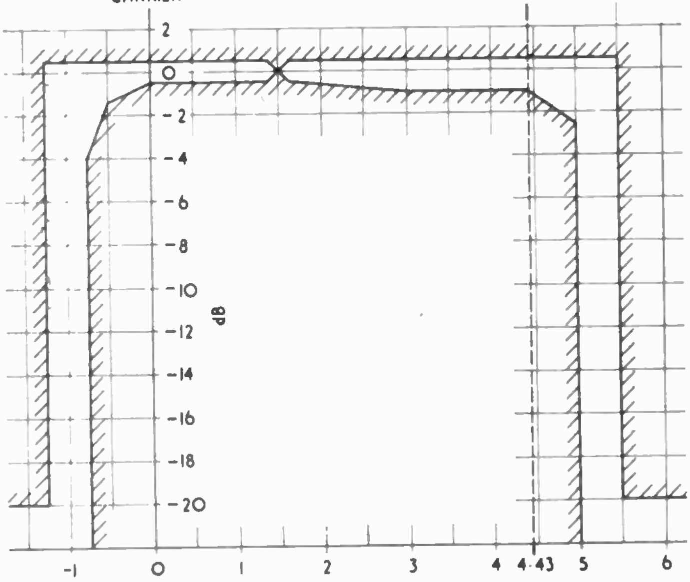
where E'_Y is the luminance component and is given by;

$$E'_Y = 0.299\, E'_R + 0.587\, E'_G + 0.114\, E'_B$$

E'_U and E'_V are the chrominance signals and are given by;

$$E'_U = 0.493\,(E'_B - E'_Y)$$
$$E'_V = 0.877\,(E'_R - E'_Y)$$

The signals $E'_B - E'_Y$ and $E'_A - E'_Y$ are the colour difference signals and are given by;



VISION TRANSMITTER, AMPLITUDE/FREQUENCY RESPONSE

$$E'_B - E'_Y = -0.299\, E'_R - 0.587\, E'_G + 0.886\, E'_B$$
$$E'_R - E'_Y = +0.701\, E'_R - 0.587\, E'_G - 0.114\, E'_B$$

E'_R, E'_G and E'_B are the red, green and blue gamma corrected voltages required for tristimulus matching. The gamma value for the correction is 1/2.8 (the display tube gamma is taken to be 2.8).

$E'_V \cos 2\pi$ fsct is positive during odd lines of the 1st and 2nd fields and during even lines of the 3rd and 4th fields.

In the absence of a colour content in a picture, the chrominance signals disappear.

The resulting video signal for fully saturated primary and complimentary colours at full luminance is shown in Fig. 2a and b.

The bandwidth of the colour difference signals follows approximately a Gaussian curve and is

< 3 dB at 1.3 MHz
> 20 dB at 4 MHz

4.4 Colour Synchronization

Colour synchronization is achieved by a synchronizing burst. Details of the burst are as follows:—

(a) Frequency: 4.43361875 MHz ± 5 Hz

(b) Duration: 10 cycles

(c) Location: In the blanking period; starts 5.6 μs after the half amplitude point on the leading edge of the line synchronizing pulse.

(d) Amplitude: 40% peak-to-peak of the reference black to reference white signal level.

(e) Bandwidth: The burst has a build-up time which corresponds to the bandwidth restriction of the colour difference signals.

(f) Phase: In relation to the E'_U signal the phase is; + 135° ± 1° on odd lines of the 1st and 2nd fields and on even lines of the 3rd and 4th fields. − 135° ± 1° on even lines of the 1st and 2nd fields and on odd lines of the 3rd and 4th fields. (See also Fig. 3.).

5. SPECIAL SIGNAL TRANSMISSION

Supervisory or telemetry signals or signals for other purpose approved by Australian Broadcasting Control Board may be transmitted during the field blanking period, but not before lines 17 and/or 330.

6. TRANSMITTER

6.1 Vision to Sound Power Ratio

The peak envelope power of the vision radiated signal and mean power output of the sound radiated signal bear a power relationship of 10:1.

6.2 Response of the Vision Transmitter

The vision transmitter frequency response is within the limits shown in Fig. 4. The radiated signal at the channel limit frequencies, should be attenuated by more than 20 dB relative to the signal at 1.5 MHz above the vision carrier.

The group delay vs frequency response of the transmitter and standard vestigial sideband demodulator should be flat to 5 MHz. At the colour sub-carrier frequency the demodulator should have a group delay of 0.170 µs relative to the delay at low frequencies.

6.3 Vision Carrier Noise

The noise in the audio output of an intercarrier receiver due to the phase modulation of the vision carrier should be at least 46 dB below the level corresponding to full deviation for a modulating frequency of 400 Hz.

6.4 Sound Transmitter Modulation

Audio signal pre-emphasis time constant is 50 µs.

The modulation frequency range of the transmitter is 30 Hz to 15 kHz. ●

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The Hornet calculator draws 30 mA on standby and 60 mA with all digits alight — so the simple supply shown in Fig. 1 is adequate.

An even simpler charging method is shown in Fig. 2. This enables the calculator to be charged up by a car battery. Note, the 0.1 µF capacitor *must* be included — its purpose is to absorb transients on the incoming 12 Vdc supply. The capacitor should preferably be a disc ceramic type (low inductance).

With the values shown, both circuits can supply enough energy to actually power the calculators — as well as charging the batteries. ●

WARNING

It is inadvisable to use constant current chargers (such as the ETI 519) with this calculator. Such chargers provide a high output voltage at the end of charge. If the calculator were to be operated during this period it could be damaged by over-voltage.

Fig. 1

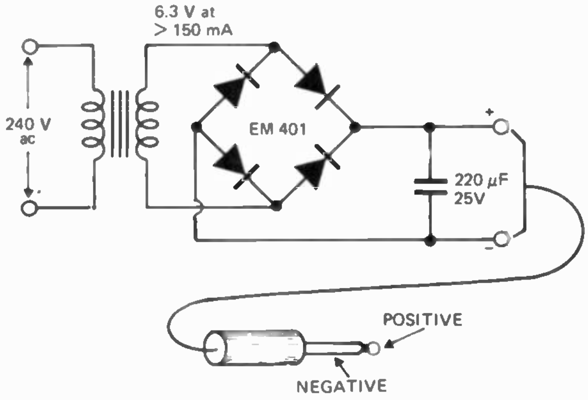
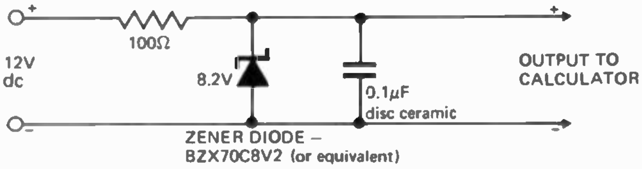


Fig. 2



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INTERNATIONAL BROADCASTING -MILITARY INVOLVEMENT

This article by C.M. Stanbury details the manner in which air transportable high-power broadcasting stations have been and may be used for military purposes.

It is intended simply as a factual technological article, no political or philosophical judgement is either intended or implied.

IN MID-1974 some Australian listeners caused a stir in the world by reporting that the American Forces Radio & Television Service was operating the first short wave broadcast station on the Antarctic continent. As we noted in Electronics Today, February 1974, the U.S. military has become ever increasingly involved in international broadcasting to the general public. But the "real action" does not involve AFRTS, at least not AFRTS as the public knows it.

THE EVOLUTION OF PORTABLE FACILITIES

During the past 20 years the technological changes which have received the most attention by rank and file broadcasters are satellite communications and the super power transmitter/antenna installations. Yet satellites still play virtually no part in *direct* international broadcasting to the general public (even most point-to-point linkage to overseas relays continues to be carried by short wave, or undersea cable) and power increases, while effective on medium and long wave are less so on the relatively narrow hf bands. During these past two decades, the really effective technological gain has in fact been the little heralded development of "instant" transmitter sites, i.e. highly portable equipment with powers of at least 50 kW.

The United States had pioneered this field. Three different American agencies have been involved at one time or another. The Central Intelligence Agency (C.I.A.), the Voice of America (i.e. the USIA which is responsible to the Dept. of State), and the Dept. of Defence.

Excluding Voice of America's converted coast guard cutter "Courier", the first 50 kW portable was built for the C.I.A. in the mid-50s. It was housed in a van and intended to move from location to location along the Czech border just inside West Germany. It was also air-transportable but not to the same degree that later units were. During the 1968 uprising, the Russians claimed that the clandestine Free Czech Radio was using similar units. It is true the original unit may have been between assignments at the time but otherwise there is no evidence to support the Soviet allegation. However the significant point is that this by now slightly antique unit was still in use in the early '70s clearly indicating that C.I.A. technology has not progressed much past the mid-'50s – a level of technology which is now in many hands. The Russians themselves showed portable capabilities in the Czech uprising, the BBC owns such units (and the British may have also experimented with them around the Persian gulf circa 1970) – and Turkey was shopping for something similar shortly before the 1974 Cyprus crisis.

In 1961 the CIA's portable was involved in the Bay of Pigs debacle. Several books have been written on this intriguing piece of contemporary history but for the purposes of this article it is only important to note that shortly thereafter the U.S. military decided to setup its own portable broadcast strike force. As did the Voice of America.

The Pentagon system, known as the "Flying Radio City" although not intended for operation while in flight, was built by Gates (but units are now assembled by the U.S. Army Strategic Communications Command itself) while the original VOA units were built by Collins' Alpha division. Both consisted of 50 kW medium and short wave units. Both received some publicity in the general and trade press but the Voice of America received the major share. The Flying Radio City medium wave unit used a single tower "jack-up" antenna (multi-tower directional arrays have since been added). Both Voice of America's medium and short wave units were directional from their inception. The military's portable stations can be put on the air within eight hours of arrival: Voice of America's took 11 days.

When the Cuban crisis developed in the fall of 1962, only the VOA's portable was ready. It took as long to put on the air (at Marathon Key, Florida) as a makeshift military broadcast station on Dry Tortugas Key. When in the summer of 1963 it was decided to make the Marathon facility more directional, the supposedly "unique" VOA portable was not replaced with a conventional facility. Instead, a third tower was simply added and the "portable" remains at Marathon to this day. When the VOA decided to setup a portable station in Vietnam (760 kHz) one of the Pentagon's Flying Radio Cities was used (however the VOA has continued to add to its own stockpile of short wave portables).

THAILAND, DOMINICAN REP. & RHODESIA

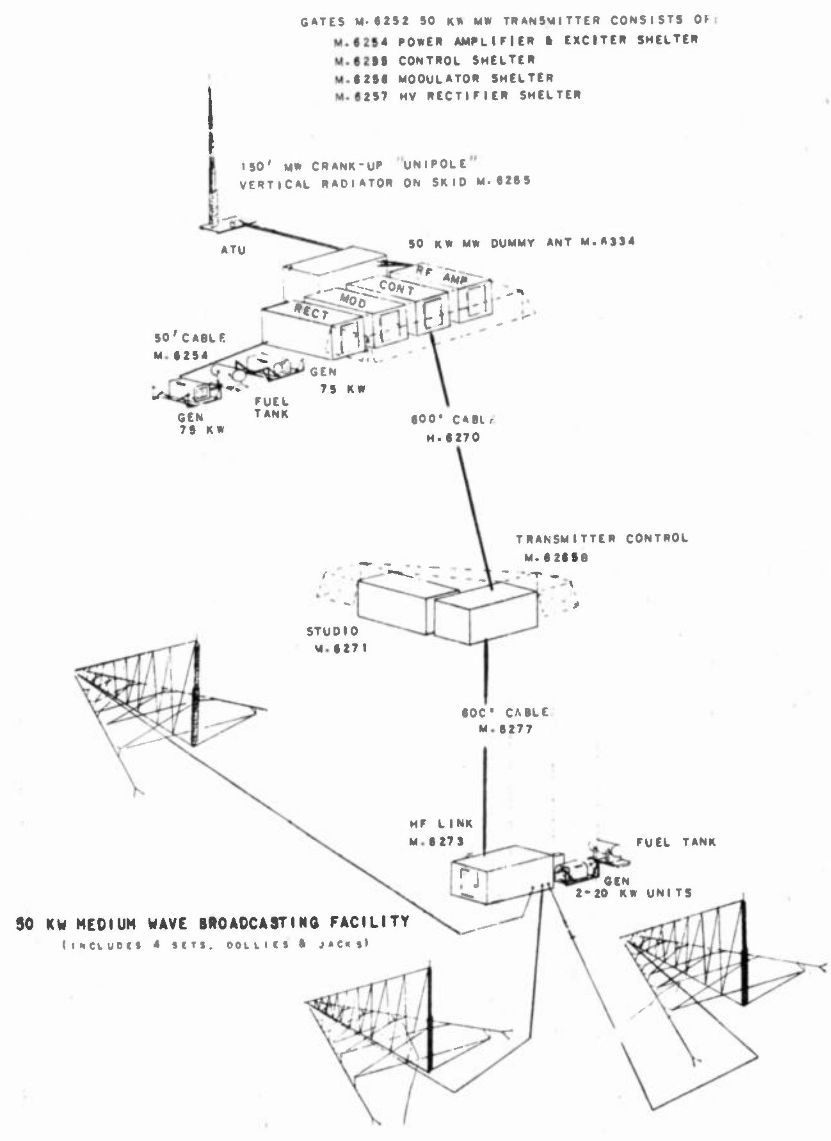
To list all the possible uses to which the Flying Radio Cities have been put would fill several pages. Both the medium and short wave units were

INTERNATIONAL BROADCASTING -MILITARY INVOLVEMENT

supposedly tested in the summer of 1963 at Yuma (Arizona). But even these transmissions have an air of mystery about them. According to the Jan. 1964 issue of BROADCAST ENGINEERING, transmissions extended over a two month period and were intended for reception on "standard household receiving sets" in the Panama Canal Zone. SWLs in various parts of the world reported reception of "VOA Yuma" (VOA programs were relayed) but somehow there is not one report in any DX bulletin of medium wave reception. However our purpose here is not to dig up old mysteries but to demonstrate the important role the U.S. military has come to play in international broadcasting. Therefore we shall only cite three incidents where the facts are reasonably well documented.

Excepting the Arizona tests, there have been only two acknowledged incidents of Flying Radio City use in over a decade. One was the VOA's Vietnam station (and that has not been oublicized). A second is station HSKN which began operations during the autumn of 1963 in northern Thailand (to aid the Bangkok government in its psychological war with Marxist insurgents). Although initial press reports indicated the Flying Radio City's medium wave range to be only 95 km, HSKN was heard on 843 kHz by monitors of verified reliability as far away as California. Subsequently this unit was flown back to the Sacremento Army Ordinance Depot (headquarters of AFRTS Special Mission), given a directional antenna, heard from coast to coast during early AM tests, then returned to Thailand.

In April 1965 there was a revolt against the military junta in the Dominican Republic – and the junta was left without a major media outlet. However immediately after U.S. Marines arrived, the military appeared on the air with a new station, HIFA, announcing its location as San Isidro air base, the junta stronghold northwest of Santo Domingo, on 647 kHz. The press offered no explanation for HIFA's sudden appearance. The report circulated in SWL and DX circles was that HIFA had taken over the facilities of HIAT ("Radio Universal") which normally operated on 650 kHz. Further an official station list from the Dominican government shows that HIAT's transmitter was located in an east Santo Domingo suburb which was either 'rebel' territory or at best 'no man's land'.



'Flying Radio City', the Gates helicopter – transportable 50 kW broadcasting station.

BRITISH INVOLVEMENT

In the fall of 1965 Rhodesia made its unilateral declaration of independence and the BBC, or more precisely the British Diplomatic Wireless Service hastily set up a medium and short wave relay station at Francistown, Bechuanaland (now Botswana). According to an expert eye witness account the initial unit was a "50 kW Gates transmitter . . . on the air within 24 hours." It is probable that this unit was loaned by the U.S. State Department rather than the Pentagon.

CHILE

Immediately after the death of President Salvador Allende in 1973, Chilean short wave broadcasting outlets began turning up with increased power. In addition, at least five new jamming transmitters were placed on the air. These were of very high power, one of them could be received in eastern North America over a path which was entirely in daylight and at a time when no other station from lower South America could be heard on the band. This reception from lower South America could be heard on the band. This reception was noted by the author (in Canada) on a relatively consistent basis from February through April 1974. As a jammer is usually designed to provide maximum signal throughout the operator's own nation — rather than, for example, concentrating the signal at low radiation angles — this reception is highly significant: at the very least it indicates a remarkably directional antenna (which would be ideally suited to Chile's narrow north/south geographic configuration).

In September 1974 President Ford acknowledged to a global audience that the U.S. had, prior to the 1973 coup, provided aid to anti-Allende segments of the Chilean media in response to attempts by the Santiago government to silence opposition. The speed with which Chilean media expanded after the coup clearly suggests the advance procurement of portable units: equipment even more sophisticated in terms of power and antenna configuration that the original Flying Radio City. However, as in the case of the Francistown station, it is highly improbable that any American personnel were directly involved in Chilean broadcasting and in fact CIA officials have testified before a U.S. Congressional sub-committee that what aid (primarily financial) they provided the Chilean opposition reached it through intermediaries in both Latin America and Europe. Presumably Pentagon media equipment would have reached the Chilean military in a similar fashion.

UNITED STATES INFORMATION AGENCY
WASHINGTON 20547

July 29, 1969

Dear Mr. Stanbury,

Thank you for your letter of July 24, 1969. Your report of receiving our European medium wave transmissions during the Apollo mission indicates that extremely unusual conditions existed during that time period.

The medium wave facility in Hue, South Vietnam is utilizing the Gates transportable transmitter.

Enclosed are VOA QSL cards for the two medium wave reports and other literature which may be of interest to you.

Thank you again for your letter and interest in the Voice of America.

Sincerely,

George Jacobs, Chief
Frequency Division
Broadcasting Service

THE FUTURE

The evidence cited so far establishes that the U.S. military has both directly and indirectly been involved during the past 15 years in many of the most internationally crucial broadcast operations, and that in one critical field at least the Pentagon's broadcast technology is at the most advanced possible level. Apart from this the technology has at times been used by non-American entities.

According to the January 1966 issue of the U.S. trade publication 'TECHNICIAN ENGINEER', the U.S. military experimented with airborne TV broadcasting as early as the 1962 Cuban missile crisis. The same article vaguely hints at a somewhat similar operation during the 1965 Dominican confrontation. Throughout the latter half of the 1960s AFRTS carried on television broadcasts in both Vietnamese and English from aircraft circling over Saigon under the name of project Blue Eagle. There was also medium, short wave and FM sound transmissions from Blue Eagle but no reliable information is available on them as a result of a series of hoax transmissions perpetrated by one or a group of American SWLs with their own clandestine transmitter!

The major share of U.S. space technology is in the hands of the Pentagon. They are therefore in the best position of any agency anywhere in the world to develop a direct TV broadcast satellite system on channels presently used for conventional TV transmissions. Because of the high priority and degree of secrecy which automatically surrounds military research and development, the Pentagon is not likely to be hampered by ITU rules and conventions in designing and testing such satellites (ITU rules already prohibit airborne transmissions from international waters such as were carried on during the Cuban missile crisis).

Meanwhile, now that both BBC and the British Independent Broadcasting Authority have experimentally begun quasi-facsimile broadcasts — it is facsimile in every sense except that there is no permanent product — on regular VHF TV channels, interest in that media may pick up internationally. As indicated in the Feb. 74 ETI, the Pentagon already engages in more short wave facsimile broadcasting, for utility purposes, than any other agency in the world. And of course the same satellite, or aircraft, which might be used for international TV broadcasts could even more readily be used for facsimile.

AFRTS

A point which must be stressed is that the Pentagon's international broadcast activities have been *primarily technological* rather than in the area of programme content. The Psychological Warfare unit would have been responsible for those airborne Cuban television transmissions during the missile crisis, and probably produced some of the clandestine short wave broadcasts during the Vietnam war. American Forces Radio and Television stations maintain staffs of newsmen and disc jockeys but otherwise all AFRTS programming is simply a relay of the American commercial networks, and great care is taken to present a cross-section.

Remote AFRTS television stations are fed by satellite while local radio outlets are often fed via powerful Voice of America transmitters. Although these are primarily point-to-point feeds (complete with instructions to station managers) they operate on the regular SW broadcast bands so that American civilians living abroad will also be reached — a service apparently not constrained by international convention! ●

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8811	Quad 2-input MOS interface gate 15V open collector DIP	.30

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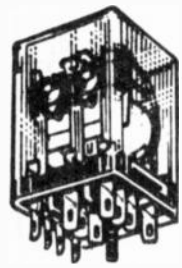

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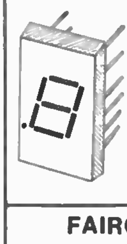
Complete with data $7.00
Data only $1.00

SLA-1 OPCOA



Pin compatible with MAN-1.

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COUNTER DISPLAY KIT—CD-2

This kit provides a highly sophisticated display section module for clocks, counter or other numerical display needs.

The RCA DR-2010 Numitron display tube supplied with this kit is an incandescent seven-segment display tube. The .6" high number can be read at a distance of thirty feet. RCA specs. provide a minimum life for this tube of 100,000 hours (about 11 years of normal use).

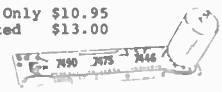
A 7490 decade counter IC is used to give typical count rates of up to thirty MHz. A 7475 is used to store the BCD information during the counting period to ensure a non-blinking display. Stored BCD data from the 7475 is decoded using a 7447 seven-segment decoder driver. The 7447 accomplishes blanking of leading edge zeroes, and has a lamp test input which causes all seven segments of the display tube to light.

Kit includes a two-sided (with plated through holes) fibreglass printed circuit board, three IC's, DR-2010 (with decimal point) display tube, and enough Molex socket pins for the IC's.

Circuit board is .8" wide and 4 3/8" long. A single 5-volt power source powers both the IC's and the display tube.

CD-2 Kit Complete Only $10.95
Assembled and Tested $13.00

Board Only $2.50



RCA DR2010 NUMITRON

RCA DR2010 Numitron digital display tube. This incandescent five-volt seven-segment device provides a .6" high numeral which can be seen at a distance of 30 feet. The tube has a standard nine-pin base (solderable) and a left-hand decimal point. Each $4.00
SPECIAL 4 for $17.50

COUNTER DISPLAY KIT—CD-3

This kit is similar to the CD-2 except for the following:

a. Does not include the 7475 quad latch storage feature.
b. Board is the same width but is 1" shorter.
c. Five additional passive components are provided, which permit the user to program the count to any number from two to ten. Two kits may be interconnected to count to any number 2-99, three kits 2-999, etc.
d. Complete instructions are provided to pre-set the modulus for your application.

CD-3 Board Only $2.25
IC's, 7490, 7447 $2.75
RCA DR2010 tube $5.00

Complete kit includes all of the above plus 5 programming parts, instructions, and Molex pins for IC's. Only $9.25

LM309K: 5-VOLT REGULATOR

This TO-3 device is a complete regulator on a chip. The 309 is virtually blowout proof. It is designed to shut itself off with overload of current drain or over temperature operation. Input voltage (DC) can range from 10 to 30 volts, and the output will be five volts (tolerance is worse case TTL requirement) at current of up to one ampere.

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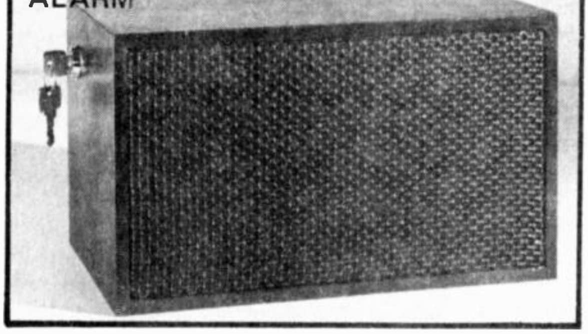
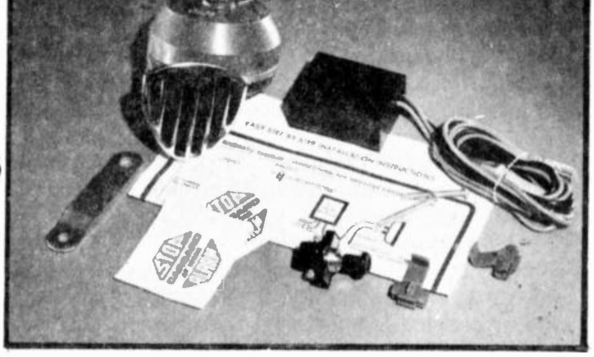
XL250 BURGLAR/INTRUDER/FIRE ALARM





RB200 CAR BURGLAR ALARM

XL250 BURGLAR/INTRUDER/FIRE ALARM

- Complete kit ready to install
- Additional sensors, alarm accessories may be added any time to meet future needs
- Fully automatic operation, simple to operate
- Protects the family against burglars, intruders and fires (with optional sensors)
- Do-it-Yourself Installers Handbook included

The XL250 SECURITY SYSTEM offers the kind of professional protection you have been looking for at realistic prices. The "heart" of the system is the XL250 control module which uses custom designed CMOS technology to achieve the high reliability and low current drain essential for security systems. The XL250 can accept any sensor (open or closed circuit) and triggers instantly. A special feature is the programmable delay unit which can be added to the designated exit door to provide automatic exit/entry so the alarm can be set from within the house. The output of the alarm is an ear piercing electronic siren which automatically resets after about 10 minutes.

THE XL250 SYSTEM INCLUDES control console disguised as a loudspeaker box fitted with a key operated master switch with 2 keys, 5W horn loudspeaker (indoor/outdoor type), magnetic door/window switches, emergency push button, 100' hookup wire and security handbook. Operates on a standard 12 volt lantern battery.

12 months manufacturer's warranty: $66.00 incl. post and packaging.

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• SD-20	Emergency tamper push button	$ 1.50
• SD-40	Ultra Thin Pressure mat 55 cm x 85 cm (for under carpets, rugs, etc).	$11.25
• SD-50	Foil Tape/Terminal kit (for protecting plate glass)	$ 4.25
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• AS-60	5 Watt reflex horn loudspeaker (for external siren etc.)	$11.25
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RB200 CAR BURGLAR ALARM

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The RB200 SYSTEM INCLUDES RB200 alarm module, highly efficient electrical horn, on/off switch, wiring connectors, mounting hardware, 2 CARGARD warning decals and full step-by-step installation instructions.

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RB200 CAR ALARM FOR $37.50 ☐

ACCESSORIES: ....

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Enclosed is my cheque, postal note, money order for $..... I understand that the goods are covered by a 12 months warranty and a money back guarantee applies if I am not completely satisfied within 14 days of purchase.

ELECTRONICS -it's easy! PART 16

SUPPLIES built permanently into equipment as fixed parameter units usually operate within reasonably well-defined operating limits. Fault conditions are, therefore, less likely to occur on the supply output, but are still a reality.

By contrast, general-purpose supplies designed to provide variable output for device testing, circuit development and multi-purpose use are prone to a number of fault conditions which could destroy components.

With the reduction in cost of power supply circuits, it is now practicable (and wise) to always employ protective devices that sense external or internal fault conditions and apply protective measures to the supply which prevent damage to both the supply and, possibly, the load being driven.

A wide variety of faults can occur. The supply itself may be damaged by excessive input overvoltage which may occur either as a steady-state overload or as a brief excitation transient. Protective measures include using a simple wire-fuse or magnetically-operated circuit breakers that can break the circuit with greater reliability and speed than fuses. The same transients may destroy the bridge-rectifier diodes, these cannot effectively be protected by fuses or breakers. One technique to overcome this is to use diodes that are much heavier than really needed; another is to supplement these with an RC network across the output of the transformer — to provide a reduced impedance path for voltage transients.

On the output of the supply, protection is needed to prevent too low a load impedance drawing excessive current. We know that a constant current supply uses a series monitoring resistor to produce a control voltage. The same method can be used to limit output current. A simple method often used in series regulators is illustrated in Fig. 1. The diodes D1 and D2 do not conduct until the voltage drop across the small series resistor reaches the forward voltage of the diodes (0.4 for germanium, 0.7 for silicon). If the output of the supply is short circuited the diodes will conduct and limit the output current to a value

$$I = \frac{V_{D1} + V_{D2}}{R_s}$$

Thus if germanium diodes were used and R_s was one ohm the supply would limit at

$$\frac{0.4 + 0.4}{1} = 800 \text{ mA}$$

Another serious condition that can occur is for the supply to produce (if only momentarily) *overvoltage* at the output. Protection against this is essential, for excessive voltage can destroy semiconductor loads connected to the supply. The technique used is very rapidly to sense when overvoltage occurs and immediately connect a very low resistance shunt across the output terminals. For obvious reasons this device is known as "crowbar" protection!

A well-designed "crowbar" takes into account operating times (microseconds is quite feasible), recovery time after triggering; triggering sensitivity and many other features.

The simplest crowbar arrangement is to place a suitably rated (and voltage value) Zener diode across the output, as depicted in Fig. 2. If the voltage exceeds the Zener voltage the Zener conducts, clamping the output to a point just above the normal maximum voltage available from the supply. Excessive current is controlled by the current limiting protective arrangement presumably built into the supply.

More sophisticated methods compare the output voltage to a reference source and use any sudden difference to trigger (see Fig. 3) a silicon-controlled-rectifier which shorts the output thus either blowing the supply fuse or putting the supply into current limit.

TRACKING SUPPLIES

Many circuits, IC op-amps for instance, require dual voltages — that is, positive and negative values referred to a common zero voltage. Some circuits require that both supplies provide exactly the same value of voltage, regardless of differences in load currents or fault conditions which may affect one output only. Another

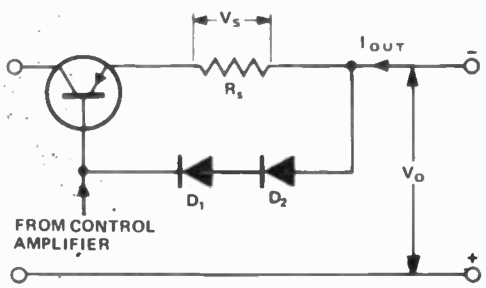


Fig. 1. Automatic current limiting is obtained with a series sensing resistor. This method of control is often used in series-pass voltage regulators.

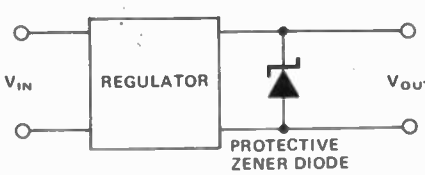


Fig.2. A Zener diode across the output provides "crowbar" protection against overvoltage.

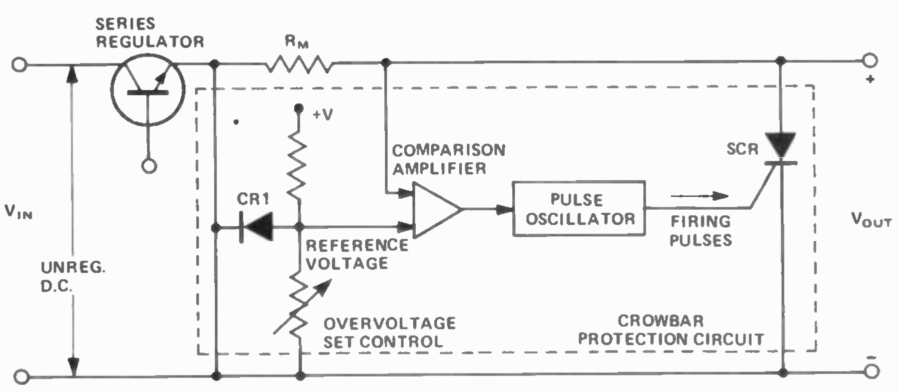


Fig.3. Active control can provide more effective crowbar protection. This circuit uses a silicon-controlled rectifier to short the output should overvoltage occur. The supply of course must be able to withstand such a short.

need for uniform supply outputs is where a number of slave supplies are required to follow a master unit. Supplies that have this inbuilt facility to follow external voltage are said to possess auto-tracking capability.

Auto-tracking is provided by comparing the two (or more) outputs using any (negative or positive) resultant error signal to control the regulator of one supply. One arrangement is shown in Fig.4.

Auto-series operation is also available in some proprietary units. This enables a number of units to be connected in series in order to provide increased voltage. Sensing circuitry ensures that the voltage is shared evenly across each unit.

HEAVY-DUTY SUPPLIES

The series pass regulator transistor is capable of medium-demand currents. Several transistors may be paralleled to increase the total capacity. However, the method becomes wasteful at high power levels as considerable power must be dissipated in the series pass elements.

A common way to provide greater power is to use the mechanically-driven variable transformer arrangement shown in Fig. 8, page 77, of the previous article in this series.

Another method uses special transformer designs that provide a reasonably wide degree of self-regulation, by varying magnetic leakage between primary and secondary windings or, by resonating the transformer windings with a tuning capacitor (transformer core saturates at a constant level).

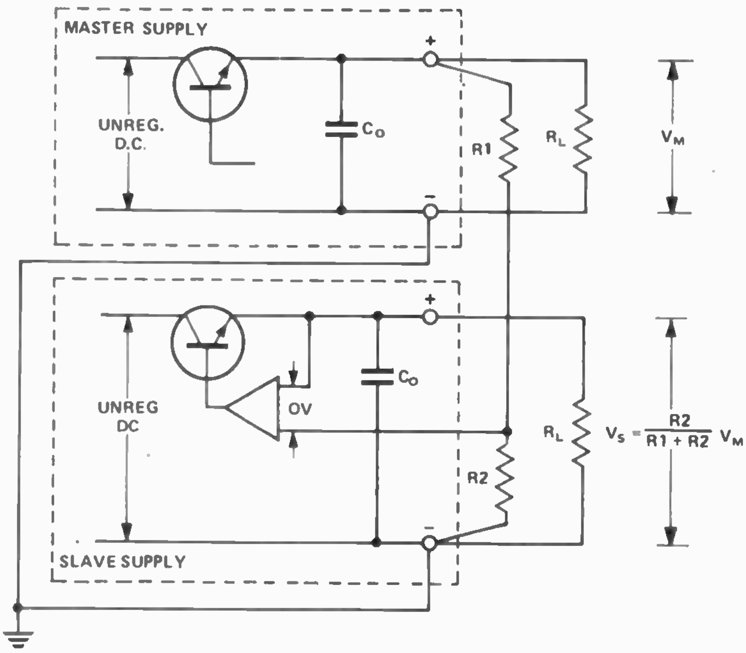
If a switch were to be incorporated, instead of the series-pass transistor, it could be operated with an on/off ratio such that the average power allowed to pass is controlled. This chopped waveform may then be filtered to provide smooth dc. Switching regulation, as this kind of operation is known, is one of the most efficient forms of regulator design because very little power is wasted. The output voltage is compared with a reference value, as before, and the resulting error signal is converted into an equivalent variable-rate, on-off digital signal. This, in turn, is used to control the on-off ratio of the series transistor switch. Where power loss must be minimized, switching regulators are essential.

SILICON CONTROLLED RECTIFIERS

Another kind of switching regulator uses the silicon-controlled rectifier SCR diode (see Fig. 5).

Silicon controlled rectifiers, unlike ordinary silicon diodes, have four semiconductor layers and three terminals (anode, cathode and gate).

Fig.4. Auto-tracking of two supplies can be achieved by using feed-back to sense the error between them apply correction to one of them.



Like a normal diode the SCR will conduct when the anode is positive with respect to the cathode. But, unless the gate is also positive, the SCR will not conduct at all! The SCR may be switched on at any point in the positive cycle by a positive voltage on its gate. Once the SCR is switched into conduction the gate loses control until the anode-to-cathode potential falls to zero. Thus in operation a single positive pulse will switch the SCR on at any desired time within the positive half cycle and, by varying the time at which this pulse occurs we may control the average power passed by the SCR.

To pass both positive and negative

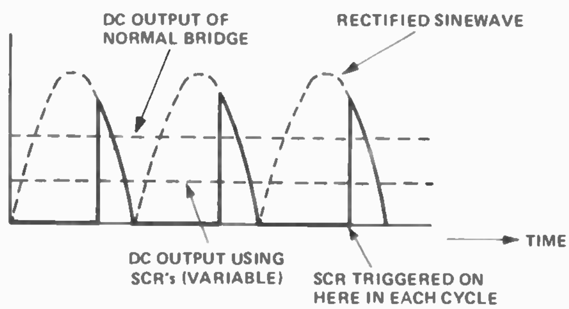
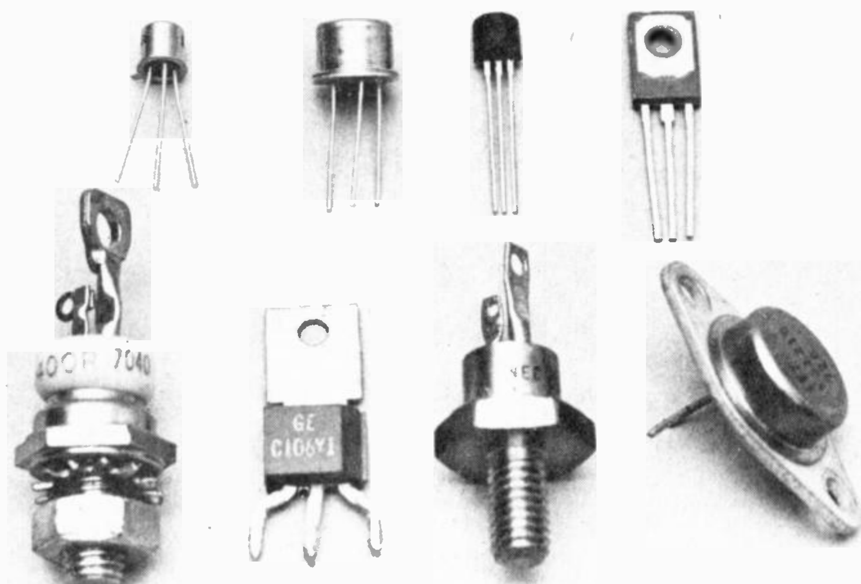


Fig.5. A range of silicon-controlled rectifier SCR's. The waveforms show how only a portion of each half cycle of the rectified sine-wave is switched through thus reducing the effective output voltage.



ELECTRONICS -it's easy!

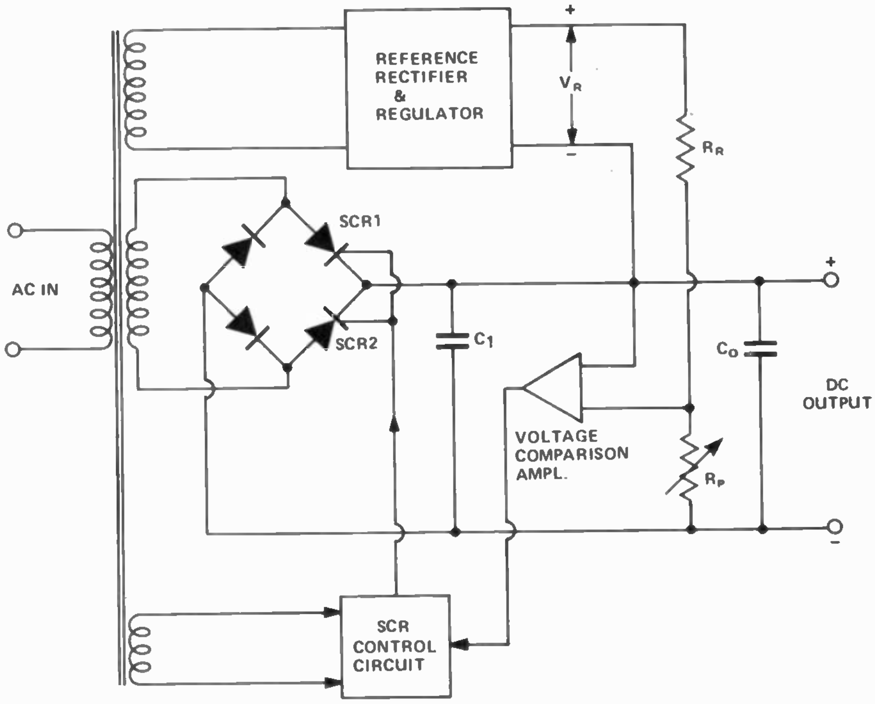


Fig.6. Use of SCR's in the power supply rectifier-bridge stage. The SCR control circuit output decides the average output of the bridge.

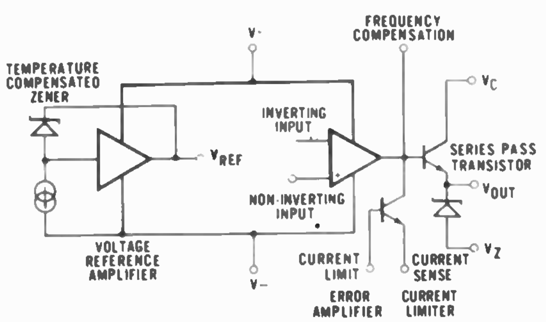
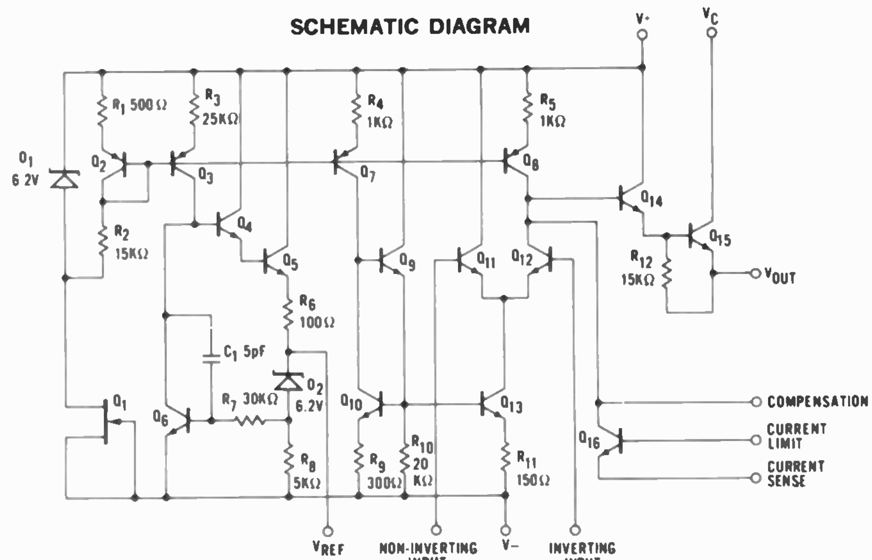


Fig.7. Circuit diagram and system schematic of uA723 I.C. regulator chip. An external series-pass power transistor stage is needed to complete the regulator.



half cycles we must use two SCRs connected appropriately or use a special device — called a TRIAC — which can be switched on for either polarity.

The schematic of a regulated supply using SCR power control is shown in Fig. 6. The power handling limits of SCR devices range to thousands of amps. As their main feature is control of power by switching, not by dissipation of unused energy, they do not need the same degree of cooling for a given load as would the series-pass transistor method.

INTEGRATED CIRCUIT REGULATORS

In recent years, special purpose IC components have become available that include a reference voltage supply, a comparator and a drive circuit for controlling an external series-pass regulator transistor all in one small device.

One such chip is the µA723 shown schematically in Fig. 7. From the internal circuit diagram it is clear that these units are capable of providing excellent regulation. The output voltage is adjustable on demand by altering the proportion of the output voltage which is compared to the reference voltage by an error amplifier. Ancillary built-in circuitry provides current limiting and crowbar action if needed.

Also available are regulator IC's which have the series-pass power stage formed on single silicon chips. The LM109 and LM309 are such regulators (circuit shown in Fig. 8) and provide 5 V with output load in excess of 1 ampere. The LM309 has internal thermal overload protection, internal current limiting and is virtually blow-out proof. As is shown in Fig. 8, nothing could be simpler to use if a fixed voltage is needed. The cost is a mere three dollars — thereby, powerfully demonstrating that today's electronic discipline is a matter of system rather than component design.

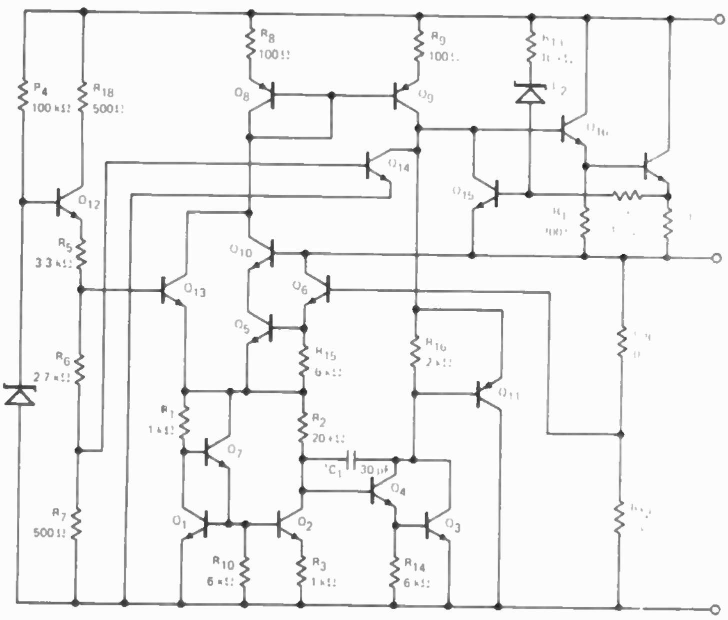
Further Reading

References given in the article before last are most relevant to the design of regulators. On the more specific aspects of design and use, the following are worth considering for purchase:

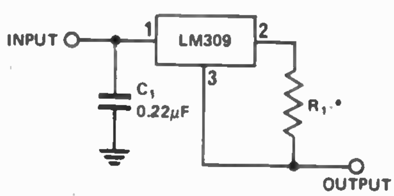
"Zener diode handbook" Motorola, 1967.

"Thyristor projects using SCRs and Triacs" R.M. Marston — Butterworths, 1974.

"Silicon rectifier handbook" Motorola, 1966.

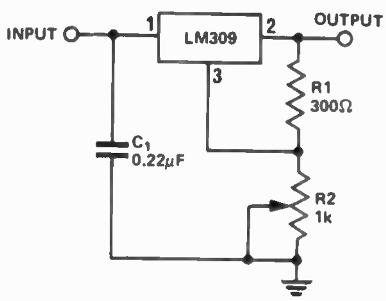


CURRENT REGULATOR

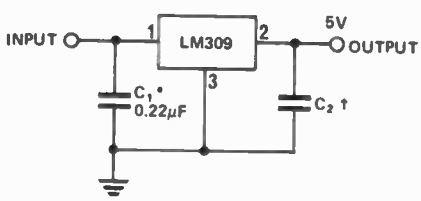


* DETERMINES OUTPUT CURRENT

ADJUSTABLE OUTPUT REGULATOR



FIXED 5V REGULATOR



* REQUIRED IF REGULATOR IS LOCATED AN APPRECIABLE DISTANCE FROM POWER SUPPLY FILTER.

† ALTHOUGH NO OUTPUT CAPACITOR IS NEEDED FOR STABILITY, IT DOES IMPROVE TRANSIENT RESPONSE.

Fig.8. The LM309 I.C. regulator has the series-pass transistor (Q17) formed on the same chip. The circuitry is most sophisticated. Several different applications are shown schematically.

Simple regulated supply provides 1.5 to 15 volts at up to 1 ampere.

Earlier in this course details were given of an unregulated power supply that provides a dc output varying from 18 V at no load, dropping to 10 V at maximum load.

This unit can be extended by the addition of a series-pass regulator that employs an IC regulator chip and a power transistor. It incorporates current limiting and the output can be preset to provide any voltage between 1.5 and 15 V with a load current as high as 1 amp.

The circuit diagram for the complete regulated supply is shown in Fig. 9. By studying this, in conjunction with Fig. 8, it can be seen that adjusting RV1 provides the comparator error amplifier with a reference voltage up to the full 7.15 V produced by the built-in Zener reference circuit. Resistors R_2 and R_3 provide a divider chain that is tapped to enable the actual output voltage to be attenuated by a factor of 2.2. Thus the output is controlled so that it is 2.2 times the reference voltage provided by RV1.

The capacitor connected between pin 9 and pin 2 provides frequency compensation; improved feedback control performance is obtained by appropriate selection.

Resistor R_{sc}, in series with the output, is a current-sensing resistance. Its value, and hence the voltage developed across it, (at pin 1) determines the current limit point. Pin 10 clamps the emitter of Q1 if V_{Rsc} exceeds 0.6 V.

The maximum output voltage and current obtained from the unit is a function of components used. Using a 15 V centre-tapped transformer with 1 A capacity it provides 1 A at 10 V and 0.5 A at 15 V. Output voltage can be changed by altering the ratio of R_2 and R_3 with smooth manual control being obtained with RV1.

Maximum output must not exceed 25 volts. (The complete set of components for this unit is available as project ETI 111.) ●

ELECTRONICS – in practice

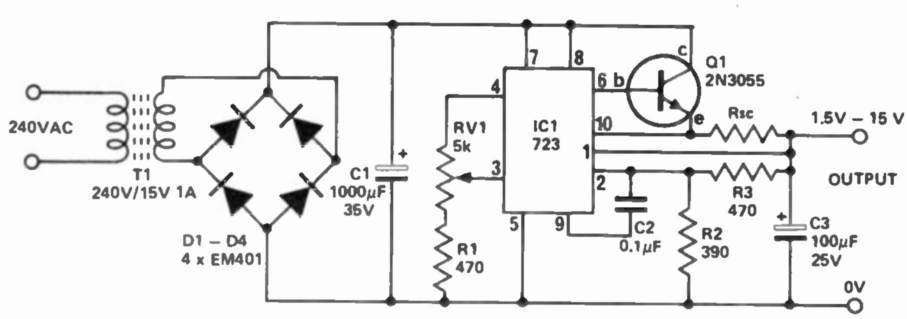


Fig.9. This regulated supply, based on a μA723 IC, provides an output adjustable between 1.5 and 15 volts.

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7400	$ .19	7447	$1.15	74145	1.15
7401	.19	7448	1.15	74150	1.09
7402	.19	7450	.24	74151	.89
7403	.19	7451	.27	74153	1.29
7404	.22	7453	.27	74154	1.59
7405	.22	7454	.39	74155	1.19
7406	.39	7460	.19	74156	1.29
7407	.39	7464	.39	74157	1.29
7408	.25	7465	.39	74161	1.39
7409	.25	7472	.36	74163	1.59
7410	.19	7473	.43	74164	1.89
7411	.29	7474	.43	74165	1.89
7413	.79	7475	.75	74166	1.65
7415	.39	7476	.47	74173	1.65
7416	.39	7483	1.11	74175	1.89
7417	.39	7485	1.39	74176	1.65
7420	.19	7486	.44	74177	.99
7422	.29	7489	2.75	74180	1.09
7423	.35	7490	.76	74181	3.65
7425	.39	7491	1.29	74182	.89
7426	.29	7492	.79	74184	2.69
7427	.35	7493	.79	74185	2.19
7430	.22	7494	.89	74190	1.59
7432	.29	7495	.89	74191	1.59
7437	.45	7496	.89	74192	1.49
7438	.39	74100	1.65	74193	1.39
7440	.19	74105	.49	74194	1.39
7441	1.09	74107	.49	74195	.99
7442	.99	74121	.57	74196	1.85
7443	.99	74122	.53	74197	.99
7444	1.10	74123	.99	74198	2.19
7445	1.10	74125	.69	74199	2.19
7446	1.15	74126	.79	74200	7.95

LOW POWER TTL

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74L02	.33	74L55	.33	74L91	1.45
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74L04	.33	74L72	.49	74L95	1.69
74L06	.33	74L73	.69	74L98	2.79
74L10	.33	74L74	.69	74L164	2.79
74L20	.33	74L78	.79	74L165	2.79
74L30	.33	74L85	1.25		
74L42	1.69	74L86	.69		

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74H08	.33	74H40	.33	74H62	.39
74H10	.33	74H50	.33	74H72	.49
74H11	.33	74H52	.33	74H74	.59
74H20	.33	74H53	.39	74H76	.59

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74C04	.75	74C107	1.50	74C164	3.50
74C08	.75	74C151	2.90	74C173	2.90
74C10	.65	74C154	3.50	74C195	3.00
74C20	.65	74C157	2.19	80C95	1.50
74C42	2.15	74C160	3.25	80C97	1.50
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5311	28 pin BCD 6 dig mux	4.95		Fits 14 pin DIP — .11 bubble lens	2.75
5312	24 pin 1 pps BCD 4 dig mux	4.95	MAN 7	Red 7 seg .270"	.99
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DTL

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741	Comp Op AMP	mDIP TO 5	.35
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COMPONENT NEWS

RECORDER MONITORS PC BOARD TEMPERATURES DURING PREHEATING AND AUTOMATIC SOLDERING

Accurate indication of printed circuit board temperatures during preheating and flow soldering, per MIL-S-46844A (MI), is provided by the Telatemp Model 110 Temperature Recorder.

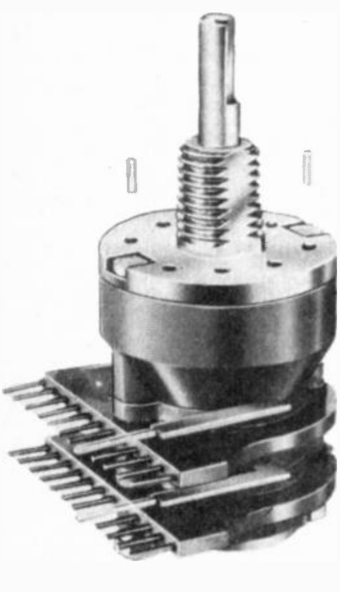
Model 110 contains six calibrated heat-sensitive increments. These increments are silver-coloured windows which turn irreversibly black at their rated values. Incremental values ranging from 100°F to 350°F are available in 10°F steps. Response time is less than one second. Accuracy is ±1%.

After removing the protective backing, the Model 110 is easily applied to the surface of the PC board. A single Model 110, covering 160° F to 210° F, is ideal for monitoring PC boards during preheating operations. Model 110's with higher incremental values also serve this purpose and provide a warning if sensitive components are in danger of overheating. Telatemp recorders of smaller size and with fewer increments are also available.

MIL-S-46844A (MI), covering automatic flow soldering of PC board assemblies, requires gradual preheating to 180°F, and maintenance of that temperature ±20°F.

Further details:– NS Electronics Pty. Limited, Cnr. Stud Road & Mountain Highway, Bayswater, Vic. 3153.

ADJUSTABLE STOP ROTARY SWITCHES



ACME Engineering, Victoria, offer the new Grayhill Series 71 adjustable stop rotary switch which is of multideck, multipole, solder lug or PC termination configuration.

The adjustable stop feature is inventoried as standard with solder lug of PC mountable (terminals on one side) termination. Either version is available in 30° or 36° angles of throw and with a maximum of 12 enclosed rotary decks. One to four poles per deck are available in the solder lug type and one or two poles per deck in the PC mountable variety.

The Series 71 is the popular economical version of a small multideck enclosed rotary switch. In addition to low price, the Series 71 features a gold plated contact system, moulded-in position terminals, and diallyl insulating material.

Further details: Acme Engineering Co. Pty. Ltd., Kilsyth. Vic. 3137.

HIGH PRECISION, MICRO-POWER INSTRUMENTATION AMP

The LH0036G, a hybrid instrumentation amplifier from National Semiconductor, is a true micropower circuit designed for precision, differential signal processing. Users will find it particularly useful in applications such as premultiplex signal conditioners, isolation amplifiers (e.g., in medical telemetry), thermocouple amplifiers, active filters, control interfaces and in battery-powered uses in general.

A combination of high input impedance (300 MΩ) and high common-mode rejection ratio (100 dB) accounts for the LH0036G's accuracy: gain deviation from formula is only 0.3% typ. The power supply operating range is very wide, from ±1 V to ± 18 V, and the circuit's power demand is only 90 µW at the low end of the supply voltage range.

Users of the LH0036G can programme its gain from X1 to X1000 with a single resistor. Output bandwidth is also adjustable – from 350 Hz (small signal) to 5 kHz (full power) at unity gain – as is the input bias current. A guard-drive output pin is provided.

The LH0036G is specified for operation between –55° and +125°C; an industrial version, the LH0036CG operates from 25° to + 85°C. Both parts are housed in hermetic, 12-lead, TO-8 metal cans.

Further details: NS Electronics Pty. Ltd., Cnr. Stud Road & Mountain Highway, Bayswater, Vic. 3153.

CHEAPER SOS-CMOS

A full line of standard CMOS-on-sapphire circuits is now available from Inselek Corp. in relatively low-cost plastic packages. Plastic versions of half of the firm's commodity INS4000 line have already been introduced and are already in stock.

SOS CMOS circuits offer speed and power advantages over CMOS built on silicon substrates. However, they have been substantially more expensive in commercial grades because Inselek, the sole source of standard CMOS-on-sapphire products, has used only ceramic packages. And bulk-silicon CMOS has been available in plastic packages at about half the price of ceramic-packaged SOS.

Now, however, Inselek's plastic-packaged versions of its standard SOS line are priced at or near the equivalent 4000-Series CMOS parts. SOS gates are priced at 59 to 73 cents in thousand quantities.

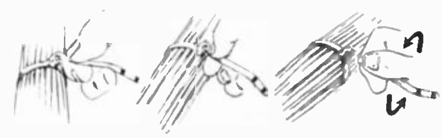
Further details: Integral Design Pty Ltd., 105 Hawthorn Rd., Caulfield, Vic. 3161.

THERMAL SWITCH

Hybrid Electronics Australia recently announced the development of a thermal switch which undergoes an extremely dramatic change of resistance with temperature of 70°C. This unique property gives the thermal switch applications in areas such as electronic circuit protection, motor protection, air conditioning, fire protection, and high stability thermal ovens – in short any application having a need for a defined thermal point at 60°C to 80°C.

Hybrid Electronics Australia Pty Ltd, Factory 4, Jersey Road and Malvern Street, Bayswater, Vic. 3153.

CABLE TIE NEEDS NO INSTALLING TOOL



Most cable ties require tools to instal, especially where controlled tension is necessary. Many types of tools are available from simple plier types to air operated fully automatic placement tools.

The latest introduction to the Australian market is the TYGER TAIL Ty-rap that has a unique design that features small, virtually invisible slits on the sides of the tie that permits the tail to be twisted off easily and quickly with a twist of the wrist. No installing tool is necessary.

This new tie substantially reduces wire tying time for installation and repair in control equipment, automotive and plant maintenance. It is ideal for tying temporary cable runs where quick installation and quick removal are desirable.

Further details: Thomas & Betts Pty. Ltd., P.O. Box 91, Brookvale, NSW 2100.

HYBRID DEVELOPMENTS

Although thick film hybrid circuits are well known in the electronics industry, the advantages and economies they offer have not been fully utilised by Australian industry in general.

The hybrid thick film technique involves the printing, trimming or adjusting and assembly of many components onto a

COMPONENT NEWS

substrate – rather like a miniature printed circuit board.

The degree of miniaturisation and complexity possible with hybrids has been capably demonstrated in a brochure recently released by Hybrid Electronics Australia – one of the circuits shown contains 11 transistors and diodes, 40 resistors and 8 capacitors all encapsulated on a substrate measuring 40 mm x 15 mm, in addition the precision trimming of resistors has eliminated the need for the manufacturer to use expensive and relatively unreliable potentiometers.

The utilisation of hybrid circuits in a system enables the equipment manufacturer to effect considerable savings in time and labour, reliability is improved and space requirements are dramatically cut. Service and repairs, generally by replacement, are correspondingly fast. The brochure is obtainable from Hybrid Electronics Australia Pty Ltd, Factory 4, Jersey & Malvern St., Bayswater, Vic. 3153.

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FALSELY represents that goods are new.

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SPECIFICATIONS:

IC150

Frequency Response:— HI-LEVEL ±0.6 db 3 Hz-100 kHz; PHONO ±0.5 db of RIAA, calibrated. **Hum and Noise:**— HI-LEVEL 100 db below 2.5V, "A" weighted; PHONO 80 db below 10 MV input. **Distortion:**— THD essentially unmeasurable; IM .003% at rated output. **Phono Input:**— Sensitivity 1MV at 1kHz for 2.5V out; Overload 33-330 MV at 1kHz (adjustable). **Output:**— Rated at 2.5 volt, typically 10V before overload. **Volume Control:**— Over 60 db dynamic range with calibrated tracking. **Loudness:**— Excellent simulation of Fletcher Munson curves down to 60 phono, co-ordinated with volume control. **Phase Shift:**— Typically + 1° to −12° 20Hz to 20 kHz. **Tone Controls:**— ± 15 db at 30 Hz to 15 kHz. **Filters:**— (High and low filters).

D150

Frequency Response:— ± 0.1 db 20-20 kHz at 1 watt into 8 ohm;.± 1 db 4-100 kHz. **Power Output:**— 100 watt RMS into 8 ohm, both channels operating. **Power Bandwidth:**— ± 1 db, 5-20 kHz at 75 watt RMS into 8 ohms. **Distortion:**— THD typically 0.002%. (At .01 to 75 watts) IM typically 0.005%. **Damping Factor:**— Greater than 200 from zero to 1 kHz 8 ohms. **Weight:**— 25 lbs.

THE AMCRON PHILOSOPHY

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Audio Magazine said:— "IC150 — We were all able to measure hum and noise levels of approximately — 93 db below 2.5 volts output, and phono noise of about .50 microvolts — D150 — at a typical output of 75 watts (8 ohms) IM was measured at 0.002%, by implication, THD might be expected to be approx. 0.0005% which neither Amcron nor we could measure. If you want the very best, our endorsement of the IC150/D150 is completely given without any reservations.

Stereo Review said:— IC150 "We found the frequency response to be down only 0.3 db at our lowest limit of 5 Hz and 1 db at 225 kHz. The RIAA equalization was so accurate (±0.25 db) that we may have been checking the residual errors in our setup."
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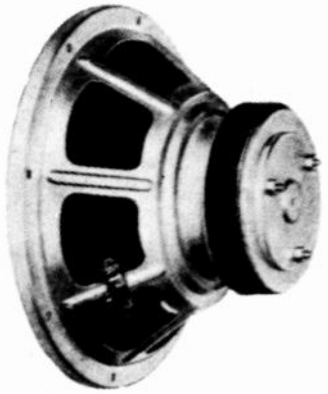

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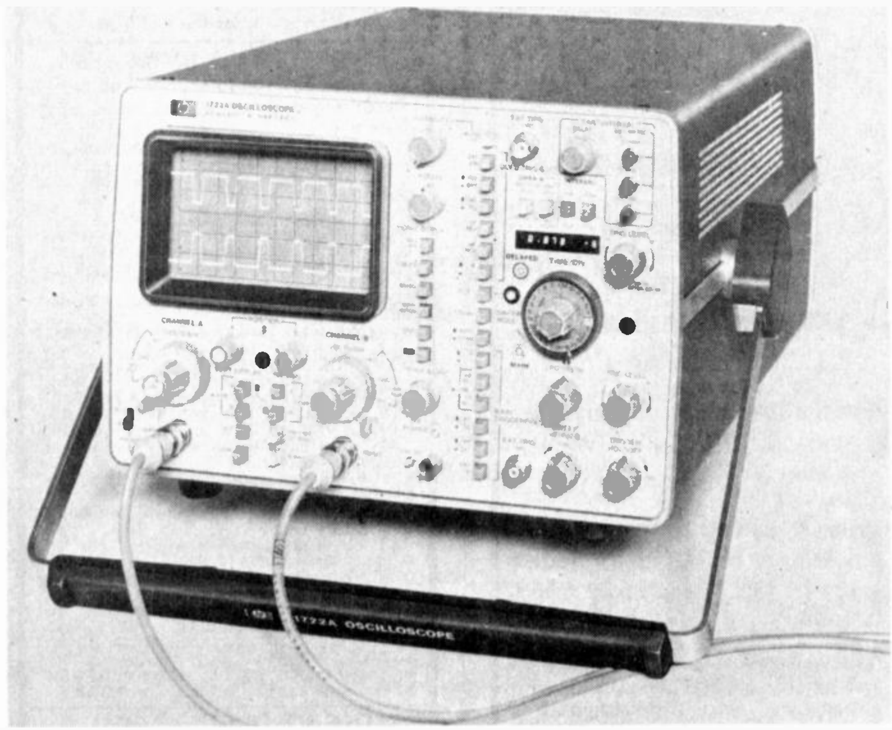
EQUIPMENT NEWS

MICROPROCESSOR IMPROVES SPEED, ACCURACY OF 275-MHz OSCILLOSCOPE

Using the microprocessor from the familiar HP-35 Calculator, a new dual-channel 275-MHz oscilloscope, Model 1722A from Hewlett-Packard, provides digital LED readout of time interval, frequency, dc voltage, peak or instantaneous voltage, and per cent difference between amplitudes. All these, and the scope display, are taken from a single probe to the circuit under test. The resulting benefits are improved accuracy, increased measuring speed, reduction in the sources of human error, and greater convenience.



Time Interval

Such measurements as clock phase, risetime, pulse width, period or propagation delay can be made with resolution as great as 20 ps. With an exclusive new HP technique, dual delayed sweep, both the start and stop points of a time interval measurement can be displayed as intensified markers on the screen. The interval, thus precisely defined, is then calculated by the microprocessor and digitally displayed on the LED readout. For maximum possible accuracy, the start and stop points on the trace, displayed alternately, may be overlapped. There is no counting of lines, no interpolating between lines, and no mental multiplying of dial settings. Desired time intervals can be preset into the LED readout, and the tested circuit then may be adjusted, with the same techniques, with digital accuracy.

When the 1722A is set to the 1/TIME mode, the microprocessor computes the reciprocal of whatever was set in the TIME mode, and displays the answer on the LED's. If that was the period of a waveform, the display is a direct readout of frequency (or repetition rate). Like time interval, frequency may be preset, a tested circuit then precisely adjusted to match.

Voltage

The 1722A may be set so its LED's digitally indicate the average (dc) voltage at the input of Channel A. It functions then as an autoscaling 3½-digit DVM. The display can also be compensated if a 10:1 divider probe is used. There is a POSITION mode with which the amplitude of any point on the display may be measured, either relatively or absolutely, thus giving instantaneous voltage levels. A reference level may be established, and any other displayed level then compared with it, so the unit also functions as a differential voltmeter. And there is a simple technique by which the percentage difference between any two amplitudes on the screen may be calculated and displayed. Percentage difference, too, may be preset.

The 1722A is based on the familiar HP Model 1720A Oscilloscope, and retains all its performance characteristics. That includes full 275-MHz bandwidth in both 50-ohm and 1-megohm input modes, over the full 6 x 10 cm display area, in vernier as well as calibrated settings, and over the full 0^{o} to $55^{o}C$ environmental temperature range. Vertical deflection factors are 10 mV/div to 5V/div over the full 275-MHz band, with 2% attenuator accuracy. The 50-ohm input is internally compensated for faithful pulse reproduction and accurate transition time measurements. Stable internal triggering to 300 MHz requires only 1 cm of deflection: because the trigger sync take-off is just after the attenuator, the display remains stable regardless of changes in position, vernier, or polarity controls.

Further details: Hewlett-Packard Australia Pty Ltd, 31-41 Joseph St. Blackburn, Vic. 3130.

ELECTRONIC INVENTORY CONTROLLER

An Inventory Controller capable of keeping records of up to 4000 items in its memory has been introduced by Stocol. A print-out of any item or group of items can be called for at any time, and a 800 item all-inclusive inventory statement can be printed in under four minutes.

Items can be updated at any time, and the memory accepts figures in up to six digits for each item. Quantities that come in or go out can be quickly ascertained in the dual form of visual display and print at any time around the clock.

Further details from:– Technical & Scientific Equipment Co. Pty Ltd., G.P.O. Box 241E, Melbourne, 3001.

EXPANDED SCALE DIGITAL pH METER

A pH meter (Model 113 Digital) which provides the expanded facilities of specialised instruments at a price claimed to be competitive with general purpose pH meters, has been developed by Evans Electroselenium Ltd, of Halstead, Essex, UK.

The maker claims that users will no longer have to choose between the general purpose instrument which is accurate enough for present needs and the highly accurate more expensive meter which future work loads could require.

Features include digital readout for clear, error-free readings, and a push-button expand facility available over the entire pH or mV range, providing the necessary resolution for research pH and ion selective electrode determinations.

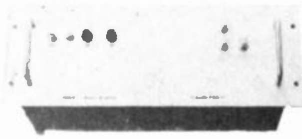
When used in the normal range mode, the least significant figure is eliminated and an electronic circuit automatically rounds the next digit up or down. Temperature, calibrate, and slope controls are included, so that measuring conditions can be standardised easily.

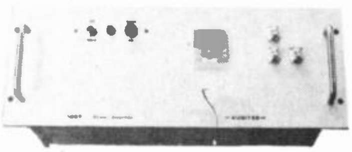
Further details: Tosco Pty Ltd., P.O. Box 245, Hawthorn, Vic. 3122.

Continued on Page 101

RACK MOUNTING

100 WATTS





250 WATTS

Model 1009 125 watts r.m.s. into 4 ohms at 0.1% t.h.d. $108.50 + 15% sales tax.

Model 1027 250 watts r.m.s. into 8 ohms at 0.2% t.h.d. output balanced 45V line $195.00 + 15% sales tax.

Both amplifiers mount in a standard 19 inch p.m.g. rack, and are available with optional v.u. meters and preamplifiers. The outputs are fully short-circuit protected, and input sensitivity is 1 volt with a preset volume control.

Auditec Modules are available from:

- All branches of Kitsets Aust. Pty Ltd.,
- Allan Oliver Electronics Pty Ltd., 188 Pacific Highway, St. Leonards.
- Delsound Pty Ltd., 103 Cavendish Rd., Coorparoo, Qld.
- Custom Amplifiers, 64 Talbragar St., Dubbo, NSW.
- Bundaberg Hi-Fi, 244 Bedrge St, Bundarerg, Qld.

For full details and price list of all Auditec Modules and other products send the coupon below, or contact

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E.T. 3/75

FM TUNER

P&P $2.00
Heathkit AJ-1214
AM/FM Stereo Tuner Kit $179.75

250 WATTS R.M.S. INTO 8 OHMS

The new 027 module from Auditec — Recommended price $98.50 + 15% sales tax.

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009 125 watt power amplifier **$52.50.**
013, 014 Siren modules **$9.55**
015 Guitar/Public address/entertainment preamps **$12.90.**
016 6-channel mixer module **$7.95.**
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023 Regulated power supply for all Auditec preamps **$12.95.**
024 Variable regulated laboratory power supply **$22.00.**
025 Stereo magnetic preamplifier to professional specs **$15.90.**
028 Stereo 20 watt power amplifier **$32.25.**
Prices of 001, 2, 5, 025, 028 plus 27½% sales tax; all others plus 15%.

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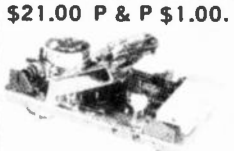
$21.00 P & P $1.00. Stereo Recording and Playback Pre-Amp Kit for VORTEX Cassette Deck



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ELECTRET MICROPHONES

Frequency Response: 50-13,000Hz; Power Supply: 1 Penlight Battery; Amplifier: FET Impedance Convertor; Output level: (1,000Hz) —68 dB ±3 dB; Polar Pattern: Omni-directional; Dynamic Range: Up to 90 dB SPL; Max. Sound Pressure: 120 dB SPL; Battery Life: 6,000 Hours Coninuois.

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EQUIPMENT NEWS

FM STEREO ALIGNMENT GENERATOR

Sound Technology Model 1000A FM alignment generator is designed specifically to permit fast, accurate adjustment of monaural and stereo FM systems. The 1000A uses "dual sweep", a refinement of conventional sweep alignment techniques to provide a unique visual display of receiver performance.

An operator need only connect the 1000A's RF output (variable in frequency from 88 to 108 MHz and adjustable in level from 0.5μV to 30,000μV) to the receiver antenna terminals and feed the receiver audio output to the 1000A's built-in filter. Distortion and tuning characteristics will then be displayed – even on an inexpensive oscilloscope – without probing inside the receiver.

The instrument has switchable left and right audio tones as well as 19 kHz pilot tone test, phase test, and composite output for separate alignment and testing of stereo decoders.

The Model 1000A is primarily a service instrument but when coupled to the 1100A Signal Conditioner it forms a miniature precision FM transmitter.

Outputs from phonograph, tape recorders, and cassette recorders may be fed into the 1000A/1100A combination and translated into an extremely high quality FM stereo signal anywhere in the broadcast band independent from multipath, weak signals and traffic interference.

This means that sales/service organisations need not depend on local stations for programme material and that potential customers can make comparative listening tests between good and indifferent receivers.

Further details: Arlunya Pty. Ltd., P.O. Box 113, Balwyn, Vic. 3103.

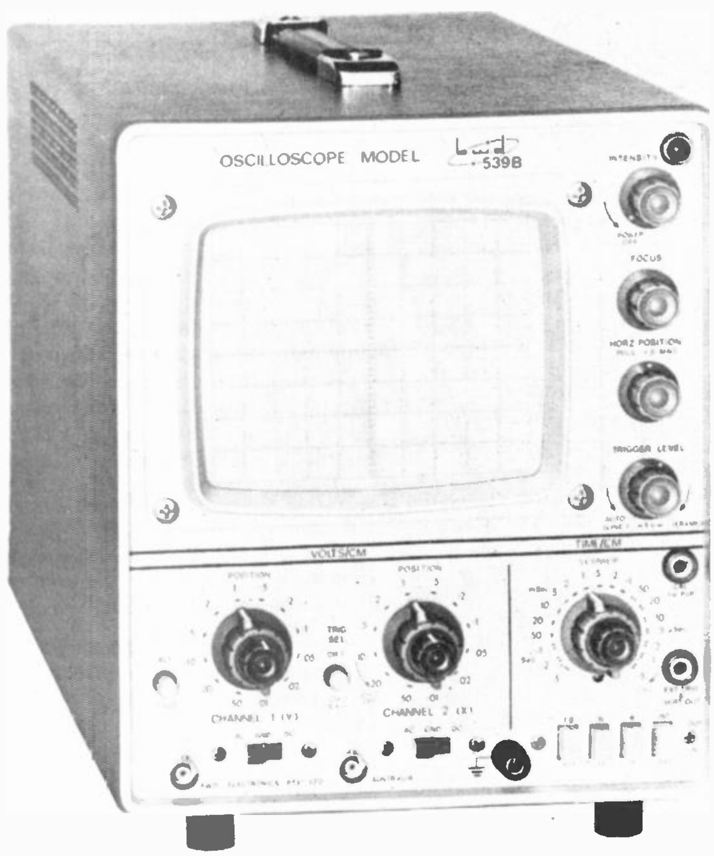
NEW BWD DUAL TRACE 'SCOPE

At the start of their 20th year of instrument design and manufacture in Australia, B.W.D. Electronics have released a new dual trace oscilloscope, model 539B.

The new model features DC – 16 MHz –3 dB vertical amplifiers with a sensitivity range of 10 mV to 50 V/cm. Additionally a cascade facility provides single channel operation of 500 μ V/cm with a 3 Hz to 30 kHz bandwidth. The Time Base range extends from 100 nsec/cm down to 2.5 sec/cm in 19 steps with a vernier control and x5 magnification. Triggering extends from 1 Hz to well over 30 MHz for both internal or external sources. An active sync. separator ensures a jitter-free lock to line or from TV waveforms. The cal waveform is a 1% fast rise time line frequency square wave. Its leading edge corresponds within two degrees of the input ac power line zero cross over. As a trigger source it ensures the time base starts at zero cross-over for phase measurements of line frequency signals. Identical X-Y is incorporated and phase corrected to better than 1 degree from dc to almost 200 kHz. Horizontal bandwidth is dc to better than 2 MHz –3 dB. An 80 x 100 mm viewing area and 3.3 kV acceleration voltage ensures bright well focused displays.

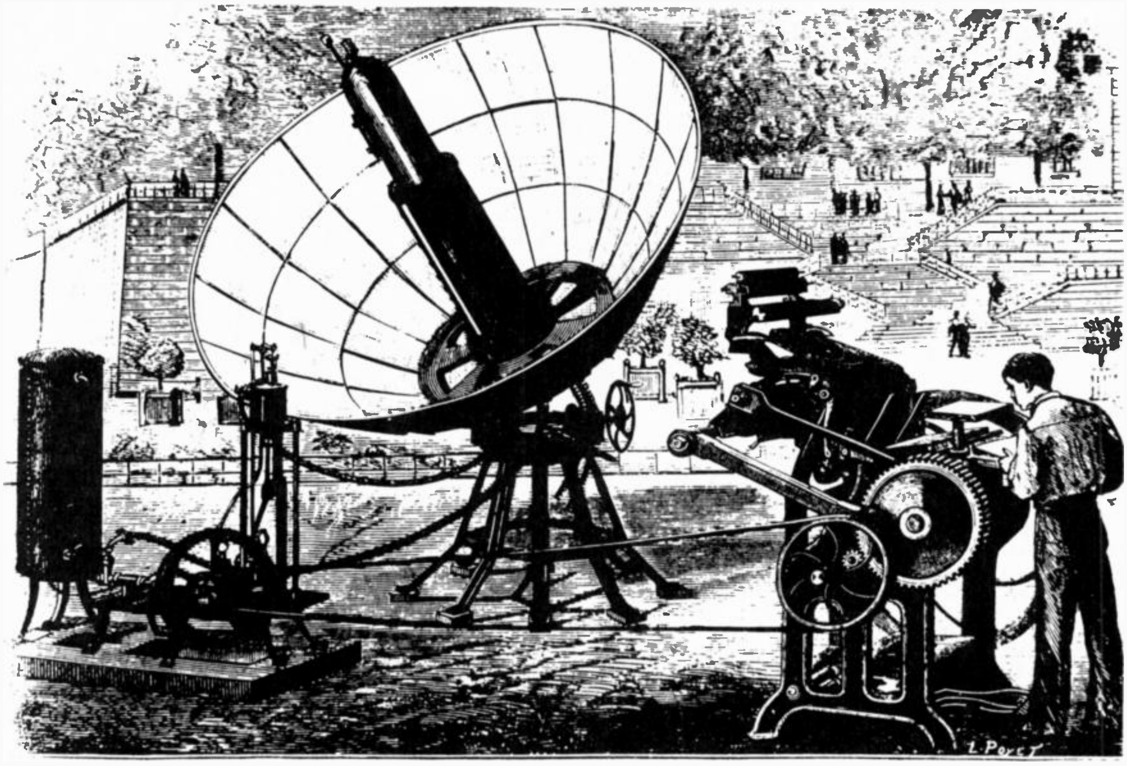
The amplifier and triggering characteristics extend well beyond the specified –3 dB level. A special chart is included in the handbook showing the actual response to beyond 80 MHz. An attenuator multiplier curve allows this extension of the normal bandwidth to be used to make calibrated measurements to better than 40 MHz.

Further details: BWD Electronics Pty Ltd, 331-333 Burke Rd., Gardiner, Vic. 3146.



SENSORS ON by Talus

SOLAR POWER YET!



Printing press driven by solar energy (1882)

LAST FEBRUARY I arrived in Britain just a few days after petrol once again became freely available. Rumour had it that there had never been a genuine shortage — it was all an oil company plot, but true or not, petrol *had* been in very short supply.

The British truly responded in yet another time of need. Shops were, indeed, lit by gas lamps, government buildings were allowed only half lighting and heating. Parking stations were in absolute darkness. The road speed limit was down.

Later I went to America where 55 mph speed limits were still in force. Imagine driving a new 6.0 litre V8 on a six lane divided highway over hundreds of kilometres of Arizona desert at such a speed! The Americans were tolerant — highway patrols and helicopter patrols helped. But no wonder the Americans were worried by an oil shortage. They had a lot more to lose than we have for they have become accustomed to refrigerated airconditioning in every conceivable shell — houses, offices, factories, cars, service stations, road houses, churches. Even the smallest outback cheap motel has it. To give an idea of the immense load this draws, one system airconditioning a New York building has the cooling effect the equivalent of 100 000 tonnes of ice each day. There are a lot of such buildings in the States.

Australia hardly felt the impact of the energy crisis for we are not so dependent on fuel in our domestic lives as the Americans. We were lucky that time.

Recently I came across an interesting paperback for energy conservationists. It is called "Handbook of Homemade Power" — a Bantam book of the Mother Earth Series. It is crammed with ideas about generating your own power. Unfortunately it does not indicate how to do it more cheaply than via oil or electricity, but at least once the capital investment is made you are getting something for nothing. Mind you, to fully implement many of the suggestions — solar panels, windmills, etc, — would make your house look like a gadgeteer's paradise.

Solar power is not a new idea — alchemists and chemists have used concentrating lenses to heat chemical reactions for centuries. However, the prize must go to Monsieur Abel Pifre, a French engineer who operated a small printing press for 5½ hours on 6th August, 1882, using steam raised by a 3.5 m diameter solar concentrator. Even though the day was overcast, the engine generated about 500 W of power — which was nowhere as efficient as is possible today. The report of the day said: "there is little doubt that such a solar engine will be a boon to the population of hot areas which so often suffer from a shortage of fuel".

How about solar energised air-conditioning for houses — the hotter the day, the greater the amount of cooling? ●

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KC6MX	8W RMS	50Hz-20kHz
C60	10W RMS	35Hz-7500Hz
C60X	10W RMS	30Hz-17kHz
C80	20W RMS	35Hz-8kHz
C80X	20W RMS	35Hz-20kHz
C100	20W RMS	40Hz-11kHz
C100X	20W RMS	40Hz-20kHz
C12P guitar	30W RMS	55Hz-10kHz
C12P woofer	30W RMS	35Hz-10kHz
C12PX wide range	30W RMS	35Hz-13kHz
C12PX guitar	30W RMS	55Hz-13kHz
12U50	50W RMS	25Hz-11kHz
12UX50	50W RMS	40Hz-13.5kHz
MIDRANGE		
C6MR	20W RMS	450Hz-6600Hz
KC5MR	15W RMS	700Hz-14kHz
TWEETERS		
X20 horn	—	3kHz-30kHz
X30 dome	—	3kHz-30kHz
KC 3G X cone	—	1.5kHz-19kHz
5FX cone	—	4kHz-20kHz

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AR68

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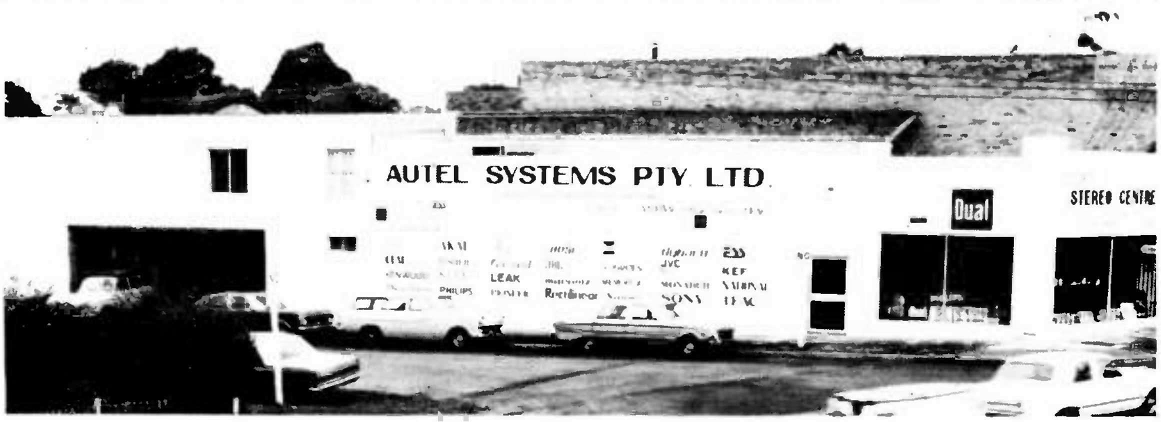

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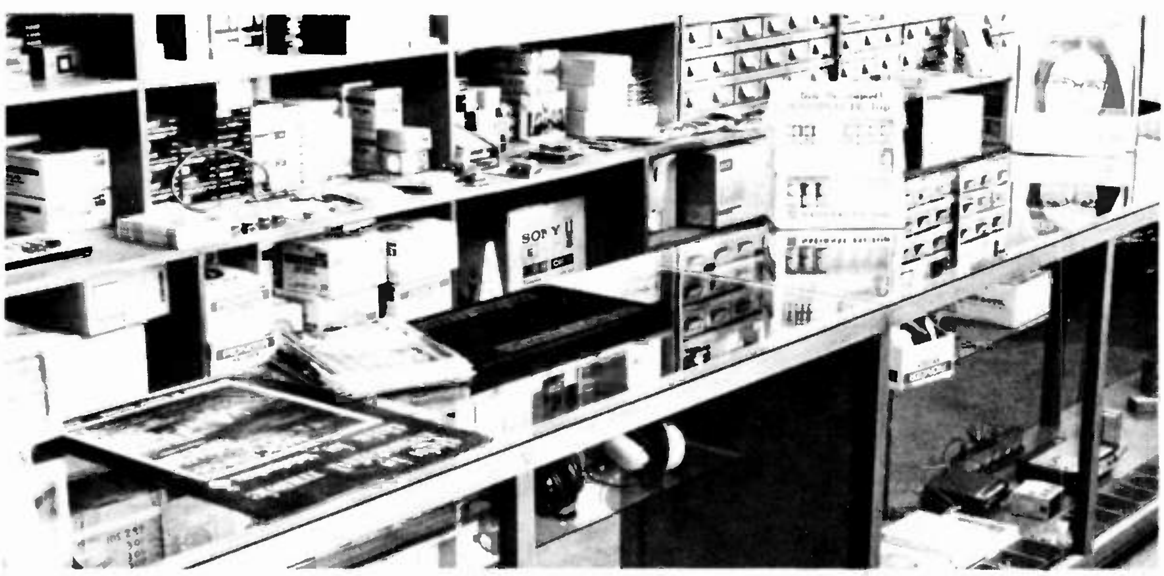

Want a lead to suit your set to match that accessory? Want any type of plug? Also, complete stocks of spare parts for National, Nivico, Teac, Jorgen, ESS, Marantz, and many others. Largest range of equivalent parts to suit those hard-to-get spare parts for rare models.

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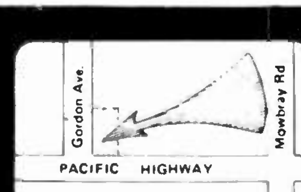

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IDEAS FOR EXPERIMENTERS

A potpourri of circuits, ideas, hints and tips.

SIMPLE DIGITAL CAPACITANCE PROBE FOR COUNTER

This simple adaptor enables a digital counter to be used to measure capacitance.

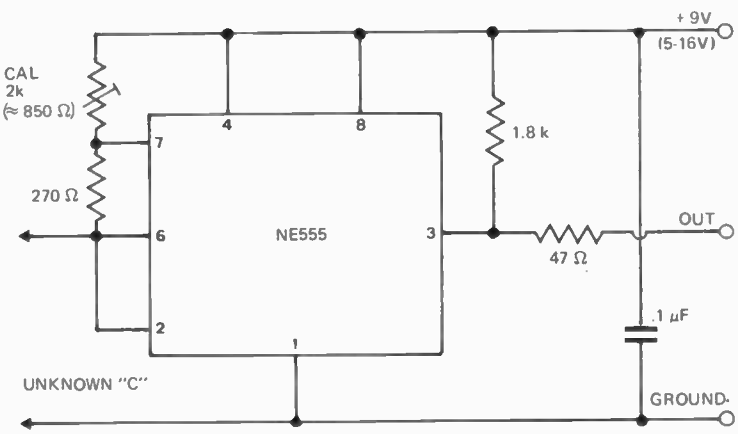
Various ICs may be used but the 555 series is the most practical and readily available.

Probe output is coupled to the digital counter via coax. The counter is switched to the 'period' ranges with seconds read as µF, milliseconds as nF and microseconds as pF.

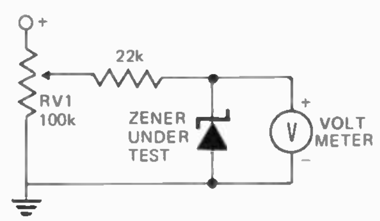
Accuracy depends on the accuracy of the calibration capacitors and of the power supply regulation. A calibration chart could of course be used if great accuracy or small capacitance value is required.

My prototype unit accurately measured a 50 000 µF capacitor and a 2 µF could still be measured accurately with a 47 k resistor paralleled across it. Lowest measurable value was about 500 pF.

— L.W. Brown,
Burwood, Vic.



ZENER DIODE CHECK



Unmarked Zener diodes may be tested using this simple circuit.

An external power supply giving a voltage higher than the highest expected rating of the Zener diodes to be tested is required.

Potentiometer RV1 is adjusted until the meter reading stabilizes. This reading is the Zener diode's breakdown voltage.

RADIO NOISE LIMITER

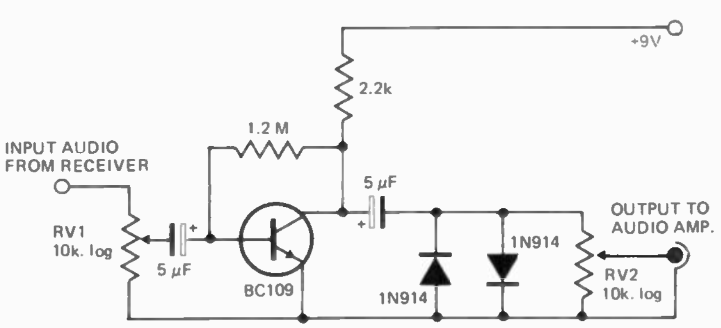
Short-wave listening is often marred by unpleasant static noise.

Because static can be of a much higher level than the required signal, it may "numb" the ear's ability to hear to lower level sounds. This is due to a sort of physiological AGC system in our hearing.

If we limit these static peaks to a much lower level the required signal will be more intelligible.

This circuit operates by limiting the amplitude of incoming signals to a pre-set level. Signals below this level are not affected.

Operation is quite simple. Potentiometer RV1 is advanced as much as possible without the signal becoming distorted and harsh. At this point the amplitude of the wanted signal is just below 0.6 V — the clipping level of the two diodes. Any static and other high amplitude noise is now limited to this level.



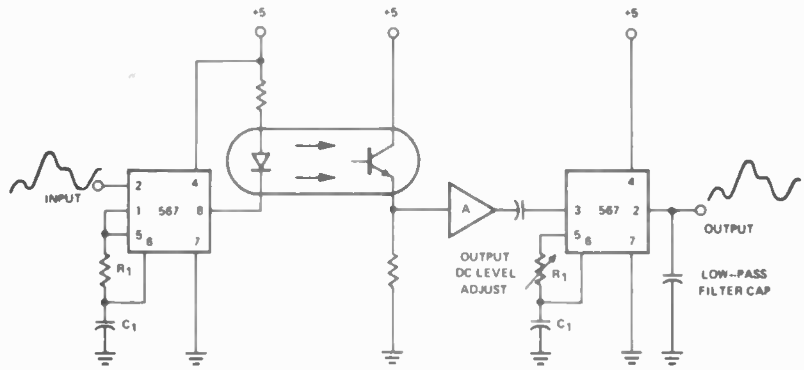
As the name of this section implies, these pages are intended primarily as a source of ideas. As far as reasonably possible all material has been checked for feasibility, component availability etc, but the circuits have not necessarily been built and tested in our laboratory.

Because of the nature of the information in this section we cannot enter into any correspondence about any of the circuits, nor can we provide constructional details.

Electronics Today is always seeking material for these pages. All published material is paid for — generally at a rate of $5 to $7 per item.

IDEAS FOR EXPERIMENTERS

INFORMATION TRANSFER



SOMETIMES it is necessary to transfer an analogue signal from one system to another without making any electrical connections.

This can be done with two phase-locked-loops in an fm system using light as the transmission medium. Because of the high degree of electrical isolation obtained, low level signals can be transmitted without interference, even if there is a large potential difference between the sending and receiving circuits.

The circuit is shown above right.

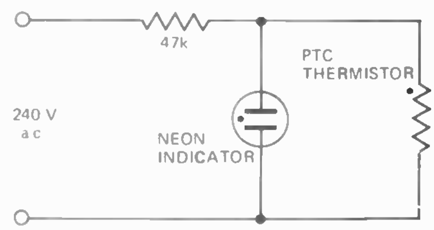
Transmitter is an NE 567 phase-locked-loop IC operating as a voltage controlled oscillator which drives the LED section of an opto-coupler. The LED will flash at the operating frequency of the oscillator which is in turn dependent on the input signal level and the values of R, and C.

The output signal from the opto-coupler drives an amplifier which provides an output of sufficient amptitude (50 to 200 mV) to drive the receiving NE 567 phase-locked-loop. The receiver operates as an fm detector which demodulates the output of the opto-coupler to provide the original input signal. The inherent non-linearity of the transfer function in the two phase-locked-loops cancel one another out to give an extremely linear information transfer.

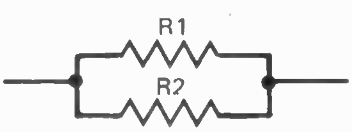
Based on an application note from SDS Components, UK.

SIMPLE FIRE ALARM CIRCUIT

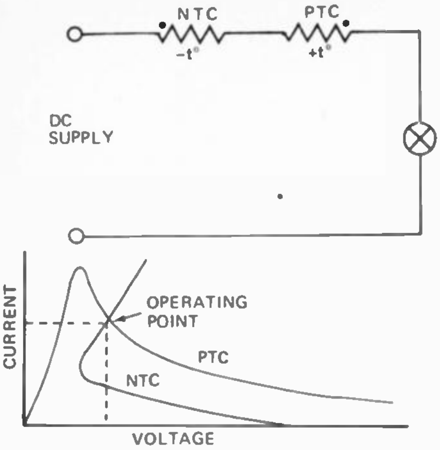
A voltage divider made up of a resistor and positive temperature co-efficient thermistor has its incremental voltage fed to a neon indicator lamp. The thermistor is used as the temperature sensor. Its value is such that under normal ambient conditions the neon voltage across it is below striking voltage for the neon. If a fire causes the thermistor to heat up, its resistance rises, and the neon ignites giving a visual alarm. The value of the PTC thermistor is selected to give the necessary resistance change to ignite the particular neon lamp used. An audible alarm can be activated by adding suitable electronic circuitry.



RESISTORS IN PARALLEL

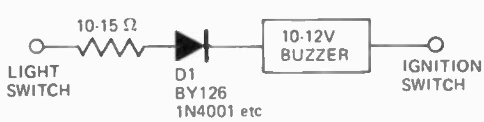


R2 \ R1	10	12	15	18	22	27	33	39	47	56	68	82	100
10	5.00	5.45	6.00	6.43	6.88	7.30	7.67	7.96	8.25	8.48	8.72	8.91	9.09
12	5.45	6.00	6.67	7.20	7.76	8.31	8.80	9.18	9.56	9.88	10.20	10.47	10.71
15	6.00	6.67	7.50	8.18	8.92	9.64	10.31	10.83	11.37	11.83	12.29	12.68	13.04
18	6.43	7.20	8.18	9.00	9.90	10.80	11.65	12.32	13.02	13.62	14.23	14.76	15.25
22	6.88	7.76	8.92	9.90	11.00	12.12	13.20	14.07	14.99	15.79	16.62	17.35	18.03
27	7.30	8.31	9.64	10.80	12.12	13.50	14.85	15.95	17.15	18.22	19.33	20.31	21.26
33	7.67	8.80	10.31	11.65	13.20	14.85	16.50	17.88	19.39	20.76	22.22	23.53	24.81
39	7.96	9.18	10.83	12.32	14.07	15.95	17.88	19.50	21.31	22.99	24.79	26.43	28.06
47	8.25	9.56	11.37	13.02	14.99	17.15	19.39	21.31	23.50	25.55	27.79	29.88	31.97
56	8.48	9.88	11.83	13.62	15.79	18.22	20.76	22.99	25.55	28.00	30.71	33.28	35.90
68	8.72	10.20	12.29	14.23	16.62	19.33	22.22	24.79	27.79	30.71	34.00	37.17	40.48
82	8.91	10.47	12.68	14.76	17.35	20.31	23.53	26.43	29.88	33.28	37.17	41.00	45.05
100	9.09	10.71	13.04	15.25	18.03	21.26	24.81	28.06	31.97	35.90	40.48	45.05	50.00
120	9.23	10.91	13.33	15.65	18.59	22.04	25.88	29.43	33.77	38.18	43.40	48.71	54.55
150	9.38	11.11	13.64	16.07	19.19	22.88	27.05	30.95	35.79	40.78	46.79	53.02	60.00
180	9.47	11.25	13.85	16.36	19.60	23.48	27.89	32.05	37.27	42.71	49.35	56.34	64.29
220	9.57	11.38	14.04	16.64	20.00	24.05	28.70	33.13	38.73	44.64	51.94	59.74	68.75
270	9.64	11.49	14.21	16.88	20.34	24.55	29.41	34.08	40.03	46.38	54.32	62.90	72.97
330	9.71	11.58	14.35	17.07	20.63	24.96	30.00	34.88	41.14	47.88	56.38	65.68	76.74
390	9.75	11.64	14.44	17.21	20.83	25.25	30.43	35.45	41.95	48.97	57.90	67.75	79.59
470	9.79	11.70	14.54	17.34	21.02	25.53	30.83	36.01	42.73	50.04	59.41	69.82	82.46
560	9.82	11.75	14.61	17.44	21.17	25.76	31.16	36.46	43.36	50.91	60.64	71.53	84.85
680	9.86	11.79	14.68	17.54	21.31	25.97	31.47	36.88	43.96	51.74	61.82	73.18	87.18
820	9.88	11.83	14.73	17.61	21.43	26.14	31.72	37.23	44.45	52.42	62.79	74.55	89.13
1000	9.90	11.86	14.78	17.68	21.53	26.29	31.95	37.54	44.89	53.03	63.67	75.79	90.91



THERMISTOR OSCILLATOR

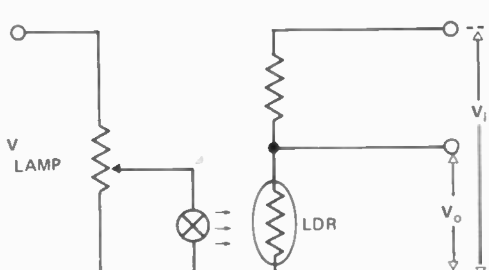
A simple very low frequency oscillator can be made by interconnecting one positive temperature co-efficient and one negative temperature co-efficient thermistor in series. For conditions of oscillation the characteristics of the two devices have to be chosen carefully. The operating point is determined by the intersection of the two curves.



AUTOMOBILE LIGHT REMINDER

This circuit ensures that car lights are switched off when the ignition is turned off.

Any low power silicon rectifier diode will be satisfactory together with a suitable 12 V buzzer or bell. Only two connections are required. The alarm will sound if you leave the lights on after cutting the ignition.



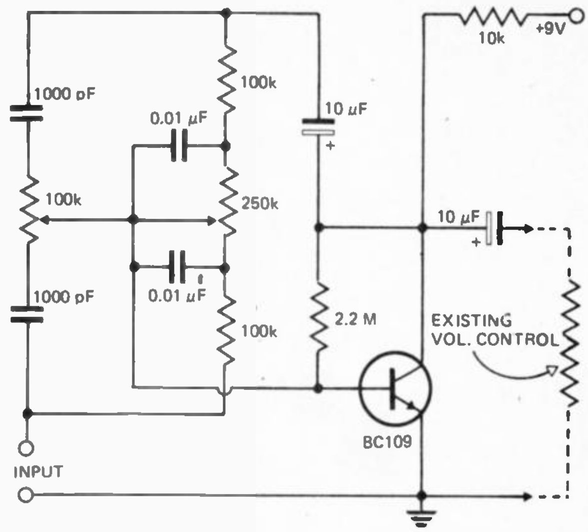
CRACKLE-FREE POTENTIOMETER OPTO-ISOLATOR

The resistance of a light dependent resistor (LDR) varies as the light falling upon it varies — hence its name! When wired into a divider network it forms an excellent crackle-free potentiometer.

It also provides excellent electrical isolation of the manual control — often a valuable feature where high voltage circuits must be isolated from low voltage circuits.

ADVERTISER'S INDEX

IDEAS FOR EXPERIMENTERS

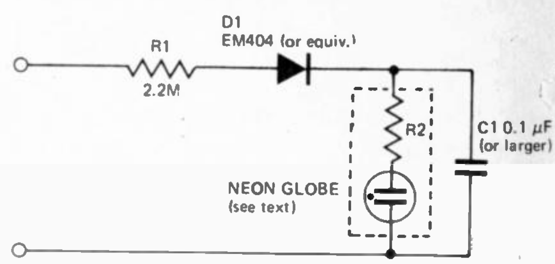


TONE CONTROL CIRCUIT

This simple single-transistor circuit will give approximately 15 dB boost or cut at 100 Hz and 15 kHz respectively. A low noise audio type transistor is used, and the output can be fed directly into any existing amplifier volume control to which the tone control is to be fitted.

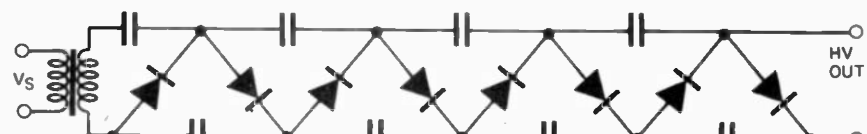
The gain of the circuit is near unity when controls are set in the "flat" position.

NEON FLASHER WARNING



A flashing pilot light is likely to be more attention-getting than a pilot light which is continually on. This circuit will cause a neon globe to flash at a rate determined by the value of the capacitor placed in series between the diode and mains, neutral line. The neon globe may be used on its own or with a 270 k resistor in series with it as used in ready assembled 240 V pilot lamps. However, the value of R2, if used at all, is dependent on the flashing rate and effect desired by the individual constructor. All voltage ratings on components have been deliberately increased to protect the components from overload. R1 should be left as 2.2 Meg., the flashing rate being determined by the values of C1 and R2.

This neon flasher could be used for triggering a triac etc. having the advantage of showing when the device is being triggered and being an economic, reliable triggering device. Average current drawn by the neon globe is around 25 micro-amps and the triac etc. would need an appropriate trigger current. This circuit is ultra-reliable but not very stable as regards to its flashing rate.



VOLTAGE MULTIPLIER

Sometimes a very high voltage is required for applications such as for ionisers or a CRT supply.

With this circuit the high voltage secondary of an ordinary power transformer can have its output voltage multiplied any number of times determined by the number of stages "cascaded".

It is important to note that the rating of individual diodes and capacitors should be twice the transformer output voltage V_s.

The capacitor value and diode rating are determined by the required output current.