JUNE 1976 $1.00*
NZ $1.15

electronics TODAY

INTERNATIONAL

Train controller
5 watt stereo
Novice transmitter

Registered for posting as a periodical — Category C

HOW TO CHOOSE MICROPHONES

A turntable with features you'd expect only on a more expensive unit

One feature you'll notice is the price; in fact we believe it to be 'the best buy' turntable available today.

With features only expected on more expensive units, such as wow and flutter of 0.5 WRMS thanks to the DC motor with FG (frequency generator) servo-controlled circuits.

How's this for a list of features. Practical, purposeful features like

- ☐ illuminated stroboscope
- ☐ elliptical stylus
- ☐ completely automatic tone arm return
- ☐ viscous-damped cueing lever
- ☐ anti-skating dial scale control
- ☐ CD4 ready
- ☐ audio insulated legs

and the list just goes on.

Any way you want to look at it, you'll agree the Technics SL23 is a sound buy, with appearance and performance to match.

WARRANTY AND SERVICE BY HACO

For a National Technics Catalogue please write to:
National Technics Advisory Service, P.O. Box 49, Kensington, N.S.W. 2033.

National Technics

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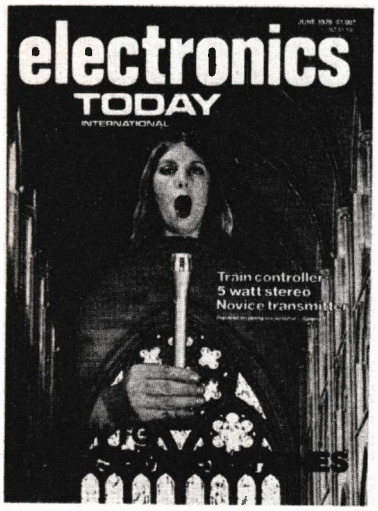
electronics TODAY INTERNATIONAL

A MODERN MAGAZINES PUBLICATION

JUNE 1976, VOL. 6 No. 6

Editorial Director Collyn Rivers
Assistant Editor Steve Braidwood



*Recommended retail price only

COVER: Microphone survey on page 16. Photo composition by George Hofsteters.

PROJECTS

FEATURES

DATA SHEETS

NEWS & INFORMATION

Hand made sound.

With JBL you know you're not just paying for the name. You're paying for a quality of sound that is impossible to mass produce.

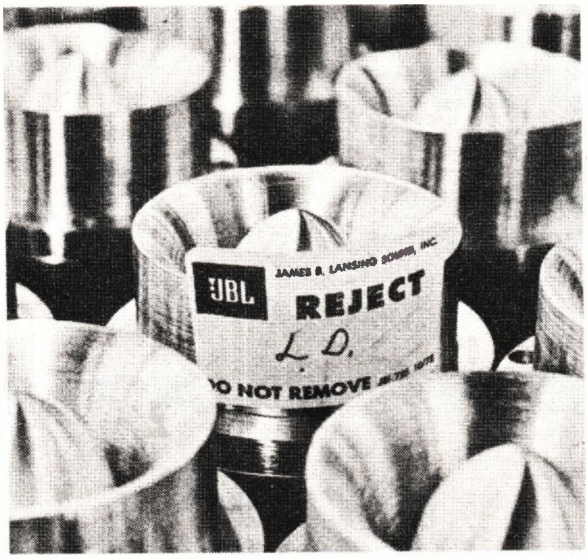
JBL's require equipment so specialised we had to design and build our own.

Cabinet tolerances are typically held to 1/64th of an inch.

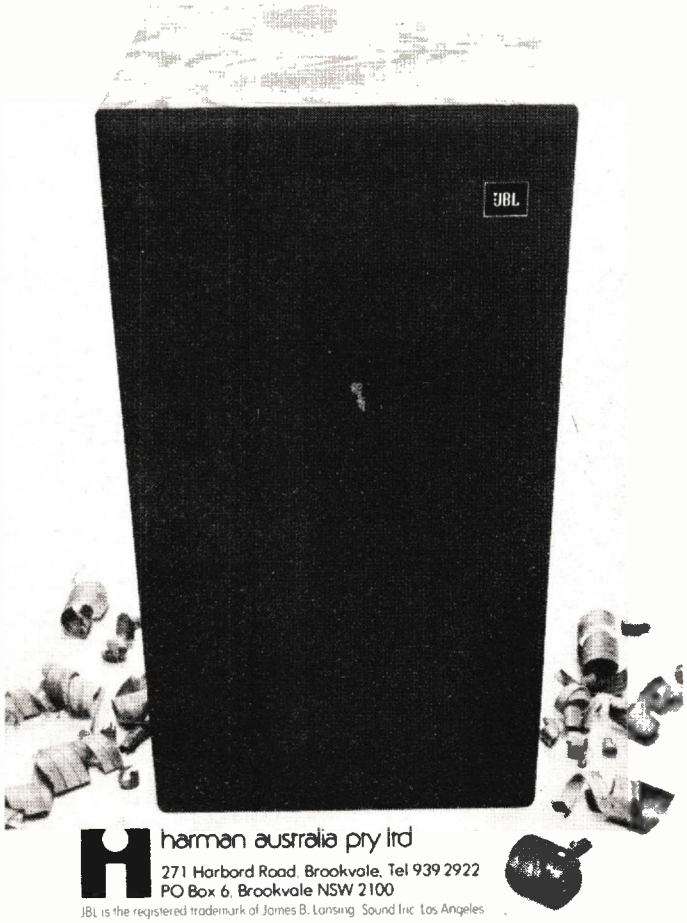
Until we developed them just recently, most JBL's were out of the normal person's reach. Now you can own a pair of JBL's for around $500.

They're still more expensive than ordinary speakers, but then they're JBL's aren't they.

If we cut out all the things we do by hand, and the checking double checking and rejecting, we could probably produce a speaker for about 25% less. But then it wouldn't really be a JBL. Our reputation is based on an unchanging commitment to quality. We make no compromises. Never have, never will. The same applies to all the JBL range. Like the JBL Decades.



Near enough is just not good enough.



harman australia pty ltd
271 Harbord Road, Brookvale, Tel 939 2922
PO Box 6, Brookvale NSW 2100

news digest

IR FOR THE HARD OF HEARING

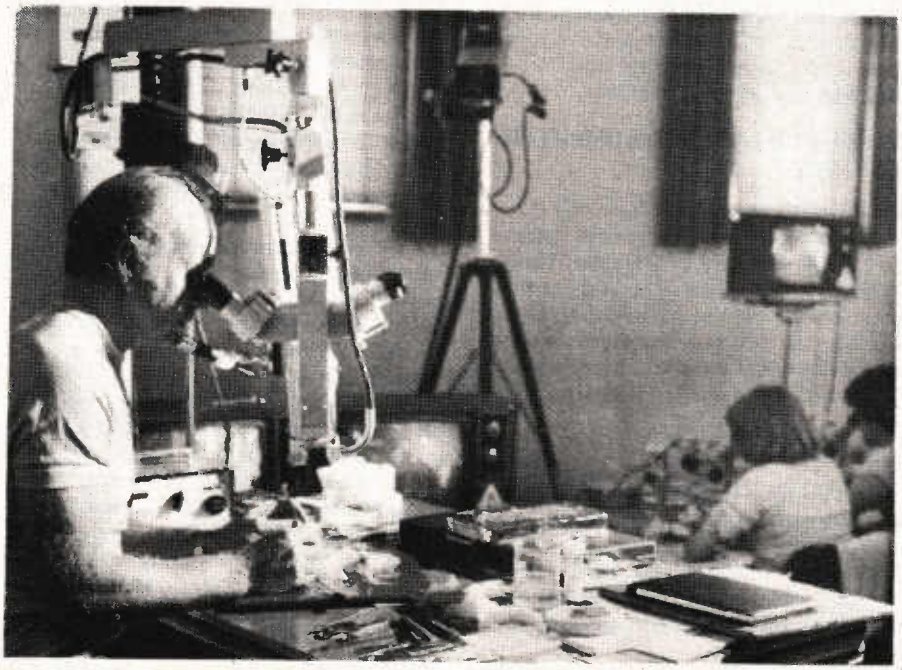
A wireless infrared communication system for use in classrooms for the hard-of-hearing has been developed by Seimens. Being free of cables and leads, the pupils can move about unhindered and yet be in constant touch with the teacher, via their headphones. The system is superior to the induction systems previously used in that the transmission is contained within the walls of one classroom.

In the classroom there are four infrared radiators, which are either fixed on mobile stands and placed around the room or mounted on the walls or ceiling. Each radiator has twelve LEDs; the 48 diodes are sufficient to ensure that a classroom measuring about 80 sq metres is evenly "illuminated". The total power of the radiation is only 0.5 watts.

MICROSURGERY CAMERA

The potential of TV as a teaching aid was demonstrated recently at an International Microsurgery Workshop in Sydney, attended by about 30 surgeons from abroad and Australia. By means of a Hitachi compact colour TV camera linked to a high power microscope, microsurgical techniques were shown on colour TV monitors, and the surgeons were then able to copy the methods shown on the screens.

The demonstrators used a Zeiss microscope with a Hitachi 9015 camera mounted integrally to the viewing optics. This was the first demonstration in Australia of this camera from AWA Rediffusion, recently appointed a distributor of Hitachi closed circuit television products in Australia. The Hitachi 9015 is about 100 mm square and 220 mm long. More details from AWA Rediffusion Pty. Ltd.



ELECTRONICS SHOW

Australia's first consumer Electronics Show is to open in Sydney this August. The show, to be held in the Sydney Hilton, is sponsored by the High Fidelity Association and supported by Hi-Fi Review. It will include seminars and the first conference of Australia retailers. The show will be open to the public for limited periods.

30 MINS OF TV ON A CARD!

A photosensitive plate, 127 x 178 mm, costing about 25c to make, can store a digitised TV programme. The Digital Recording Company of New York already has a prototype and plans to make pre-production units available in about a year. The company estimates that playback equipment could cost as little as US$300.

The system uses microscopic dots and spaces, at a density of 300 000 000 bits per square inch, to record the data.

TIME DELAY PROBLEMS

We apologise to readers who had to wait longer than usual for their May issue. The delay was a result of production problems we were facing at that time and for the next few issues ETI will not appear in the shops until the beginning of the month on the cover.

news digest

SINGLE MASK BUBBLE MEMORY

In magnetic bubble memories that are controlled by current pulses and a rotating magnetic drive field, three or more masks are needed for processing one chip. The Philips Research Laboratories in Eindhoven have made an experimental bubble memory requiring only one mask per chip. Writing, reading and erasure are achieved by temporary changes of the sense of rotation of the drive field.

ONE WATCH, TWO DISPLAYS

Now available in the US is the new Pulsar men's watch from Time Computer. This watch uses separate LED displays for time and day of the week. By not adapting seven-segment displays for alpha characters the letters are given a more readable shape.

KODAK INSTANT ELECTRONICS

Kodak's new instant cameras are using a four-function bipolar linear IC to control aperture selection, shutter speed, and indicators for flash required and low battery. The eight pin transparent plastic DIP also includes a silicon photo diode.

ELECTRONIC ALARM WATCH

The Japanese manufacturer, Citizen Watch, are marketing (overseas at the moment) an LCD watch which displays hour, minutes and seconds, and in addition has an alarm facility.

VOICE CONTROLLED COMPUTER FOR NAVY

EMI Threshold Ltd has delivered its third voice-operated computer system to the UK Ministry of Defence. This system, which is operated and controlled solely by human speech, is to be used by the office of the Hydrographer of the Navy for digitising feature information of navigational charts.

CB SELF-LICENSING

The FCC has introduced a temporary system to cope with the flood of applications for CB licences. The applicant simply fills in a form and makes a call-sign by taking the letter K, adding his initials, and then his zip code.

HP27

A new pocket calculator combining the most frequently used scientific, statistical and financial functions has been introduced by Hewlett-Packard. The HP-27, priced at $217.00 including tax, ($195.00 excluding tax), contains more preprogrammed functions and operations than any other HP pocket calculator.

The HP-27 is the first pocket calculator to incorporate tools to perform most scientific calculations as well as financial capability. For the business person, the calculator provides a combination of compound interest and statistical capabilities.

The HP-27 provides several new functions: in statistics – variance, correlation coefficient and normal distribution; in finance – net present value and internal rate of return for up to 10 uneven cash flows. Ten addressable memories for data storage, five financial memories, the last-x memory and the

four operational stack memories allow the user to make complex, lengthy calculations without having to record intermediate answers or re-enter constant data. Six selectable clearing options increase the flexibility of use of the calculator's memories.

Customer deliveries will begin within four weeks from Hewlett-Packard Australia Pty. Ltd., 31-41 Joseph St. Blackburn, Vic 3130.

GILETTE WATCHES

Gilette, the razor company, has ordered digital watch modules for LED watches they plan to market later this year in the US.

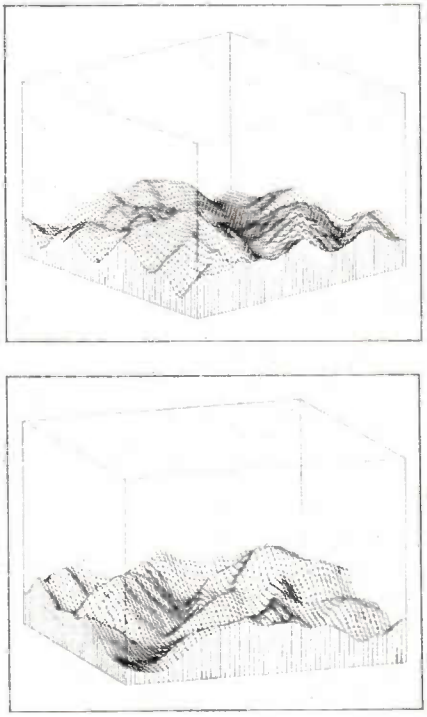
NEW TEKTRONIX TERMINAL

The lowest priced computer graphics terminal from Tektronix, the 4006-1, has been announced recently. The 4006-1 is compatible with most mainframe computers and it will be supported by the same graphic software available for Tektronix' complete family of graphic terminals, plus a new Interactive Graphing Package.

Hard copy compatibility is included using the Tektronix 4631 hard copy unit. Off-line storage can be provided by the Tektronix 4923 Digital Cartridge Tape Recorder.

The crisp, clear (800,000 point) graphics and the low price is expected to invite both OEM accounts and end users.

The newly-developed Interactive Graphing Package enables the non-programmer to generate on-screen single and multiple line graphs, bar charts, log plots and calendar plots. Additional features of this package include automatic sealing and interactive labelling.



These two plots show a digitised perspective of a landscape constructed from a contour map. The two views are of the same area: one from the southeast and one northwest. The user can rotate the plot for any view.

(Continued on page 11)

The Convoy BIG 'C' Story

New premises, 4 Dowling Street Sydney. Free Parking Opposite

Convoy

New Premises with the BIG 'C' Motif at Woolloomooloo

In the space of three months a remarkable change has been made to an old building at the wharf end of Dowling Street, Woolloomooloo, where Convoy has moved from their smaller premises nearby. It has been completely renovated and transformed into a complex of showrooms to demonstrate and supply high quality High Fidelity equipment and Colour T.V., in three separate acoustically treated rooms, Audio Visual Programming studios, an A.V. Theatrette, Administration, and well equipped Service facilities. Ample space is available for Convoy's activities in the Wholesale distribution of TDK Tape and top line Hi-Fi equipment.

Entrance Foyer to Convoy Sound

The Convoy Sound Story

CONVOY SOUND – This is the new trading name by which retail activities will be known in future – previously The Technocentre. For Hi-Fi enthusiasts considering the purchase of quality equipment, a visit to Convoy Sound provides the opportunity to hear a wide range of famous brands, listen in comfort without the intrusion of traffic noise or other equipment and talk with experienced sales staff. Clients may park at the Shell Service Station opposite without charge. The three acoustically treated demonstration rooms enable clients to hear equipment as it would sound in their home environment.

THE B & O ROOM – As you enter the new showrooms on your left is a demonstration suite entirely devoted to Bang & Olufsen equipment, attractively designed in a Scandinavian decor and natural Pine. Convoy are the B & O specialists in the Sydney area for the Danish Bang & Olufsen (B & O) equipment. A company that enjoys the highest reputation for design orientated High Fidelity equipment and what are regarded by many as the finest colour T.V. sets in the world.

THE SWINGER'S ROOM – Ahead of you the "Swinger's Room" is a complete contrast with its bright and exciting decor. This suite has been set aside for the more popular medium and upper quality equipment from selected and famous brands which include B & W, Harman Kardon, J.B.L., Marantz, Nakamichi, Peerless, Pioneer, Sonab, Teac, Technics etc. A room designed for the young enthusiasts and those interested in the modern trends of music.

CONNOISSEUR'S ROOM – A few steps to the right and you walk into the "Connoisseur's Room", quietly elegant in its decor, this suite has been established for the sound perfectionist, who may sit in a quiet relaxing atmosphere and experience the subtle differences that are to be heard in the world's best amplifiers, tape decks and loudspeakers.

No one who is considering a really top quality system, or who wants to measure their own system against the best, should miss visiting this unique sound demonstration.

Convoy
Products & Services

TDK Magnetic Tapes

Nakamichi Spoken Here Cassette Recorders

B&W Loudspeakers

Accuphase アキュフェーズ Amplifiers

ELECTROSONIC

TDK Magnetic Tapes and Cassettes
Convoy are the exclusive distributors in Australia for TDK Electronics Co. Limited, one of the world's leading manufacturers of magnetic tape. Founded in 1932, today TDK is renowned the world over for its magnetic tape technology and its complete lines of Audio, Video and Computer grade tapes of unsurpassed quality.

Audio Visual Demonstration Theatrette

Nakamichi Research Inc. is now generally accepted as the world leader in design and manufacture of cassette recorders with a quality equalling the best reel-to-reel tape recorders.

Bowers & Wilkins (B & W) Monitor Loudspeakers
John Bowers who founded B & W just over 10 years ago has been a pure sound fad for many years. All B & W speakers are designed to produce clean natural uncoloured sound without distortion. The latest product from B & W, the DM6, has been described as the finest domestic loudspeaker yet produced.

Convoy Service Division

Accuphase Amplifiers and Tuner Amplifiers
Accuphase design philosophy greatly reflects the origin of its brand name. It is derived from the two words, "ACCURATE" and "PHASE". Accuphase equipment can even be likened to a rare "Stradivarius". At least, that is how much stress is attached in manufacturing policy to originality and handcraftsmanship.

Electrosonic
Electrosonic Limited London, England, are one of the leading designers and manufacturers of electronic control equipment for synchronised slide/sound Audio Visual presentations.

Audio Visual Encoding Studio

THE CONVOY STORY

Company Growth Built on Quality

Convoy was founded in March 1965 by its Chairman Malcolm Goldfinch in Kent Street, Sydney. He maintains a close interest in the business and makes frequent trips overseas to keep in touch with new product development and the manufacturers Convoy represents in Australia. The Company achieved steady growth during its early years which first made necessary its move to Maclean Street, Woolloomooloo. Progress accelerated over the past three years requiring much larger premises.

The firm's Managing Director, Dennis Gowing who joined Convoy in January 1973, attributes the Company's growth largely to the careful selection of outstanding products to represent — all are market leaders in their respective fields, yet complimentary to each other. Dennis Gowing says, "By specialising in top quality equipment, the reputation of Convoy can only stand or fall on the excellence and performance of the equipment and services the Company presents to its clients". "For this reason irrespective of the manufacturer's Warranty, our technicians carefully test all items of equipment sold prior to sale and in many instances we offer our own Warranty which exceeds the manufacturer's Warranty. For example, Convoy offers a 5 Year Warranty on some top quality amplifiers".

Why Woolloomooloo?

Convoy requires considerable space and parking for its various activities. In a City location the noise of traffic impairs the effective use of demonstration rooms, city parking is difficult and costly for clients and staff, and high city rents would make it difficult to hold down prices.

Convoy's management decided to remain in the area where they had become so well known over the last six years, as Woolloomooloo is conveniently located only eight minutes away from the production, advertising and promotional world in North Sydney, City Professional Investment and Commercial areas, Macquarie Street Doctors and still within easy reach of Kings Cross and the Eastern Suburbs.

Clients contemplating the purchase of top quality Hi-Fi equipment, or involved in the encoding of an Audio Visual programme or planning a Multi-Screen presentation, will find Convoy easy to identify with its attractive and very distinctive "Big C" exterior building decoration.

Company Organisation

Convoy is organised into autonomous yet complimentary Divisions.

Convoy Sound handles the Retail activities of the Company

Convoy TDK Division is responsible for the Australia wide distribution of TDK tape.

Convoy Wholesale Division handles the exclusive distribution of top quality Hi-Fi equipment.

Convoy Electrosonic handles the sale and hire of Electrosonic equipment for Audio Visual presentations.

Convoy Service provides technical service back-up to all Convoy Divisions also Warranty and other service to clients.

Convoy Sound

is the new trading name by which the retail activities will in future be identified. The main showrooms and demonstration rooms are located on the Ground Floor at 4 Dowling Street, Woolloomooloo, Sydney. A smaller City showroom devoted exclusively to Bang & Olufsen equipment, was recently opened at 387 George Street at the rear of Dukes Records.

In the Dowling Street premises all the demonstration rooms are acoustically treated to resemble the acoustics in your own home. Although they are just a few paces from each other, they enclose you completely in their own special and separate worlds of sound. Being free of ambient noise from traffic one can listen undisturbed and at peace and judge the quality of sound at low volume as you would use in your own home. Dennis Gowing says, "You cannot demonstrate top quality Hi-Fi equipment against a background of traffic noise or with other equipment operating in the same showroom".

TDK Tape Division

Convoy are the exclusive distributors in Australia for TDK ELECTRONICS CO. LTD one of the world's leading manufacturers of top quality magnetic tape. TDK are credited with bringing about a "revolution" in tape technology which turned the cassette into a true high fidelity medium. TDK's latest breakthrough in tape technology is Super Avilyn — SA. An entirely new magnetic particle completely interchangeable with Chromium Dioxide, but with superior sensitivity in low and middle frequencies and much reduced headwear. Authoritative commentators have said that Super Avilyn tape looks like being one of the most important advances in tape formulations in the mid-seventies.

Wholesale Division

Executive offices and wholesale trade displays are located on the First Floor. This Division handles the Australia wide distribution of top quality Hi-Fi equipment including world renowned brands such as Bowers & Wilkins Loudspeakers, Nakamichi Tape Decks and Accuphase Amplifiers.

Convoy Electrosonic

A major portion of the First Floor is given over to Convoy's Electrosonic Division. If you plan a marketing seminar, an exhibition or permanent Audio Visual installation, here you will find experts to advise you, a theatrette to demonstrate and discuss your requirements, and a fully equipped A.V. encoding studio. A wide range of equipment for single or multiscreen synchronised Slide/Sound Audio Visual presentations is available, either on outright sale or rental. Convoy Electrosonic equipment is in use at ● Hunter Douglas Domus ● Regatta Point Exhibition Canberra ● O.T.C. Theatrette Broadway Sydney ● L.J. Hooker auction rooms Sydney ● C.S.I.R.O. Observatory Parkes etc. etc.

Clients for whom Convoy have handled touring A.V. presentations includes A.N.Z. Bank ● Ford Motor Company ● Liptons Tea ● G.E. ● S.C. Johnson ● National Bank ● Hoover ● V.W. etc. etc.

Convoy Service

Convoy's technicians have the service capability and experience to handle the most complex electronic audio and audio visual equipment. A large well equipped Service Department is located on the Top Floor of the new building.

Convoy is made up of a young enthusiastic team of competent executives, all specialists in their respective areas. They have at their disposal probably the best facilities for demonstrating top quality sound and Audio Visual equipment in Australia, if not the Southern hemisphere. The products they represent are world leaders in their respective areas.

CONVOY INTERNATIONAL PTY LIMITED,

A complete service for quality high fidelity, colour T.V. and audio visual equipment.

MAIN SHOWROOMS
4 Dowling St., Woolloomooloo
Sydney 2011.
Tel: 357 2444 358 2088.
Telex AA23111

B&O
CITY SHOWROOM
387 George St., City
(in Dukes Records)
Tel: 29 1364

news digest

NEW GENERAL COVERAGE RECEIVER FROM YAESU MUSEN

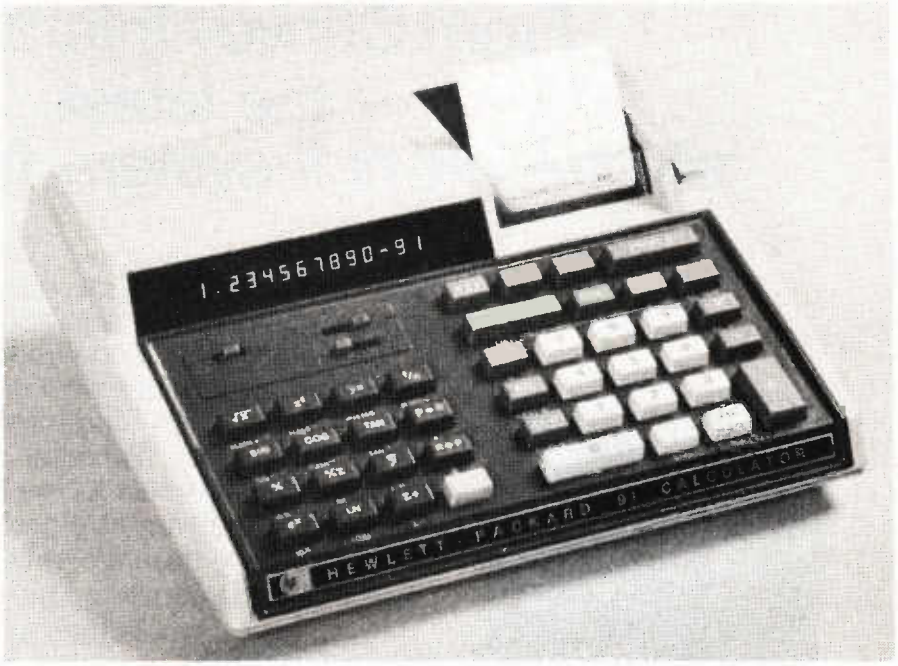
A new general coverage receiver has appeared from Yaesu Musen. It is the FRG-7, based on the design of the Wadley Loop drift cancellation circuit. It covers the range 0.5 – 30 MHz continuously in 1 MHz bands, with dial readout of better than 5 kHz.

The FRG-7 accepts any of three power sources: 230 V ac, external 12 V dc and internal 8 dry cells. The FRG-7's Wadley loop system, coupled with its triple conversion superhet circuit provides an extremely high sensitivity and excellent stability.

The Australian agents for Yaesu Musen are Bail Electronic Services, 60 Shannon Street, Box Hill North, Vic 3129.

DIGITAL WATCH WITH HANDS!

A Swiss company, Zenith Time, have a digital watch which looks like a conventional 'analogue' watch: it displays the time on ordinary watch hands. Below and to the right of the dial there is a small LED display which can show seconds, date, or am/pm. Setting of either section is by push-button.



ALI'S THE LOUDEST

High volume speakers of the future are likely to be made from aluminium. The moving elements (the cone and voice coil) of speakers used by rock bands frequently overheat and fail. A division of US's Keene Corporation has recently developed an adhesive-coated aluminium foil for use in these sensitive components.

RF SWEEP GENERATORS

Two new RF sweep generators have been announced by Tektronix: SW 503 (50Ω) and the SW 503 Option 1 (75Ω). Both generators cover a frequency range of 1 to 400 MHz. They have variable sweep rate, step attenuator, 20 dB vernier attenuator, and a crystal controlled marker generator which provides comb type markers at 1, 10, and 50 MHz.

A unique feature when used in concunction with a DC 502 Digital Counter (with option 7 installed) is their ability to provide a variable marker covering the entire 1 to 400 MHz frequency range with the marker frequency read directly on the digital counter.

The picture shows the SW503 (Option 1) in the TM 515 power module with DC502 (Option 7) counter, DM502 Digital Multimeter and SC502 scope. Tektronix Australia, 80 Waterloo Road, North Ryde, NSW 2113.

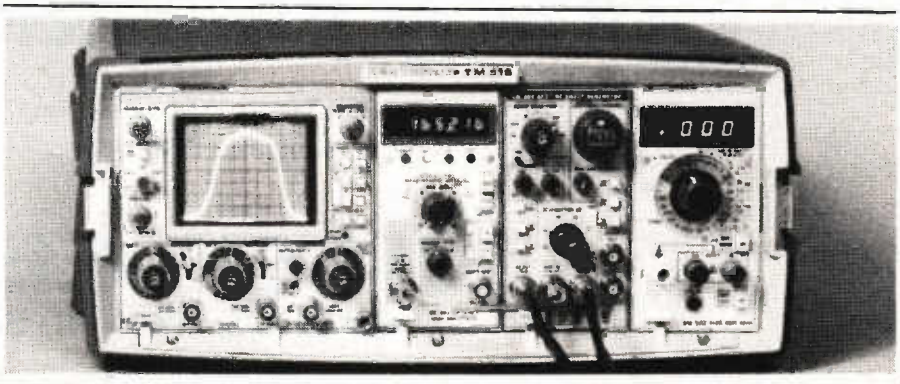
PORTABLE PRINTING CALCULATOR

The first of a new generation of small, portable printing calculators operating on rechargeable batteries or line current was introduced by the Hewlett-Packard recently. The HP-91, priced at $487 ($541.79 including sales tax, if applicable) is an advanced scientific calculator with a large display and a buffered keyboard (so data may be keyed in at high speed).

The 1.2 kg calculator is small enough (229 x 203 x 64 mm) to fit into a briefcase for travel or a desk drawer for security. The HP-91 is a more powerful version of the HP-45 pocket calculator, with the added capability of creating a printed log of all calculations. It has all of the preprogrammed functions of the HP-45, plus 16 addressable memory registers instead of 9; engineering notation; performs regression and linear estimates; three percent functions instead of two; and keyboard buffering seven keystrokes deep.

A 220-page owner's handbook is included with the calculator. It contains user instructions and a comprehensive application section that gives the most efficient keystroke sequences for solving problems in the fields of mathematics, statistics, finance, navigation and surveying. An AC adapter/recharger and a carrying case also come with the new calculator.

The HP-91 is available approximately four weeks after receipt of order from Hewlett-Packard Australia Pty Ltd., 31 Joseph St., Blackburn, Vic 3130.



New Rondo 3000X

From Convoy International- the latest 'silver-look' hi fi system from Pioneer.

It must be the last word in stereo systems.
A rare marriage of design purity and sound excellence.
In the Rondo 3000X, the imposing receiver-amplifier hits a new peak in functional elegance. The turntable is precise in profile. While the 3-way, 3 speaker system has a clean-cut brilliance. In this new Rondo, 'X' marks the difference between today and the exciting sounds of tomorrow.

Covered by exclusive Pioneer 1-2-3 warranty.

$489

See it now...hear it now at

Convoy International PTY. LTD.

4 Dowling Street, Woolloomooloo. 2011
Telephone 358-2088.

PIONEER®
leads the world in sound

PN101

news digest

ADD YOUR OWN COLOURS

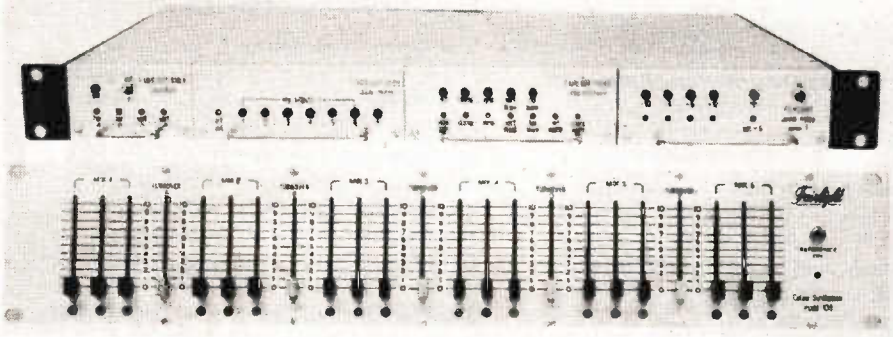
A video colourising device is now available from Fairlight Instruments. The Fairlight Colour Synthesiser, Model 108, generates a six colour image from a standard black and white video source. Each selected colour is allocated to one of six grey-scale ranges, between black and white.

Video production units can use this equipment to add any desired colours to B/W or colour film, or videotape. The 108 is especially useful for graphics and animation. Startling effects can be achieved by selecting unusual or complementary colours.

An interesting feature of the 108 is that the colour turnover points (the grey level at which one colour changes to another) are variable. Setting up is facilitated by a switchable reference band test pattern. The colours and turnover points are displayed in order of grey-scale value across the top of the output picture.

The unit can generate its own sync and blanking, if required, allowing a complete colourising system to comprise a black and white camera, a colour monitor and the 108. For studio situations sync and blanking can be accepted externally.

For further information contact Fairlight Instruments Pty Ltd., 15 Boundary Street, Rushcutters Bay, NSW 2011. Telephone 31-3606.



LEADLESS PACK

General Instrument's Microelectronics division are to offer some of their ICs in leadless packages. The Mini-Pak is much smaller than its DIP equivalent: 13 x 13 x 3 mm versus 38 x 13 x 5 mm for a 28-connection chip. GIM will offer its TV game and several calculator chips in the new format. The connections are made to an array of solder bumps on the underside of the square substrate.

RAIL FORCE TRANSDUCER

British Rail scientists have developed a simple method of measuring the internal rail force of a long length of rail in service. Until now there has been no reliable means for determining the force other than by cutting the rail and measuring the resultant change in length. This method does not require cutting the rail.

The transducer is a cylinder 29 mm in diameter (the standard fishbolt hole size on BR). The transducers operate on the vibrating wire principle and each device has two sensing elements built into it to cover a stress measuring range of 700 kN compressive to 300 kN tensile load. Readings from the transducers are taken using the portable strain measuring instrument (type GT1169). Temperature readings are made at the same time to monitor changes in stress free temperature. A rail force value is then determined using a calibration curve.

The Australian agents are Richard Foot (Australia) Pty. Ltd., 63 Hume Street, Crows Nest, NSW 2065.

FOR THE URBAN SPACEMAN

A new organisation has been formed in the US to give non-NASA people a say in the future of the space programme. The National Space Institute is open to people from all walks of life and it will present their views to NASA and Congress. Membership fees (in US$) are: $9 (under 18), $15 (annual, adult), $100 (life) and $1000 (corporate). Members will get advice on technical queries, and a magazine is planned. NSI is designing a 'Space Product' logo for manufacturers to use on products based on space technology.

MPU ON TV

MACE are able to supply Matrox products MTX1632 and MTX816. These modules will display alphanumeric data on a standard TV monitor when connected to the address and data buses of a microprocessor system. The 816 gives 8 lines of 16 characters and the 1632 gives 16 lines of 32 characters. The one-off prices are $194 and $285, plus sales tax and duty (if applicable). Delivery time is 6 to 8 weeks. From Measuring and Control Equipment Co. Pty. Ltd., 9 Mobbs Lane, Carlingford, NSW 2118.

news digest

MICROPROCESSOR WATCHES

Intel will soon be producing chips that answer the varying market (as far as features are concerned) problems of the watch-chip manufacturer. It is possible to mask-program the chips for 4-, 6-, or 8-digit displays, up to 8 timing functions, and a choice of segment styles and alphanumerics.

MS MOVE

MS Components have moved to new premises in Redfern. The shop, at 164-166 Redfern Road gives increased display area for the company's hi-fi products: KEF, Ultralinear, Lenco, Sherwood, etc.

The company also sells components from the shop – direct or by mail order. The new phone number is 69 5922.

ELECTRONIC OLYMPICS

The Olympic Radio and Television Organisation will employ a trained staff of 1680 for the two weeks July 17th to August 1st. TV services will be provided for 70 countries and radio for all 110 countries represented. Provision will be made for 700 commentators and there will be at least 19 mobile units, 87 VTRs, 103 CTV cameras, 17 slow-motion VTRs and 4500 audio circuits! Australia's programmes, like those from other major broadcasters, will come from augmented productions, using some ORTO feed but supplementing this with our own cameras and production.

ETI KITS IN NEW ZEALAND

Good news for our readers on the other side of the Tasman. We have, from time to time, received letters from our New Zealand readers enquiring after the availability of kits of components for several ETI projects. Often the smaller New Zealand market has discouraged local suppliers from assembling kits and with the import restrictions it has been virtually impossible for New Zealand hobbyists to build a number of popular projects.

Applied Technology Pty. Ltd., a leading supplier of kits to the Australian market, has now made arrangements to have a range of the more popular ETI kits available directly to New Zealand readers, and has established a small warehouse facility in Auckland. The local operation is to be staffed by Kiwi enthusiasts. Negotiations are currently proceeding to establish the necessary licences, and from our initial investigations most kits will be available. There is also a strong possibility that most components, particularly semiconductors, will also be offered.

Further enquiries may be directed to Applied Technology (N.Z.) Pty. Ltd., The Electronic Mailbox, P.O. Box 4289, Auckland, New Zealand.

NIPPON MPUs

Nippon are hoping to win a large proportion of the Japanese microcomputer market with a range of new products that will completely match the range of 8-bit devices presently produced by Intel.

PROJECTION TV

After the introduction of the Advent (Video Beam) projection TV in 1974, other models are being developed by Advent and other US companies. GE have demonstrated a rear-projection type offering perfect registration and high brightness. A single beam source eliminates convergence problems and the colour image is formed by deformation of a thin oil film. The screen is then illuminated with a xenon arc source giving an image seven times brighter than models projecting a conventional picture tube image.

ERRATUM P. 65 MAY 1976

The special offer with Dick Smith Electronics had a typing error on the coupon: the text correctly stated that 25 EM402 diodes were available for $1.

WIN A CALCULATOR!

Each month we are offering an electronic calculator as a prize in this regular competition. This time it is the Unitrex 901MR mini slide-rule electronic calculator. All you have to do is complete the crossword below and get it back to us by the 16th of July. Then we will draw coupons from a barrel until we find a correct entry. The winner will be announced in ETI soon afterwards.

Send to:
Calculator Contest (June)
Electronics Today International
15 Boundary St
Rushcutters Bay NSW 2011

'Win a Calculator Contest'

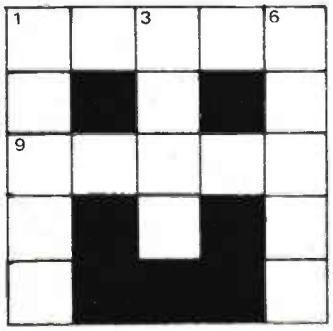
NAME .....

ADDRESS .....

.....

..... P/code...

Permit No TC 7578



THIS MONTH'S PRIZE

The Unitrex 901MR is a mini slide-rule calculator with full memory. Using algebraic logic it can handle chain and mixed calculations, displaying the results on its 8-digit display. Squares, square-roots and reciprocals are automatic and a true 4-key memory selectively stores and accumulates in a separate register. The percentage key enables add-on and discount capability. There is automatic constant on all four main functions. The calculator indicates credit balance and overflow. Case and batteries are included.

CLUES

ACROSS

1. *Alter me oar (electrically)*
9. *One problem on the TV in Hanover*

DOWN

1. *Jostle*
3. *The man who invented the telephone*
5. *Modulator-demodulator*

RESULT OF APRIL CONTEST

What are the chances of 2 or more people out of a group of 26 having the same birthday? Surprisingly it is odds on . . . almost 60%! The nearest answer on the entry coupon was 63% and the winner is Mr Y Young of Applecross, WA.

SENNHEISER

MICROPHONES

Sennheiser offers the widest choice of studio quality microphones. Used by the TV and prominent commercial broadcasting stations, Sennheiser microphones will satisfy every application and requirement.

Sennheiser's significant design features give you low sensitivity to noise and vibration, with maximum brilliance of reproduction and perfect directional characteristics.

If you would like to know more about the huge range of Sennheiser microphones, now is the time to talk to Cunninghams.

R.H. Cunningham Pty. Ltd.

VIC: 493-499 Victoria St.,
West Melbourne. 3003
Phone: 329 9633

N.S.W.: 4-8 Waters Rd., Neutral Bay. 2089. Ph. 909 2388
W.A.: 65 Balcombe Way, Balga. 6061. Ph. 494 919
QLD: L. E. BOUGHEN & CO., 30 Grimes St., Auchenflower. 4066. Ph. 370 8097

S.A.: Werner Electronic Industries Pty. Ltd., Unit 25, 6-8 Gray Street, Kilkenny. 5009. Ph. 268 2801

TELEX: Melbourne 31447, Sydney 21707, Brisbane 41500.

RHC6471

Choosing your microphone

A microphone simply converts sounds to audio signals, or does it? There are many types of microphone and they all perform in different ways. So don't just pick the first one that comes to hand; this article will help you decide which mike is best for the job.

The Shure PE5EQ E-Qualidyne microphone.

MICROPHONE SPECIFICATIONS tend to be masterpieces of obscurity. The beginner faced with buying a microphone has to reconcile conflicting requirements between the equipment he already has, the recordings he wants to make, and the amount of money he can afford to pay. The literature he gets from manufacturers may or may not be very helpful.

Microphones react differently to sounds coming from different directions. The most important direction, of course, is from the front. The directional response can be considered as a comparison between this front or 'on-axis' response and all other directions.

A polar plot or polar diagram, three of which are shown in Fig. 1, is a line joining all those points around the microphone which give the same output for a given sound level. In

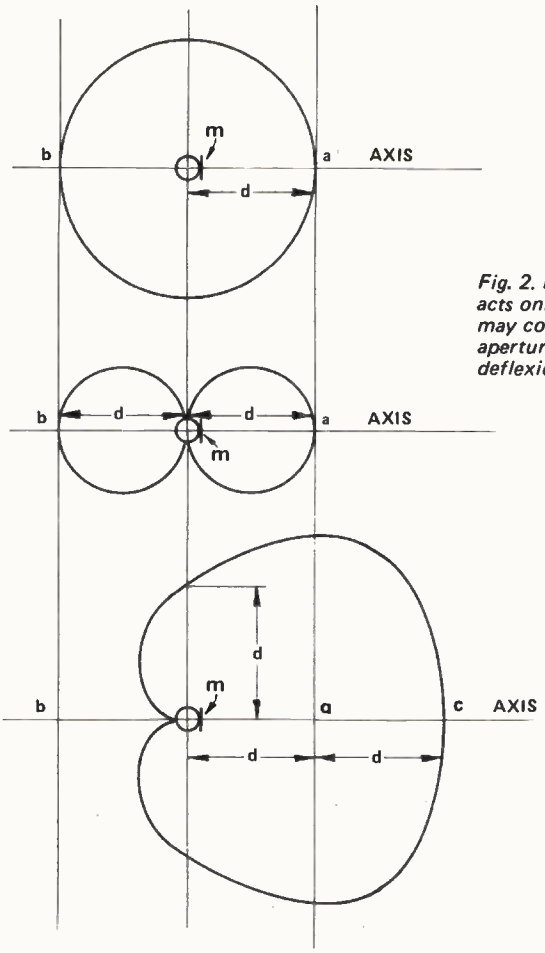


Fig. 1. Polar Diagrams.
Top: Omnidirectional response.
Centre: Bidirectional or figure of eight.
Bottom: Cardioid, the sum of the top and the middle responses.
Response at c in the bottom diagram is the same as that at a on the other two diagrams, where a to m = a to c.

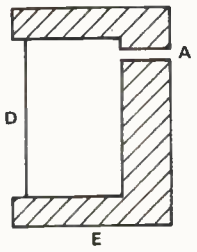


Fig. 2. Pressure operation. Diaphragm D reacts only to rapid pressure changes, which may come from any direction. A is a small aperture to avoid permanent diaphragm deflexions, E is the enclosure.

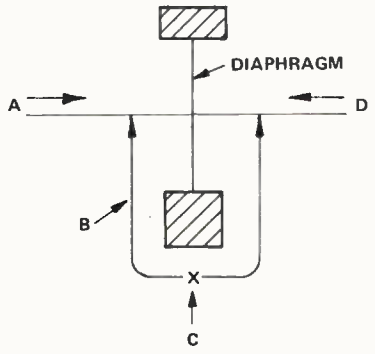


Fig. 3. Pressure gradient operation. Distance x is the path difference between the front and the back of the diaphragm.

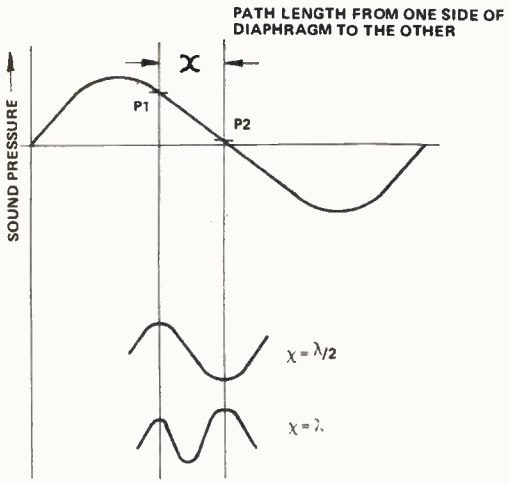


Fig. 4. Pressure gradient and frequency. As the wave travels distance x its amplitude (i.e. the pressure) changes and the diaphragm senses this differential.

other words, if you were to move a sound all around the omnidirectional microphone shown at the top of Fig. 1 you would get the same output from the microphone without having to move closer to it. On the other hand, if you were to move a sound round the figure of eight microphone there would be no response from the microphone at the sides at right angles to its axis but the response would increase again towards the back.

PRESSURE TRANSDUCER

The directional characteristics of the microphone depend on its construction. If, as in Fig. 2, the rear of the diaphragm is totally enclosed apart from an atmospheric pressure equalisation tube, then the diaphragm will react only to rapid changes in air pressure. If the diaphragm is not so big as to interfere with the sound waves it will respond to sound from any direction since these changes in pressure can approach from any direction. Thus it is a pressure transducer.

Another kind of operation is pressure gradient operation. The diaphragm (Fig. 3) is exposed on both sides. A sound wave coming from direction A strikes the front of the diaphragm first and then travels round to the back. In doing so it will have to move distance x, the path difference between front and back. In this time the pressure at the front of the diaphragm will have altered according to the pressure pattern of the incoming wave. If the wavelength of the sound is long compared with x (Fig. 4) the pressure change which occurs while the wave travels distance x will not be great. In the limit, when the sound pressure is constant, there will be no difference along the path length x at all. At low frequencies x will be small compared with the wavelength and it can be assumed that P_1 to P_2 is a linear portion of the pressure curve, so that $P_1 - P_2$ genuinely represents the pressure gradient. Here the force on the diaphragm is proportional to frequency, and this is roughly true until the distance is a quarter of the wavelength of the sound.

CARDIOID PATTERNS

The pressure gradient microphone will only respond to sounds from the front. Sounds from position C in Fig. 3 will have no effect on the diaphragm since pressures on either side of it are equal. Sounds from D will have the same effect as those from A but will be phase reversed since they move the diaphragm in the opposite sense, so that although the microphone would give the same voltage output at B as at A, the output at A would be +V and the voltage at B would be −V. It is for this reason that if the omnidirectional and figure of eight characteristic are combined — as they can be by connecting an omnidirectional microphone element to a figure of eight element — then the responses of the two characteristics add at the front and subtract at the back, giving the cardioid characteristic shown in the third part of diagram 1.

PHASE SHIFT

The cardioid characteristic can also be obtained as follows. Figure 5 shows a phase shift operated microphone, in which the amount by which the phase of the incident wave is shifted between the front and the rear of the microphone is related to the angle of incidence of the sound wave. In the diaphragm shown, the path difference

Choosing your microphone

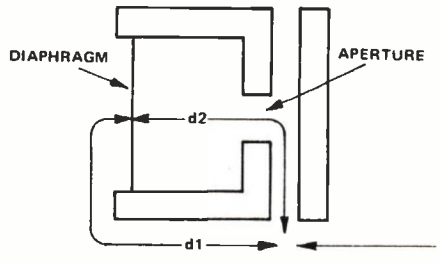


Fig. 5. Phase shift operated microphone.

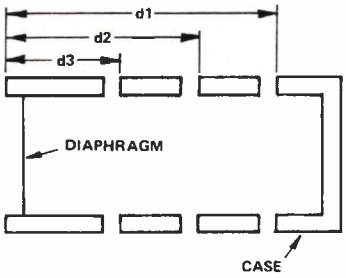


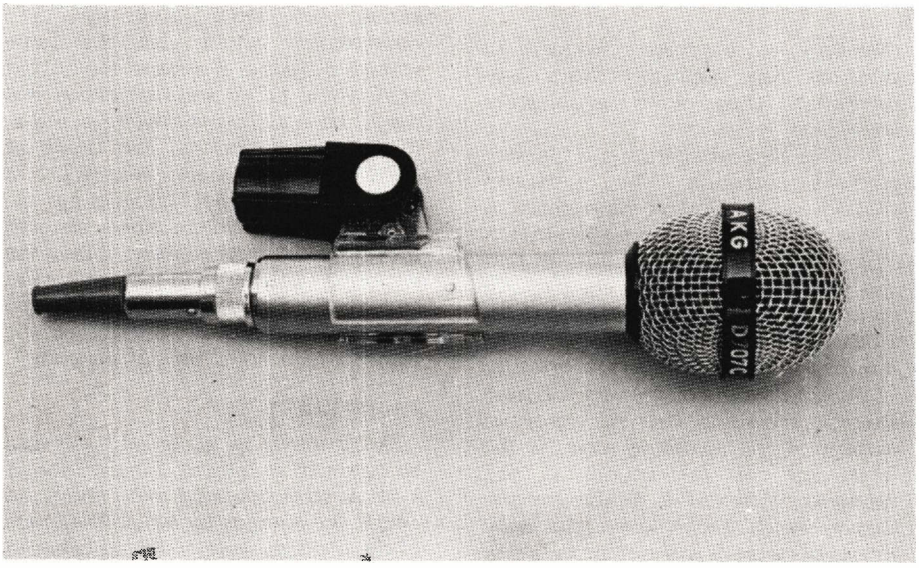
Fig. 6. Ported phase shift microphone.

for sound behind the microphone is zero because $d_1 = d_2$. This means that there will be no response to sounds coming from the back. If the sound comes from the front there will be a phase shift which will reinforce the motion of the wave impinging on the front of the diaphragm. For the arrangement shown, the reinforcement will be maximum when $d_1 + d_2 = \lambda/2$ making the pattern frequency dependent, and in a practical microphone ports are provided for the high, medium and low frequencies to give a uniform response, as shown in Fig. 6. Here d_1 is the distance to the low frequency port, d_2 that to the mid frequency port and d_3 is that to the high frequency port. The three ports can be replaced by a long slot.

As the size of the ports or slot tends to zero the microphone will tend to become pressure operated, giving an omnidirectional pattern. As the size of the ports tends towards infinity, where the back of the diaphragm is open, the microphone will tend toward pressure gradient operation, giving a bidirectional or figure of eight pattern. When the apertures are between these sizes the microphone will act in a combination of pressure and pressure gradient operation, giving various forms of cardioid pattern.

HAND MICROPHONES

The omnidirectional microphone is best for use as a hand microphone. There is less handling noise and the user need not be on axis for the microphone to give full output. The omnidirectional microphone, is also less prone to a phenomenon known as 'proximity effect', which means that as the microphone gets nearer to the source of a sound it exaggerates the bass response. On the other hand an omnidirectional microphone is not easily used in public address work because it may pick up the sound from an audience loudspeaker and re-amplify it, causing howl-round or feedback. This is best eliminated by using a cardioid, which does not respond to sounds coming from behind it and will not be so affected by auditorium loudspeakers. Often auditorium loudspeakers are placed in front of the performers and have their own directional pattern which prevents their output reaching the stage microphones.



The AKG D707C microphone.

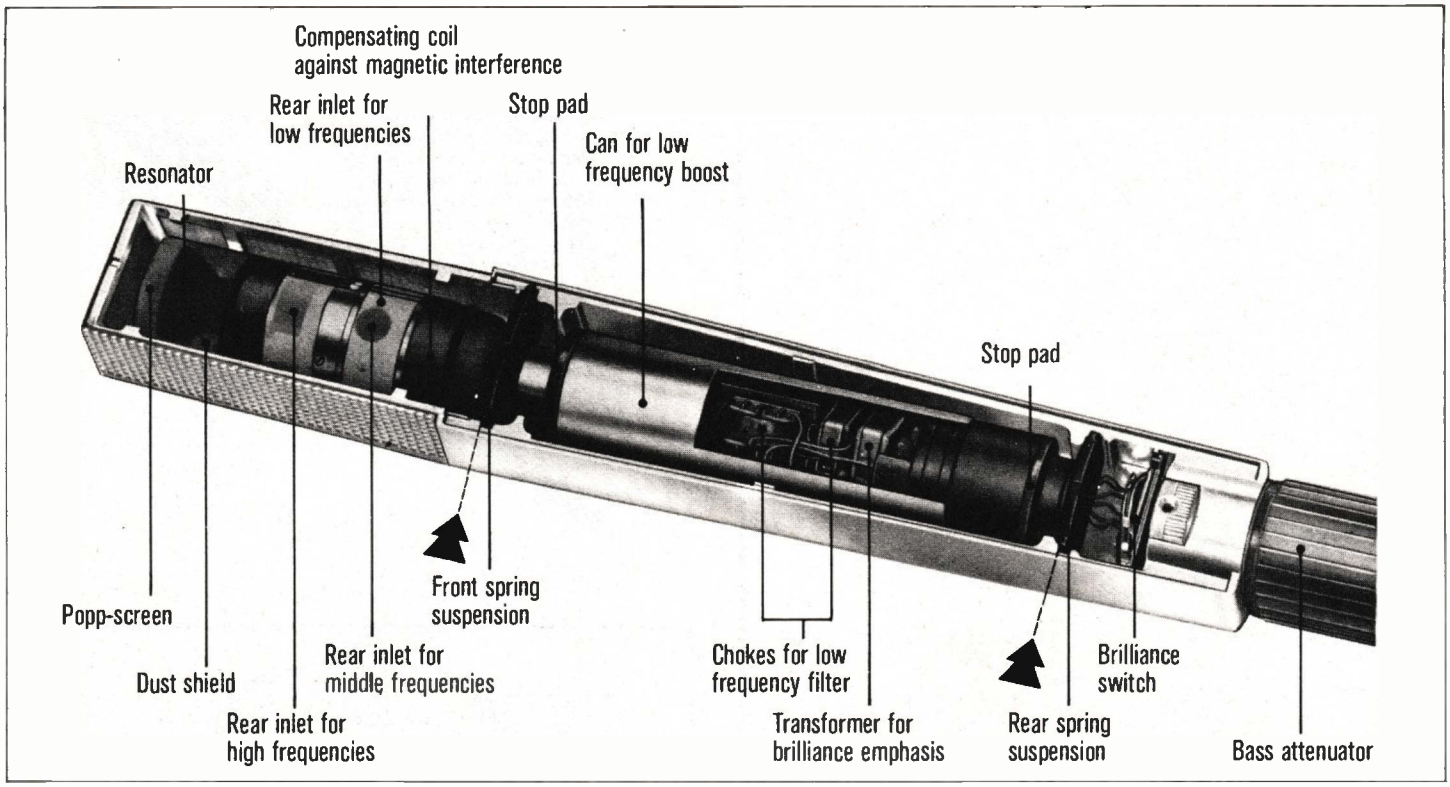
POPPING

Another problem is breath popping, which occurs when a performer sends a puff of hot steamy air into the internal organs of a microphone. Omnidirectional microphones are less sensitive to this kind of thing and cardioids can be protected from it by windshields. A ribbon might not recover. If a windshield is used on a cardioid with a port or aperture in the body of the microphone, as in the AKG series, the ports should be windshielded too.

The figure of eight combination overcomes disadvantages inherent in the omnidirectional and cardioid designs. The omnidirectional, while it has many advantages, responds to echoes and reverberations in a room as well as the direct sound. The cardioid responds, in general, to the direct sound, which is why it tends to be used in situations where an audience is present and it can therefore reduce the coughs, chair scrapes and, if you're unlucky, snoring that may occur on such occasions. On the other hand the cardioid tends to produce a very dry sound, particularly if used too close, and recordings made this way can often be said to need some reverberation. The figure of eight is a perfect compromise, on many occasions, introducing just the right amount of reverberation and keeping off unwanted noise.

REFLECTIONS

Figures 7 and 8 show the common situation when recording. In Figure 7 the microphone receives a direct sound from the instrument as well as numerous indirect sounds reflected from walls, floor and ceiling. For a variety of reasons in a concert hall these tend to be predominantly sounds reflected from the side of the hall. The cardioid will tend to diminish its response to sounds as they come from a direction nearer the back of the



Inside the elaborate Sennheiser MD411 studio microphone. The transducer is isolated against the vibrations of the outer housing by the suspension springs.

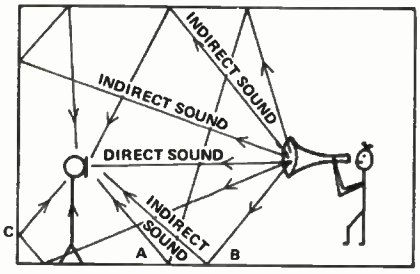


Fig. 7. If the mike is too far away the indirect sounds (echoes) drown the direct sounds.

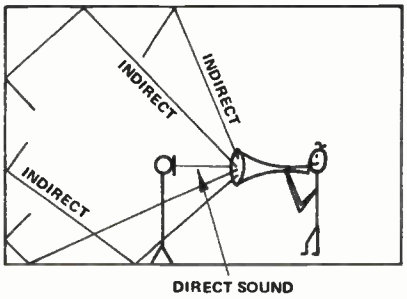
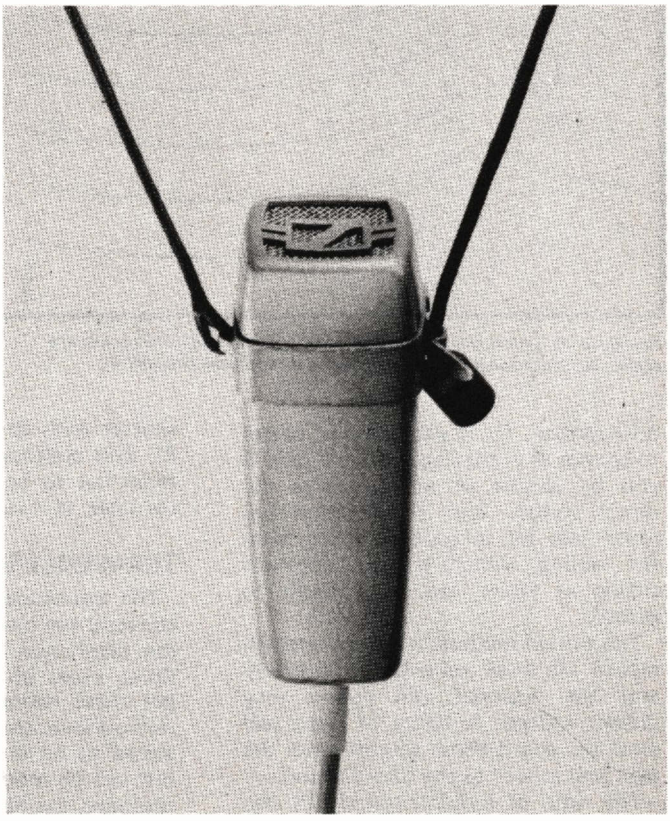
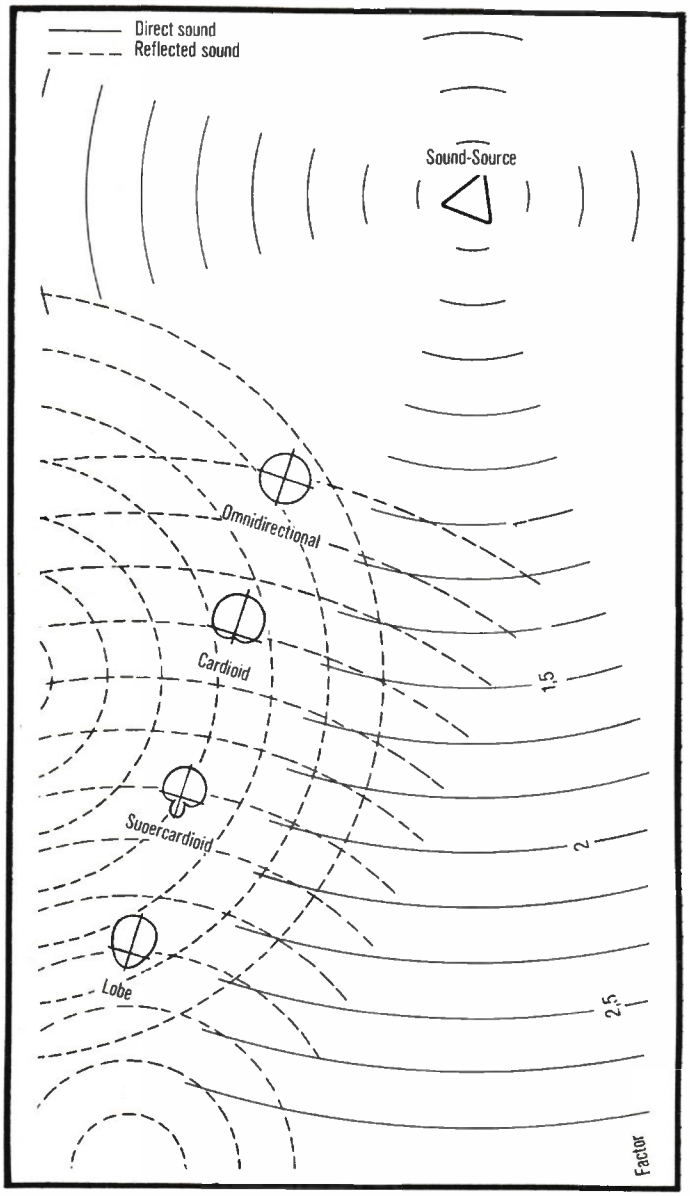


Fig. 8. Moving the mike closer in alters the direct/indirect sound ratio.

The Sennheiser Lavalier microphone MD214. The response of this microphone is designed to give a natural voice reproduction when it is worn on the chest. It is designed to reduce rustling noise as the wearer's clothes rub against it.

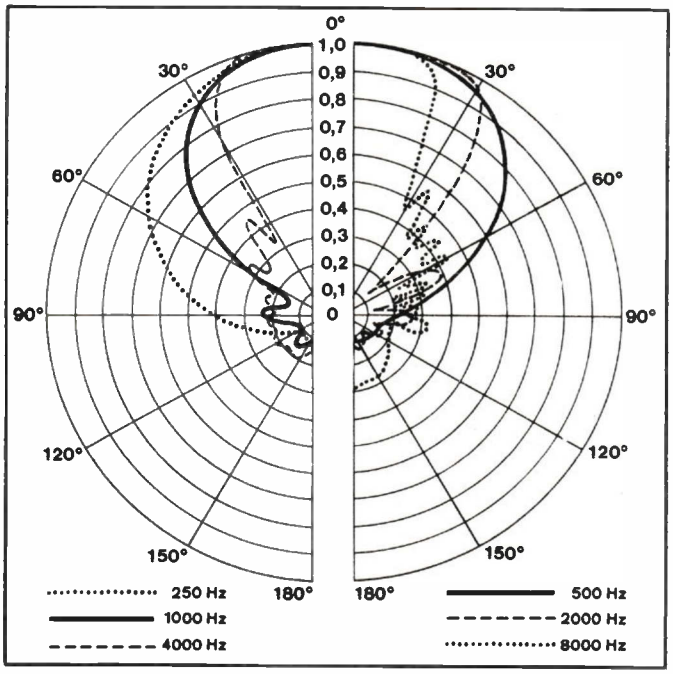


Choosing your microphone



Positions at which the intensities of direct and radiated sound are equal, for microphones with differing directional properties.

The Sennheiser MKH 815 condenser microphone. This device combines the interference and pressure gradient principles to give smooth frequency response and high directionality. The length is 550 mm but the performance makes it ideal for out-of-shot use in film and TV. The graph shows the polar response at six frequencies.



microphone. So it will respond better to sounds at A than sounds at C, and B will be almost as well heard as the direct sound. The B reflection has much less far to go than those from the ceiling, which is why speakers sitting at tables can be difficult to record.

The omnidirectional microphone will record all these reflections faithfully and the trumpet will sound very distant indeed. A figure of eight will tend to record those sounds from the rear wall as well as the direct sound.

The ratio of indirect sound can also be varied by giving the direct sound a shorter path to the microphone (Fig. 8). This approach should be used if an omni has to be used, but as we shall see later, it is not suitable for ribbons.

TRANSDUCERS

The transducer is the element which converts the mechanical movements of the diaphragm into electrical signals. Three types of transducer are used to get these various response in quality microphone: the **moving coil**, which is suited to an omnidirectional response but can be modified to give a cardioid response, the **ribbon**, which is far more suited to figure of eight operation than other responses, and the **capacitor**, condenser or electrostatic microphone.

Both moving coil and ribbon microphones work on the same principle — that when a conductor moves in a magnetic field an electrical signal is induced in the conductor. The size of the signal depends on the rate at which the conductor moves across the field.

CHEAP MICROPHONES

Before looking at the three high quality transducers, there are two other types to consider — the carbon microphone and the crystal

microphone. The carbon microphone is seldom used these days.

It operates by monitoring the resistance of a capsule of carbon granules as it changes under pressure from a diaphragm. The quality is poor but the high output (the change in a small dc bias voltage) was an attractive feature back in valve days.

The crystal microphone is common today where a cheap microphone is needed. The quality is adequate for speech work and the high impedance output easily drives simple transistor amplifiers. Two Rochelle Salt elements with metal electrode coverings form a square bimorph. Three corners are fixed to pillars in the housing of the transducer and the fourth corner is connected to the centre of the diaphragm.

Another type used, especially in mobile communication, is the rocking armature type. The frequency response of these microphones coincides with the valuable section of the speech frequencies and avoids a lot of background noise.

MOVING COIL

In Fig. 9 the moving coil is attached to a diaphragm, and when sound waves hit the diaphragm the coil moves and gives a signal across its ends. The same happens in the ribbon microphone.

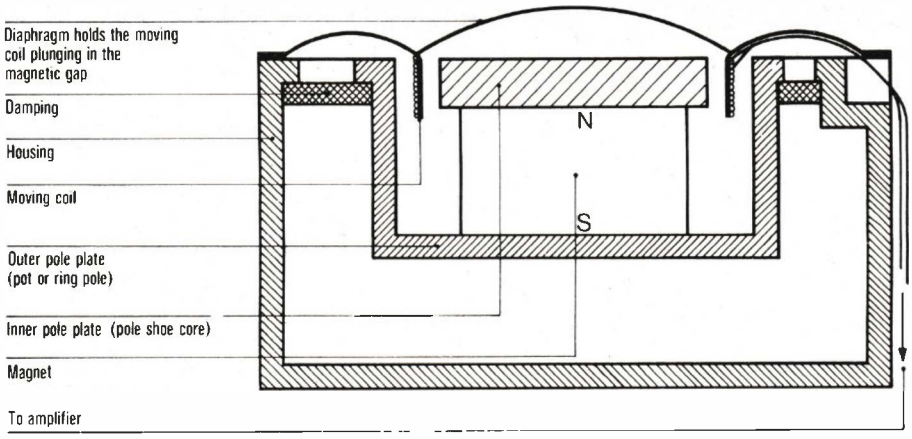
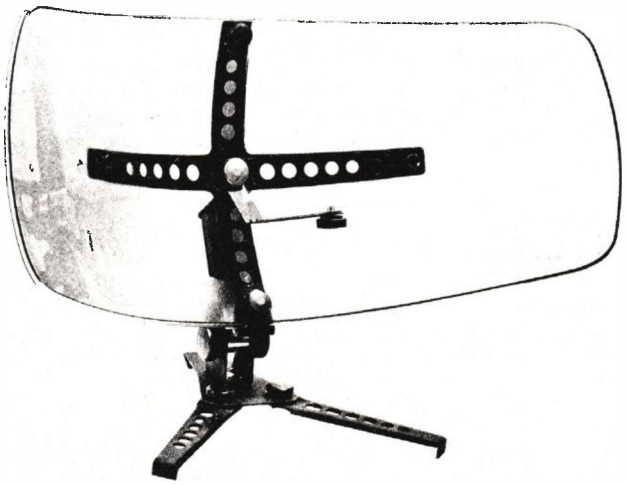


Fig. 9. Transducer principle of the moving-coil microphone.

The moving coil is more widely used in studios and on stage than any other. It is robust, gives a good output level, has a good transient response and frequency response, and is reliable and inexpensive. It is best suited to omnidirectional work and can become rather complicated if used as a cardioid. Even as an omni the response becomes less omnidirectional at high frequencies because the case interferes and this has to be compensated for by making the microphone smaller — though as it gets smaller the output decreases.

The impedance of the moving coil microphone is low, between 20 and 30 ohms. Also, compared with the output of the lower quality crystal and ceramic types of microphones, the output is low, so a transformer may be needed to step up both impedance and output voltage for the input of the tape recorder, amplifier or mixer. Often the transformer is built into the case of the microphone and can be fitted with a number of secondary tappings, so that the microphone can be matched into a variety of impedances.



Another way to get a highly directional response: the parabolic reflector. The reflector on the JVC TL-E71 gives a 15 dB gain at 5 kHz. The picture shows only the reflector, the microphone has to be attached to the arm. This is a useful accessory for the amateur recordist who wants to make wildlife tapes.

The Sony ECM-99 "one-point" stereo microphone. This makes stereo recording easy for the novice; both microphones are in one housing with built-in wind screen.

The Shure SM5A is a boom microphone with a built-in 100 Hz hi-pass filter to cut out subsonic transients (caused by rapid boom movement or wind). These transients can overload the recorder's input.

Choosing your microphone

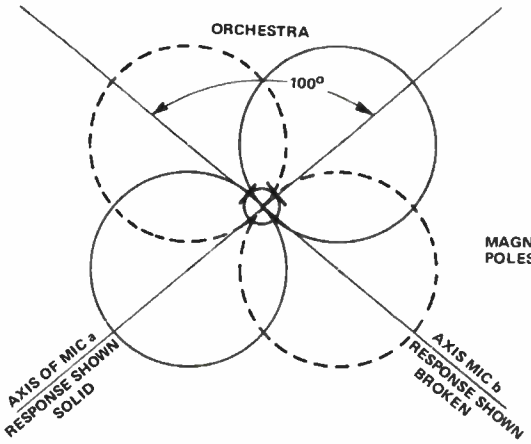
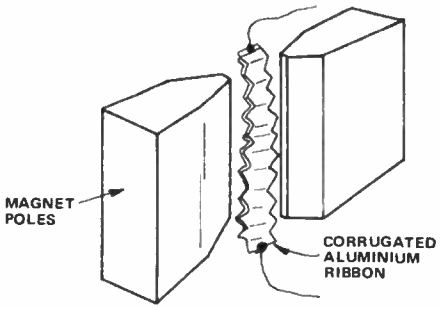


Fig. 12. Use of two ribbon mics for orchestral recording.



Ribbon microphone.

RIBBON

Figure of eight operation is usually achieved with a ribbon microphone. Much of the foregoing remarks about the need for a transformer apply here as they do with the moving coil microphone, except that the ribbon microphone has a far lower impedance and output than the moving coil microphone. The impedance might be as low as an ohm and a transformer is always needed, particularly since a ribbon microphone with a wide frequency response is likely to give a very low output. The ribbon microphone is an excellent choice for stereo, where two arranged as shown in Fig. 12 may give excellent results for recording an orchestra.

Note that if two microphones are to be used for recording stereo the off-axis response is very important. Since they will not be pointed directly at the orchestra they need to reproduce high frequencies at an angle to the front of the microphone. Most manufacturers of repute give some idea of the off-axis response of a microphone by publishing a polar diagram plotted at various frequencies.

Orchestral recording is ideal for the ribbon microphone, since it is very prone to 'proximity effect', and should never be used near to loud bassy instruments. It is also very delicate and cannot be used outside, where a gust of wind may damage it permanently. It should never be used held in the hand, since it is more prone to handling noise than any other microphone. It may have a large stray magnetic field, so a ribbon microphone should be kept away from recording tapes.

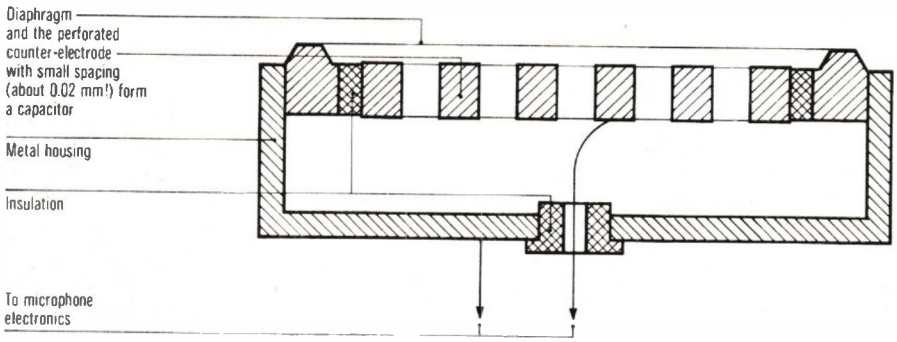
Ribbon microphones can also be used to make small studios less dead without including reflections, particularly those from tables. A bi-directional microphone can be used for two persons speaking, one either side, and for drama it is very useful for an actor to be able to step 90° round the microphone to 'disappear' from the scene. For more speakers, as in a discussion, it is better to use an upward facing cardioid, which will, again, cut out those unwanted table reflections and paper shuffling sounds without making the discussion sound as though it is being held in a room lined with cotton wool or at night in the centre of the Simpson desert. Broadcasting studios often have a well in the middle of the table for placing such a microphone in and another advantage of this is that it tends to lower the microphone's prominence in the minds of those having to speak into it, particularly if they are not experienced broadcasters. Note that a ribbon microphone should be used at mouth level in such circumstances.

CAPACITOR

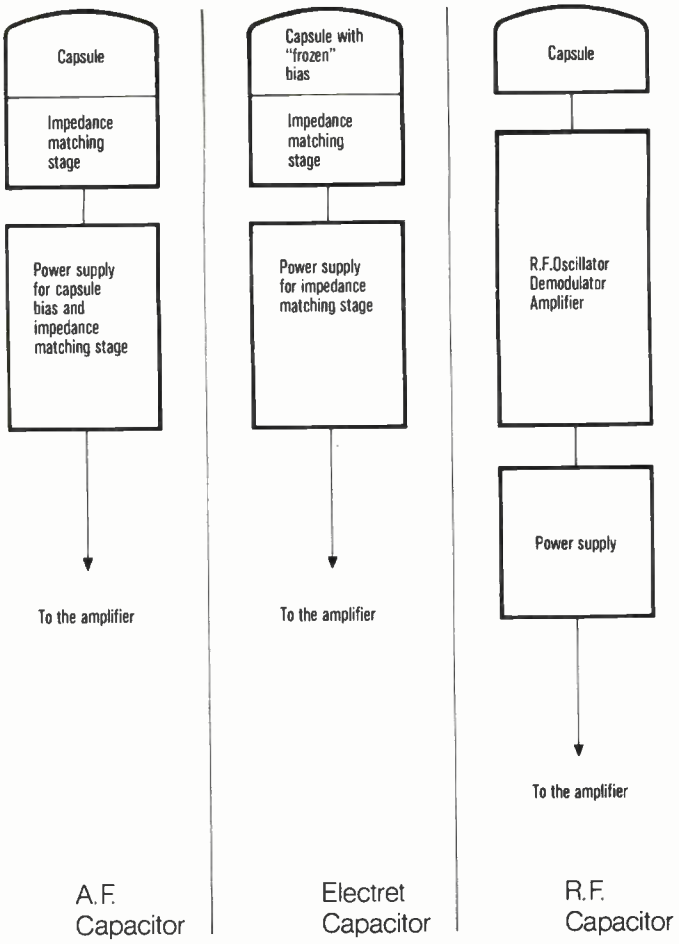
The capacitor microphone can be arranged to have any of the three polar patterns and even any in between. It works on the principle that if the charge on a parallel plate capacitor is kept constant the voltage across the plates is proportional to the distance between the plates. One plate is kept fixed and the other is flexible and responds to sound, so that the sound varies the voltage across the plates, and gives an audio output signal. The charge on the plates is kept constant by polarising the plates via a large resistor, see Fig. 11, and the audio voltage is extracted via an isolating capacitor. The microphone has a flexible plate on either side of the fixed plate so that two outputs are obtained which can be added, subtracted or mixed in varying degrees to obtain various polar patterns.

Capacitor microphones undoubtedly exhibit the best frequency response, and can be flat up to 15 kHz or so, with a −3 dB point as high as 18 kHz or higher. In addition they have very high output level, can be very small and, as we have seen, can give various polar patterns.

The problem with a capacitor microphone is that its source is a small capacitance, which gives a very high value of source impedance at audio frequencies. Any signal source with a high source impedance may suffer from stray fields picked up by the cable connecting it to its amplifier and from a deterioration in frequency response along the cable. Thus a buffer amplifier has to be built close to the microphone cable. This means that the

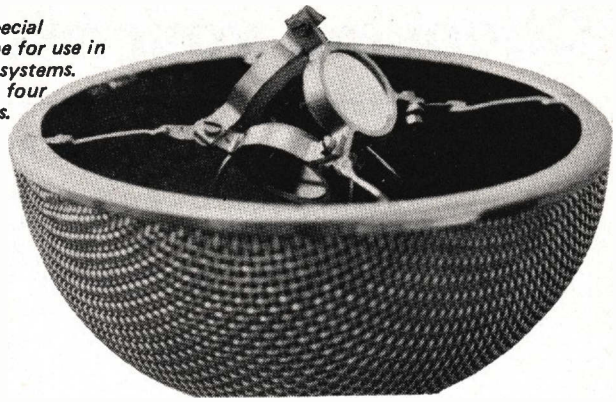


Transducer principle of the capacitor microphone.



Three types of capacitor microphone system: AF, Electret and RF.
AF *The capacitor is charged at a constant rate via a very high resistance. The variations in capacitance produce variations in charge voltage which need to be transformed to lower impedances before they are fed to the pre-amplifier.*
Electret *In this type there is no need for an external polarising voltage: special foils are used which are permanently charged (a special process in their manufacture provides a charge which will never die away). However the acoustic properties of the foils are inferior to those of the AF capacitor mike.*
RF *These mikes give low noise figures. The capacitance is used in a discrimination tuned circuit to which RF (usually 8 MHz) is applied. The discriminator gives an AF output to match the capacitance changes in the microphone. These types are for studio use.*

This is a special microphone for use in ambisonic systems. It contains four transducers.



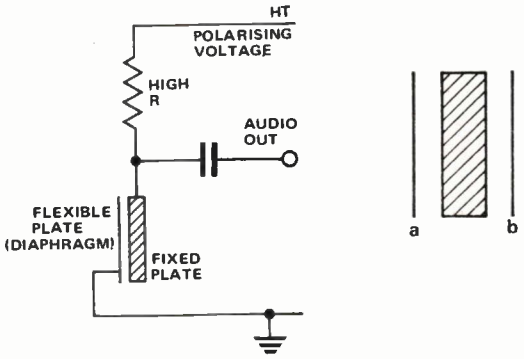


Fig. 11. Some capacitor microphones have a flexible plate either side of a fixed plate. Each single diaphragm gives a cardioid response so that if the two outputs are added, the results is omnidirectional, and if subtracted is bi-directional or each cardioid can be used alone.

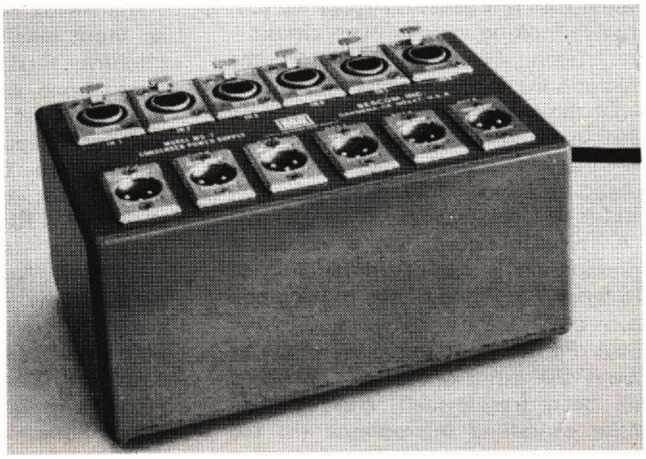
amplifier has to be powered but, on the other hand, the output can be as high as the amplifier designer requires.

All this means that for a capacitor microphone you may need an external power supply and an internal impedance convertor. Sometimes the diaphragm is made of metal-flashed plastic, which can distend in heat, such as found under television lighting. Even if the capacitor polarising voltage is supplied by an electret — a permanently polarised crystal — a battery is still needed to power the buffer amplifier because the electret cannot supply any current. The electret may be an uncertain proposition and perhaps susceptible to heat and moisture. Even an externally powered capacitor microphone is susceptible to an increase in noise in humid conditions.

SPECIFICATIONS

The moving coil microphone can respond to frequencies up to about 12 kHz or so and, when the microphone has two elements and a crossover, just as in a loudspeaker, the response can go up to 14 or 15 kHz, although the off-axis response may not be quite as good as that because of the separation between the capsules. The ribbon microphone has a response up to 10 kHz but is off axis response is equally good 50° either side of the axis.

The sensitivity of the microphone is a measure of the voltage it delivers for a given sound input. It is one of the most confusing of microphone specifications since it can be defined in



Users of capacitor microphones often need to change batteries, but with this supply they can run up to six mikes from the mains. A constant 48 V is supplied at up to 14 mA. From Sescom.

Choosing your microphone

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so many ways. Typical definitions are mW/10 dynes/cm^2, mV/dyne/cm^2, mV/N/m^2, mV/microbar, and MV/Pa. Alternatively the quantity can be expressed in –dB.

Dynes/cm^2, n/m^2, microbars and Pa are all ways of expressing pressure, so that the preceding figure is a measure of the output for a given pressure on the diaphragm of the microphone.

1 microbar =
1 dyne/cm^2, and 1 N/m^2 = 1 Pa.
10 microbars or dynes/cm^2 =
1 N/m^2 or 1 Pa.

One microbar is the peak level of a normal voice 1 metre from the microphone. A singing voice is likely to be much louder and a trumpet or trombone even more so.

We have already seen that the output of the microphone varies according to the output impedance. The output may be defined in mW into a given load, usually 600 ohms, or it may, more often, be defined as a voltage, in which case it is generally specified as if it were looking into an open circuit – the open circuit voltage of the microphone is the highest and that is what the manufacturer wants to show you in his specification! (a 600 ohm microphone feeding into 600 ohms would produce only half its open circuit voltage.

A typical figure for a capacitor microphone is 1.5 mV/dyne/cm^2, or 15.0 mV/Pa. Some of the moving coil microphones vary between 0.5 and 1 mV/Pa. A ribbon microphone can be about the same once the impedance has been transformed, although one noise cancelling microphone (in the STC range) has an output in the region of less than 0.1 mV/Pa.

The sensitivity may be defined in negative dB, where the dB reference should be stated and can be any of the quantities previously mentioned, such as 1V/Pa or 1 mW/dyne/cm^2.

IMPEDANCE AND MATCHING

The next problem is that you have to match the microphone output to your amp or tape recorder input. There are two rules here: the output impedance should be a half or a third the input impedance of the device into which it is feeding, and the sensitivity of the microphone should be two to four times the maximum input sensitivity of the device into which it is feeding. This gives enough input from the microphone to avoid too low a signal, which would increase noise, and it also means that there will not be so much output from the microphone that the input to the recorder is overloaded.

The Revox A77, for instance, quotes an input sensitivity of 0.15 mV at 6 kilohms. First, you're looking for a microphone with a maximum output impedance of around 2 k. Next you want an output from the microphone of between 0.3 and 0.6 mV. This means that the sensitivity will be between –70 dB and –64 dB. The reference is 1 V / microbar, or 10V/N/m^2. Note that if the voltage is doubled the sensitivity increases by 6 dB. If the reference is 1 mW into 600 ohms the reference is 0.776 V and 1 mW into 1 kohm gives 1 V.

The self generated noise in the microphone varies with its source impedance, and the lower this is the better from the noise point of view. At any rate the noise should be between 20 and 30 dB measured to DIN standard 45405, or defined as between 0.2 and 0.3 Veff.

The dynamic range of a microphone is a measure of its ability to record the softest and the loudest sounds equally well. At the top end it will begin to distort once the sound reaches a certain loudness and the level at which the microphone distorts by, say, one per cent can be taken as the reference level. At the quiet end the microphone may give an output which is barely above its own noise level. The dynamic range should be between 120 and 130 dB. It should be noted that this quantity isn't all that significant since the limitations of the input amplifier are more likely to be dominant – if the microphone gives out more than 1mV/dyne/cm^2 the output will be 0.1 V at a sound level of 114 dB or so, which can occur, and the amplifier is likely to distort.

Finally, the front to back ratio for a cardioid should be between 15 and 25 dB, the higher the better, depending on the application. ●

AKG

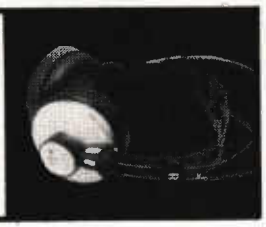
Microphones & Headphones

D109 — Weight only 35g. Attractively styled and miniaturised, cable length 10m, Omni-directional characteristics.
Technical Data: Type: Dynamic pressure receiver; Frequency reponse: 50 . . . 15000 Hz; Tolerance within: max. ± 3.5 dB; Sensitivity at 1000 Hz: 0.1 mv/μ bar (—80 dbv); Impedance at 1000 Hz: 200 ohms ± 15%; Min. Actual Load Impedance: 400 ohms; Directional Polar Response: spheric; Weighted Noise Level: 0.26μ veff (filter CCITT-C/DIN 45 405); Unweighted Noise Level: 0.2μ veff; Max. Sound Pressure level at a distortion factor of a 0.5% at 1000 Hz: 500μ bar (128 dB SPL); Diaphragm: MAKROFOL

D190 — Wind and pop-shield, pronounced directional characteristics, removable grille cap for easy servicing.
Technical Data: Type: Dynamic pressure gradiant receiver; Frequency Range: 30 . . . 16,000 Hz; Sensitivity at 1000 Hz: 0.23 mv/μ bar (-73 dbv); Impedance at 1000 Hz: 280 ohms ± 20%, Min. Actual Load Impedance: 500 ohms, Directional Characteristics: Cardioid; weighted noise level: 0.25μ veff (Filter CCITT-C/DIN 45 405); Unweighted Noise Level: 0.2μ veff; Max. Sound Pressure Level at a distortion of 0.5% at 1000 Hz: 500μ bar (128 dB SPL).

D707 — Microphone system elastically suspended preventing mechanical shocks from reaching the transducer. Available with DIN and Cannon connectors.
Technical Data: Type: Dynamic pressure gradiant receiver; Frequency Response: 60 . . .16,000 Hz with a tolerance of max. ± 3.5 dB; Sensitivity at 1000 Hz: 0.15 mV/μ bar (-76.5 dbv); Impedance at 1000 Hz: 230 ohms ± 20%; Min. Actual Load Impedance: 400 ohms; Directional Polar Response: Cardioid: Weighted Noise Level: 0.26μ veff (filter CCITT-C/DIN 45 405); Unweighted Noise Level: 0.2μ veff: Max. Sound Pressure Level at a distortion of 1% at 1000 Hz: 500μ bar (128 dB SPL); Diaphragm: MAKROFOL.

D2000 — Functional design and robust construction, heavy diecast housing with matt finish. Available with DIN and Cannon connectors.
Technical Data: Type: Dynamic pressure gradiant receiver; Frequency Response: "bass" position, 25 . . . 15,000 Hz. "medium" position, 50 . . . 15,000 Hz; Tolerance within: max. ± 2.5 dB; Sensitivity at 1000 Hz: 0.23 mv/μ bar; Impedance at 1000 Hz: 220 ohms ± 20%; Min. Actual Load Impedance: 500 ohms; Directional polar response: Cardioid; Weighted Noise Level: 0.26μ veff; Unweighted Noise Level: 0.2μ veff; Max Sound Pressure Level for a non-linear distortion factor of 1%: 500μ bar (128 dB SPL).



K140 — "Cardan" — ultra light weight yet robust construction. One cable only for both earpieces, wiring completely integrated inside headband.
Technical Data: Frequency Range: 20 . . . 20,000 Hz; Normal Power Requirement: 50 mw per channel, for a sound pressure level of 112 dB (80μ bar) at 1000 Hz; Max. Undistorted Continuous Power Level: 119 dB SPL per system equivalent to 250 mw or 12v per system, at less than 1% thd; Sensitivity at 1000 Hz: 15μ bar/v < 1.5 Pa/v < 97.5 dB SPL; Impedance: 600 ohms ± 20% per channel over the entire frequency range.

K160 — Flexible double headband offers additional comfort, has detachable earpieces.
Technical Data: Frequency Range: 16 . . . 20,000 Hz; Normal Power Requirement: 1 mw per channel, for a sound pressure level of 112 dB (80μ bar) at 1000 Hz equivalent to 775 mw per system; Max. Undistorted Continuous Power Level: 125 dB SPL per system equivalent to 20 mw, or 3.5v per system, at less than 1% thd; Sensitivity at 1000 Hz: 100 μbar/v < 114 dB SPL; Impedance: 600 ohms ± 20% per channel over the entire frequency range.

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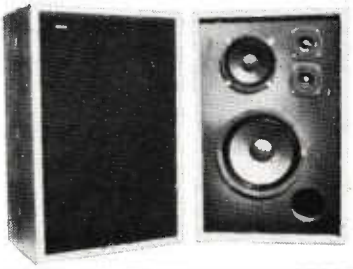

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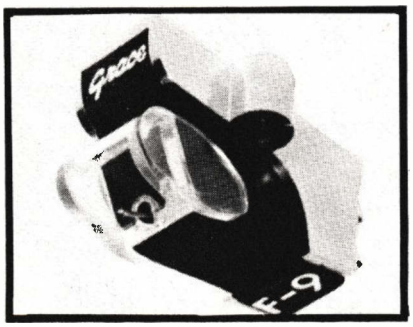

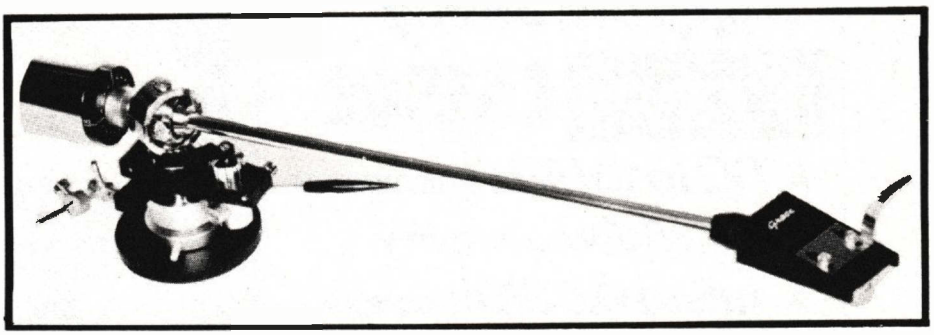

CARTRIDGES:

With cartridges, with tone arms, with whatever, there will always be some who claim to be the best there is. Probably, they'll be seen around exhibitions a lot, on equipment being demonstrated, and so on. But we believe it's well worthwhile taking a little time to consider what "the best" really means; in terms of quality *and* in terms of price.

About the Grace F9E/Extended Range 4 Cartridge (just one of the F9 Series) Hi-Fi Review had this to say: "The F9-E is one of the sweetest sounding cartridges we've heard, providing a very full sound with virtually no audible distortion. It would be suitable for use with top quality systems where it's capabilities could be fully realised."

Based on the renowned F8 series, (including Gold Medal winning, best selling F8L eliptical cartridge, and F8C Custom with luminal trace eliptical stylus), the new F9 range may very well cause the discerning purchaser to ask just where all that extra money is going in what some would allege to be "the best".

TONE ARMS

Typifying the range of Grace Tone Arms is the Grace G707 low mass arm. In order not to distort the mid frequencies, because of dead mass, the G707 is provided with a non interchangeable acrylic head shell. This is an integral part of the entire arm. However, changing cartridges can still be easily achieved. Model G840F has the Universal type interchangeable head shell.

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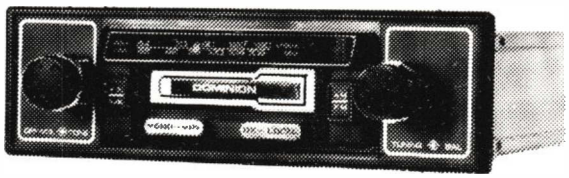

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Antennas – Part 2

Last month Roger Harrison, VK2ZTB, looked at the basic concepts of antennas and showed you how to build simple dipoles and baluns. In this final part he describes other popular antennas and their construction.

ANOTHER ARRANGEMENT OF the basic dipole is the 'folded dipole' or 'two-wire' dipole. The advantage of this is that it transforms the impedance of the feedpoint by a factor of four. This allows the use of higher impedance two-wire balanced feedlines such as the 300 ohm flat TV ribbon type. This has the advantage of being cheaper. It is also possible to construct your own two-wire feedline. The folded dipole also has the advantage of increasing the bandwidth of a dipole which is generally in the vicinity of only 2%-5% of the resonant frequency of the antenna. However, the bandwidth of an ordinary single-wire dipole is quite adequate to cover the novice bands.

Nevertheless, if you have plenty of 300 ohm TV ribbon on hand, or only wish to spend a limited amount on the antenna and feedline, particularly where there is a long run of feedline involved, the folded dipole is a good alternative.

The basic construction is shown in Fig.13. The lengths are obtainable from Fig.6. The centre insulator can be made in a similar manner to the one illustrated in Fig.9 or the feedpoint joint can be sandwiched between two blocks of plastic screwed together. The antenna itself can be made from TV ribbon as illustrated. One wire is cut at the centre to make the feedpoint to which the 300 ohm feedline is connected. Each wire is soldered together at the ends. Alternatively, two wires of about 14 gauge to 18 gauge (or 10/010 hookup wire) are run parallel to each other, using wooden or plastic spacers. The wires can be spaced anywhere between 100 mm and 200 mm apart. Use wider spacing, say 200 m, on 3.5 MHz and narrower spacing on the 21 MHz and 27 MHz bands.

The feedline is ordinary 300 ohm TV ribbon which is a very inexpensive feedline. As most transmitters are arranged to have a low impedance unbalanced output, generally 50 or 70 ohms, a balun will be necessary. The transformation from 300 ohm to 70 ohms is about four-to-one (4:1). Consequently a suitable balun must not only convert from balanced to unbalanced but also transform the impedance by the appropriate ratio. This may be purchased or you can make one.

There are two simple methods that can be used to make this sort of balun. As for the 1:1 balun, you can make a wideband 4:1 transformer, or construct a balun from coax.

Wideband 4:1 Balun Construction. This is constructed in exactly the same manner as the 1:1 transformer using three, 180 mm lengths of enamelled copper wire twisted together at about two twists per 10 mm. Wind three turns through the two holes of the balun core previously recommended. (Neosid type 1050-1-F14). Find and identify the three starts and finishes, and then connect them as shown in Fig.14.

It does not matter a great deal in this application if the transmitter output and receiver input is intended to match into 50 ohms, as the mismatch is quite small and most circuits will cope with this with little or no degradation in performance.

Coaxial Cable 4:1 Balun Construction. This type of balun is sometimes referred to as a 'trombone' balun as its form, illustrated in Fig.15, is reminiscent of that instrument. A loop of coax is added, in series with the feedpoint end of the coax feedline as shown. This results in a 4:1 impedance transformation as well as a balanced-to-unbalanced transformation.

The three ends of the coax lines may be taped together and the inner and outer conductors connected as in Fig.15. Alternatively, three coax plugs may be used to terminate the ends of

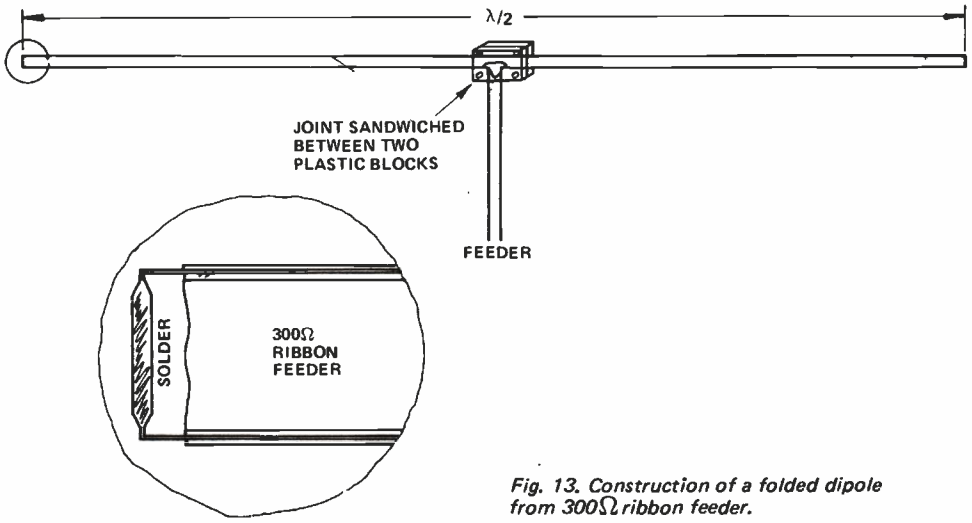

Fig. 13. Construction of a folded dipole from 300Ω ribbon feeder.

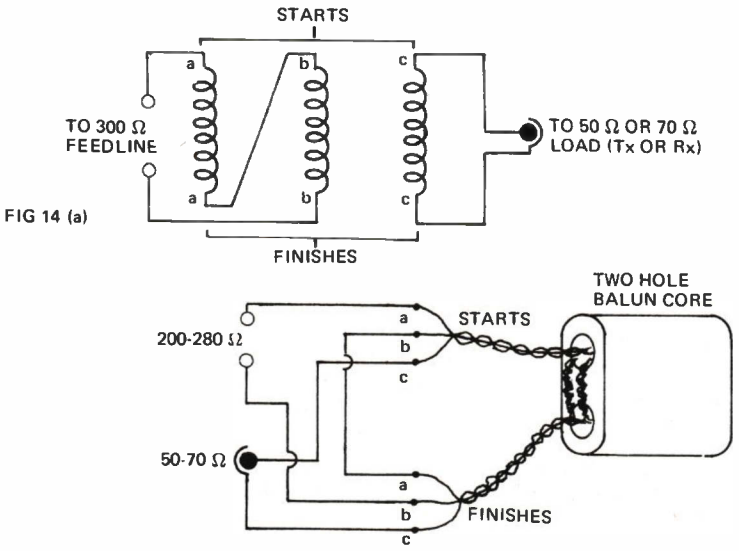

FIG 14 (a)

Fig. 14. Construction and connections for a 4:1 wideband balun transformer.

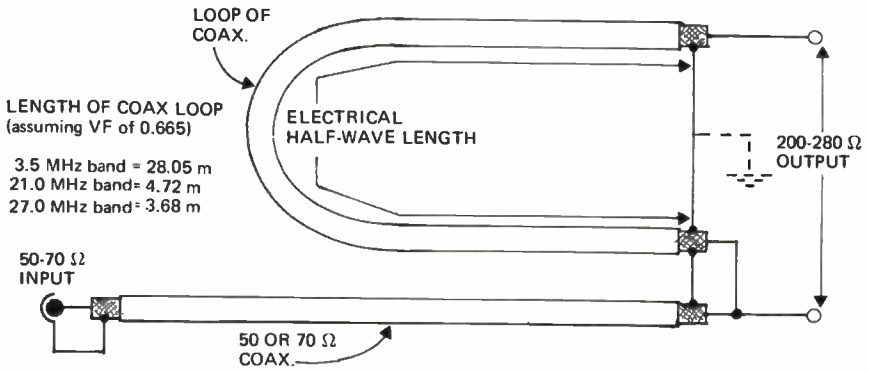

Fig. 15. Coax balun giving 4:1 impedance transformation.

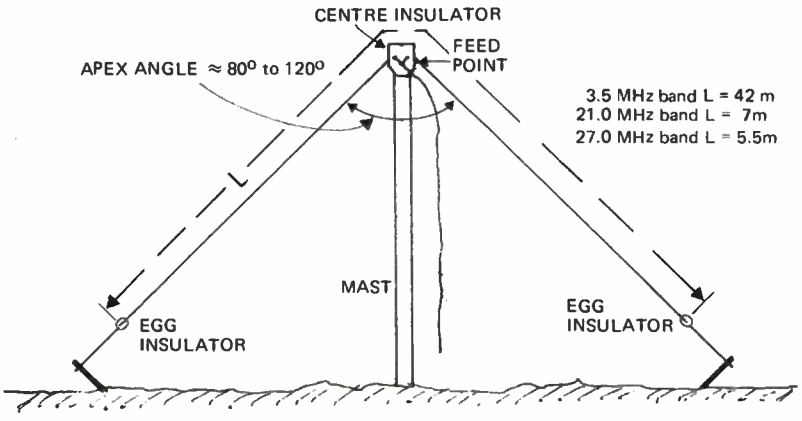

Fig. 16. The "Inverted Vee" dipole.

the feedline and the loop, and these plugged into suitably mounted sockets – whatever takes your fancy.

The length of the loop is an electrical half-wavelength, taking into account the velocity factor of the cable. The lengths given in Fig.15 are for polyethylene insulated coax, having a velocity factor of 0.665. The trombone loop may be suitably coiled and taped for convenience. This sort of balun is too heavy to suspend from the feedpoint of a folded dipole and it is probably easier to mount the balun somewhere near the transmitter and receiver.

THE INVERTED-VEE DIPOLE

To erect any of the dipoles just discussed, two supports are needed, one for each end. This is not always convenient. A dipole may be supported at the centre and the elements taken down at an angle as illustrated in Fig.16. However, this changes the resonant frequency of the antenna and it needs to be somewhat longer than a plain dipole cut for the same frequency. The angle between the elements may be between 80° and 120°.

The lengths given in Fig.16 are a compromise as the actual length for resonance of the antenna on the desired frequencies will vary depending on the apex angle and the height of the ends above the ground. The apex angle should not be less than 80° as the currents in the elements tend to cancel and the antenna efficiency suffers.

Coax may be connected directly to the feedpoint if necessary, but the use of a 1:1 balun is recommended. The inverted-vee may be constructed like the folded dipole if the use of 300 ohm TV ribbon feedline is contemplated.

As the actual resonant frequency of an inverted-vee varies depending on its construction, trimming the lengths may be a desirable procedure to obtain maximum efficiency. For this operation, one needs a suitable SWR indicator, or better still, an impedance bridge and lots of patience. The ends are trimmed equally a little at a time, for minimum SWR or for best null on the impedance bridge, at the centre frequency of the band of interest.

The ends may be only a metre or so off the ground for the 3.5 MHz antenna.

The inverted-vee antenna has a largely omnidirectional radiation pattern in the horizontal plane. It also has the advantage of being able to receive and radiate vertical as well as horizontally polarized signals and it also exhibits a

In my article in the MAY issue on ANTENNAS, a vile canard has been perpetrated in Fig. 10 on page 26. There is NO SUCH THING as a ferrite balun core made by Philips, type 4322-020-3150. It is also mentioned in the text on the same page. Sorry 'bout that folks. Apologies all round.

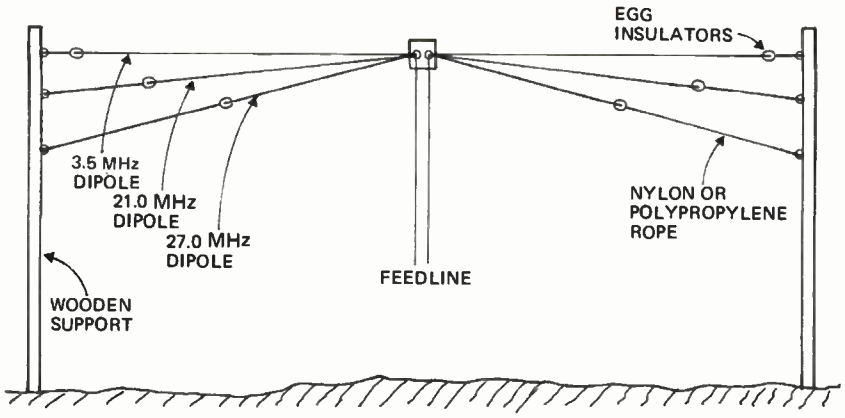

Fig. 17. The multiband dipole.

low radiation angle making it a good antenna for DX working.

THE MULTIBAND DIPOLE

The multiband dipole is illustrated in Fig.17. In essence, it is simply a number of dipoles constructed for different bands, parallelled at the feedpoints.

It can be fed directly with coax, although this is not really recommended. It is better practice to use an appropriate balun (1:1) as previously described. Only the wideband balun can be used as the coaxial baluns are single frequency devices.

The lengths can be obtained from Fig.6. Each dipole need not be attached to the same support so that they all lie in the same plane as illustrated, but they may be run at angles to one another. In fact, this is a good idea if you can physically arrange it.

THE SINGLE-LOOP ANTENNA

This antenna consists of a single square loop of wire, approximately one wavelength long, mounted vertically, appearing as a diamond, and fed in one corner. Owing to its size, it is rather too large to be practical on the 80 metre band. The antenna, and dimensions for 21 MHz and 27 MHz, is illustrated in Fig.18. It presents a good match to 50 ohms at the feedpoint and either of the 1:1 baluns is recommended for feeding a coax cable.

The wire used should be a heavy gauge (14g to 18g B & S) single strand wire (enamelled or tinned copper wire). Alternatively, 10/010 or heavier hookup wire could be used. Install egg insulators at the corners B and D, to take the two guy ropes. Insulate corner C also if a metal mast is used. Instead of using two guy wires to hold out the two corners B and D, a wooden cross-arm could be used.

The single-loop antenna has a bi-directional radiation pattern, broadside to the plane of the loop. Because of this, it is preferable to orient the loop broadside to the main direction you wish to work. This antenna can be rotated if you wish, in which case it should be constructed with the cross-arm supporting corners B and D. It is a very effective and yet simple antenna for DX working on 21 MHz and 27 MHz. Mount it as high as possible to gain the most effectiveness from it. It has some gain over a dipole which is an advantage, and a low radiation angle which is, naturally, helpful for DX working.

A NOTE ABOUT FEEDLINES

As far as possible, the feedline should always be run away from dipoles at right angles to the antenna in order not to disturb the radiation.

If you do not wish to use a folded dipole, and yet need to use the inexpensive 300 ohm TV ribbon for a feedline, 4:1 baluns can be mounted at each end of the feedline as shown in Fig.19.

When terminating coax where it is mounted outside, seal the end of the cable with waterproof insulation tape or with a proprietary sealing compound (such as Selleys sealing compound). Always solder joints. ●

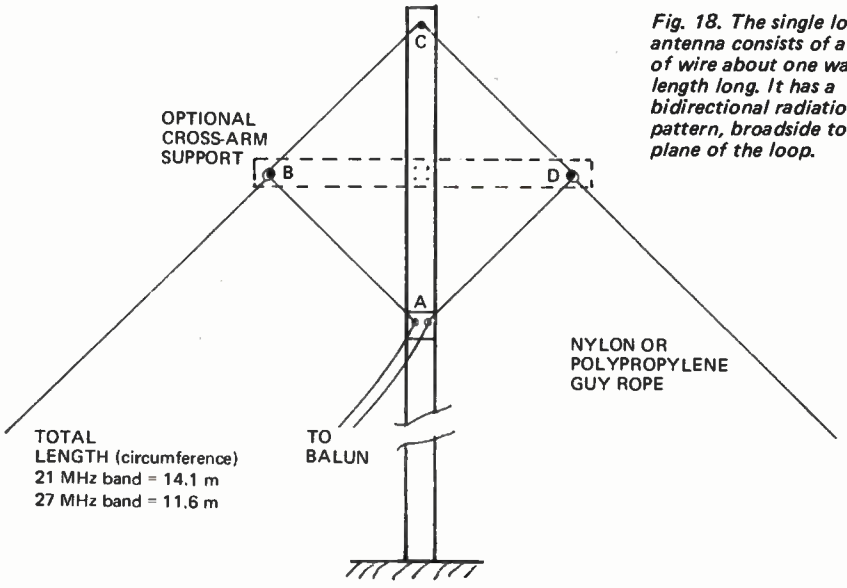

Fig. 18. The single loop antenna consists of a length of wire about one wavelength long. It has a bidirectional radiation pattern, broadside to the plane of the loop.

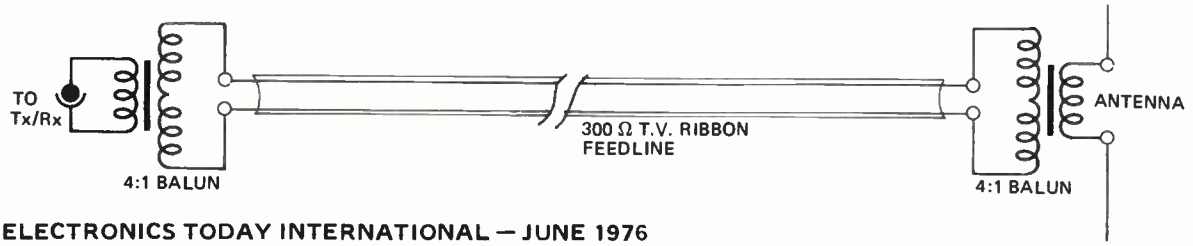

Fig. 19. Using inexpensive 300 ohm TV ribbon to feed an antenna with a low impedance feedpoint, instead of using coax.

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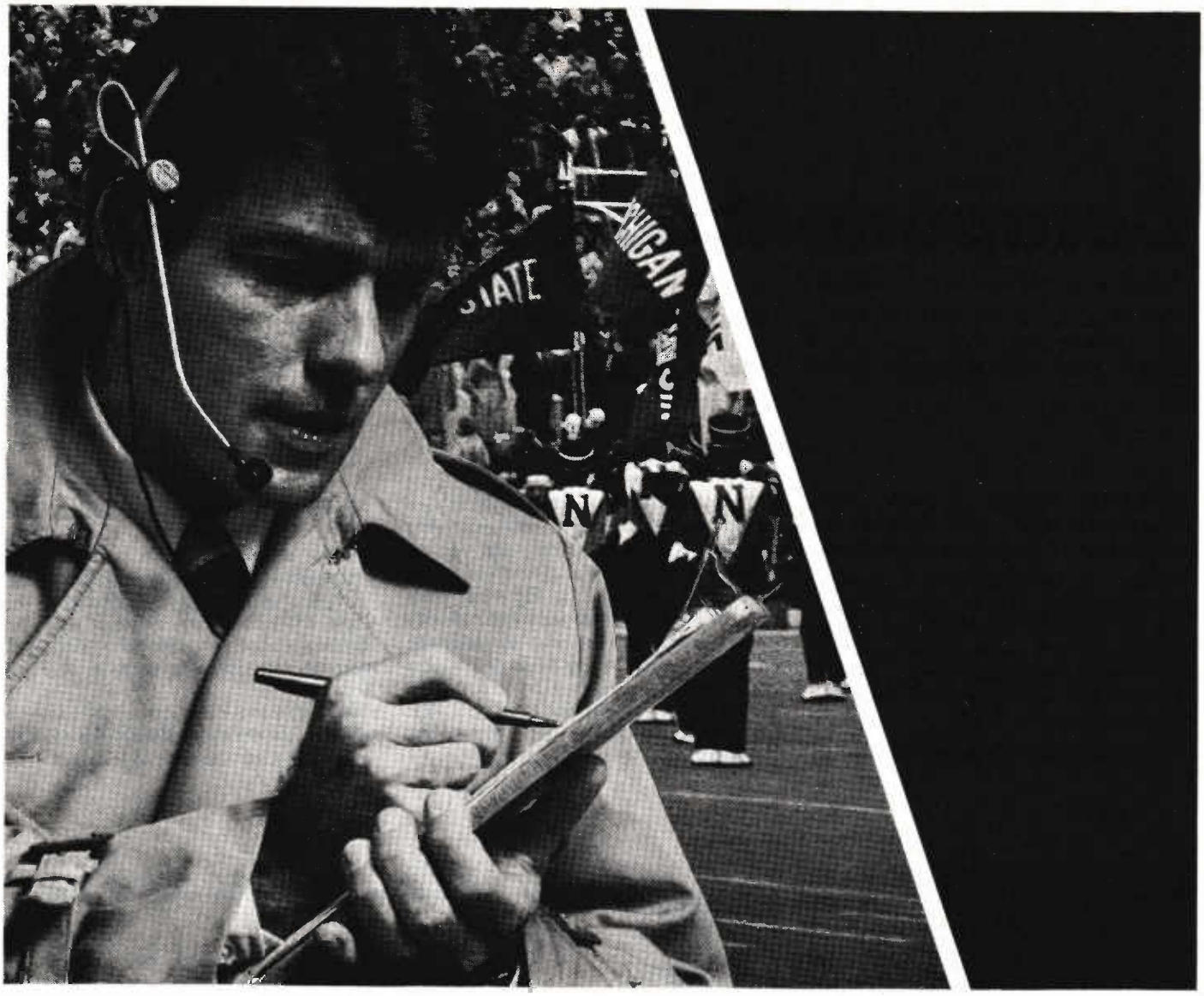

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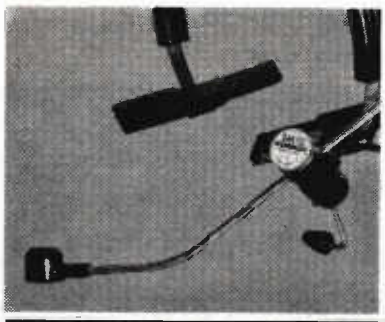

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AE104/FP

Component codes and values

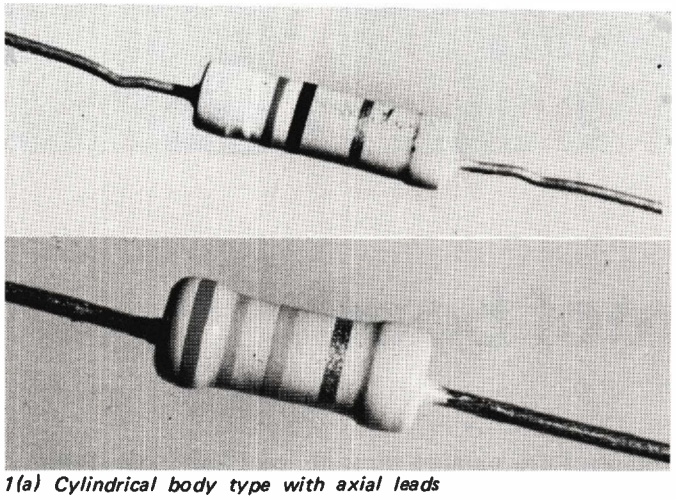
This issue carries the third part of our series on electronic components, which so far has dealt only with capacitors. This article looks more generally at the codes used to mark passive components and the ranges of values available.

MODERN FIXED RESISTORS, capacitors and RF chokes are encapsulated in a variety of packages.

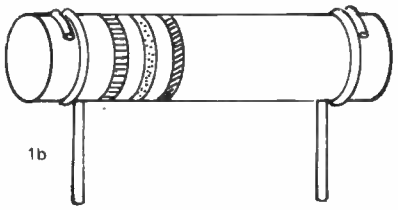
For resistors, the most common package is a cylindrical casing having axial leads (Fig 1). Cylindrical body types having radial leads and single-ended types are also manufactured. Some power resistors are rectangular with a square cross-section – Fig. 1. (d).

Fixed capacitor encapsulations take a wider variety of shapes, which are largely dictated by the manufacturing process. Plastic film and paper capacitors are often cylindrical with axial leads – as shown in Fig 2 (a). They are also moulded into rectangular shapes having leads coming out at opposite ends – as shown in Fig 2 (b), or through one side for convenient printed circuit mounting – as shown in Fig 2 (c). Ceramic capacitors are commonly disc-shaped or square (plate-types) – see Fig 2 (d) and (e) respectively. Older type ceramic capacitors were usually tubular with radial leads as in Fig 2 (f) although at least one manufacturer still makes and markets capacitors in this style. Moulded mica capacitors are usually square or rectangular with leads coming out opposite ends as in Fig 2 (b).

Moulded inductors, principally used as RF chokes are generally cylindrical with axial leads, very similar to resistors.

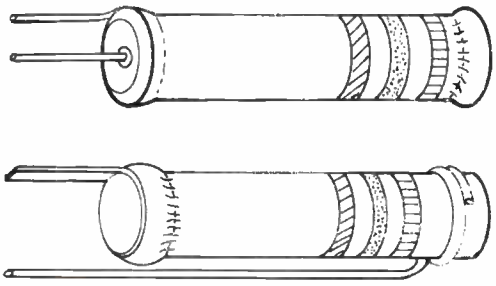


1(a) Cylindrical body type with axial leads

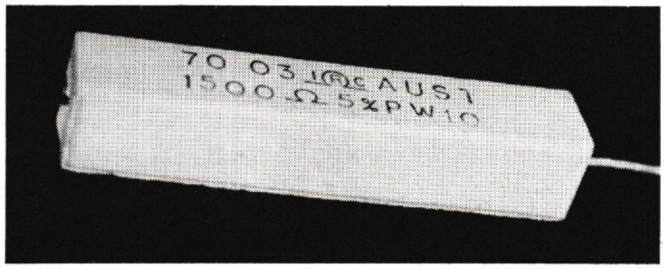


1(b) Cylindrical body type with radial leads

Figure 1. Common body shapes of small, modern fixed resistors. RF chokes and some capacitors are similarly encapsulated.

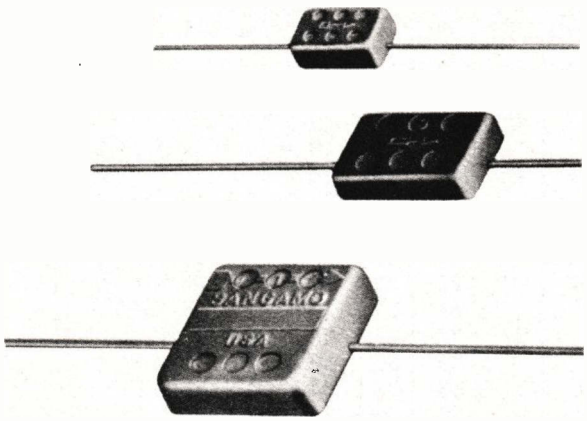


1(c) Single-ended cylindrical body types

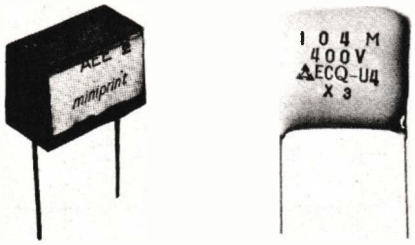


1(d) Rectangular-shaped power resistor

2(a) Cylindrical body capacitor with axial leads

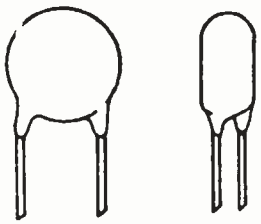


2(b) Flat moulded capacitors



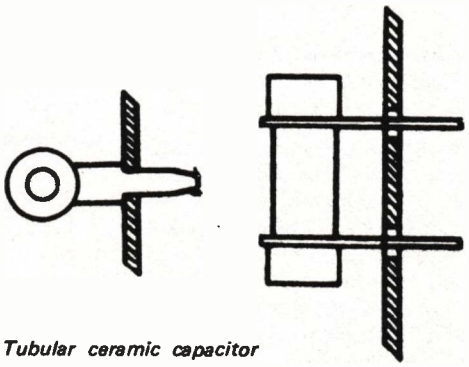
2(c) Flat-moulded capacitors suitable for printed circuit mounting.

Figure 2. Common body shapes for various capacitor styles.



2(d) Disc-shaped ceramic

2(e) Square- or plate-shaped ceramic capacitor



2(f) Tubular ceramic capacitor

Component Markings

The value, tolerance and other characteristics are marked on the body of fixed components using one of three basic systems:—

(d) directly on the body

(b) a series of coloured bands or dots according to a standard code.

(c) a series of numbers and letters according to a standard code — known as a typographic code.

The basic colour code is given in Table 1. Its use on typical cylindrical-shaped components is illustrated in Fig 3. The first and second digits represent the significant figures of the component value. The decimal multiplier determines the position of the decimal point and the order of the value of the component — i.e., ohms, megohms etc, or μF, pF etc. The tolerance indicates the tolerance range either side of the nominal value of the component. This means that the actual component value

THE STANDARD COLOUR CODE **TABLE 1**

colour	significant figure	decimal multiplier	tolerance ±%
BLACK	0	1	20 *
BROWN	1	10	1
RED	2	10^2 or 100	2
ORANGE	3	10^3 or 1000	
YELLOW	4	10^4 or 10,000	
GREEN	5	10^5 or 100,000	
BLUE	6	10^6 or 1,000,000	
VIOLET	7	10^7 or 10,000,000	
GREY	8	10^8 or 100,000,000	
WHITE	9	10^9 or 1,000,000,000	
GOLD	—	0.1 or 10^{-1}	5
SILVER	—	0.01 or 10^{-2}	10
none	—		20

* used with capacitors

Component codes and values

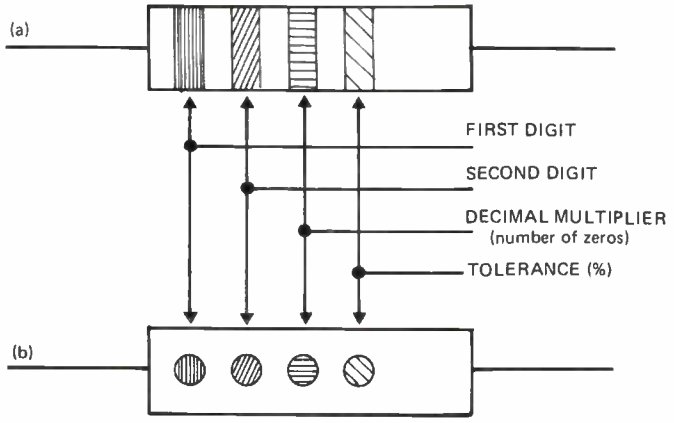


Fig. 3. How the colour code values on a resistor are used to calculate the value and tolerance.

TABLE 2

Preferred numbers in a decade for the E6, E12, E24 & E96 series

E6 20%	E12 10%	E24 5%	E96 1%		E96 and 2%			
10	10	10	10.0	10.2	10.5	10.7		
		11	11.0	11.3	11.5	11.8		
	12	12	12.1	12.4	12.7			
		13	13.0	13.3	13.7	14.0	14.3	14.7
15	15	15	15.0	15.4	15.8			
		16	16.2	16.5	16.9	17.4	17.8	
	18	18	18.2	18.7	19.1	19.6		
		20	20.0	20.5	21.0	21.5		
22	22	22	22.1	22.6	23.2	23.7		
		24	24.3	24.9	25.5	26.1	26.7	
	27	27	27.4	28.0	28.7	29.4		
		30	30.1	30.9	31.6	32.4		
33	33	33	33.2	34.0	34.8	35.7		
		36	36.5	37.4	38.3			
	39	39	39.2	40.2	41.2	42.2		
		43	43.2	44.2	45.3	46.4		
47	47	47	47.5	48.7	49.9			
		51	51.1	52.3	53.6	54.9		
	56	56	56.2	57.6	59.0	60.4		
		62	61.9	63.4	64.9	66.5		
68	68	68	68.1	69.8	71.5	73.2		
		75	75.0	76.8	78.7	80.6		
	82	82	82.5	84.5	86.6	88.7		
		91	90.9	93.1	95.3	97.6		

may lie anywhere between the tolerance extremes. Tolerance is usually quoted as a percentage.

The way in which the standard colour code is applied on a component and how other characteristics, such as voltage rating or temperature coefficient, are indicated is explained in detail in the sections of this series dealing with component marking codes.

Typographic marking codes take a variety of forms. They generally involve a group of numbers indicating the value of the component, and prefix or suffix letters (or both) indicating other characteristics such as voltage rating, tolerance etc. The letters are deciphered by reference to tables showing the characteristic accorded to a particular letter. These tables are drawn up according to a standard international convention. The different typographic codes used and how to interpret them are also explained in the sections on component marking codes.

Preferred Values

If you examine the values of fixed components, you will notice that the values appear 'odd', and further more,

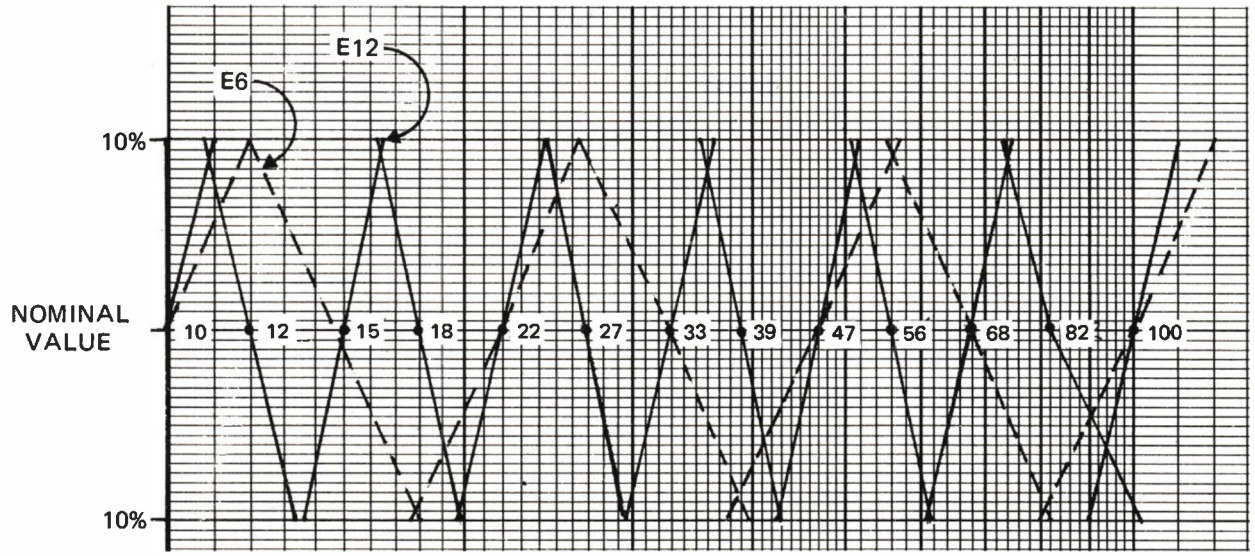


Figure 4: Tolerance extremes of the E6 and E12 preferred series of values.

that the same significant figures repeat in each decade – i.e., 47, 470, 4700; .0068, .068,0.68 etc. This is because a system of what is called *'preferred numbers'* or *'preferred values'* is used. The basic system of preferred numbers spans the decade from 10 to 100. Higher and lower decades simply have the decimal place shifted right or left accordingly.

There are several preferred number series, the three most common ones have six, twelve and twenty four numbers per decade and are known as the E6, E12 and E24 series respectively. The numbers in a decade of each of these series are given in Table 2. Each number is derived from a constant difference between numbers (or steps) of $10^{1/6}$ for the E6 series, $10^{1/12}$ for the E12 series and $10^{1/24}$ for the E24 series. The numbers are rounded off to two significant figures for convenience. These numbers provide a convenient tolerance range for component values in the different series. The E6 series is used for ± 20% tolerance components, the E12 series for ± 10%, and the E24 series for ± 5% components.

For close tolerance, high stability components, the E96 series is used. This provides a series of 96 numbers per decade, each being approximately 2% higher than the preceding value. Thus, this series is used for components having specified tolerances of 1% and 2%. The tolerance extremes of 1% components overlap. As the values need to be quoted to three figures, the component markings will, accordingly, be different from those components having values

TABLE 3

Tolerance extremities for the E6, E12 and E24 preferred value series

–20%	–10%	–5%	nominal value	+5%	+10%	+20%
8	9	9.5	10	10.5	11	12
		10.5	11	11.6		
	10.8	11.4	12	12.6	13.2	
		12.4	13	13.7		
12	13.5	14.3	15	15.8	16.5	18
		15.2	16	16.8		
	16.2	17.1	18	18.9	19.8	
		19.0	20	21.0		
17.6	19.8	20.9	22	23.1	24.2	26.4
		22.8	24	25.2		
	24.3	25.7	27	28.4	29.7	
		28.5	30	31.5		
26.4	29.7	31.4	33	34.7	36.3	39.6
		34.2	36	37.8		
	35.1	37.1	39	41.0	42.9	
		40.9	43	45.2		
37.6	42.3	44.7	47	49.4	51.7	56.4
		48.5	51	53.6		
	50.4	53.2	56	58.8	61.6	
		58.9	62	65.1		
54.4	61.2	64.6	68	71.4	74.8	81.6
		71.3	75	78.8		
	73.8	77.9	82	86.1	90.2	
		86.5	91	95.6		
E6	**E12**	**E24**		**E24**	**E12**	**E6**

lower extremities ← | → upper extremities

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PA 2/L

Component codes and values

in the E6, E12 or E24 series. The values in the E96 series are also shown in Table 2.

The tolerance specification indicates that a component may have a value, differing from the nominal value, anywhere between the limits specified. For example, a 1000 ohm resistor with a tolerance specification of ± 10% may have a value anywhere between 900 ohms and 1100 ohms.

The tolerance extremities for the E6, E12 and E24 series are indicated in Table 3 and the way in which the tolerance extremes overlap are illustrated, for the E6 and E12 series, in Fig. 4.

A batch of components of the same nominal value may not have actual values spread throughout the tolerance range, centred on the nominal value. For example, a batch of ± 20% tolerance components may have actual values between +10% and +17% of the nominal value. More usually, actual values may be spread between say, −18% and +11% with a few outside this range. Those components falling within the tolerance extremities of the closer tolerance series are usually selected from the batch prior to marking. Thus, a batch of ± 20% tolerance (E6 series) components of a particular nominal value, may not contain any values within ± 5% of the nominal value. However, there may be many in the batch within ± 5% (or closer) of a value 10% higher than the nominal value. As an example, a batch of 1000 ohm resistors may have most of the actual values spread between 1045 ohms and 1155 ohms, with the rest scattered across the tolerance range.

Apart from resistors, capacitors and RF chokes, zener diodes are manufactured according to the preferred values system also, having nominal zener voltages according to the E24 series and voltage tolerances of ± 2% and ±5%.

The temperature coefficient characteristic of capacitors may also be specified with values in the preferred series, usually from the E24 series, although for convenience, and by convention, only selected numbers through several decades are used. This is discussed in the section on capacitors.

Selecting and Substituting

In many applications in electronic circuits, the component values, unless otherwise specified, may be varied substantially without markedly affecting the performance of a circuit. This applies particularly to decoupling and bypass components where components having tolerances of −20%, +80% are commonly used. Apart from this, tolerance limits of component values in a particular circuit or portion of a circuit, of ± 20% are common, otherwise the E6 series of values would not be used. This wide latitude in tolerance limits rarely has much effect on the performance of a circuit. If close tolerance components are necessary then they will be specified on the circuit or in any description of the circuit.

(It should be noted however that 5% tolerance resistors are now almost universally available and cost little more — if anything at all — than 10% or 20% resistors. For this reason, 5% resistors are generally specified for Electronics Today's projects). ●

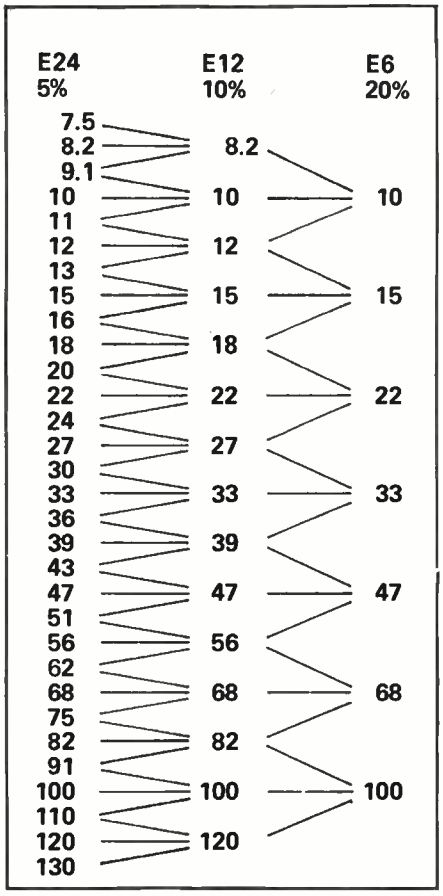

TABLE 4

CHOOSING THE RIGHT VALUE

(1) SUBSTITUTION: If a component cannot be replaced by a substitute of the same nominal value and tolerance rating, it can be replaced by a closer tolerance component of any of the 3 values shown in the next column on the *left*.

(2) DESIGN: Find the nearest value (to the calculated value) in the left-hand column. If high tolerance is not important an appropriate value from the column on the *right* may then be selected.

The problem with buying a receiver today is that someone, somewhere has one better.

Here it is.

The RX 802 AM/FM Stereo Receiver by Rotel. It's the top of our line and probably the best receiver your dollars could buy.

What makes it the best? Engineering precision. 2x50 watts RMS continuous power, both channels driven into 8 Ohms with less than 0.5% THD from 20 to 20,000 Hz. Ceramics filters, integrated circuits and an AM/FM tuner section with 1.5 μV sensitivity, that independent lab reports could only describe as 'outstanding'.

There are also a couple of other points you'll find interesting. Like input jacks for two turntables and input/output jacks for two tape decks.

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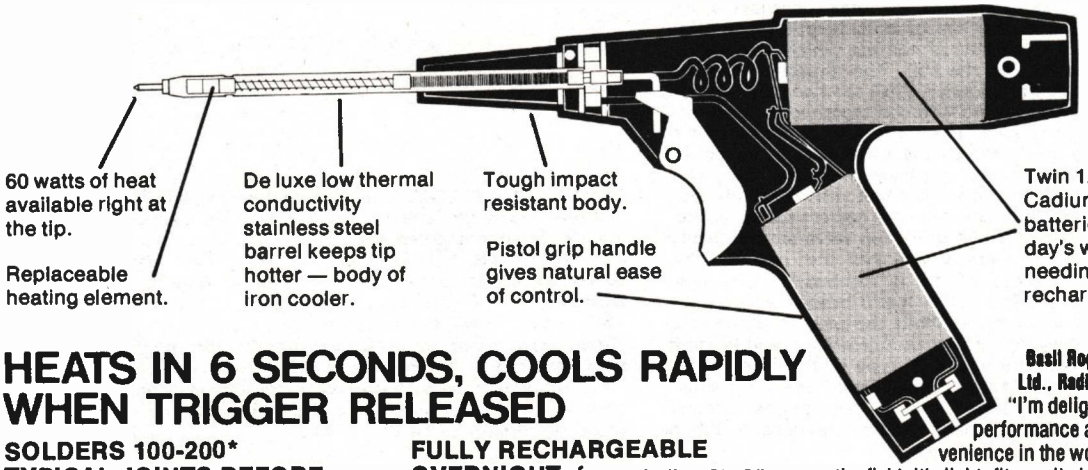

HEATS IN 6 SECONDS, COOLS RAPIDLY WHEN TRIGGER RELEASED

SOLDERS 100-200* TYPICAL JOINTS BEFORE RECHARGING
*Light electrical connections. Capacity will vary for lighter or heavier joints.
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6 TV GAMES ON ONE IC

WHK will distribute one of the most advanced TV Games MOS Circuit in Australia. This 24 Pin device has been designed to provide 6 different games using a standard television receiver. The MOS Circuit is intended to be battery powered and a minimum number of external components are required to complete the system.

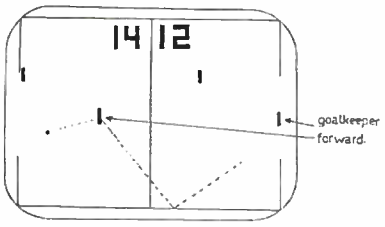


Fig. 2. Football Game

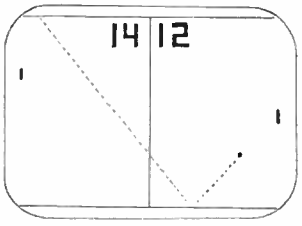


Fig. 1. Tennis Game

FEATURES: 6 selectable Games — Tennis, Football, Squash, Pelota or Rifle Shooting — two games; Automatic Scoring; Score display on TV Screen, 0 — 15; Selectable Bat Size; Selectable Angles; Selectable Ball Speed; Automatic or Manual Ball Service; Realism Sounds; Shooting Forwards in Football Game; Visually defined area for all Ball Games.

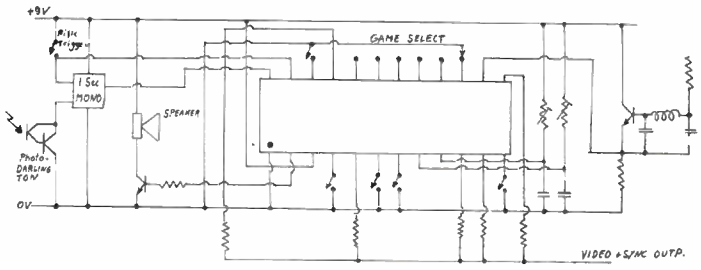
OPERATING CHARACTERISTICS: TENNIS & FOOTBALL: With the Tennis game the picture on the television screen would be similar to Fig. 1 with one 'bat' per side, a top and bottom boundary and a centre net, the individual scores are counted and displayed automatically in the position shown. The detail of the game will depend upon the selection of the options. Considering the situation where small batts are used and all angles, after reset has been applied, the scores will be 0, 0 and the ball will serve arbitrarily to one side at one of the angles. If the ball hits the top or bottom boundary it will assume the angle of reflection and continue in play. The player being served must control his bat to intersect the path of the ball. When a 'hit' is detected by the logic, the section of the bat which made the hit is used to determine the new angle of the ball. To expand on this, all 'bats' or 'players' are divided logically into four adjacent sections of equal length. When using the four angle option it is the quarter of the bat which actually hits which defines the new direction for the ball. The direction does not depend upon the previous angle of incidence. With the two angle option the top and bottom pairs of the bats are summed together and only the two shallower angles are used to programme the new direction of the ball. The ball will then traverse towards the other player. reflecting from the top as necessary until the other player makes his 'hit'. This action is repeated until one player misses the ball. The circuitry then detects a 'score' and automatically increments the correct score counter and updates the score display. The ball will then serve automatically from the centre line towards the side which had just missed. This sequence is repeated until a score of 15 is reached by one side, whereupon the game is stopped. The ball will still bounce around but no further 'hits' or 'scores' can be made. While the game is in progress, three audio tones are output by the circuit to indicate top and bottom reflections, bat hits and scores. The 'football' type is shown in Fig. 2, and with this game each participant has a 'goalkeeper' and a 'forward'. The layout is such that the 'goalkeeper' is in his normal position and the 'forward' is positioned in the opponent's half of playing area. When the game starts, the ball will appear travelling from one goal line towards the other side. If the opponent's forward can intercept the ball, he can 'shoot' it back towards the goal. If the ball is missed it will travel to the other half of the playing area and the first team's forward will have the opportunity of intercepting the ball and redirecting it forward at a new angle according to the 'player' section which is used. If the ball is 'saved' by the 'goalkeeper' or it reflects back from the end boundary, the same forward will have the opportunity to intercept the outcoming ball and divert it back towards the 'goals'. A 'score' is made in the 'football' game by 'shooting' the ball through the defined goal area. The scoring and game control is done automatically as for the tennis game. The same audio signals are used to add atmosphere to the game.

SQUASH: In this game (not illustrated) there are two players who alternately hit the ball into the court. The right hand player is the one that hits first, it is then the left hand player's turn. Each player is enabled alternately to insure that the proper sequence of play is followed.

PELOTA: This game is similar to squash except that there is only one player.

RIFLE SHOOTING: This game (not illustrated) has a large target which bounces randomly about the screen, a photocell in the rifle is aimed at the target. When the trigger is pulled the shot counter is incremented, if the rifle is on target the hit counter is incremented, a hit noise is generated and the target is blanked for a while. After 15 shots the score appears but the game can still continue.

RIFLE GAME NO. 2: In this game the ball traverses the screen from the right under control of the manual serve button. Otherwise the game is as above.



PRICE & DELIVERY: The manufacturer of this "6 in 1 TV Game IC" has received huge orders from Europe. The proposed delivery of our large order is scheduled for October 76. Due to the great demand for this outstanding IC we suggest you place your order now. Price each $28.00. Prepaid Orders received before August 15th $25.20 each. Discount: 1 — 4 nett, 5 — 9 less 5% 10 — 24 less 10%, 25 onwards less 15%. Post, Pack & Insurance $2.00 per Order. With your Order Acknowledgement you receive full Circuit diagrams. We intend to manufacture a PC Board to suit at extra cost.
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We searched high and low, reel to reel and deck to deck. For sound recording equipment that has the same high standard of manufacture as our leading camera brands. Top of our list came a brand named Dokorder. Dokorder's reel to reel tape decks are available in two and four channel stereo featuring three-motor and three-head facilities. Dokorder machines range in price from less than $285 to around $915. Advanced design features include electronic operation of tape transport, speed change and multi-sync facilities on the more expensive models. Cassette decks are available with amplifier options, the celebrated Dolby noise reduction system and many other special features.

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PA3/D

Five watt stereo

This simply-constructed amplifier gives high quality reproduction for surprisingly low cost. The five watts per channel output is sufficient for the average listening room even when inefficient loudspeakers are used.

THIS PROJECT UTILISES A NEW advance by IC manufacturers. A few years ago no-one would have believed a complete stereo hi-fi amplifier could be made from just two ICs plus a few passive components. Today more and more components are contained within the IC so a power amplifier is as easy to use as an op-amp.

Easy to build — Readers who were previously apprehensive about building audio power amplifiers should have no trouble with this design — there is little to go wrong.

Adequate Power — The output is unlikely to be found lacking unless the loudspeakers are very inefficient. Speakers of this type usually belong to the hifi enthusiast who spends lots of money on his system; the inefficiency of the speakers is compensated for in the amplifier. In an average set-up it is unlikely that you would, under normal listening conditions, be able to tell the difference between the ETI444 and a twenty watt amplifier.

FIVE WATT HI-FI AMPLIFIER

LM379 — National Semiconductor recently supplied ETI with samples of their new dual five-watt audio amplifier IC — the LM379. The circuitry around the IC is very simple in comparison to most of those previously available. The gain is set in a similar way to that for an operational amplifier: by the ratio of two resistors in the feedback network. In addition the IC features internal stabilization, current limiting and thermal protection.

Preamp — We decided to try the IC in conjunction with the dual low-noise preamplifier IC also from National Semiconductor — the LM382. The combination results in a simple stereo amplifier which works very well indeed.

Whilst tone control could be achieved very simply it was decided that the performance of the amplifier deserved good treatment. So we use more effective tone controls.

The result is a five-watt stereo amplifier, ETI 444, simple and inexpensive to build, and with a surprisingly high performance.

CONSTRUCTION

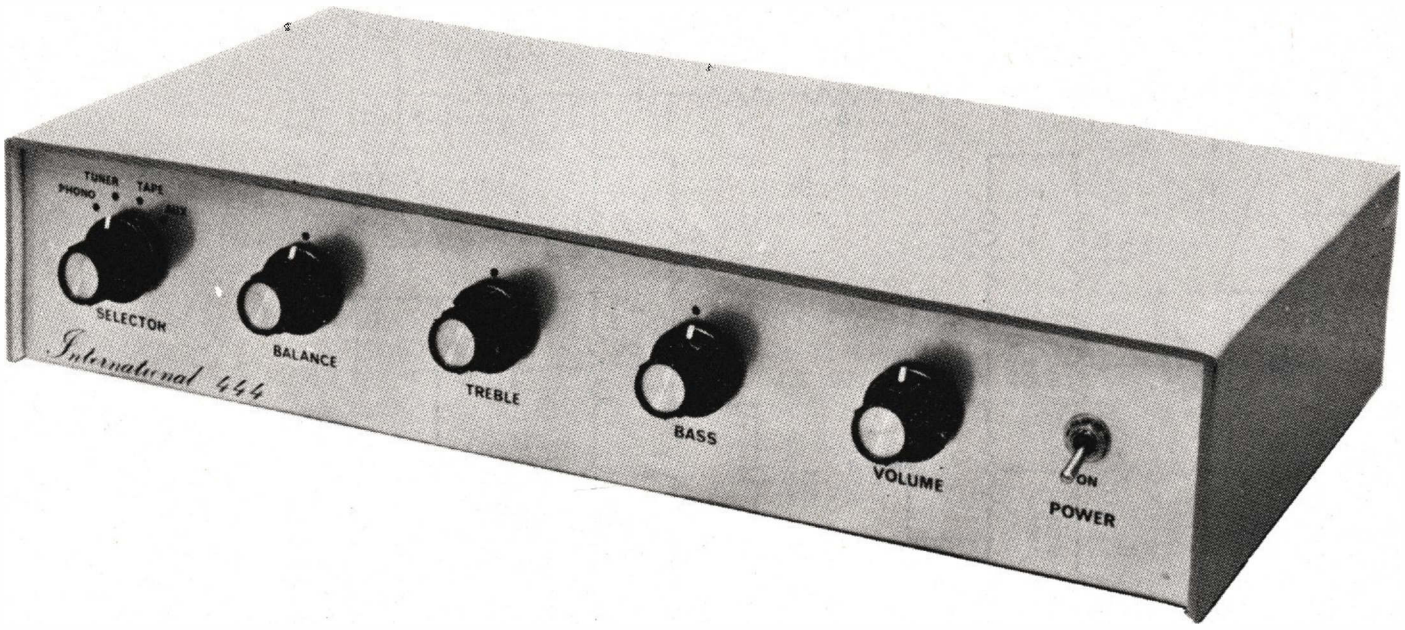
As with most straightforward projects the use of a printed circuit board is not only desirable from an ease of construction point of view, but it also helps to ensure identical results to those of our prototype.

The components may be assembled to the board in any order but we find it preferable to assemble the low-height components first, ie, resistors, diodes. Before installing IC2 make sure that a hole of about 6 mm diameter is drilled in the board at the end where the heatsink is to be mounted (after the IC is installed). Take care that all polarized components, such as diodes, ICs, electrolytic capacitors and integrated circuits, are mounted with the correct orientation.

Solder 25 to 50 mm lengths of tinned copper to each of the lugs on the potentiometers and then mount the potentiometers in the appropriate

MEASURED PERFORMANCE OF PROTOTYPE ETI 444

POWER OUTPUT	
Into 8 ohms	5 watts per channel
DISTORTION	
At 3 watts out	0.15%
At 4 watts out	0.5%
At 5 watts out	3.0%
FREQUENCY RESPONSE	
High-level input	+10 dB, −3 dB 4 Hz to 200 kHz
SENSITIVITY	
Magnetic input	1.5 mV
High level input	190 mV
LOAD IMPEDANCE	8 ohms or higher
!NPUT IMPEDANCE	
Magnetic input	approx. 100 k
High level input	approx. 10 k
SIGNAL TO NOISE RATIO	
High level input	67 dB
Phono input (ref 10 mV in)	64 dB unweighted

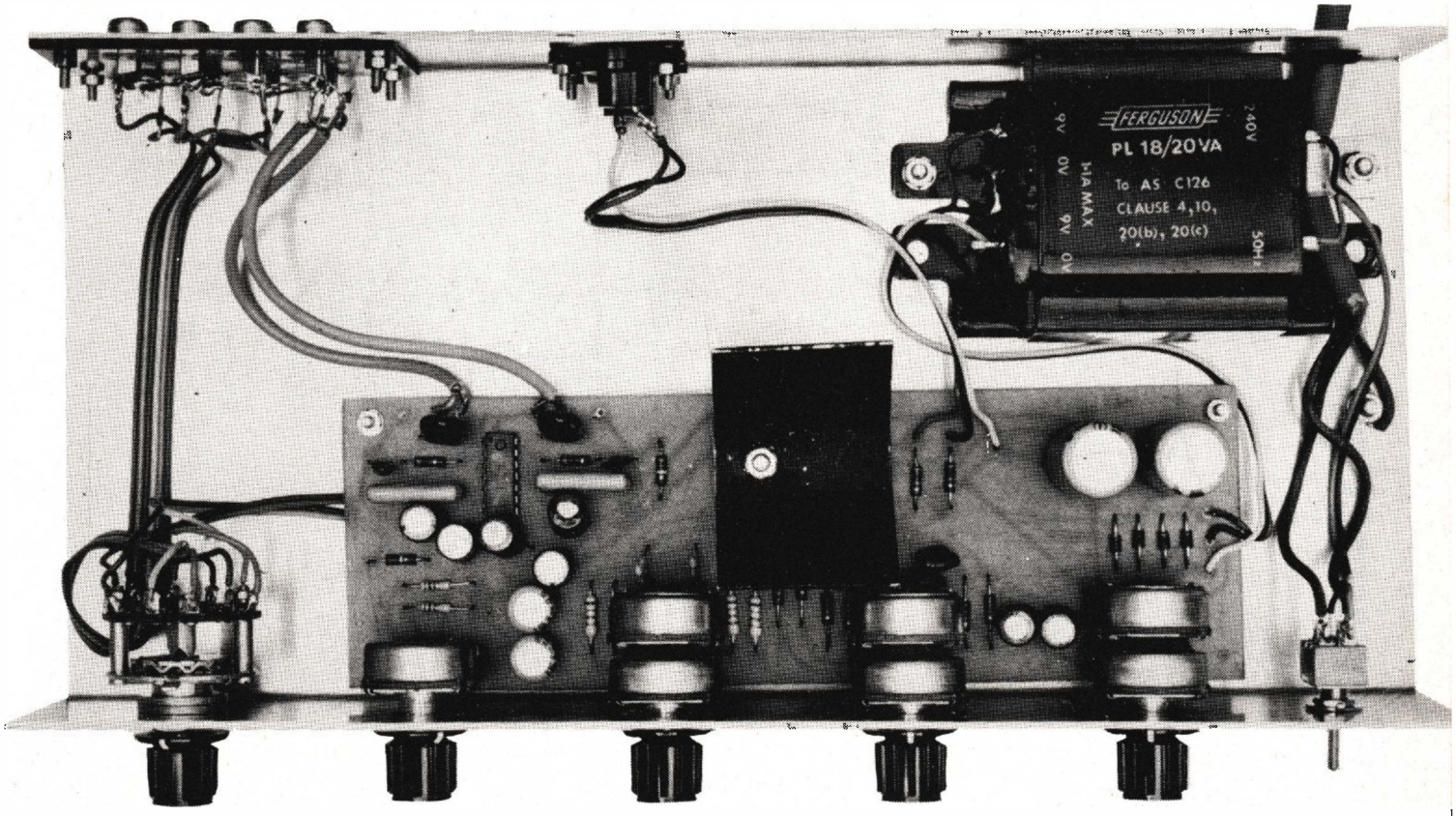


position by threading the tinned copper wires through the holes provided in the printed-circuit board. Pull the wires down so that the lugs are almost flush with the board and the potentiometers are all in line. Then solder the wires.

The heatsink may now be mounted onto IC2 using a single nut and bolt. Care must be taken to ensure that the heatsink does not touch any of the potentiometers as it is at a potential of −12 volts.

The unit may now be mechanically assembled by securing it to the front panel by means of the potentiometer shafts and nuts, and by fitting two 6.4 mm spacers between the rear of the board and the chassis.

Finally wire the unit as shown in the component overlay diagram.



Five watt stereo

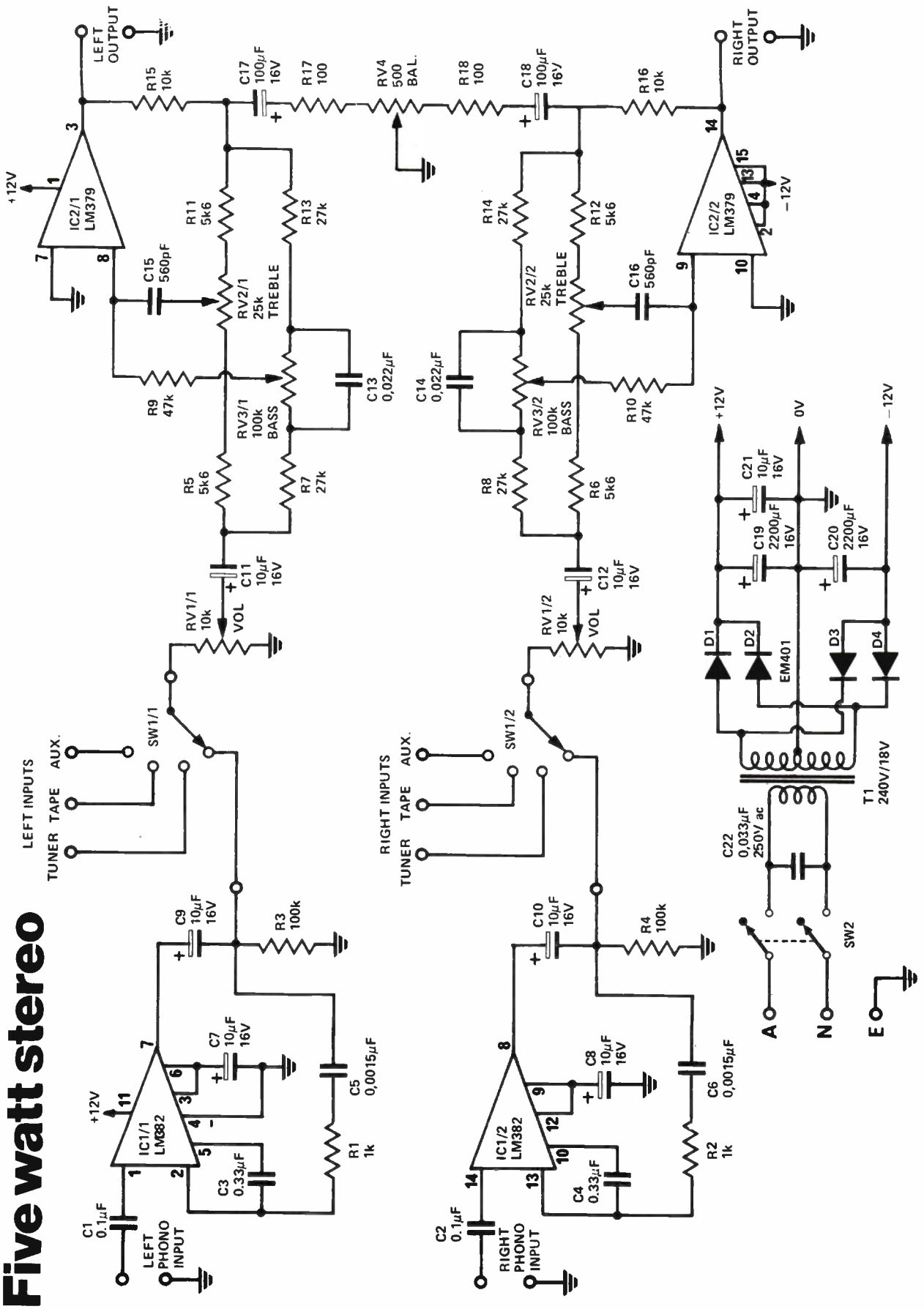


Fig. 1. Circuit diagram of the amplifier.

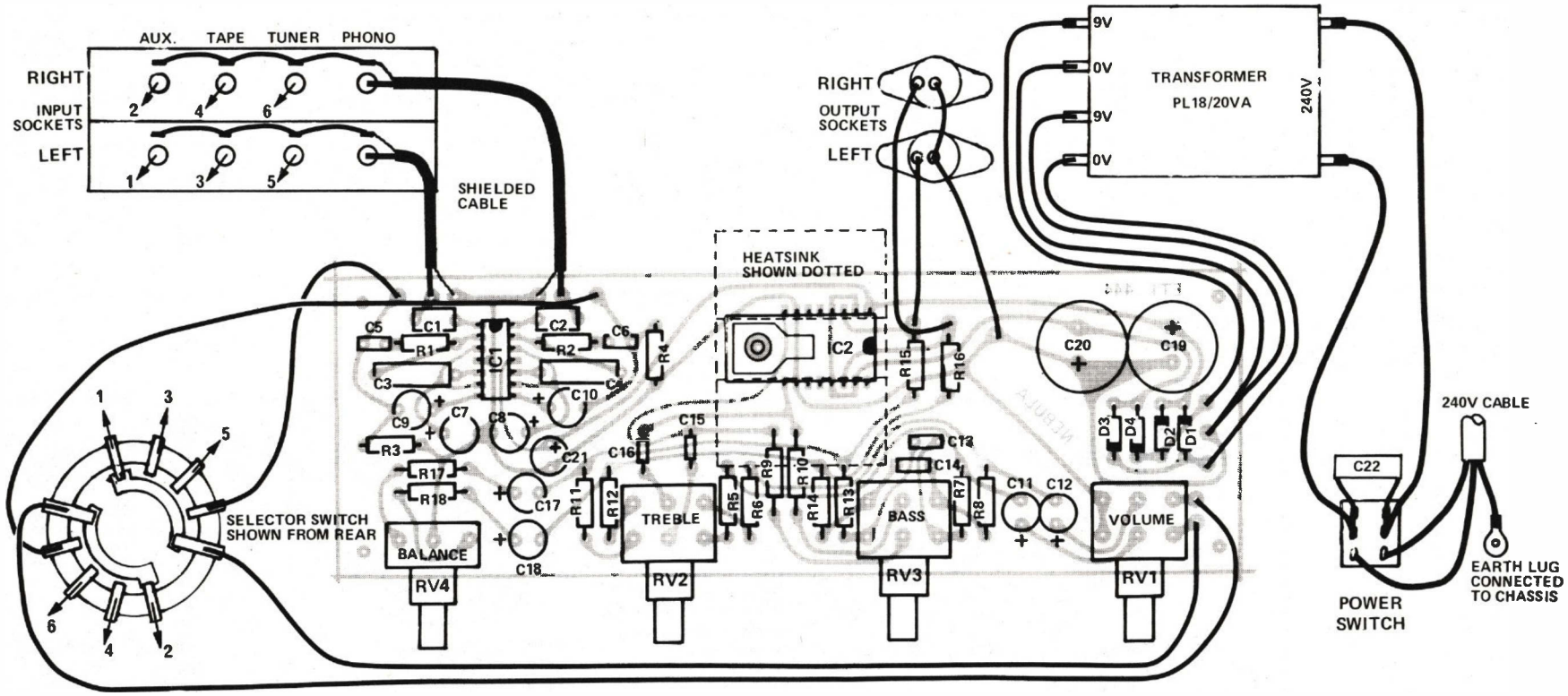


Fig. 2

PARTS LIST — ETI 444

Resistors

R1,2	1 k	½W	5%
R3,4	100 k	"	"
R5,6	5k6	"	"
R7,8	27 k	"	"
R9,10	47 k	"	"
R11,12	5k6	"	"
R13,14	27 k	"	"
R15,16	10 k	"	"
R17,18	100	"	"

Potentiometers

RV1	10 k log rotary dual
RV2	25 k lin rotary dual
RV3	100 k lin rotary dual
RV4	500 ohm lin rotary

Capacitors

C1,2	0.1 µF polyester
C3,4	0.33 µF polyester
C5,6	0.0015 µF polyester
C7-C12	10 µF 16 V electro
C13,14	0.022 µF polyester
C15,16	560 pF ceramic
C17,18	100 µF 16 V electro
C19,20	2200 µF 16 V electro
C21	10 µF 16 V electro
C22	0.033 µF 250 V ac

* 1000µF 16 V will do if 2200 µF is not available.

Semiconductors

D1-D4	EM401 or similar
IC1	LM382
IC2	LM379

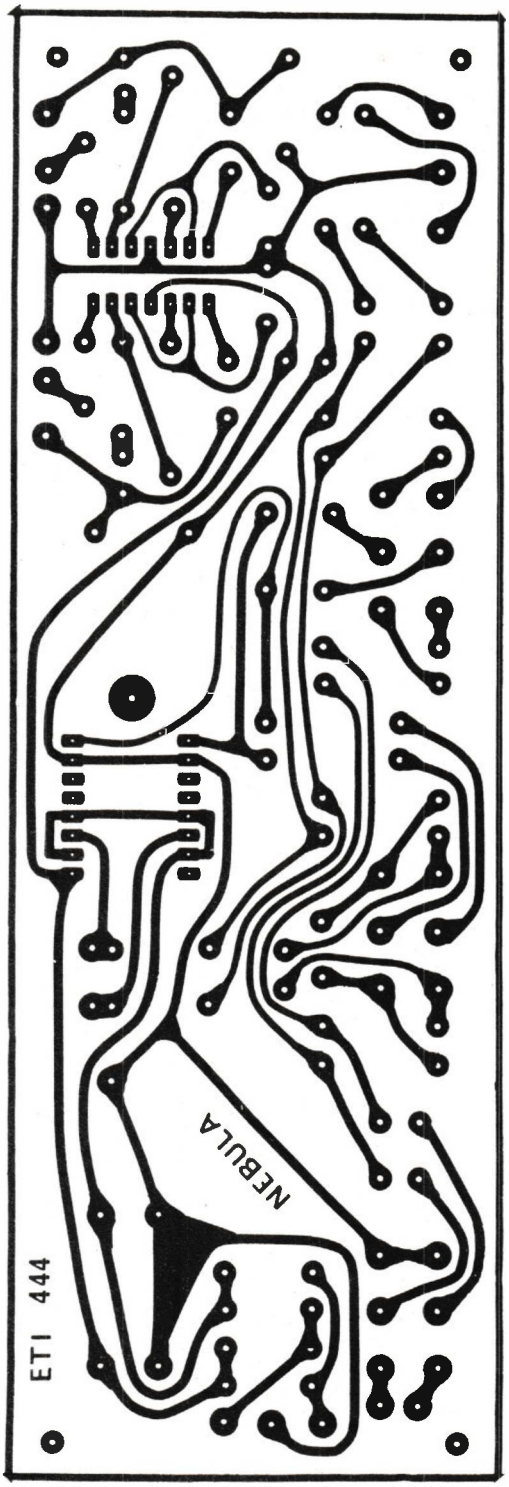
Switches

SW1	2 pole 4 position rotary
SW2	2 pole toggle

Miscellaneous

PC board ETI 444
Chassis to Fig 5
Cover to Fig 6
Heat sink to Fig 7
Front panel to Fig 3
Transformer 240 V-18 V PL 18/20 VA
3 core flex, plug, clamp, grommet and earth lug
2 Two pin DIN sockets
2 Four way RCA sockets
4 Rubber feet
2 6.4 mm spacers
5 Knobs

Five watt stereo



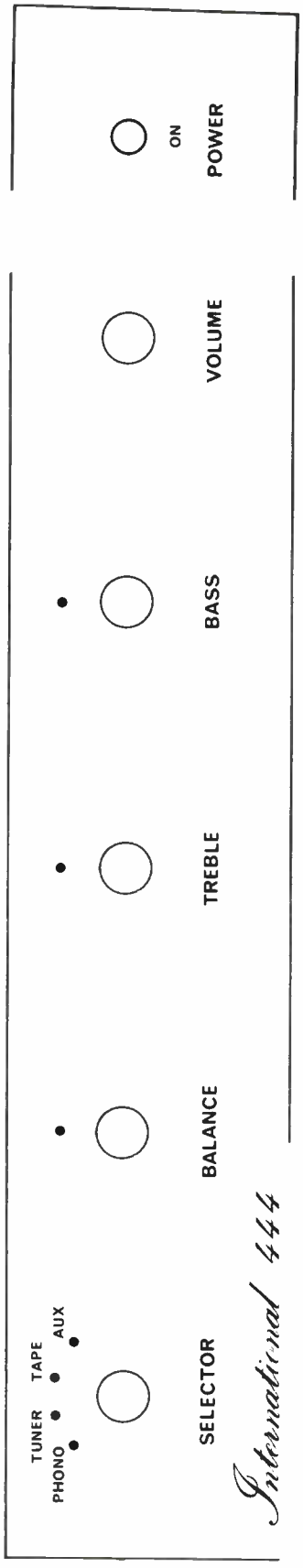


Fig. 3. Front panel artwork. The material we used was brushed anodized aluminium, silk screened black. For size see metalwork detail.

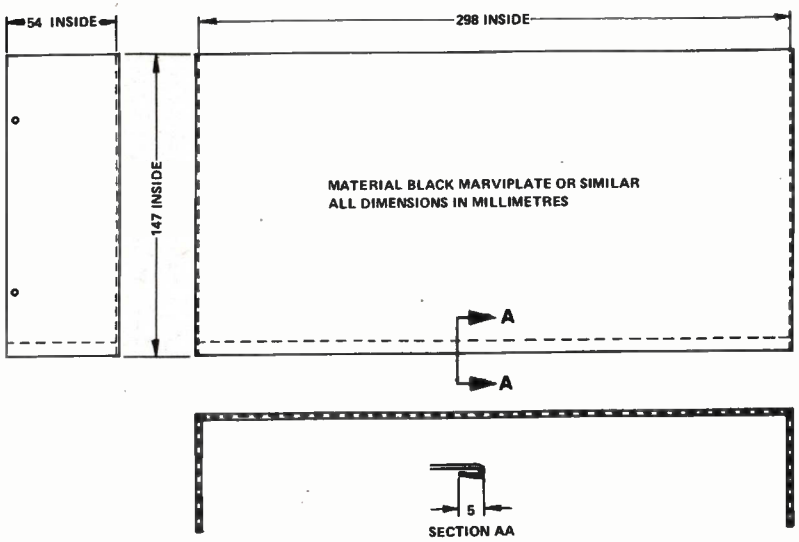
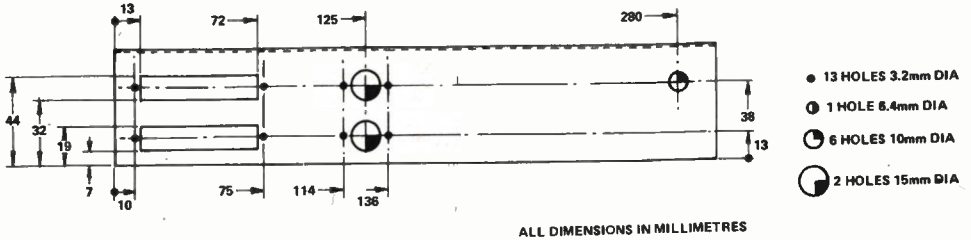
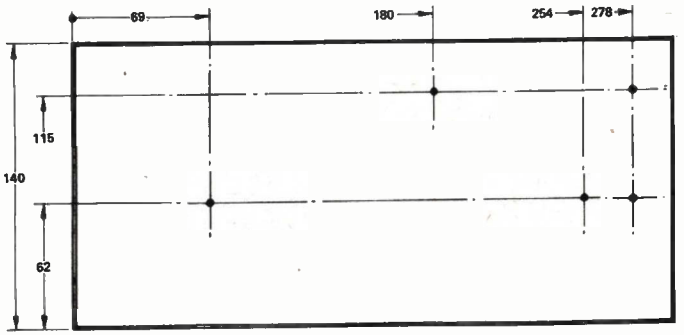
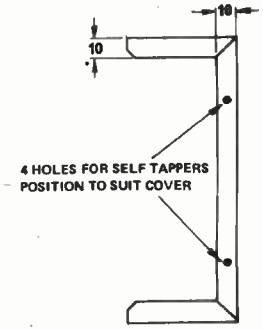


Fig. 6. Cover detail.







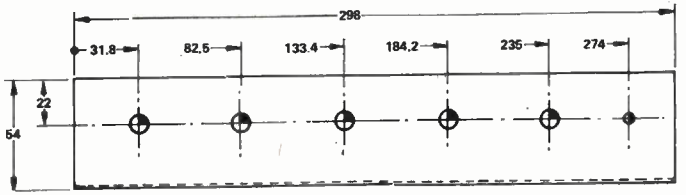


Fig. 5. Chassis metalwork.

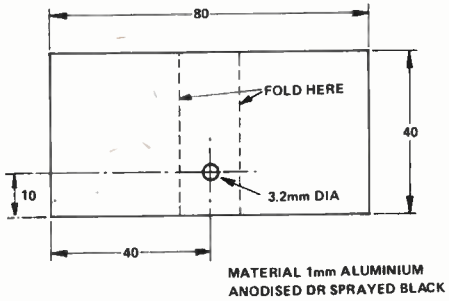


Fig. 7. The heatsink for the LM379. The heatsink described will get quite hot when the amplifier is run at full output. If it has been blackened by painting it may smell a little at first but this will soon pass away. For normal domestic listening this size heatsink will be found to be entirely adequate but if the amplifier is to be run continously at full sinewave output it would be advisable to increase the size of the heatsink. No damage can be caused by using the smaller heatsink however as the IC is thermally protected and will simply shut down if it gets too hot.

HOW IT WORKS ETI 444

THE output of a magnetic cartridge is normally of the order of 5 mV at one thousand hertz. However in the recording process the high frequencies are recorded at a higher amplitude than the low frequencies (in order to reduce noise). The curve of amplitude-versus-frequency used in the recording process is known as the RIAA curve. When the record is replayed the reverse characteristic of gain-versus-frequency must be applied to restore a flat frequency response. This process in the amplifier is known as RIAA equalization.

The first stage of the ETI444 amplifier uses an LM382 dual low-noise preamplifier IC. This stage is designed to amplify and to equalize the output of a magnetic cartridge. The internal circuit diagram of this IC is shown on p73. Note that many of the resistors needed to bias the IC (and to provide equalization) are provided within the chip and very few external resistors are required to make it function as an RIAA compensated amplifier.

The second IC is an LM379 — a dual stereo power amplifier which provides six watts rms per channel with supply rails of ± 13 volts. The IC is unusual amongst power amplifiers in that it can be used in a similar fashion to conventional op-amps (except that it is capable of driving a low impedance load of 8 ohms).

The gain-versus-frequency response of the power amplifier is set by the bass and treble controls. The overall gain is set by the ratio of I+R15/(R17 + RV4). The part of RV4 corresponding to a particular amplifier is that between the wiper and the outside tag connected to that amplifier. Thus the gain of the two amplifiers may be varied differentially by varying RV4 (which acts as a balance control). The level of the input to the power amplifier is selected by RV1 (which acts as a volume control). Switch SW1 selects the input to the power amplifier from either the RIAA preamplifier or from tuner, tape or auxiliary inputs as required.

The power supply is simply a bridge rectifier and centre-tapped transformer arrangement which provides ± 12 volts dc. With both channels driven this is adequate to provide an output of 5 watts per channel before clipping.

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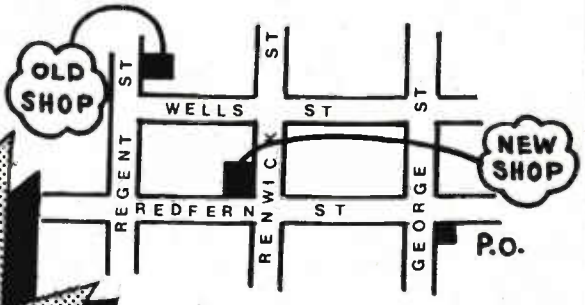

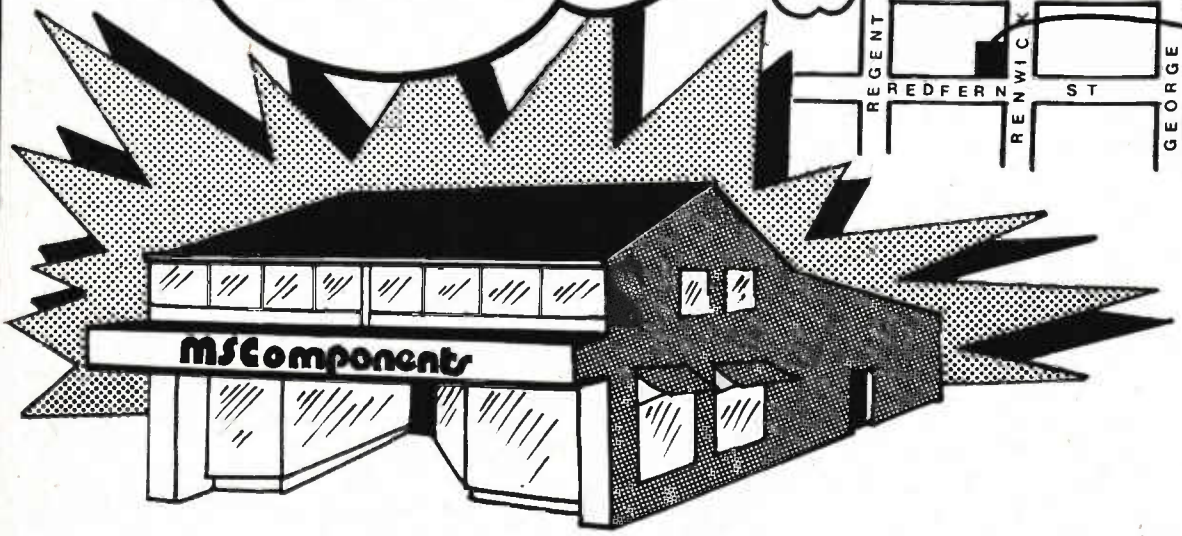

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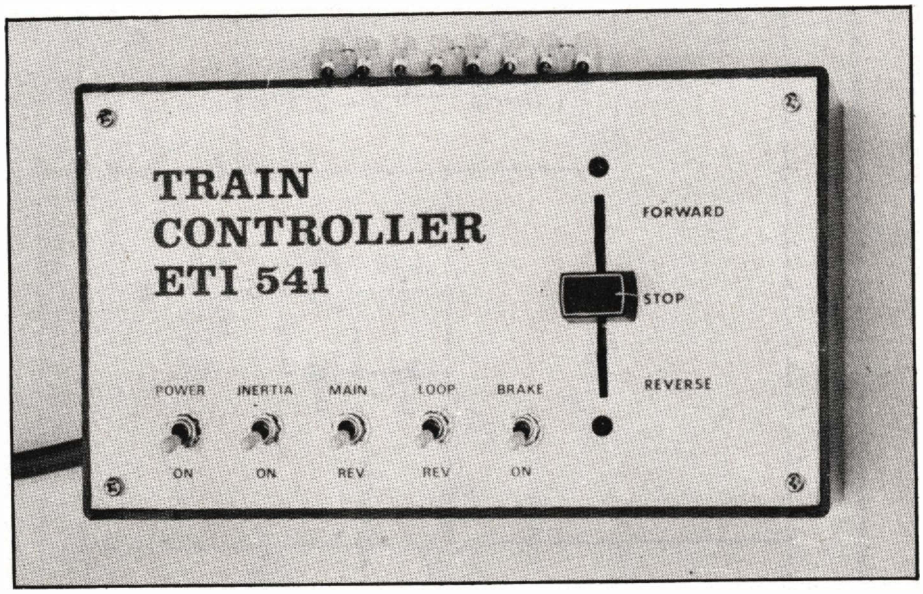
Train controller

A simple project offering auto-reverse, inertia, emergency brake and loop track facilities.

MODEL TRAINS HAVE ALWAYS BEEN popular with both lads and dads — with dads perhaps coming first. Many a boy has complained "Daddy won't give me a turn". It seems there is some inexplicable attraction in playing trains which never dims with the passing years. A couple of our friends have recently decided to buy train sets — for the kids (they say). Our model train controller project was designed to give them many features that are not found in commercially available controllers (for roughly the same cost). Most commercial devices cost around $30 and consist of a transformer followed by a selenium rectifier, a high power rheostat and an automotive globe. Such controllers have numerous operating disadvantages mainly due to their very poor voltage regulation.



Our controller It may look a little complex but in fact it is very simple to build and quite inexpensive. If the full capability is used the features of the controller are:

- Forward or reverse control by a single slide potentiometer (centre for stop)
- Separate reversing switch for the main track
- Short-circuit proof
- Regulator-type control circuitry
- Emergency brake (which stops the train instantly regardless of the position of other controls
- Simulated inertia (gives more realistic starts and stops)
- The facility to operate with track loops

Loop operation Although not possible with simple controllers, loop operation adds much operating fun and realism to any model railroad and the feature is well worth including. A typical loop is shown in Fig. 1. and the operational problems of such a loop are as follows:

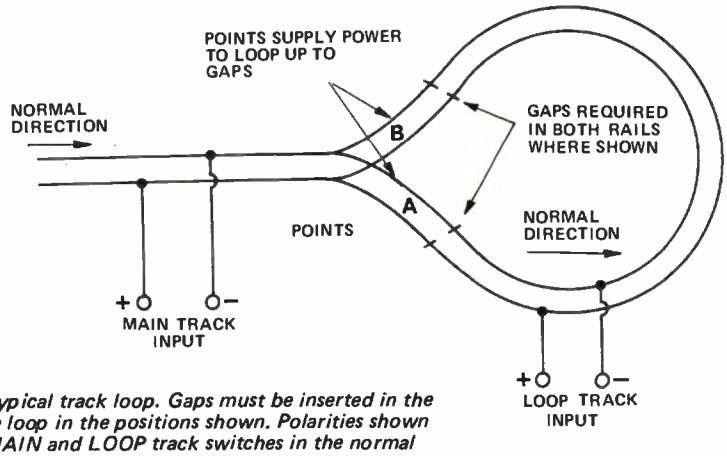


Fig. 1. A typical track loop. Gaps must be inserted in the rails of the loop in the positions shown. Polarities shown are with MAIN and LOOP track switches in the normal position.

If a train is approaching the loop and the 'main' and 'loop' switches are both set at normal, the polarity of the voltages to the track will be as shown. If the points are set so that the train enters the loop towards 'A' it will continue normally around the loop. If the points are now set to 'B' so that the train may

(Continued on page 55)

Train controller

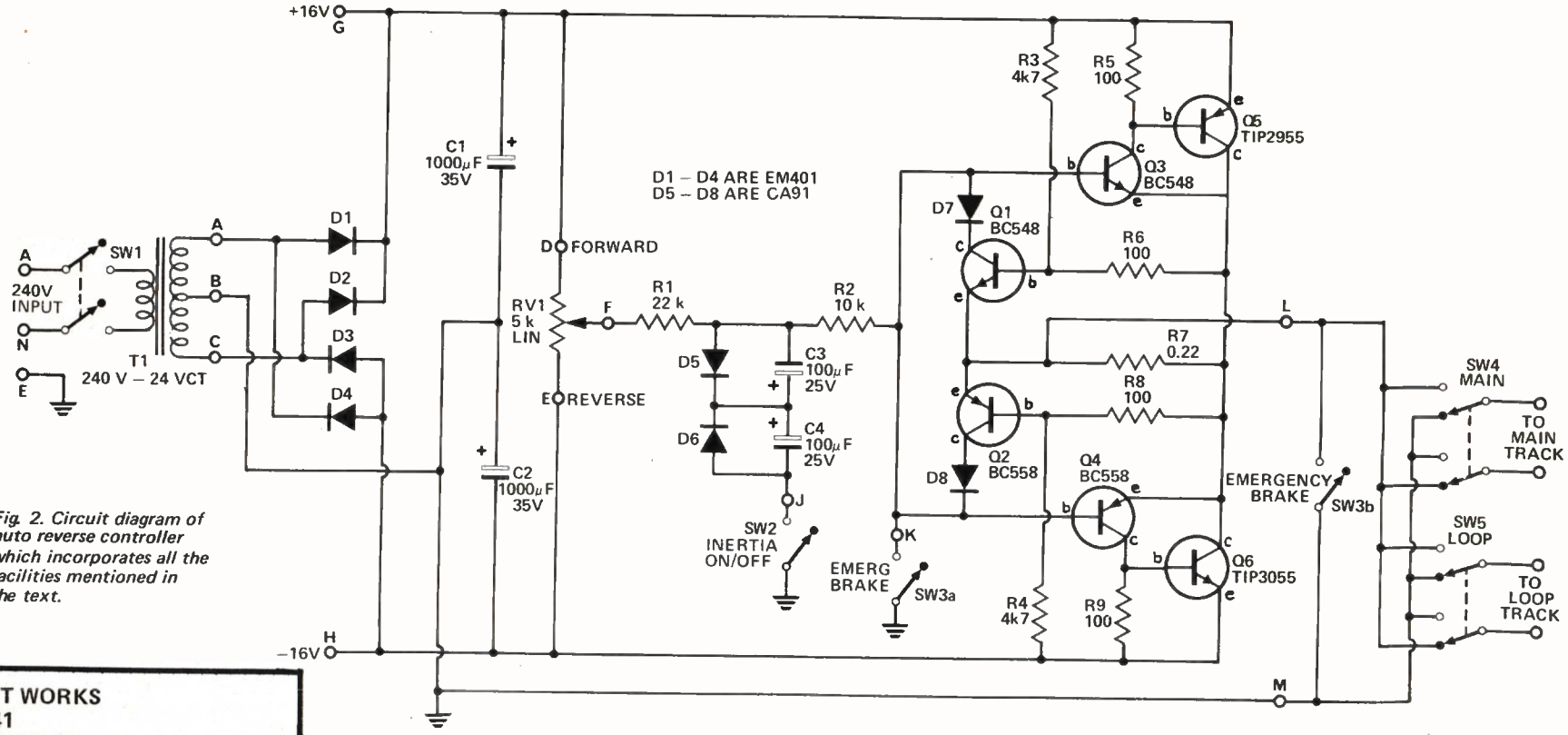


Fig. 2. Circuit diagram of auto reverse controller which incorporates all the facilities mentioned in the text.

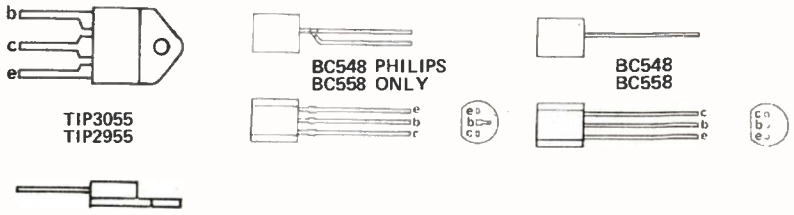
HOW IT WORKS
ETI 541

TRANSFORMER T1 reduces the 240 volt mains to a supply of 24 volts (centre tapped) which is then rectified by D1 to D4 to provide supplies of +16 and –16 volts dc. The speed control potentiometer is connected between these supplies so that its wiper may select any potential between plus and minus 16 volts, depending on setting.

The output of the potentiometer must be well buffered before it can supply enough power to run a train. This is achieved by transistors Q3 and Q5, for the forward direction (that is for output voltages between zero and +15 volts), and by Q4 and Q6, for the reverse direction (that is for output voltages between zero and –15 volts). The output voltage at the collectors of Q5 and Q6 will be about 0.6 volts closer to zero than the voltage at point 'K' (providing the voltage at point 'K' is more than 0.6 volts away from zero). This means that the control

PARTS LIST
AUTOMATIC-REVERSE CONTROLLER

Resistors			
R1	22 k	½ W	5%
R2	10 k	"	"
R3,4	4 k7	"	"
R5,6	100 ohm	"	"
R7	0.22 ohm	5 W	"
R8,9	100 ohm	½ W	"
RV1	5 k lin 45 mm slide potentiometer		



potentiometer will have a small dead band in the centre of its travel where the output voltage remains at zero. This is an advantage because it is frequently necessary to set the controller for exact zero output.

To protect the transistors from damage in the event of an overload or a short circuit, transistors Q1 and Q2 are used to monitor the output current (by measuring the voltage across R7) and the voltage across the output transistors. By this method the power dissipation in the output transistors is controlled such than when driving into a short circuit only about one ampere is available. Yet when set to about 12 volts, about two amps is available to drive normal loads. The diodes D7 and D8 are included to protect the transistors Q1 and Q2 against reverse bias which can occur under certain conditions.

To add the 'inertia' facility or 'momentum', as it is sometimes called the control voltage from RV1 is filtered by C3 and C4. This means that if the potentiometer is suddenly moved from stop to full forward (for example) the voltage applied to the transistor buffer rises only slowly. The train accelerates at a realistic rate without wheel spin. A similar action takes place when the train is stopped. If the controller is moved from full forward to full reverse the train will slow down and stop for a short time and then start off and increase speed in the reverse direction. The diodes D5 and D6 allow normal electrolytics to be used in this position.

If inertia is being used and an emergency situation occurs, eg train moving into a siding that it should not be entering, the brake facility may be used to short the track (SW3b) and also the input to the buffer stage (SW3a). The brake over-rides the speed control and by its use the train will be stopped in a much shorter distance than it would if the power were simply switched off.

When loops in the track system are used, as described in the introduction, a separate reversing switch is used to control the polarity in the loop with respect to the main line so that the train may go into and come out off the loop without any change in speed. The two controller outputs required for this mode of operation must each be reversible and this is performed by SW4 and SW5.

If a second controller is required for another train in the system then it may be built without the power supply. The second controller may be powered by linking the +16, 0 and −16 volt lines between the two controllers.

Capacitors
C1,2 1000 µF 35 V pc mounting electro
C3,4 100 µF 25 V pc mounting electro

Transistors

Q1, 3	BC548
Q2, 4	BC558
Q5	TIP 2955 *
Q6	TIP 3055 *

* with insulation kit

Diodes

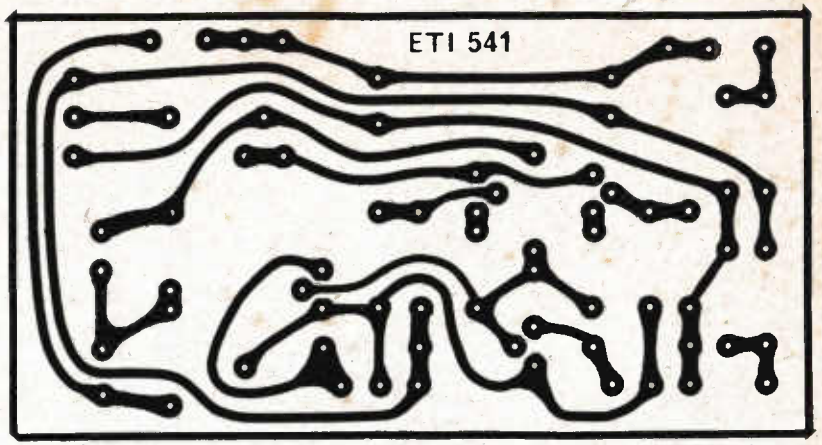
D1-D4	EM401 or similar
D5-D8	OA91 or similar

Miscellaneous
PC board ETI 541
Transformer PL24/20 VA or similar
SW1 toggleswitch DPDT 240 V rated
SW2 toggle switch SPDT
SW3-SW5 toggle switch DPDT
Plastic box 196x113x60 mm
12 Pc board pins
3 core flex, plug and clamp
Heatsink/support to Fig. 8.
8-way connector strip
2-way connector strip
2 6BA c/s screws & nuts 10 mm long
Front panel (Scotchcal)

FOR MANUAL REVERSE CONTROLLER
Delete
R4, R8 and R9
C2 and C3
Diodes D3-D8
Transistors Q2, 4 and 6

If no loops are involved in the track layout SW4 and SW5 can be deleted on automatic reverse controller and SW5 on manual reverse controller.

For a second controller delete T1, SW1, D1-D4 and the power cord in the second controller.



Printed-circuit board layout ETI 541 train controller. Full size 65 x 105 mm.

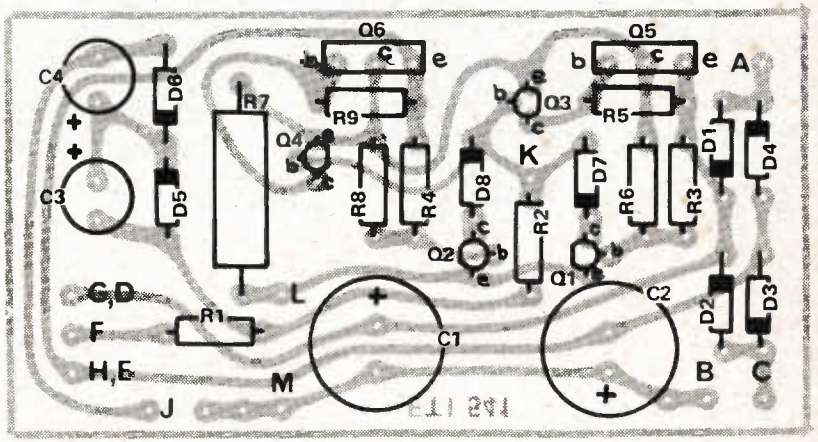


Fig. 3. Component overlay — auto reverse controller.

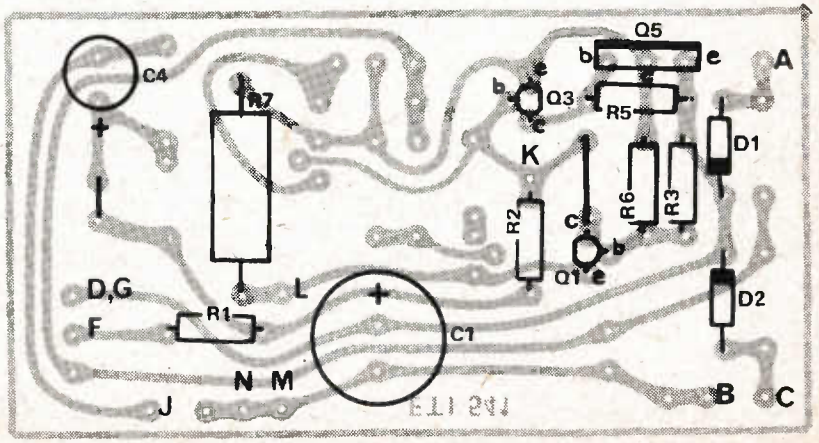


Fig. 4. Component overlay — simple controller.

Train controller

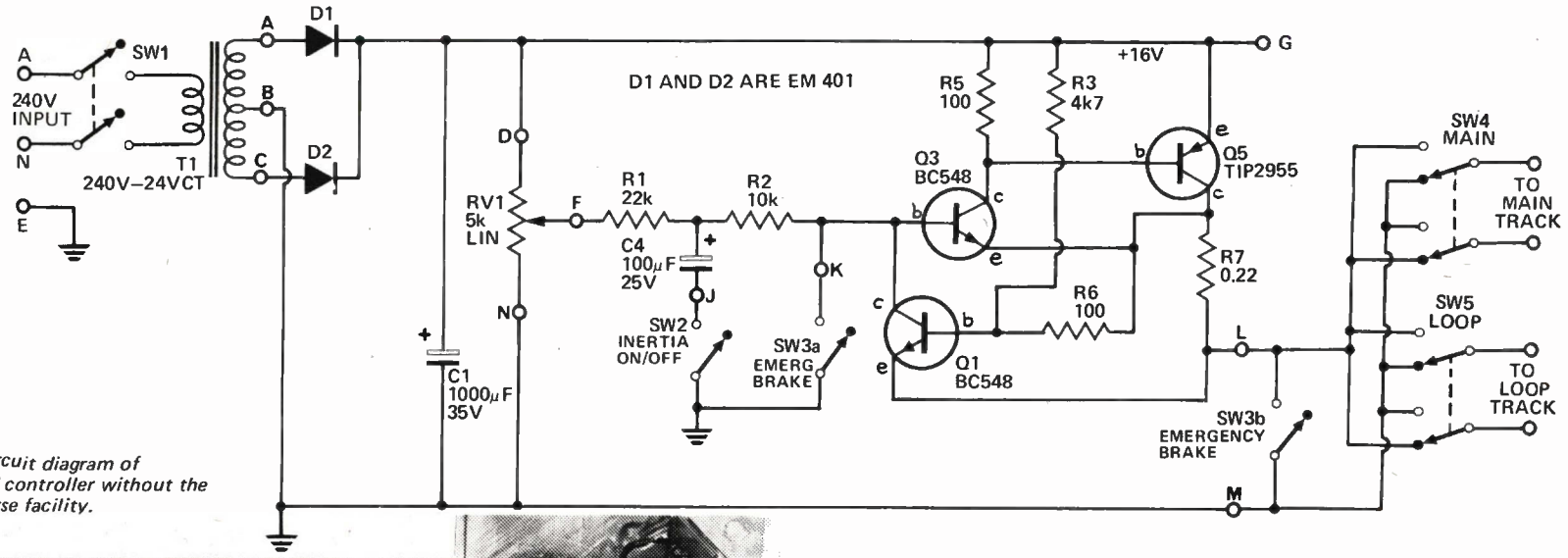
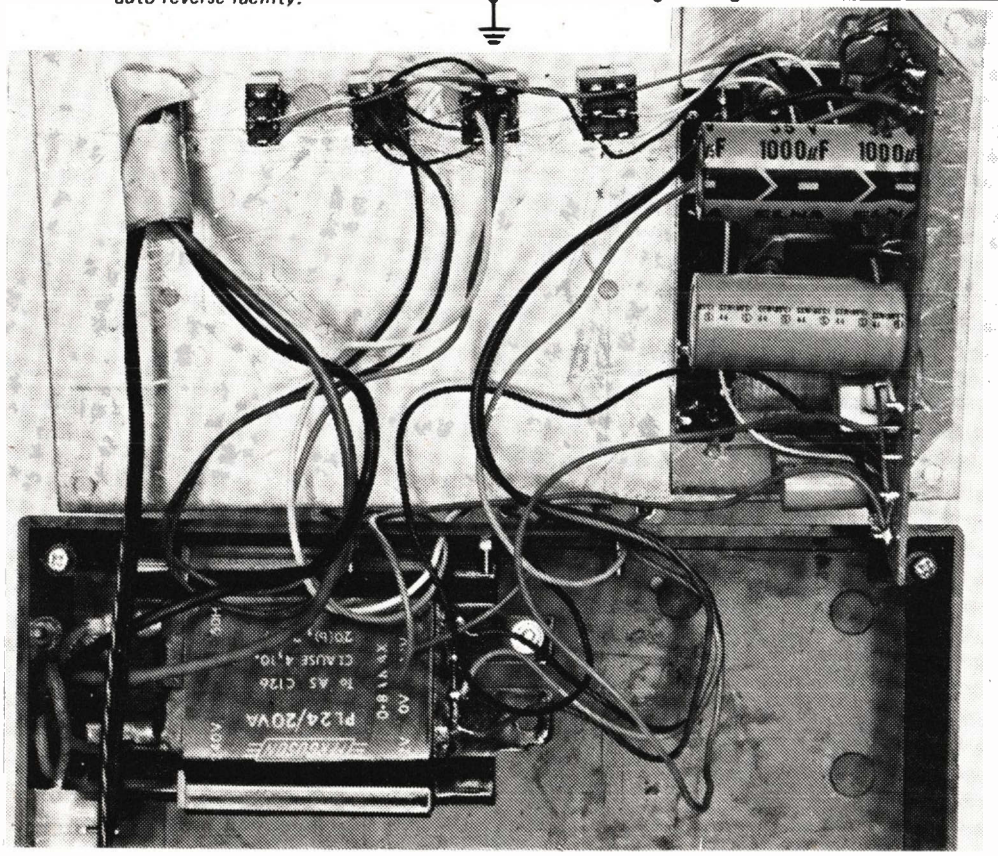
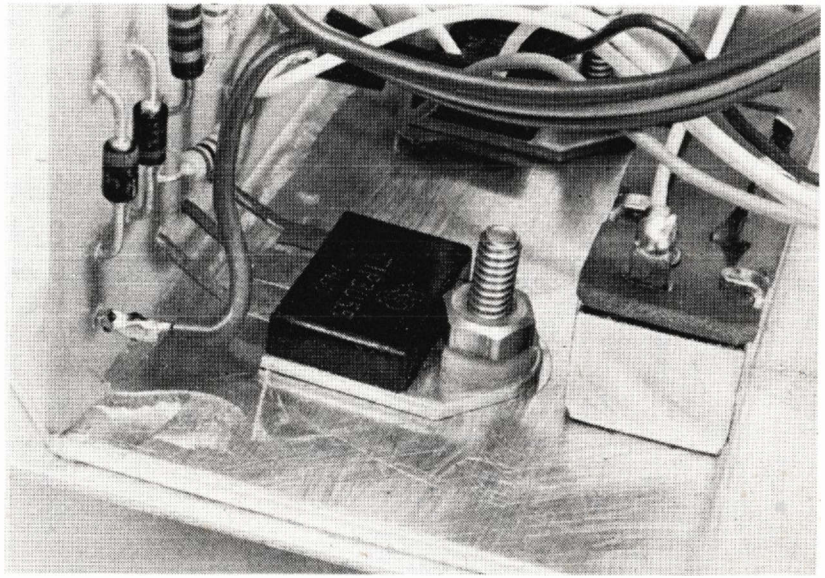


Fig. 5. Circuit diagram of simplified controller without the auto-reverse facility.





The power transistors are mounted to a bracket with countersink bolts. They can, if desired, be mounted directly on the front panel. Note how the pcb is mounted – by epoxying to the bracket.

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- ☐ reciprocals, change sign, exchange and display/register
- ☐ memory minus, memory plus, memory clear, memory exchange recall and clear/clear entry keys.
- ☐ Degrees/radians conversions.
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- ☐ Automatic constant in all four basic functions.
- ☐ Full 8 digit display with arithmetic, RNP logic and 3 level stack.
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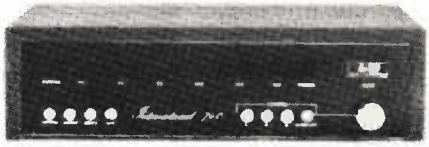

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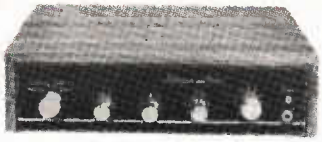

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ETI 5/76

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Cerwin-Vega speakers are built to take the absolute maximum power with the absolute minimum distortion.
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The sound is always clean and crisp, no matter what the volume. Which is why many of the world's leading rock groups use Cerwin-Vega.
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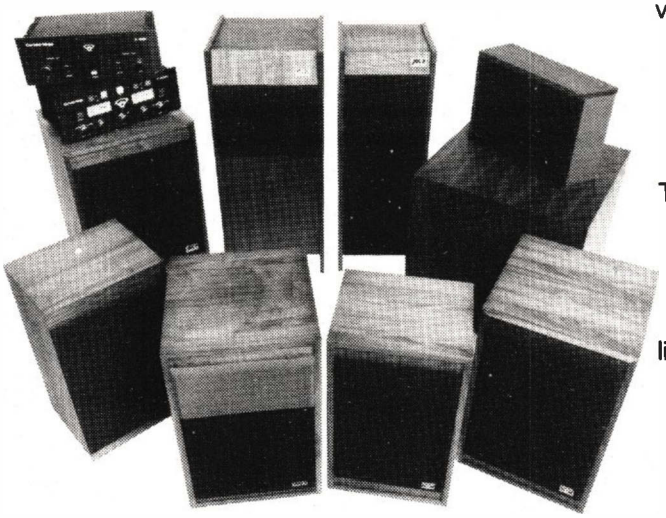

Cerwin-Vega

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Various types of record cleaners have been available for decades. However, most of these products have failed to keep pace with modern advances in record materials and recording techniques. The Tracker RC-1 record cleaning solution was developed to meet these modern demands.

Tracker cleaning products went into stringent testing at the Chemistry Dept. at the University of Victoria, B.C., Canada in 1974 and as this chart shows, Tracker RC-1 dramatically reduced the records static charge.

Further information on the Canadian Tests is available by writing to us at Box No. 882, G.P.O. Sydney, 2001.

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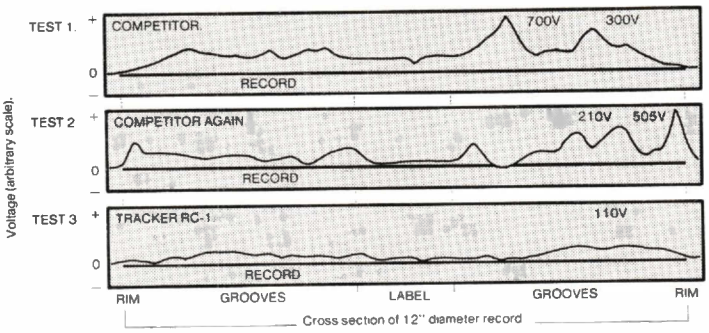

These 3 traces show static charge on the same record after cleaning twice with a major competitive solution, then once with Tracker RC-1 solution.

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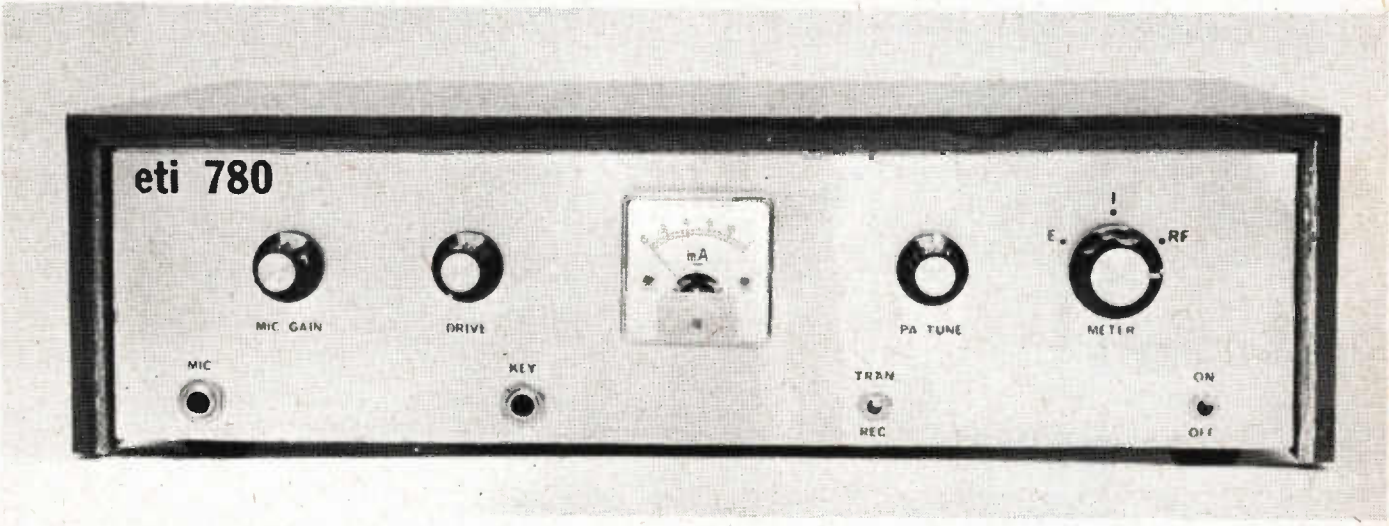
PKB88530 A

Novice transmitter

Designed by Kevin Barnes

Last month we introduced the design philosophy of our transmitter and described its operation in general terms. We continue this month with full construction details.



COMMENCE CONSTRUCTION BY winding all the coils in accordance with the winding data shown on page 74. Then construct the heatsinks for the BDY92 (Q5) and the BD139 (Q3), as shown in Figure 6 and the photographs. Mount the BD 139 to its heatsink using a 6BA by 9 mm screw, an insulating mica washer and silicon grease. Now mount the BDY92 to its heatsink, using a mounting kit and silicon grease, but use *two* mica washers between the transistor and the heatsink to reduce the capacitance between the transistor case and earth. Do not mount either heatsink to the board at this time.

Transmitter board Mount the resistors and the fixed capacitors to the transmitter board, according to the component overlay. Note that R16 is also an inductor and is constructed by winding a length of jug element wire on a Philips ferrite bead. Resistor R16 acts as the current shunt for the meter. Its resistance of 0.5 ohms is best measured by passing one ampere through a length of the wire and finding the length required to obtain a voltage drop of half a volt.

Resistor R17 is selected to give half scale reading on the meter for one amp of collector current through Q5. In the prototype the value required was 680 ohms. We suggest that you use this value temporarily and trim later if required. Capacitor C21 (emitter bypass for Q2) should have a ferrite bead on one lead. The capacitors in the output network must be polystyrene and rated at 630 volts.

The impedance matching network, consisting of C9, C10 and L1 has a low Q and on the prototype we found the response was broad enough. However if you have any problem in obtaining sufficient drive to Q5 (with insufficient drive one amp collector current can not be obtained) change the value of C9 (by small amounts) to correct this.

Once all the resistors and capacitors have been fitted to the board you can install the semiconductors, coils and the crystal. The heatsink supporting the BD139 should now be screwed to the board and the leads of the transistor soldered into position. Note that the heatsink also acts as a shield (as does the BDY92 heatsink) and should therefore be earthed to the board by means of the mounting screws. Now mount the relay and the PA tuning capacitor C18.

The BDY92 heatsink bolts onto the rear of the chassis (not to the board). It is a good idea to first temporarily mount the board into the chassis and the heatsink to the rear panel. The tap on the toroidal transformer T4 should now be connected to a solder lug under the nearest bolt securing the BDY92 to the heatsink. Now connect the emitter of the BDY92 to earth on the pcb by a piece of very thick wire or a piece of pc board and wire as shown in Figure 6 and the photographs. Once this lead and the base lead of the transistor have been positioned the board and heatsink assembly can be

(text continued on page 78)

Novice transmitter

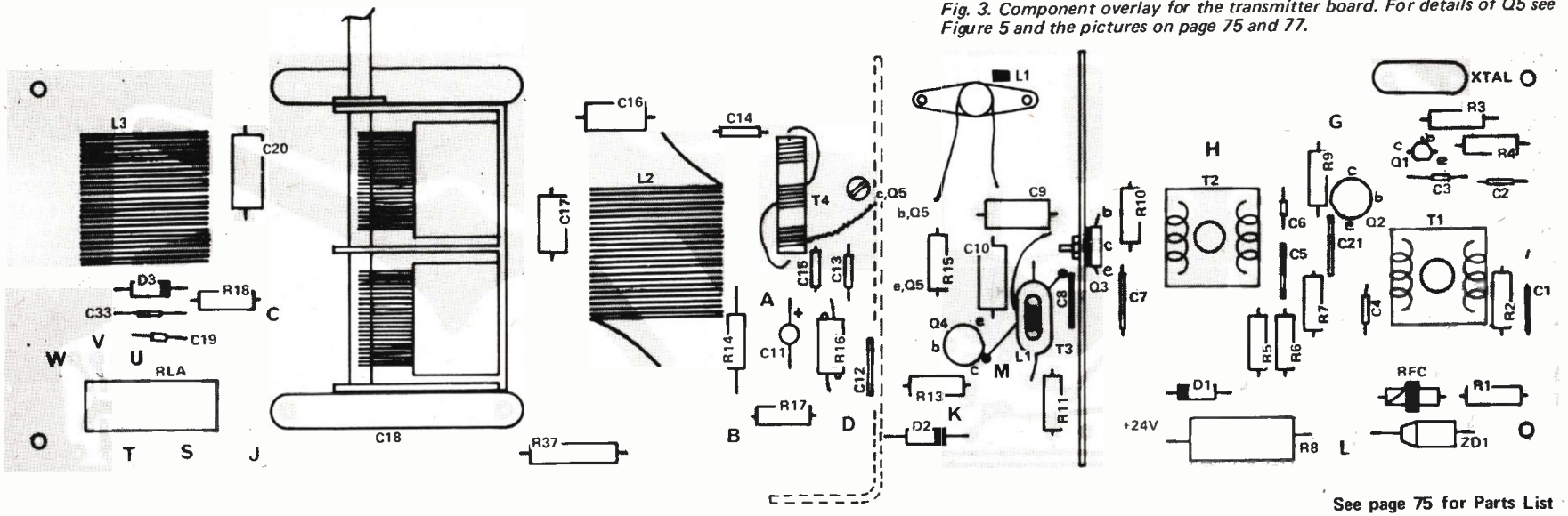


Fig. 3. Component overlay for the transmitter board. For details of Q5 see Figure 5 and the pictures on page 75 and 77.

See page 75 for Parts List

HOW IT WORKS — ETI 780

The operating frequency of the transmitter is determined by a crystal oscillator consisting of transistor Q1, transformer T1, a crystal and other associated components. Capacitor C3 provides the feedback necessary to maintain oscillation. The output from the oscillator is link-coupled to the base of transistor Q2 — a buffer amplifier designed to minimise loading effects on the oscillator, and to deliver maximum power gain.

The emitter resistor for Q2, R9, is returned to earth via the normally-closed contacts of the morse-key socket and the transmit/receive switch (T/R switch). Thus if the morse key is inserted, or the T/R switch is in the receive position, Q2 is disabled. This prevents the output of the oscillator from reaching the power amplifier (PA). By this means the transmitter is disabled unless the morse key (if inserted) is operated or the transmit mode is selected.

The output from Q2 is link-coupled from T2 to Q3 which is a class-C RF power amplifier. The input to Q3 is shunted by R10 in order to keep changes in the input impedance low during the periods when Q3 is not conducting. The emitter current of Q3 (and hence the drive power to the PA) is controlled by the effective impedance of Q4, as set by the potentiometer RV1. RV1 is therefore used to set the dc input power level to the PA.

The high output impedance of Q3 is matched to the low input impedance of Q5 (shunted by R15) by means of the transformer T3 and the 'T' network consisting of C9, C10 and L1. The Q of this network is kept low so that its frequency response is broad.

The low output impedance of Q5 is stepped up by the broad-band toroidal transformer T4 which feeds the RF into a double-pi network formed by C16, L2, C17, C18, L3 and C20. This network reduces the harmonic content of the output to a safe level and additionally, adjustment of C18 makes the final impedance match to the antenna.

The output power is then fed to the antenna socket via the change-over relay. A sample of the output is taken by C19 and is converted to a dc signal by D3 and C33. This signal is used to drive a meter thus providing an indication of power output. On the supply-rail side of the transformer T4 capacitors C13 and 15 provide RF bypassing at HF and VHF frequencies whilst R14 and C11 provide bypassing for frequencies below 3.5 MHz. The resistor R16 is a low value meter shunt and the current through Q5 develops a voltage across R16 which is monitored by the meter. This reading of current in Q5 together with a reading of the voltage at point 'A' allows the operator to measure the input power to the final stage.

Diodes D1 and D2 form an analogue AND gate which allows transistor Q3 to draw current from whichever of two supplies is the higher — the 13 volts to the oscillator or the output voltage from the modulator. Thus when Q5 is called on to supply peaks of power and this requires drive from Q3 beyond what can be provided by the 13 volt supply the additional drive capability is provided by the modulator.

The modulator. The output from the microphone is voltage amplified by ICIa and ICIb which have gains of 100 and 10 respectively. RV2 is a front-panel mounted gain control for the microphone, provided to allow the operator to use microphones with different sensitivities. Capacitors C22, 24 and 28 have been selected to tailor the audio-frequency response at the low end whilst C25 trims the response at the high end. Restricting the audio bandwidth in this manner does not affect legibility but improves efficiency and reduces the bandwidth of the transmitter. Diodes D4 and D5 are clipping diodes which remove any positive or negative peaks from the audio modulation which would otherwise overmodulate the PA. A low pass-filter is formed by C27 and R26, and RV3 is used to adjust the gain so that a fully-clipped signal corresponds to 100% modulation. The output from RV3 is taken to ICIc which, as a low-pass active filter, removes the harmonics that were produced by the clipping process. If these harmonics are radiated they cause interference to nearby channels.

The series modulator is formed by ICId, Q6 and Q7. The modulator is in effect a voltage amplifier with a high output current capability and a voltage gain of 100. The values of R36 and R34 are the same and therefore the voltage at the emitter of Q6 must be the same as that at the slider of RV4 if there are to be equal currents into the positive and negative terminals of ICId — and if the circuit is to be balanced. Therefore any ac which is injected into the IC via C32 is balanced by a change in current through R36. Thus the voltage at the emitter of Q6 varies proportion to the input voltage applied to R32.

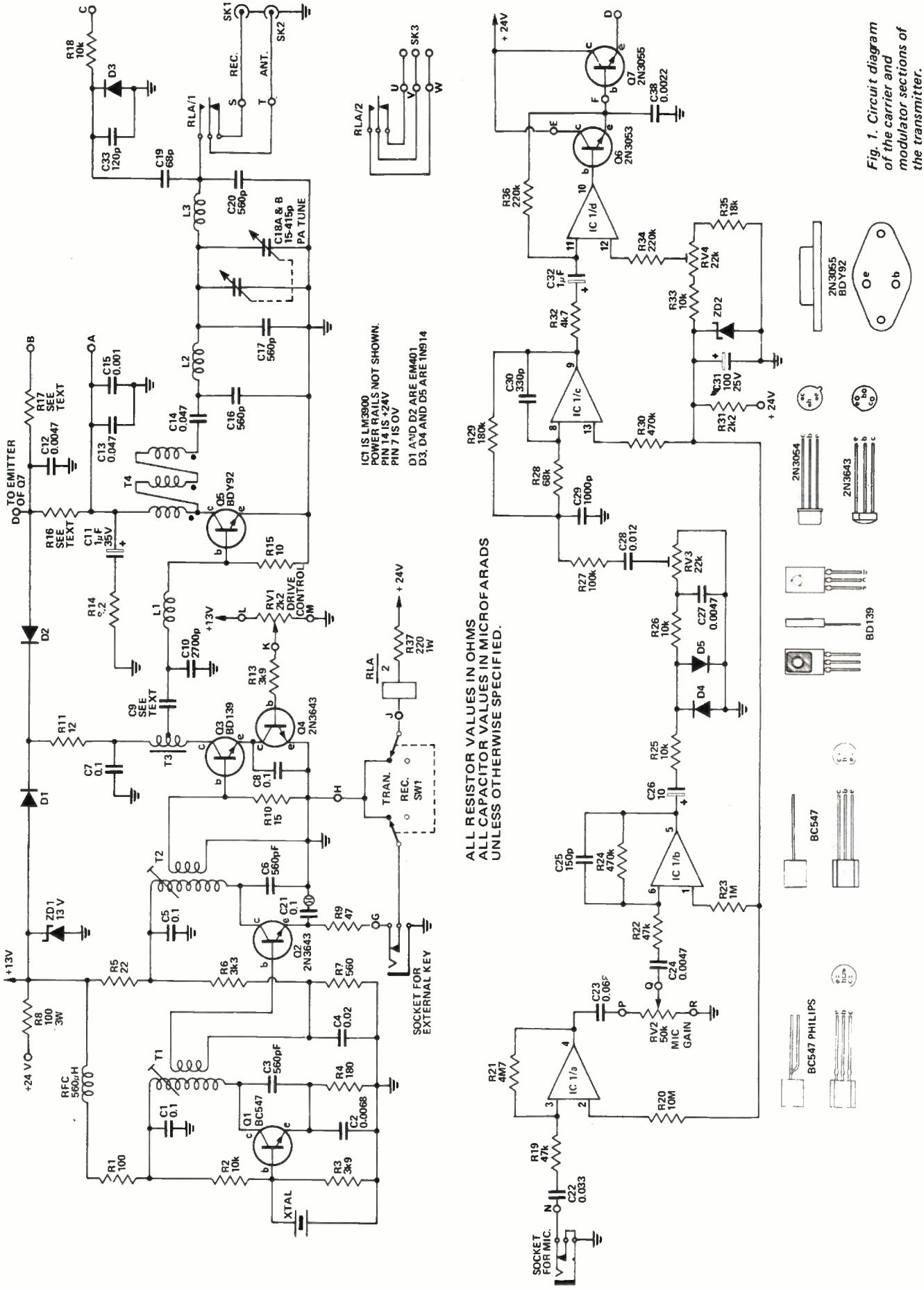


Fig. 1. Circuit diagram of the carrier and modulator sections of the transmitter.

Novice transmitter

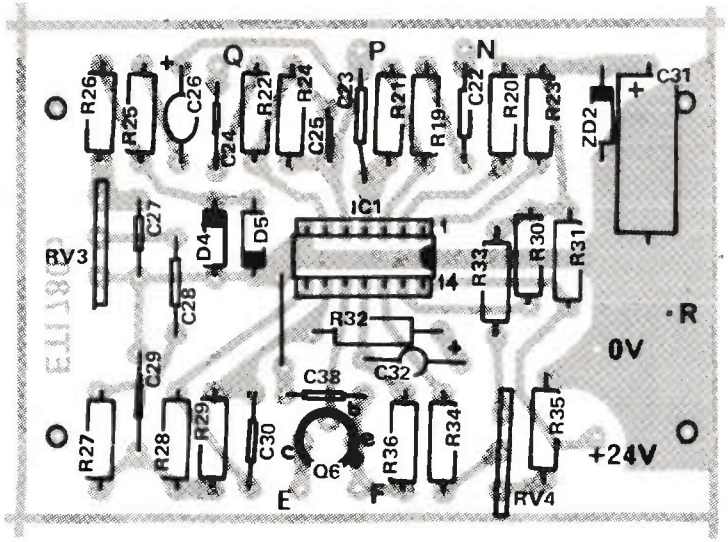
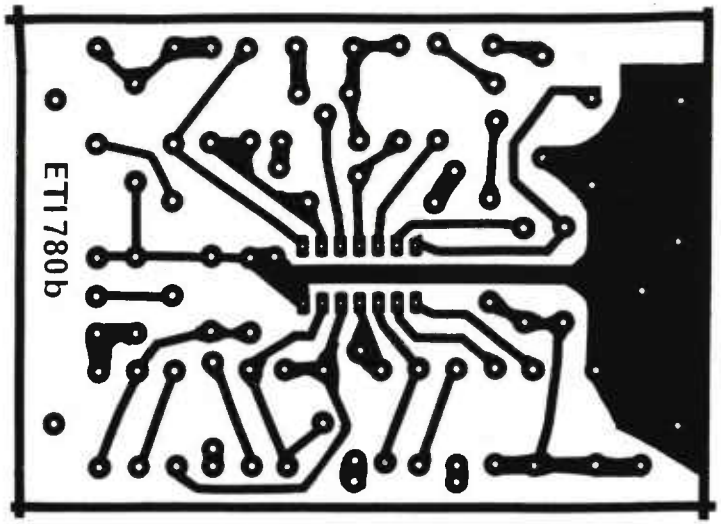


Fig. 4. Component overlay for the modulator board.



Printed-circuit layout for the modulator. Full size 63 x 92 mm.

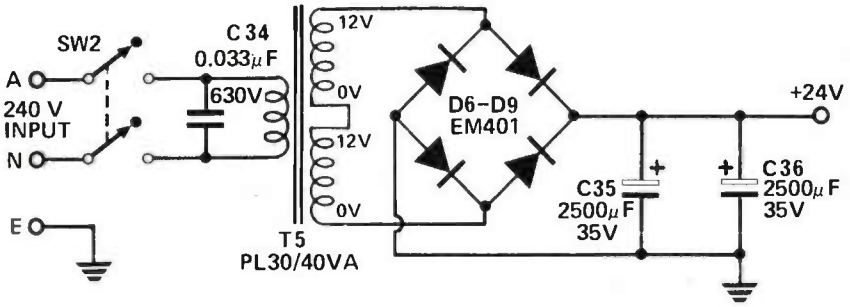
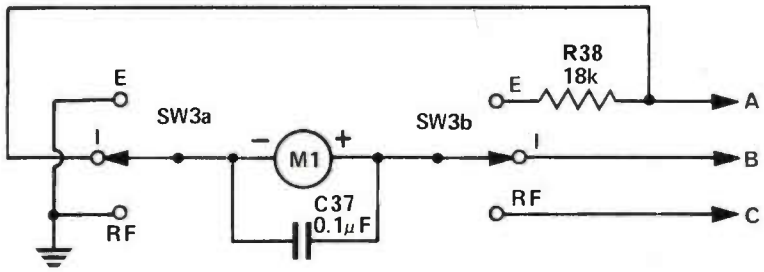
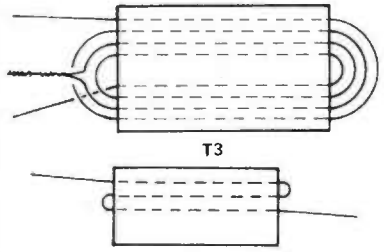


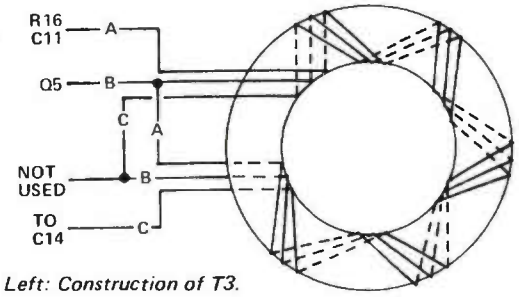
Fig. 2. Power Supply and metering circuitry.



WINDING DETAILS



NOTE
EACH TURN GOES
THROUGH A DIFFERENT HOLE



Left: Construction of T3.

Right: Construction of T4.

TRANSFORMERS

T1 and T2. Both these transformers are close wound on a Neosid former 7 mm diameter by 35 mm long. Primary windings are 28 SWG enamelled copper. Secondary windings are 22 SWG enamelled copper.

Turns. T1 Primary 21
Secondary 2
T2 Primary 21
Secondary 4 (no not 5)

T3 Transformer T3 consists of four turns centre — tapped, wound on a 14 mm long ferrite TV balun.

Former Philips 4322 020 69750 or similar
Turns 4 turns of 20 SWG enamelled copper

T4 Transformer T4 is trifilar wound (on a ferrite toroid) and has an outer diameter of 23 mm, an inner diameter of 14 mm and a height of 7 mm. The ferrite material is Philips type 4C6.

Toroid Philips 4322 020 91070
Turns 6 turns trifilar wound of 1.2 mm wire.

INDUCTORS

L1. Inductor L1 is wound on a 7 mm Neosid former, slug-tuned with an F29 slug.

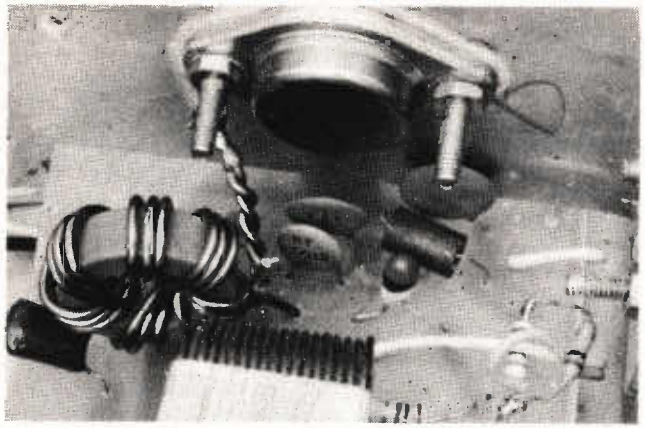
Turns 8 turns close wound of 20 SWG enamelled copper.

L2, L3. Both these coils are 25 mm in diameter, air cored, and are held together with 6 mm wide strips of masking tape.

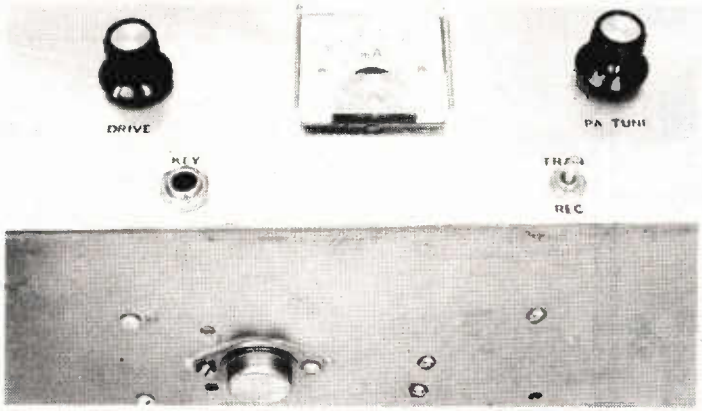
RESISTOR R16.

This resistor is made by winding a length of jug-element wire (see text) through a ferrite bead having dimensions of 6 mm diameter and 10 mm long.

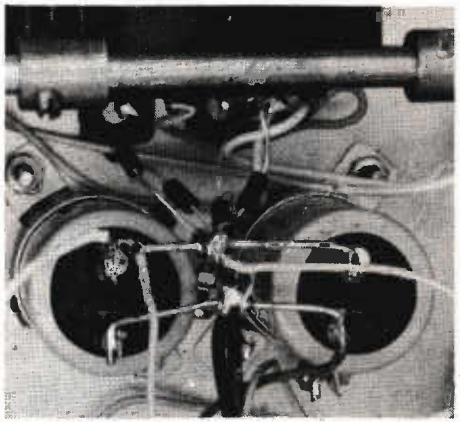
Bead type Philips 4312 020 31500 or 4312 020 31550



The toroid (T4), one pi-tank coil (L2) and the PA transistor (Q5).



Transistor Q7 is mounted underneath the chassis.



The power supply.

PARTS LIST — ETI 780

Resistors

R1	100	½ W	5%
R2	10 k	"	"
R3	3k9	"	"
R4	180	"	"
R5	22	"	"
R6	3k3	"	"
R7	560	"	"
R8	100	5 W	5%
R9	47	½ W	5%
R10	15	"	"
R11	12	"	"
R12	not used	"	"
R13	3k9	"	"
R14	8.2 Ω	"	"
R15	10	"	"
R16	See text and table I.		
R17	See text		
R18	10 k	½ W	5%
R19	47 k	"	"
R20	10 M	"	"
R21	4M7	"	"
R22	47 k	"	"
R23	1 M	"	"
R24	470 k	"	"
R25	10 k	"	"
R26	10 k	"	"
R27	100 k	"	"
R28	68 k	"	"
R29	180 k	"	"
R30	470 k	"	"
R31	2k2	"	"
R32	4k7	"	"
R33	10 k	"	"
R34	220 k	"	"
R35	18 k	"	"
R36	220 k	"	"
R37	220	1 Watt	5%
R38	18 k	½ Watt	5%

Capacitors

C1	0.1 µF ceramic
C2	0.0068 µF polyester
C3	560 pF ceramic
C4	0.02 µF ceramic
C5	0.1 µF ceramic
C6	560 pF ceramic
C7	0.1 µF ceramic
C8	0.1 µF ceramic
C9	1800 pF styroseal
C10	2700 pF styroseal
C11	1 µF 35 V tag tantalum
C12	0.0047 µF ceramic
C13	0.047 µF ceramic
C14	0.047 µF polyester
C15	0.001 µF ceramic
C16	560 pF styroseal
C17	560 pF styroseal
C18	variable 2 gang 15-415 pF
C19	68 pF ceramic
C20	560 pF styroseal
C21	0.1 µF ceramic
C22	0.033 µF polyester
C23	0.068 µF polyester
C24	0.0047 µF polyester
C25	150 pF ceramic
C26	10 µF 35 V tag tantalum
C27	0.0047 µF polyester
C28	0.012 µF polyester
C29	1000 pF polyester
C30	330 pF ceramic
C31	100 µF 25 V electrolytic
C32	1 µF 35 V tag tantalum
C33	120 pF ceramic
C34	0.033 µF 630 V polyester
C35	2500 µF 35 V electrolytic chassis mount
C36	2500 µF 35 V electrolytic chassis mount
C37	0.1 µF ceramic
C38	0.0022 µF polyester.

Diodes

D1, 2	EM 401 or similar
D3	IN 914 or similar
D4, 5	IN 914 or similar
D6-9	EM 401 or similar

Zener Diodes

ZD1	Zener 13 V 1.5 W
ZD2	18 V 400 mW

Transistors

Q1	BC 547
Q2	2N3643
Q3	BD 139
Q4	2N3643
Q5	BDY92
Q6	2N3053
Q7	2N3055

Integrated Circuits

IC 1	LM 3900

Potentiometers

RV1	2k2 linear
RV2	50 k linear
RV3	22 k trimpot
RV4	22 k trimpot

Switches

SW1	DPDT toggle C & K 7201
SW2	DPST 240 V ac 1 amp.
SW3	Wafer switch 2 pole 5 position

Miscellaneous

Crystal 3.5 MHz band.

T1,2,3,4	Transformers in accordance with Table 1.
T5	Transformer power Ferguson type PL30/40VA.
Relay	12 volt 2 changeover 280 ohm coil
Meter	0-1 mA 42 mm square.

9 spacers, 3 TO3 mounting kits, nuts bolts and washers, brackets to Fig 6, chassis and cover, 2.6 mm x 75 mm extension shafts, power cord and plug, 2 rubber grommets, cable clamp and four rubber feet.
2 RCA sockets
2 6mm jack sockets.
4 knobs
1 5 pin socket
Coils and transformers as per Table I.
RFC choke 560 µH, pc boards ETI 780 A and B

Novice transmitter

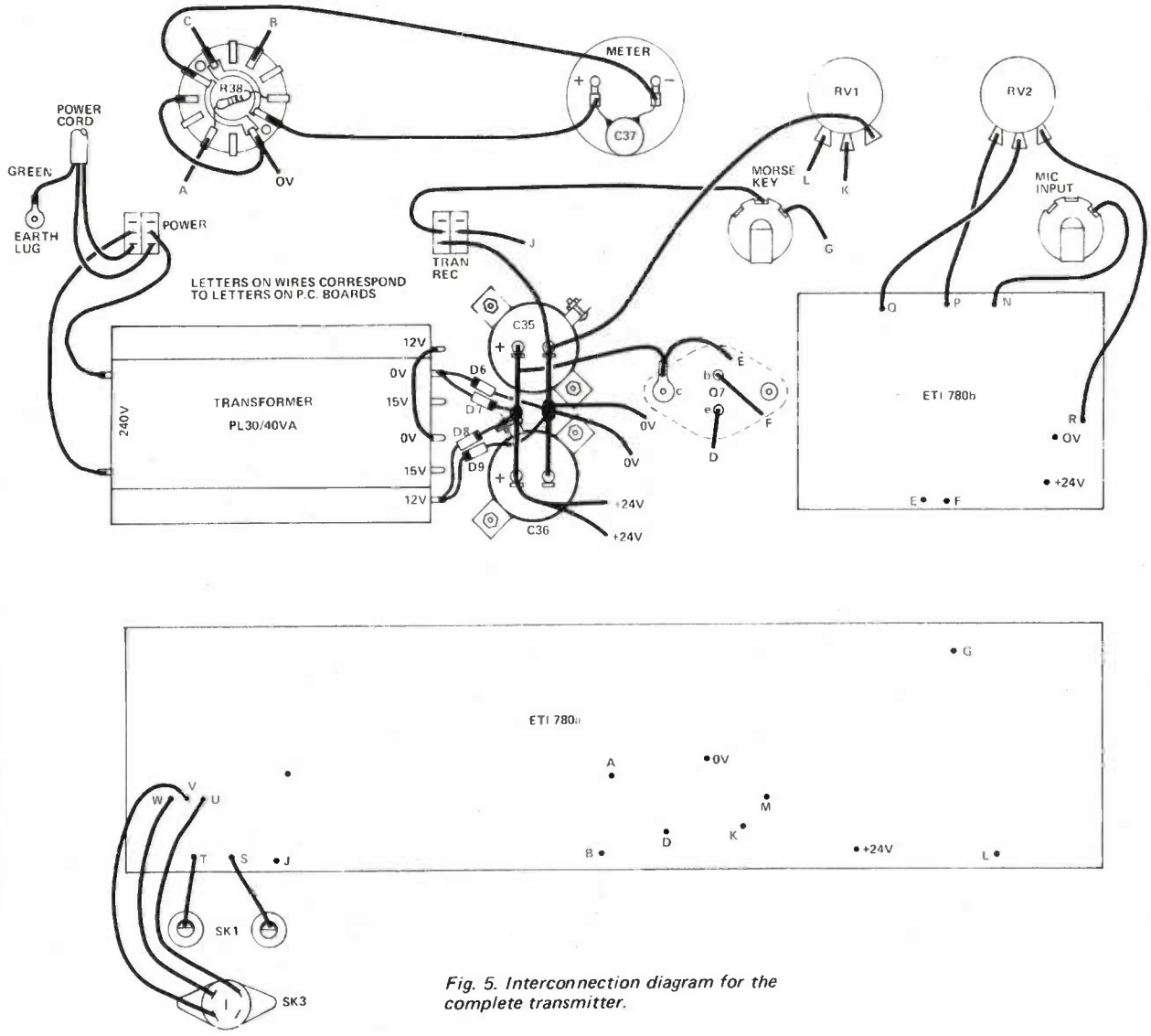
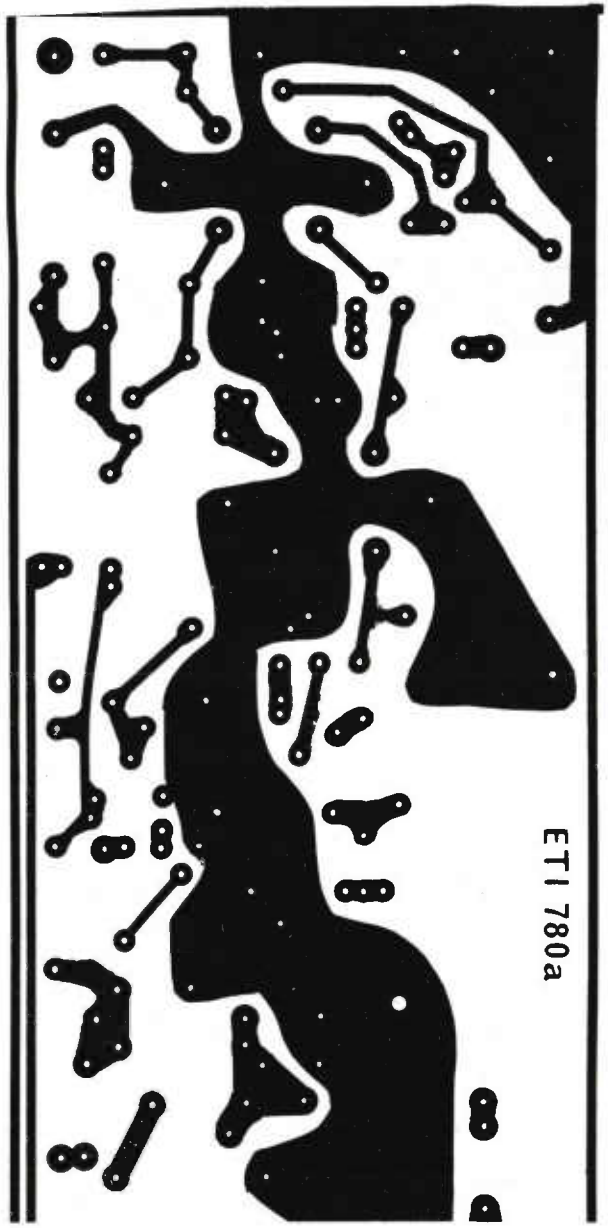
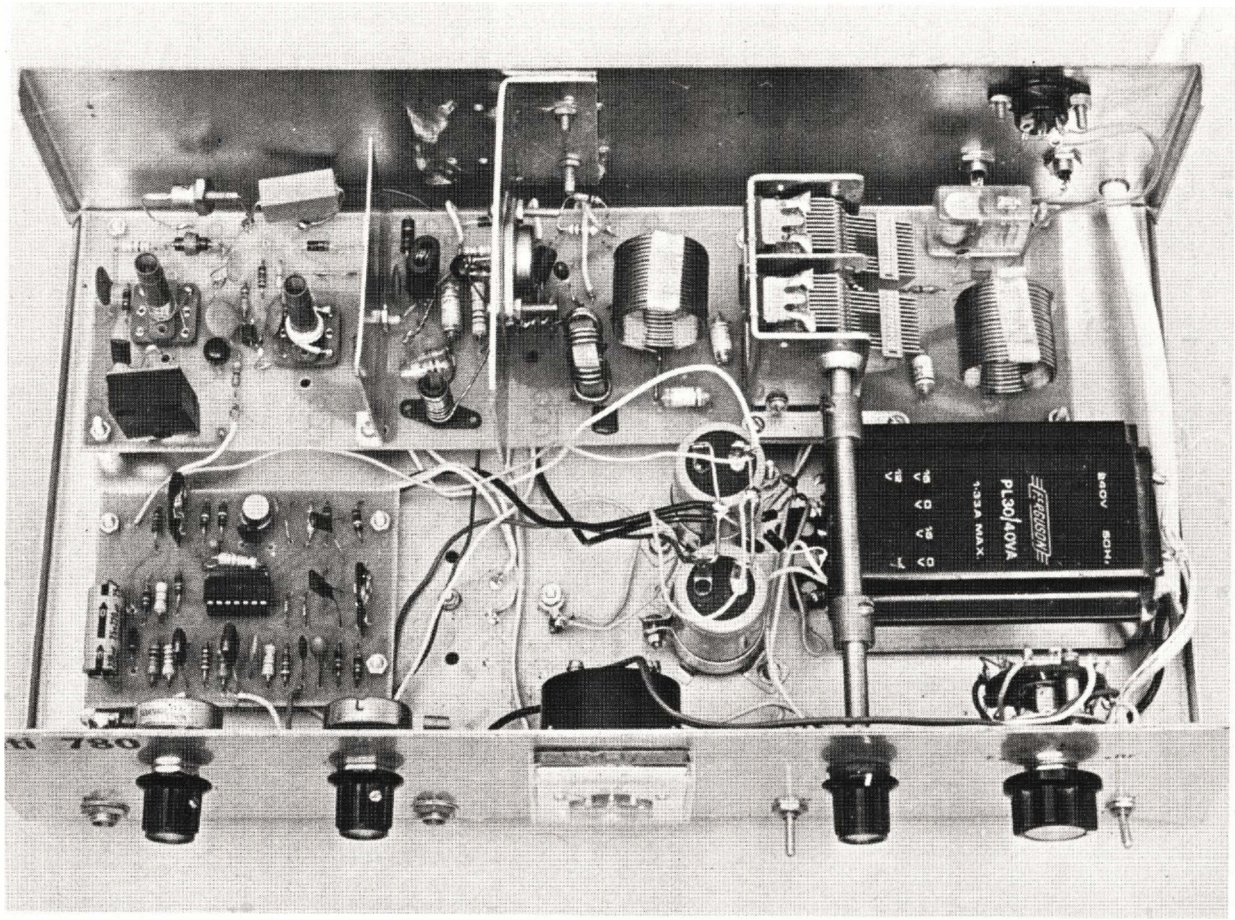
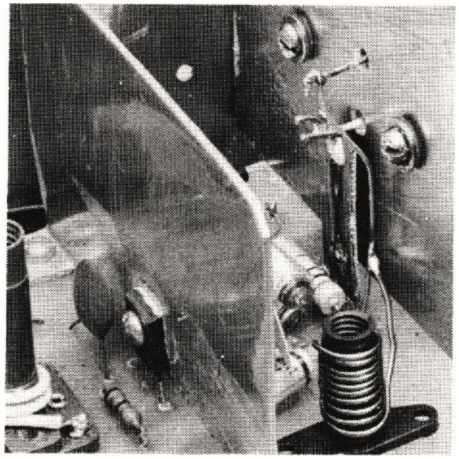


Fig. 5. Interconnection diagram for the complete transmitter.

Printed-circuit layout for the transmitter board. Full size 295 x 77 mm.



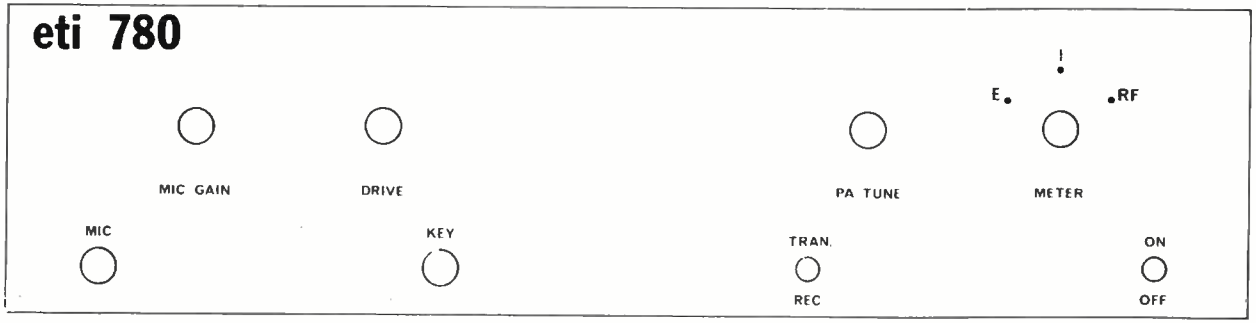




The heatsink for the BDY92 is on the right and that for the BD139 (Q3) on the left. Note the emitter connection for Q5 constructed from a piece of PC board to which the emitter lead is soldered. See also Figure 6.

Inside the transmitter. The modulator board is on the left and the RF board at the rear.

Front panel artwork. Full size 334 x 82 mm.



Novice transmitter

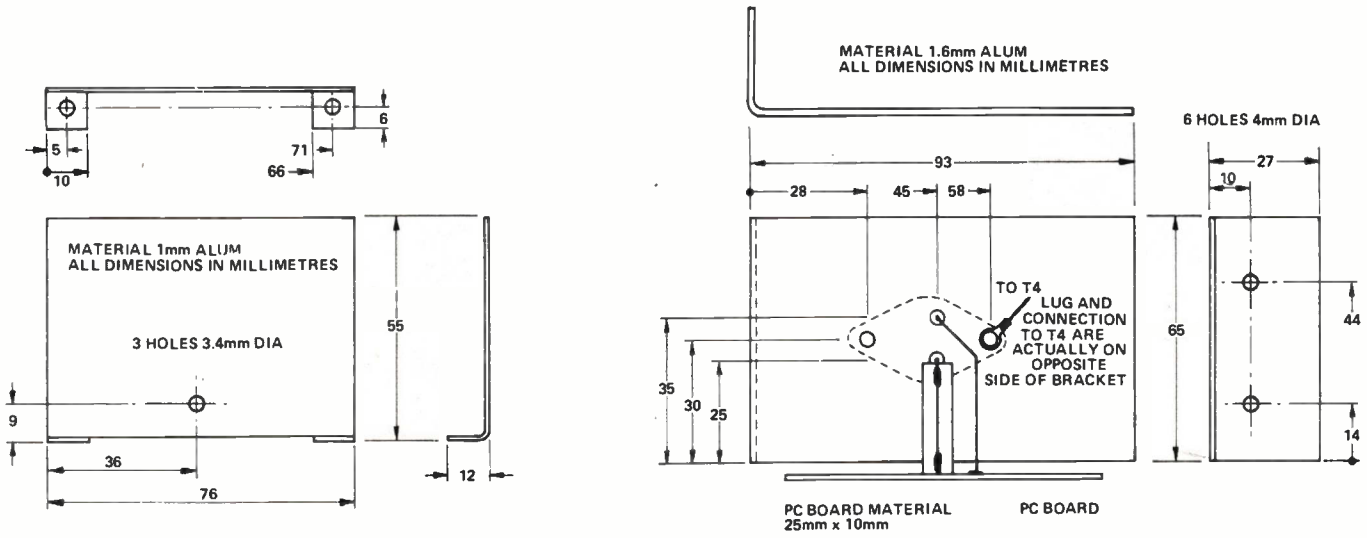


Fig. 6. Heatsinks for Q3, BD139 (left), and for Q5, BDY92 (right). Note the emitter lead for the BDY92 is constructed from a piece of pc board and a piece of thick tinned copper wire. See the photo on page 77.

Continued from page 71.

removed to solder these leads in position.

Using the interconnection diagram as a guide, attach a length of hookup wire to each point on the board which has to be terminated elsewhere and then bolt the completed board and heatsink assembly into the chassis. Note that all the standoffs are made of brass.

Modulator board Assemble components to the board as shown in the second component overlay, taking care to correctly orientate the integrated circuit, the transistors, electrolytics and the diode. Attach leads to all points which have to be terminated elsewhere and mount the board into position in the chassis. Now mount the 2N3055 (Q7) underneath the chassis using an insulation kit.

Final assembly Fit the power cord through a grommet in the rear of the chassis and secure with a cable clamp. Then terminate the cable as shown in the interconnection diagram. Fit the power transformer, filter capacitors and all switches and pots to the front panel. Interconnect components as shown on the wiring diagram and then extend the shaft of the PA-tuning capacitor out through a grommet in the front panel by means of two 6 mm diameter extension shafts.

Fit large rubber feet to the chassis so that Q7 has sufficient clearance and fit a plastic cover to the transistor to protect against accidental short circuits.

Setting up Commence the setting up procedure by adjusting RV4 to mid position and RV3 to its minimum position. Terminate the output of the transmitter into a 75 ohm dummy load, set the drive control, RV1, fully anticlockwise. Set the T/R switch to the 'receive' position.

Switch on the transmitter and ensure that Q5 is not drawing current. If it is check for a fault.

Now adjust the slug in transformer T1 until the oscillator is working. This may be determined by checking the voltage across the 100 ohm resistor, R1 – this should peak to a maximum as the slug is tuned. If the oscillator does not operate check the operating frequency of the coil and the capacitor with a GDO. If this is OK then the fault might be due to insufficient feedback. To cure this reduce the value of C2. Changing the value of C2 affects the resonant frequency of T1 so it may be necessary to modify the value of C3 in order to stay within the adjustment range.

Once the oscillator is working correctly switch the T/R switch to 'transmit' and adjust the slug in T2 for a voltage peak across R5 (22 ohms). Now whilst observing the current on the meter turn up the drive control until a quarter scale reading is obtained. Now adjust the tuning for maximum power into the dummy load (indicated by a peak on the meter in the RF position).

Check the voltage at the junction of R16 and C13 and adjust RV4 to give 10 volts at this point. Now adjust the value of R1 to obtain a half scale reading on the meter in the 'E' position. This connects the meter to read the voltage to the PA. Continue to adjust the drive and PA tuning until the current read by the meter does not increase any further. Advance the drive slightly past this point. Check the meter 'I' calibration by measuring the voltage across R16 and then calculating the current.

Audio The settings required for RV2 and RV3 are best found by experiment when 'on-air'. An initial starting point can be found whilst running the transmitter and listening to the output on a receiver (make sure that the receiver is not overloaded) by putting RV3 in its minimum output position and adjusting RV2 for maximum recovered audio at the receiver (with least distortion). Now, whilst keeping the distortion as low as possible, increase the output from RV3 and decrease RV2 (keeping the recovered audio volume maximum) until the distortion starts to increase and a reduction in RV2 makes no difference to the audio level. At this point the clippers D4 and D5 are beginning to operate. Check for splatter and if excessive adjust RV3 until the splatter just stops.

That completes the setting up and the transmitter is now ready to help you communicate with the outside world. ●

I.L.P.

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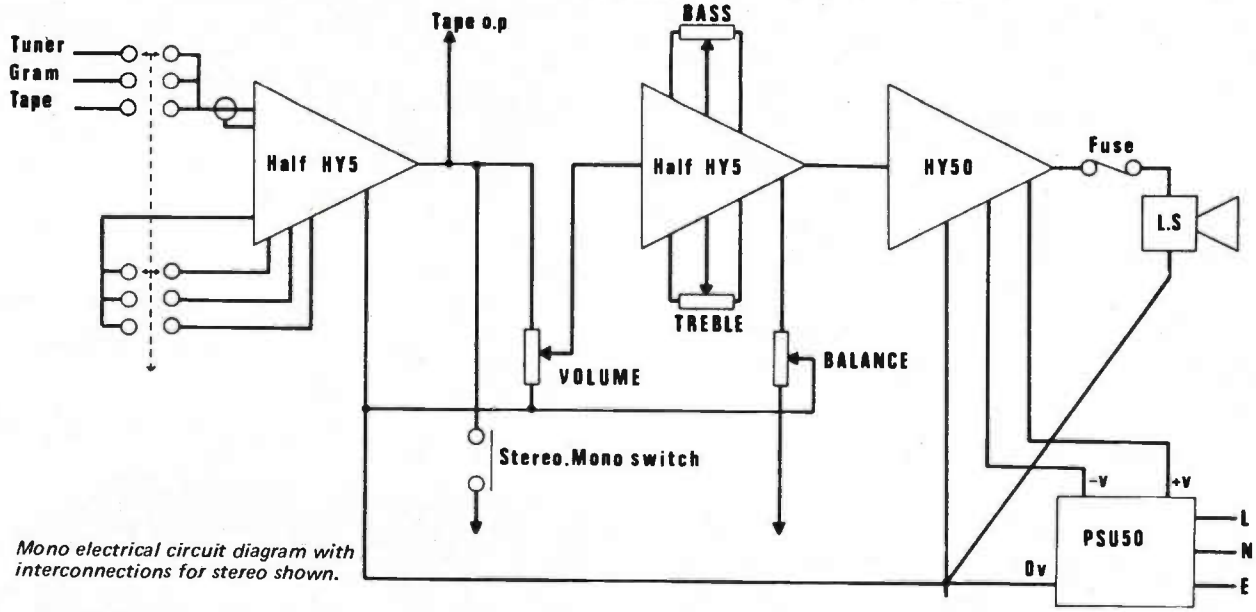
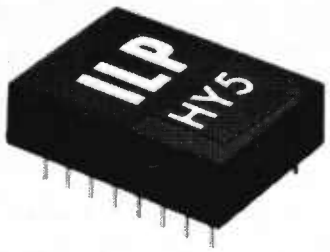


Mono electrical circuit diagram with interconnections for stereo shown.



The HY5 is a complete mono hybrid preamplifier, ideally suited for both mono and stereo applications. Internally the device consists of two high quality amplifiers—the first contains frequency equalisation and gain correction, while the second caters for tone control and balance.

TECHNICAL SPECIFICATION

Inputs

Magnetic Pick-up	3mV, RIAA
Ceramic Pick-up	30mV
Microphone	10mV
Tuner	100mV
Auxillary	3-100mV
Input impedance	47kΩ at 1kHz.

Outputs

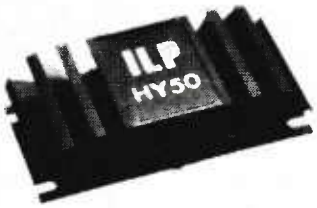
Tape	100mV
Main output Odb (0.775 volts RMS)	

Active Tone Controls

Treble	±12db at 10kHz
Bass	±12db at 100Hz

Distortion 0.05% at 1kHz
Signal/Noise Ratio 68db
Overload Capability 40db on most sensitive input
Supply Voltage ±16—25 volts.

PRICE $16.06 P&P $0.30

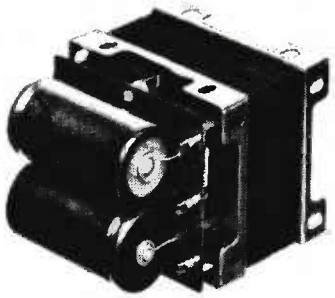


The HY50 is a complete solid state hybrid Hi-Fi amplifier incorporating its own high conductivity heatsink hermetically sealed in black epoxy resin. Only five connections are provided: Input, output, power lines and earth.

TECHNICAL SPECIFICATION

Output Power 25 watts RMS into 8Ω
Load Impedance 4—16Ω
Input Sensitivity Odb (0.775 volts RMS)
Input Impedance 47kΩ
Distortion Less than 0.1% at 25 watts typically 0.05%
Signal/Noise Ratio Better than 75db
Frequency Response 10Hz—50kHz ! 3db
Supply Voltage ! 25 volts
Size 105 x 50 x 25 mm.

PRICE $20.27 P&P $0.40



The PSU50 incorporated a specially designed transformer and can be used for either mono or stereo systems.

TECHNICAL SPECIFICATIONS

Output voltage	50 volts (25–0–25)
Input voltage	210–240 volts
Size	L.70, D.90, H.60 mm.

PRICE $20.41 P&P $2.00

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Consider the special concern for low phase shift and stability to minimise distortion; the exclusive 'Linear equaliser', the worlds first 'touch mute circuitry' to reduce volume instantly, and so on, and so on. But then, have a 'test drive'; a good long one. It's the only real way to get the 'total feeling'.

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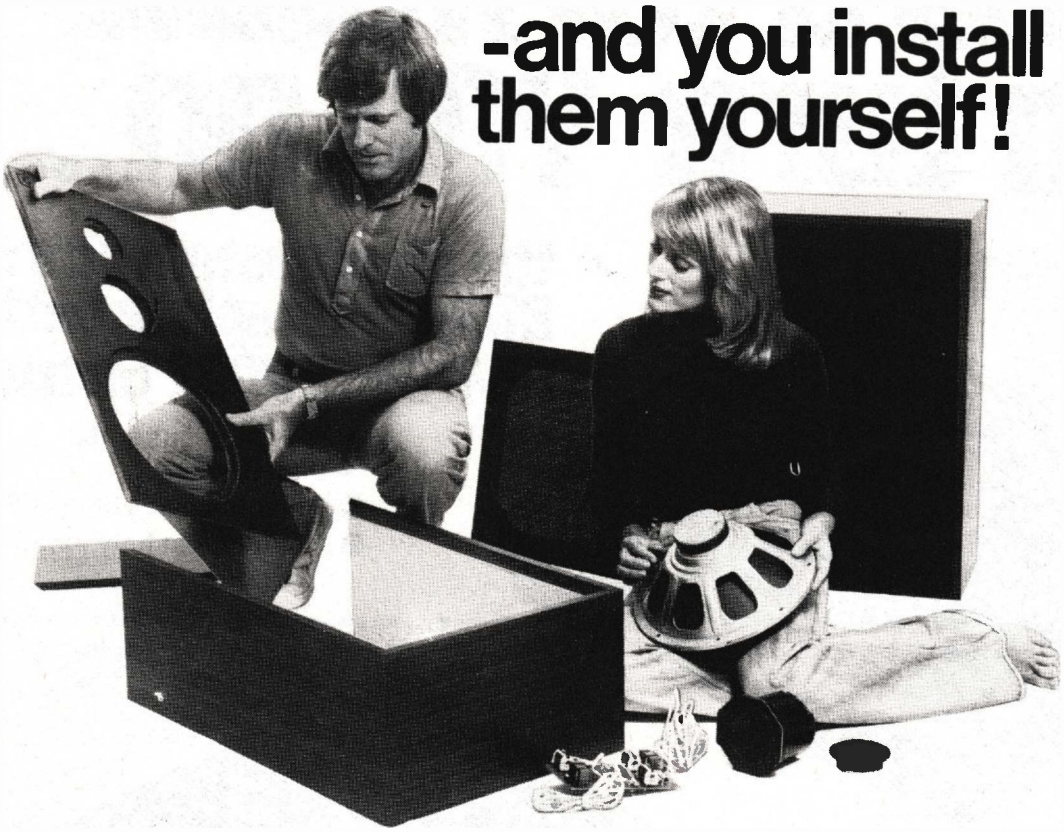

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MODEL C-7077/P MULTIMETER. **Specifications:** 100,000 ohms/volt DC; 10,000 ohms/volt AC; DC volts — 5,5; 25; 50; 250; 500; 1,000. AC volts — 10; 50; 250; 500; 1,000. DC amps — 10μA; 2-5 mA; 25 mA; 500 mA. Ohms — 10 kΩ; 1 MΩ; 10 MΩ; 100 MΩ. Centre scale — 150Ω; 15 KΩ; 150 KΩ; 1-5 MΩ. Decibel — —20 to +22 dB. Dimensions — 151 x 102 x 48 mm Diode protected movement. Carrying case available Model C.

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MODEL OL64 D/P MULTIMETER. Very ruggedly constructed this model is particularly suitable for workshops. It features special scales for measurement of capacitance and inductance. Diode protested movement: **Specifications:** 20,000 Ohm/Volt DC. 8,000 Ohm/Volt AC. DC volts — 0.25; 1; 2.5V; 10; 50; 250; 1,000; 5.000. AC volts — 10; 50; 250; 1,000. DC amps: 50μA; 1 mA; 50 mA; 500 mA; 10 A. Ohms — 4 KΩ; 400 KΩ; 4 MΩ; 40 MΩ. Centre scale — 40Ω; 4,000Ω; 40,000Ω; 400,000Ω. Decibel: —20 to +62 dB, Dimensions: 6" x 4-1/5" x 2"; 152 x 107 x 51 mm. Capacitance: 250 pF to 0.02 uF. Inductance — 0/5000H Carrying case available Model C.

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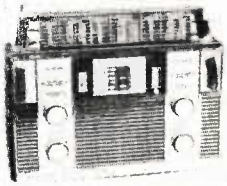

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SPECIFICATION: Single injector approx 1 kHz level 0-5V. Gain: 60 dB. Input impedance: Over 75K ohms. Attenuation Factor: 0-20-40-60 dB. Output Impedance: 8 ohms and 600 ohms. Meter: VU200 uA. Speaker: 2¼ Dynamic. Power Supply: 9 Volt Dry Cell. Size: 5¾ x 3 x 2". Supplied complete with two shielded test leads (AF & RF). R.F. probe and instruction manual. **$37** P.P. $2.00

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HC18 holders. Standard size fit. All modern transceivers with 455 kHz I.F. 27.065 mHz. 27.085 mHz. 27.125 mHz. 27.155 mHz. 27.185 mHz. 27.205 mHz. 27.225 mHz.

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SPECIFICATIONS:

TE-20/D R.F. SIGNAL GENERATOR

SPECIFICATIONS: Frequency Range: 120kc/s — 500mc/s (6 Fundamental Bands and 1 Harmonic Band). Frequency Accuracy: ±2%. Audio output: to 8 volts. Internal Modulation: Approx. 400c/s. Tube complement: 12BH7A, 6AR5, Silicon Diode and Germanium Diode. Printed Circuit for uniform characteristics. Power Source: 105/125, 220/240 volts AC, 50/60 cps 12 watts. Dimensions: 140 x 215 x 170mm. Weight: 2.8kg.

$52.50 p.p. $2.00

TE-22/D AUDIO GENERATOR

SPECIFICATIONS: Frequency Range: Sine Wave — 20 to 200,000c/s in 4 bands. Square Wave — 20 to 30,000cps. Frequency Response: ± 1½ dB. Output Impedance: 1 Kohm. Frequency Accuracy: ± 5%. Output Voltage: Sine wave 7 volts (RMS). Square wave 7 volts (P-P). Distortion: Less than 2%. Tube complement: 6BM8, 12AT7, 6x4. Accessory: 1 — Output cable. Power Supply: AC 50/60 cps 220—240 volts. Dimensions: 215 x 170 x 140mm. Net Weight: 3 Kgs. **$62.50** p.p. $2.00

TE-15 TRANSISTOR GRID DIP METER.

SPECIFICATIONS: Transistors: 3 and 1 diode. Meter: 500uA F/S. Battery: 9 volts PP3. Dimensions: 180 x 80 x 40mm. Weight: 730 g. Frequency Range: 400 kc/s — 280 mc/s with 6 coils; A coil 0.44—1.3 mc/s; B coil 1.3—4.4 mc/s; C coil 4—14 mc/s; D coil 14—40 mc/s; E coil 40—140 mc/s; F coil 120—280 mc/s.

$39.50 p.p. $2.00

FS5 SWR AND R.F. POWER METER.

Power Range: 0, 10W, 100W (2 ranges). SWR: 1:1, 1:3. Freq. Response: 3MHZ—150MHZ. Suitable Connector: M type. Impedance: 50 ohm, 75 ohm. Dimensions: 160 x 85 x 98 mm. Weight: 750 g. **$29.50** p.p. $2.00

ELECTRONICS —it's easy!

PART 31

Digital computer systems — peripherals, stores and microprocessors.

ALL COMPUTING SYSTEMS HAVE a Central Processing Unit, (discussed previously) and a number of pieces of external equipment associated with them. Such additional units, known as peripherals are necessary to handle the flow of information between the outside world and the Central Processing Unit (CPU).

The range of peripherals available today is extensive. Basically the design aims are to provide interfaces between the human or automatic plant user and the computing system which are the easiest to use, the cheapest to implement and which have the means to transfer data as fast as is desired.

At present — though this will undoubtedly change in the future — we are unable to communicate with the computer by the same means that we communicate with each other — that is by direct speech and vision. Peripherals, are by necessity of our technological and economic limitations still very much compromises to the ideal, except in applications where the computer interfaces to hardware plant, such as in process control, when interface problems are easier to solve as such systems communicate by the same signal formats.

Card and Tape Punches and Readers — In order to make good use of the high speed of electronic computing circuits, the input and output functions should ideally be capable of transferring the data at a comparable speed. Rarely has this ideal been realised. The throughput rate of peripherals has been speeded up enormously since the first EDP system but, similarly, the rate of computation has been increased.

Because of this shortcoming, data (in human operator use) is first prepared by hand onto a medium that can feed into the EDP system at rates far exceeding the operator's ability. It is then stored in the machine ready for access when the CPU needs it.

The earliest form of input/output medium used punched holes made in a pile of paper cards or a continuous tape. We inherited these from a 17th century weaving machine via the Hollerith census sorter. Figure 1 shows the commonly used Hollerith coded punched card. The holes are punched out in a code that represents the alphanumeric symbols shown above each row. Figure 2 is a section of punched tape: these are available with 5,6,7 and 8 hole positions across the tape width. (The smaller hole is for the timing drive sprocket). Tape readers are built to read code from a specific width tape: that is, a 5-hole tape could not be used on an 8-hole system. Tapes and cards which are to be used extensively can be made in more durable materials such as oiled paper, Mylar and aluminium-Mylar.

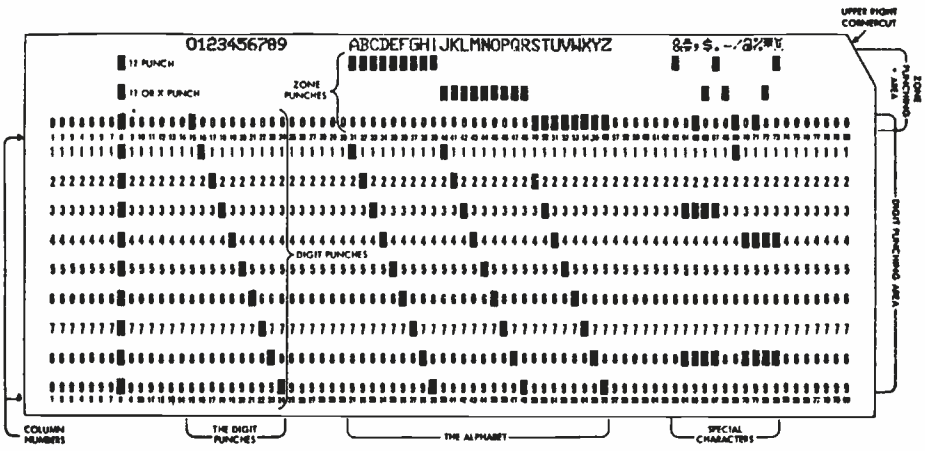


Fig. 1. Standard Hollerith Code used for punched cards.

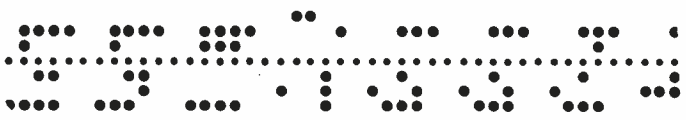


Fig. 2. Section of 8-hole punched tape. Two rows on the wider side of the central sprocket holes are not used in this data.

The holes in cards are produced by mechanical punches. These comprise a punching head by which the appropriate holes are made for each character in response to a typewriter keyboard-input. Keyboard layouts are based on the familiar office typewriter. Extra keys are added for computer applications to enable a greater range of control by the operator. Such additions vary widely.

Tape can be punched automatically whilst the teleprinter type of terminal, such as shown in Fig.3, is used as a typewriter. Where the tape is generated as part of an automatic process — as in a data logger, a smaller punch unit is used which incorporates punch drivers activated by control signals — no keyboard is needed. Such a unit is illustrated in Fig.4.

Card and tape readers consist of a transport mechanism that passes the medium across reading heads. Recognition of a code represented by holes is accomplished by mechanical fingers making direct electrical contact (in the slower readers) or by solid-state optical sensing using LED lamps and photo-diode arrays set to sense the passage of light through a hole position. Some method of synchronising the code position with the data values is essential.

Cards can be punched by an operator at rates between 250-500 per hour. They are often checked on a verifier machine that determines if the card is punched in the same way as the check operator keys the code a second time. They can, by contrast, be machine read or sorted, at 200-1000 cards per minute depending upon the complexity of the task.

Tape punching is confined to similarly slow rates of production at the operator stage of preparation. When the punch is

Fig. 3. Keyboard teletype terminals provide hard copy and perforate a paper tape (seen lower left) at the same time. The same facility usually can also print hard copy from a ready made tape.

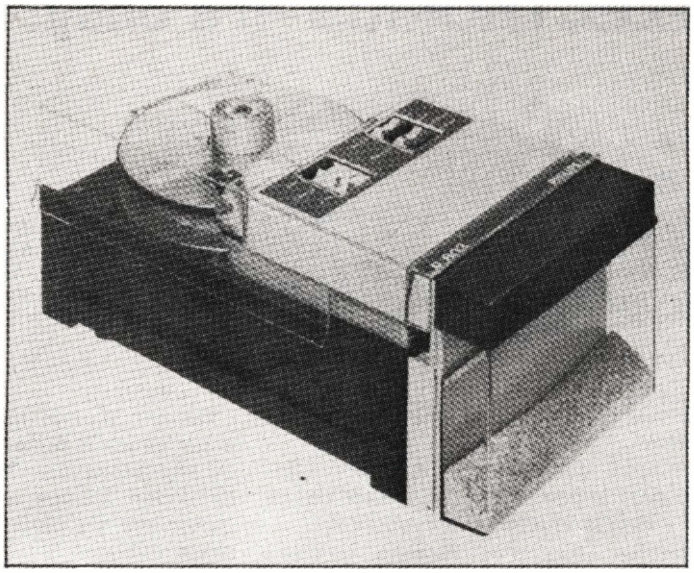


Fig. 4. This Philips P803 unit punches tape at 75 c.p.s.

machine operated, punching rates can rise to 150 characters per second. The speed at which punched tapes can be read varies from very slow, using mechanical sensing up to 600 characters per second or more with high-performance optical equipment.

A considerable amount of electronic logic and drive circuitry is needed to operate a punch unit. Figure 5 is the block diagram of a reader using brushes to sense the presence of holes. Input commands to the punch would emanate from the control unit of the EDP system.

Magnetic Tape Input/Output Units — Cards and paper tape store information about commands to the EDP system (the programme) and hold the numerical data to be manipulated. They are, therefore, a form of permanent data storage. They suffice (in the form described above) as a data store when the data quantity is not great. A recent trend, which has speeded up data transfer and reduced the bulk needed to store the programme and data, makes use of magnetic tape in cassette form. The compact unit shown in Fig.6 can transfer data at 6000 bits per second at a density of 30 bits per millimetre of tape. (Total capacity on a cassette — five million bits). These can also be used as additional memory in the system.

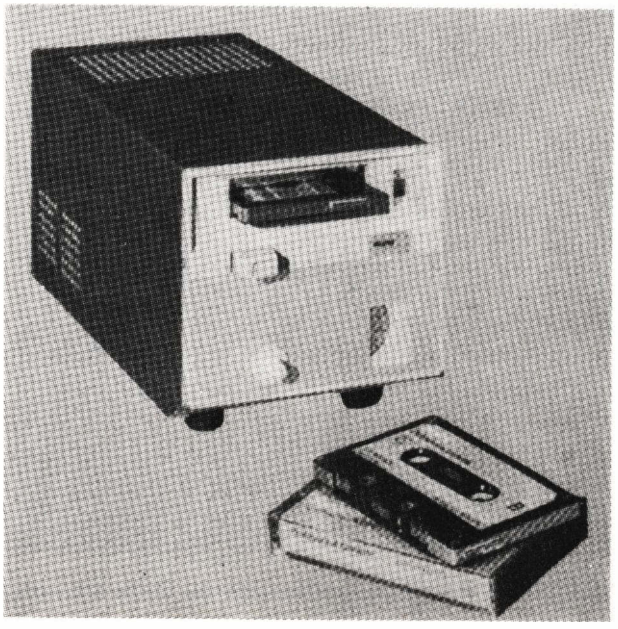
Printers — Teletype units are able to provide hard copy printout but due to the slow printout resulting from letter by letter operation they are not used as the main alpha-numeric output of an extensive EDP system. They can printout at only 10 characters per second or so.

The line printer was evolved to speed up this form of output. It prints all the characters of a complete line simultaneously. Line lengths are typically 132 characters and the faster models can print lines at rates exceeding 1000 lines per minute. (For which an outlay of $50,000 is required!)

Printing mechanism vary considerably, ranging from development of the fundamental typewriter method, to devices that print each character from a 5 x 7 matrix of dots. Line printers were originally bulky units. Today desktop, typewriter size units, are in common use (Fig.7).

Printers can be programmed via the EDP system to provide any format required — periodic reports, invoices, records, data lists, software record. A crude form of graphical display can also be produced using the position in a line

Fig. 6. Cassette form of magnetic tape is finding greater application as a standard EDP and computing caculator peripheral.



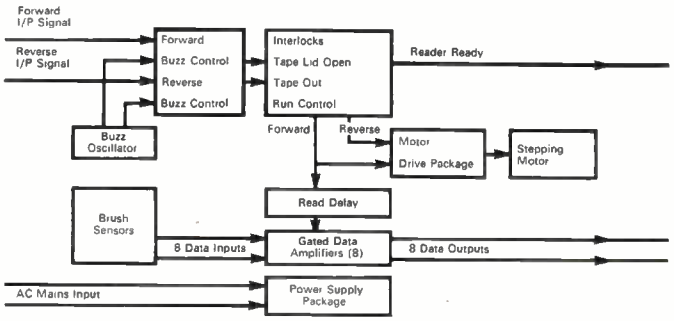


Fig. 5. Block diagram of early model Data Dynamics low-speed tape reader (30 c.p.s.).

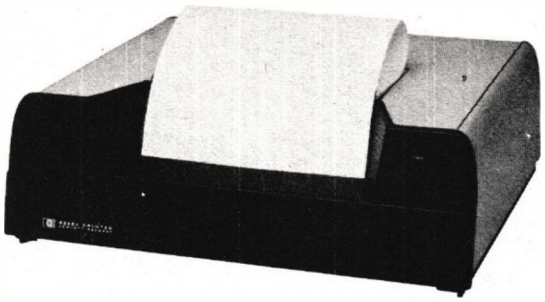


Fig. 7. This Hewlett Packard 2607A desk-top line printer provides hard copy output (with 6 copies) at 200 lines per minute.

as one ordinate and the lines as the other.

When computers are used for automatic pagination the printer can be one that produced print-type direct.

Graphic Display – Plotters – Many computational tasks ideally require a graphical display of output information not a long list of numbers. Plotters may be of x-y type or y-t type.

The x-y type of plotter is arranged so that the graph paper is held stationary and the pen is capable of being driven both vertically (y axis) and horizontally (x axis).

The y-t plotter has a roll of graph paper which is driven at a constant (and usually adjustable– speed; the pen can be driven in one axis only (y axis). Hence the y-t plotter basically plots a single variable against time. Plotters made particularly for computer operation will be provided with the interface facility that enables direct connection to the EDP system. (Normal plotters require an extensive amount of extra equipment to make them compatible).

Computer controlled plotting of x-y format has the ability to be scaled on demand and to generate alpha-numeric legends on the plot. It is an easy matter to replicate the plot – the programme is run again.

Plotters may be of the analogue drive kind (a later part discusses plotters in detail) but due to the nature of digital processing the result may still have a quantized appearance if the resolution is not sufficiently small. Alternatively the axes may be driven with stepping motors – such machines are called incremental plotters.

Flat-bed style of x-y plotters are available which can handle paper of all sizes – from a few centimetres square to size of a wall. A medium-size computer controlled flat-bed plotter is shown in Fig.8.

Line drawing rates are limited by inherent electro-mechanical response to around 0.4 m/s in small plotters. The very large machines, when under tight control, are usually capable of around 0.1 m/s translation rates when working to precisions of 25 μm. A desk top x-y plotter is shown in Fig.9.

Some y-t plotters incorporate bi-directional drive for the t axis (the paper drive) enabling very long lengths of paper to be driven back and forth along the roll in order to produce an x-y form of plot from a y-t format machine.

Graphic Display – Visual Monitors – Many applications require rapid call-up of data that is presented in a way that can be easily read by the operator. It may be quite unimportant to receive it as hardcopy. The cathode ray tube (television) type of display was an obvious choice. Such displays are known as visual display units, VDU for short.

Originally, visual display units were very limited because of the need for a

Fig. 8. Series 500 automatic drafting system by Gerber Scientific.

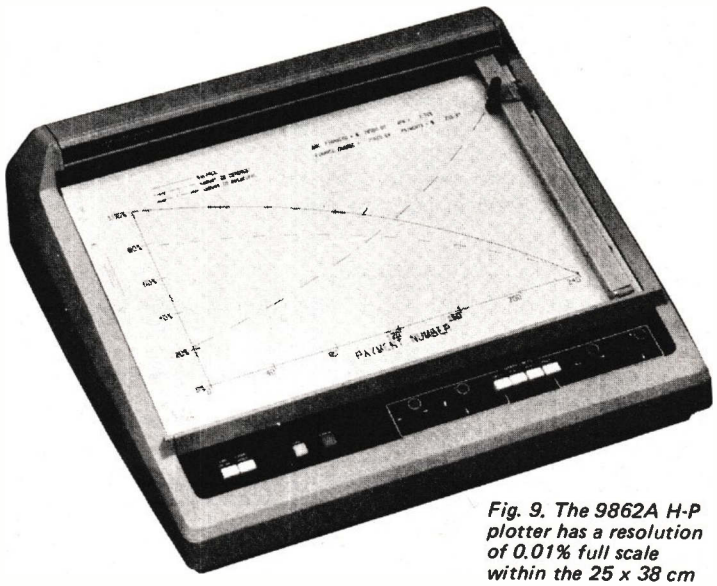


Fig. 9. The 9862A H-P plotter has a resolution of 0.01% full scale within the 25 x 38 cm area. It will plot vectors at 30 cm per second.

considerable amount of storage with which to generate written and graphical display forms. However solid-state mass data storage is now relatively inexpensive and VDUs in one form or another are now standard peripherals.

The simplest use of VDUs is to display alpha-numeric information — a section of the software programme, a readout of process plant variables, airline arrivals and departures. This is achieved using digital control and data storage to cause the beam of the CRT to deflect, blanking appropriately, to form the appearance of a static written page.

When the operator becomes involved with the data on the screen and is given the ability to manipulate it toward a desired task the terminal is said to be an interactive graphic terminal. An early example of this is given in Fig.10 which depicts a system whereby air traffic controllers are trained using display terminals.

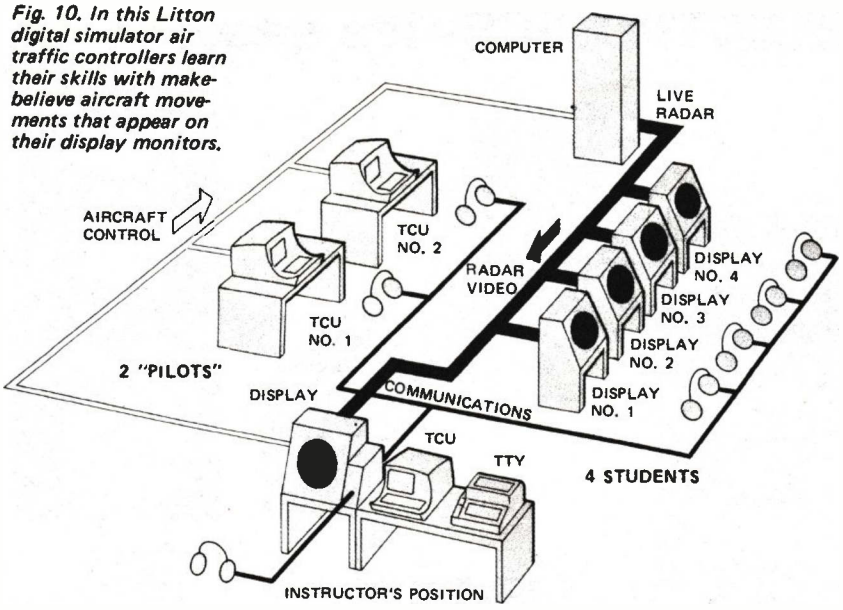
Once it had been realised how the VDU could be used to produce line drawings designers sought ways to 'draw' on the screen. The result was the 'light-pen'. The operator holds a special stylus on the screen of the CRT. Closed loop controls cause the spot to lock onto movements of the stylus. If the trace path is to be retained, the x, y and intensity coordinates values are fed into the digital memory. Once a line is drawn it can be retained and regenerated in this way. Other operations enable the operator to automatically erase sections of line, straighten lines and smooth curves by computer processing. The complete drawing can then be permanently recorded as hard copy on a plotter or as a data set. Interactive methods have saved an enormous amount of time in tasks such as deciding the extremes of a motor-car wheel movement during the many combinations of springing and steering positions within the wheel arch.

Today's graphic terminals are extremely versatile. Completely self-contained units which incorporate a built-in processor are in common use. A recent release is shown in Fig.11.

Improvements in the storage-tubes used to hold the displays of a CRT system have been coupled with the power of modern computing to provide display terminals that have half-tone photographic quality presentation. Figure 12 shows the quality (after our recopying) obtainable. The images shown are entirely reconstructed on the VDU from digital, not analogue data. Colour displays are also coming into use adding yet more dimensions to the interaction available to the operator.

A recent project of the Australian National University gives some idea of the use of the interactive VDU. In the Department of Engineering Physics a team of research workers have developed a colour display terminal that can call-up the data recorded by the ERTS satellite. The computing system has in its memory file copies of the original ERTS data. Using the graphic terminal the operator can select which form of photograph — IR, false colour, etc., to study. He can then rapidly zoom into a particular area using a joystick control expanding the spatial scale as the search becomes concentrated. Other control includes enabling the colours to be digitized into level zones and to be complimented..

Fig. 10. In this Litton digital simulator air traffic controllers learn their skills with make-believe aircraft movements that appear on their display monitors.



Instrumentation Interfaces — When the digital computer has to manipulate measurement and control data from analogue processes, the system must be provided with the appropriate A to D and D to A converters, and the multiplexing arrangement which forms the data logger These interface peripherals were mentioned in the 29th part of this series.

MODEMS and other links — When computer data has to be transmitted over considerable distances it becomes expedient to use telephone lines or

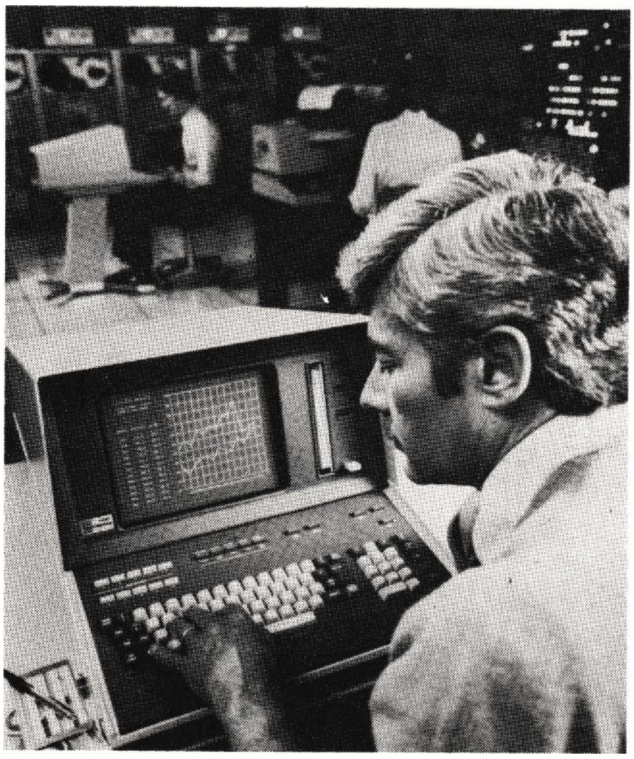


Fig. 11. Interactive graphic units often now incorporate their own processing and memory to form an off-line self-contained unit — 4051 Tektronix BASIC graphic computing system.

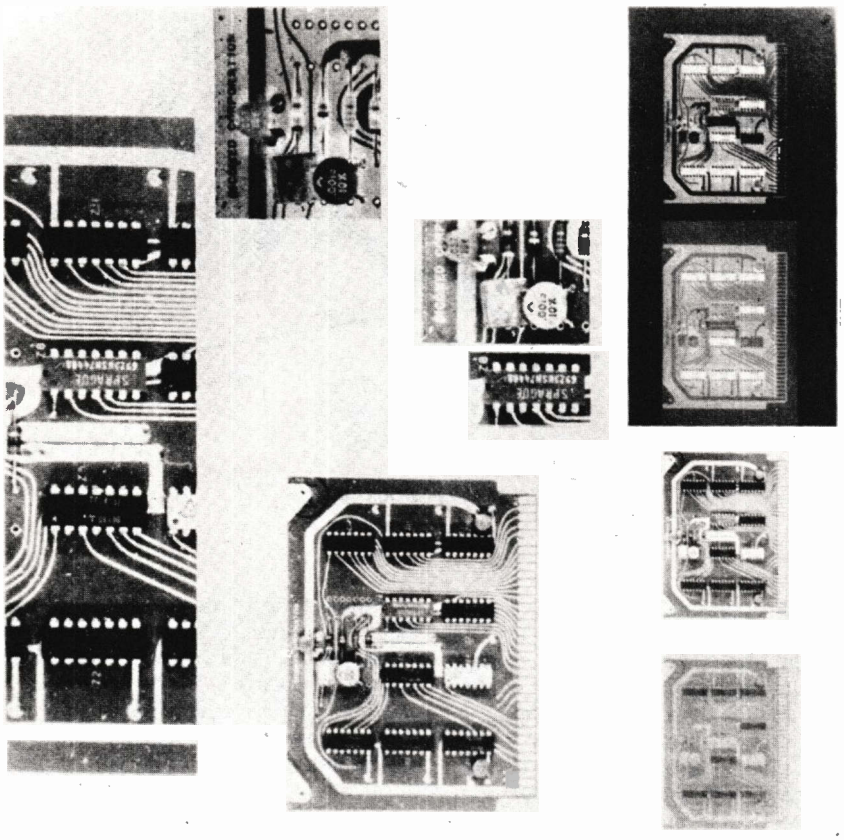
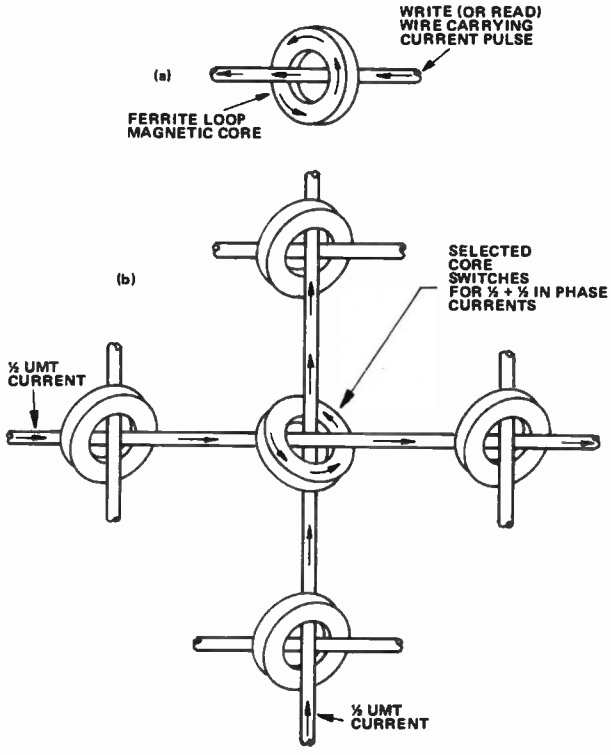


Fig. 12. This multiple image presentation is photographed from the screen of DICOMED digital image display unit.

Fig. 13. *(a) When a large enough write current passes in one direction through the ferrite core the core becomes magnetised in one polarity. It thus records a bit.*
(b) A second wire is added to act as an inhibitor or enhance line.
(c) Finishing touches being added to a Philips 3-D core store. (20 planes of 64 x 64 cores, one X wire, one Y wire, read and inhibit wires).



microwave links. Units interfacing computers over telephone lines have become known as MODEMS (a word built by combining Modulator and Demodulator). Links are dealt with in Part 32 – in which signals and transmission are covered.

Miscellaneous Peripherals – New methods for communicating with the power of an EDP system continue to be devised in an endeavour to overcome the interface difficulty humans have with electronic machines. We are still a long way from the stage where we need only casually to talk to the machine. Steps are, however, in progress toward this aim with research into spoken word and written word recognition. Neural research into brain waves may one day be coupled with electronic hardware to provide direct thought-links.

Special cases demand special solutions. Work at Warwick University in England has resulted in computer controlled production of braille maps for the blind. Automatic mapping and language translation are other areas where positive progress is being made into very complex human communication processes.

STORAGE

Inside a CPU and external to it will be found a memory of some kind. This is used to store the vast quantities of coded data needed to perform the various tasks.

Memory within the CPU is characterised by the need for high speed access to any data bit needed. The requirement on capacity is less stringent. Memory external to the CPU will, by

the necessity of machine organisation, be a little slower to access but it will usually need much greater storage capacity.

CPU Memory — Core — storage is needed in the CPU to hold important programme instructions and to act as a temporary home for data generated in the course of a manipulation.

There are many options open to the designer but the storage method that has emerged as the optimum for CPU storage is magnetic core storage — known simply as the core store. (This situation will, however, soon change, the preference going to solid-state methods). Magnetic core storage makes use of the fact that magnetically hard materials, such as ferrite, will swing remanent magnetism polarity from one state to the other with the passage of a quite widely toleranced current through a wire passed through the core — see Fig.13a. To make a practical core store it is necessary that any chosen core can be switched on demand. If a second wire is passed through the loop this can be used to prevent or enhance the magnetic switching action by the passage of the current.

A core store comprises a plane of ferrites arranged in a grid as shown in Fig. 13b. Two half-current units appearing in the same direction in a core will switch that core but no other. Thus two lines will select a unique core in the plane as the place to store or readout one bit.

To read out the values it is necessary to interrogate the selected core using input signals in the write wires that will, if switching takes place, induce currents in an additional readout wire. As this process can destroy the data on the core a test means may be provided to rewrite it again ready for reuse. Figure 13c shows a stacked core-plane. Ferrite cores are typically 0.1 mm overall. Planes are either stacked one on the other or mounted flat on a printed circuit board to provide a memory unit. The capacity of core storage varies from thousands to millions of bits. Core-store is more usually quoted in word capacity, words being of 32-60 bit length. The terminology is to refer to capacity as, for example, 32 k of 16 bit words. (This is often incorrectly written as 32 K — the lower case k should always be used as this is the *only* correct abbreviation for '1000'). Core storage can be cycled in 100 ns (typically) with some systems taking only 10 ns. The disadvantages of core are the relatively high cost resulting from the labour intensive production method and the comparatively large space needed.

Delay Lines — Another reasonably fast storage system makes use of the delay-line concept. It is the property of materials, such as mercury, to pass only waves of acoustic energy at a given rate of propagation. Early computers used mercury delay lines in which the acoustic equivalent of a binary word was sent down a tube of mercury to emerge at a later time at the other end. Whilst in transit the word was in storage. The method (if used at all in a computer today) would now be implemented using solid wires or clocked-on registers. It has the severe shortcoming of low storage capacity.

Solid-state — Although core storage still forms part of many computer installations the current trend is clearly toward the use of a solid-state circuitry which stores bits in register style flip-flop systems. Read only memories (ROM), content addressable memories (CAM), random access memories (RAM), and Programmable ROM devices (PROM) are available as IC chips with typical arrays downward from 512 eight bit words — that is 4096 bits on a single IC chip. Figure 14 shows just one of a huge range of alternatives — 1024-bit read-only memory. Memories such as this exhibit a typical delay from address to output of 36 ns. Chips such as these are also available ready mounted as memory cards with as much as 65 536, 16-bit word capacity.

Peripheral Memory — The storage media listed above gives high-speed rapid access but all are expensive. Many others and cheaper forms of storage can be used if short access time requirements are relaxed.

Magnetic Tape — This is basically the same as reel-to-reel domestic tape recording, magnetic tape storage used in computing however records digital rather than analogue data on the magnetic coating of the tape. Reels are generally 10.5 inch in diameter with multiple track use. They are run at much greater speeds than domestic units. They can store around 30 bits per millimetre and maybe run as fast as 25 metres/second. Speeds used are not standardised to any degree. Each track on the tape can only be accessed serially: to obtain a specific data word may involve the whole tape being run through with subsequently long access time. Figure 15 shows a typical reel-to-reel unit.

Magnetic Disks — These are thin disks coated with magnetic recording material. Their advantage is that they can be accessed at any point on the surface by moving the read in read out head to the appropriate part of the disk, as the disk rotates, (at speeds of 3000) r.p.m.). In an alternative procedure the reading is done by a fixed head for each

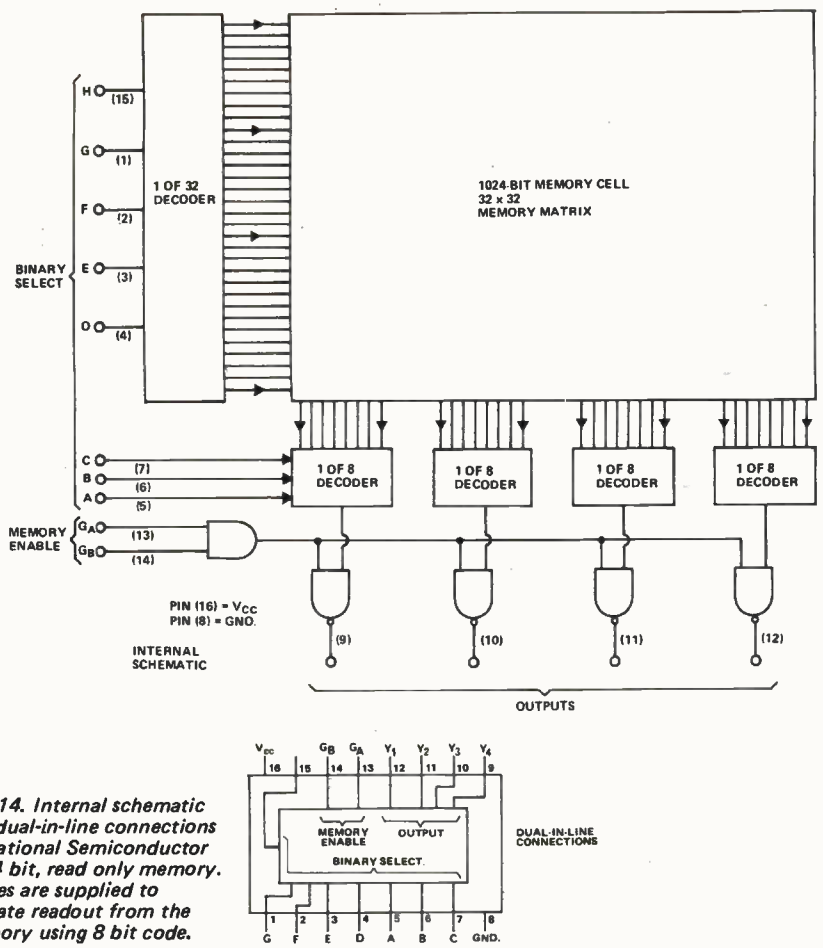


Fig. 14. Internal schematic and dual-in-line connections of National Semiconductor 1024 bit, read only memory. 8 lines are supplied to operate readout from the memory using 8 bit code.

Fig. 15. The Hewlett-Packard 7970 magnetic tape unit designed as a peripheral to EDP systems.

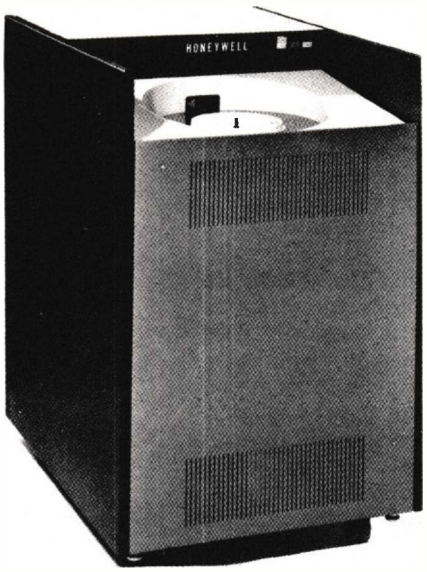


Fig. 16. Honeywell model 4720 moving-head disk storage device.

track. Each track may store 36 000 bits. The moving head disk storage unit shown in Fig.16 can store up to 7.5 million words.

Even greater storage is obtained by permanently stacking as many as 72 disks on top of each other on a common drive spindle. Each surface has its own head giving access to any part of any surface. Such a unit could store 600 million words. Access time is, however, limited by mechanical response times — typically 100-300 ms. Small interchangeable disk stacks are also used. These are known as disk packs. Floppy disks are a variation of the disk memory.

Magnetic Drums — Where better access times than disks are needed, but not at the cost of magnetic core, the magnetic drum may be suitable. A large drum (0.3-0.6 m in diameter) coated with magnetic material rotates continuously at high speed. Reading heads are stacked up the drum. Access time with these is as low as 5 ms. Storage is upward of 2000 million characters.

Other magnetic arrangements include short strips of tape that are individually selected to be drawn through a reading head, and magnetic cards which are held in magazines ready for automatic sorting in a special console. Card systems are not as slow as might be thought — any one of, say, 500 million characters can be accessed in 100 ms by a suitable design arrangement.

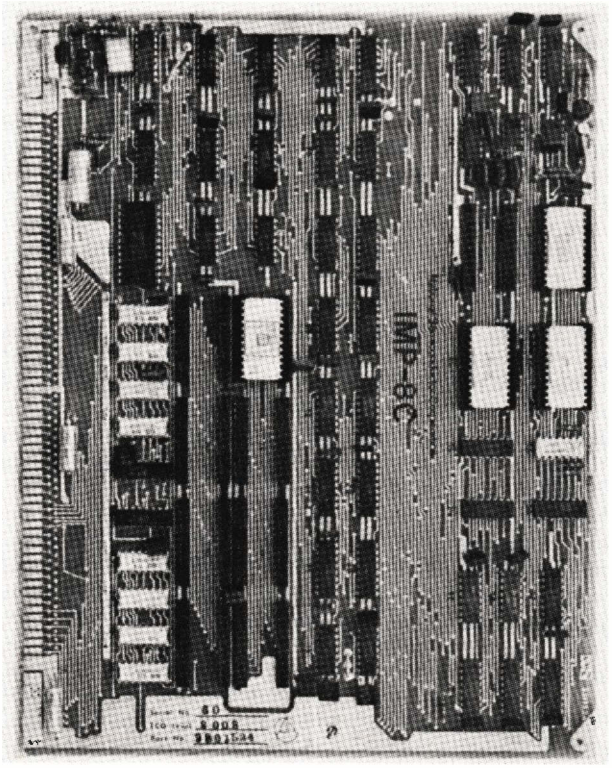


Fig. 17. This National Semiconductor IMP-8C general purpose processor uses MOS/LSI devices.

MICROPROCESSORS

We saw in the previous part that computers are based upon the availability of a CPU, stores, input/output units and other peripherals. Integrated circuit manufacturing methods become economical only when very large volume sales result and it was to the computing systems market that the IC makers looked around 1970. The main problem, however, was the need to devise a basic general-purpose integrated-circuit that would satisfy a large enough group of users.

At first the trend was to manufacture special-purpose computing systems that were hardwired (connections made permanently) to cause the system to perform a stated computing function — such as a pocket calculator for commercial or scientific computation.

The trend then moved toward another philosophy — the microprocessor. These single card integrated-circuit systems (one is illustrated in Fig.17) possess the ability to be programmed to perform the task needed by the customer. Although the overall system is usually more complex than hardwired specials, the much greater increase in demand has reduced the price to quite unbelievable levels — a few hundred dollars buys a complete basic micro-processor system

ABA	Add Accumulators	INS	Increment Stack Pointer
ADC	Add with Carry	INX	Increment Index Register
ADD	Add		
AND	Logical And	JMP	Jump
ASL	Arithmetic Shift Left	JSR	Jump to Subroutine
ASR	Arithmetic Shift Right		
		LDA	Load Accumulator
BCC	Branch if Carry Clear	LDS	Load Stack Pointer
BCS	Branch if Carry Set		
		LDX	Load Index Register
BEQ	Branch if Equal to Zero	LSR	Logical Shift Right
BGE	Branch if Greater or Equal Zero		
BGT	Branch if Greater than Zero	NEG	Negate
BHI	Branch if Higher	NOP	No Operation
BIT	Bit Test		
BLE	Branch if Less or Equal	ORA	Inclusive OR Accumulator
BLS	Branch if Lower or Same		
BLT	Branch if Less than Zero	PSH	Push Data
BMI	Branch if Minus	PUL	Pull Data
BNE	Branch if Not Equal to Zero		
BPL	Branch if Plus	ROL	Rotate Left
BRA	Branch Always	ROR	Rotate Right
BSR	Branch to Subroutine	RTI	Return from Interrupt
BVC	Branch if Overflow Clear	RTS	Return from Subroutine
BVS	Branch if Overflow Set	SBA	Subtract Accumulators
CBA	Compare Accumulators	SBC	Subtract with Carry
CLC	Clear Carry	SEC	Set Carry
CLI	Clear Interrupt Mask	SEI	Set Interrupt Mask
CLR	Clear	SEV	Set Overflow
CLV	Clear Overflow	STA	Store Accumulator
CMP	Compare Index Register		
		STS	Store Stack Register
COM	Complement	STX	Store Index Register
CPX	Compare Index Register	SUB	Subtract
		SWI	Software Interrupt
DAA	Decimal Adjust		
DEC	Decrement	TAB	Transfer Accumulators
DES	Decrement Stack Pointer	TAP	Transfer Accumulators to Condition Code Reg.
DEX	Decrement Index Register	TBA	Transfer Accumulators
		TPA	Transfer Condition Code Reg. to Accumulator
EOR	Exclusive OR	TST	Test
		TSX	Transfer Stack Pointer to Index Register
INC	Increment	TXS	Transfer Index Register to Stack Pointer
		WAI	Wait for Interrupt

Fig. 18. Typical microprocessor instruction set.

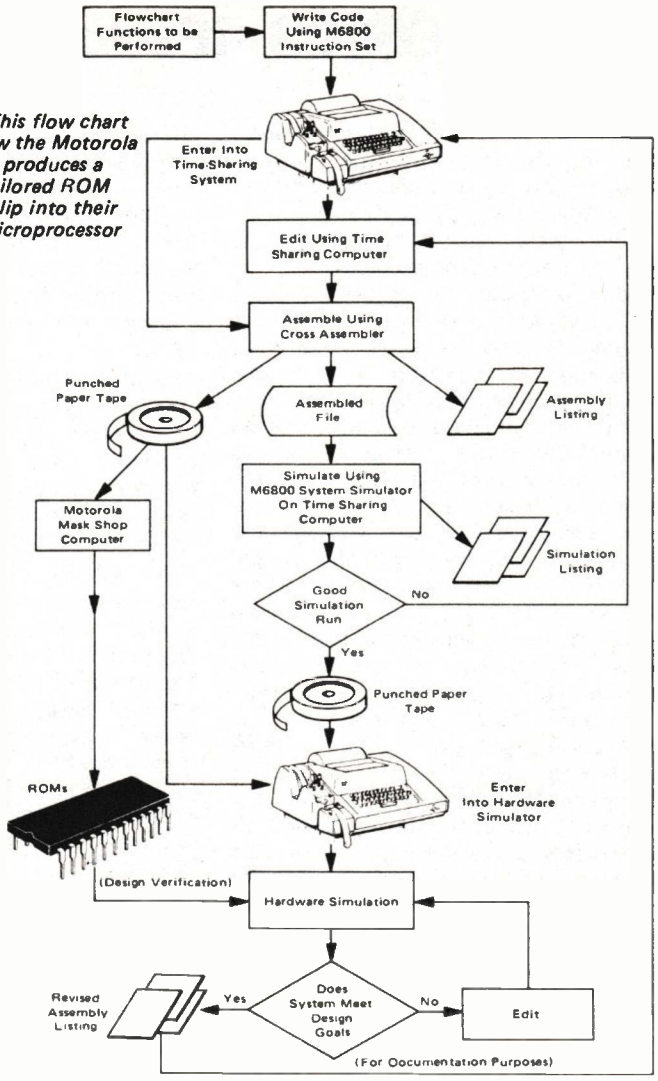


Fig. 19. This flow chart shows how the Motorola Company produces a custom-tailored ROM ready to slip into their M6800 microprocessor system.

with as much power as the minis of a decade ago. Predictions, at present, are that they could fall further to a mere $50.

To make a programme microprocessor system, the user has to write a software programme at a basic machine-language level. Each microprocessor has its own instruction set built in – this tells the system what to do with data. It is written in mnemonic code using code letters to denote operations – such a list is given in Fig.18.

The programme, thus written in mnemonic code, is further translated into the circuit binary form (object code) with an assembler. The object form of code is then ready to be fed into the Random Access Memory (RAM) or Read Only Memory (ROM) of the microprocessor system. Figure 19 shows a system design and verification

procedure used to produce custom made ROMs. The peripherals are then interfaced to the unit and the complete computing system is ready to go.

The process may sound easy, but as can be imagined considerable skill is needed to set up a microprocessor. Such skill demands extensive customer training material — large handbooks, application and hardware — see Fig.20. In fact the stage has been reached where makers will soon have to face a situation where descriptive literature is as expensive or more expensive than the hardware itself. To this end they continually strive to reduce the complexity and to standardise design. We should soon be in the position where microprocessors are sold as standard tools which are each used in exactly the same way to service the enormous number of custom jobs available. Literature may degenerate to a short-form pamphlet. The actual computing part of an Everyman's Complete Microprocessor System is a very small part of the whole. Peripherals and software are now the major cost consideration. It is not feasible to describe microprocessors more fully in this series, however a short series of articles devoted specifically to microprocessors will be published in ETI soon.

Further reading — References listed in the previous part provide descriptions and illustrations of computer peripherals and storage methods. "Computers at Work" by J.O.E. Clark, Bantam Book, is a worthwhile discussion on how and where computer interface are used for all manner of needs.

Infotech International of Maidenhead, UK, have recently released 12 000 pages of state-of-the-art reports on computer operation and trends. They are, however, much too expensive for the reader to procure. The sets costs over $2000 on an individual basis!

The subject of microprocessors has recently been discussed in depth in several electronics publications — Practical Electronics, Wireless World and Electronics Today International (UK edition) have each run introductory series. "Development and Trends of the Microprocessor" by J. Tobias, Control Systems (Sydney), 3, 17-31, 1975 is an extensive study and it includes a summary chart of dozens of systems offered.

"Microprocessors — an Introduction" by F. Horne, NS Application Note AN114, 1974, is a basic statement.

"Microprocessors — Why They Evolved and What They Are" by M. Levi, N.S. Imp Brief 1, 1974, is also useful as a starting point.

"New Blocks for the Computer Builder" by D. Aspinall, New Scientist, 18 September, 1975 gives a basic survey including some facts about production.

An extensive self-contained introduction is "Introduction to Microprocessors", H. Tireford, Motorola Semiconductor Products, 1975.

Manufacturers of microprocessors will freely supply descriptive data to aid the user of their own style of unit.

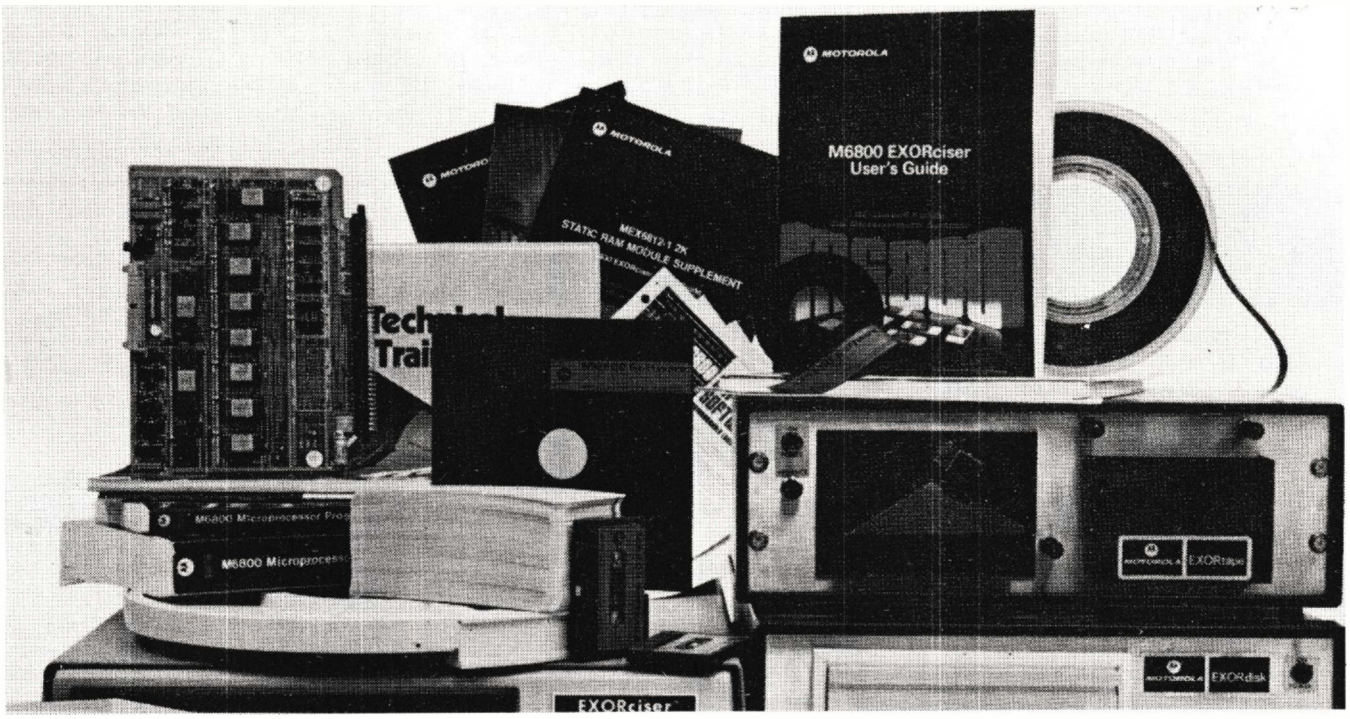


Fig. 20. Array of support products for Motorola M6800 microprocessor systems.

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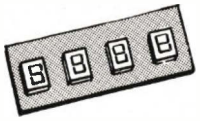
- Frequency Counter . . . . . Kit 012 + Kit 030 + Kit 016 + Kit 014 or 031
- RPM Counter . . . . . Kit 012 + Kit 030 + Kit 020 + Kit 032



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- Input voltage: 25V max.
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(Needs 8-20 volt transformer.)

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KIT 017 DIGITAL VOLTMETER

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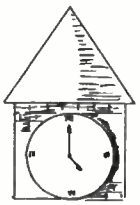
Kit 016 . . . . . $16.50

KIT 020 RPM COUNTER

RPM Counter. Counts from 1 to 100,000 RPM.

Kit 020 . . . . . $ 8.95

KIT 014 1MHZ CRYSTAL TIME BASE



1 MHz crystal chain time base divider. Output: 1 MHz, 100 KHz, 1 KHz, 100 Hz, 10 Hz, 1 Hz, 0.1 Hz. Accuracy better than .005%.

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* *

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Kit No. 70250-2R (DL727 readouts) ... $27.50
Kit No. 70250-3R (DL747 readouts) $29.50

Kits contain all components, PCB's, switches, alarm speaker and instructions. (Does not include 12-15 volt transformer and case).

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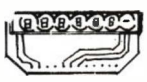

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FND70
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Common Cathode type by Fairchild
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5 for $7.50

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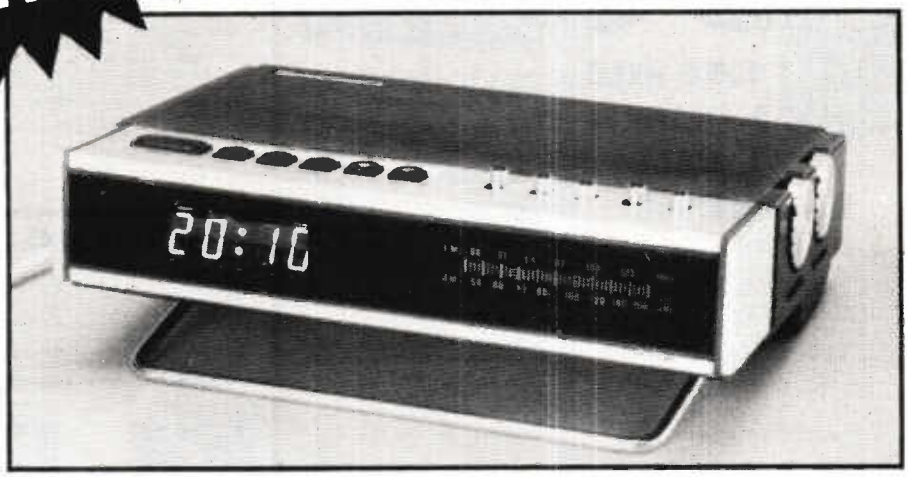

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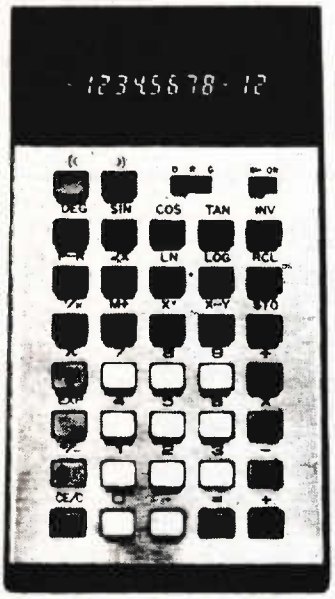
Decimal Degree ⟷ Degree, Minute, Second



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  - •decimal degree ↔ degree, minute, second conversions
  - •sin, cos, tan, $\sin^{-1}$, $\cos^{-1}$, $\tan^{-1}$, 10^x, e^x, ln, log, x^y, $1/x$, $\sqrt{x}$, and x^2
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2) Add $2.00 for packaging & delivery

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LC-10D		40.00	12	*Green display *Square root, & reciprocal *x to y power
LC-1233s	33.00	44.00	12	*Large green display - 8 digit mantissa and 2 digit exponent memory *Two levels of parenthesis *Trig functions: *Logarithmic functions: *Factorial functions: x! e^x, a^x *Square root & reciprocal
LC-831s	22.00	33.00	12	*Green 8-digit display *Fully floating decimal point *One memory *Trigonometric functions: *Logarithmic functions: Power functions: e^x, x
LC-20F	22.00	31.00	12	*Display: green, signed 8-digit floating point of signed 5-digit mantissa with signed 2-digit exponent *Scientific functions: sin, cos, tan, $\sin^{-1}$, $\cos^{-1}$, $\tan^{-1}$, e^x, 10^x, ln log, x^y $1/x$, $\sqrt{x}$, and x^2 *One independent memory *Two levels of parenthesis.
LC-21F	12.00	21.00	3	*Large green 8-digit display *Chain operation *Memory *Square root *Constant operation *Fully floating decimal point *Percentage calculation
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MANUFACTURER	NUMBER OF MONITORS USED IN U.S. STUDIOS
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JBL	339
EV	82
KLH	39
AR	34
Tannoy	24

But we're not really satisfied — even with this impressive track record. We're still trying to better ourselves. In fact, Altec has three all-new studio monitors available right now. They're a whole new generation of speakers designed to meet the whole new range of tomorrow's dynamic recording techniques. Your studio may need them. Why not call us for full details.

Altec gives you the best of both worlds proven leadership, plus an unrelenting commitment to doing a better job. That's because we've really grown to enjoy being # 1 in studio monitor sales during the past three decades. And we intend to stay right there for at least the next three decades by always being our own biggest competitor — in research, in quality, in service and in satisfying the demanding needs of an ever-evolving industry. The domestic ALTEC recently introduced into Australia has already gained rapid response from the discerning Hi-Fi enthusiasts.

Domestic from

$320

pair

Number one. And have been for nearly 3 decades.

Limited numbers of 604E professional monitors available at $285 each.

ALTEC

the sound of experience

KENT HI-FI

(WHERE THE BEST EQUIPMENT COSTS LESS)

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SYDNEY
ph: 29-2743

Ideas for experimenters

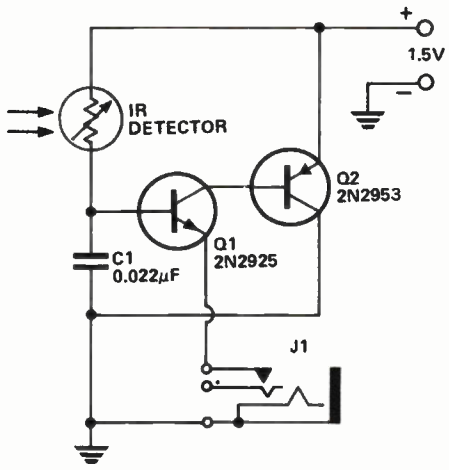
These pages are intended primarily as a source of ideas. As far as reasonably possible all material has been checked for feasibility, component availability etc, but the circuits have not necessarily been built and tested in our laboratory. Because of the nature of the information in this section we cannot enter into any correspondence about any of the circuits, nor can we produce 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.

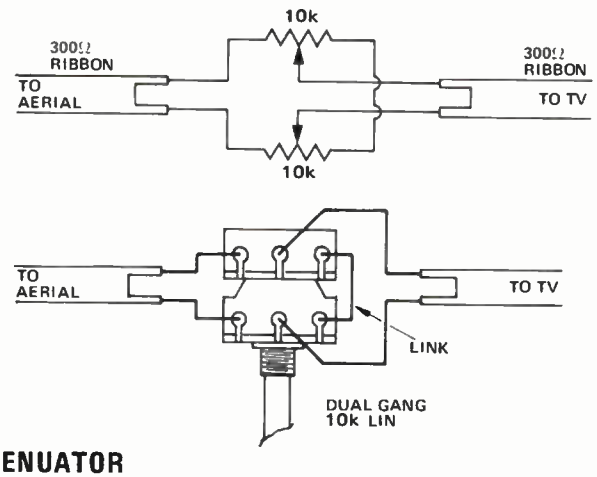
IR FINDER

The heart of the infra-red finder is a two-transistor oscillator whose output frequency is varied by a thermistor. IR rays falling on the thermistor alter its resistance and the output frequency.

Normally a low pitched sound will be heard. However, when the IR finder is pointed towards a heat source, the pitch increases. An ordinary flash-light was used for the housing and its reflector was used to focus the radiation onto the thermistor, thereby increasing the sensitivity of the unit.

The prototype IR finder responded to the heat of an ordinary candle 50 feet away. It may be used to locate miscellaneous warm objects such as water pipes and the electronics handyman can use it to locate overheated components.

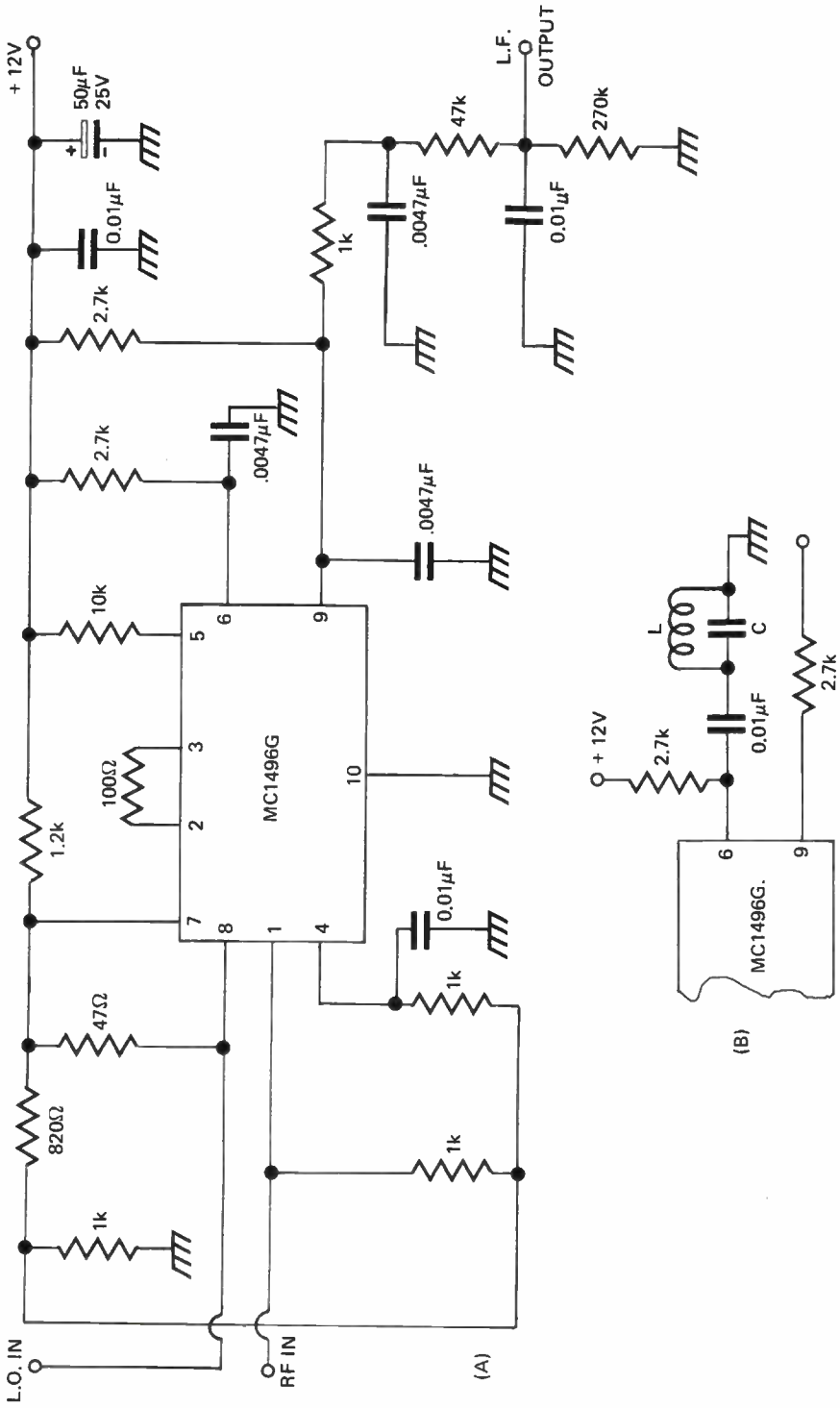




TV SIGNAL ATTENUATOR

A useful circuit for anybody doing TV repairs is an aerial attenuator to check AGC and sync. It will also simulate low level signals if the repair shop has a strong signal but the customer uses rabbit ears or lives in a poor signal area. Mismatch has never been found a problem.

Ideas for experimenters



IC BALANCED MIXER

Motorola put out a very good balanced mixer, type MC1446G, which makes an excellent RF to IF mixer and a product detector. The product detector circuit is shown in (a) above. About 3 to 5 μV input is required at the LO input. The input impedance is fairly low, as is the output impedance.

Only the output circuit needs to be changed (shown in (b)) to use the IC on IF frequencies.

PACKAGE OF TEN — DEDUCT 15%

PACKAGE OF ONE HUNDRED — DEDUCT 25%

TTL

7400	.16	7451	.20	74153	1.14
7401	.18	7453	.20	74154	1.29
7402	.17	7454	.20	74155	1.23
7403	.18	7460	.20	74156	1.23
7404	.22	7464	.40	74157	1.14
7405	.22	7465	.40	74158	2.06
7406	.40	7470	.35	74160	1.60
7407	.40	7472	.35	74161	1.44
7408	.21	7473	.40	74162	1.71
7409	.22	7474	.40	74163	1.60
7410	.18	7475	.66	74164	1.83
7411	.29	7476	.45	74165	1.83
7413	.63	7483	.91	74166	1.71
7414	.81	7485	1.27	74170	2.65
7416	.40	7486	.46	74173	1.71
7417	.40	7489	2.48	74174	1.86
7420	.18	7490	.59	74175	1.60
7422	.30	7491	1.12	74176	1.02
7423	.33	7492	.82	74171	.97
7425	.31	7493	.69	74180	1.04
7426	.30	7494	1.08	74181	3.43
7427	.33	7495	.91	74182	.91
7430	.23	7496	.91	74184	2.29
7432	.26	74100	1.50	74185	2.29
7437	.40	74105	.51	74187	4.50
7438	.40	74107	.46	74190	1.35
7440	.20	74121	.48	74191	1.35
7441	1.13	74122	.52	74192	1.25
7442	.89	74123	.69	74193	1.19
7443	1.00	74125	.62	74194	1.25
7444	1.00	74126	.72	74195	1.02
7445	1.02	74132	1.02	74916	1.44
7446	1.07	74141	1.20	74197	1.02
7447	1.02	74145	1.20	74198	2.06
7448	1.20	74150	1.12	74199	2.06
7450	.20	74151	.91	74200	5.90
				74279	1.08

LOW POWER

74L00	.29	74L51	.33	74L90	1.71
74L02	.29	74L55	.38	74L91	1.67
74L03	.29	74L71	.29	74L93	1.94
74L04	.29	74L72	.45	74L95	1.94
74L06	.29	74L73	.56	74L98	3.21
74L10	.29	74L74	.56	74L164	3.21
74L20	.38	74L78	.91	74L165	3.21
74L30	.38	74L85	1.44		
74L42	1.71	74L86	.79		

LOW POWER SCHOTTKY

74LS00	.36	74LS32	.38	74LS95	2.09
74LS02	.36	74LS40	.45	74LS107	.59
74LS04	.36	74LS42	1.40	74LS164	2.20
74LS08	.38	74LS74	.59	74LS193	2.20
74LS10	.36	74LS90	1.30	74LS197	2.20
74LS20	.36	74LS93	1.30		

HIGH SPEED

74H00	.25	74H22	.25	74H61	.25
74H01	.25	74H30	.25	74H62	.25
74H04	.25	74H40	.25	74H74	.39
74H08	.25	74H50	.25	74H101	.39
74H10	.25	74H52	.25	74H102	.49
74H11	.25	74H53	.25	74H103	.58
74H20	.25	74H55	.25	74H106	.58
74H21	.25	74H60	.25	74H108	.60

SCHOTTKY

74S00	.38	74S08	.52	74S22	.38
74S02	.45	74S10	.38	74S32	.52
74S03	.38	74S20	.38	74S74	.38
74S04	.45				

8000 (NATIONAL)

8091	.61	8220	1.49	8811	.65
8092	.61	8230	2.19	8812	1.02
8095	1.25	8288	1.49	8822	2.19
8121	.80	8520	1.16	8830	2.19
8123	1.43	8552	2.19	8831	2.19
8130	1.97	8563	.62	8836	.29
8200	2.33	8810	.70	8880	1.19
8214	1.49				

8000 (SIGNETICS)

8263	5.79	8267	2.59		

9000

9002	.40	9309	.79	9601	.89
9301	1.03	9312	.79	9602	.79

DTL

930	.15	937	.15	949	.15
932	.15	944	.15	962	.15
936	.15	946	.15	963	.15

6 DIGIT LED CLOCK KIT

INCLUDES:
- MM5314 clock circuit
- 6 FND70 LED displays (.250" red 7 segment)
- All necessary transistors, resistors & capacitors
- 1 double sided PC board accommodates LED's & clock circuitry
- Schematic & instructions
- Does not include 12V-300 ma transformer, switches & case **$12.95**

QUANTITY DISCOUNT NOT APPLICABLE ON THIS ITEM

IC SOCKETS

Solder Tail - low profile

8 pin	$ .19	24 pin	.45
14 pin	.22	28 pin	.59
16 pin	.24	40 pin	.69
18 pin	.35		

WIRE WRAP - gold plate

14 pin .59

CMOS

4000A	.30	4018A	1.39	4066A	1.02
4001A	.29	4020A	1.49	4068A	.51
4002A	.29	4021A	1.39	4069A	.51
4006A	1.55	4022A	1.10	4071A	.30
4007A	.30	4023A	.29	4072A	.40
4008A	1.79	4024A	1.02	4073A	.45
4009A	.66	4025A	.29	4075A	.45
4010A	.62	4027A	.68	4078A	.45
4011A	.33	4028A	1.13	4082A	.40
4012A	.29	4030A	.51	4518A	1.89
4013A	.52	4035A	1.46	4528A	1.84
4014A	1.49	4040A	1.39	4585A	2.10
4015A	1.49	4042A	1.69	4901A	.45
4016A	.56	4049A	.68		
4017A	1.19	4050A	.68		
74C00	.25	74C74	1.20	74C162	2.93
74C02	.30	74C76	1.54	74C163	3.06
74C04	.51	74C107	1.30	74C164	3.06
74C08	.78	74C151	3.00	74C173	2.61
74C10	.40	74C154	3.62	74C195	2.66
74C20	.40	74C157	2.02	80C95	1.35
74C42	1.55	74C160	2.85	80C97	1.13
74C73	1.20	74C161	2.93		

CALCULATOR CHIPS

CT5002	12 digit, 4 function fixed decimal — battery operation 40 pin	2.79
CT5005	12 digit, 4 function plus memory, fixed decimal 28 pin	2.99
MM5725	8 digit, 4 function, floating decimal 28 pin	1.98
MM5736	6 digit, 4 function, 9V battery operation 18 pin	3.95
MM5738	8 digit, 5 function plus memory and constant floating decimal, 9V battery operation 24 pin	4.50
MM5739	9 digit, 4 function, 9V battery operation 22 pin	5.35

MEMORIES

1101	256 bit RAM MOS 16 pin	1.50
1103	1024 bit RAM MOS 18 pin	1.95
1702A	2048 bit static PROM elect. prog. - UV eras. 24 pin	14.95
2102 (2602)	1024 bit static RAM DTL/TTL comp. 1 ms 16 pin	2.95
2102-1	Same as 2102 except 500ns	2.99
5203	2048 bit static PROM elect prog. - UV eras. 24 pin	10.95
5260	1024 bit dynamic RAM MOS 16 pin	1.95
5261	1024 bit dynamic RAM MOS 16 pin	2.19
5262	2048 bit dynamic RAM MOS 22 pin	2.25
7489	64 bit ROM TTL 16 pin	2.48
82523	256 bit PROM SCHOTTKY 16 pin	3.69
F93410	256 bit RAM bi-polar 16 pin	1.95
74187	1024 bit ROM TTL 16 pin	5.95
74200	256 bit RAM tri-state 16 pin	5.90

TANATLUM CAPACITORS SOLID-DIPPED +20%

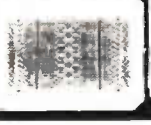
.1 mfd	35V	.25 ea.	6.8 mfd	6V	.30 ea.
.33 mfd	35V	.25 ea.	6.8 mfd	50V	.40 ea.
1 mfd	35V	.25 ea.	10 mfd	25V	.40 ea.
2.2 mfd	20V	.25 ea.	15 mfd	10V	.40 ea.
2.2 mfd	35V	.30 ea.	33 mfd	10V	.40 ea.
4.7 mfd	16V	.30 ea.	47 mfd	6V	.40 ea.

SHIFT REGISTERS

MM5013	1024 bit accum. dyn. 8 pin	1.75
MM5016	500/512 bit dyn. 8 pin	1.59
SLS-4025	Quad 25 bit	1.29
2504	1024 bit multiplexed dyn 8 pin	4.95

UNIVERSAL BREADBOARD

Silver plated copper circuit board 3.1 16" x 3.1 16" 2 rows of 2" holes for DIP IC's + space for transistors, resistors & capacitors. Versatile and simple for breadboarding IC circuits **$1.50 ea.**



JULY SPECIALS

1103	Memory	10/$10.00	100/$88
5260	"	10/$11.90	100/$104
5261	"	10/$11.90	100/$104
5262	"	10/$13.90	100/$122
5002	Calculator Chip	10/$11.90	100/$104
5005	" "	10/$13.90	100/$122
5738	" "	10/$20.00	100/$176
309K	5V Regulator	10/$10.00	100/$89
741	Operational Ampl.	10/$2.50	100/$22
3900	Quad amplifier DIP	10/$3.20	100/$29
74123	Dual Monostable Multivibrator	10/$5.60	100/$50
MAN 1	Display	10/$11.90	100/$104

CT5005 CALCULATOR CHIP

12 digit — 4 function with memory **$1.39**

7001 CLOCK CHIP

4-6 digit, 12-24 hr. alarm, timer and date circuits — with data **$6.95**

DVM CHIP 4½ DIGIT

MM5330 — P channel device provides all logic for 4½ digit volt meter. 16 pin DIP with data **$12.95**

MM5738

8 digit multiplexed — five function — chain operation 2 key memory — floating decimal — independent constant — interfaces with led with only digit driver — 9 V batt. oper. 24 pin **$3.95**

CLOCK CHIPS

MM5311	6 digit multiplexed BCD, 7 seg 12-24 Hr, 50-60 Hz 28 pin	$4.45
MM5312	4 digit multiplexed BCD, 7 seg 1 pps. 12-23 Hr, 50-60 Hz 24 pin	3.95
MM5314	6 digit multiplexed 12-24 Hr, 50-60Hz 24 pin	4.45
MM5316	4 digit, 12-24 Hr, 50-60 Hz, alarm 40 pin	5.39
CT7001	6 digit, 12-24 Hr, 50-60 Hz, alarm, timer and date circuits 28 pin	7.95

MISC DEVICES

ULN 2208	FM gain block 34dB mDIP	1.39
ULN2209	FM gain block 48dB mDIP	1.59
2513	64 x 8 x 5 character generator	11.00
CA 3046	Transistor array 14 pin DIP	.86

METAL FILM RESISTORS

±1% ¼ WATT

QTY	PRICE EACH	PRICE MINIMUM 10 PER VALUE	PRICE MINIMUM 100 PER VALUE
0 - 10	$.20		
10 - 100	.20	$.15	
100 - 1000		.10	$.09
1000 -		.10	.08

RESISTANCE (OHMS)

22.6	71.5	182	887	11.8K	40.2K
23.7	78.7	187	1.15K	13.0K	45.3K
25.5	84.5	191	1.5 K	15.0K	48.7K
30.9	105	205	2.49K	18.2K	54.9K
34.8	110	232	3.57K	19.1K	60.4K
40.2	115	243	4.75K	19.6K	64.9K
45.3	137	499	5.49K	22.6K	69.8K
51.1	147	604	6.04K	24.9K	84.5K
61.9	158	715	7.15K	28.0K	
64.9	178	806	8.25K	37.4K	

Zener Diodes, Diodes & Rectifiers

IN 4868	Diode	250V	$ .25 ea.
IN 715A	Zener	11V	.25
IN 747A	Zener	3.6V	.25
IN 754A	Zener	6.8V	.25
IN 756A	Zener	8.2V	.25
IN 904	Sw. Diode	30V	.10
IN 914	Sw. Diode	100V	.10
IN 4858	Zener	120V	.25
IN 5230A	Zener	4.7V	.25
IN 5242B	Zener	12V	.25

DISPLAYS

MAN1	$1.95
MAN2	3.95
MAN3A	.19
MAN5	2.95
MAN6	3.95
MAN7	1.49
MAN8	2.95
MAN66	2.95
DL10A	2.19

DISCRETE LED'S

ME4	$ .29
MV50	.15
NSL100	.15
NSL101	.15
NSL102	.15
XC209-R	.18
MV5020 RED	.18
GREEN	.18
AMBER	.18
CLEAR	.18

MULTIPLE DISPLAYS

NSN33	3 digit .12" red LED	1.79
HP5082-7405	5 digit .11 red LED	3.49
HP5082-7414	4 digit .11 red LED	3.25
SP-425-09	9 digit .25 gas disch.	1.79

5% OFF ON ORDERS OVER $50.00
10% OFF ON ORDERS OVER $100.00
15% OFF ON ORDERS OVER $500.00

LINEAR CIRCUITS

300	Pos V Reg (super 723) TO-5	$ .82
301	Hi Perf Op Amp mDIP TO-5	.33
302	Volt follower TO-5	.61
304	Neg V Reg TO-5	.92
305	Pos V Reg TO-5	.82
307	Op AMP (super 741) mDIP TO-5	.30
308	Micro Pwr Op Amp mDIP TO-5	1.02
309K	5V 1A regulator TO-3	1.35
310	V Follower Op Amp mDIP	1.23
311	Hi perf V Comp mDIP TO-5	1.09
319	Hi Speed Dual Comp DIP	1.30
3201	Neg Reg 5, 12, 15 TO-220	1.60
320K	Neg Reg 5.2, 12 TO-3	1.60
322	Precision Timer DIP	1.96
324	Quad Op Amp DIP	1.75
339	Quad Comparator DIP	1.69
340k	Pos V reg (5V, 6V, 8V, 12V, 15V, 18V, 24V) TO-3	1.94
340T	Pos V reg (5V, 6V, 8V, 12V, 15V, 18V, 24V) TO-220	1.71
370	AGC/Squelch AMPL DIP	1.20
372	AF-IF Strip detector DIP	2.93
373	AM/FM/SSB Strip TO-5	2.42
376	Pos V Reg mDIP	.68
380	2w Audio Amp DIP	1.30
380-8	8w Audio Amp mDIP	1.25
381	Lo Noise Dual preamp DIP	1.75
382	Lo Noise Dual preamp DIP	1.75
531	High Slew rate Op Amp	2.95
540	Power driver TO-5	2.95
550	Prec V Reg DIP	1.02
555	Timer mDIP	.69
556A	Dual 555 Timer DIP	1.71
560	Phase Locked Loop DIP	4.54
562	Phase Locked Loop DIP	4.54
565	Phase Locked Loop DIP TO-5	1.39
566	Function Gen mDIP TO-5	2.59
567	Tone Decoder mDIP	2.49
709	Operational AMP TO-5 or DIP	.30
710	Hi Speed Volt Comp DIP	.69
711	Dual Difference Compar DIP	.30
723	V Reg DIP	.71
733	Diff. video AMPL TO-5	1.02
739	Dual Hi Perf Op Amp DIP	1.23
741	Comp Op Amp mDIP TO-5	.37
747	741 Dual Op Amp DIP or TO-5	.82
748	Freq Adj 741 mDIP	.40
1304	FM Mulpx Stereo Demod DIP	1.23
1307	FM Mulpx Stereo Demod DIP	.85
1456	Op Amp mDIP	1.83
1458	Dual Comp Op Amp mDIP	.71
1800	Stereo multiplexer DIP	2.85
3900	Quad Amplifier DIP	.49
7524	Dual core memory sense Amp	.52
7525	Dual core memory sense Amp	1.13
8038	Voltage contr. osc. DIP	4.89
8864	9 DIG Led Cath Drvr DIP	2.59
75150	Dual Line Driver DIP	1.75
75451	Dual Perepheral Driver mDIP	.40
75452	Dual Peripheral Driver mDIP	.40
75453	(351) Dual Periph Driver mDIP	.40
75491	Quad Seq Driver for LED DIP	.82
75492	Hex Digit driver DIP	.92

Date sheets on request. Add 30c each if item is priced below $1.00 each.

The prices as listed are in Australian dollars. Send bank cheque with order. If international postal money order is used send receipt with order. Shipment will be made via air mail — postage paid — within three days from receipt. Minimum order — $5.00.

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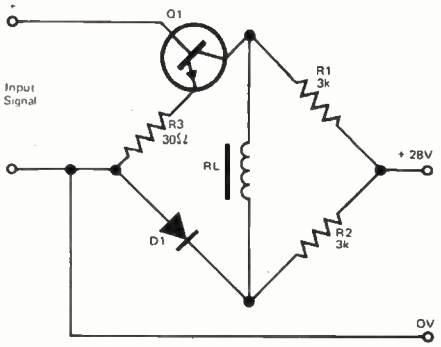
Duty may be payable on products imported.

Ideas for experimenters

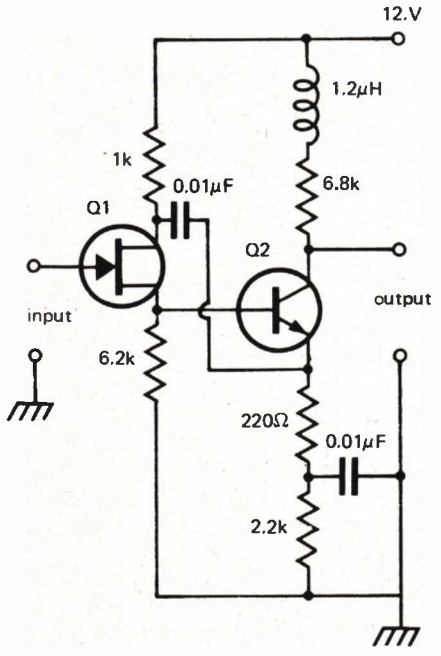
TEMPERATURE STABILIZED RELAY



Accurate relay trip-point operation can be obtained over an ambient temperature range from -50°C to +90°C using this simple circuit.

The temperature sensitivity of the silicon transistor Q1 is balanced out by the silicon diode D1. Gain/temperature stabilization may be obtained if required by using a positive temperature co-efficient resistor for R3.

BROAD BAND AMPLIFIER



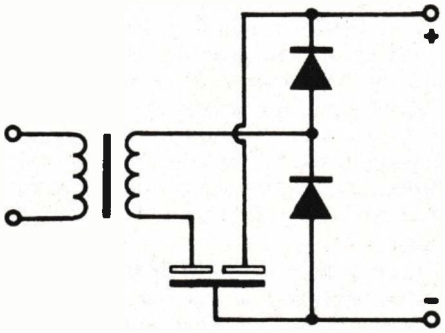
This circuit has a typical gain of 10dB and bandwidth of 90 MHz.

Input impedance is around 10 megohms in parallel with 1.0pF. Output impedance is reasonably high and depends mainly on Q2; output capacitance will be around 2 to 3pF with careful construction.

FET, Q1, should be an n-channel type with low gate source capacitance and a high cutoff frequency.

The transistor, Q2, should have a high gain-bandwidth product and low collector-emitter capacitance. Careful selection can extend the bandwidth beyond 100 MHz.

MODIFIED VOLTAGE DOUBLER



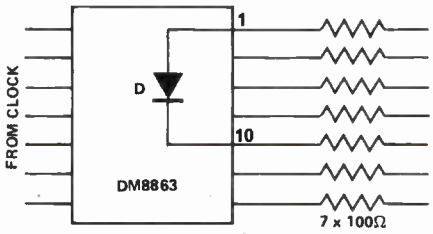
Twin electrolytic capacitors take up less space than two separate units but cannot normally be used in voltage doubler circuits.

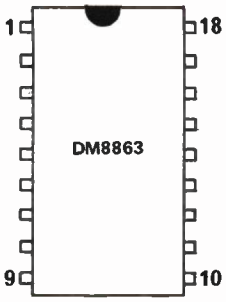
However a slight modification to the circuit allows twin electrolytics to be used, with the can connected to chassis.

Alternatively, in low voltage circuits where high value electrolytic capacitors are used, two capacitors may be used without the necessity of insulating the case (generally the negative terminal) of one of them.

Ideas for experimenters

CLOCK MODIFICATIONS



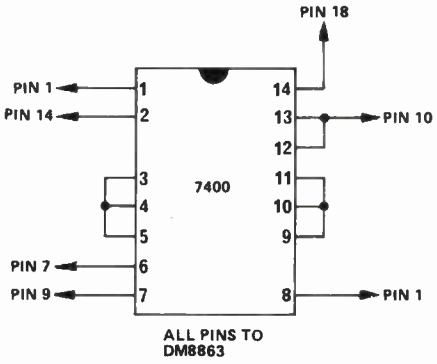


Here are a couple of modifications that can be made to the digital clock project in ETI January 1975.

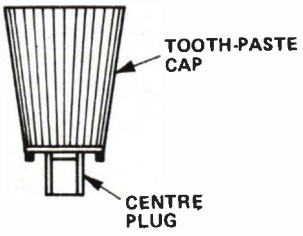
To start with, the supply voltage to the DM8863 is not filtered, which in some cases can cause flickering of the display (or individual segments). A 220 nF capacitor between pins 18 and 9 will fix this. Although the supply voltage to the buffer is increased by this procedure (and thus the voltage to the display) it is still within the specified range.

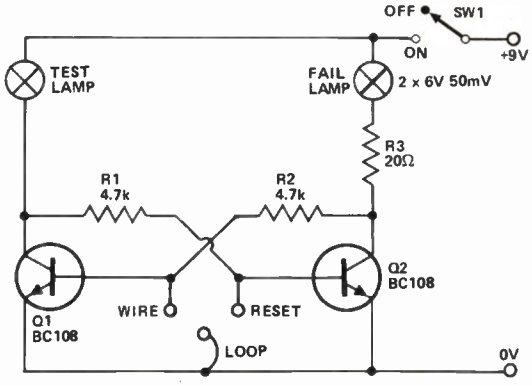
A diode between pins 10 and 9 of the buffer will add a top bar to the 6, changing 6 to 6, which some people think looks better.

After changing the appearance of the 6, one really needs to change the 9 as well. If a logic Nand gate has one of its input connected to pin 1 and the other input to pin 14 of the DM8863, and the output from the Nand gate is connected to pin 7, the nine will change from 9 to 9 without affecting any other number. The current needed to illuminate segment D for a nine is drawn from the Nand gate.



The gate used was from a 7400, followed by an inverter, one of the other gates in the IC. If desired, the other two gates of the 7400 can be used instead of the diode for improving the number six.





CASSETTE WINDER

This is a device for taking up the slack in cassettes. Take the centre "plug" from a Memorex cassette and glue it to the cap of a toothpaste tube.

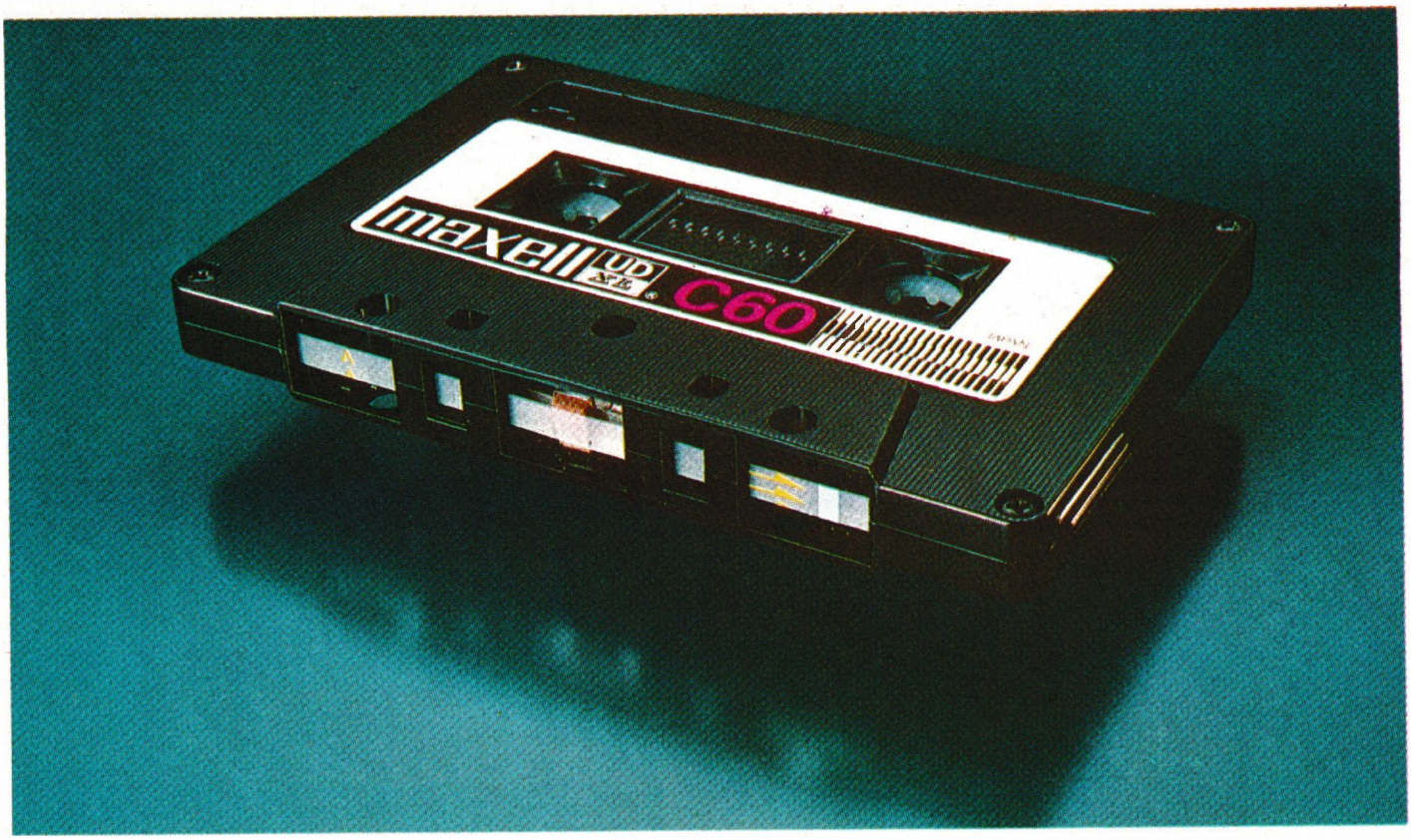
It provides better grip than a pencil, and doesn't cost 75c.

CHEAT-PROOF BENDY WIRE GAME

This gadget is an amusing novelty at a fete or party. The aim of the game is for the player to manipulate a loop along a bent piece of wire without the two touching.

If the player touches the loop to the wire, the fail lamp lights and will remain on until the reset contact is touched with the loop.

R1 ensures that the fail lamp will light if the power supply is interrupted. The value may need experimenting with to achieve maximum lamp brightness, but still maintains its "cheat-proof" purpose.



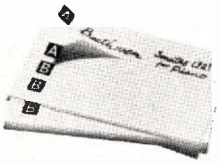
Introducing the revolutionary UD-XL EPITAXIAL cassette

UD XL

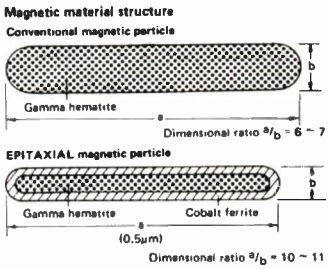
Developed by MAXELL this completely new EPITAXIAL magnetic material combines the advantages of the two materials (gamma-hematite and cobalt-ferrite): the high sensitivity and reliable output of the gamma-hematite in the low and mid-frequency ranges and the excellent performance of the cobalt-ferrite in the high-frequency range. The result is excellent high-frequency response plus wide dynamic range over the entire audio frequency spectrum.

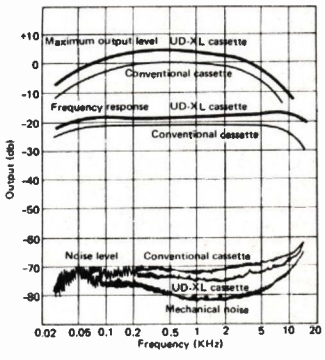
Compared to chrome tape, sensitivity has been improved by more than 3.5dB. Because EPITAXIAL is non-abrasive, it extends to the life of the head. Consequently, the UD-XL delivers smooth, distortion-free performance during live recording with high input. When using UD-XL it is recommended that tape selector be in the NORMAL position.

Fidelity is also ensured by a precision-manufactured cassette shell with a special anti-jamming rib that provides smooth tape travel and helps eliminate wow and flutter.



Another good idea of the UD-XL cassette is a replaceable self-index label. Simply peel off the old label and put on a new one when you change the recording contents. No more mess on the label.





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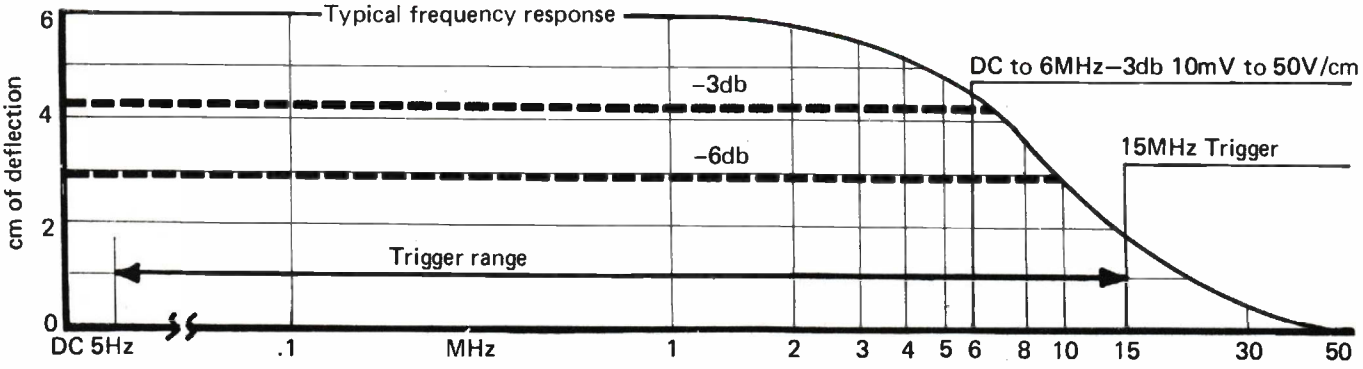

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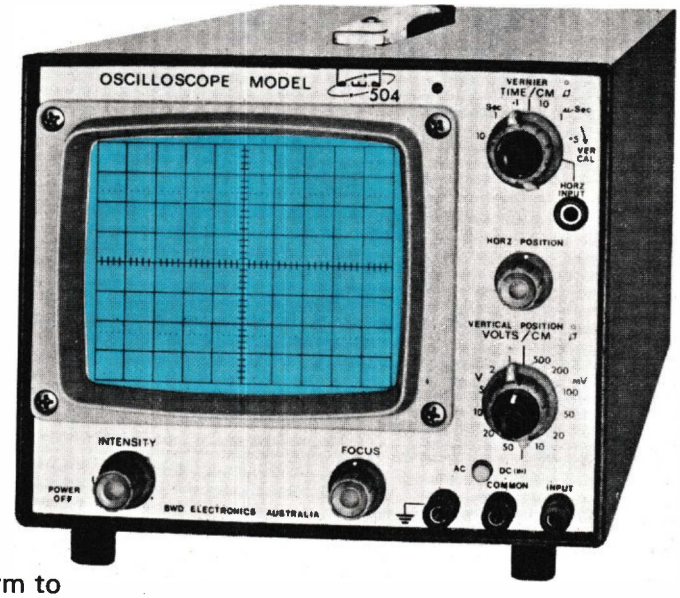

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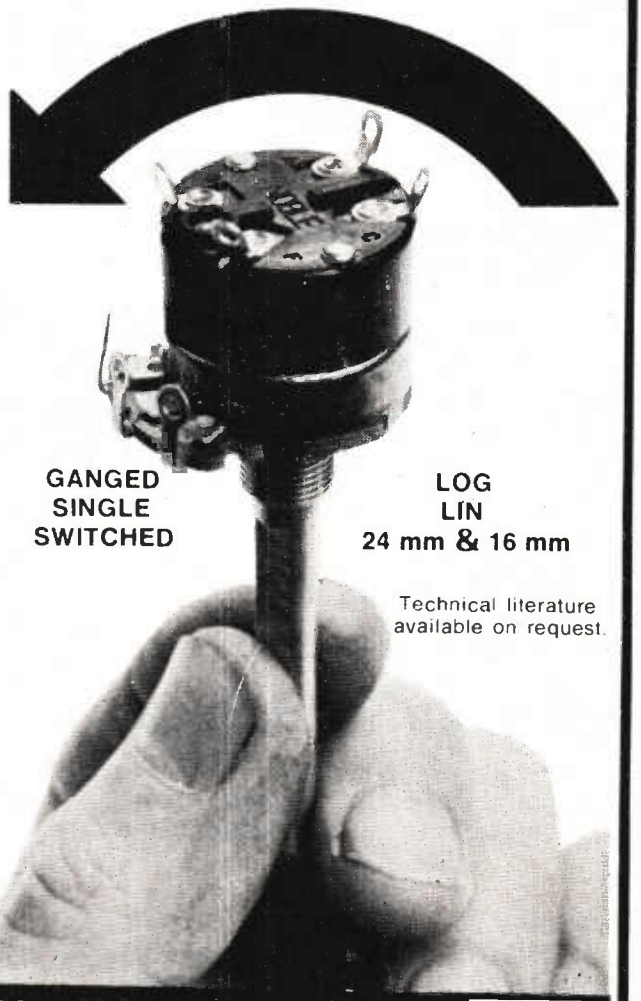

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AUDIO FACTS

JAPANESE CASSETTE

The Elcaset, developed jointly by Sony, Matsushita and Teac, is new competition for the Compact Cassette of Philips. The compact cassette uses 3.81 mm tape at 48 mm per second; the Elcaset uses 6.3 mm tape at 95 mm per second. The Elcaset carries a narrow cue track (for control of the playback equipment or synchronisation of slides or film) with each stereo pair. Machines are planned for later this year. Hopefully we will soon have machines for Europe's cassette rival, BASF's Unisette.

DRAMATIC ADVANCE IN RECORDED SOUND

During this past month we have been listening to dbx encoded gramophone records played back via a dbx type 124 decoder.

The results can only be described as remarkable. We have never before heard records reproduced with such clarity, dynamic range or total lack of surface noise. The performance quality was literally as good as that obtainable from studio master tapes.

The process electronically compresses the recorded signal by a factor of 2:1 at the time the master disc is cut, and expands the signal by a complementary factor of 1:2 at the point of playback. If a dbx encoded master tape is used, full dynamic range and freedom from noise will be realized upon playback. Master tapes produced with other types of noise reduction systems, or with no noise reduction at all, may be used and the played back disc will sound equal to the master tape.

dbx encoding eliminates the chief limitation which prevents conventional records from duplicating the quality of music performed live, namely, that ordinary discs are limited to a dynamic range of some 60 dB; whereas, music in concert performance may have well in excess of 100 dB dynamic range.

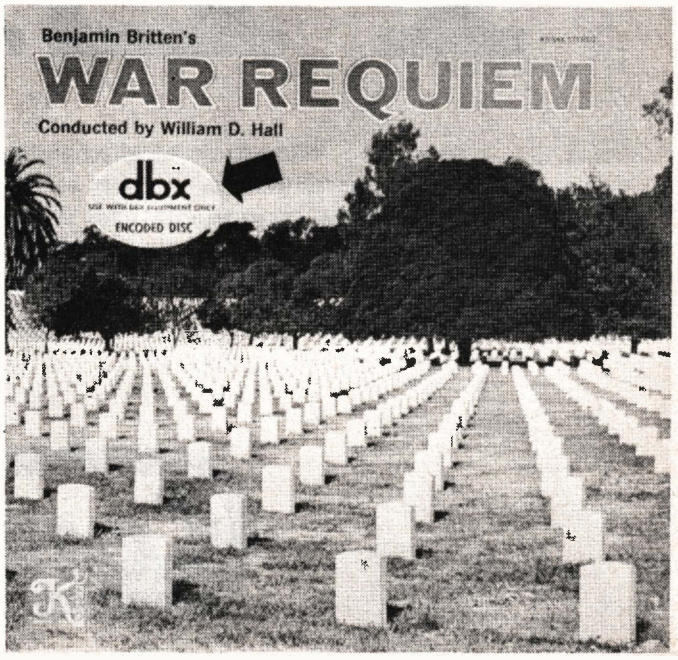
The dbx process compresses the dynamic range of the music to a "dynamic range envelope" which fits conveniently within the inherent limitations of the record medium, then expands the music to its full original dynamics at the point of playback. This compression and subsequent expansion reduces record surface noise and other unwanted background noise to inaudibility, so that when the musical programme stops, no sound of any kind is heard from the playback system.

The complete absence of background noise also makes the quiet portions of the music easier to hear, and the definition of individual voices and instruments in ensemble music is dramatically improved.

A significant advantage of the dbx disc encoding process is that it does not obsolete any existing manufacturing technique or equipment presently in use in the recording industry, nor does it increase actual product cost in any way. On the contrary, dbx encoding offers numerous opportunities for reducing the cost of recorded music without compromising quality. For example, with dbx encoding, record grooves may be placed closer together, increasing the amount of music on a record by up to 30%. Also, dbx encoding places the quietest sound so far above the surface noise level that lesser cost record pressing materials may be substituted for virgin vinyl without audibly affecting playback quality. And finally, because dbx encoding makes many of the mechanical steps in record preparation and production less critical, much rework and fine tuning in the production process can be eliminated. The only cost to the record producer is the nominal one time investment in the required dbx encoding equipment used at the disc mastering stage.

Electronic expansion circuitry, similar in cost and complexity to Dolby B and quad matrices, is required at the point of playback to properly decode the dbx compressed signal. The decoder circuitry is now available to audio equipment manufacturers for inclusion in audio components and systems on a license basis. We understand that Teac are including it in some of their latest gear.

Two commercial record labels have already announced discs in dbx encoded format. Klavier Records have produced a range



dbx encoding labels may soon be a common sight.

AUDIO FACTS

of such recordings and Stan Kenton's Creative World label has recently completed several sessions with the Kenton band in dbx format and expects to issue future disc releases in dbx encoded as well as standard format.

We hope to be able to publish a full technical article dealing with the dbx encoding system very soon.

NEW RONDO SYSTEM FROM PIONEER

Pioneer hi-fi equipment is invariably excellent value for money — particularly so with that company's 'package deal' systems.

The new Rondo 3000X is no exception. Heart of the system is a new AM/FM stereo tuner/amplifier which has a (continuous) power output of 13 watts per channel into the four ohm speakers supplied.

This new tuner/amplifier has a number of interesting features. These include a volume control adjustable in 41 discrete steps and a phase locked loop in the stereo decoder — this ensures adequate stereo separation as well as rendering the circuitry less sensitive to changes in temperature and humidity — say Pioneer.

The speakers supplied with the new system are three-way bass reflex units incorporating a 200 mm woofer, 66 mm midrange and a similar sized dome tweeter.

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To this end we have appointed a small number of Hi-Fi Specialists to bring you Stanton, Fons, S.A.E., Monitor Audio and Neal state-of-the-art components.

We invite you to audition this remarkable equipment at the selected Hi-Fi specialists listed overleaf.

the remarkable products...

STANTON

STANTON pickups are the almost unanimous choice of recording studios, Radio Stations and TV stations.

They are unique in that they offer spectacular performance without fragility. They also lead the field in consistency—a quality lacking in most pick-ups.

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Stanton 681 EEE, the New Calibration Standard . . . . Stanton's finest Cartridge.

Stanton 681 EE, for application where slightly greater tracking pressure than 681 EEE is required.

Stanton 500A, the Broadcast Standard Cartridge as used by the majority of radio stations throughout Australia.

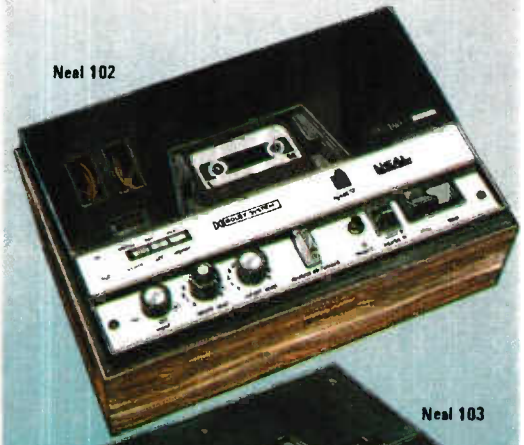
Fons

FONS is a new name to the world of hi-fi. Built in Scotland, the Fons CQ30 turntable has such exciting features as:—

- ☐ D.C. Servo controlled motor with gold plated commutator and silver plated brushes.
- ☐ Speeds, push button selected for 33, 45 and 78 RPM but continuously variable from 29 to 100 RPM.
- ☐ Hyper-concentric bearing typically better than ± 0.000076mm.
- ☐ Rumble typically -79dB.
- ☐ Wow and Flutter better than ± 0.03%.
- ☐ Anti-feed back phase cancellation suspension system.

Fons claim that the virtual absence of wow and flutter, rumble and vibration lead to a noticeably cleaner sound, and direct comparisons with other units certainly confirm this. In fact, direct comparison with another highly regarded unit using the same Stanton 681 EEE cartridge showed a dramatic improvement.

Neal 102



Neal 103

NEAL

Neal is a name new to Australia but it has established a formidable reputation in the U.K. for quality, ruggedness and performance stability.

The Neal Transcription Cassette Recorder is the product of people who have many years experience in the design and manufacture of tape recording equipment.

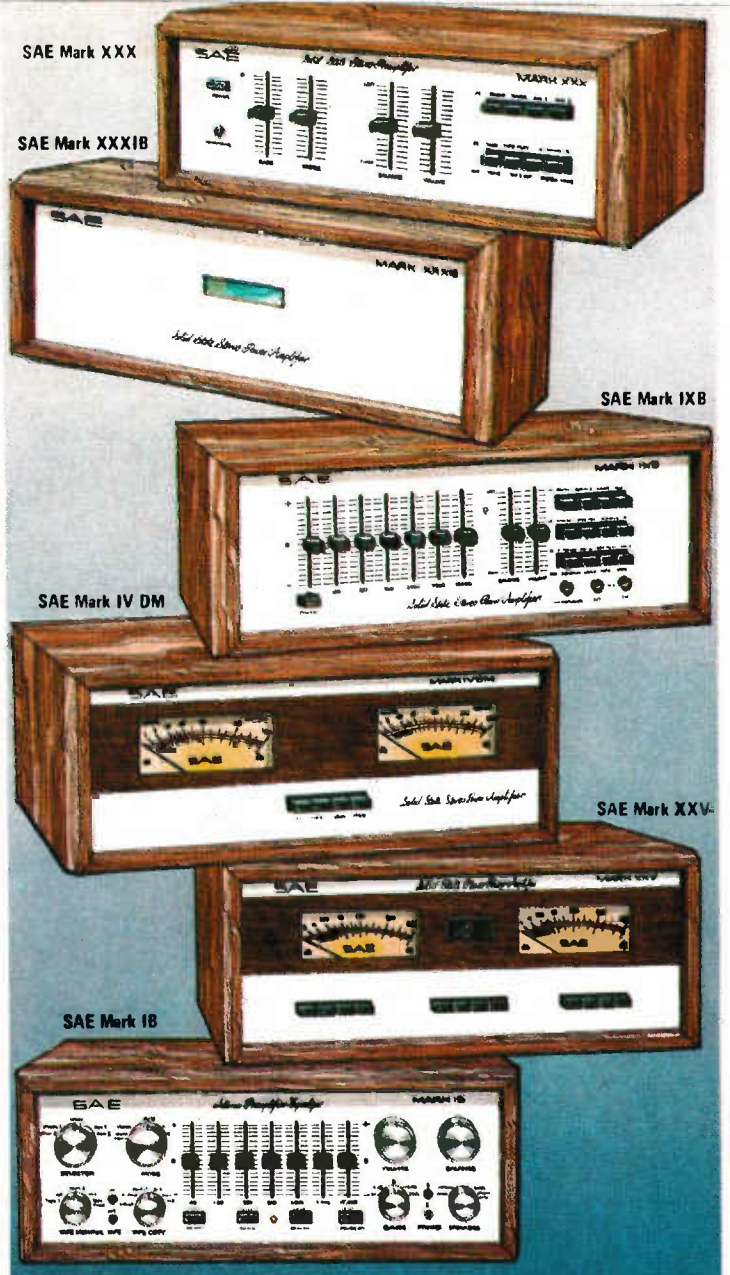
The one word that sums up their design and their product is "integrity". You will find no miracles, no way-out designs, no change for the sake of change, just an obsession with doing everything the right way.

Separate preamplifiers are used for each of the three stereo inputs to reduce noise. This also allows three stereo (or six mono) inputs to be mixed.

Bias is readily adjustable to optimize performance from any tape, thanks to Neal's exclusive Varitape facility.

Neal are the only cassette recorder company in the world to offer the ultimate quality control check. A cassette actually recorded on the machine you buy. This is your guarantee of quality.

"Hi-Fi for Pleasure" (August 1975) consider the Neal 103 as being "the obvious choice of the serious enthusiast or semi-professional".



SAE

S.A.E. Preamplifiers, Power amplifiers and Equalizers have taken the professional field by storm. The acceptance of S.A.E. into their ranks has been almost unprecedented.

Mark XXX Preamplifier with Mark XXXIB Power Amplifier brings you Connoisseur Sound at budget prices. All unnecessary items have been omitted in the pursuit of the highest possible performance to price ratio.

The S.A.E. Mark XXXIB was tested by "High Fidelity" in May 1974, at 0.031% THD 20HZ to 20KHZ at 50 watts output per channel.

Mark IXB Preamplifier with Mark IVDM Power Amplifier. This combination brings you a versatile Equalizer Pre-amplifier with a power amplifier that was described in the "Popular Electronics" May, 1975 review as "True state-of-the-art performance with distortion levels that cannot be measured with any but the most advanced laboratory instruments." "For all purposes the Mark IVDM is a distortionless amplifier". Actual measurements were 0.005% at Rated 100 watts per channel and only 0.1% at 190 watts per channel!

Mark XXV Power Amplifiers. This is surely today's ultimate amplifier. It is rated at 300 watts per channel, both channels driven, into 8 ohms, and S.A.E. ratings are almost unreasonably conservative! Built-in forced air cooling ensures long life for all components.

Mark IB Preamplifier was designed for those who have, or intend to have, very complete audio installations.

"Stereo Review" October, 1975, says "When it comes to operating and control flexibility, the S.A.E. Mark IB has few peers."

The harmonic distortion, excluding hum which "was far below audibility" was 0.0025% at all frequencies up to 20,000HZ.

Monitor Audio

MONITOR AUDIO is another new company. It has leapt to prominence in only two years. In the "Practical Hi Fi Audio" October 1975, comparison of ten loudspeakers including Spendor BC1, B & W DM4, Kef Cadenza, IMF Super Compact, the Monitor Audio MA5 Series 11 was chosen as best of all. Its very low colouration, sweet-sounding treble, openness, and tight extended boss endeared it to the reviewers.

Similarly the tiny MA7 was chosen as the best of five speakers in a test conducted by "Popular Hi Fi" (June 1975) although it was the smallest and cheapest of the units tested.

At the top of the range is the mighty MA3 which retains the qualities that have established Monitor Audio at the pinnacle of loudspeaker design and manufacture, but combining these—possibly for the first time—with a power output which is awesome and a level of bass distortion which must set new standards.

"Practical Hi Fi and Audio" May 1975, measured the third harmonic distortion of the MA3 at 100 HZ at "close to 1 per cent" at 96dB sound pressure level. At the critical midrange the distortion is between 0.3% and 0.6%.

They go on to say "The first impression one gets when listening to the MA3 is one of physical presence, and this quality seems to be independent of the closeness of recording. This may be attributable to the exceptional smoothness of its midrange unit together with the use of a very analytical tweeter."

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Autel Systems Pty. Ltd.
639 Pacific Hwy., Chatswood.

VIC.: Sound City, 360 Lonsdale St., Melbourne.

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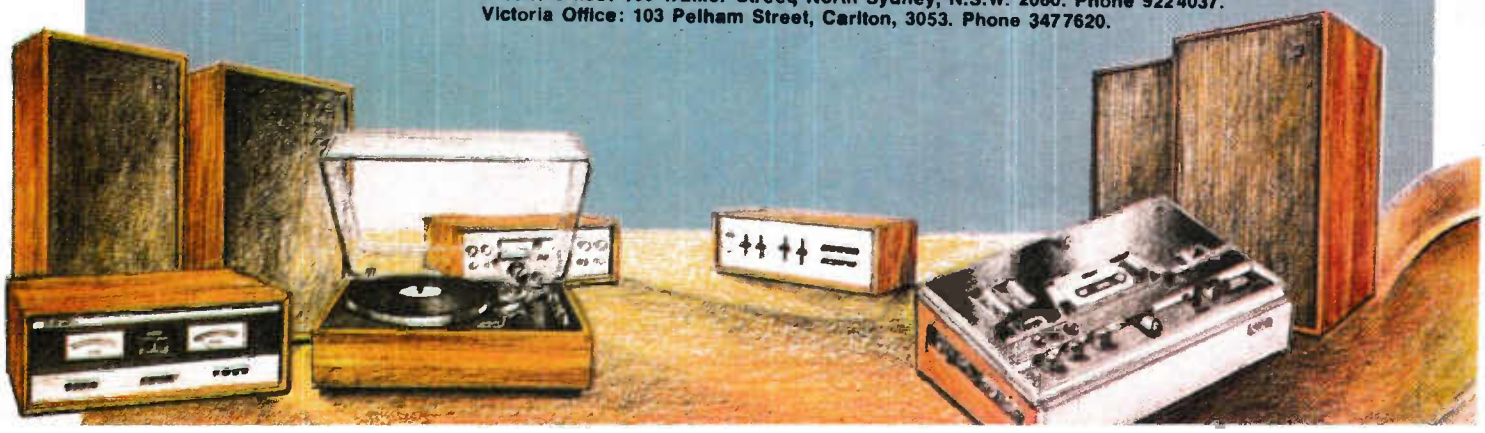

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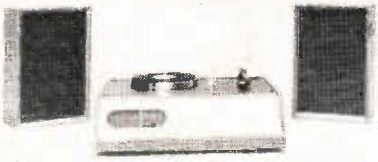

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