AUSTRALIA'S DYNAMIC MONTHLY SEPTEMBER 1972 50c

electronics TODAY INTERNATIONAL

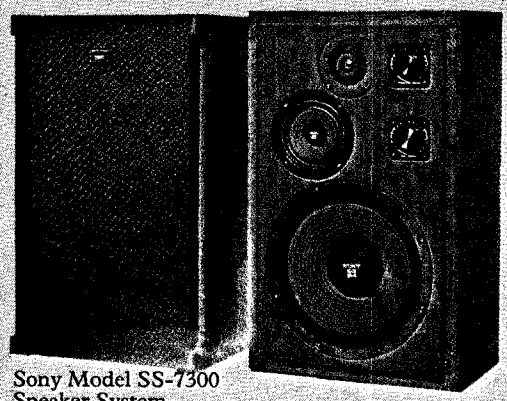
OPTO ELECTRONICS

DIGITAL FREQUENCY METER PROJECT

HEATING CONTROLLERS

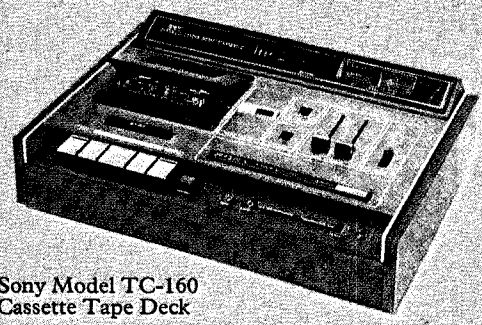
this is SONY

Sony Model TC-730
Stereo Tape Recorder



Sony Model SS-7300
Speaker System

Sony Model TA-1130
Stereo Amplifier



Sony Model TC-160
Cassette Tape Deck

Sony Model TS-5520
Hi-Fi Turntable

the pathfinder

SONY never intends to follow others. SONY has always been the pathfinder in electronics — discovering new trails where no one has ventured. Out of this philosophy has grown a policy of innovation and development, of improvement and refinement, of absolute quality, resulting in SONY's world-wide reputation for enterprise and excellence. SONY sets the standard. Because SONY is the pathfinder.

SONY

JACOBY ☀ KEMPTHORNE

SYDNEY: 26-2651, MELBOURNE: 329-6866, ADELAIDE: 93-2388/9, BRISBANE: 44-4488, PERTH: 28-5725, LAUNCESTON: 2-5322, **Agents:** CANBERRA: 47-9010, NEWCASTLE: 61-4991, FAIRY MEADOW: 84-8022.

Models illustrated form only a minute fraction of the vast Sony range. For more information contact any one of the phone numbers listed above.

electronics TODAY INTERNATIONAL

SEPTEMBER 1972 Vol. 2 No. 6

main features

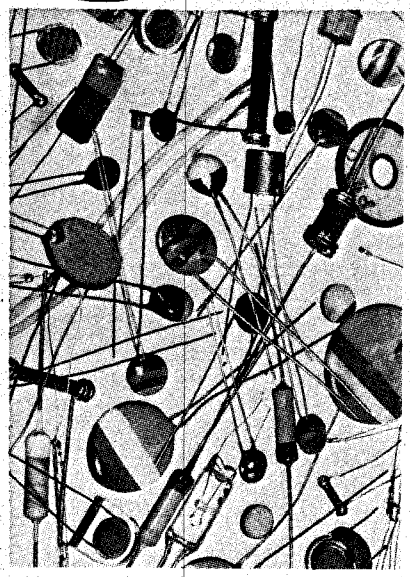
projects

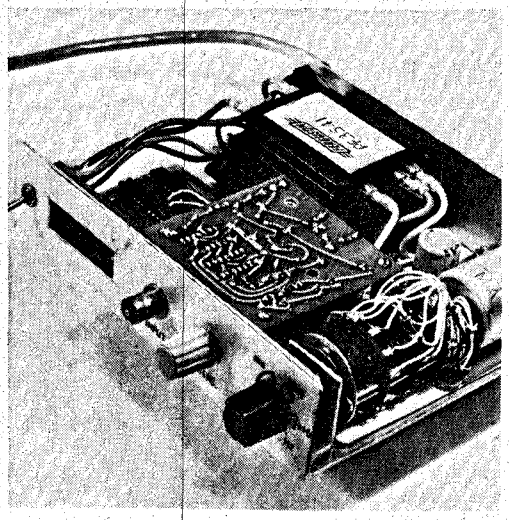
product tests

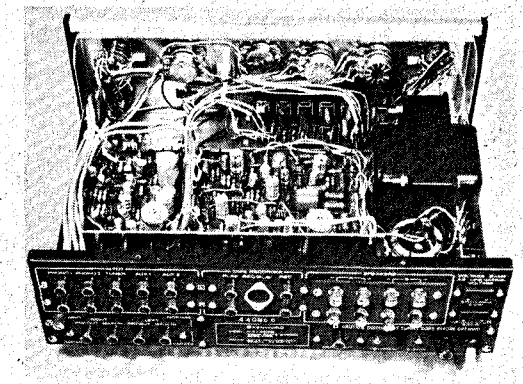
reviews

news & information

Cover: A selection of Philips Channel Electron Multipliers.







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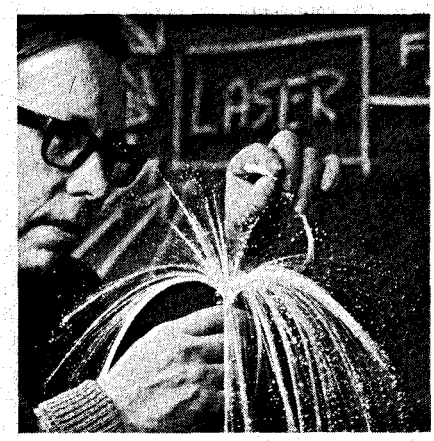
news digest

LASER BEAM TELEPHONE CALLS



A new transmission concept is being examined by the British Post Office which employs laser beams to carry telephone calls along glass fibres. The principle behind it is that since the frequency of light is so much greater than that of a radio wave the potential information capacity of a light beam is correspondingly greater.

In the simulation seen here, each pinpoint of light represents a hair-thin strand of glass capable of carrying as many as 2,000 simultaneous telephone conversations. The simulation was obtained by passing light along a bunch of special glass fibres which act as a waveguide.

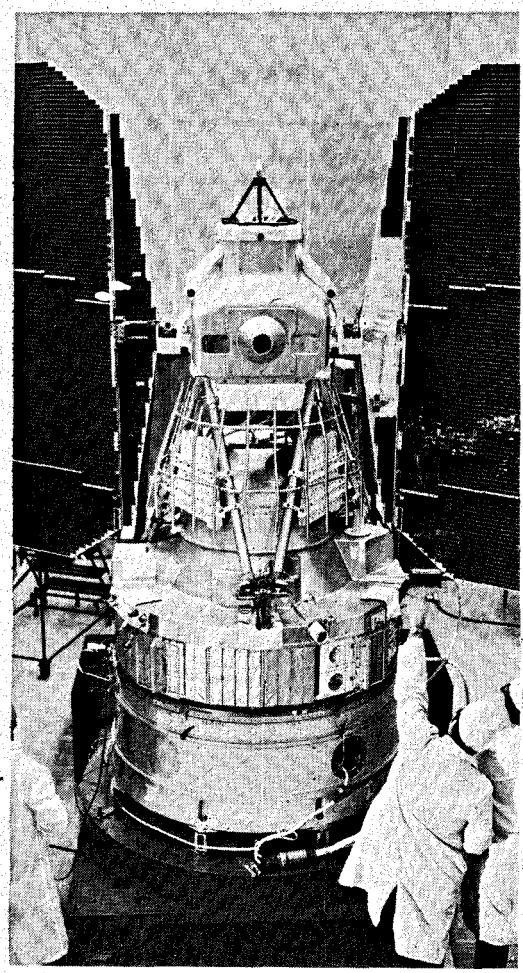
To provide for a capacity of some hundreds of millions of pulses per second special fibre structure is needed, consisting of a very narrow core of one type of glass, surrounded by a thicker layer of a second type of glass. The overall diameter is about 50 to 100 micro-metres (microns). The light wave is 'guided' by the cylindrical boundary between the two layers of glass.

ERTS-A

The Earth Resources Technology Satellite (ERTS-A) Spacecraft is shown in flight configuration with solar panels deployed after tests at the G.E. Valley Forge Plant. NASA is currently developing two experimental Satellites (ERTS A/B); the first to be launched in 1972 and the second during the following year.

The Earth Resources Technology Satellite program is a first step in the merger of space and remote sensing technologies into a system devoted to developing the ability for more efficient management of the earth's resources. Design of the observatory is based on the highly successful Nimbus meteorological satellites which have regularly returned pictures of the earth's weather state since 1964.

The ERTS observatory will operate in a polar orbit, 500 miles above the earth, and return images from two independently functioning multi-spectral sensors. A Data Collection System on board the observatory will gather environmental information from earth-based platforms and relay this data to the ground processing facility.



looking for a medium the only question is . . .

Selecting a stereo amplifier in the medium price range poses only one major question . . . not which brand . . . but which model Sansui?

There's absolutely no doubt that dollar for dollar Sansui solid state stereo amplifiers offer more performance, more real power and greater reliability. So down to the nitty-gritty. *Which model Sansui?*

THE ALL-NEW SANSUI MODEL AU-505.

Now examine these abridged AU-505 specifications:

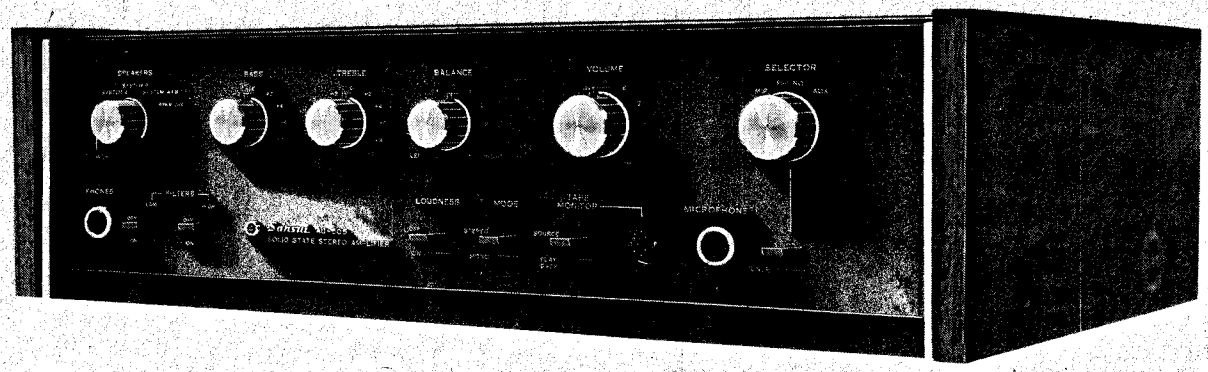
Power output:	*Music power — 90 watts at 4 ohms, 70 watts at 8 ohms*
	R.M.S. power — 70 watts at 4 ohms, 50 watts at 8 ohms
Frequency response:	*20-60,000 Hz. ± 2 dB.*
T.H.D.:	*Less than 0.5% at full rated output.*
Channel separation:	*Better than 50 dB.*
Input sensitivity:	*3 mV. (magnetic pickups), 4 mV. (microphone), 200 mV. (tuner, tape recorder, auxiliary).*
Dimensions:	*16" x 11" x 4 9/16"*
Price:	*$199* (recommended price).*

We confidently predict that the all-new Sansui AU-505 is destined to become one of the most popular stereo amplifiers ever available in Australia.

With almost double the power of the AU-101, the AU-505 represents terrific value at only $199 . . . and that's the *most* you will pay, for trading in your old equipment can reduce the price *considerably.*

Facilities on the new AU-505 offer great flexibility in tone control . . . provision is made for A-B speaker switching . . . a new flip-switch instantly provides tuner input . . . and both headphone and microphone jacks are situated on the front panel, together with a DIN tape recorder socket. Ask for complete specifications when you visit your franchised Bleakley Gray dealer!

***All Sansui models feature all-silicon transistor design**
***All output stages are semi-complementary Darlington SEPP-ITL OTL designs — no input or output transformers — consequently less distortion.**



ASK FOR FULL DETAILS. SEND THE COUPON RIGHT AWAY AND WE'LL SEND YOU ALL THE FACTS.

Bleakley Gray Corporation Pty. Limited,
28 Elizabeth Street, Melbourne, 3000
Telex: 31904
Please send me all the facts about the Sansui Model AU-101, AU-505, AU-555A* in detail . . . and the name of my nearest franchised dealer.

NAME .....

ADDRESS .....

..... POSTCODE .....

*Delete items not required

Sansui

SANSUI — COMBINING TONAL QUALITY AND POWER.

priced amplifier? which Sansui?

THE PROVEN AND POPULAR SANSUI MODEL AU-101.

When reviewing the all low-noise silicon transistor AU-101 **"Electronics Australia"** said . . . *"the best comment we can make about the AU-101 is that few amplifiers, regardless of price, give an overall test result as good as this."* **"Electronics Today"** said . . . *"Performance of the Sansui AU-101 belies its low price" . . . "The hum and noise performance are both very good and better than most other amplifiers at twice the price" . . .*

Look at these abridged AU-101 specifications:

Power output:	*Music power — 50 watts at 4 ohms* *44 watts at 8 ohms* *R.M.S. power — 36 watts at 4 ohms* *30 watts at 8 ohms*
Frequency response:	*20-60,000 Hz. ± 2 dB.*
T.H.D.:	*Less than 0.8% at full rated output.*
Channel separation:	*Better than 45 dB.*
Input sensitivity:	*3 mV. (magnetic cartridge), 4 mV. (microphone), 200 mV. (auxiliary and tape recorder).*
Dimensions:	*16" x 11" x 4⅝"*
Price:	*$149* (recommended price)*

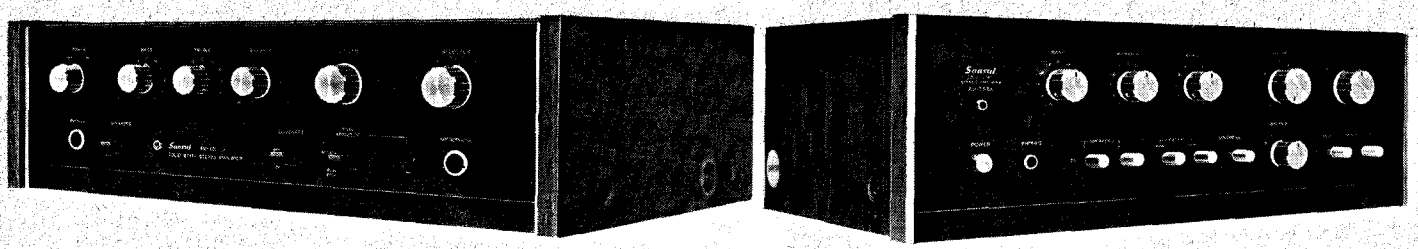
THE CHOICE OF THE ENTHUSIAST — THE SANSUI MODEL AU-555A.

Few amplifiers have received the acclaim afforded the Sansui AU-555A by the dedicated high fidelity enthusiast. All over Australia *(and the rest of the world)* the AU-555A has been selling in ever increasing volume. *What's the secret?*

Basically, **tonal quality.** Similarly priced competitors are left a long way behind . . . and some avid music lovers claim there's very little perceptible difference between the AU-555A and the top-of-the-line Sansui AU-999 in terms of tonal quality. *Of course, the AU-999 is a simply superb amplifier . . .*

Let's look at the abridged AU-555A specifications:

Power output:	*Music power — 85 watts at 4 ohms* *R.M.S. power — 66 watts at 4 ohms* *50 watts at 8 ohms* *60 watts at 8 ohms*
Frequency response:	*20-40,000 Hz. ± 1 dB.*
T.H.D.:	*Less than 0.5% at full rated output.*
Channel separation:	*Better than 60 dB.*
Input sensitivity:	*2 mV. (magnetic pickups), 180 mV. (tuner, tape recorder, auxiliary)*
Dimensions:	*15⅝" x 11 x 5⅜".*
Price:	*$237* (recommended price)*



PRICES. Prices quoted are recommended prices only . . . the actual cost can well be less. Trade-in valuations can make a world of difference! See your Bleakley Gray franchised dealer!

Sansui Distributors: Australia, excluding W.A.: **Bleakley Gray Corporation Pty. Limited.**

Head Office: *28 Elizabeth Street, Melbourne. 3000. Tel. 63 8101*. Telex: 31904.* ***Sydney Office:*** *53 Victoria Avenue, Chatswood, N.S.W. 2067. Tel. 40 4522*.* ***Canberra Office:*** *25 Molonglo Mall, Fyswick, A.C.T. 2609. Tel. 95 6526.* ***Adelaide Office:*** *301 South Terrace, Adelaide, S.A. 5000. Tel. 23 6219.* ***N.T.:*** *Pfitzner's Music House, Smith Street, Darwin. 5790. Tel. 3801.* ***Qld.:*** *Sydney G. Hughes, 154-158 Arthur Street, New Farm, Brisbane. 4005. Tel. 58 1422.* ***Tas.:*** *K. W. McCulloch Pty. Ltd., 57 George Street, Launceston. 7250. Tel. 2 5322.*

W.A. Distributors: *Atkins Carlyle Ltd.,* 1-9 Milligan Street, Perth. 6000. Tel. 22 0191.

Sansui equipment is manufactured by: Sansui Electric Co. Ltd., 14-1, 2-chome, Izumi, Suginami-ku, Tokyo, Japan.

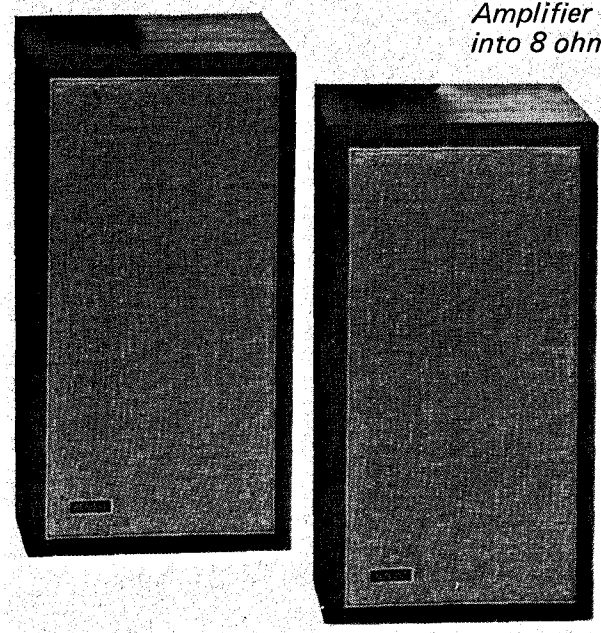
SG-3A-872

AUTEL SYSTEMS PTY LTD

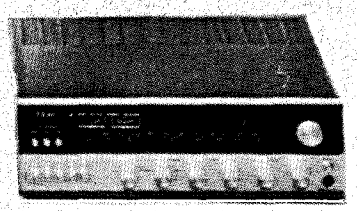
PRESENTS THE WORLD'S TOP EQUIPMENT AT SYDNEY'S BEST PRICE

Super System $599

Larger Advents



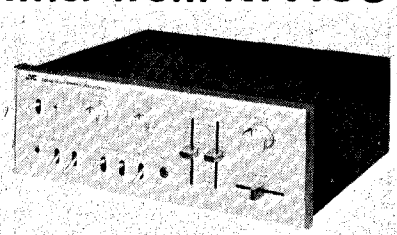
TEAC AG300 Tuner
Amplifier — 36 RMS per channel into 8 ohms — response 10-30,000 Hz



DUAL 1214 T/T
Complete — PLUS SHURE M55E Cartridge.

INTRODUCING . . . A fine new amplifier from NIVICO

VN300

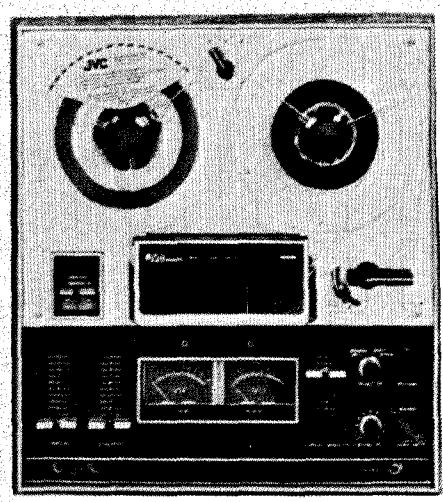


15 RMS per channel. Filters (Low.Hi) A + B Speakers — superior to all competitors. $160 List Price.

NIVICO 1664u SPECIAL!

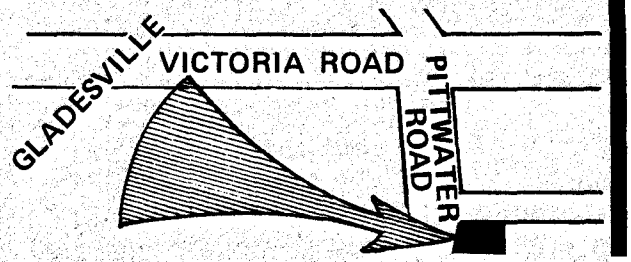
Professional
- 3 heat —
- 4 track —
- Stereo Tape Deck
- ECHO
- Sound On Sound
- Hi Bias SW
- Source/MON Switch.

$299



AUTEL SYSTEMS PTY LTD

20 Pittwater Rd., Gladesville. PH: 89-0663.
OPEN THURSDAY NIGHT



news digest

PHILIPS OFFER ON VIDEO CASSETTE

Philips will make its video cassette recording system freely available to other manufacturers in order to promote world-wide standardisation of VCR.

Philips some years ago offered its audio Compact Cassette system in the same way. As a result there is now one audio Compact Cassette system throughout the world.

Like the audio cassette system, the video cassette recording system was developed by Philips.

In Europe 10 companies manufacturing PAL colour TV equipment have already agreed to adopt the VCR system. PAL has been chosen by the Australian government for this country's colour TV transmissions. Three more companies are expected soon to sign VCR standardisation agreements with Philips.

Now Philips and Shiba Electric Company of Tokyo have agreed that Shiba will submit an official standardisation proposal to the Electronic Industries Association of Japan's standardisation committee.

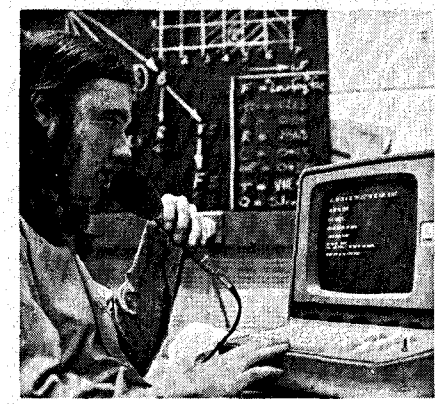
This proposal relates to the NTSC system, the colour television system used in Japan and the United States.

North American Philips Corporation has made a similar proposal to the Society of Motion Picture and Television Engineers.

SPEAKING TO COMPUTERS

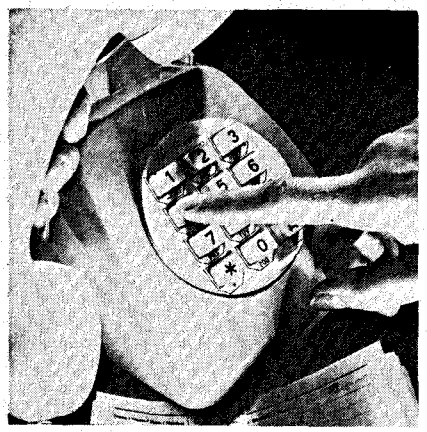
This practical demonstration of how people can talk to a computer and then have their answers and further instructions visually displayed on a television screen, illustrates one of the areas of research currently being undertaken by the National Physical Laboratory near London.

The primary communication channel for man-to-man contact is speech, and the logic of computer development seems to imply that ultimately we shall require our computers to understand spoken commands and, perhaps, respond in simulated or artificial speech. The problem arises as to how



we can develop inexpensive and reliable speech recognition devices, and inflections which the human voice has. Speech recognition can easily be demonstrated for a limited vocabulary. The further aim of the NPL's work is to improve the recognition methods, to make large vocabularies possible, without the need for special training of the machine operators, and without restricting them to certain classes of speech.

SPEAKING COMPUTER GIVES TELEPHONE INFORMATION



A computer that answers telephone enquiries using synthetic speech has been developed by Siemens for communications within PABX systems and has been demonstrated as a computer information service for warehouses. Enquiries are fed in via the telephone keyboard and the computer answers with the aid of a vocoder, a device which enables it to articulate its answers in synthetic speech. The orderer dials the computer as he would an ordinary subscriber, uses the rotary dial or punch buttons of his telephone, to indicate the order number of the article he requires and is then given details regarding price and stock situation. Likewise, he uses the punch buttons for placing orders.

Siemens technicians are working on even more far-reaching communications systems. The automatic telephone information service has shown that it is possible to transmit words as well as numbers from the telephone to the computer. In dialogue with the

BUY STATE OF THE ART SOLID STATE COMPONENTS— Direct from the United States!

All listed prices are in Australian dollars, International Postal Money Orders (please send PO receipt with order for immediate shipment). Banque Chasiers check (preferably in US funds) and rated company cheques (with foreign exchange stamp approval affixed) will be accepted. Due to recent Australian government restrictions we are not able to clear personal checks . . . All goods are new unused surplus and are fully guaranteed. Orders will be shipped within two workdays of receipt of same. All customs forms will be attached. Minimum order amount is $5.00, do not add postage — we pay postage. Surface mail for orders under $10.00 and Air Mail for orders over this amount.

DATA SHEETS ARE PROVIDED FOR EACH ITEM PURCHASED

DIGITAL INTEGRATED CIRCUITS (dual in line package)

Signetic	TTL (5 volt operation)	
8440	Dual 2/2 and or invert gate	$0.40
8455	Dual 4 input buffer	0.40
8480	Quad 2 input NAND gate	0.40
8H16	Dual 4 input NAND (high speed)	0.40
8H70	Triple 3 input NAND (HS)	0.40
8H80	Quad 2 input NAND (HS)	0.40
8H90	Hex inverter (HS)	0.40
8H21	Dual JK flip flop (HS 60MC)	1.25
8290	Decade counter (HS 60 MC)	3.50
8292	Decade counter (low power)	1.40
8251	BCD to decimal decoder	1.75
7480	Gated full adder	0.80
7413	Dual 4 input NAND Schmidt triggers	1.75
74181	Arithmetic logic unit	5.00
8260	Arithmetic logic unit	3.50
8261	Fast carry for above	1.40

Send for free brochure listing hundreds of bargains.

Signetic DTL (5 volt operation) dual in line

SP629	Flip flop	$0.40
SP659	Dual 4 input buffer	0.35
SP670	Triple 3 input NAND gate	0.35
SP680	Quad 2 input NAND gate	0.35
SP690	Hex inverter	0.35

Signetic "Utilogic"

This family of logic offers medium speed combined with a greater noise margin than is available from either DTL or TTL logic. Power requirements are the same as TTL/DTL (single 5 volt supply).

"Utilogic" dual in line package

LU300	Dual 3 input expander	$0.35
LU301	Quad 2 input diode expander	0.35
LU305	6 input NAND	0.35
LU306	Dual 3 input NAND	0.35
LU314	7 input NOR	0.35
LU317	Dual 4 input expandable NOR	0.35
LU333	Dual 3 input expandable OR	0.35
LU334	Dual 4 input expandable NAND	0.35
LU356	Dual 4 input expandable driver	0.35
LU370	Triple 3 input NOR	0.35
LU377	Triple 3 input NAND	0.35
LU387	Quad 2 input NAND	0.35

LINEAR INTEGRATED CIRCUITS

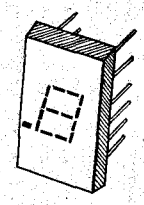
Fairchild and Signetic devices (no choice). Some of this line is not marked but it is fully tested and sold on a money-back guarantee. State first choice on package (TO-5, 8-pin dual in line, or 14-pin DIP—we will not ship flat packs).

NE526	High speed comparator	$1.00
NE565	Phase lock loop	4.25
NE566	Function generator	4.25
NE567	Tone decoder	4.25
709	Popular operational amplifier	0.40
5558	Dual 741 op amp (compensated)	1.25
747	Dual 741 op amp	1.10

LED DISPLAY

The MAN1 is a seven segment diffused planar GaAsP light emitting diode array. It is mounted on a dual in line 14-pin substrate and then encapsulated in clear epoxy for protection. It is capable of displaying all digits and nine distinct letters.

FEATURES:



High brightness, typically 350ft.-L @ 20ma.
Single plane, wide angle viewing, 150°.
Unobstructed emitting surface.
Standard 14-pin dual in line package.
Long operating life, solid state.
Operates with IC voltage requirements.

ONLY $4.25

"UTILOGIC" SPECIAL

Ten (10) pieces of LU321 dual JK flip flops and four pages of application information describing ripple counters (3 to 10) and divide by 12 up/down binary and decade counters, shift registers and self-correcting ring counters.

Complete package only $4.00

LINEAR SPECIAL

Ten (10) 741 fully compensated operational amplifiers with data sheet and two (2) pages of application notes covering the basic circuits for op-amps.

EACH $0.65 PACKAGE $6.00

Please specify first and second choice of: TO-5, 8-pin MINI DIP, 14-pin DIP.

LM309K—5 volt regulator

This TO-3 device is a complete regulator on a chip. The 309 is virtually blowout proof, it is designed to shut itself off with overload of current drain or over temperature operation.

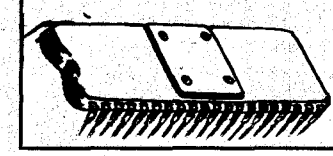
Input voltage (DC) can range from 10 to 30 volts and the output will be five volts (tolerance is worst case TTL requirement) at current of up to one ampere.

EACH $2.50
FIVE for $10.00

LSI—CALCULATOR ON A CHIP

This 40 pin DIP device contains a complete 12 (twelve) digit calculator, Add, Subtract, Multiply, and Divide. Outputs are multiplexed 7 segment MOS levels. Input is BCD MOS levels. External clock is required. Complete data is provided with chip (includes schematic for a complete calculator).

Complete with data, $14.95



Data only $1.00

COUNTER DISPLAY KIT—CD-2

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

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

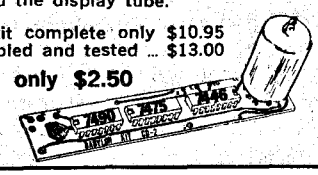
A 7490 decade counter IC is used to give typical count rates of up to thirty MHz. A 7475 is used to store the BCD information during the counting period to ensure a non-blinking display. Stored BCD data from the 7475 is decoded using a 7447 seven segment decoder driver. The 7447 accomplishes blanking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

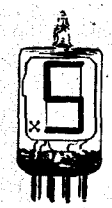
Kit includes a two sided (with plated through holes) fibreglass printed circuit board, three IC's, DR-2010 (with decimal point) display tube, and enough Molex socket pins for the IC's.

Circuit board is .8" wide and 4⅜" long. A single 5 volt power source powers both the IC's and the display tube.

CD-2 kit complete only $10.95
Assembled and tested ... $13.00

Board only $2.50





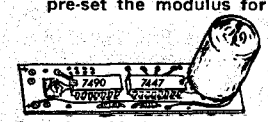
RCA DR2010 Numitron digital display tube. This incandescent five volt seven segment device provides a .6" high numeral which can be seen at a distance of 30 feet. The tube has a standard nine pin base (solderable) and a left-hand decimal point. Each $5.00

SPECIAL 5 for $20

UNIVERSAL COUNTER DISPLAY KIT CD-3

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

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



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IC's 7490, 7447 2.75
RCA DR2010 tube 5.00

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

256 BIT BI-POLAR FIELD PROGRAMMABLE READ ONLY MEMORY

This Signetic No. 8223 IC operates at 5 volts and contains 32 x 8 bit wide ROM which can be field programmed. Each $10.00

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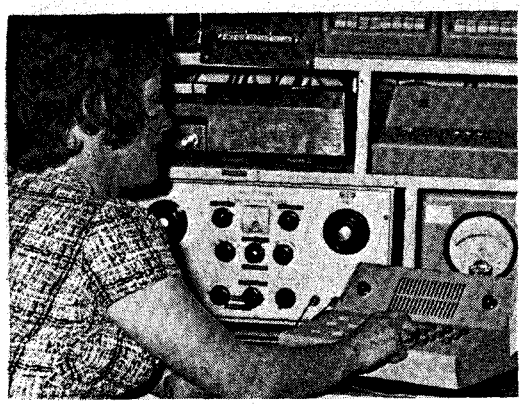
news digest

computer each digit also signifies several letters, since ten digits have to cover all 26 letters of the alphabet. Number 2, for example, has an additional representation in the letters A, B and C. The computer is programmed to recognise meaningful combinations in rows of letters.

In the Siemens model the internal telephone numbers of company location are stored in the computer. When an enquirer wants to know one of these numbers he dials the computer and is asked by the vocoder voice to feed in the surname of the person concerned. If this is sufficient to ascertain the telephone number the vocoder immediately indicates it. If not, the first name is requested and, if necessary, his department.

This development indicates new, unforeseeable possibilities for wide use of speaking computers.

PERSONAL PAGING FOR OLYMPICS



Final tests are carried out at the London based Multitone Electric Company on their new personal paging system which has been specially designed for the Olympic Games in Munich.

The system will operate on a special frequency and incorporate 700 light-weight receivers enabling constant contact to be maintained with the Games' organisers, officials, stewards, pressmen, radio and television commentators, wherever they may be in Munich or its surrounding areas.

The receivers — each only the size of a cigarette packet — are said to be easily carried in the pocket and will receive from a central encoder (shown right) a series of coded 'bleeps' — rapid for urgent and slow for non-urgent calls.

A similar system incorporating 80 receivers will be used for the sailing at Kiel.

news digest

PDP-11 TO CONTROL SYDNEY TRAFFIC

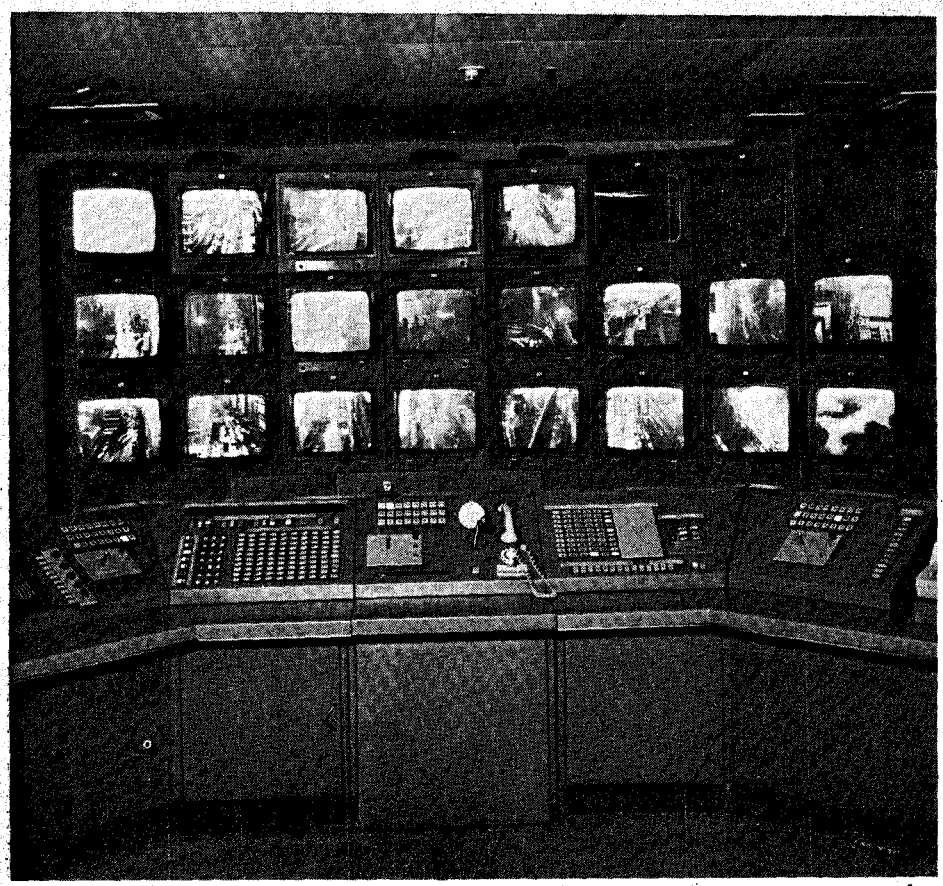
The N.S.W. Department of Motor Transport will install a PDP-11/20 purchased from Digital Equipment Australia Pty Ltd, to control the flow of traffic in Sydney. During the twelve month period from June 1972 the computer will take control of traffic lights at eighty street intersections in the city, gradually replacing the electromechanical system which has operated since 1961.

The department already has another PDP-11/20 which was used by the Traffic Signals Division last year for the developmental work, including program testing. Recently, this computer has been controlling the flow of traffic in Oxford Street as a pilot operation to test the new control system. The installation will be retained for use in designing future extensions.

The electromechanical equipment in use at present represents an average cost of $1,500 for each set of traffic lights, compared with only $700 for the new computer-based system. Maintenance costs are also significantly lower for the new system. Another important advantage of the computer system is that it can be programmed to respond to changes in traffic, so that the flow of vehicles along a major route can be optimized. This approach has been made feasible by the successful development of the induction loop for detecting vehicles as they approach an intersection.

The new control system which will be located at the Traffic Control Centre at Brisbane Street, consists of a PDP-11/20 processor with a 12k word store, a high-speed paper tape reader and punch, a multiplexer, and a general purpose 16-bit interface. Each set of traffic lights will have a 16-bit register for controlling and monitoring. The registers were designed by staff at the Department of Motor Transport, and are connected directly to the traffic lights via the existing control lines. By means of a system of interrupts, each set of lights uses the central processor for about 0.5 per cent of its time.

Approximately 160 sets of lights will be controlled when the system is fully expanded, with control of traffic extending from Edgecliff to Drummoyne. Beyond these limits, regional computer control networks are expected to be built in the future, designed along principles which will have been established at the city Traffic Control Centre.



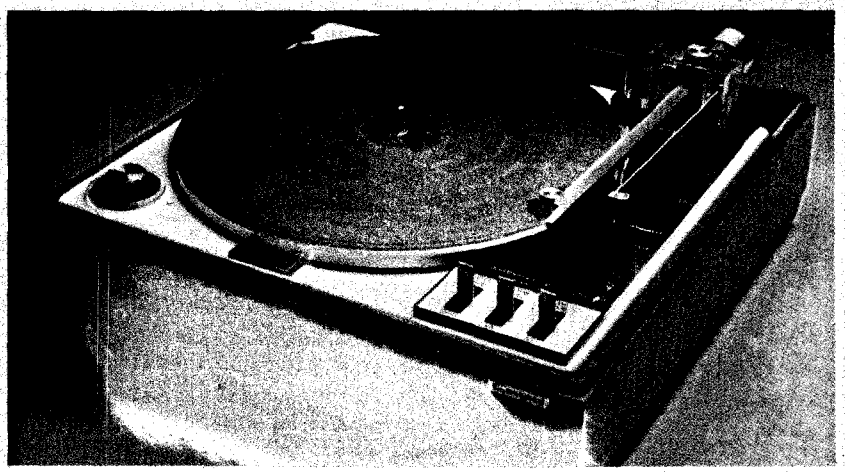
The Garrard Zero-100:* no other turntable can do so much for your Hi-Fi system

Don't take our word for it, read what the experts have to say.

"Now and again, in the world of audio, there comes a piece of equipment that is not only different enough to catch public imagination but also technically sound enough to allay the suspicions of the ultra-conservative. Such a device is the Garrard Zero 100".
Records and Recording (UK)

"A simple list of all the Zero-100 features should serve to spotlight the changes that have been incorporated in this model . . .
15-deg. vertical tracking angle adjustment/ Sliding-weight stylus-force adjustment — easy to adjust as little as one-tenth of a gramme/Magnetic anti-skating control/Spring-loaded tonearm safety restrictor (lock)/Long-taper variable speed control/ Illuminated stroboscope, with two bands of lines, one for each speed/Rotating manual spindle/Proven Synchro-Lab motor-combination of induction and synchronous types/Full-diameter platter/Safe 2-point record support/Handsome combination of chrome, brass and plexiglas for tonearm mounting."
Audio (USA)

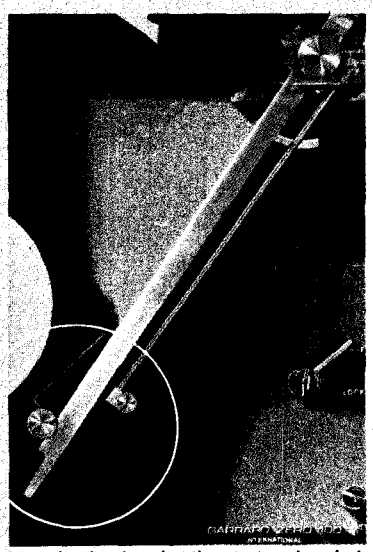
"The most striking feature of the pickup arm, of course, is the auxiliary rod to the right of the straight, rectangular cross-section aluminium arm. This is pivoted at both ends and its effect is to rotate the cartridge housing directly above the stylus tip so that at all points, as the pickup tracks across the record, the plane of the stylus motion remains truly at right angles to the groove. This causes the reproducing stylus to imitate the motion of the cutting stylus very accurately in tracking the recorded waveform, and is in contrast to the normal pivoted arm which tracks in an arc across the record. The angular error is a small, but important, source of harmonic distortion".
The Gramophone (UK)

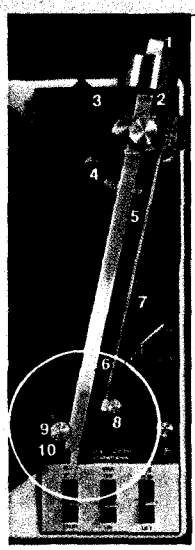


*Also available in a single player version . . . The Zero-100S which incorporates the same outstanding features of the Zero-100 and provides the facility for automatic play of single records.

For more than 50 years Garrard has led the world in turntable technology and provided millions of people with countless hours of listening pleasure. Thorough research, creative product development and rigid quality control have assured Hi-Fi enthusiasts and equipment manufacturers of consistent quality. Makers of the world's finest record players, radiograms and Hi-Fi systems have repeatedly made Garrard turntables the automatic choice for their equipment. Garrard has pioneered and introduced virtually every significant new feature in record playing units, making considerable contributions to the present high standards of high fidelity. Two "Queen's Award to Industry" the "Mercurio d'Oro" (Italy) and "Maker of the Microphone" (USA) are awards presented to Garrard as a result of their engineering achievement and progressiveness.

The models illustrated below are representative of the current advanced range of Garrard turntables. Twelve models are available comprising both automatic and single play versions to suit individual requirements.





The pivoting head at the start and end of a playing cycle.

1. Brass counterbalance weight
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4. Gimballed pivots
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6. Low resonance pickup arm
7. Control arm
8. Control link pivot
9. Pickup head pivot
10. Vertical cartridge angle adjustment (on auto player only)

If you'd like to read our full facts on the Zero-100 write now for colour brochure

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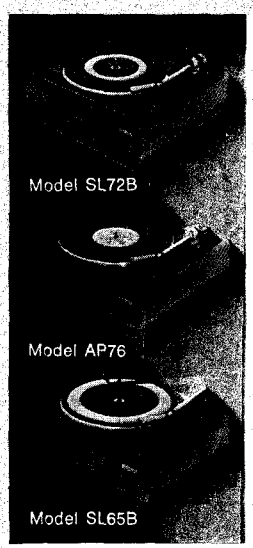
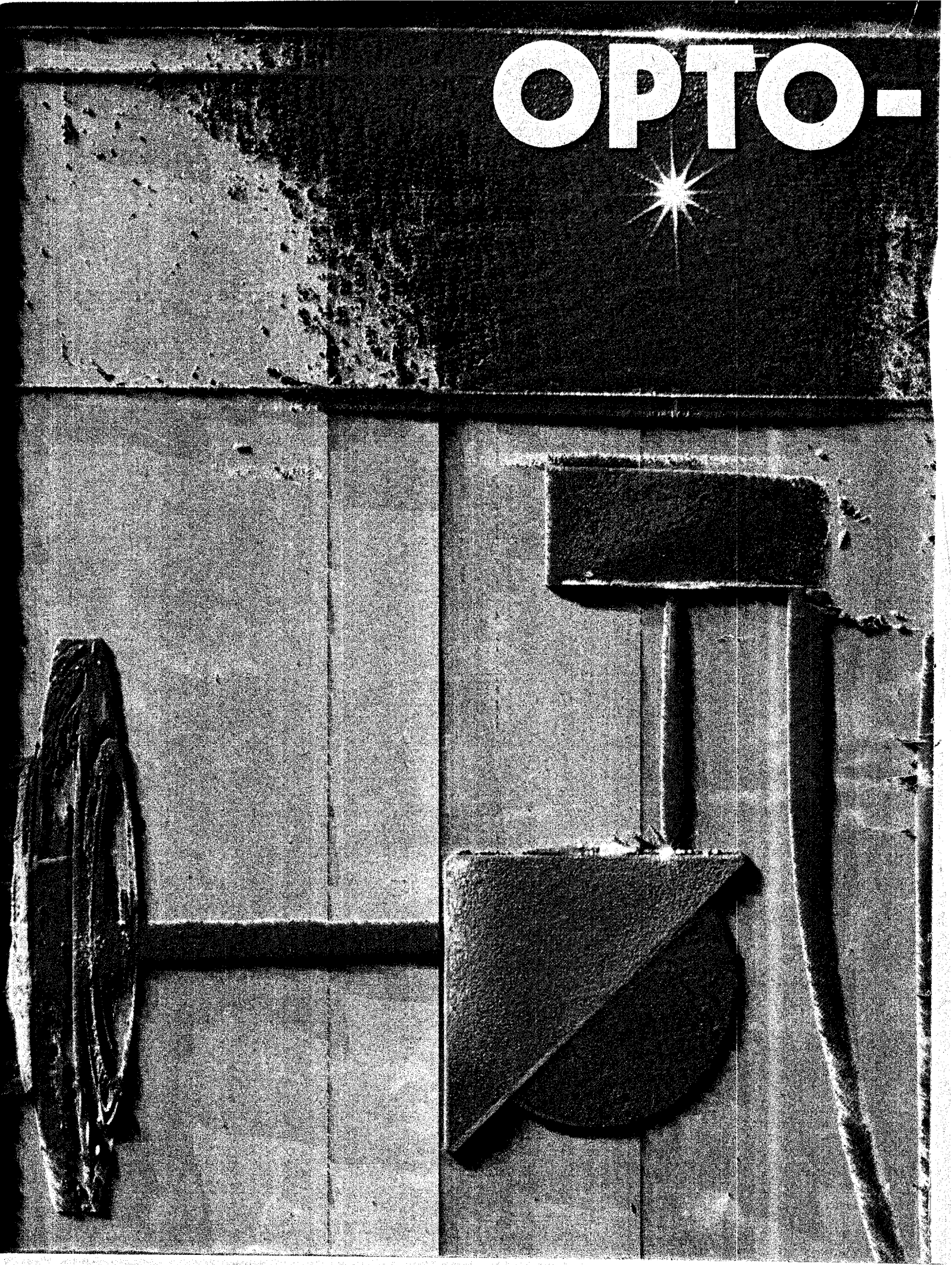


AD 51


OPTO-

ELECTRONICS
- BASIC SYSTEMS

There is an exciting revolution taking place in the electronics industry — that of Optoelectronics. More and more devices based on the transmission and reception of light, or near light radiation, are finding their way into electronic equipment principally because optoelectronic devices offer characteristics unmatched by conventional methods. Factors such as sensitivity, isolation, bandwidth and low power consumption are better attainable by optoelectronic rather than conventional devices in specific applications.

The proliferation of devices and applications is increasing at a greater than exponential rate. We have just begun to learn.

Typical applications include — optical communication links which offer bandwidths of several gigahertz as well as privacy, liquid crystal displays having extremely low power consumption, and a host of applications utilising the coherent light generated by LASERS. Even LASER weapons are with us — it has been reported recently that a ballistic missile was shot down by a powerful LASER.

The developments in optoelectronics are indeed revolutionary and will have a far reaching effect on our technology and our way of life.

Articles in this series will include:—

* **Basic systems**
* **Photosensitive materials and devices**
* **PIN photo diodes**
* **Silicon phototransistors**
* **Light emitting diodes (and displays)**
* **Lasers**
* **Holography**
* **Optical memory systems**
* **Liquid crystal displays**
* **Opto-electronic applications**

IN the design of opto-electronic systems a knowledge of the factors governing transmission and reception of radiant energy is essential. Consider the classical problem of an optical link as shown in Fig. 1.

To properly utilise such a system we must know many factors including the following:—

1) The spectral distribution and radiation pattern of the emitted energy from the source.
2) The characteristics of the optical lens system.
3) The source intensity.
4) The spectral response and sensitivity of the detector.

TABLE 1 — Radiometric and Photometric Terminology

Description	Radiometric	Photometric
Total Flux	Radiant Flux, P. in Watts	Luminous Flux, F. in lumens
Emitted Flux Density at a Source Surface	Radiant Emittance, W. in Watts/cm^2	Luminous Emittance, L in lumens/ft^2 (foot Lamberts), or lumens/cm^2 (Lamberts)
Source Intensity (Point Source)	Radiant Intensity I_r in Watts/steradian	Luminous Intensity, f_L, in lumens/steradian (candela)
Source Intensity (Area Source)	Radiance, Br, in (Watts/steradian)/cm^2	Luminance, B_L, in lumens/steradian)/ft^2
Flux Density incident on a Receiver Surface	Irradiance, H, in Watts/cm^2	(Illuminance, E, in lumens/ft^2 (footcandle)

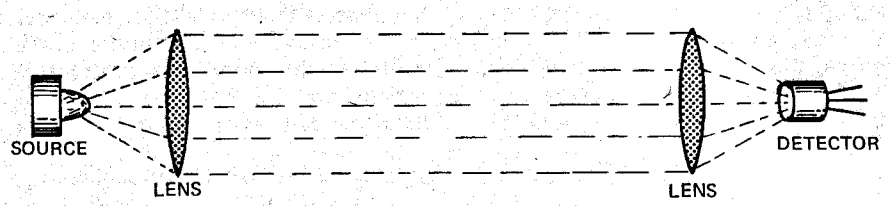


Fig. 1. A basic opto-electronic system.

The majority of these factors are given in manufacturer's data sheets but in addition we must understand how to manipulate the geometric and unit system factors involved. It is the purpose of this article to present a survey of the methods of solving problems such as that above.

The first problem that one meets with, is defining the quality, quantity and directivity of the emitted energy from the source. There are two systems of defining radiated energy in use, these are the Radiometric System and the Photometric System. Although the two systems to some extent describe the same phenomenon

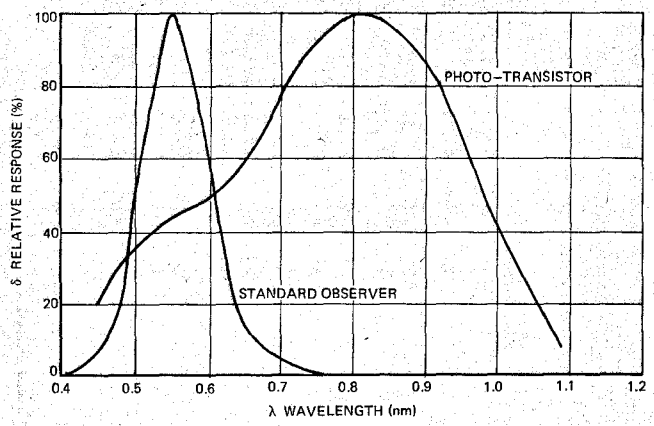


Fig. 2. Spectral response for Standard Observer and a typical phototransistor.

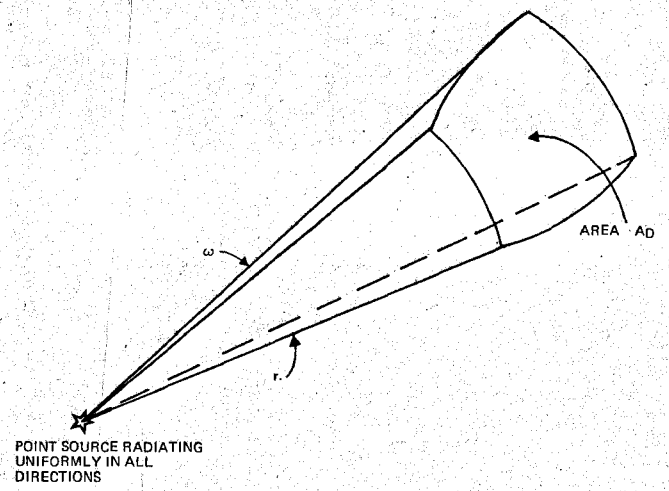


Fig. 3. Point source geometry.

TABLE 2 – Point Source Relationships

Description	Radiometric	Photometric
Point Source Intensity	1_r, Watts/steradian	1_L lumens/Steradin
Incident Flux Density	H (Irradiance) $= \frac{1_r}{r^2}$ Watts / distance^2	E (Illuminance) $= \frac{1_L}{r^2}$ lumens/distance^2
Total Flux Output of Point Source	$P = \pi 1_r$ Watts	$F = 4\pi 1_L$ lumens

they are entirely different, but both are essential and useful.

The photometric system defines energy relative to its visual effect. As an example, light from a standard 60-watt bulb is certainly visible, and as such, has finite photometric quantity, whereas radiant energy from a 60-watt resistor is not visible and has zero photometric quantity. Both items have finite radiometric quantity.

The defining factor for the photometric system is the spectral response curve of a standard observer. This is shown in Figure 2 and is compared with the spectral response of a typical phototransistor. The defining spectral response of the radiometric system can be imagined as unit response for all wavelengths.

A comparison of the terminology for the two systems is given in Table 1.

There exists a relationship between the radiometric and photometric quantities such that at a wavelength of 550nm, the wavelength of peak response for a standard observer, one watt of radiant flux is equal to 680 lumens of luminious flux. For a broadband of radiant flux, the visually effective, or photometric flux is given by integrating with respect to wavelength, the spectral response curve of the device multiplied by that for the standard eye.

A similar integral can be used to convert incident radiant flux density, or irradiance, to illuminance:

Fortunately, it is usually not necessary to perform the above integrations. The photometric effect of a radiant source can often be measured directly with a photometer.

Unfortunately, most phototransistors are specified for use with the radiometric system. Therefore, it is often necessary to convert photometric source data, such as the lumen rating of an incandescent lamp to radiometric data. This will be discussed shortly.

GEOMETRIC CONSIDERATIONS

In the design of electro-optic systems, the geometrical relationships are of prime concern. A source will effectively appear as either a point source, or an area source, depending upon the relationship between the size of the source and the distance between the source and the detector.

Point Sources

A point source is defined as one for which the source diameter is less than ten percent of the distance between the source and the detector.

Figure 3 depicts a point source radiating uniformly in every direction. The detector area, A_D can be approximated as a section of the area of a sphere of radius r whose center is the point source.

The solid angle, ω, in steradians subtended by the detector area is

$$\omega = \frac{A_D}{r^2}$$

Since a sphere has a surface area of $4\pi r^2$, the total solid angle of a sphere is

$$\omega S = \frac{4\pi r^2}{r^2} = 4\pi \text{ steradians}$$

Table 2 lists the design relationships for a point source in terms of both radiometric and photometric quantities.

The above discussion assumes that the photodetector is aligned such that its surface area is tangent to the sphere with the point source at its centre. It is entirely possible that the plane of the detector can be inclined from the

TABLE 3 – Design Relationships for an Area Source

Description	Radiometric	Photometric
Source Intensity	B_r, Watts/cm^2/steradian	B_L, lumens/cm^2 steradian
Emitted Flux Density	$W = \pi B_r$, Watts/cm^2	$L = -B_L$, lumens/cm^2
Incident Flux Density	$H = \frac{B_r A_s}{r^2 + \frac{d^2}{2}}$ Watts/cm^2	$E = \frac{B_L A_s}{r^2 + \frac{d^2}{2}}$, lumens/cm^2

TABLE 4 Conversion Factors

I

Illuminance Units

	lux (lx.)	phots (ph.)	foot-candles (ft.-c)
Lux (metre-candles) lm/m² -	1	0.001	0.0929
Phots (1m/cm²) - - -	10,000	1	929
Foot-candles (lm/ft²) - -	10.764	0.001076	1

II

Luminance Units

	nits cd/m²	stilbs (sb.)	cd/in²	cd/ft²	millilamberts (mL.)	foot-lamberts (ft.-L.)	apostilbs (asb.)
Candelas per sq.m.(nits)	1	0.0001	0.000645	0.0929	0.3142	0.2919	3.1416
Stilbs (cd/cm²)	10,000	1	6.452	929	3141.6	2919	31,416
Candelas per sq. in.	1550	0.155	1	144	486.9	452.4	4869
Candelas per sq. ft.	10.764	0.001076	0.00694	1	3.382	3.1416	33.82
Millilamberts	3.183	0.0003183	0.002054	0.2957	1	0.929	10
Foot-lamberts	3.426	0.0003426	0.002211	0.3183	1.0764	1	10.764
Apostilbs	0.3183	0.00003183	0.0002054	0.02957	0.1	0.0929	1

(Value in unit in left-hand column) x (conversion factor) = (value in unit shown at top of column).

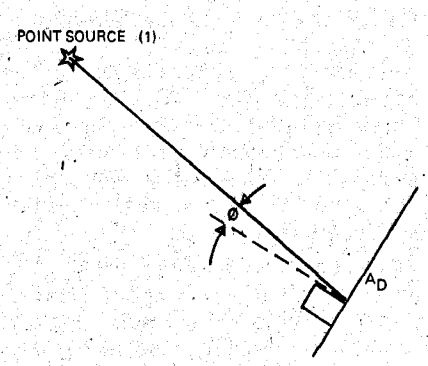


Fig. 4. Detector not normal to source direction.

tangent plane. Under this condition, as depicted in Figure 4, the incident flux density is proportional to the cosine of the inclination angle, Φ. Therefore,

$$H = \frac{I_r}{r^2} \cos \Phi, \text{ and}$$

$$E = \frac{I_L}{r^2} \cos \Phi.$$

AREA SOURCES

When the source has a diameter greater than 10 percent of the separation distance, it is considered to be an area source. This situation is shown in Figure 5. Table 3 lists the design relationships for an area source.

LENS SYSTEMS

A lens can be used with a photodetector effectively to increase the irradiance on the detector. As shown in Figure 6a, the irradiance on a target surface for a point source of intensity, I, is

$$H = I/d^2$$

where d is the separation distance.

In Figure 6b a lens has been placed between the source and the detector. It is assumed that the distance d' from the source to the lens is approximately equal to d, and the solid angle subtended at the source is sufficiently small to consider the rays striking the lens to be parallel.

If the photodector is circular in area, and the distance from the lens to the detector is such that the image of the source exactly fills the detector surface area, the radiant flux on the detector (assuming no lens loss) is

$$P_D = P_L = H' \pi r_L^2,$$

where

P_D is the radiant flux incident on the detector.

P_L is the radiant flux incident on the lens.

H' is the flux density on the lens, and

rL is the lens radius.

Using equation (12),

$$H' = 1/d^2 = H.$$

The ratio of irradiance on the detector with a lens to the irradiance without a lens is given by:—

$$\frac{H_D}{H} = \frac{r_L}{r_d}^2$$

That is, if the lens radius is greater than the detector radius, the lens provides an increase in incident irradiance on the detector. To account for losses in the lens, the ratio is reduced by about ten percent.

$$R = 0.9 \frac{r_L}{r_d}^2$$

where R is the gain of the lens system.

It should be pointed out that arbitrary placement of a lens may be more harmful than helpful. That is, a lens system must be carefully planned to be effective.

For example, the phototransistor usually contains a lens which is effective when the input is in the form of parallel rays (as approximated by a uniformly radiating point source). Now, if a lens is introduced in front of the phototransistor as shown in Figure 7, it will provide a non-parallel ray input to the transistor lens. Thus the net optical circuit will be misaligned. The net irradiance on the phototransistor chip may in fact be less than without the external lens.

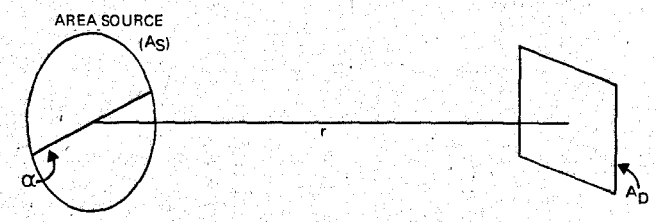


Fig. 5. Area source geometry.

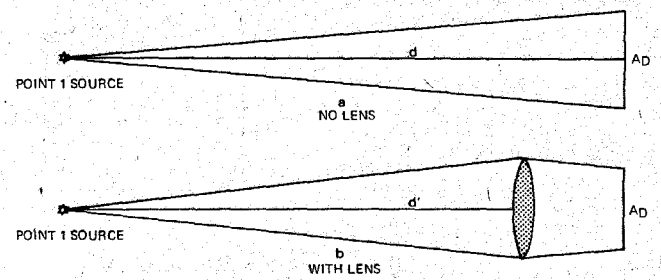
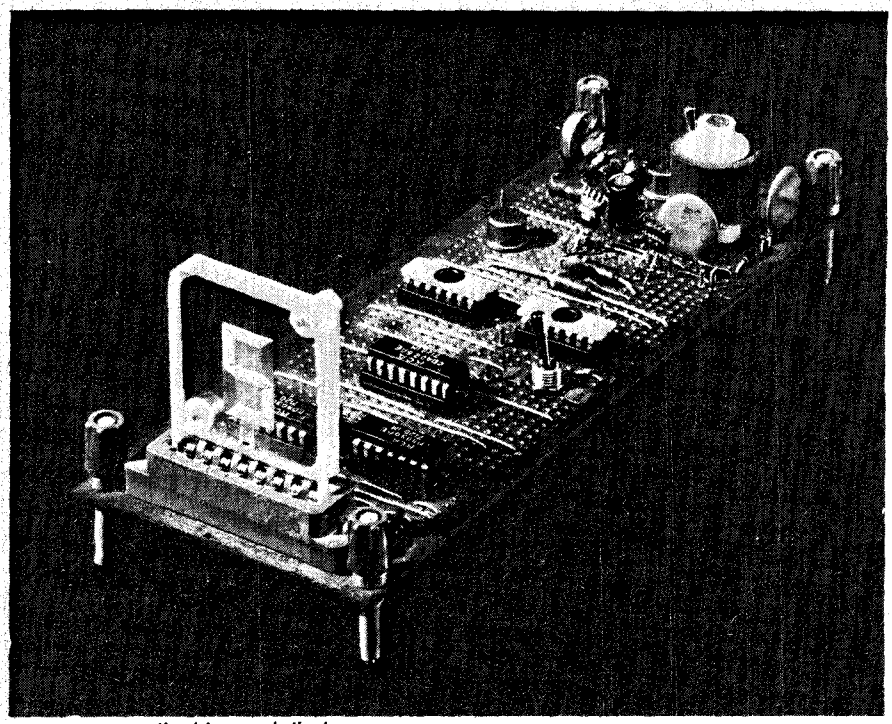


Fig. 6. Use of lens to increase the irradiance on the detector.



Demonstration liquid crystal display

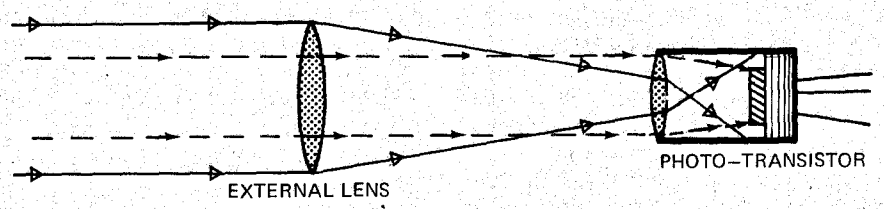


Fig. 7. Possible misalignment due to the arbitrary use of an external lens. Dotted lines indicate performance without lens.

The circuit of Figure 8 does show an effective system. Lens 1 converges the energy incident on its surface to lens 2 which reconverts this energy into parallel rays. The energy entering the phototransistor lens as parallel rays is the same (neglecting losses) as that entering lens 1. Another way of looking at this is to imagine that the phototransistor surface has been increased to a value equal to the surface area of lens 1.

FIBRE OPTICS

Another technique for maximizing the coupling between source and detector is to use a fibre optic bundle to link the phototransistor to the light source. The operation of fibre optics is based on the principle of total internal reflection.

Figure 9 shows an interface between two materials of different indices of refraction. Assume that the index of refraction, n, of the lower material is greater than that, n', of the upper material. Point P represents a point source light radiating uniformly in all directions. Some rays from P will be directed at the material interface.

At the interface, Snell's law requires:

$$n \sin \theta = n' \sin \theta',$$

where

θ is the angle between a ray in the lower material and the normal to the interface,

and

θ is the angle between a refracted ray and the normal. By rearranging we obtain

$$\sin \theta' = \frac{n}{n'} \sin \theta.$$

By assumption, n/n' is greater than one, so that

$$\sin \theta' > \sin \theta$$

However, since the maximum value of sin θ' is one and occurs when θ' is 90°, θ' will reach 90° before θ does. That is, for some value of θ, defined as the critical angle, θC, rays from P do not cross the interface. When $\theta > \theta C$, the rays are reflected entirely back into the lower material, or total internal reflection occurs.

Figure 10 shows the application of this principle to fibre optics. A glass fibre of refractive index n is clad with a layer of glass of lower refractive index, n'. A ray of light entering the end of the cable will be refracted as shown. If, after refraction, it approaches the glass interface at an angle greater than θC, it will be reflected within the fibre. Since the angle of reflection must equal the angle of incidence, the ray will bounce down the fibre and emerge, refracted, at the exit end.

The numerical aperture, NA, of a fibre is defined as the sine of the half angle of acceptance. Application of Snell's law at the interface for θ_C, and again at the fibre end will give.

$$NA = \sin \Phi = \sqrt{n^2 - n'^2}.$$

For total internal reflection to occur, a light ray must enter the fibre within the half angle θ.

Once a light ray is within the fibre, it will suffer some attenuation. For glass fibre, an absorption rate of from five to ten per cent per foot is typical. There is also an entrance and exit loss at the ends of the fibre which typically result in about a thirty per cent loss.

As an example, an illuminance at the source end of a three-foot fibre bundle would appear at the detector with a loss of 50%. This assumes an absorption loss of ten percent per foot.

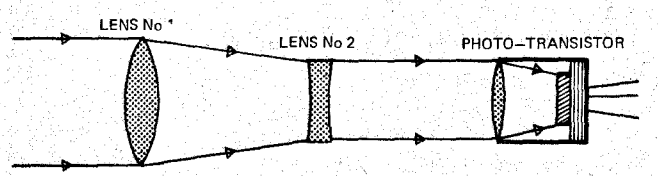


Fig. 8. An effective lens system for phototransistors.

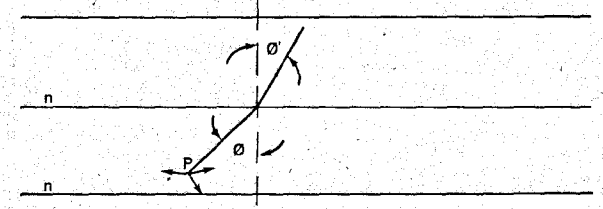


Fig. 9. Ray refraction at an interface.

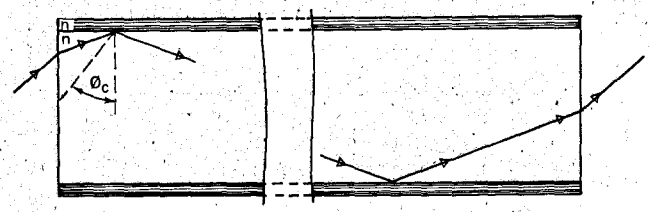


Fig. 10. Refraction in an optical fibre.

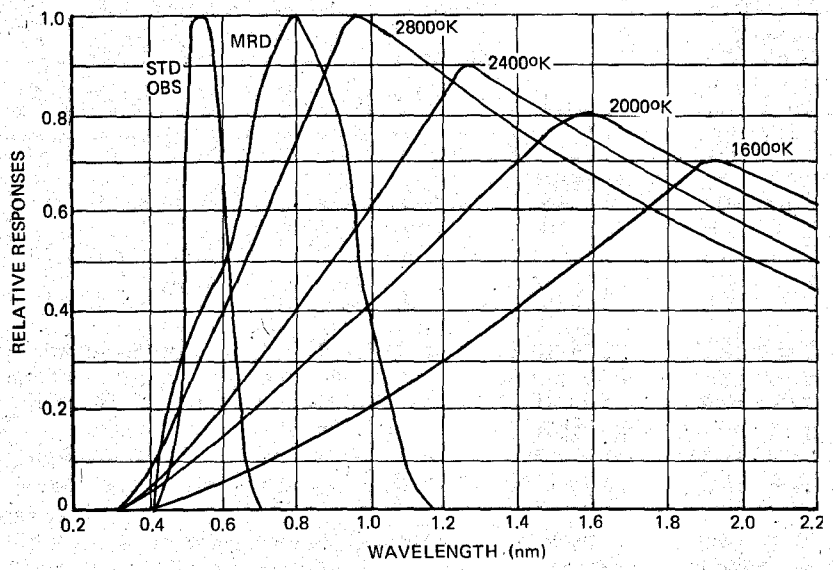


Fig. 11. Radiant spectral distribution of a tungsten lamp.

TUNGSTEN LAMPS

Tungsten lamps are often used as radiation sources for photodetectors. The radiant energy of these lamps is distributed over a broad band of wavelengths. Since the eye and the phototransistor exhibit different wavelength-dependent response characteristics, the effect of a tungsten lamp will be different for both. The spectral output of a tungsten lamp is very much a function of colour temperature.

Colour temperature of a lamp is the temperature required by an ideal blackbody radiator to produce the same visual effect as the lamp. At low colour temperatures, a tungsten lamp emits very little visible radiation. However, as colour temperature is increased, the response shifts towards the visible spectrum. Figure 11 shows the spectral distribution of tungsten lamps as a function of colour temperature. The lamps are operated at constant wattage and the response is normalized to the response for both the standard observer and a typical phototransistor series are also plotted. Graphical integration of the product of the standard observer response and the pertinent source distribution from Figure 11 will provide a solution to the flux and irradiance problems referred to earlier.

Effective irradiance

Although the sensitivity of a photodetector to an illuminant source is frequently provided, the sensitivity to an irradiant source is more common. Thus, it is advisable to carry out design work in terms of irradiance. However, since the spectral response of a source and a detector are, in general, not the same, a response integration must still be performed. The integral is similar to that for photometric evaluation, and again, such an integration is best evaluated graphically.

Graphical integrations have been performed for the Motorola MRD series of phototransistors for several values of lamp colour temperature. The results are given in Figures 12 and 13 in terms of ratios. Figure 12 provides the irradiance ratio, H_E/H versus colour temperature. As the curve shows, a tungsten lamp operating at 2600°K is about 23.6% effective on the MRD series devices. That is, if the broadband irradiance of such a lamp is measured at the detector and found to be 20 mW/cm², the transistor will effectively see

$$H_E = 0.236\ (20) = 4.72\ \text{mW/cm}^2$$

The specifications for the MRD phototransistor series include the correction for effective irradiance. For example, the MRD450 is rated for a typical sensitivity of 0.8 mA/mW/cm². This specification is made with a tungsten source operating at 2870°K and providing an irradiance at the transistor of 5.0mW/cm². Note that this will result in a current flow of 4.0mA.

However, from Figure 12, the effective irradiance is

$$H_E = (5.0)(.255) = 1.28\text{mW/cm}^2$$

By using this value of H_E and the typical sensitivity rating it can be shown that the device sensitivity to a monochromatic irradiance at the MRD450 peak response of 800nm is

$$S = \frac{I_C}{H_E} = \frac{4.0\text{mA}}{1.28\text{mW/cm}^2} =$$

$$3.13\text{mA/mW/cm}^2$$

Now, as shown previously, an irradiance of 20 mW/cm² at a colour temperature of 2600°K looks like

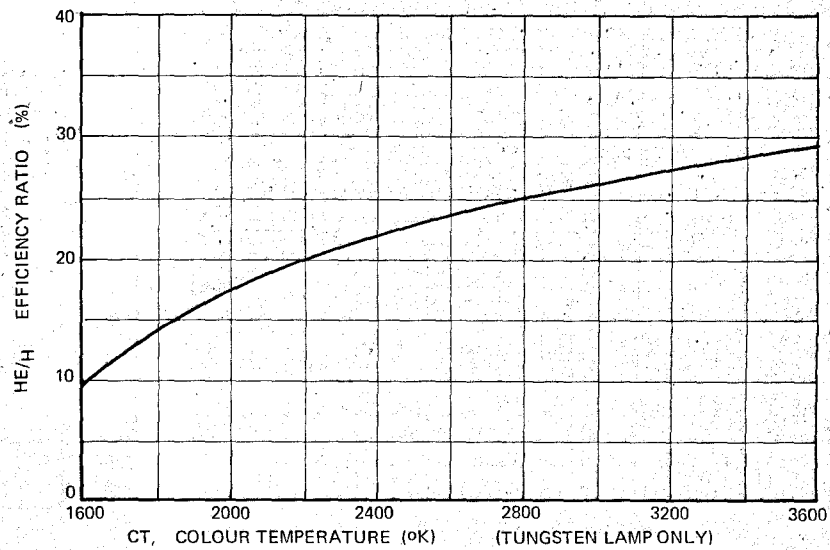


Fig. 12. Phototransistor irradiance ratio versus colour temperature.

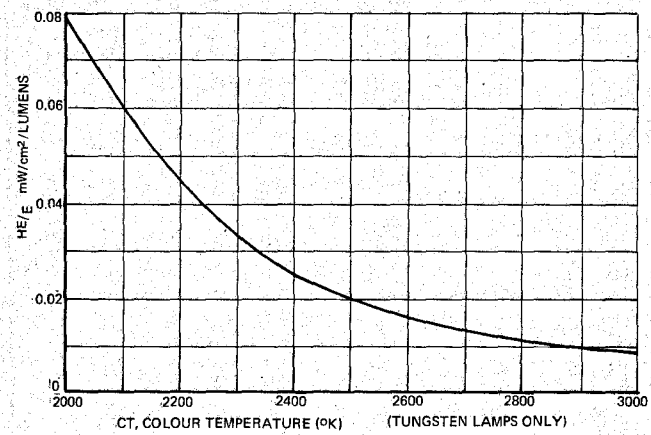


Fig. 13. Phototransistor irradiance/illuminance ratio versus colour temperature.

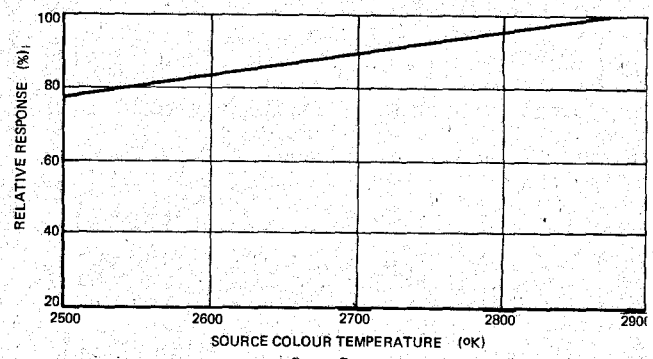


Fig. 14. Relative phototransistor response versus colour temperature.

monochromatic irradiance at 800nm of 4.72 mW/cm². Therefore, the resultant current flow is

$$I = SH_E\ (3.13)(4.72) = 14.4\ mA$$

An alternate approach is provided by Figure 14. In this figure, the relative response as a function of colour temperature has been plotted. As the curve shows, the response is down to 83% at a colour temperature of 2600°K. The specified typical response for the MRD450 at 20mW/cm² for a 2870°K tungsten source is 0.9mA/mW/cm². The current flow at 2600°K and 20 mW/cm² is therefore

$$I = (0.83)(0.9)(20) = 14.9mA$$

This value agrees reasonably well with the result obtained earlier. Similarly, Figure 13 will show that a current flow of 6.67 mA will result from an illuminance of 125 lumens at a colour temperature of 2600°K.

Determination of Colour Temperature — It is very likely that a circuit designer will not have the capacity to measure colour temperature. However, with a voltage measuring capability, a reasonable approximation of colour temperature may be obtained. Figure 15 shows the classical variation of lamp current, candlepower and lifetime for a tungsten lamp as a function of applied voltage. Figure 16 shows the variation of colour temperature as a function of the ratio.

$$\rho = \frac{MSLP}{WATT}$$

where

MSLP is the mean spherical lumens at the lamp operating point and WATT is the lamp IV product at the operating point.

As an example, suppose an indicator lamp is used as a source for a phototransistor. To extend the lifetime, the lamp is operated at 80% of rated voltage.

Rated Volts	Rated Current	MSL
6.3V	150mA	0.52 approx.

Geometric Considerations

The lumen ratings on most lamps are obtained from measuring the total lamp output in an integrating sphere and dividing by the unit solid angle. Thus the rating is an average, or mean-spherical-lumens. However, a tungsten lamp cannot radiate uniformly in all directions, therefore,

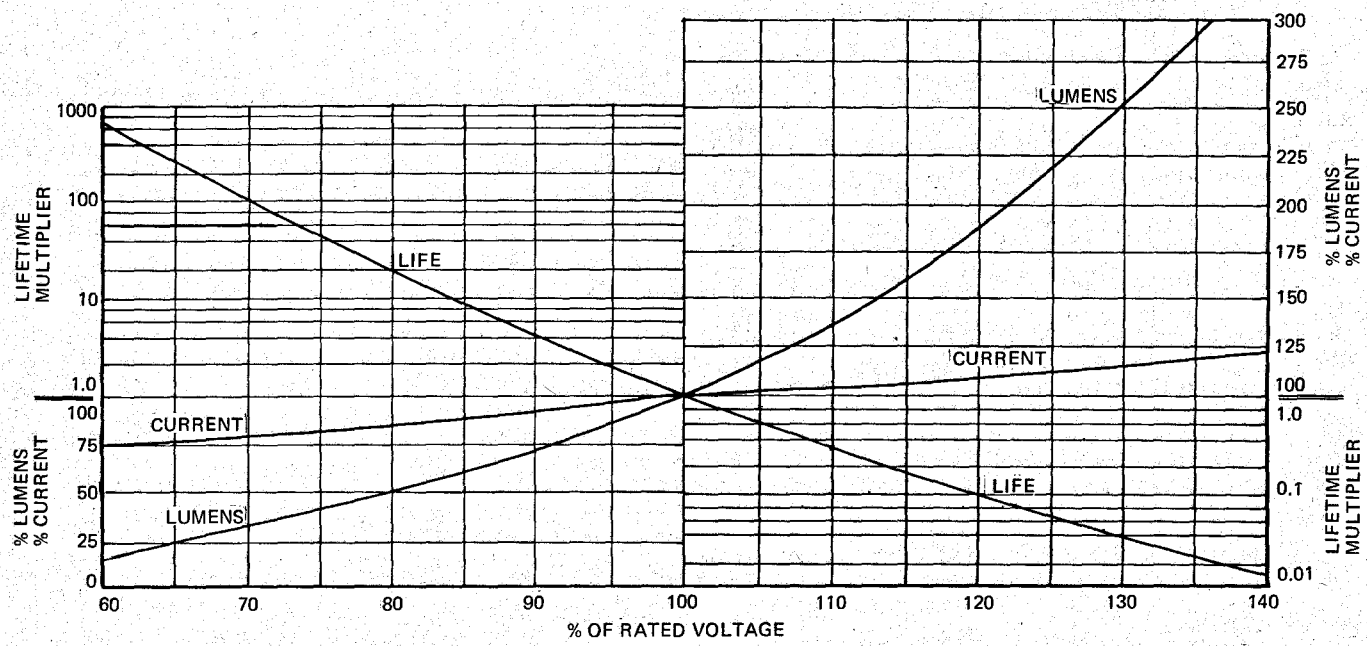
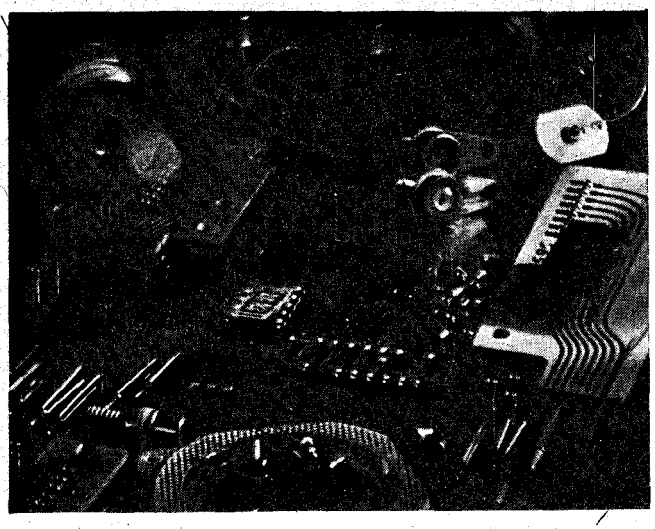


Fig. 15. Tungsten lamp parameter variations versus rated voltage variations.



Various opto-electronic devices in the Texas Instruments range.

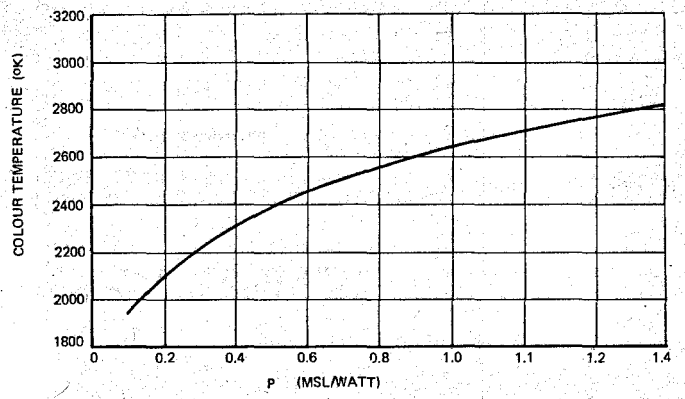


Fig. 16. Colour temperature versus candle power/power ratio.

the lumen rating varies with the lamp orientation. Figure 17 shows the radiation pattern for a typical frosted tungsten lamp.

The circular curve simulates the output of a uniform radiator, and contains the same area as the lamp polar plot. It indicates that the lamp horizontal output is about 1.33 times the rated MSL, while the vertical output, opposite the base, is 0.48 times the rated MSL.

The actual polar variation for a lamp will depend on a variety of physical features such as filament shape, size and orientation and the solid angle intercepted by the base with respect to the centre of the filament.

If the lamp output is given in horizontal lumens (HLR), a fairly accurate calculation can be made with regard to illuminance on a receiver.

A third-form of rating is beam lumens, which is provided for lamps with reflectors.

In all three cases the rating is given in lumens/steradian or candlepower.

SOLID STATE SOURCES

In contrast with the broadband source of radiation of the tungsten lamp, solid state sources provide relatively narrow band energy. The gallium arsenide (GaAs) light-emitting-diode (LED) has spectral characteristics which make it a favourable mate for use with silicon photodectors. LED's are available for several wavelengths, as shown in Figure 18, but as the figure shows, the GaAs diode and the phototransistor are particularly compatible.

The GaAs response and the MRD series response indicates that the efficiency ratio, H_E/H, is approximately 0.9 or 90%. That is, an irradiance of 4.0 mW/cm² from an LED will appear to the phototransistor as 3.6 mW/cm². This means that a typical GaAs LED is about 3.5 times as effective as a tungsten lamp at 2870°K. Therefore, the typical sensitivity for the MRD450 when used with a GaAs LED is approximately

$$S = (0.8)(3.5) = 2.8\text{mA/mW/cm}^2$$

An additional factor to be considered in using LED's is the polar response. The presence of a lens in the diode package will confine the solid angle of radiation. If the solid angle is θ, the resultant irradiance on a target located at a distance d is

$$H = \frac{4P}{\pi\theta^2 d^2} \text{ watts/cm}^2,$$

where

P is the total output power of the LED in watts
θ is the solid angle in steradians, and
d is the distance between the LED and the detector in cm. ●

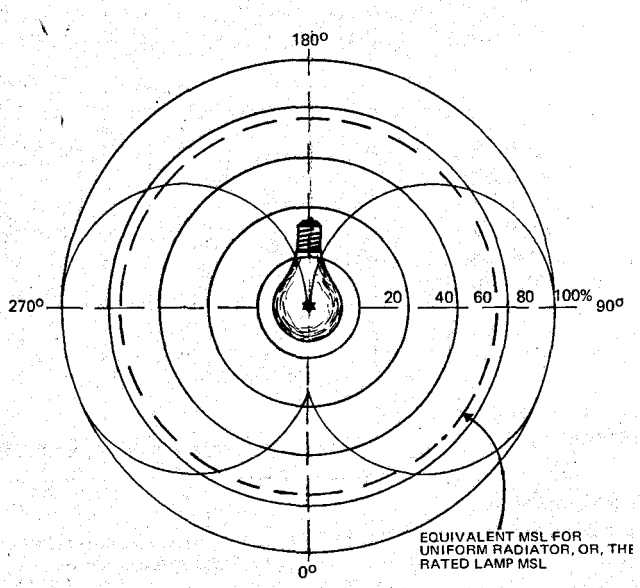


Fig. 17. Typical radiation pattern for a frosted incandescent lamp.

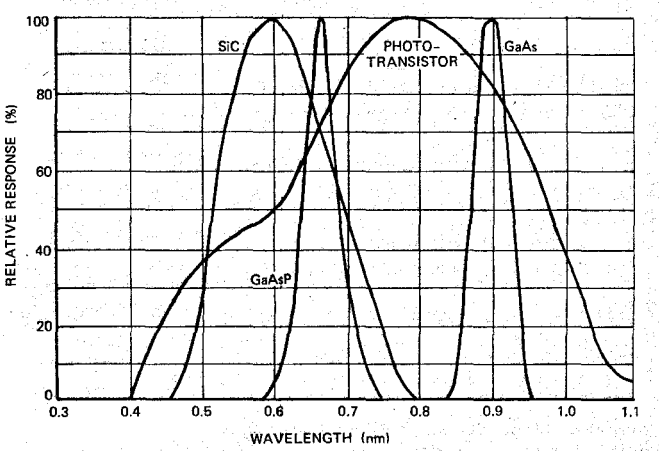
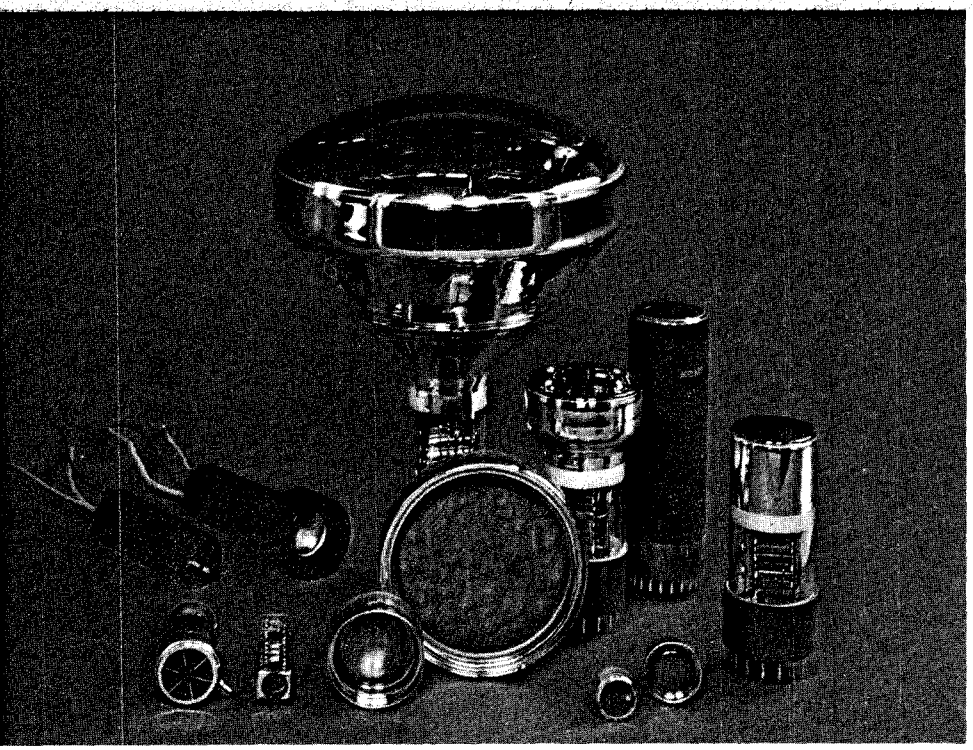


Fig. 18. Spectral characteristics for several LEDs compared with response of a typical phototransistor.

OPTO-ELECTRONICS

PHOTO SENSITIVE MATERIALS AND DEVICES



Part of the range of Philips' Photomultipliers.

In this article we discuss the various methods and equipment used in the detection and measurement of light and near light radiation.

THERE are many materials and devices which are in use now, or have been in the past, for converting light or near-light radiation directly into electrical energy. These photosensor devices may be grouped into three broad categories:—

1) Photo emissive
2) Photo voltaic
3) Photo conductive

PHOTO EMISSIVE DEVICES

The basic form of photoemissive device is similar to an ordinary vacuum tube diode in that it is a two electrode device and is built into a glass envelope which may be either highly evacuated, or filled with an inert gas.

The vacuum devices are used in instruments specifically designed for the precise measurement of illumination levels, whereas the gas filled devices are generally used in switching-mode designs where a large photo-current change is required with small changes of incident illumination. Typical applications of gas filled photodiodes are in flame-failure detectors and burglar alarms.

The structure of a typical photo-diode is as shown in Fig. 1. A single rod or loop of wire forms the anode. The cathode, a curved metal plate located behind the anode, is coated with an emissive material which will liberate free electrons in proportion to the amount of incident light. These electrons are attracted to the anode, which is at a positive potential with respect to the cathode, and hence a current flows through the external circuit, again proportional to the incident light level.

Two types of alkali-earth materials are used for the cathode coating, depending on the spectral response required. These are:—

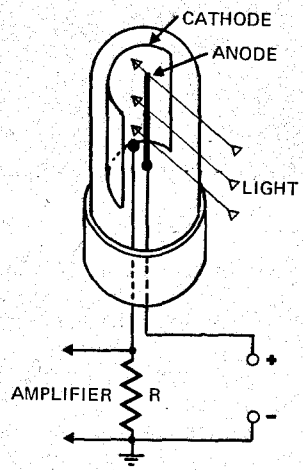


Fig. 1a. Photo-emissive vacuum-tube diode.

1) Caesium-antimony (blue sensitive)
2) Caesium-oxidised silver (red sensitive).

Dark Current

Some current flows due to thermionic emission and leakage without any illumination incident on the cell. This current, known as the *dark current*, varies with ambient temperature and applied voltage and is the factor which limits the ultimate sensitivity of the cell.

The Photomultiplier Tube

Photo emissive diodes have largely been replaced by their solid-state counterparts, but there are some

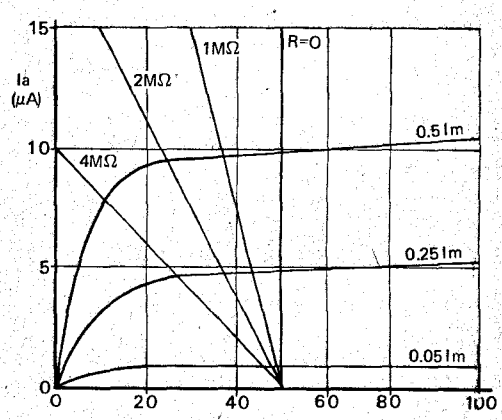
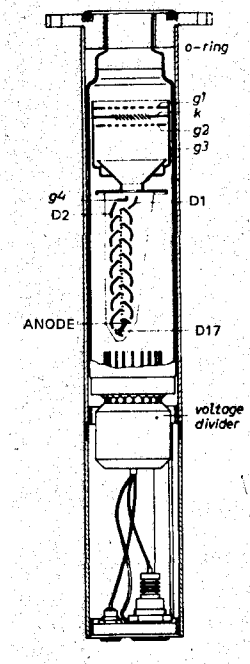
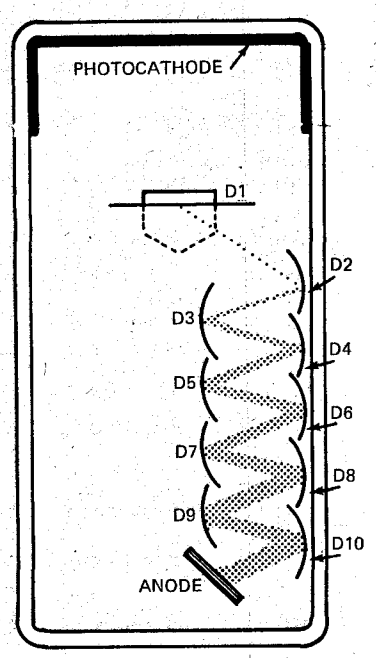


Fig. 1b. Characteristics of vacuum-tube photo-emissive diode with various load resistors.





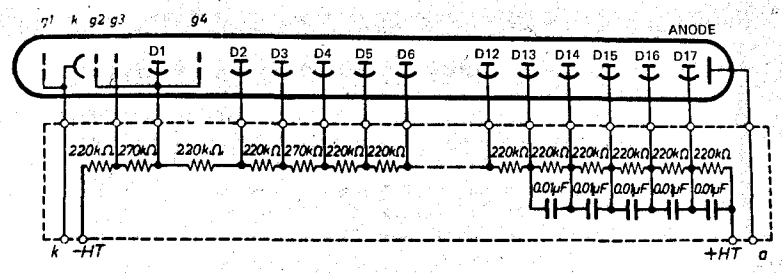


Fig. 3. Power supply divider chain for photomultiplier.

Fig. 2b. Illustration of electron multiplication process of photomultiplier.

Fig. 2a. Construction of typical photomultiplier tube (Philips).

devices, developments of the basic photo-emissive diode which are still widely used in observatories etc for the measurement of extremely low light levels. This is the photomultiplier tube — these devices have gains of the order of 10^8 and offer signal to noise ratios virtually unmatched by photo-semiconductor/amplifier combinations. The construction of a typical photomultiplier is shown in Fig. 2.

The cathode of the photomultiplier has a coating of translucent alkali-earth material (caesium antimonide) on the inner surface of the faceplate. Incident light, passing through the face plate, releases electrons that are attracted to electrode D1 which is at a positive potential with respect to the cathode. These electrons impinging on D1 release secondary emission electrons that are attracted to D2 which is held at a higher potential than D1. The process continues with electron multiplication occuring at each stage. The intermediate elements commonly called dynodes, are coated with emissive material, the number of dynodes depends on the application and is usually between 9 and 14. Using this principle photomultipliers can achieve sensitivities better than 125 microamps per lumen. This high sensitivity means that the tube cannot be connected to the power supply under normal light conditions without damage. A luminous flux of less than 10^{-5} lumen is sufficient to cause the maximum permissible anode current to be exceeded.

The photomultiplier is obviously a valuable tool for the detection and measurement of very low light and radiation levels. The device is much used by astronomers and is capable of detecting and measuring single photons and particles.

Photomultipliers do have some disadvantages however, some of these are:—

1) with tubes having 9-14 dynodes a supply of 1500 to 2100 volts is required (150V per dynode).

2) the supply must be extremely well regulated. If a gain stability of 1% is required, a supply with a regulation of 0.1% must be provided. That is power supply regulation must be 10 times better than the accuracy required.

3) an external divider must be provided to give the necessary electrode voltage steps. Fig. 3.

4) the device must be switched on for at least half an hour before use to allow the dark current to stabilise.

Channel Electron Multiplier.

The channel electron multiplier, a relatively new device, is particularly suitable for the detection of low level radiation in the ultra-violet and soft X-ray regions (1500 to 2Å). The operating principle is similar in many ways to that of the photomultiplier tube but it is physically much simpler and smaller (an inch or so in diameter) and does not require a resistive divider.

The device is essentially a small curved glass tube, the inside of which is coated with a high resistivity material. When a potential is applied between the ends of the tube, the resistive surface becomes a continuous dynode, electrically analogous to the separate dynodes of the photomultiplier together with the resistive divider chain used to establish the separate dynode potentials.

The channel electron multiplier operates happily in a vacuum. For space research the environmental vacuum is sufficient, and there is then no window separating the multiplier from the radiation source with consequent loss of sensitivity. The devices were in fact used as the principal charged particle detector in the Apollo mission lunar environment experiments and have also found use in rocket-probe investigations of plasma in auroral zones.

Operation of the device is as follows — an electron (or other charged particle) entering the low potential end of the channel multiplier, generates secondary emission electrons on collision with the wall of the tube (Fig. 4). These are accelerated along the tube until they strike the wall again, where further secondary emission electrons are generated. This process is hence similar to that in the photomultiplier, but — the number of collisions and therefore stages of multiplication is indeterminate due to the number of different electron paths possible. Hence the principle application of this device *is to produce an output pulse for each incident charged particle.* It is therefore primarily a particle counter without the photomultiplier's ability to measure energy levels accurately. It can be compared in some measure to the geiger counter.

The devices are typically operated in

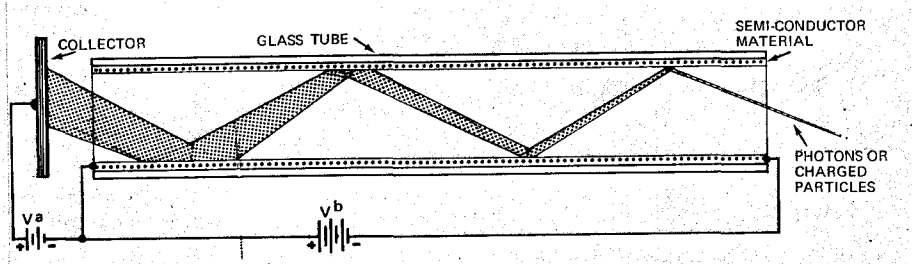


Fig. 4. Operating principle of basic electron multiplier.

OPERATING CHARACTERISTICS OF LIGHT—SENSITIVE DEVICES

Parameter	Photo-transistor S1 (PNP or NPN)	Photodiode S1	Photo SCR	Photovoltaic & S1	Photoconductive Selenium	Photo-conductive Only Cd S, Cd Se	Photoemissive (Photo-tubes Etc.)
Fatigue or Hysteresis	None	None	None	None	Fatigue: Worst Case: (R_{Load} — $R_{Int.}$)	Hysteresis: Conductance function of the cell's exposure to light & duration.	Anode current decreases with time.
Bilateral Electrical Characteristic	No	No	No	No	No	Yes	No
Maximum Operating Temperature.	125°C	125°C	100°C	150°C	Continuous 85°C Intermittent 100°C	75°C	75°C to 100°C
Maximum Voltage	50 VDC	100 VDC	200 V_{BO} See Note 1	V_R=1-5V See Note 3	V_R=1-2V See Note 3	Up to 1000V	2800V (Anode)
Current Capability	1-50 mA	50-200μA at 200 mW/cm²	1.4 A	1 A See Note 2	150 mA	10 mA-1.0A	Up to 10 mA
Power Dissipation	50-400 mW	Up To 50 mW	2 Watts	Up To 400 mW See Note 3	75 mW	50 mW-25 Watts	10 mW-1 Watt
Frequency Capability	200 KHZ	200 KHZ (Pin Device up to 10 MHZ)	1 KHZ	50 KHZ	5 KHZ	1kHz	10MHz
Rise Time and Fall Time	2-100 μ Sec.	Up To 2 μ Sec.	2 μ Sec.	0.5-100 μ Sec.	1 m Sec.	0.2 to 100 m Sec.	0.1 μ Sec.
Spectral Response	Visible To Near IR	Visible To Near IR	Visible To Near IR	Visible To Near IR	UV To Near IR	Visible To Near IR	UV To IR
Color Sensitivity	More Red Than Blue	More Red Than Blue	More Red Than Blue	More Red Than Blue With Filter & Heat Absorbing Glass Approx. Std. Obs. Curve	More Blue Than Red with Kodak Wraten Filter #G1 Approx. Std. Obs. Curve.	More Red Than Blue	At Higher Voltages Are slightly more Red Sensitive.
Useful Operating Light Levels	0.001-20 mW/cm²	0.001-200 mW/cm²	2-200 mW/cm²	.001 mW/cm² 1.0 Watt/cm² See Note 2	0.1-70 mW/cm²	0.001-70mW/cm² or 10^{-3} to 10^{+3} Pt. C.	10^{-9} — 500 mW/cm²
Long Term Stability	Good	Excellent	Good	Excellent	Poor To Good	Poor To Good	Good
Size	Small	Smallest	Small	Medium	Medium	Medium	Large

NOTES: (1) V_{BO} — Breakover Voltage
(2) Subject to an energy density limitation of 1.0 watt/cm²
(3) Normal operating range

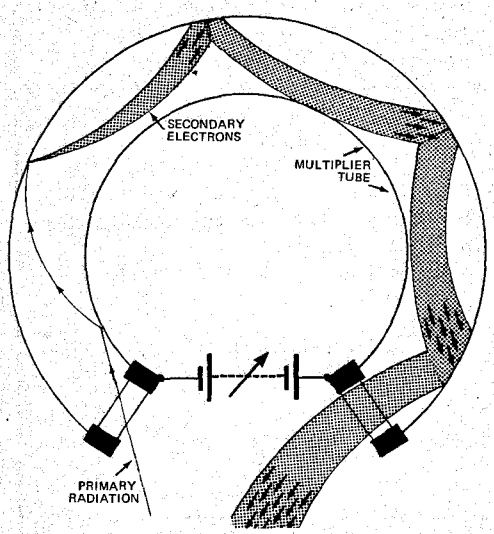


Fig. 5a. Curved tube improves electron multiplier operation.

the saturation mode (gain independant of particle energy) with an applied potential of 2.5kV. In this mode the gain is typically of the order of 3 x 10^8. Below saturation, that is when the gain is 10^7 or less, there is some proportionality between output and input, but as stated above, there is a spread of pulse amplitudes because of the many possible electron paths and accurate energy level measurements are not possible.

It has been found that the gain of a device using a straight glass tube is limited because of an effect known as "ion feedback". In the collision process some positive ions are liberated which drift back towards the front of the tube where they collide with the wall generating spurious output pulses. If the tube is curved rather than straight, the ions strike the wall before they have acquired sufficient energy to liberate secondary emission electrons. Electron gain however, is unaffected as electrons need acquire an energy of only 50eV in order to liberate secondary emission electrons from the tube wall.

The multiplier will respond to ions, particles, X-rays or any other sufficiently energetic radiation. The detection efficiency of a channel multiplier is different for the various forms and energies of excitation, but any particle or quantum capable of exciting an electron from the dynode surface has a finite probability probability of detection.

The Image Converter and The Image Intensifier.

Image converters are devices which convert an applied image, which may

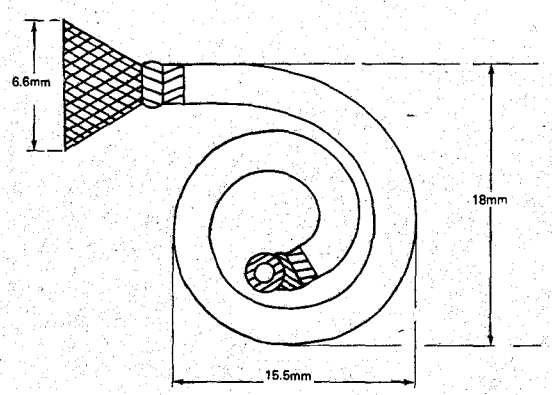


Fig. 5b. Dimensions of typical Philips electron multiplier (see also front cover picture).

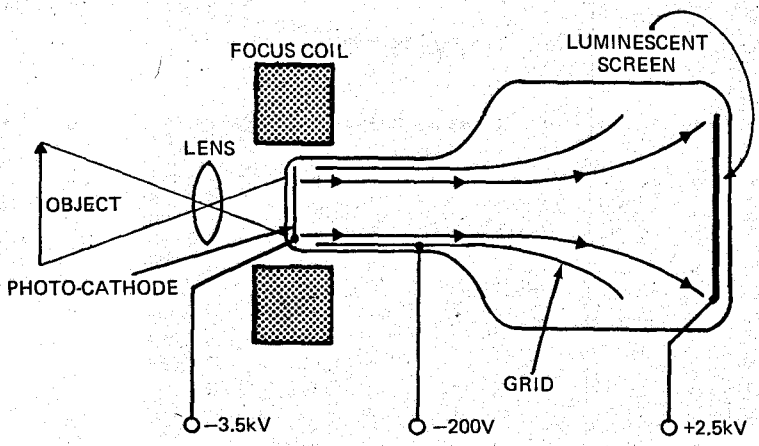


Fig. 6. The image converter tube.

be either visible or invisible into a visible image on a fluorescent screen. The principle of operation may be understood by reference to Fig. 6. An infrared image, for example, may be focused onto the photoemissive cathode which emits electrons from each tiny segment of the surface in proportion to the incident radiation. These electrons are accelerated along the tube by an electric field and impinge on a screen at the far end of the tube which is coated with phosphors, and hence produces a visible image. Apart from the use as a converter, the tubes are also sometimes used as a shutter for high speed photography by applying very short pulses to the control grid thus gating the tube on for a very short period.

The image intensifier is similar to the image converter but is specially designed to produce a very bright final image and hence finds considerable use in electron microscopy and in low light level television systems.

PHOTOCONDUCTIVE DEVICES

A photoconductive device is essentially a resistor in which the resistance value changes in inverse proportion to the amount of incident light energy.

Photoconductors are typically made of amorphous semiconductor materials such as cadmium sulphide (CdS), and cadmium selenide (CdSe).

The cadmium sulphide cell (sometimes known as a light dependent resistor LDR) is a compact and inexpensive detector of infra-red radiation. Basically the device consists of a ceramic substrate which supports a layer of photo-conducting cadmium sulphide. Metallic electrodes make contact with the device the whole being mounted in a protective enclosure. When exposed to visible radiation it exhibits the greatest change of resistance of any photoconductor, varying 4 to 6 orders of magnitude between the dark and illumined conditions. Its dark resistance is of the order of 5×10^{11} ohms. The energy band gap is 2.4 electron volts, providing a cut-off wavelength of 500nm. (Fig. 7). The response of the cell closely matches that of the human eye and it is quite often used for photographic exposure meters and inexpensive illumination meters.

One disadvantage of cadmium sulphide cells is their slow recovery rate. Starting with an illumination level of 100 lux, the recovery rate during the first 20 seconds, after removal of the illuminant, is 200kohm per second. This limits their use to relatively steady state applications.

Cadmium selenide photoconductors are very similar to cadmium sulphide devices but have an energy gap of 1.8 electron volts. Hence the spectral response extends further into the near-infrared region with a peak at 700nm. Cadmium selenide also has a very high ratio of dark to light resistance.

If a silicon PN junction sensor is reverse biased by an external voltage, it will act in a photoconductive mode. The amount of reverse current will be proportional to the intensity of the incident radiation. When used in this reversed biased mode, the silicon junction is known as a photo diode.

Photoconductive devices are passive and must be supplied with power in order to work. Hence modern photographic exposure meters using cadmium sulphide cells are also fitted with a mercury battery.

PHOTOVOLTAIC DEVICES

Photovoltaic devices convert incident radiation directly into electrical power, producing voltage and current without the need for a separate bias

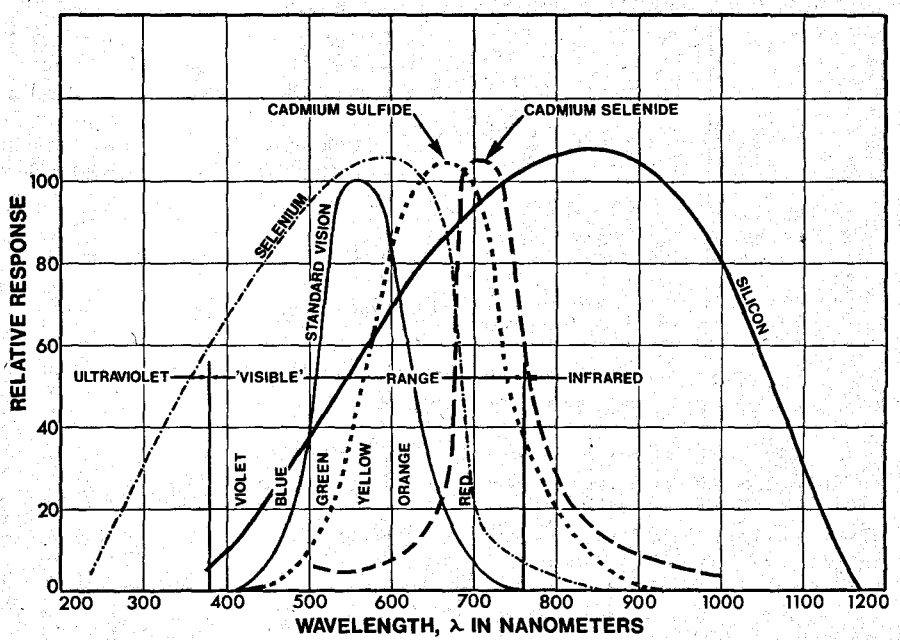


Fig. 7. Typical photodetectors — comparison of spectral responses.

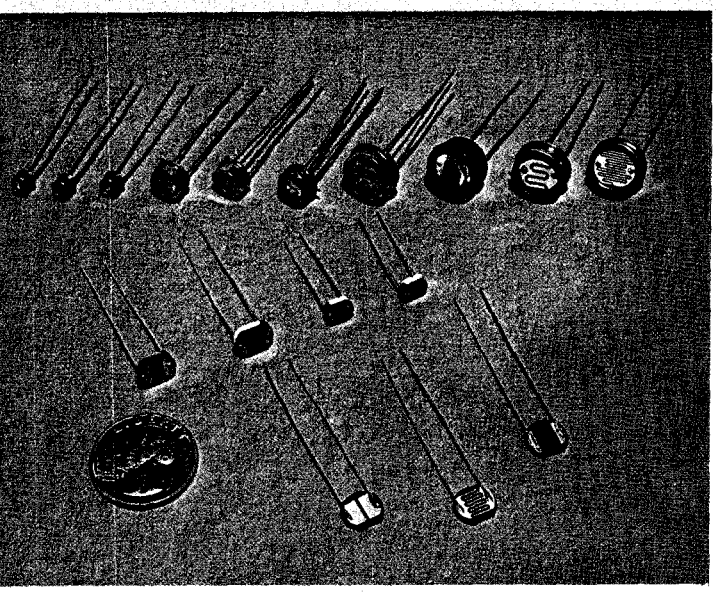


Fig. 8a. Photoconductive cells (Vactec Inc).

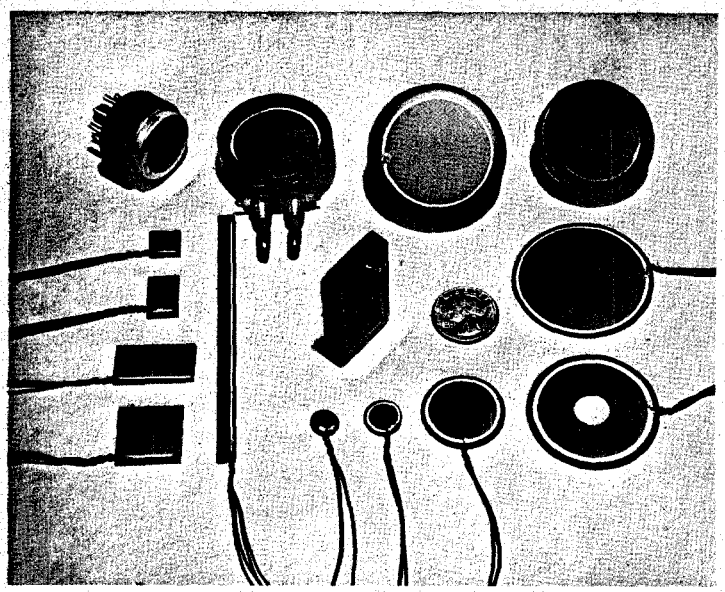


Fig. 8b. Photovoltaic devices (Vactec Inc).

supply. The photons of light impinging on a semiconductor junction form hole/electron pairs. These are acted upon by the internal field at the junction, resulting in a potential difference and hence a current when an external circuit is completed.

Typical examples of early photovoltaic cells are the copper oxide and selenium types. Typical modern devices are silicon solar cells, photo diodes and photo transistors.

The Selenium Cell

The selenium cell, also sometimes known as the barrier layer cell, has been in use for many years in photometric equipment and more recently in automatic cameras and exposure meters. The reasons for its use are its high efficiency in the visual range and its high output for a given radiant power. The output is high enough in fact to operate a relay directly.

The short circuit output of the selenium cell is directly proportional to the irradiation, and to the detector area irradiated, whereas the open circuit voltage is logarithmically proportional to irradiation.

Silicon Photo Diodes

Silicon photo diodes may be used in either the photoconductive (reverse biased) or the photovoltaic (zero biased) modes, but because size of the active area is usually small they are used almost exclusively in the reverse biased photoconductive mode in order to obtain significant signal levels.

The physical size of the effective (active) area will affect the leakage current, junction capacitance and the device sensitivity to incident radiation. These characteristics in turn greatly influence the frequency response and switching time parameters.

The reverse biased photodiode's signal current is linear over a wide range of irradiance, provided the load plus series resistance is not current limiting. On the other hand, at extremely low irradiance levels, signal linearity is limited by the shot noise current for the operating noise bandwidth. Shot noise current results from reverse leakage current and is minimized by reducing surface leakage to the minimum through planar, diffused, oxide passivated fabrication.

In many applications, the photodiode is used with an amplifier circuit. Basic considerations for the amplifier include proper photodiode reverse bias voltage (to reduce the diode shunt capacitance) and amplifier input impedance. Impedance should be as high as possible for high gain or low noise requirements, or as low as possible for high speed of response.

Another class of photodiodes are PIN diodes which are ultra-fast devices (up to 10MHz) with a very low noise figure.

These devices in some areas may be used to replace photomultipliers.

Silicon Phototransistors

Silicon phototransistors have inherent gain which provides a much higher output than photodiodes for a given irradiance level. However, the phototransistor may not provide usable output signal levels at low irradiance levels. Due to gain fall off at low currents, a phototransistor at low irradiance level may not produce more signal output than a photodiode. Therefore, a designer should first determine the type of light source to be used and its radiation level before device selection. Performance characteristics can be obtained from a manufacturer's data bulletins.

In most cases, the phototransistor is operated open base (floating) see Fig.9 The photo-induced current is the transistor base current; the collector-base junction is reverse biased and the diode current is the reverse leakage current. Thus if the incident radiation is applied to the base, a significant increase is base current is observed. If the emitter injection efficiency is large enough, collector current will increase significantly and will observe the relationship.

$$I_C = (h_{FE} + 1)\, I_\lambda$$

where I_C is the collector current, hFE is the forward current gain, and I_λ is the photo-induced base current.

PIN diodes and phototransistors are discussed more fully in a later article.●

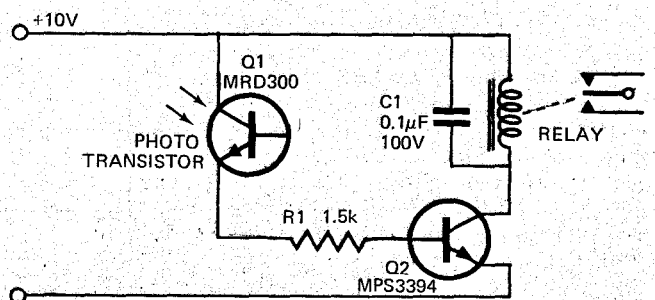


Fig. 9. Circuit of light operated relay illustrates open base operation of a photo-transistor.

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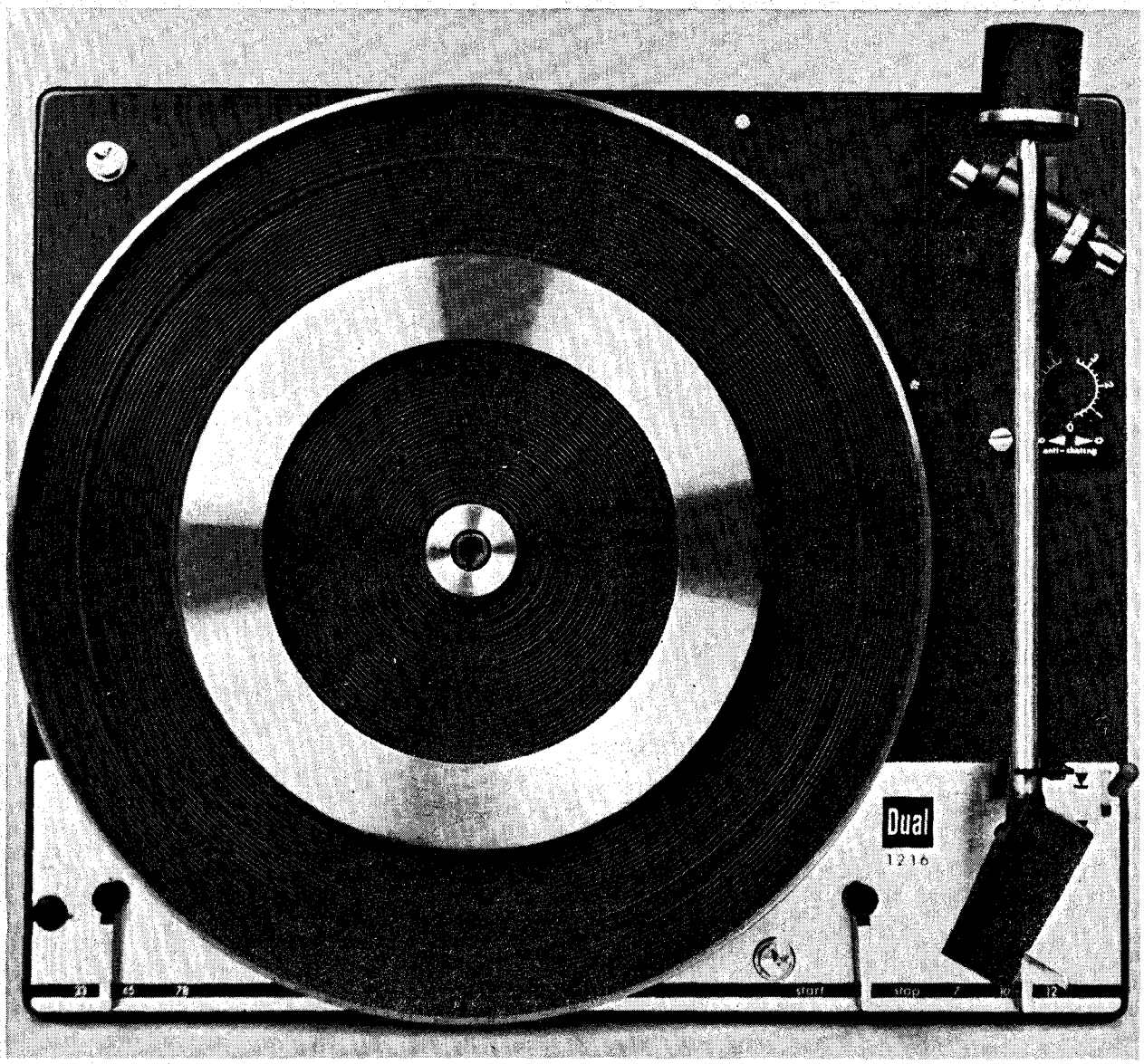

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Better than 38 dB.

Power Consumption
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Dimensions
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Weight
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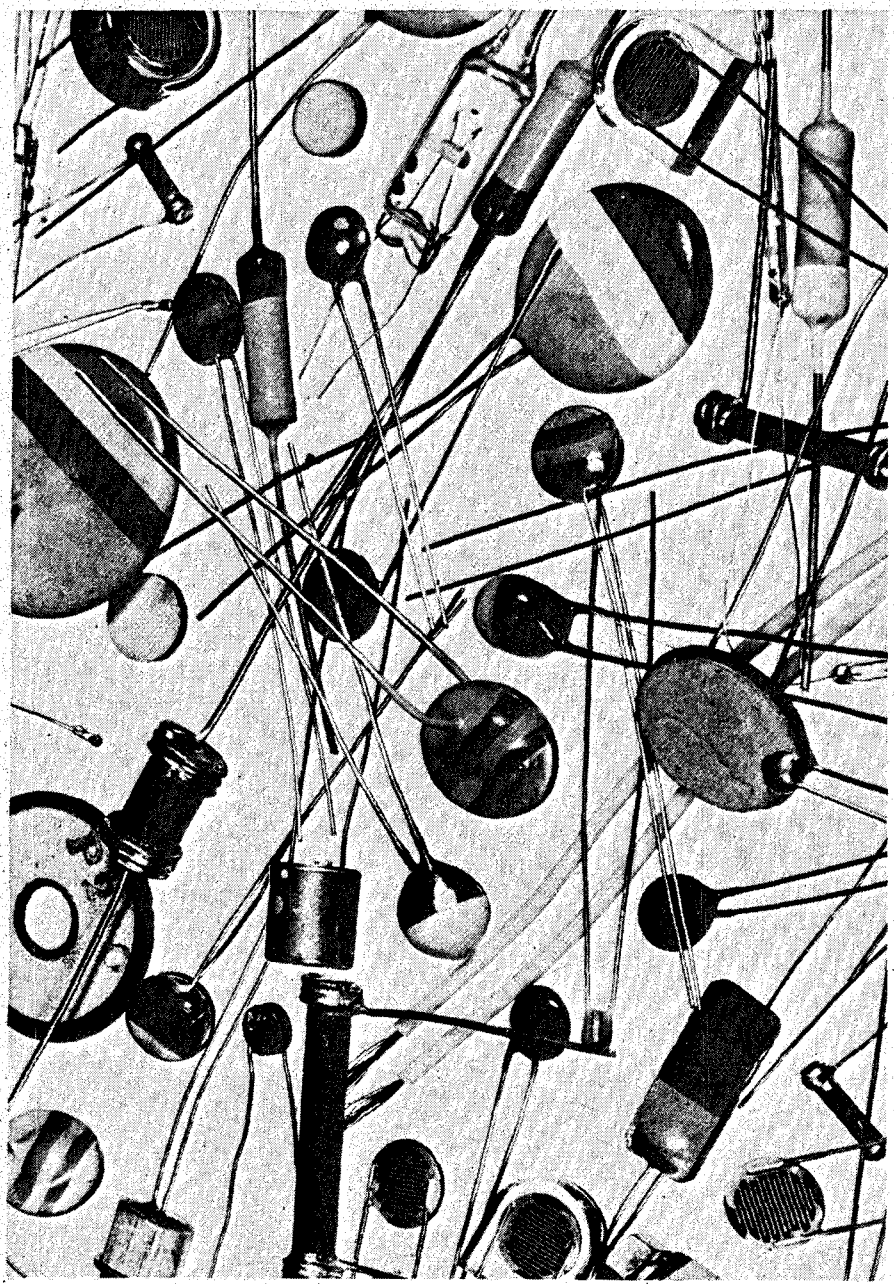
PRACTICAL GUIDE TO TEMPERATURE CONTROL

PART 11

In this article, Collyn Rivers shows how thermistors are used for temperature control.



Thermostats and contact thermometers — described in the first article in this series are essentially 'on/off' devices. They cycle continuously above and below the required temperature.

Their major limitation is that (with few exceptions) they can only control energy on an 'all or none' basis. It is because of this that the majority of heating systems controlled in this way are characterized by a large overshoot when initially coming up to the set temperature.

This problem is overcome by using sensing elements in which changing temperature causes linear changes in one or another electrical parameter. Of these, the most commonly used are thermistors, resistance thermometers, and thermocouples.

THERMISTORS

Thermistors are temperature-dependent resistors generally having a negative temperature coefficient. Thus, the resistance of a thermistor decreases as the temperature increases. This change in resistance is typically between 3% and 6% per degree Celsius at room temperatures.

In construction, thermistors are small, solid, semiconductors made of various metal oxides. They are produced in several shapes and sizes as rods, discs, beads, washers, and flakes.

For temperature control applications, the thermistor is located within the space to be controlled. A small current is caused to flow through the thermistor and the resultant voltage drop — which is proportional to temperature — is compared with a reference voltage. Any resulting difference voltage is used to control the energy applied to the heating elements.

Figure 1 shows the relationship

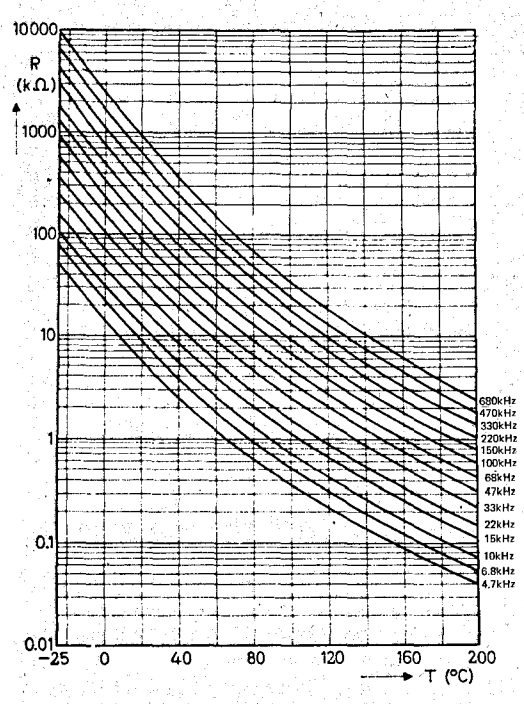


Fig. 1. Relationship between temperature and resistance for 14 different thermistors.

between resistance and temperature for 14 different thermistors. Taking the lowest curve as an example, it can be seen at −25°C the resistance is 50k. This is reduced to approx 5k at 0°C and finally to around 40 ohms at 200°C. The resistance (4.7k) shown on the right side of the graph is the resistance at 25°C, and it is at this temperature that the 'resistance' of any specific thermistor is generally given. The graph shows thermistors in which the 25°C resistance may vary from as little as 4.7k to as high as 680k. Thermistors are available with 25°C values as low as 2 ohms.

The 25°C resistance value of a thermistor becomes stable after a thousand or so hours of use, but before this time has passed, quite considerable changes may take place.

Figure 2 shows a plot of percentage change in resistance value against elapsed time for two commonly used thermistors. It is clear that for good stability, thermistors must always be aged (at high temperature) before use in critical applications. Always so if they are to be used for temperature measurement.

Although as described earlier, thermistors enable control circuitry to be used in a manner other than straight 'on/off' control, many thermistor controlled circuits still have the basic 'on/off' characteristic. However as the response time of a thermistor may be much quicker than that of a thermostat or contact thermometer, 'on/off' thermistor controlled circuits generally have far less initial overshoot.

SIMPLE THERMISTOR CONTROL

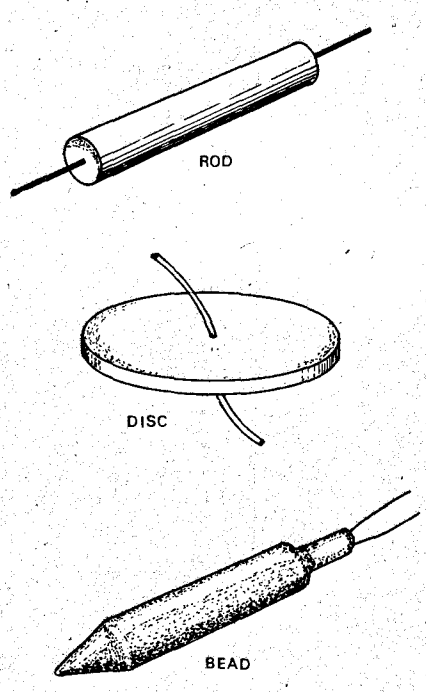
A relatively low cost on/off type thermistor controller is shown in Fig. 3.

This is a simple circuit ideal for controlling ovens, hot plates, soldering irons, water baths etc. The circuit will control the temperature to within one degree or less over a temperature range from 0°C to 100°C.

Transformer T1 may be an old filament transformer having two secondary windings, each of 12.6 volts, 0.5 amps or so. Winding W1 supplies energy to the relay RL1 through SCR1, the second winding (W2) supplies 12.6 volts ac to the bridge circuit of thermistor R1, resistors R2 and R3, and temperature setting potentiometer RV1.

Power is supplied to the heating element via the 'normally open' contacts of relay RL1. In other words power is applied to the load when the relay coil is energized.

When the heating load is colder than required, the resistance of the thermistor will be higher than that of potentiometer RV1 and this unbalances the bridge in such a way



Construction of various types of thermistors

that a positive voltage is applied to the gate of SCR1 when its anode is positive. This causes it to trigger and hence power is supplied to RL1. The contacts of RL1 close and power is applied to the heating elements of the load.

As temperature increases, the resistance of the thermistor decreases until eventually it becomes less than that of RV1. This unbalances the bridge in the opposite direction and now a negative signal is applied to the gate of SCR1 while the anode is positive.

The SCR now turns off, thus de-energizing RL1, and hence removing power from the load.

The type C106 SCR chosen for this circuit can handle relay coil operating currents up to a couple of amps. This

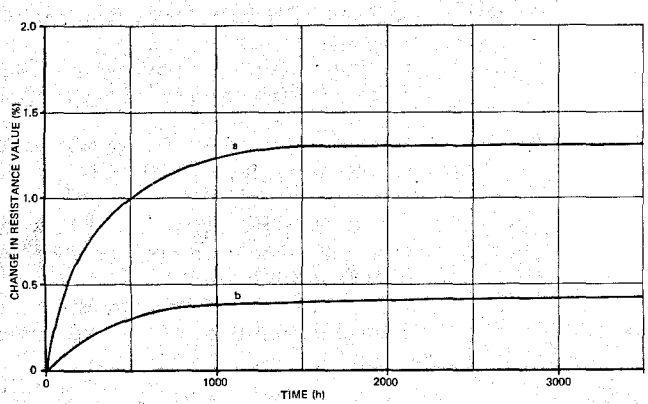


Fig. 2. How thermistors change characteristics during initial period of use. (a) Disc type thermistor with 1 watt load (b) Miniature bead type thermistor with 20mW load.

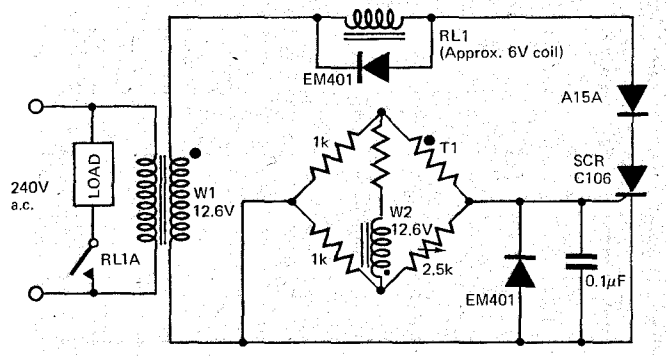
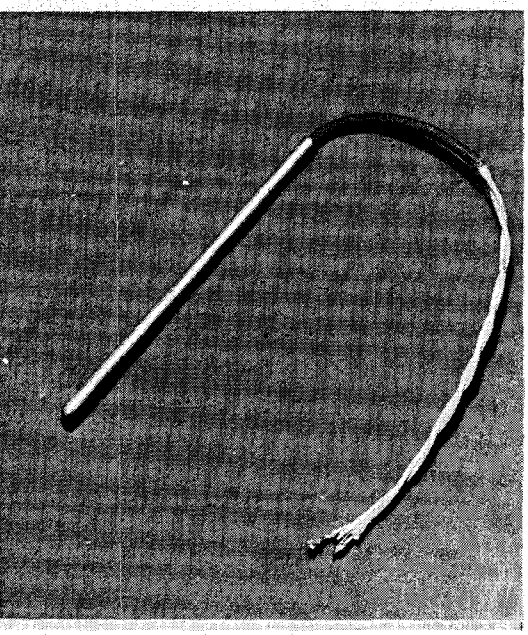


Fig. 3. Versatile low-cost controller.



Thermistor protected by metal sheath operates to 300°C.

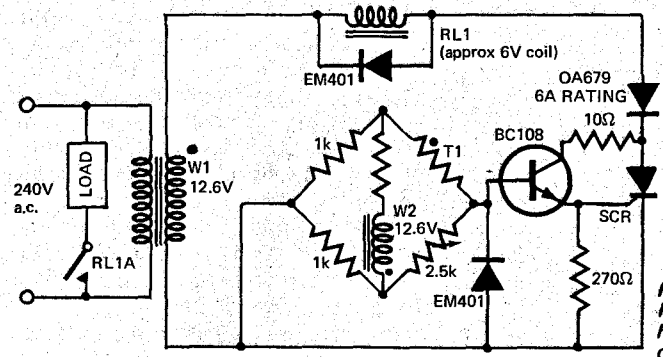


Fig. 4. Basically similar to Fig. 3, this circuit can handle relay operating coil currents of up to six amps.

is adequate for a fair sized relay capable of switching at least ten to fifteen amps. Heavier loads (including three-phase loads) can be handled either by using RL1 to energize a larger contactor or by modifying the circuit to obtain a larger triggering signal capable of controlling a heavy current SCR.

A circuit capable of switching six amp coil currents is shown in Fig. 4. Operation of the circuit is similar to that described for Fig. 3. except that transistor Q1 is used to amplify the bridge output signal.

Either of the circuits shown in Figs. 3 and 4 may also be used to control cooling loads — such as fans, refrigerators, air conditioners etc. The required 'opposite' operation can be achieved simply by connecting the load to a pair of normally closed contacts on RL1 — or by reversing the leads on the transformer secondary winding W2.

The thermistor chosen for the applications described above should have a resistance of approximately 1000 ohms at a temperature halfway up the control range required.

The circuits shown in Figs. 3 and 4 have very considerable operational flexibility, for within the limits triggering and current handling limits of the SCR, a relay may be chosen to suit the characteristics and size of the load. Thus either single or three-phase loads of practically any voltage and current may be catered for.

TOTALLY SOLID-STATE CONTROL

Although the circuits shown in Figs. 3 and 4 are extremely reliable there are many applications in which a totally solid-state system is to be preferred, for if correctly designed, a totally solid-state system is inherently more reliable and practically maintenance free.

Another major advantage of solid-state electronic control systems is that proportional control may readily be obtained.

Unlike the 'on/off' system in which full power is applied to the load until the required temperature is reached, proportional control continuously varies the power applied to the heating element in an amount depending upon the deviation between the actual temperature and the required temperature (Fig. 5).

Solid-state controllers — apart from having either 'on/off' or proportional control — may be categorized as using either phase control or zero voltage switching techniques.

Phase control is a technique used to control the effective power input to a load by a process of rapid on/off switching. In this the ac supply is connected to the load for a controlled (but variable) fraction of each half cycle. A full description of this technique was included in the Practical Guide to Triacs series — published in Electronics Today, July 1971.

This type of circuit, although inherently suitable for proportional control applications, generates large amount of radio interference, primarily at low and medium frequencies. It seriously affects reception of long and medium wave radio transmissions and may also interfere with audio equipment.

Whilst the extent of rfi may be reduced by filtering, the size of chokes required for large loads — such as heating systems — becomes excessive.

Phase control also introduces another problem — namely power factor. This is adversely affected and some power supply authorities object to this quite strongly.

Zero voltage switching overcomes most of the problems inherent in phase control systems.

The technique differs from phase control in that line voltage is switched

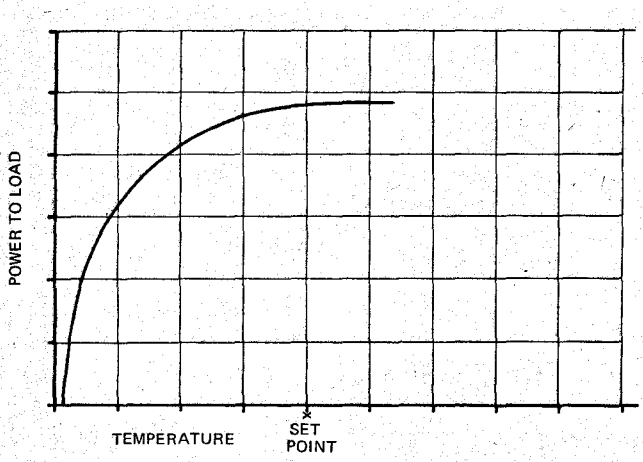


Fig. 5.

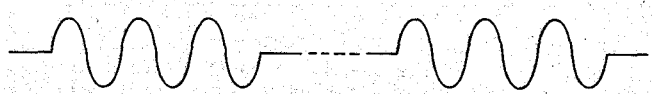


Fig. 6. Zero-voltage switching waveform

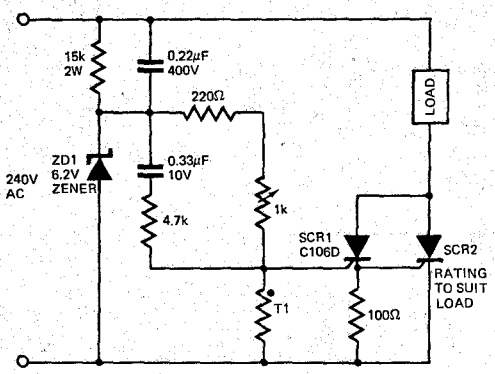


Fig. 7. Basic half-wave zero-voltage switching circuit.

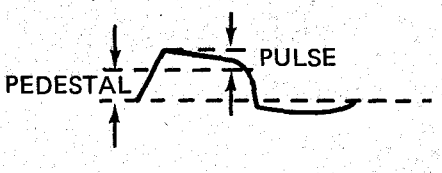


Fig. 8. Pulse and pedestal wave-form of circuit shown in Fig. 7.

'on' as well as 'off' only at the zero crossing points on the ac waveform. The power applied to the load is controlled by varying the ratio of time that power is applied, to the time that power is switched off.

At first sight this technique appears similar to the basic 'on/off' thermostat systems — and so to a point it is. The main difference is that power is switched only at zero crossing points of the ac waveform — apart from this the 'on/off' cycle may be very much quicker. For example, if only a small amount of power is required to maintain the set temperature, the circuit may pass only a few complete half-cycles and then remain switched off for a further twenty or thirty complete half-cycles before repeating the sequence (Fig. 6). A simple zero voltage switching circuit is shown in Fig. 7. In this circuit there is also a 'half power' mode within the temperature differential in which every second sine-wave is applied to the load.

The sensing differential of this circuit is approximately ±1/4°Cabout the set point and neither changes in ambient temperature not line input voltage degrade the accuracy.

The action of the circuit is as follows: Zener diode ZD1 forms a voltage pedestal of 6.2 volts (nominal) amplitude by clipping the incoming 240 volt ac supply. This pedestal is differentiated by capacitor C2 and resistor R2 to form a pedestal of reduced amplitude with a pulse superimposed on top of the pedestal (Fig. 8). This waveform is then applied to the gate of SCR1.

Zero voltage switching action is provided by the pulse (which is superimposed on the 'pedestal' at the beginning of the positive going line voltage) appearing at the anodes of SCR1 and SCR2. This pulse is shifted to the correct phase by C1 and R1.

As the controlled temperature approaches the set point, the decreasing resistance of the thermistor continuously decreases the height of the pedestal until the amplitude of the pulse plus pedestal is insufficient to trigger SCR1.

The lock-in configuration of SCR1 plus SCR2 virtually eliminates errors due to ambient temperature variations affecting SCR2 trigger voltage.

As the heating load of this circuit is in series with an SCR the power applied to the load will be half-wave. This may not necessarily be a severe limitation as many heating elements have more than sufficient heating capacity, and the inevitable loss when only halfwave power is applied may well be acceptable. If an element is being constructed specifically for the application then of course the element may be designed for half-wave power.

The zero voltage switching action of this circuit eliminates the need for rfi filtering. Hence the cost is very much lower than a comparable phase control circuit in which rfi components would be necessary.

SIMPLE PHASE CONTROL

The zero voltage switching circuit shown in Fig. 7 should be compared with the phase control circuit shown in Fig. 9. This latter circuit has a very similar performance and — with the exception of rfi components — similar cost. It is commonly used to control the temperature of photo-developer baths. Again like the circuit shown in Fig. 7 it has half-wave output.

The 10 megohm potentiometer connected from the positive rail to the emitter of the unijunction controls the 'gain' of the circuit. In effect it controls the temperature range over which proportional action is obtained. It is not an essential feature of the design and may be omitted (or replaced by a suitable value fixed resistor if required).

Shown in Fig. 10. is a full-wave version of the circuit described above. The basic operating principle is similar, the main difference being that a Triac is used in place of the SCR. The pulse transformer shown in this circuit consists of two windings, each of approximately 100 turns of 24G enamelled copper wire, on a ½" diameter ferrite rod. Each winding must be well insulated from the other, and from the ferrite rod. Construction of this pulse transformer is not at all critical and minor variations from the specification should not affect operation of the circuit.

It should be noted that both these phase control circuits result in ac potential being applied across the thermistor. This may be overcome in the latter circuit by supplying the firing circuit via an isolating transformer rather than via a dropping resistor.

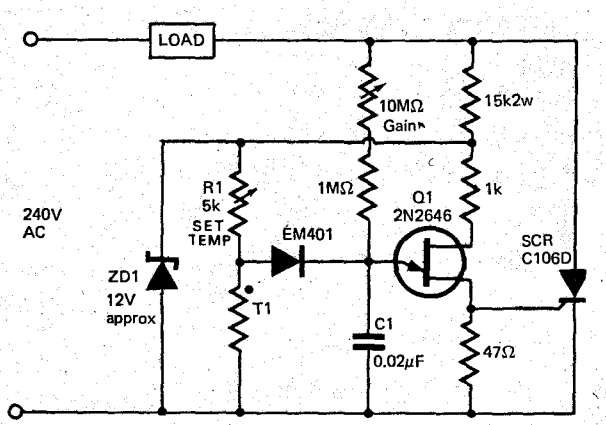


Fig. 9. Half-wave phase control system.

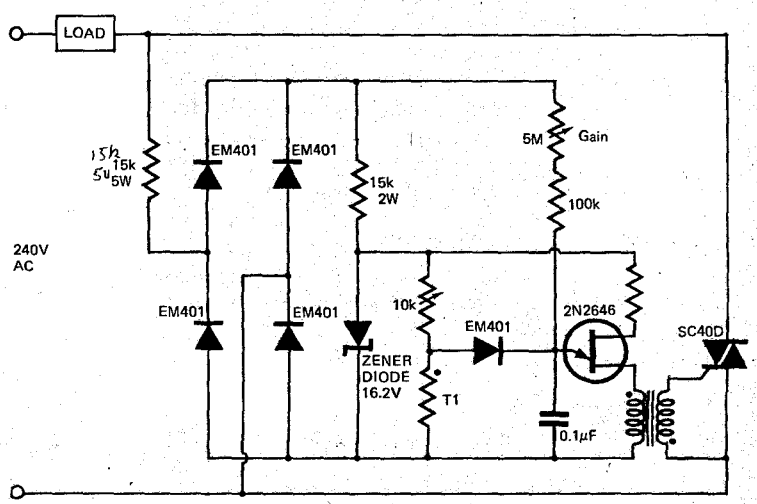
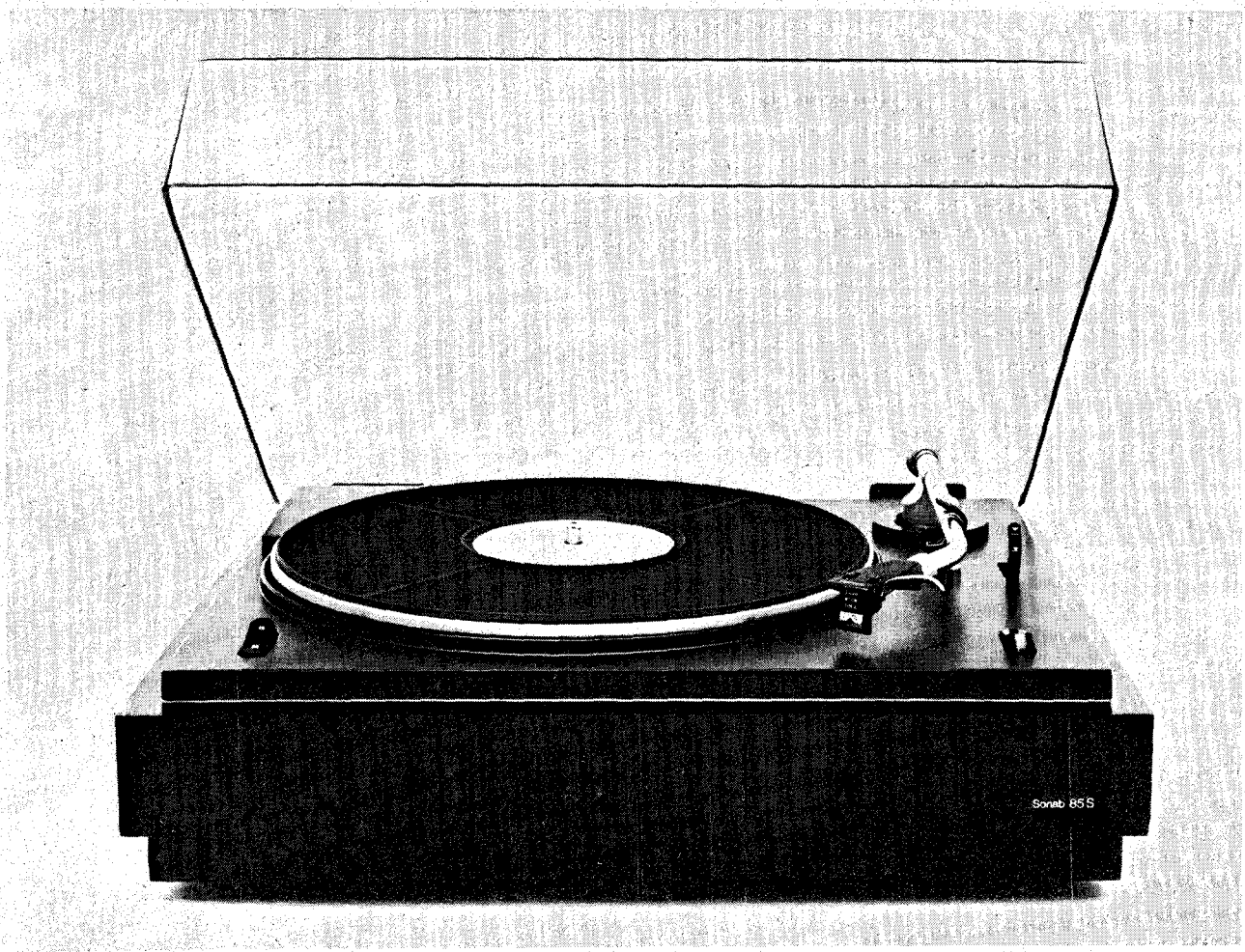


Fig. 10. Full-wave version of phase-shift controller shown in Fig. 9.

The magic round about



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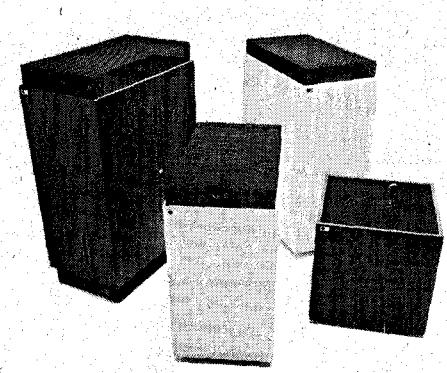
For literature on Sonab turntables and the rest of the Sonab range—and the name of your nearest dealer, phone or write to us.



Sonab

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Advances in Read Only Memories

A new device from National Semiconductor offers considerable advantages over previously available Read Only memories.

READ only memories (ROMs) are finding every increasing useage in modern instrumentation and computational equipment. The devices are particularly suited for applications where a small fixed memory is required. Typical applications would be for code conversion, random logic synthesis, look-up tables, character generators and for micro-programming.

Development has been towards putting as many memory bits as possible into standard IC packages, and towards improving the ease of customer programming.

One of the latest devices in this field is the new electrically programmable 2048-bit read only memory. (PROM) from National Semiconductor.

The new device known as the MM4203/MM5203 uses silicon gate technology to achieve bipolar compatability. The device is a non-volatile memory organized as 256 eight-bit words, or 512 four-bit words.

Programming of the memory contents is accomplished by storing a charge in a cell location by programming that location with a 45 volt pulse.

Operation is completely static, no clocks are required and the output is organised for common-data busing using the National Semiconductor TRI-STATE principle.

One of the most interesting features of the device is the optional "memory erase" feature which considerably enhances the attractiveness of the device for laboratories and experimenters. This erasability is achieved by shining ultra-violet light through a quartz window on the top of the chip. This allows the cell stored charge to leak away and hence the device can be re-programmed for another application.

This field programmability coupled with high speed operation (maximum access time of One microsecond) and compatability with existing bipolar logic makes the device a very versatile addition to the state of the art.

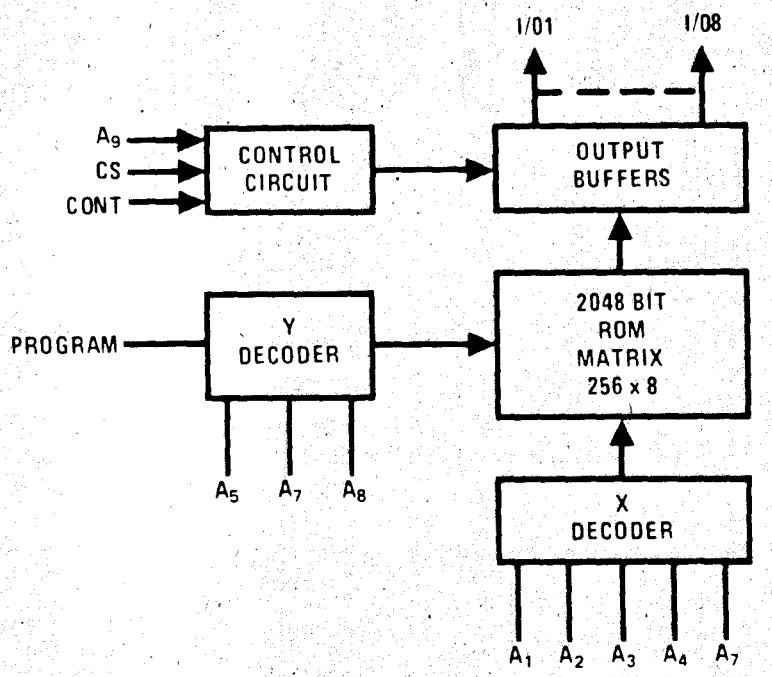

Fig. 1. Block diagram of National MM4203/MM5203 ROM

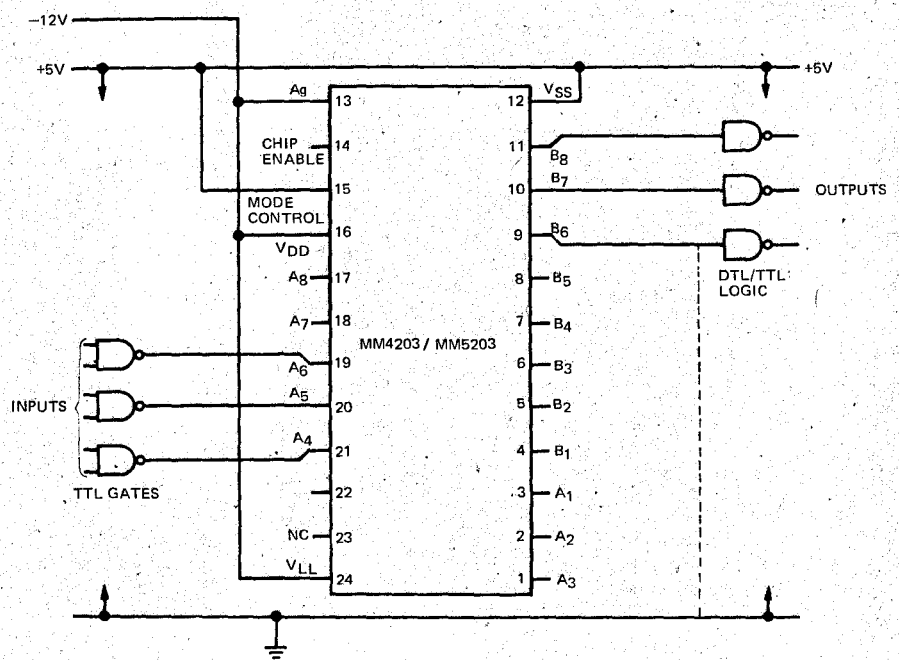

Fig. 2. ROM connections and typical application as 256x8 PROM with TTL intertace.

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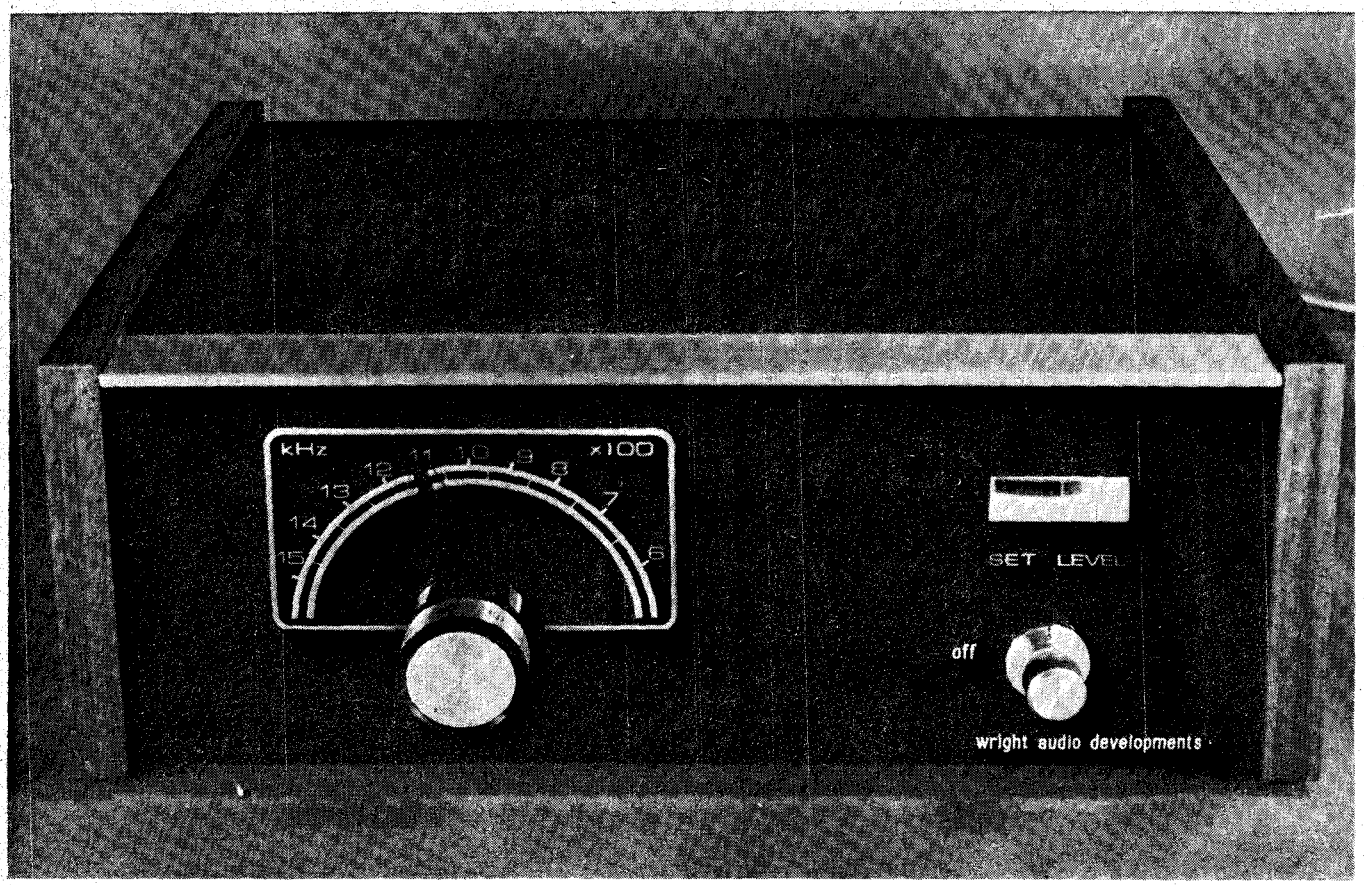


IN Australia the absence of FM broadcasting, limits the hi-fi enthusiast to monophonic AM broadcast transmissions and the T.V. sound channels, apart from his own records or tapes. And probably because of the long held (and to some extent correct) belief that AM sound is not of sufficiently good quality to warrant the expense of a good tuner there are very few high quality AM broadcast-band tuners commercially available.

Many of the Japanese manufacturers have in their range combined AM tuner/amplifiers, but in general, these units are in the lower price bracket and the tuners do not provide the maximum performance of which the transmitted signal is capable.

It has long been our belief that if a good tuner was to be provided on the Australian market it would probably be designed in this country. The reason for this is that with Australia's slow (or even non-existent) moves towards FM broadcasting it is one of the very few countries left where the *only* broadcasts are AM. AM tuners designed for the American or European market are not designed to provide a wide bandwidth, but more for range and selectivity with limited bandwidth. A quick check on Japanese AM tuner-amplifiers — even the most expensive — showed that the bandwidth was typically ,6 kHz with the *cheaper* units providing 5 kHz with 3dB limits.

The belief that there is a market in Australia for a high performance radio tuner is also shared by a small Australian company who produces the Wright LDT3A tuner — the subject of this review.

The unit has an impressive appearance. The front panel is concealed behind perspex and is illuminated and thereby made visible only when the mains power is switched on.

The case has oiled timber ends, consistent with the styling of most modern bookshelf amplifiers. The front panel has a rotary pointer with a frequency-calibrated scale behind, the tuning knob is concentric with the pointer shaft — on a vernier with about a 4:1 ratio.

MANUAL IF GAIN CONTROL

On the other side of the panel is a tuning meter and manual IF gain control. Most people have not seen a manual IF gain control in decades, but in striving to obtain the ultimate in performance from a tuner it is necessary to revert to this technique.

There are two reasons for this. The first is that normally the detector will provide optimum output in terms of signal to noise ratio and distortion; secondly, automatic volume controls rely upon varying the gain of the IF stage, and this results in intermodulation distortion and increased noise at the audio frequencies unless complex circuits are used. The obvious solution is, therefore, to use a manual gain control.

The Wright tuner is not as easy to use as a normal broadcast receiver and tuning in stations requires a reasonable amount of care if the best performance is to be obtained. The procedure consists of tuning in the station roughly by ear, adjusting the IF gain control to approximately the correct level then readjusting the tuning until a very slight dip is observed on the inbuilt meter. When this has been done, the station carrier frequency is in the exact centre of the pass band and optimum frequency response is obtained. The IF gain control can then be set to the correct level on the meter.

While this procedure requires a fair amount of fiddling the end result makes it worthwhile.

Subjectively, we found that there were not many programmes with sufficient inherent quality to get good sound reproduction. There are however, some noticeable exceptions, (such as recorded ABC concerts from the Sydney Town Hall). But listening to these few programmes made the tuner seem worthwhile, for while the tuner would not often be used to its maximum capability it is possible that is justifies the cost of approximately 20 long playing records over a period of time.

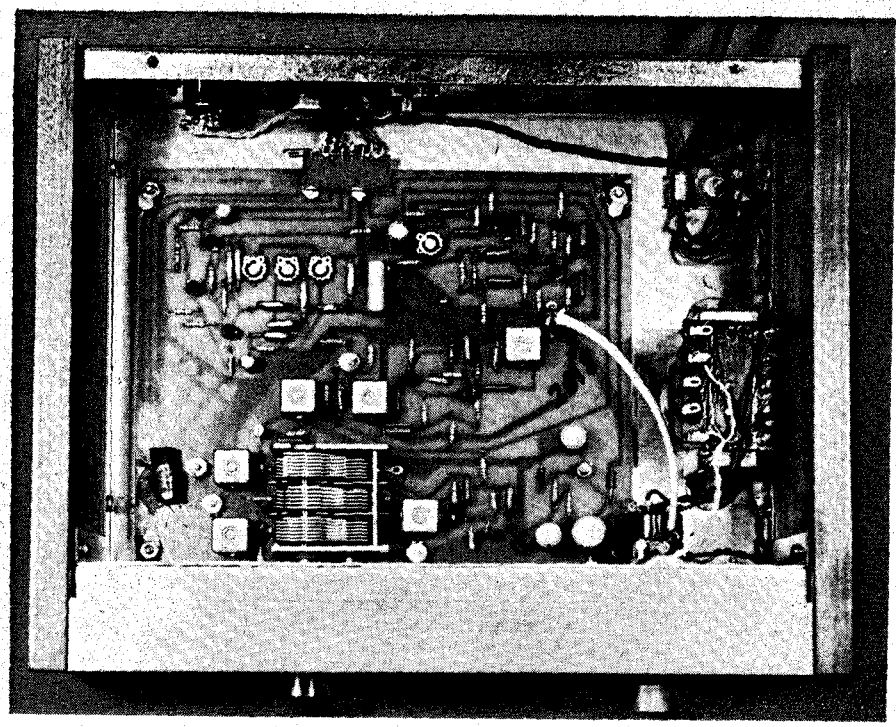
WIRE LOOP AERIAL

A considerable amount of thought has gone into the design of the tuner, even to the type of aerial, which is a wire loop rather than a single piece of wire or a ferrite rod. This can be orientated so as to provide a measure of rejection of unwanted noise.

The indoor aerial loop does not look particularly attractive, being yet another 10-15 feet of wire to be concealed behind the system but it does offer the required consistent performance and loading on the input circuit.

An alternative aerial for country use utilizes a 50 ohm coaxial cable to an outside balun and loop aerial.

From the aerial the signal passes through a double-tuned band-pass-filter into a FET mixer stage. This circuit provides both efficient conversion and minimum loading on the filter circuit. From the mixer the IF signal passes through a pair of overcoupled tuned amplifiers and then through a single tuned stage. The combination produces a bandpass filter with a flat top and relatively sharp skirts. At this point in the circuit the gain is controlled by a potentiometer prior to being fed into the rectifier circuit.



THE WRIGHT LDT-3A AM TUNER

The rectifier circuit uses an operational amplifier to obtain linear conversion with consequent low distortion. This is necessary since diodes alone cannot produce a sufficiently linear transfer characteristic. A replica of the original signal is reconstructed from the rectified signal and is used for feedback. This results in a very much more linear characteristic from the rectifier. At the output of the operational amplifier a simple conventional rectifier powered by a single transistor amplifier is used to drive the tuning meter.

For Australian hi-fidelity requirements a tuner should be capable of offering a 12-14 kHz bandwidth to obtain maximum advantage of the transmitted programme material. But as Australian broadcast stations are located exactly 10kHz apart, a 10kHz whistle can often be heard unless a notch filter is provided. Unlike many other tuner requirements the notch need only be at one fixed frequency.

A notch filter is therefore incorporated in the Wright tuner and is connected in the circuit immediately following the rectifier.

It consists of an R-C parallel T filter to produce a very sharp rejection notch. From the filter the signal passes into a two-transistor audio amplifier.

The power supply for the tuner is obtained from a half wave rectifier followed by a voltage regulator stage.

When we opened the unit up we found it to be extremely well made and well laid out on a high quality printed circuit board. The only limitation in its design which we felt could have been improved upon was the omission of a switch to remove the notch filter when it was not required. The manufacturers, however, feel that the audible difference with and without the filter is not sufficient to warrant an additional control.

MEASURED PERFORMANCE OF WRIGHT TUNER LDT-3A SERIAL NO: 2018

Frequency Response (Excluding Notch)
20Hz – 14kHz ±3dB

Total Harmonic Distortion
1.3% at 99% modulation
0.8% at 50% modulation

Signal to Noise Ratio
47dB at 300μV input
10dB at 8μV input

Image Rejection
> 60dB

Notch Frequency 10,018 Hz

Notch Depth at 10,000 Hz
40dB

Notch Depth at 10,018Hz
43dB

Output for 300μV Input 2 volts.

HOW IT PERFORMED

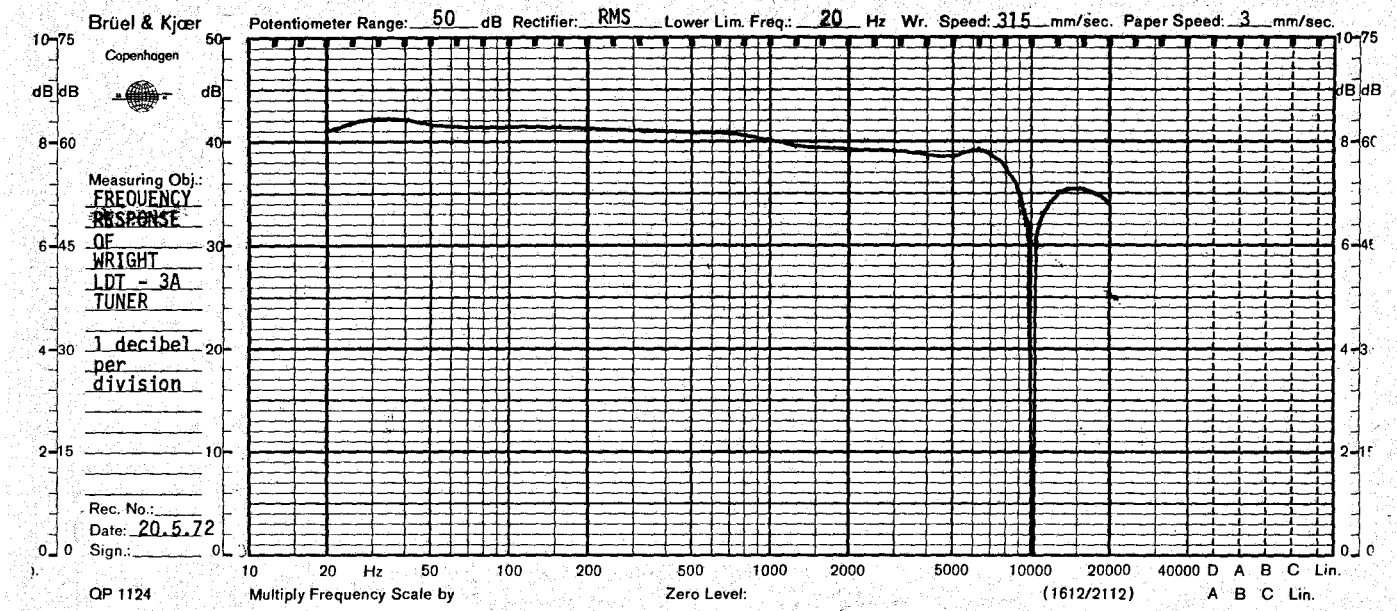
For an AM tuner the performance was nothing short of superb. It manages to combine high sensitivity with broad bandwidth, thus allowing its *possible* use in country areas.

At both high and low levels of modulation the distortion was very low and did not exceed 1.3%. With sufficient signal to drive the tuner to its correct operating point we obtained a signal to noise ratio of 47dB. The precision of the notch frequency was better than 0.2% and as it relies only upon good quality capacitors and resistors for its stability, it should remain within this tolerance.

The maximum rejection was 42dB. At 10kHz, 40dB was obtained due to a slight error in the tuning of the notch.

One of the problems with broad band AM tuners is often poor image rejection due to the low Q RF circuit which is often used. In this case the image rejection was so high as to be virtually unmeasurable and better than 60dB.

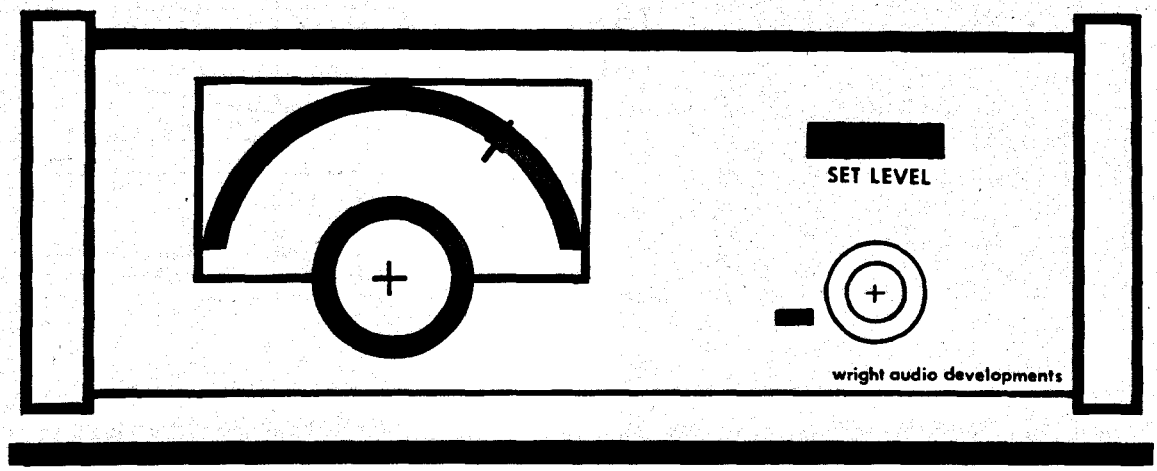
The Wright LDT 3A tuner outperforms any commercial AM tuner we have tested to date and would appear to be excellent value at a price of around $120.00. It is a pleasure to see an Australian product which combines reasonable cost, excellent performance and good appearance. ●



WILL FM BE BETTER THAN THE LDT3A?*

A NEW CONCEPT

IN AM RECEPTION



The LDT3A tuner from Wright Audio Developments uses advanced circuitry to obtain performance figures never before realised in a commercial AM tuner.

- FULL 20 KHZ BANDWIDTH
- ULTRA LOW DISTORTION
- NOISE CANCELLING ANTENNA
- ACTIVE 10 KHZ FILTER

PLUS

- COMPLETELY SOLID STATE
- MODERN STYLING
- ONE YEAR WARRANTY

***Judge for yourself – Hear it now at:–*

N.S.W. Sydney – Convoy, Encel, Sydney Hi-Fi, and W.C. Wedderspoon.
Chatswood – Milversons
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S.A. Challenge Hi-Fi, Truscotts.
W.A. Alberts Hi-Fi

Trade Enquiries

WRIGHT AUDIO DEVELOPMENTS

23 Anembo Road, BEROWRA, N.S.W. 2081.

ENERGY

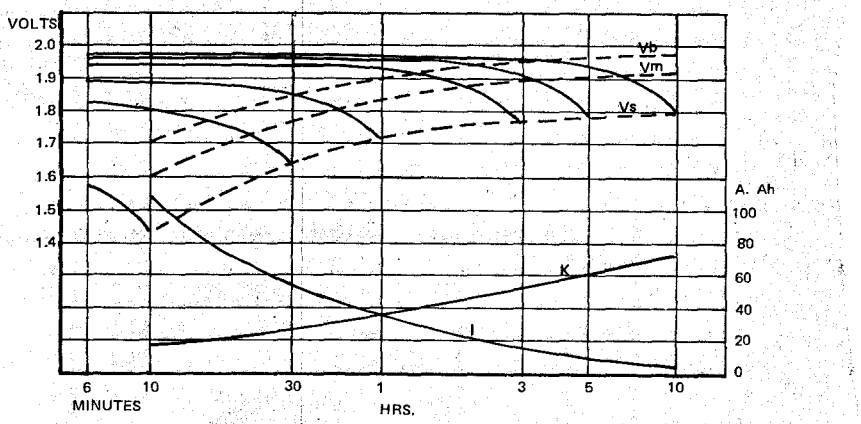


Fig. 1. Discharge curves for lead acid batteries where V_b = Initial cell volts, V_m = mean cell volts, V_s = Final cell volts, I = current in amps per positive plate and K = capacity at current I per positive plate.

ENERGY sources have attracted a great deal of Research and Development effort over the last two decades, and all existing and potential systems have been subjects of most detailed examination.

Early in the 60's, the developments in fuel cell systems caused optimistic forecasts that these devices would replace all other types of batteries for power and traction purposes. At present, however, the implementation of fuel cells in every day systems is still far from a reality.

A large variety of exotic battery couples have been devised and work is still proceeding on their development, but the manufacturers of the well established types have been active in the steady improvement of their products as well. We shall look at some of the specialised developments of each type in turn.

LEAD ACID BATTERIES

The Lead Acid System has been the most successful in terms of aggregate energy storage capacity produced each year, largely due to their use for starting, lighting and ignition in automobiles. Energy and power density have both been increased by 50% during recent years and life performance has increased quite spectacularly. At the same time costs have been held down by increased productivity in the industry.

There is a current demand for transport having low maintenance costs, low running costs and low pollutant emission. The battery electric vehicle fulfills these requirements admirably and world wide interest has led to limited production of these vehicles in several countries. Naturally a factor of major importance is the battery, and here, the lead acid battery has been found to be the most practical to date. The modern lead acid battery matches nickel cadmium in energy density and freedom from mainteinance, while its higher cell voltage (2.0 versus 1.2) means fewer cells for a given voltage. This among other applications has led to an even greater demand for lead acid batteries than ever before.

Knowledge of the mechanism by which the lead acid battery works and fails has enabled electrochemists, metallurgists and engineers to produce lead batteries designed for specific applications whilst maintaining an attractive performance/cost relationship. Performance has been improved by a better understanding of the physical chemistry of the lead/acid reaction. This understanding enables the optimum material porosity or surface area to be developed consistent with the duty cycle expected in use and hence best use of lead materials with regard to the annual cost factor of the installations' capital value.

Corrosion of positive grid structure is a major limiting factor in the life of lead-acid batteries, and new alloys have been developed to reduce this factor. Among these are the lithium and calcium lead alloys which have been used successfully for very long life battery systems. For example, Bell have found that life expectancy in telephone exchange service may be 30 years or more when using these alloys. The use in Australia of pure lead grids for emergency power batteries has shown that a life expectancy of 20 years is reasonable. In Europe batteries with tubular positive plate designs using non-antimonial lead alloys have given similar results.

In the field of emergency power batteries, other developments have been made including explosion proof catalytic recombination stoppers, and third electrodes which allow once-yearly maintenance when the batteries are used in the float or constant potential mode, and are required to supply emergency power for one hour or longer. The very low self discharge rate of these batteries (50% capacity loss per year on open circuit) allows their use in remote low drain installations where they are returned to depots for re-charging on a yearly schedule.

The power available on discharge in any electrochemical device is directly proportional to the surface area available for electrochemical reaction. This is the reason automotive starter

SOURCES

The characteristics of existing and potential battery systems are examined by John C. Howlett, Technical manager, Dunlop Batteries (Australia) Ltd.

batteries are designed with a large number of closely spaced thin plates with low resistance, inter-cell connections. In contrast, a mine-locomotive battery would be made with plates four times as thick with double the spacing between them and have inter-cell connections of cross section adequate for currents at the five hour discharge rate.

The capacity available varies inversely with the rate of discharge as shown in Fig. 1. The end point of discharge is where the voltage time curve starts to develop a definite knee, very little further energy is delivered after this point.

CHARGING SYSTEMS

The success of any battery system depends to a large extent on the design and performance of the associated charging means. With modern solid state control, the characteristics of the charger may be exactly matched to the battery for optimum system performance. Charging system constraints will be laid down in an Australian Standards Associations draft specification being generated by a group of battery technologists and charger manufacturers. These may be summarised as follows:-

The charger should be capable of recharging the battery in the minimum allowable time and the current and voltage regulation should be such that the battery electrolyte temperature does not exceed 50°C at any time. A number of parameters contribute, but the current at any particular state of charge and the percentage ripple in the rectifier output are the prime causes of increased battery temperature.

Various schedules of charging are used, but the three most common are taper charging where the charge is started at about the 5 hour rate of the battery and tapers uniformly over a 12 hour period to the 40 hour rate at finishing, this is known as a "12 Hour Taper Charge".

The most usual schedule for traction battery charging is called "The 2 Step Charge", in which a constant or nearly constant current is passed until the average cell voltage reaches 2.35 to 2.4 volts. When this point is reached, a voltage sensing device changes the charge to a taper system, and starts a 3 to 5 hour timer. This system may be used to charge a fully discharged battery in as little as 6 hours, but an 8 hour period is usually preferrable. When either of these systems is used for rapid recharge, a temperature control of some sort is necessary, the most effective being a fusible link which will open circuit the battery if its temperature exceeds 55°C.

Batteries which are used for "stand-by", or "emergency power" applications frequently have a charger permanently in parallel with the battery; arranged to float the battery at a voltage of 2.15 to 2.2 volts per cell. This cell potential will maintain the battery at 95 to 98% fully charged when a trickle charge rate of 0.4 to 0.5 milliamps per ampere hour of capacity at 10 hour rate is used. The most important feature of the above is that the voltage range is in the area of minimum corrosion rate for lead in an anodic environment and hence a system life expectancy of 15 years or more will be obtained if the rectifier system is suitably controlled. With cell voltages of this order a negligible amount of water is electrolysed from the cell and if a large volume of electrolyte is allowed above the plates, maintenance periods may be decreased to perhaps twice yearly. The addition of catalytic re-combination stoppers will further increase the time between water additions.

The rectifier needs to be of a design which minimises ripple on the dc voltage, higher ripple increases the amount of gas evolved and increases the corrosion rate. A ripple level less than 5% of the dc output voltage is normally acceptable. High ripple content will also increase cell heating

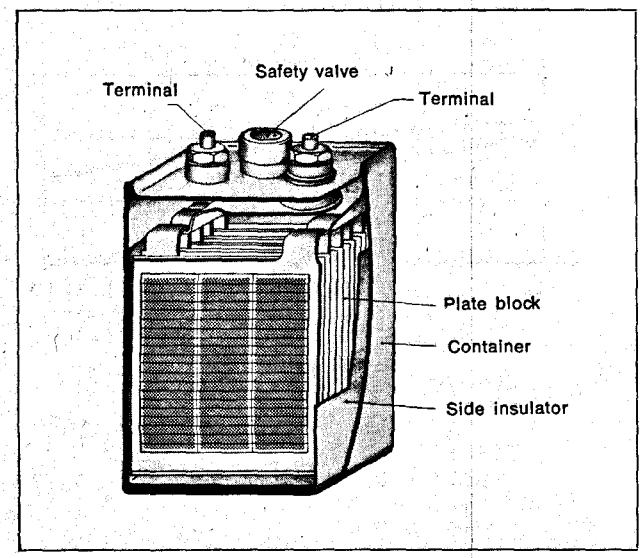


Fig. 2. Construction of typical vented alkaline battery.

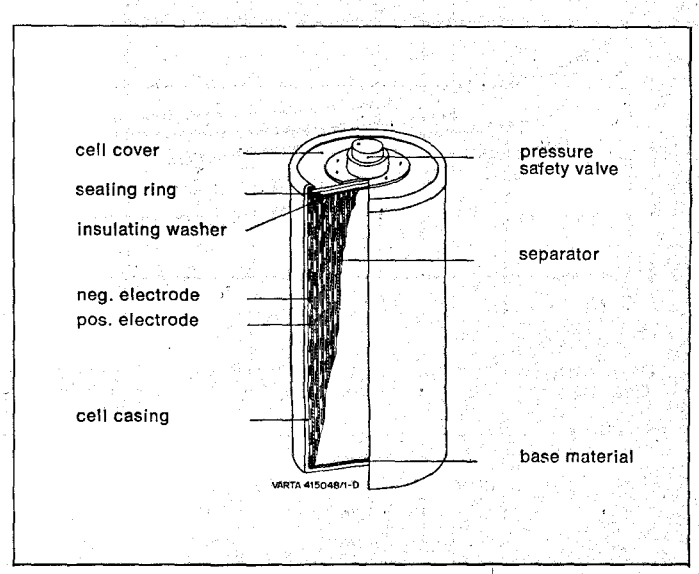


Fig. 3. Construction of sealed alkaline battery.

during re-charge and will limit the charge rate. This factor is therefore very important and should be given consideration in traction battery chargers.

Pulse Cycle Charging

The "Pulse Cycle" charge maintenance system is relatively new, but some success has already been reported with the method in applications using automotive batteries. The system charges at a constant current until a cell voltage of 2.5 volts is reached, this voltage is sensed and the charge ceases until the cell voltage falls to 2.1 volts when the charge cycle recommences. This charging method produces very little electrolysis of water in the electrolyte, maintains the battery in a fully charged condition and reduces the corrosion rate appreciably.

Lead acid battery systems exhibit very small voltage change over their normal operating range. For example:-

A 24 cell battery will float at 2.17 volts per cell or 52.2 volts and on discharge will range from 2.1 volts to 1.85 volts (5 hr. rate) with an average voltage of 1.93 volts per cell or 46.4 volts.

ALKALINE BATTERIES – NICKEL CADMIUM

There are a number of applications where batteries are required to withstand rough handling, high or low temperatures and/or very high current pulses. Additionally they may have weight constraints and be required to withstand years of float trickle charge without being liable to failure when called upon in an emergency.

Nickel cadmium alkaline batteries are capable of withstanding the above conditions to a much greater extent than lead acid. Initial cost is 3 or 4 times higher than with lead acid but in many instances the cost will be offset by the added reliability.

In a nickel cadmium battery the electrolyte functions purely as a low resistance source of ions for the electro-chemical process and part of the electrolyte is therefore not consumed in the reaction. This allows the plates to be assembled with close spacing thus providing a low resistance cell.

The electrolyte is a solution of potassium hydroxide and a small percentage of lithium hydroxide. The specific gravity of the electrolyte is held at 1.17 and thus a resistivity of 2.0 ohms/cm is obtained – the minimum possible for these solutions.

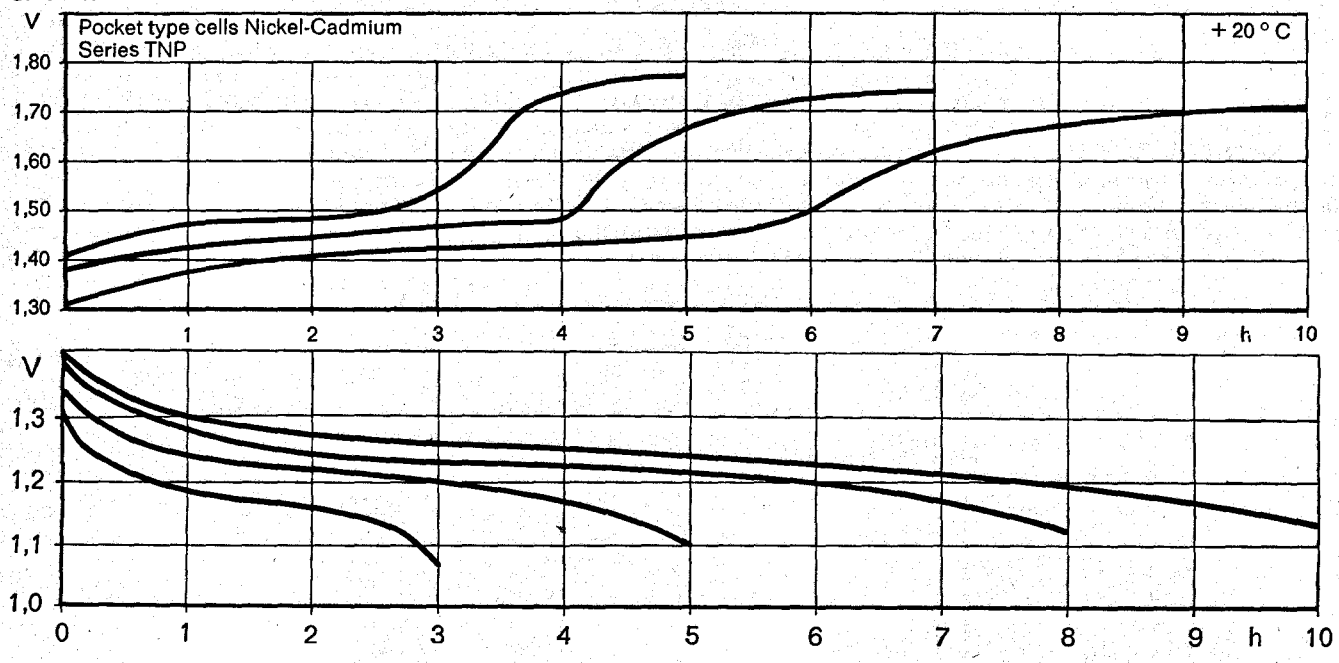
In vented alkaline cells the electrolyte readily absorbs carbon dioxide from the atmosphere thus producing potassium carbonate which interferes with positive plate operation. Vented alkaline cells therefore require maintenance at 3 to 5 yearly intervals. The cell should be emptied, washed with warm de-ionised water, refilled with fresh electrolyte and recharged before return to service.

The voltage time curve for nickel cadmium (Fig. 4) allows the construction of permanently sealed cells which have similar electrical characteristics to the vented types but are completely free from maintenance in operation. Some types are designed for float trickle charge, but of course, are very sensitive to voltage variation and ripple on the dc supply.

Sealed cells operate very satisfactorily in charge discharge cycling and are made in a range of sizes identical with those of

WHEN CHARGING AT CONSTANT CURRENT CHARGING VOLTAGE RISES FROM 1.35V UP TO 1.80V PER CELL

VOLTAGE CURVES WHEN CHARGING AT THE 5, 7 AND 10 HR. RATE AT CONSTANT CURRENT



DISCHARGE TIME IN HRS.	CAPACITY IN % OF 5 HR. RATE	DISCHARGE CURRENT INTENSITY IN % OFF 5 HR. RATE	DISCHARGE VOLTAGE AVERAGE VOLTS	DISCHARGE VOLTAGE FINAL VOLTS
10	105	53	1,24	1,13
8	104	65	1,23	1,12
5	**100**	**100**	**1,21**	**1,10**
4	97	121	1,19	1,08
3	94	157	1,17	1,06

Fig. 4. Charge/discharge characteristics of Varta type TNP alkaline cells.

Table 1. Characteristics of Typical Batteries

System	Anode	Cathode	Electrolyte	Open current voltage,	Typical operating voltage,	Capacity Ah/lb[a]	Capacity Wh/lb[b]	Remarks
Primary systems Leclanche	Zn(Hg)	MnO_2(C)	NH_4Cl-$ZnCl_2$	1.6	0.9-1.4	23	30	most common form of the dry cell; extensive applications; sloping discharge curve
Alkaline Zn-MnO_2	Zn(Hg)	MnO_2(C)	KOH	1.52	0.9-1.2	30	33	suitable for greater drain rates than Leclanche cells; sloping discharge curve
mercury cell (Rubin)	Zn(Hg)	HgO(C)	KOH-ZnO	1.35	1.30	40	53	constant voltage during discharge; heavier drains and higher capacity than Leclanche cells
Mg–MnO_2	Mg	MnO_2(C)	$MgBr_3$, Li_2CrO_4	2.0	1.6-1.8	30	46	higher capacity and voltage than Leclanche cell; 35–40% of magnesium consumed in hydrogen liberation during discharge
air-depolarised Zn	Zn(Hg)	O_2(C)	KOH	1.36	1.1-1.2	60[b]	70[b]	utilizes oxygen from air; wet type used for railway signals, home radios; dry type available but moisture loss a problem
Zn-AgO	Zn	AgO	KOH	1.8	1.4-1.5	35	53	one-shot, high-drain-rate reserve cell; also available in another form as a secondary battery
Zn-PbO_2	Zn	PbO_2	H_2SO_4	2.5	2.0-2.3	18	26	one-shot, high-drain-rate reserve cell
Zn-CuO	Zn(Hg)	CuO	NaOH	1.06	0.9-1.0			low operating voltage; used principally for railway signals
Zn-Cl_2	Zn	$ZnCl_2$	Cl_2	2.1	1.5-1.9			one-shot, high-drain-rate cell
Pb-PbO_2-$HClO_4$	Pb	PbO_2	$HClO_4$	2.0	1.6-1.8	11	19	one-shot, high-drain reserve types used for military applications
thermal cell	Ca	$PbCrO_4$(Ni)	LiCl, KCl fused	2.8	2.2			must be heated to melt electrolyte, one-shot, high-drain, military type cell
Mg-Cu_2Cl	Mg	Cu_2Cl	$MgCl_2$	1.4	1.1-1.3	25	30	one-shot, high-drain reserve cell; may be activated with sea water
Mg-AgCl	Mg	AgCl	$MgCl_2$	1.6	1.3-1.5	54	75	one-shot, high-drain reserve cell with very high capacity; may be activated with sea water
Zn-V_2O_3	Zn	V_2O_3	NH_4OH, ethylene glycol, boric acid	1.2	1.2			available commercially as a bias cell providing stable voltage at zero current over long periods
Weston standard	Cd(Hg)	Hg	$HgSO_4$, $CdSO_4$	1.019	1.2			used as a voltage standard
solid electrolyte	Ag	$CuBr_2$	AgBr	0.75				power source for radiation warning devices; charging source for low-leakage capacitors
Fery cell	Zn	O_2(C)	NH_4Cl	1.2	0.7			used extensively in foreign countries for telegraphy and telephone service; performs efficiently at low drains
Zn-AgrO	Zn	Ag_2O	KOH or NuOH	1.6	1.5	33	49	small sealed primary cell for electric wrist watch or hearing aid use; hermetically sealed
In-HgO	In	HgO	KOH	1.15	1.05			electric wrist watch battery; hermetically sealed
Experimental cells (primary) organic cathode	Mg	*m*-dinitro-benzene	$MgBr_2$	1.65	1.15[d]	56	65	one of the more promising of a large number of organic compounds being considered; multistep discharge
solid electrolyte	Ag	V_2O_3	AgI	0.46	0.38-0.46[d]			typical of a variety of similar systems that could be made commercially if applications warranted: thin flat cells providing 100 V/in. of battery length
Al-MnO_2	Al	MnO_2	$AlCl_3$,$(NH_4)_2Cr_2O_7$	1.7	1.3			higher capacity and voltage than Leclanche cell; wasteful corrosion of aluminium remains a major problem
Mg-Bi_2O_3	Mg	Bi_2O_3	$MgBr_2$	1.6	1.0	6		operates 0.2-0.3 V lower potential than HgO-Zn system but otherwise has similar voltage-time discharge characteristics
Secondary cells lead acid	Pb	PbO_2	H_2SO_4	2.2	1.95-2.05	10	20	conventional lead storage cell
Edison	Fe	Ni oxides	KOH	1.6	1.2-1.4	10	13	much longer useful life than lead storage cell but lower capacity and more expensive
	Cd	Ni oxides	KOH	1.35	1.1-1.3	10	12	available as a completely sealed cell
Cd-NiO Zn-AgO	Zn	AgO	KOH, ZnO	1.8	1.4-1.5	35	53	very high capacity and suitable for high discharge rates but smaller number of cycles than Ni-Cd or lead storage cells
Cd-AgO	Cd	AgO	KOH	1.4	1.0-1.1	30	33	greater number of cycles than Zn-AgO secondary cell
MnO-Zn	Zn	MnO_2	KOH	1.5		8	9	available only as a completely sealed cell

a *Based on total weight of commonly available size of commercial cells.*
b *Exclusive of O_2 consumed from air.*
c *Average voltage for light-drain application.*
d *2×10^{-10} A/in.^{2} drain for the first 7 yr of cell life.*

conventional primary cells. The capacity ranges from 10 milliampere hours to over 20 ampere hours at the 10 hour rate. The constant current method of charging is used with time limit facility. The degree of charge required is easily determined by discharging at the 3 hour rate for a few seconds and measuring the cell voltage accurately. When plotted on the 3 hour discharge curve, the percentage charge may be determined. The cell is then charged at the 5, 7, or 10 hour rate, in each case with constant current, for a time which is based on 125% of the calculated charge requirement.

Cell voltage of Nickel Cadmium varies from a maximum of 1.8 volts at end of charge and a nominal 1.3 volts open circuit fully charged to between 1.25 and 1.0 volt average during discharge. The optimum voltage for float trickle charge is 1.44 volts per cell at which rate the charge current should equal the capacity at the 5 hour rate divided by 300.

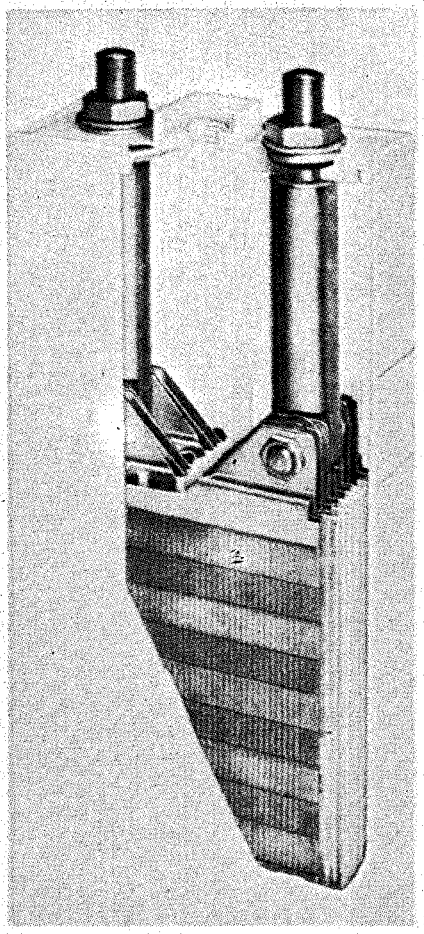
The average discharge voltage at the 3 hour rate is 1.17 volts per cell so that in a nominal 50 volt emergency power supply 38 cells would float at 54.7 volts and average 44.4 volts during a 3 hour discharge, ending at 40.2 volts.

High performance cells made with foil plates are capable of very high currents of the order of 75 times the 5 hour discharge rate and these batteries are applied to engine starting for large emergency power plants. In this application the battery is maintained at full charge by continuous trickle charge and must remain unaffected by this treatment for very long periods.

SPECIAL SYSTEMS

Many other couples have been developed and perhaps the most spectacular is the Silver Zinc system used in Lunar rovers on the moon and the 160 m.p.h. plus battery-powered car. This system delivers very high energy density, but is very costly and has limited life. Another well publicised system is the Sodium Sulphur battery being developed in U.S.A., this also has high energy density and is made from materials which are relatively abundant. The disadvantages are the high operating temperature of 800°C and the difficulty of manufacturing the special β alumina ion-exchange electrolyte.

Other exotic couples include the Lithium Fluorine cell which operates in a non-acqueous electrolyte and produces the highest yet obtainable energy density. The capability is due to the low density of the reagents and the high (3.4 volts on load) voltage of the couple.



A high capacity alkaline cell.

More recently, metal air cells and in particular Zinc Air, have been developed to semi-commercial stages and offer many attractive properties. Many problems in rechargability have to be overcome, however, before these can be considered as viable secondary batteries. The Air Electrode and Separator System has quite a long life expectancy when the cells are operated on a mechanised recharge program, i.e., the discharged zinc in the form of oxide and zincate is removed from the cell, a new zinc electrode and electrolyte added and the spent reagents are reformed to metallic zinc in another cell specially designed for this purpose.

The future of batteries for both stationary, starting and traction use is brighter then ever and developments in the established Lead-Acid and Nickel-Cadmium designs have maintained these two systems as the most reliable and economical for nearly all applications. The significant break-throughs promised for other types have not yet appeared and it is likely that these two systems will find continued use in the future. ●

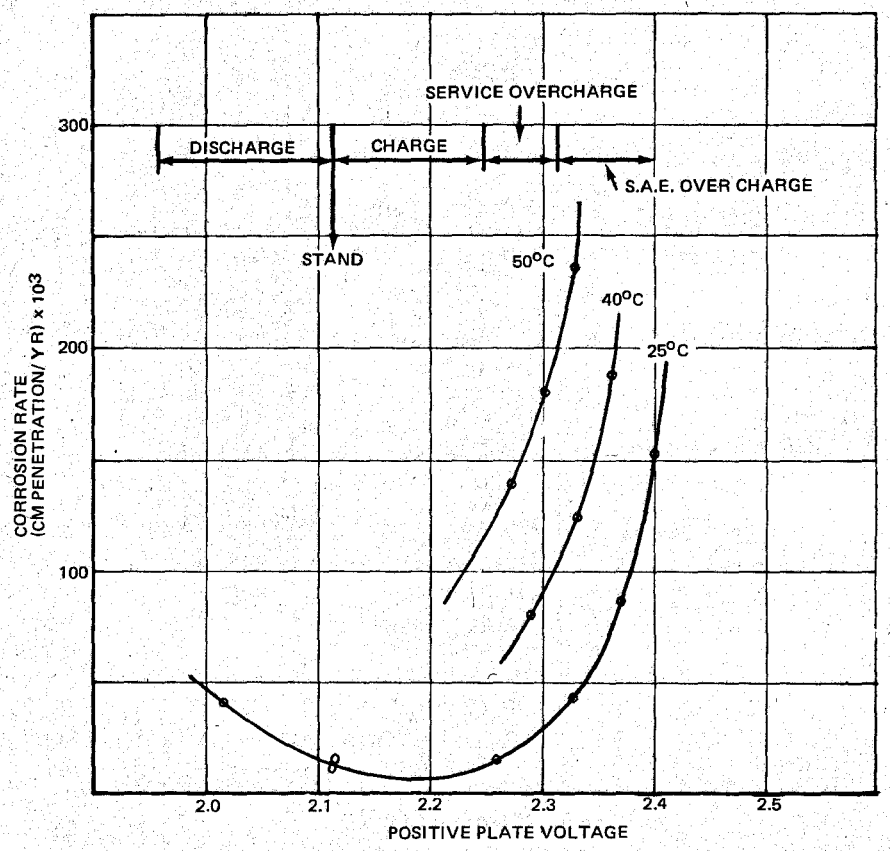
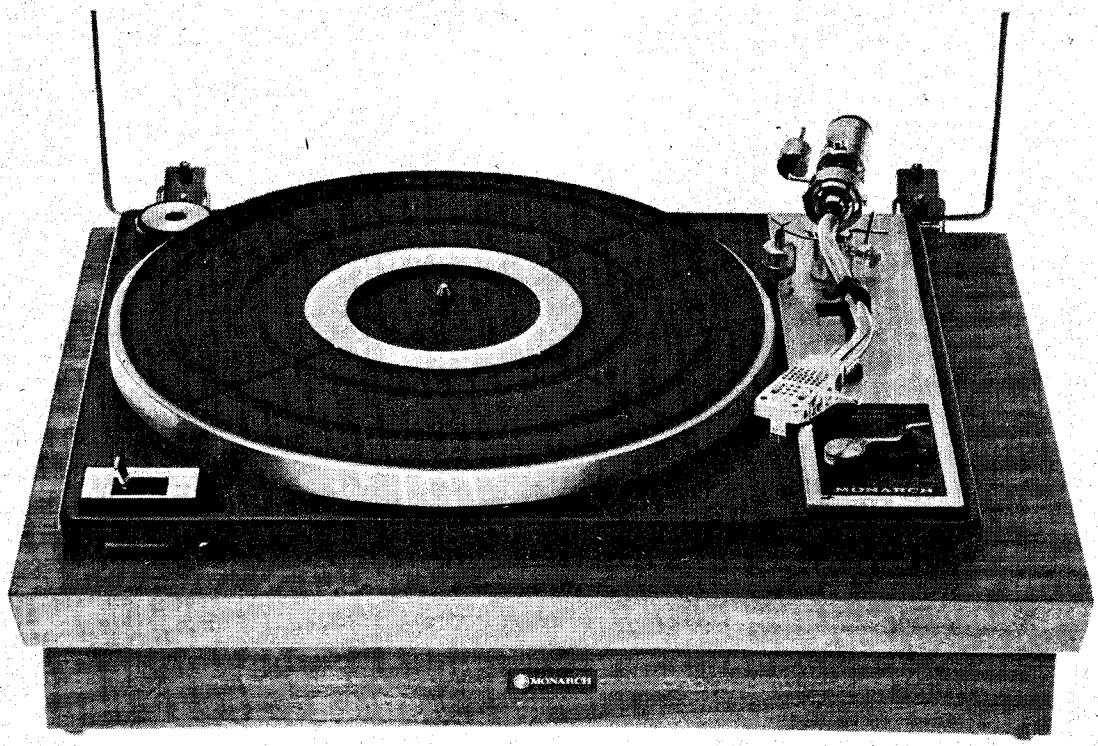


Fig. 5. Typical corrosion rate versus plate voltage per nickel-cadmium cell. The positive plate voltage is with reference to cadmium and the total cell voltage is the sum of the positive and negative plate potentials.



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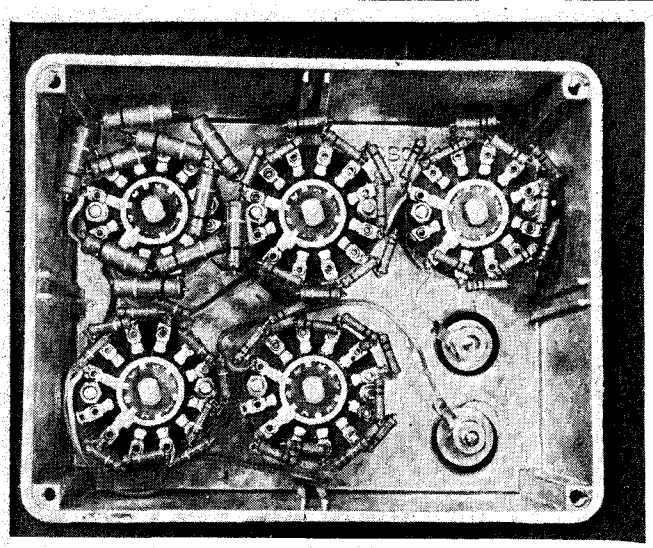
The decade resistance box.

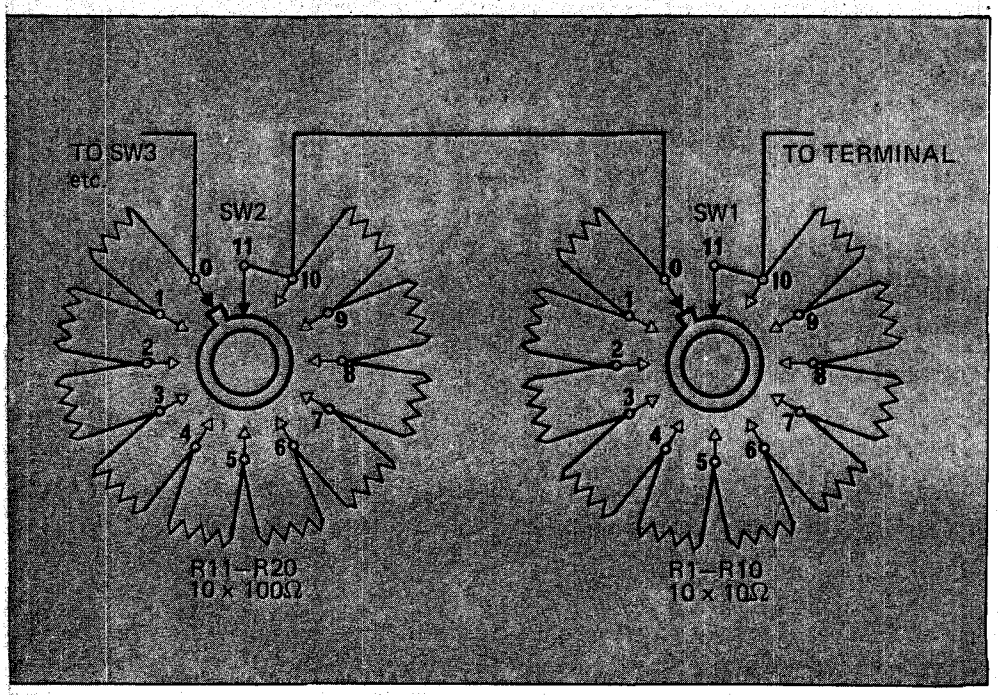


Interior of the completed unit.

DECADE RESISTANCE BOX

ET PROJECT 108

A versatile and accurate variable resistance unit for experimenters



HERE is a simple, but very valuable, addition to your electronic workshop equipment. Every experimenter constantly finds that the breadboard mock-up doesn't quite match the theory calculations, and that he needs to fiddle resistor valves.

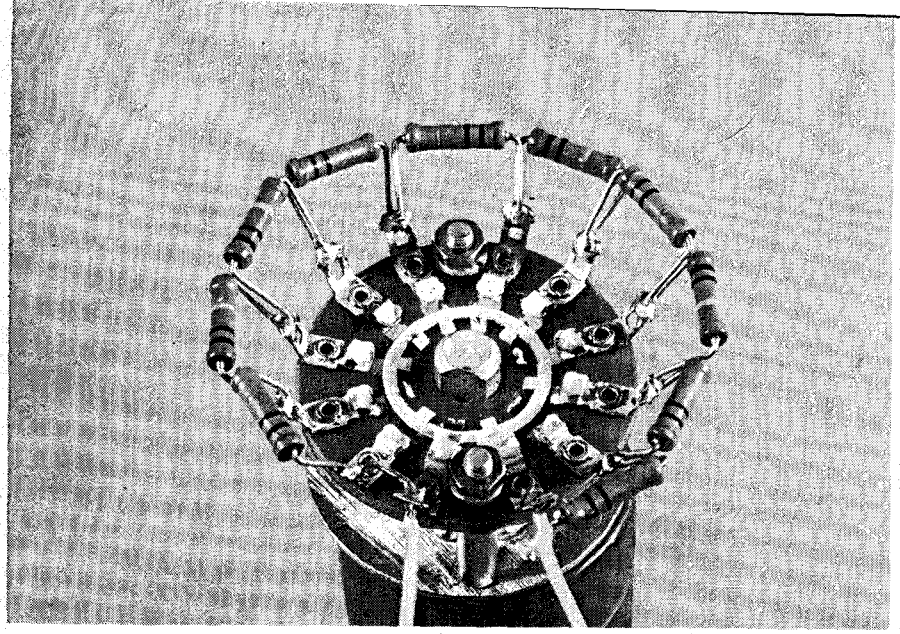
There is nothing more time consuming than the "unsolder and try another" method. This time waste may be virtually eliminated by using a good decade resistance box.

Another use for a decade box is as a precision variable-resistor in experimental measurements and to meet this requirement we have provided ten-ohm resolution and have specified 2% accuracy resistors. These resistors are available at reasonable cost, the expense of higher accuracy components being not justified for most applications.

Fig. 1. The method of interconnecting the switches.

PARTS LIST

R1 – R10 Resistor 10Ω 2% ½ watt Philips type MR30 or equivalent.
R11 – R20 Resistor 100Ω 2% ½ watt Philips type MR30 or equivalent.
R21 – R30 Resistor 1000Ω 2% ½ watt Philips type MR30 or equivalent.
R31 – R40 Resistor 10kohm 2% ½ watt Philips type MR30 or equivalent.
R41 – R50 Resistor 100kohm 2% ½ watt Philips type MR30 or equivalent.
SW1 – SW5 Wafer switch, single pole, 11 position OAK type 1 or similar.
diecast box 4½" x 3¾" x 2", ITT type 043B00 or similar.
2 binding post terminals and 3 knobs.



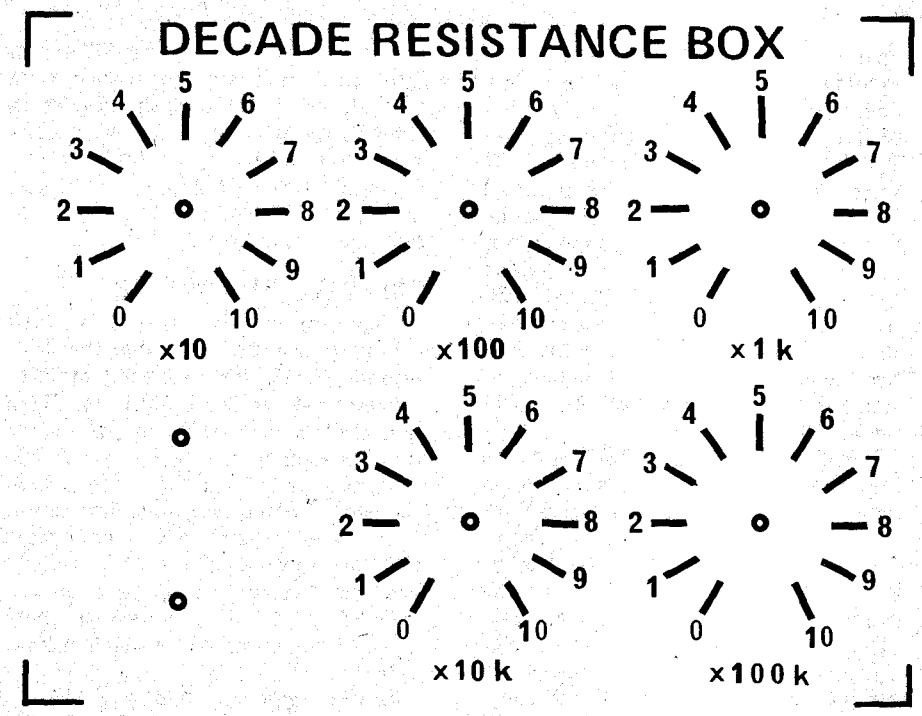


Fig. 2. The resistors are mounted to the switches as shown.

Fig. 3. Front panel overlay (full size).

will act as a fuse and protect the switch contacts from damage due to shorts. Finally connect pin "O" of SW5 to the other terminal.

In our prototype we disassembled the switches and filed away the stops thus allowing continuous rotation in either direction. Be very careful, if you decide to do this, not to damage the switch. Remove the wafer assembly taking care not to apply pressure to the rotating wiper section. Remove the circlip retaining the shaft and withdraw the shaft/clicker plate assembly. The stop may then be removed with a file and the switch reassembled. ●

CONSTRUCTION

Assemble the resistors to the switches as shown in the photograph, R1-R10 to SW1, R11-20 to SW2 and so on to SW5.

Fit the switches to the metal box and ensure that the resistors are clear of the metal box sides. If there is insufficient clearance a piece of manila-folder cardboard will provide the necessary insulation.

Connect all the switches in series, as shown in Fig.1, and then connect the wiper of SW1 to one of the input terminals with one single strand from a piece of flexible hook-up wire. This

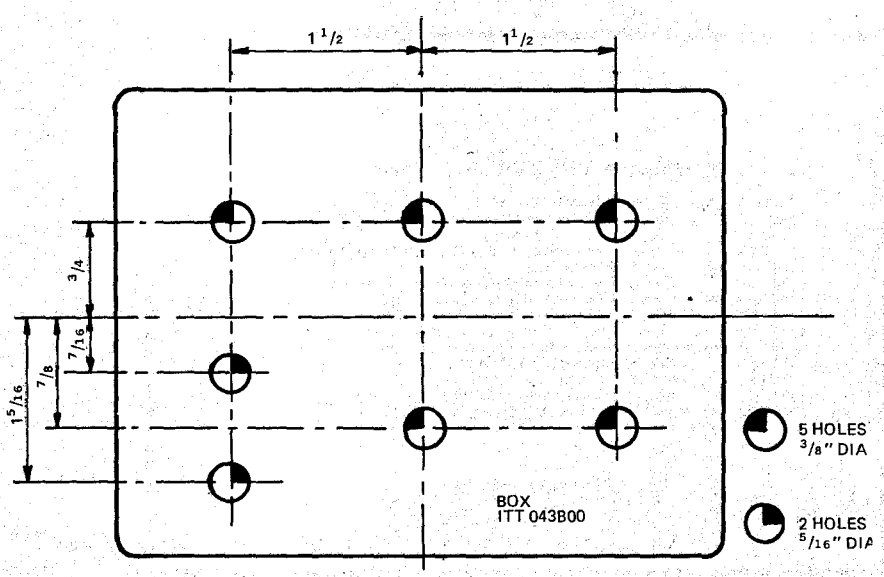


Fig. 4. Drilling details for the diecast box.

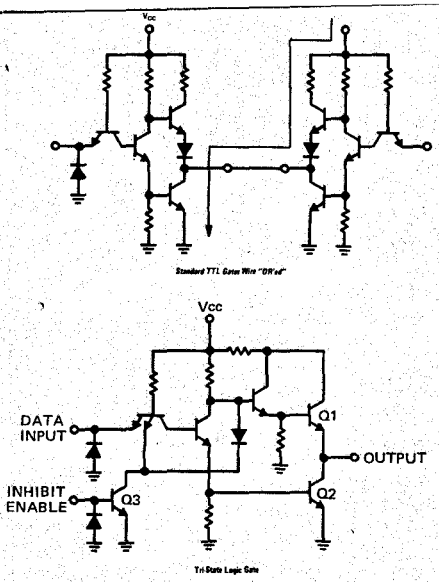


Fig. 1a. Standard TTL gates wire "OR"-ed.
Fig. 1b. TRI-STATE logic gate.

TRI-STATE LOGIC

A new form of logic known as TRI-STATE has been introduced by National Semiconductor Corp. The new devices overcome many of the limitations of TTL and are of particular value in the computer and data processing fields.

AS the state of the art progresses in digital integrated circuits, each newer logic family generally has features superior to those of its predecessor. The evolution from RTL to DTL to TTL (resistor-transistor to diode-transistor to transistor-transistor logic) improved speed, drive capability, and noise immunity.

However, when DTL was upgraded to TTL, busconnectability was lost. This function, usually called "wire-OR'ing," is a very important one in the system designer's toolbox. It not only reduces hardware but is absolutely indispensable to the bus-structured architecture so common in the computer field. The loss resulted from replacing DTL's passive-pullup output with TTL's active-pullup output to increase speed and drive.

Designers of bus-organized systems had to retain DTL or use open-collector TTL elements with external pullup resistors on each data line. This limits system speed to that of the bus-interface elements, typically 2 or 3 MHz for open-collector TTL versus 10 MHz or better for standard TTL. Most of the loss in speed is due to the RC time constant of the pullup resistor and bus capacitance, which generally adds more than 100 nanoseconds to the data transfer delay time. In addition, open-collector TTL has twice as long gate delays as standard TTL. Drive capability is also poorer.

Speed and power may not be important in some areas of logic design, but these parameters are paramount in systems which depend for efficency upon quick transfer of data via buses. The solution to the problem is provided by tri-state logic (TSL). Tri-state logic is essentially TTL with output stages, or input and output stages, that can assume three states. Two states are normal low-impedance TTL "1" or "0" states. The third as a high-impedance state that allows many tri-state devices to time-share bus lines. These devices have the speed of standard TTL, higher line-drive and noise immunity, and by eliminating pullup resistors, cut bus delays to a few nanoseconds.

TRI-STATE CHARACTERISTICS

Maximum leakage current is 40nA when the output is at either the 2.4V or 0.4V levels and does not increase substantially at the 5.0V level. When the device is placed in its active (low-impedance state) it has all the desirable qualities of TTL logic, such as speed, power, and noise immunity. The device however may be connected to the outputs of similar devices, because of its ability to be switched to an OFF state (high-impedance) where it appears to the bus as a 40μA leakage path.

Another important factor in driving a bus line is device current sourcing and

Currently available TRI-STATE devices:

DM7093	quad 2-input buffer
DM7123	quad 2-input multiplexer
MD7214	dual 4:1 multiplexer
DM7230	2:4 multiplexer and bus interchange switch
DM7551	quad D flip-flop
DM7598	256-bit expandable read-only memory
DM7598AA	sine table look-up read-only memory
DM7599	64 bit random access read/write memory
DM7831	quad single-ended/dual differential driver

The following devices will be available shortly

DM7552	decode counter/latch
DM7553	eight-bit storage latch
DM7554	hexodecimal counter latch

DM7000 series devices are to MIL-SPEC, commercial devices are the DM800 series; eg. DM7093 is equivalent to DM8093 commercial.

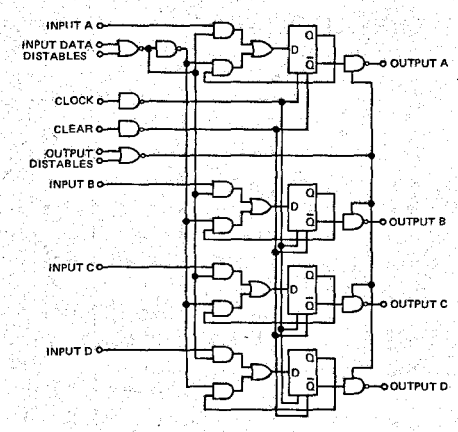


Fig. 2. Logic diagram of TRI-STATE quad flip-flop type DM8551

TRI-STATE LOGIC

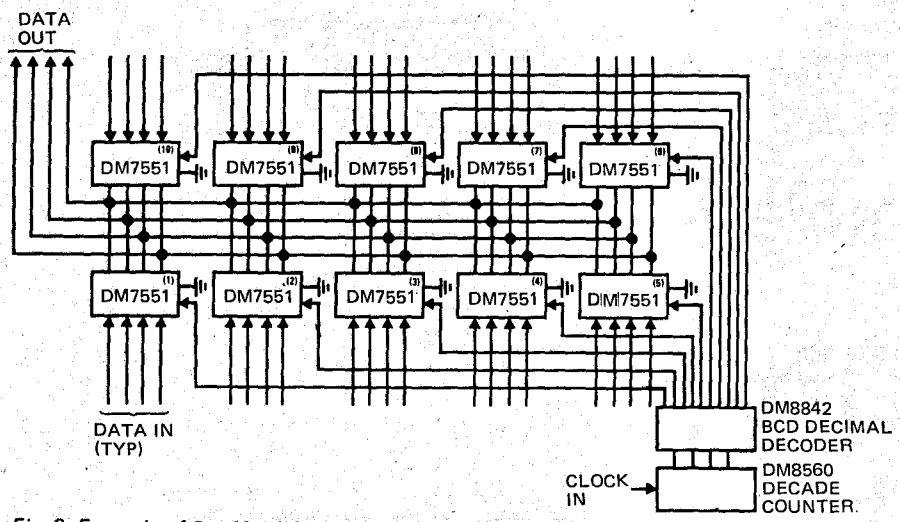


Fig. 3. Example of Bus-Multiplexing with decoder control.

sinking capability. For this reason, the tri-state output stage was designed to source 5.2mA at 2.4V and sink 16 mA at 0.2V. This is 13 times more sourcing capability than a standard TTL gate. This high sourcing capability will permit as many as 128 TSL outputs to be tied to a common bus and still provide enough sourcing current to drive three standard TTL loads.

Another advantage of the high current sourcing feature is that the standard TTL gate with 400μ maximum sourcing capability can only drive about 10 to 12 inches of line before noise problems become prohibitive. The TSL output will drive over 10 feet of line reliably. The greater sourcing capability also provides a far superior "1" level noise immunity, approximately a factor of 10 better than standard TTL devices.

LOGICAL CONTROL

It is the output stage of a standard TTL device that prohibits its use in the wire OR configuration. If the outputs of two TTL gates were connected and one of them was placed in the logical "1" condition and the other placed in the logical "0" condition, a low-impedance path would result from Vcc to ground, resulting in a catastrophic failure in one or both of the gates. (Fig. 19.) The solution to this problem (which developed into the TSL concept) is to provide a separate input that would have priority over all others and force both of the totem-pole output transistors into the OFF state. (Fig 1 b). When this inhibit input is true, the output will be in the high impedance state and any number of such outputs may be connected together without damage. If the inhibit is false (output enabled), then the output will provide a low-Z logical "0" or "1" depending upon the states of the inputs other than the inhibit/enable input. It is worth noting also that the upper device consists of a Darlington stage. This provides the increased sourcing current typical of the TSL output stage.

For some MSI/TSL devices (DM8551 for example), the inhibit/enable line input is brought out as a two input NOR gate. This permits enabling the device when both inputs are logical "0"s. This is done so that large numbers of TSL packages may be selected with TTL decoders, such as the DM8842 (BCD to decimal decoder). Such devices have active low outputs. This enables the selection of one out of 100 TSL devices with the use of only two decoders.

TYPICAL TRI-STATE APPLICATION

One of the key tri-state devices is the DM8551, a synchronously clocked quad-D latch with tri-state outputs. Its logical organization is illustrated in Fig. 2. The internal latch outputs are enabled to the device outputs through four TSL buffering gates. These gates are controlled from a single two-input NOR gate. The outputs are placed in their third state if either of the two NOR inputs is taken to the logical "1" level (high). This arrangement facilitates the selection of up to 100 DM8551's from a single pair of DM8842's (BCD to decimal decoders). This application is illustrated in Fig. 3.

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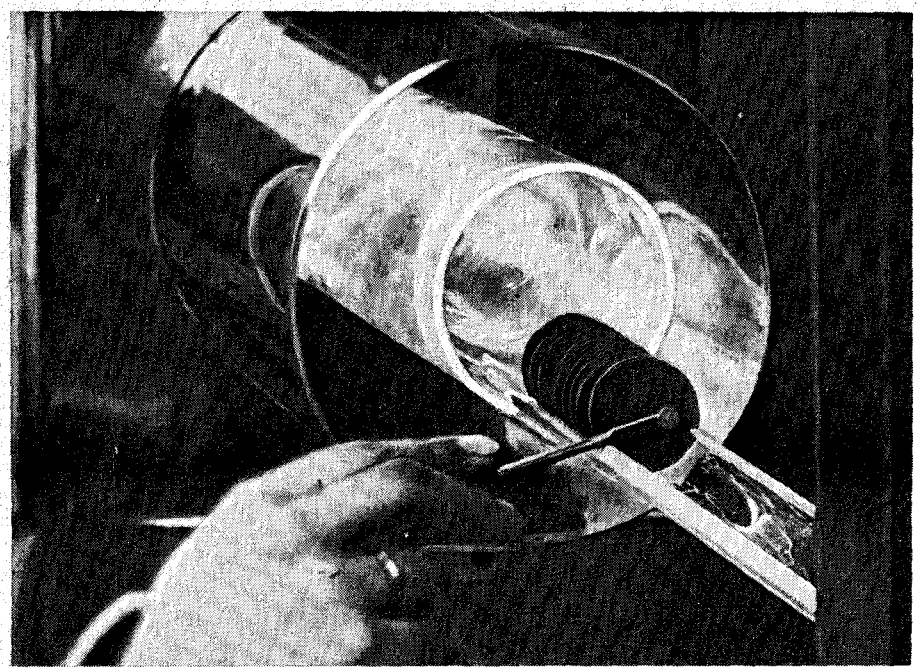

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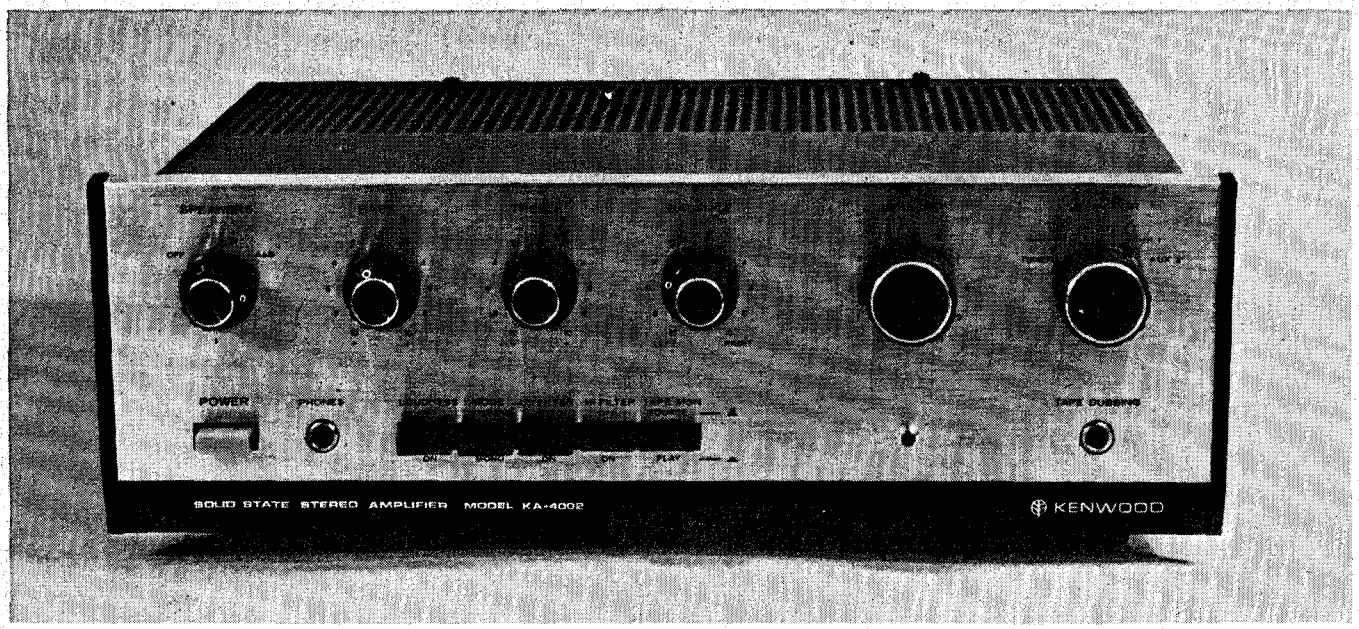


THE KENWOOD KA4002 AMPLIFIER

electronics TODAY INTERNATIONAL
product test

Excellent facilities and a genuine 20W per channel are features of this medium priced amplifier.

KENWOOD high fidelity amplifiers and equipment have made a significant impact on the world market since 1964. At that time the TRIO company of Japan decided to adopt the "Kenwood" name to improve their marketing image. The namechange request came from the Americans, and when sales boomed, the name was applied to nearly all their products except those marketed in the U.K.

The KA 4002 amplifier comes well packed in a moulded polystyrene cover and cardboard box consisting of 3 cartons inside each other. The traditional Kenwood black fascia with yellow or white engraving has been deleted in favour of a new style, polished satin aluminium face, overlying a black base. The panel has black engraving and is fitted with black knobs.

CONTROL FACILITIES

The controls are mounted on the panel in two lines their functions from left to right being.

1. Top Row

a) speaker switch with 'off', 'A', 'B' and 'A' plus 'B' systems.
b) bass control with 11 stepped positions.
c) treble control with 11 stepped positions.
d) balance control with a very sensible indented neutral position.
e) a large volume control and
f) a large selector knob with positions for a tuner input, 2 phono and 2 auxiliary inputs.

2. Bottom Row.

a) a salmon coloured power switch
b) a stereo phones socket
c) a loudness switch which has to be depressed to activate the loudness boost circuits.
d) a stereo mode switch which mixes left and right channels when depressed.
e) a low frequency filter which reduces rumble and low frequency content and provides — 10dB insertion loss at 50Hz.
f) a high frequency filter which attenuates the high frequency program content and is often needed as a scratch filter, and
g) a tape monitor control to allow playback of tapes and monitoring of source material.

As well as the above there is a small red bezel "mains on" light and a tape dubbing socket which allows connection to a tape recorder input from the amplifier front panel.

The rear panel of the amplifier has very good facilities for an amplifier in this price bracket. Firstly, it provides two phono and two auxiliary inputs as well as tuner and tape recorder inputs and secondly, it provides preamplifier output and main amplifier input

THE KENWOOD KA4002 AMPLIFIER

facilities for each channel. These can be connected or disconnected as required by means of a small slider switch. The back panel also incorporates a DIN plug connection for a tape recorder, a mono output, and one switched and one unswitched American type mains output sockets.

CONSTRUCTION

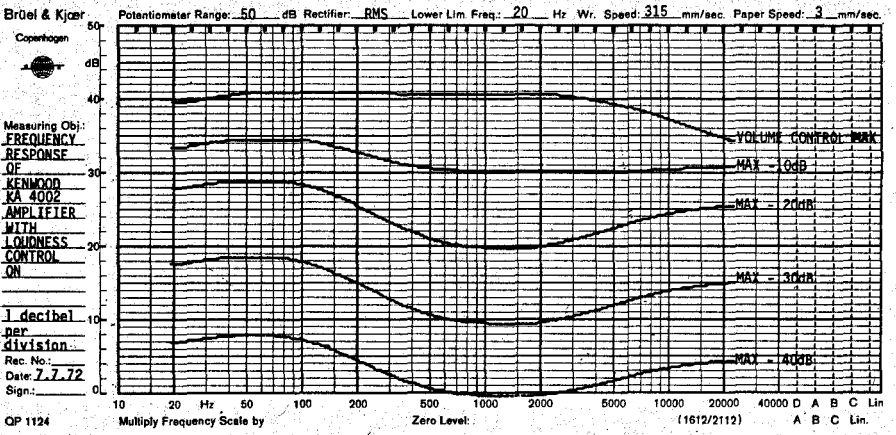
The construction of the amplifier is particularly good. The basic chassis is a well made and well ventilated, welded electro-galvanised steel tray, on to which are screwed the front and rear panels. A removeable plate is provided in the base directly under the printed circuit to provide immediate access to the circuitry.

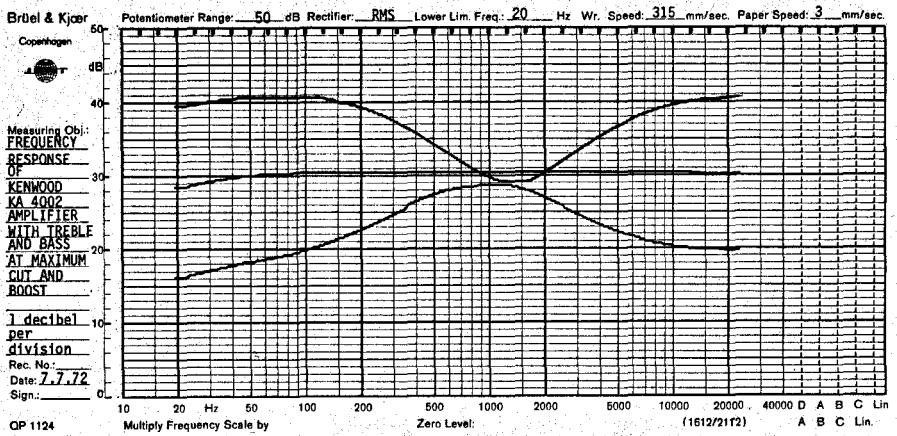
The circuitry is very compact but well laid out with a painted interconnection layout and clear component designations on the top of the printed circuit board. The switching, printed circuit board, and the potentiometer control wires are connected, using a wire wrap system, to pins on the main printed circuit and these provide excellent metering points for circuit fault finding.

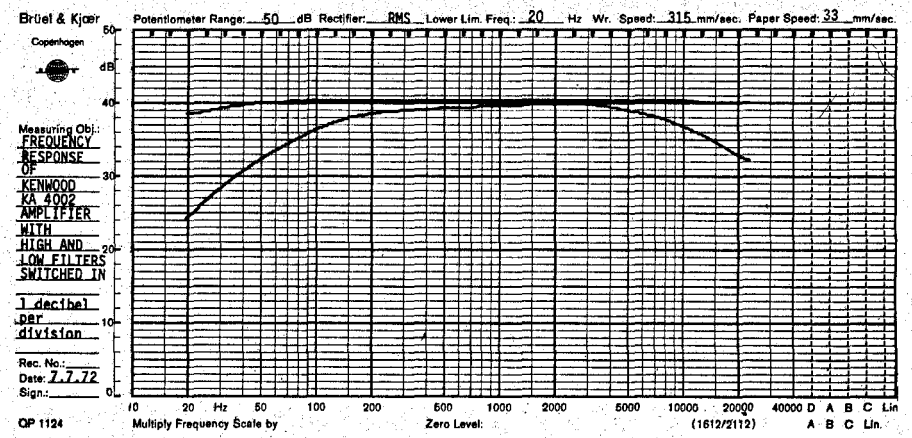
The main output transistors are mounted on a 16 gauge bright aluminium plate near the rear of the amplifier and all the transistors are high reliability silicon planars.

OPERATIONAL FEATURES

The output circuitry is electronically protected against overload, short circuit and excessive temperature. We found these circuits worked reliably, making it almost impossible to damage the amplifier by overloaded or shorted outputs.

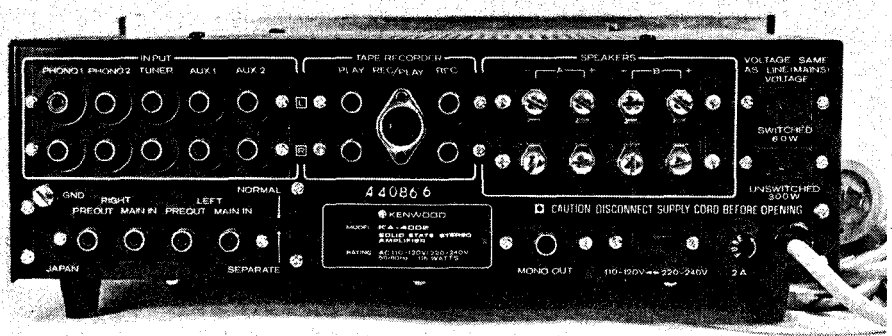






The amplifier has a few unusual performance characteristics. Firstly, the loudness control exhibited a response that was somewhat less than ideal. Over most of the range the response was normal, but at the maximum volume setting (and with a low level input) the treble response was cut and the bass response flattened out.

The switched bass and treble filters (low filter and high filter) provided an attenuation a little short of that claimed in the data, the bass being nearly correct but the treble cut was insufficient and would do little more



Rear panel of the KA4002 – could hardly incorporate any more facilities than it does.

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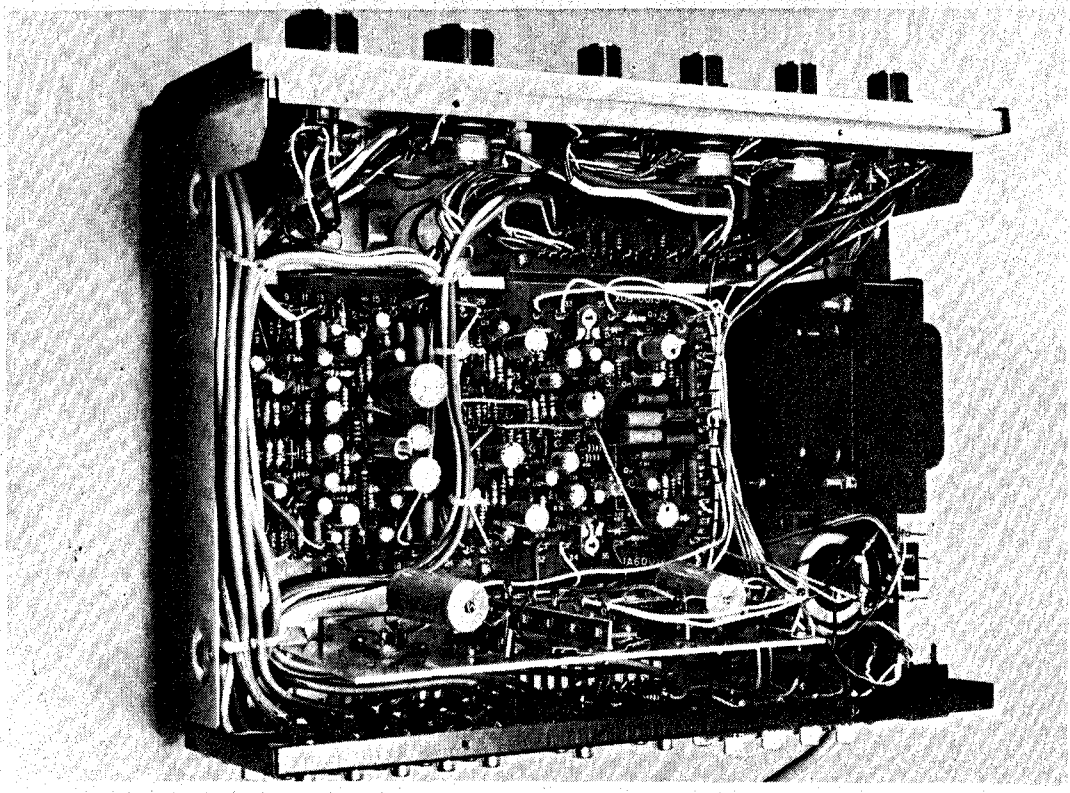
THE KENWOOD KA4002 AMPLIFIER



PC boards are neat and easily serviced.

than cut a small amount of scratchiness from an older record.

The bass and treble controls are potentiometers with mechanical indents at 2dB intervals and were well within specification. The advantage of indented setting was readily apparent on music testing as there was no trace of clicks and pops, a decided disadvantage with some of the early Japanese amplifiers fitted with switched attenuator tone controls.

The sensitivity of the phono inputs was adequate and the measured distortion was well within the limits now regarded as standard for true high fidelity performance.

As with most of the new high quality amplifiers, that we have tested, there was no audible distortion until the onset of clipping.

The amplifier is provided with a 16 page, well written and illustrated handbook, and a separately printed, single sheet, circuit diagram. We feel that a circuit diagram should also be bound into the manual.

CONCLUSION

The Kenwood KA 4002 amplifier is an excellent amplifier offering a wide range of operational facilities for patching and interconnection. Its performance and price place it well up in the range of medium priced amplifiers which provide 20 watts per channel. The human engineering aspects of its design are good and we would rate it as being good value for money. ●

MEASURED PERFORMANCE OF KENWOOD KA4002 AMPLIFIER

POWER OUTPUT INTO 8 ohm AT RATED INPUT

Both channels driven	21 watts.

FREQUENCY RESPONSE AT RATED OUTPUT

20Hz to 20kHz	+0dB, -2dB.

CHANNEL SEPARATION AND SENSITIVITY AT RATED OUTPUT

	Separation	Sensitivity
Phono Input	45dB	2.2mV
Aux. Input	56dB	140mV.

HUM AND NOISE (UNWEIGHTED) AT RATED POWER AND MAXIMUM GAIN

Phono Input	-62dB
Aux Input	-71dB

TOTAL HARMONIC DISTORTION AT RATED OUTPUT

100Hz	0.4%
1kHz	0.3%
6.3kHz	0.3%

INTERMODULATION DISTORTION 0.35%

TONE CONTROL RANGE

Bass boost at 100Hz	+10dB
Bass cut at 100Hz	-10dB
Treble boost at 10kHz	+9dB
Treble cut at 10kHz	-10dB

FILTERS

Low frequency at 50Hz	-8dB
High frequency at 10kHz	-3dB

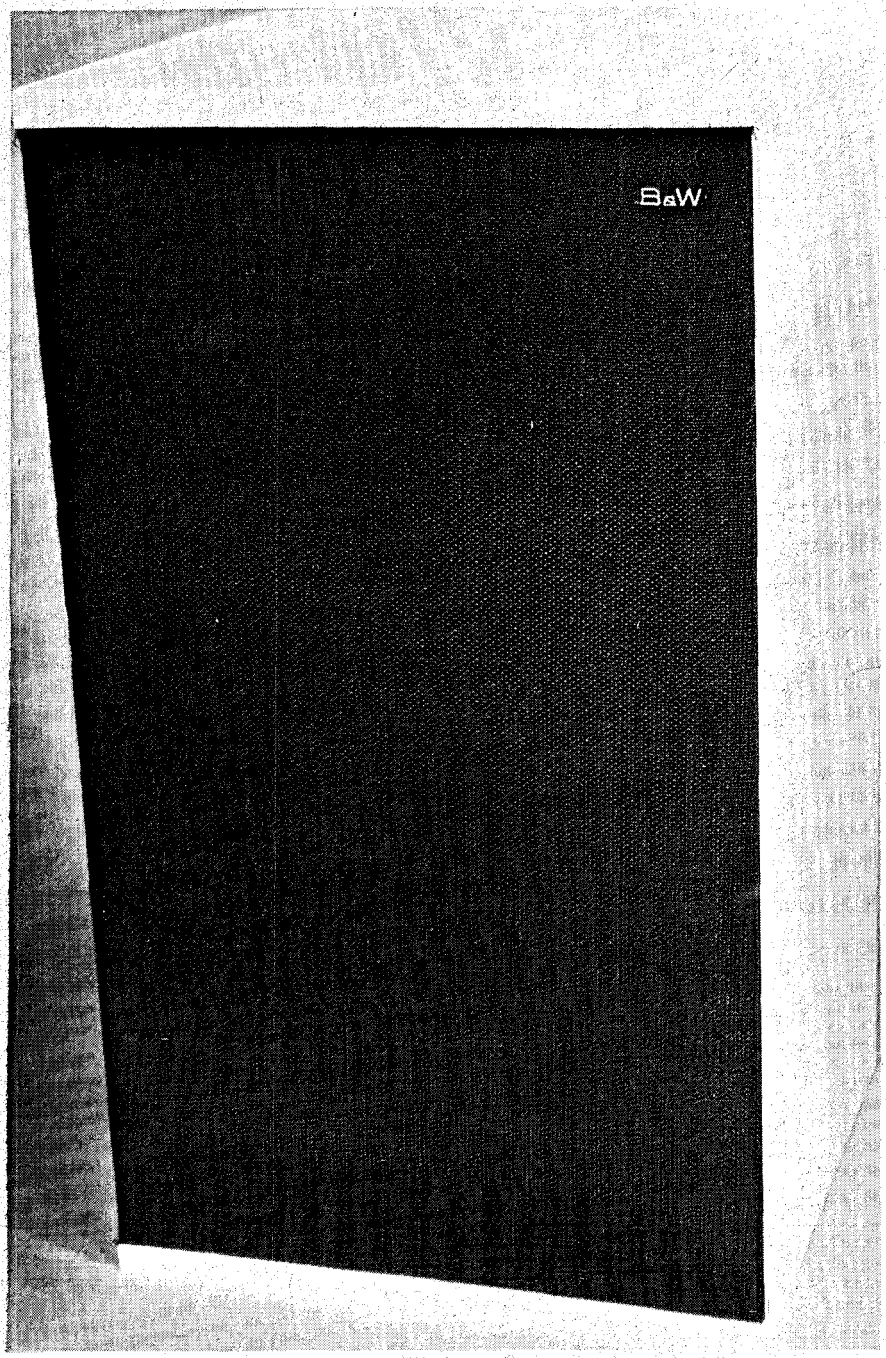
LOUDNESS AT -20DB FROM MAX OUTPUT

at 50Hz	+9dB boost
At 10kHz	+4dB boost

DIMENSIONS

Width	13¼ inches
Depth	10¼ inches
Height	5 inches
Weight	12.5 lbs
Price (recommended retail).	$199

BOWERS AND WILKINS DM2 SPEAKERS



electronics TODAY INTERNATIONAL
product test

Latest B & W speakers have exceptionally smooth response

THE Bowers and Wilkins model DM2 is the result of the company's requirement to produce a unit which filled the gap between their very small monitor speaker, the DM1, and their large monitor speaker, the DM3.

The external appearance of the DM2 is different from previous units in the Bowers and Wilkins range. This is particularly true of the one we reviewed, which was painted gloss white and fitted with a black grille with aluminium edge trims. The DM2s are also available in either a teak or walnut veneer. By contrast both the DM1 and DM3 have timber enclosures fitted with chamfered timber front trims and recessed grilles.

The main design aims of the DM2 are as follows:—

a) to improve the mid-range frequency linearity

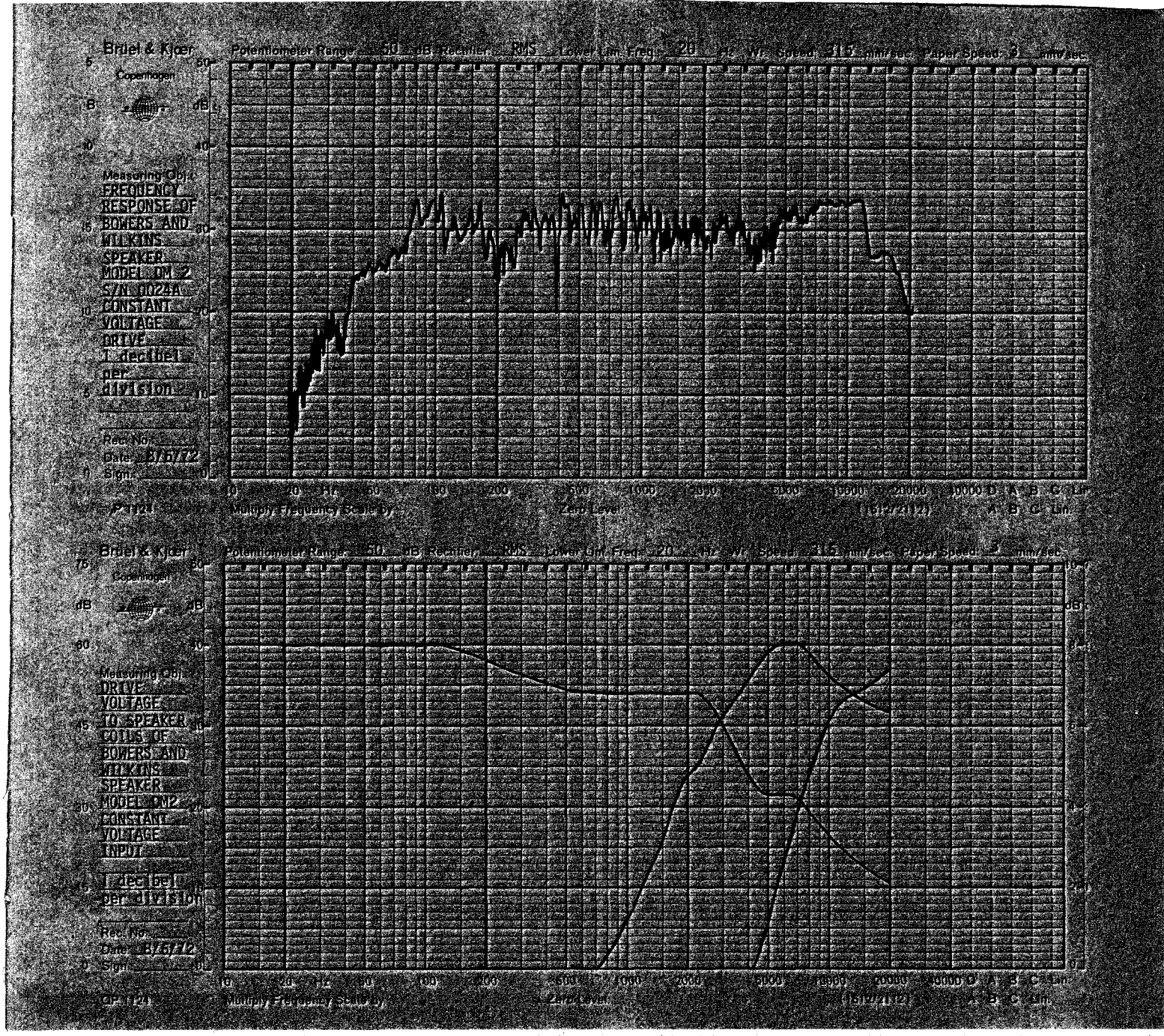
b) to evaluate and use the acoustical load line technique in the 30 to 60Hz region to enhance bass output for a given cone excursion.

c) to be economical to manufacture, so that it falls between the price of the DM1 and DM3

d) to have a similar sensitivity to the DM1

Some of these aims have been obtained with exceptional results.

The design and construction of the enclosure is very interesting because of the 1/8 wave acoustic line loading on



the oval bass/mid-range speaker. The sketch shows the folded tapered pipe which is constructed from ½" thick particle board panels rigidly fixed between the ¾" thick particle board sides of the enclosure. To correctly load the speaker, batts of coarse plasticized hair felt have been stuffed into the pipe. The aperture at the bottom of the enclosure has approximately the same area as the cone of the bass speaker located at the top of the front panel. Another interesting feature of the bass unit is the very large magnet which measures 5" diameter by ¾" thick.

Just below the 6" bass-speaker, and mounted side by side, is the 2" high-range speaker and the 1" tweeter.

COMPLEX CROSSOVER NETWORK

The cross-over networks are extremely complex, consisting of four air cored inductors, two ferrite cored inductors, 10 polyester dielectric capacitors and five high wattage resistors. These components are fitted on two printed circuit boards which have the component sizes etched on them. One board is mounted on the back of the front panel, the other board on the left hand side panel. The cross-over networks for the high range speaker and tweeter are third order Butterworth.

SUBJECTIVE IMPRESSIONS

The subjective assessment was at first deceiving because of the extremely smooth mid-range response devoid of any leaks or drop outs. This fact was particularly evident when 'A-B' tests were performed with our studio monitors — which do have a slight presence and brilliance. The 'A-B' tests also showed up the early roll-off of the low frequency response of the DM2 at approximately 65Hz. However, even with this low frequency roll-off the reproduction of the C.B.S. record "The Romantic Philadelphic Strings" was a delight to listen to, particularly the violins, which came out sharp and clear. On the heavy bass passages in the J.B.L. Contemporary Record PRO 496 the bass speaker could be slightly overdriven against the magnet

BOWERS AND WILKINS DM2 SPEAKERS

MEASURED PERFORMANCE OF B & W SPEAKER MODEL DM 2 SERIAL NO 0024A

Frequency Response 40Hz to 18kHz ± 6dB

Total Harmonic Distortion

	100Hz	1kHz	6.3kHz
1 Watt input	7%	0.8%	1%
5 Watts input	10%	1%	1.2%

Electro-Acoustic Efficiency 0.6%

Cross Over Frequencies 2800Hz and 12kHz

Woofer Resonance
In free air 80Hz
In enclosure 65Hz

Measured Impedance

100Hz	1kHz
6.5Ω	11.5Ω

Enclosure Volume 1.8 cubic feet

Dimensions 25¼" high x 13¾" wide x 13" deep

Recommended Selling Price **$274.00 each.**

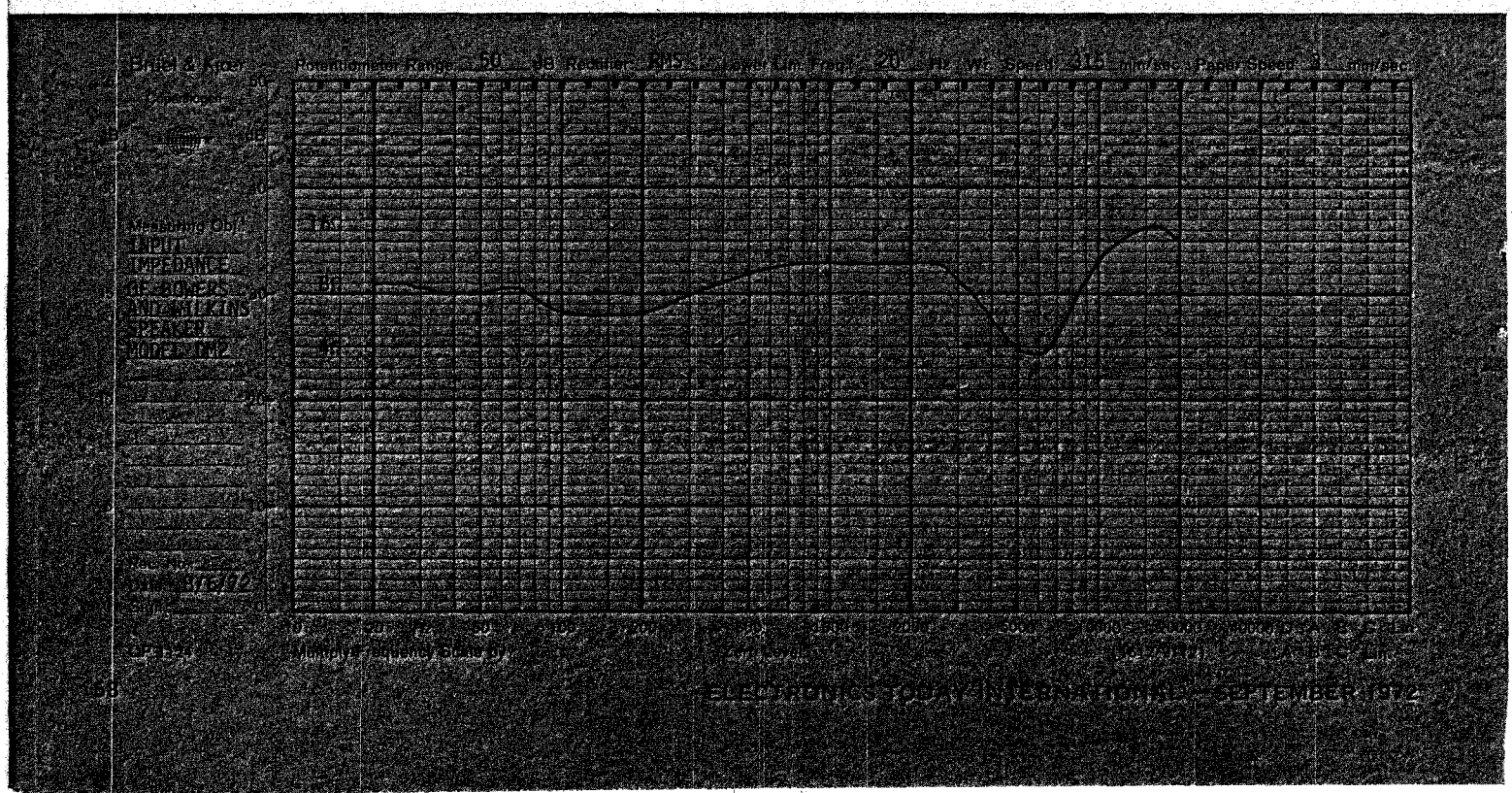
assembly on very loud passages. Some audible distortion was also apparent at the low frequency end and was mainly produced by the ferrite cored inductors. The Bextrene cone of the bass driver was extremely well constructed and did not exhibit any break up. The smooth mid-range and top end response of the speakers complemented the sound track recording of Harold Fielding's London Production of 'Show Boat', (Columbia No. SCXO 6480) giving the singers a very natural and uncoloured sound.

MEASURED PERFORMANCE

The measured performance showed one of the smoothest mid-range frequency responses that we have ever seen, being typically within ±4dB between 60Hz and 15kHz with few exceptions.

Off-axis measurements showed a slight roll off of 2dB between 1kHz and 5kHz and a very sharp roll off of 11dB between 5kHz and 10kHz plus a further 8dB loss at 15kHz. This drop off around 10kHz could be attributed to the spider fitted over the cone of the high range speaker. The domed tweeter however, behaved as expected having only a 8dB loss off-axis.

The total harmonic distortion at 100Hz was high, being 7% with 1 watt input. However, because of the high efficiency of the speaker at this frequency, this level of distortion is of less concern that it would otherwise be. Above 500Hz the total harmonic distortion was good, being around 1%



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Available as Permaseal and open vented cells – capacity from 10 milliampere hours to 12 ampere hours. Varta has a nickel cadmium accumulator to power almost every type of equipment. Varta cells can be stored for long periods without deterioration.

For technical information on how Varta DEAC nickel-cadmium rechargeable cells can be put to power for you, fill in the coupon.

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Write to: Technical Sales Manager, Head Office, Dunlop Batteries Australia, 27 George Street, Sandringham, 3191. Please send me technical information on the Varta range of nickel-cadmium rechargeable accumulators.

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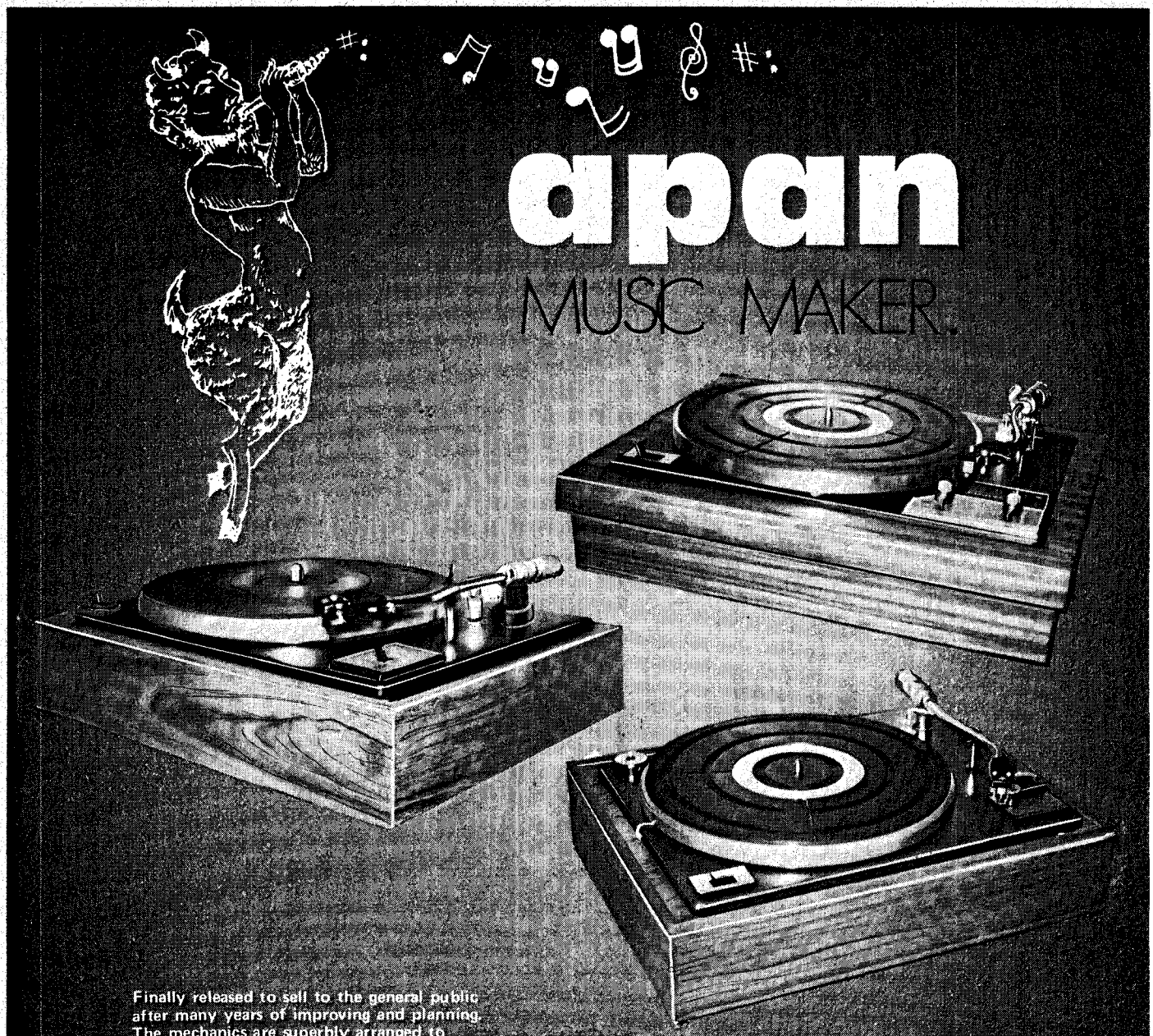

apan
MUSIC MAKER.

Finally released to sell to the general public after many years of improving and planning. The mechanics are superbly arranged to better performance and give many years of dependability.
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will astound you with the sound that it reproduces and just think of the many hours of sheer music enjoyment that you could have with one of these beautiful units. Designed to suit any decore, the BFU-121 is the first fully automatic turntable in Australia.
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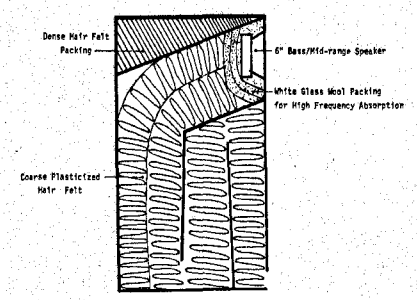


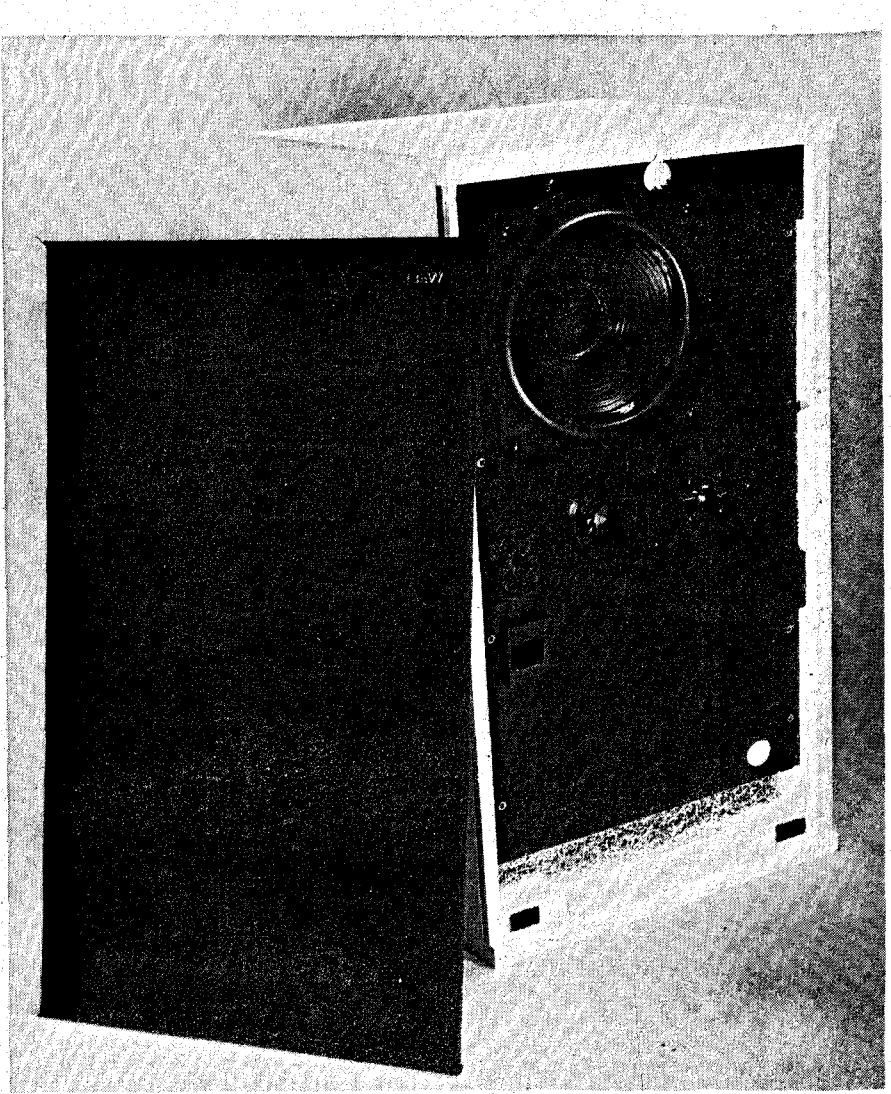
Section through Bowers & Wilkins DM2 speaker showing tapered folded horn.

right up to 10kHz. At 10kHz and above, the harmonic distortion is inaudible and therefore of no real consequence.

The cone resonance in the enclosure was the hardest we have had to detect, mainly because of the very effective dampening of the hair felt.

As with all Bowers and Wilkins monitor speakers the DM2s are supplied with individual frequency response curves, measured in Bowers and Wilkins' main anechoic chamber. They also have a production line test chamber where the speakers pass through in pairs on a conveyor belt and are checked for matching performance. The curve supplied with the speaker reviewed correlated well with our frequency response, the main difference being the smoother curve obtained by Bowers and Wilkins who use pen writing speed five times slower than that which we use.

The Bowers and Wilkins monitor speakers, Model DM2, provide an exceptionally smooth frequency response especially in the middle and upper frequency ranges. They are ideally suitable for the audio purist. ●



The completed counter has a neat appearance and the LED display is very readable.

DIGITAL FREQUENCY METER

ETI PROJECT 109

This small, but advanced, instrument measures frequency and period and has a LED display.

FOR some considerable time we have been planning a frequency counter project, but have been deterred by the ultimate cost to readers of the end product.

Recently a solution has come to hand with the release, by Hewlett Packard, of the 5082-7302 LED displays. These components incorporate a seven segment, four by seven dot matrix LED display, BCD to seven-segment decoder and four bit store, all integrated into the one pack.

The usual reading difficulty associated with 7 segment displays has been overcome in the HP device by switching off corner dots on some digits, this being achieved by the special inbuilt decoder.

The device operates entirely from TTL logic levels and a +5 volt supply, no high voltage supply being necessary as with neon indicator tubes.

These features, together with the small size of the display ICs have allowed us to build the counter into a 6½" x 1½" x 6" case whilst still offering advanced facilities at reasonable cost. There are five ranges for frequency measurements from 1Hz

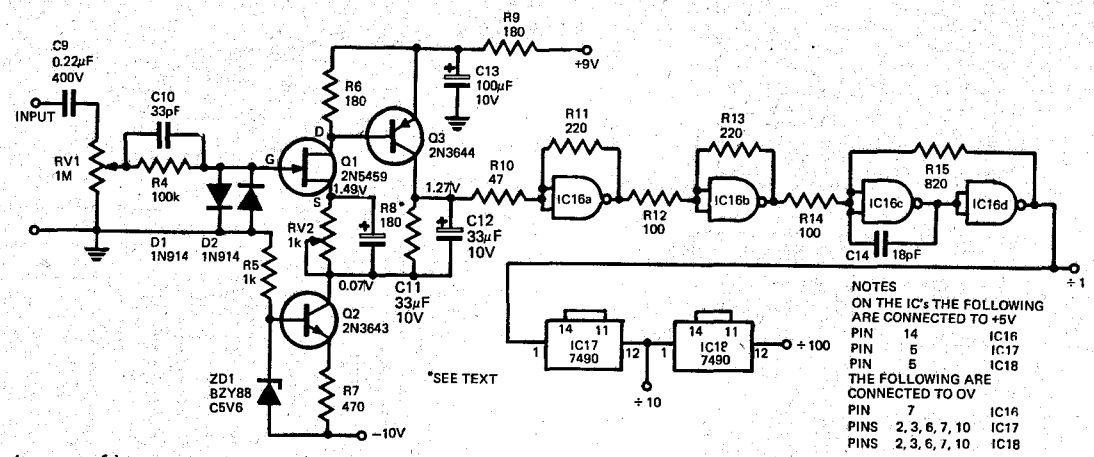


Fig. 1. Circuit diagram of input stage.

to more than 15 MHz and five period measurement ranges for time intervals of 10 nanoseconds to one second.

Hewlett Packard have assisted in the effort to reduce the cost of the instrument by offering a special deal on the display chips. This deal is available only to readers of ETI who order direct from Hewlett Packard by means of the coupon on page 66.

Integrated circuits have been used almost exclusively in the design of the counter and in fact only 3 transistors are used. Even the power supply regulator is a Fairchild IC device which features both over-current and over temperature protection.

The only transistors used are those in the input stage where high input impedance is essential and even here some amplification is performed by digital ICs operating in the linear mode.

In a later issue details will be given of a modification to provide count-mode operation, and a prescaler will be described which extends the frequency measuring capability into the 200 to 300 MHz region. As these facilities are not required by everyone and add to the cost, they were not included in the basic design.

CONSTRUCTION

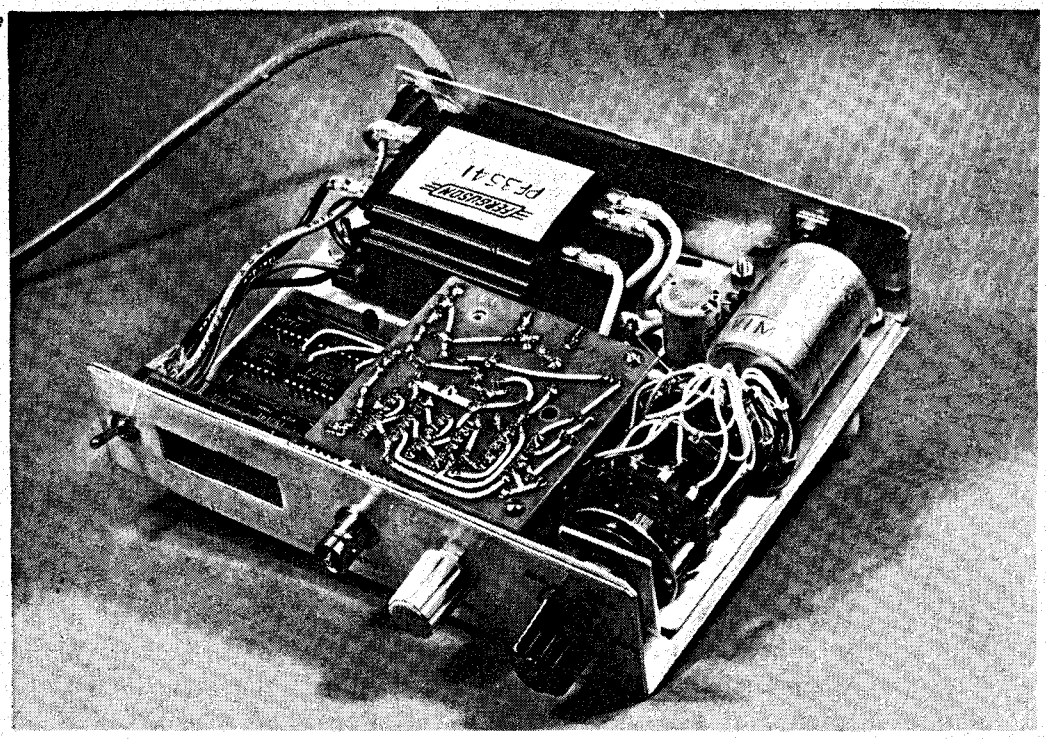
This is an advanced project and is not recommended for beginners. A simple error could ruin all the IC's (a very expensive outcome) and we suggest that you do not tackle this project unless you have a reasonable amount of electronic-constructional experience.

Full size PC boards and their associated component overlays are provided. Mount all components to the board, as shown by the overlays, paying particular attention to IC and capacitor orientation. The display board is attached to the logic board by tinned copper-wire links. The easiest method of linking, is to begin with a separation of ½" between the boards, and sew the two boards together, with a length of wire. Then pull the display board down onto the logic board and cut the wires off. Make sure that the display board is vertical before soldering.

Wire the switch as shown in Fig. 4, and note that the switch is shown from the rear and that position 11 on all wafers is not used.

A piece of circularly-polarized plastic

Internal view of the completed counter.



Metal work drawings are available from ETI at a cost of 60 cents per set including postage.

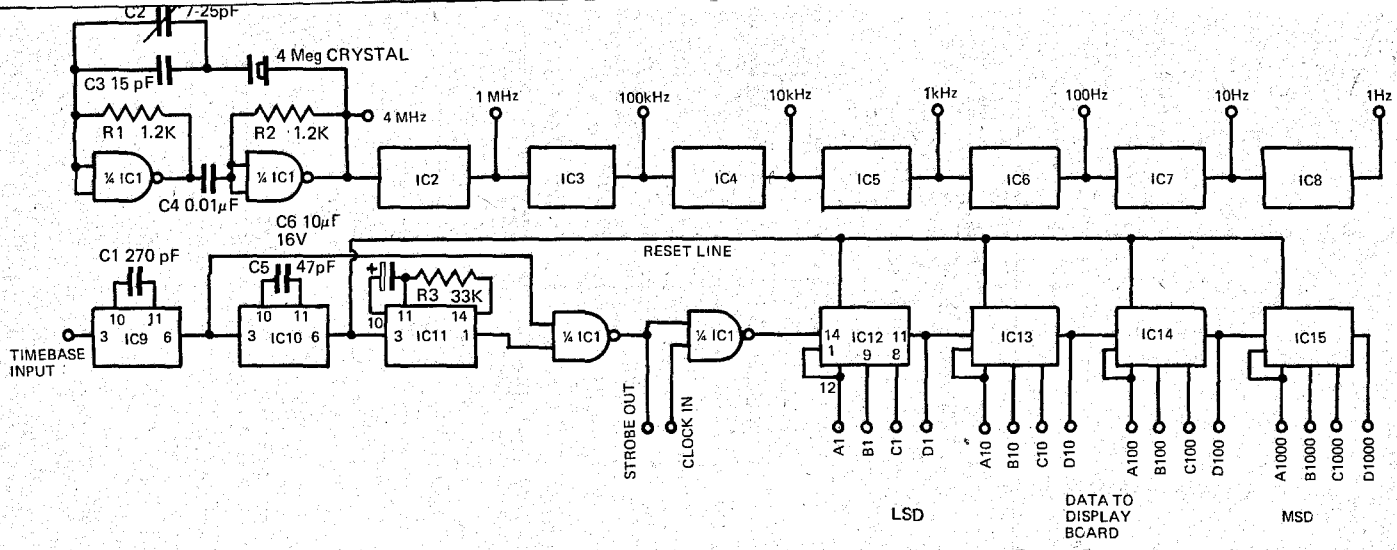
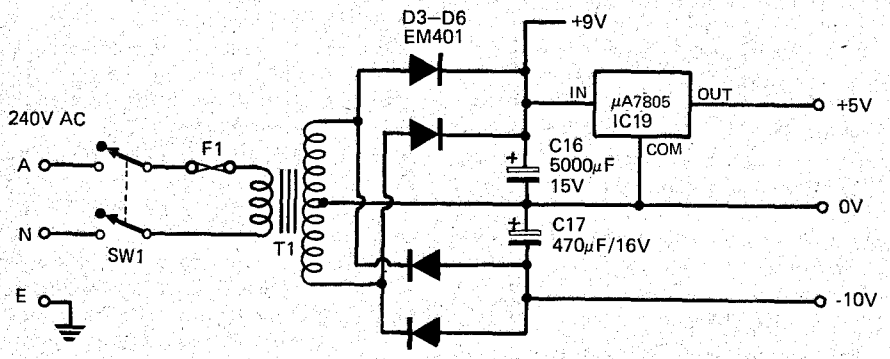


Fig. 2. Circuit diagram of logic board.

g. 3. Circuit diagram of power supply



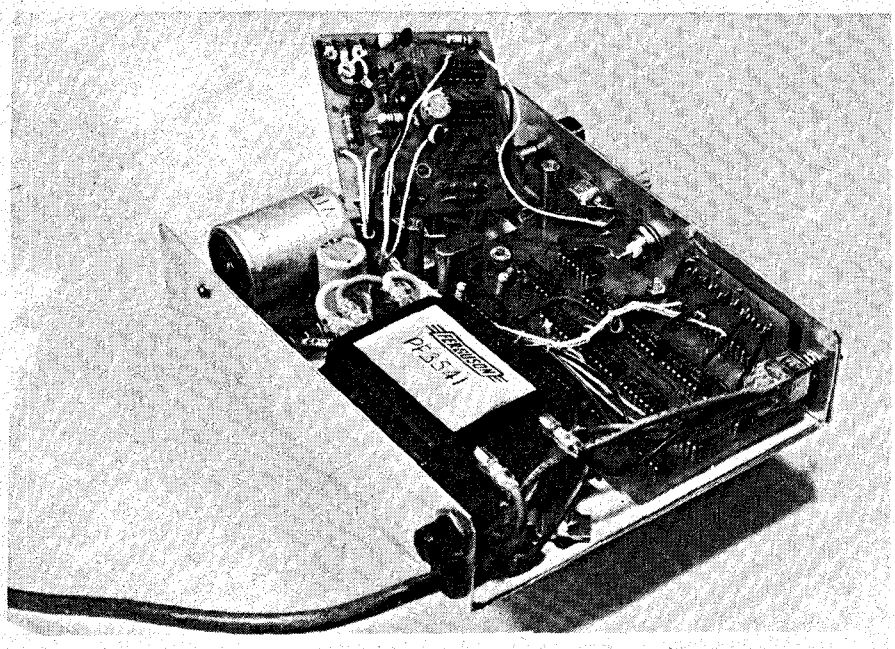
DIGITAL FREQUENCY METER

is used in front of the displays to protect them and to prevent unwanted reflections. To check which way the plastic should be mounted, place the plastic over a silver coin. Viewed through one side of the plastic the coin will appear dark blue and will appear normal through the other. Mount the plastic such that the surface which gave the dark blue appearance when against the coin, is mounted against the display chips.

A piece of insulation (manila folder coardboard is OK) should be used under the PC boards, which should be spaced from the chassis by means of full nuts. The input board is supported by 2 one inch long spacers. Further insulation should be provided over the complete unit on the inside of the cover.

TESTING

Connect a 100 Hz test signal of several volts amplitude into the input socket and adjust the sensitivity control to maximum. A display reading should be obtained, if not adjust RV2 until it is. Successively reduce the sensitivity until the counter stops and adjust RV2 to regain the display until RV2 cannot be moved any further whilst retaining stable counting. This procedure provides maximum sensitivity.



Raising the input board reveals the logic board beneath.

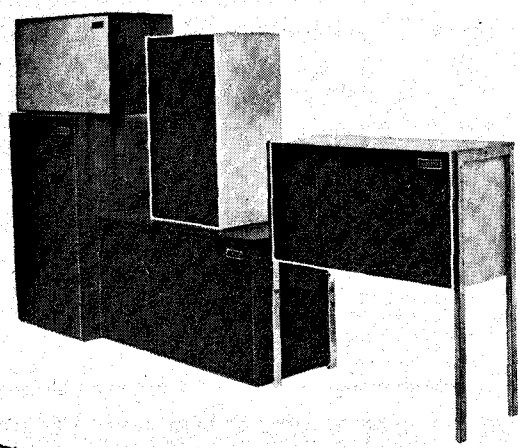
SPECIFICATION

Input Impedance	1 megohm*
Input Level	>100mV
Frequency range	<10Hz to >10MHz (Typically 15MHz)
Resolution frequency	1Hz
period	10 nanoseconds
Accuracy	Depends on calibration typically 1 part in 10^6
Dimensions	6-7/8" x 1-1/2" x 6"

* drops to 100K//33pf if sensitivity is set too high for a given input level.

COLOUR is the key to

NEW ADVENT LOUDSPEAKER DESIGNS NOW AT INSTROL



Advent loudspeakers — acclaimed world wide by reviewers, experts and music lovers for superb performance and outstanding value are now presented in exciting decorator designs. New contemporary styling in elegant walnut or romantic white enclosures have been teamed with expensive grille fabrics; in versatile buff, deep red, vibrant blue and wild plum. The addition of optional stands in gleaming chrome or black provide a wonderful new freedom of placement.

Advent loudspeakers will be a proud compliment to your decor, to your Hi-Fi system and add new dimensions to your music enjoyment. The Advent loudspeaker at $169 rrp.
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Write in for fully descriptive literature on Advent Loudspeakers (enclose 7c stamp)

DIGITAL FREQUENCY METER

PARTS LIST ET 109

Q1	FET transistor		2N5459	
Q2	transistor		2N3643	
Q3	transistor		2N3644	
D1-D2	diode		IN914	
D3-D6	diode		EM401 or IN4005	
IC1, IC16	integrated circuit		7400 or FJH131	
IC2	integrated circuit		7474 or FJJ131	
IC3-IC8	integrated circuit		7490 or FJJ141	
IC12-IC15	integrated circuit		7490 or FJJ141	
IC17-IC18	integrated circuit		7490 or FJJ141	
IC9-IC11	integrated circuit		74121 or FJK101	
IC18	integrated circuit		µA7805 (with insulation washers).	
IC19-IC22	integrated circuit		HP5082-7302	
R1, R2	resistor	1.2k	½w	5%
R3	resistor	33k	½w	5%
R4	resistor	100k	½w	5%
R5	resistor	1k	½w	5%
R6, R9	resistor	180	½w	5%
R7	resistor	470	½w	5%
R8	resistor	180*	½w	5% *see text
R10	resistor	100	½w	5%
R11, R13	resistor	220	½w	5%
R12, R14	resistor	100	½w	5%
R15	resistor	820	½w	5%
C1	capacitor	270pf ceramic Philips type or similar		
C2	capacitor	7-25pf trimmer cap.		
C3	capacitor	15pf ceramic Philips type or similar		
C4	capacitor	.01µf "greencap"		
C5	capacitor	47pf ceramic Philips type or similar		
C6	capacitor	10µf 25V tag tantalum		
C7, C8	capacitor	33µf 10V tag tantalum		
C9	capacitor	.22µf 400V		
C10	capacitor	33pf ceramic Philips		
C11,C12,C15	capacitor	33µf 10V tag tantalum		
C13	capacitor	100µf 10V elna type RB electrolytic		
C14	capacitor	18pf ceramic Philips		
C16	capacitor	5000µf 15V electrolytic (WIMA type only)		
C17	capacitor	470µf 16V elna type RB electro		
RV1	1 meg lin pot 5/8 dia.			
RV2	1kΩ trim pot (large type)			
SW1	2 pole on-off miniature toggle switch			
SW2	3 pole 11 position rotary switch OAK type F or similar.			

1 BNC socket type UG1094/U
4 meg crystal, 0.005%, 20-30°C, 25-30pf parallel cap
transformer Ferguson type PF3541
2 Knobs
1 small fuse holder, 1 x 500ma fuse
IC boards ETO37, ETO38, ETO39 and ETO40
1 piece of circularly polarized plastic 1" x 2"
3 core flex, nuts, bolts, spacers etc.

HOW IT WORKS

INPUT STAGE

Transistors Q1, Q2 and Q3 are connected as a high input impedance, low output impedance, unity gain buffer amplifier and are protected against excessive input voltage by D1 and D2. Input sensitivity is adjusted by means of RV1.

The dc output level of the buffer is adjustable over a three volt range by means of RV2. This adjustment is provided to compensate FET characteristics which vary widely from device to device. Note that with RV2 at mid point of its travel R8 is selected to obtain 1·27 volts at the collector of Q3. The output of the buffer is amplified by a factor of 3 by IC16a and IC16b and then is squared by schmitt trigger IC16c and IC16d. Capacitor C14 stabilizes the schmitt trigger and prevents oscillation. The output of the schmitt is then known as ÷ 1. This output goes to two 7490 decade counters to provide ÷10 and ÷100 outputs.

LOGIC BOARD

The logic board carries the crystal oscillator, time base dividers, monostable for reset and strobe pulse generation, and the four display decade counters.

A pair of inverting amplifiers, with a crystal in the feedback path, form the oscillator, with C2 providing frequency adjustment. If an accuracy of 0,01% is all that is required, then C2 and C3 may be replaced by a 27pF capacitor.

The output of the crystal oscillator is divided by 4 in IC2 to provide 1 MHz, and then by six decade counters, to provide frequency references from 1 MHz down to 1 Hz.

The input frequency is counted by decade counters IC12 to IC15. The accumulated count at the end of each sampling period is transferred to a store in the display ICs which remembers and displays the previous reading until a new reading is strobed in. The counters are then reset and commence a new sampling period.

The strobe and reset pulses are generated in IC9 and IC10. To prevent the display changing rapidly on short time base inputs the strobe is inhibited by IC11 if it occurs at intervals less than approximately 200 msecs. Thus the highest sampling speed is 5 per second.

DISPLAY BOARD

The display board carries the four Hewlett Packard readouts which are combination 7 x 4 LED dot display and decoder-store devices.

The display will decode what is present at the input lines when the strobe line is at logic "zero", ie low. When the strobe line goes high, logic 'one', the display is frozen at the count transferred during the strobe low condition. That is, it remembers the previous count and thus provides a steady display.

POWER SUPPLY

The secondary of transformer T1 is centre tapped, and by using two sets of diodes, +9 volt and −10 volt supplies are generated. The +9 volt supply is regulated by IC19 to provide an accurate +5 volts supply to the TTL logic. The +9 volt and −10 volts are used in the input stage. The positive line is lower than the negative line because of the heavier current drain.

A fuse rated at ½ amp is used on the input to the transformer and a double pole power switch must be used.

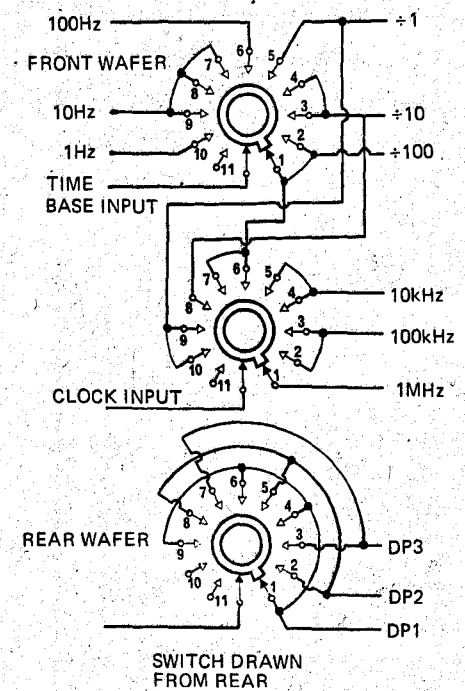


Fig. 4. Function switch wiring diagram.

CALIBRATION

The crystal frequency can be shifted ±200Hz by means of C2. The frequency can be checked by using another counter of known accuracy, or by counting a known frequency and adjusting C2 to obtain the correct reading.

Alternatively if a communications receiver is available, the 4 MHz can be zero beat against the 12 MHz PMG time signal broadcast between 7.45 am and 7.30 pm (EST). Connect a wire to the 4MHz output and wrap it round the aerial coil of the receiver and a beat will be heard. Tune C2 for zero beat.

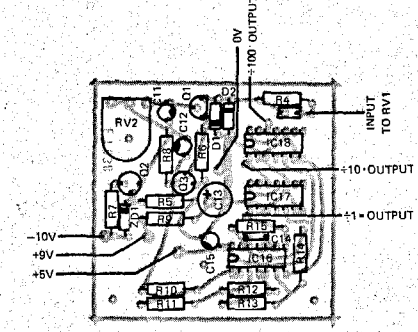


Fig. 5. Component overlay input stage.

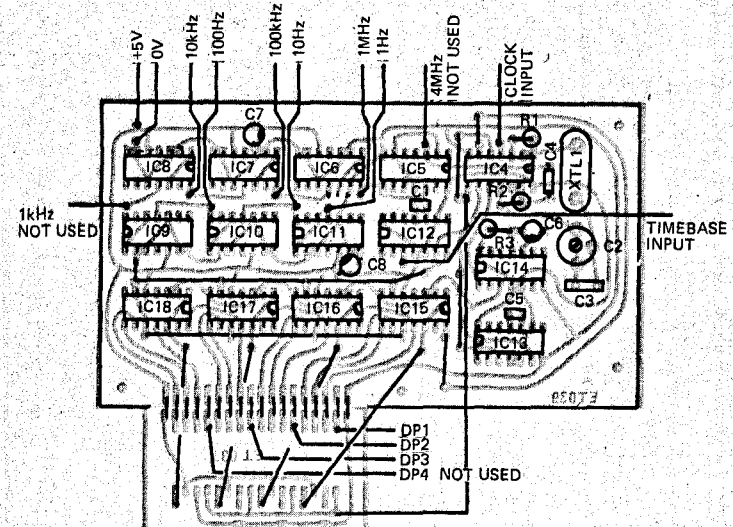


Fig. 6. Component overlay for logic board.

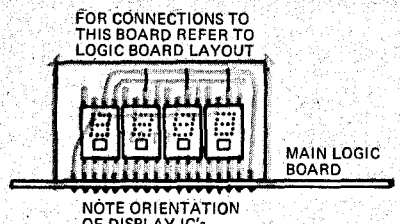


Fig. 8. Component overlay display panel board.

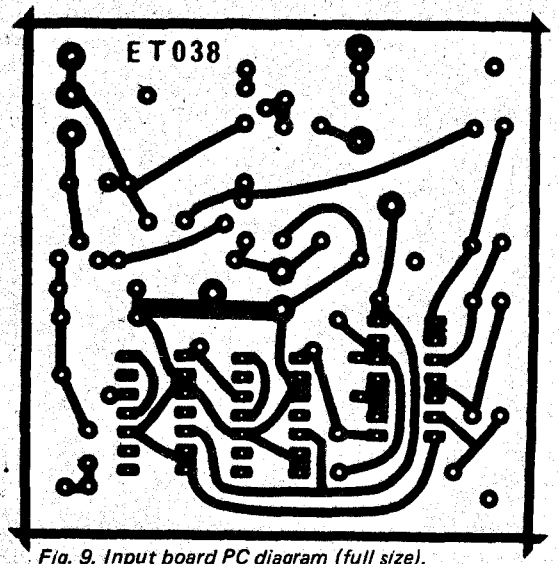


Fig. 9. Input board PC diagram (full size).

DIGITAL FREQUENCY METER

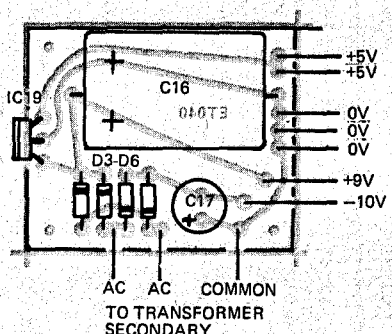
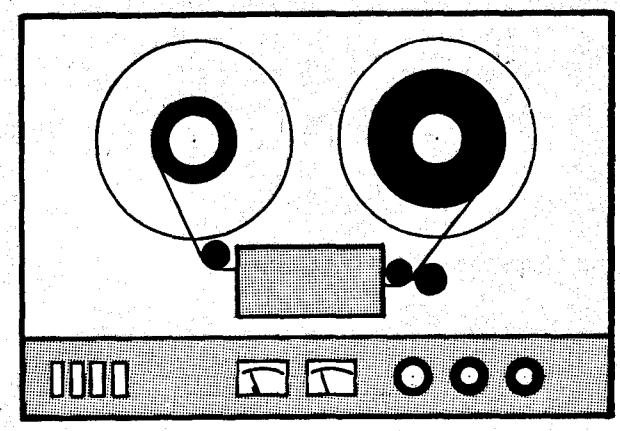


Fig. 7. Component overlay for power supply board.

(Continued on page 87)

The sound quality of reel to reel...



with the fuss-free ease of CASSETTE recording*

* KX-700 is the lowest-priced high-quality solid state Cassette Deck with the *DOLBY* unit that lowers tape hiss or background noise to that of much larger open reel decks. It's the ultimate in *compact* hi-fi recording.

It's in with the CLICK Clique

Just click a cassette into a Kenwood KX-700 Cassette Deck for the ultimate in *compact* hi-fi. Sound as real as reel to reel is yours because KX-700 incorporates the DOLBY unit that cuts tape hiss to an inaudible low . . . whether you listen on headphones or pipe the great sound through your stereo hi-fi system. There's no toying with tapes . . . cassettes click in—pop out—and your hands are free for better things. Get long-play, fuss-free real sound enjoyment . . . Kenwood KX-700 stereo Cassette Deck.

FEATURES • Dolby Unit • Super Ferrite Heads • 25-16,000 Hz. frequency response • Wow/Flutter less than 0.13% • 3-tape selector • Auto shut-off • Sliding switches • VU meters • Microphone and headphone jacks.

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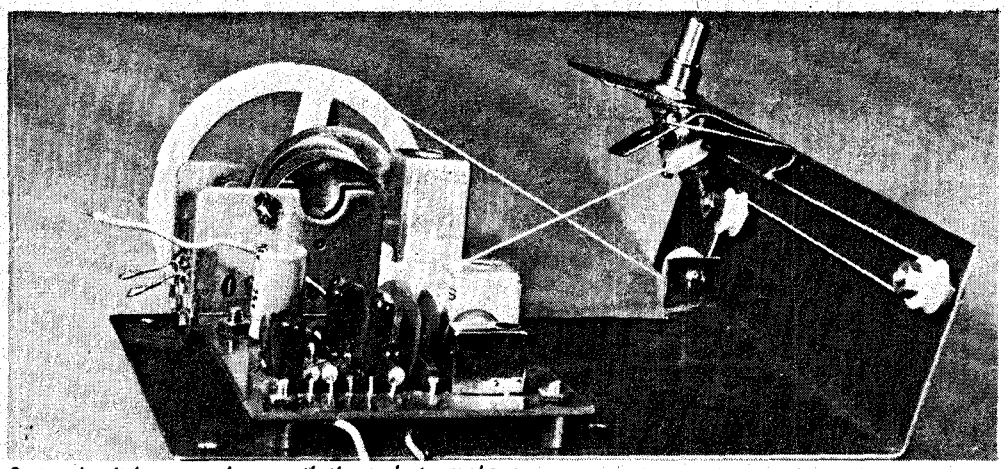
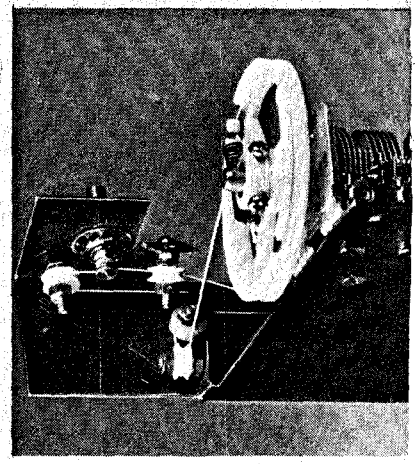
INTEGRATED AUDIO SYSTEM-ETI 425

ETI PROJECT 425





String the dial in accordance with these photographs.

In this final installment, assembly details of the tuner and dial mechanism are provided.

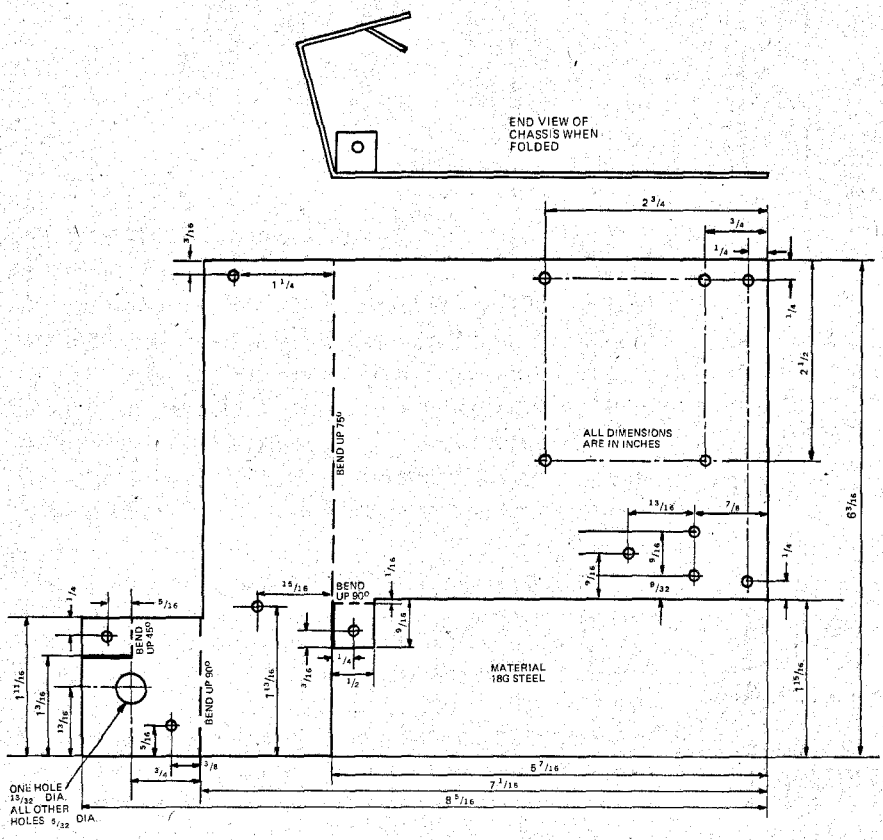


Fig. 1. The tuner chassis.

TUNER ASSEMBLY

The dial mechanism at first sight appears complex, however it is in reality quite easy to assemble. Stringing of the dial will also be found relatively simple.

Begin by mounting the pulleys. Use 1/8" screws and space the pulleys from the chassis by combinations of nuts and half-nuts to obtain alignment. The final nut retaining the pulley should be cemented in place with "Locktite" or cellulose cement.

Now mount the dial cord drive-spindle and the tuning gang to the chassis.

The pointer is constructed from a ¾" long piece of 18 or 16 swg brass tubing

(available from hobby or model shops) and a piece of 20 gauge BS wire soldered to it and bent as shown in the photograph. This should be threaded onto the dial cord before stringing the dial as shown in the photographs. Note that a spring on the dial drum is used to tension the cord which passes around the dial drive spindle twice.

Lightly crimp one end of the brass tubing on to the cord such that the pointer will stay in position; (but may still be moved). Then using the dial glass as a gauge, position the pointer on the dial cord so that the pointer overlaps the ends of the scale by equal amounts when the tuning gang is moved from end to end. Final alignment is done electrically as per the alignment procedure in the August issue.

Finally mount the PC board to the chassis using ¼" brass spacers.

MOUNTING IN THE CABINET

Mount the tuner in the cabinet using ¼" spacers and woodscrews at the rear, and the dial cord drive-spindle at the front.

The pre-amp may now be fitted, followed by the dial-scale which is constructed from two pieces of perspex, spaced by approximately 3/32" from each other, and held together by two 6BA screws. (A nut or a few washers may be used for spacing). The scale markings are on the bottom piece of perspex and the pointer travels between the two.

Wire up the tuner with reference to Fig.2 of August issue and Fig.3 of July issue. Note that pins IL and IR of SW2 are paralleled and connected to the tuner output.

This completes the project and we know that it will provide you with many hours of high-fidelity entertainment.

(Continued on page 116)

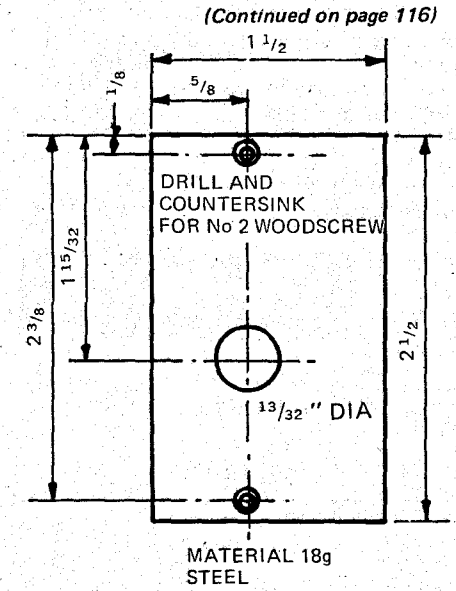
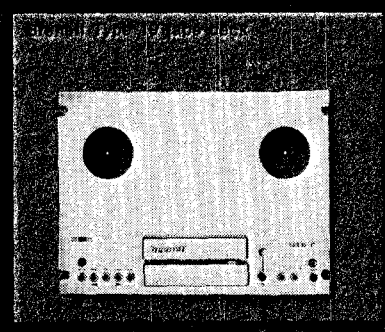


Fig. 2. Tuning spindle support plate.

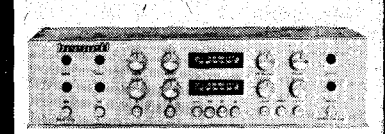
BRENELL *famous recording equipment...from* PLESSEY

Brenell ST400 stereo recorder

Brenell Mark 6 stereo recorder



Brenell tape link amplifier



The range of famous Brenell high fidelity magnetic tape recorders, decks and amplifiers for hi-fi enthusiasts and professional users is available in Australia through Plessey.

Brenell ST 400 four-track, three speed stereo recorder. A fully transistorised unit with power amplifiers and inbuilt speakers offering exceptional quality in terms of recording and playback characteristics. 6 watts RMS per channel output, 40 Hz to 14 kHz ± 2 dB frequency response, 56 dB signal to noise ratio, less than 0.08% wow and flutter, bass and treble controls effective both during recording and playback. Also ST 200 two-track stereo version.

Brenell Mk 6 hi-fi stereo recorder. Unquestionably one of the world's most versatile tape recorders for semi-professional users, it is available for two-track or four-track stereo or as a complete monaural unit including inbuilt speakers. Fully transistorised, three motors, three heads, four tape speeds, full mixing and A/B comparison facilities. 15 watts RMS per channel output, 40 Hz to 22 kHz ± 3 dB frequency response at 15 ips, wow and flutter less than 0.05%, signal to noise ratio 56 dB unweighted.

Separate tape decks and amplifiers. For specialists wanting to build up their own systems, Brenell offers high quality tape decks and amplifiers as separate components. The Mk 6 deck is for hi-fi systems, the professional, solenoid-operated Type 19 deck handling up to 10½" reels is designed for industrial and scientific use. Transistorised hi-fi tape link amplifiers for stereo or mono operation are also available.

brenell

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Distributors: Qld: L. E. Boughen and Co 30 Grimes St Auchenflower 4066. **SA:** Roger Electronics PO Box 3 Bodbury North 5092.
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AV51

PART 5

TRANSDUCERS IN MEASUREMENT AND CONTROL

In this, the fifth article in this series, Peter Sydenham, M.E., Ph.D., M. Inst. M.C., continues his discussion of position measurement and control.

SO FAR we have seen how lengths, angles, tilts and alignments are converted into a convenient electrical form for purposes of measurement or control. This article describes how these one dimensional techniques are combined to yield positional information of an object or a point lying in a plane or within a space – for there are many alternatives available where multiaxial measurements are needed. Examples are the shape of an aircraft frame, the positioning of the turbine blades inside a jet engine or a steam turbine, the control of numerically controlled machine tools to form complex shapes, the cutting of steel plates and their assembly into super-tanker ships, the measurement of the profile of radio telescope dishes, control of automatic tractors in ploughing – the list appears limitless.

CO-ORDINATE SYSTEMS

Before describing just how transducers are combined, it is necessary to become familiar with the ways in which a point in space can be defined relative to some reference system by a number of individual, single-dimension, measuring devices.

Position of a point in space can be defined by three parameters using lengths and angles. (A point has no size so orientation is of no consequence.) At least one measurement must be a length to define the physical position. Most important is that three measurements must be made relative to some kind of established reference system. Figures 1a and 1b show the two most commonly used methods using lengths only. The cartesian, or rectangular, system defines the position of P by extending lines perpendicular from each axis to give the x, y and z values. The triangular concept defines P by the lengths S_1, S_2 and S_3 which extend from the corners of a fixed-size reference base triangle. It is also quite reasonable to determine P using the angles between the base triangle and the S sides if the length of the sides of the base triangle are known. The concepts of rectangulation and triangulation are often combined for reasons of expediency. For example, using the cartesian framework we could have an $\mathcal{R}\Theta\phi$ polar system (Figure 1c) in which the length to the origin is $\mathcal{R}$ and the other co-ordinates the angles made between that line and the cartesian axes.

Position in a plane needs only two dimensions, for the third is held constant by definition. Again, at least one dimension must be a length. If the point moves along a line, two of the possible three dimensions are constant, so only one needs considering and this must be a length. Alignment could be considered as a zero-dimensional measurement, for no lengths are measured along the line. It is, however, really a 2-D case as deviations in a plane perpendicular to the line are the parameters of interest.

If the object of interest has physical size, the orientation of its shape in space is also important. As three

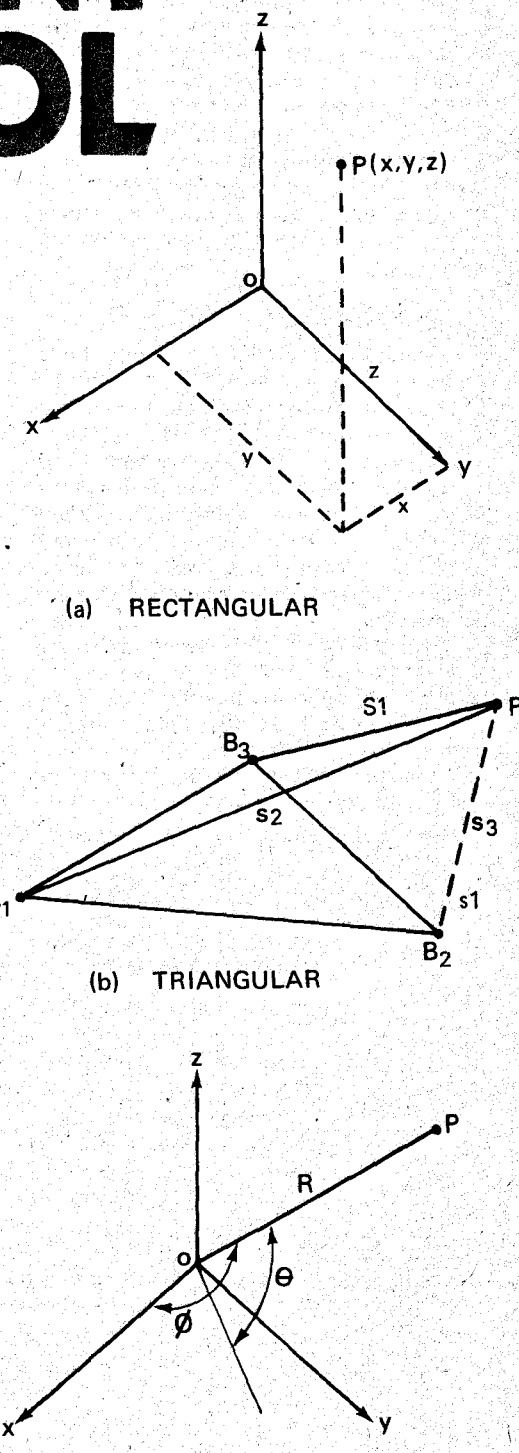

Fig. 1. Reference frameworks for multiaxial positional systems.

degrees of rotation are possible, it may be necessary to measure as many as six variables to define position adequately. A missile in flight will have pitch, roll and yaw components, as well as dimensional position values. By now, it should be clear why lengths and angles are inter-related in the practical measurement of position. The choice of reference used is largely a matter of convenience. Rectangular systems become difficult to use when sizes extend beyond several metres. Above this, polar and triangular systems come into their own. Smaller range measurements are able to utilize the rectangular arrangement for it is economically viable to manufacture the necessary mechanical reference framework.

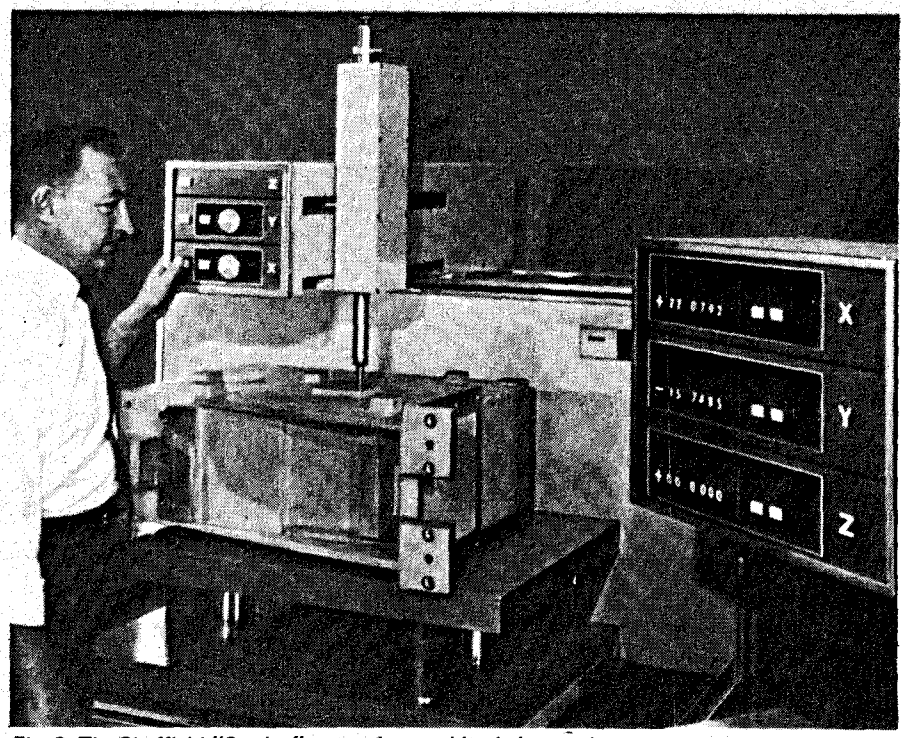

Fig. 2. The Sheffield "Cordax" measuring machine being used to inspect the critical dimensions of a machined part.

RECTANGULAR METHODS

The bulk of industrial machines built for making or measuring work-pieces use rectangular co-ordinates. In Part 2 of the current series, a large numerically-controlled machine tool was illustrated. Smaller units are more usual. A precision inspection machine having three-axis digital readout and recording facilities is shown in Figure 2. High grade machines such as this are accurate to a few micrometres when used correctly and given the right environment. Translating axes are provided as a rectangular framework having separate length transducers on each axis of movement.

The end of the stylus is the position in space being measured, and for this to be accurate, the three slides must be straight to within a micrometre, and square to within seconds of arc. Furthermore, the travelling cantilever arm must hold this angle as it translates: yet it must be stiff enough not to sag significantly as the vertical axis is moved out along its arm. These requirements can be met but at considerable cost. Inspection machines need to be more accurate than the manufacturing machine that produces the components to be checked, but as there are no machining forces involved in the structure, they can be lighter in construction. Inertia of the slides is kept to a minimum to allow the operator to move the stylus more rapidly. The framework of a numerically-controlled tool, however, needs to be especially stiff, for the inertial forces produced by its rapid movements greatly exceed the static forces. Dynamic accuracy is important to retain precision and stability from the control system.

The requirement however, is not always for three axis measurement. In printed circuit-board inspection or drilling, in map making, in bubble chamber photograph digitizing and in automatic flame cutting of sheet, to name just a few examples, the need is for only two axis measurement.

Automatic draughting machines are used extensively and many companies are in this market. Coupled to a computer they are able to produce drawings of extreme precision and complexity. For example, integrated circuit manufacture relies on them. An example of precision artwork of a Honeywell integrated circuit is shown in Figure 3. Another use for drawing machines is to check out numerical control tapes before they are used on the machine tool. This is especially useful in the ship building industry where individual varied shapes are nested together on a single stock-size plate.

If the two axes having readout are free to move, rather than being held by position servos, the machine can be

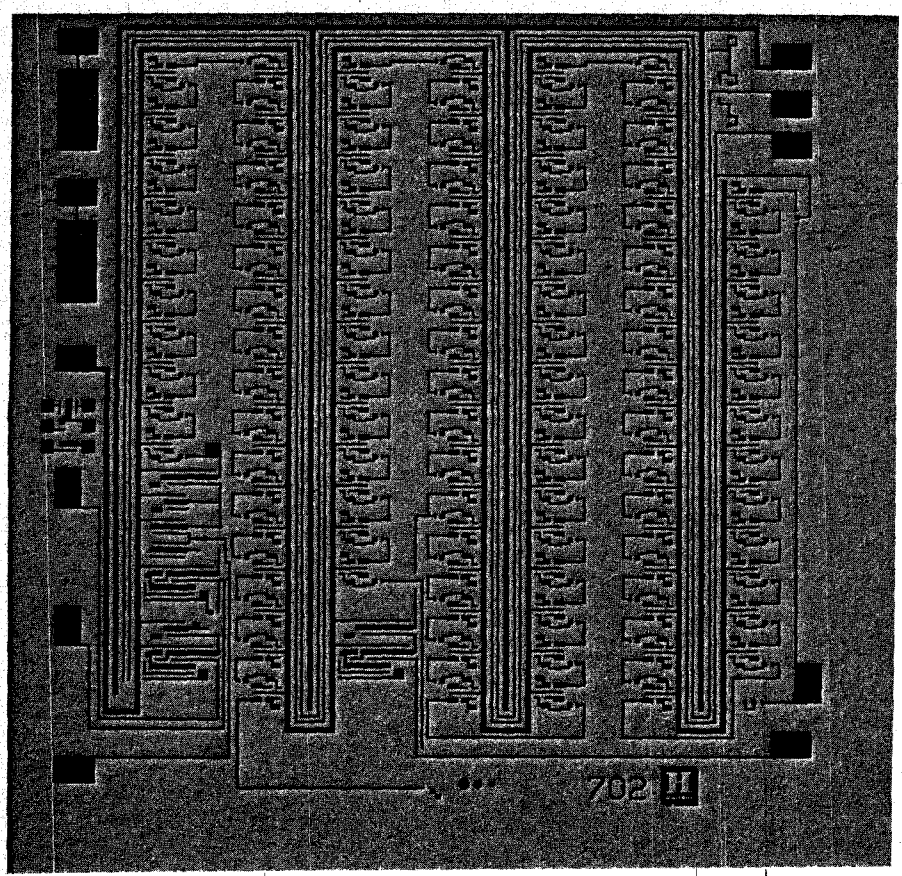

Fig. 3. Precision artwork generated on a Gerber automatic draughting machine.

used to digitize drawings. Several drawing readers and chart digitizers are available. One unit is pictured in Figure 4.

It is also possible to build a three dimensional equivalent of the drawing reader that can produce co-ordinate data as well as drawings of a free-form shape. Several car factories have automatic tracing units, one type is illustrated in Figure 5. The part to be drawn (a clay model or plaster flash of a panel) is placed inside the framework and the stylus driven down into contact. Whilst the horizontal carriage is being driven along over the part, the vertical axis follows the surface contours automatically. On each axis are length transducers that provide the three coordinate values on punched tape. An unusual feature of the unit shown in Fig. 5. is that it also draws the three views as it moves; most machines draw them on another plotter. On each side of the frame is a drawing table. The common axis of the two side view drawings drawn on each board is mechanically tied to the stylus, the other axes being electrically linked to the cross horizontal and vertical movements. The third drawn view is produced on a separate end-view board controlled by the two electrical signals.

IN-SITU OR COMPONENT-SUPPORTED MEASUREMENT

As the size of the part to be measured or manufactured increases, it becomes increasingly expensive to hold the framework stable and accurate. For instance, 20 metre bed boring mills are made at the rate of three or four per year but their cost of a million dollars each is rarely justified. Secondly, not all multi-dimensional objects can be moved to a machine for measurement or manufacture. The surveyor cannot take a building plot into the office to measure it. So for large sizes the object is measured by taking the measuring devices to them, mounting them upon or around them.

In large-scale industrial measurement this has become known as the component-supported or in-situ method of measurement. The work piece acts as a stable precise bed frame and only a small work head and measuring system is needed to provide measuring and precision manipulation facilities.

In the optical tooling procedure, light but accurate slide ways with calibrated scales are placed around, say, an aircraft frame to form x and y axes. On these move precision alignment telescopes, (see Part 4) that project a point on the fuselage out to each scale. In this manner the contour of the airframe can be checked.

This procedure has been automated by the British Oxygen Company for flame-cutting large plates by computer control. Their developmental equipment is shown in Figure 6. Two precision slides carrying motor-driven carriages are mounted at right angles around the plate to be cut. On the top of each is a telescope having an inbuilt optical position-sensitive detector that senses small errors of position between the carriage and the vertical strip light source seen on top of the cutting head. If the light source is not exactly at the intersection point of the lines of sight of the two telescopes, error signals are generated that redirect the tractor. In this way the cutting head is made to

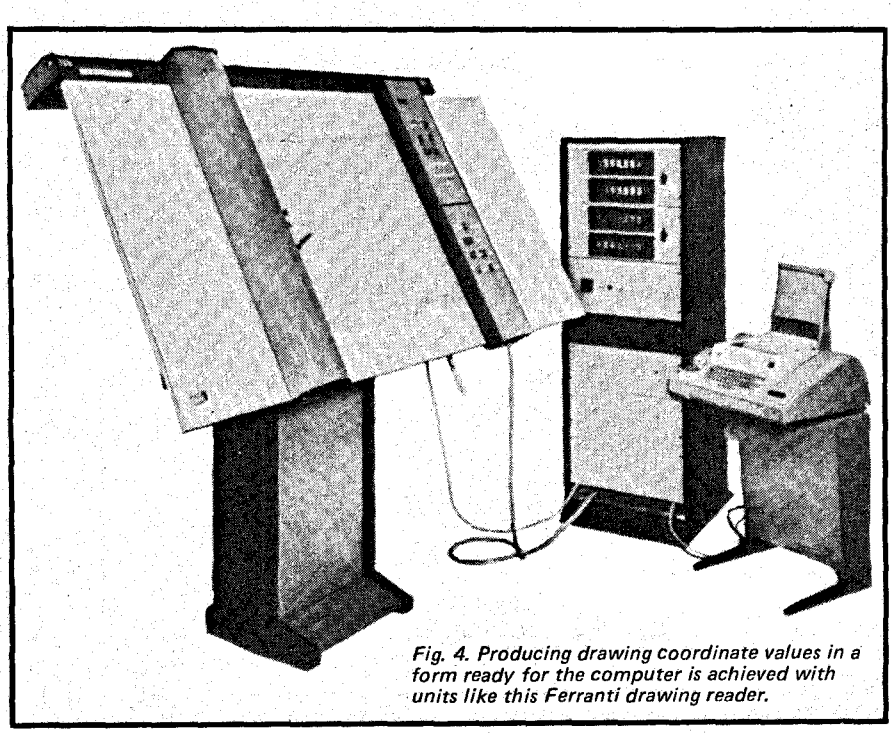

Fig. 4. Producing drawing coordinate values in a form ready for the computer is achieved with units like this Ferranti drawing reader.

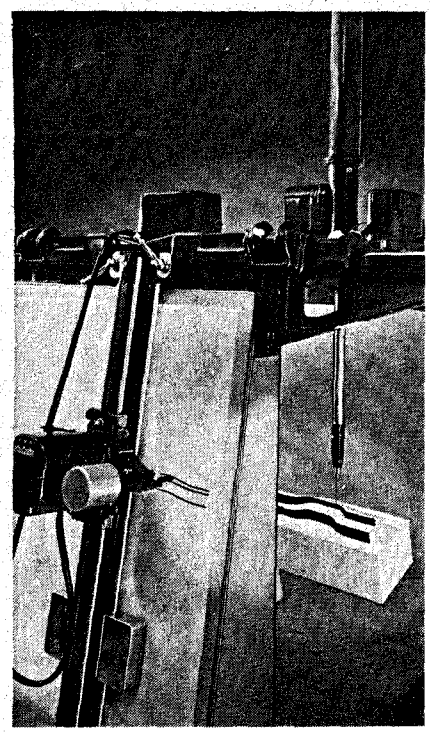

Fig. 5. This type of tracing and digitizing system is used in many automotive plants.

contour by following the carriages. The tractor itself is worthy of description. On each side of the square support frame are driving tracks. In the track links are small rollers that enable the track to slide sideways whilst driving forward. In this arrangement the direction moved by the tractor depends upon the relative velocities of each pair of tracks. The overall concept is capable of control over very large areas, the limits being set by the optical turbulence of the sight paths. Alternative methods of performing the same task have been developed as will be seen below.

TRIANGULATION METHODS

If position within a plane of large extent is needed, the use of a triangular basis of measurement is attractive, for only two fixed points are needed as a reference instead of two slideways. There are many alternative combinations for defining the points position. If a base line is fixed, two lengths will complete the triangle giving the position of the apex with respect to the ends of the base line. Other combinations use two angles and the fixed baseline or one side and one angle between it and the base line direction. In three-dimensional triangulation there are over twenty different schemes so the choice depends upon other factors of individual applications. For example, a radar unit can most simply track an object in flight by using the R, Θ, ϕ arrangement shown in Figure 1, for only one radar unit is needed.

Alternatively, two units at the ends of a known length baseline are often used

TRANSDUCERS IN MEASUREMENT AND CONTROL

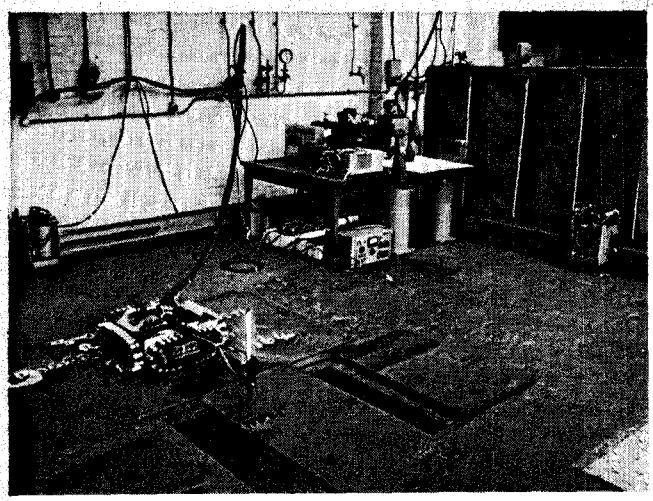

Fig. 6. Automated optical-tooling procedure for cutting large steel plates by computer control.

Fig. 7. A polar co-ordinate digitizer needing no framework.

to avoid the need to measure range distance.

One important factor that needs consideration is the attainable precision of angle measurements versus length measurements in such cases, for extreme precision angle transducers are costly. Let us now consider equipment that has proven practicable using non-rectangular methods.

Coradi, a Swiss company who specialise in mathematical instruments, have marketed a polar co-ordinate drawing digitizer that has the convenience of being useable merely by placing the unit on a drawing as shown in Figure 7. The operator places the cursor cross-hairs over the point of interest, position being recorded as the length of arm extended from the frame and the angle it makes with the base plate.

In nuclear research, bubble chambers are used to record tracks of nuclear reactions. These vapour trails are photographically recorded and their positions digitized ready for processing in digital computers. Each exposure needs hundreds of points to define it and literally millions of photographs are taken each year. Data processing is, therefore, a major problem in this research. One solution to the digitizing problem which yields a moderate rate of information coding uses a device first developed by a French team who called it a "Bidule a fil." Later it became known by the Italians as a "Mangiaspago" or "string-eater".

A schematic of one of these devices is shown in Figure 8. Thin wires, tensioned with hanging weights, pass around drums placed at the ends of a base line member. The two wires join at a viewing puck to complete a variable size triangle. As the puck is moved, each wire rotates a drum which is connected to an angle transducer thus giving a signal equivalent to the length of the wire between the puck and the drum. The Brookhaven Laboratory units are improved versions of the earlier French equipments and can digitize position within an area of 150 by 60cm – to within 10μm.

The potential of triangular measurement in industrial automatic control for large component inspection and manufacture was recognised independently in the late 1960's. Figure 9 shows an experimental trilateral equipment that can control its tool head position (seen on the cantilever arm of the printed-armature motor-driven tooling actuator) to within a few parts of a million in areas of up to 20m by 10m. The demonstration angle-iron base line holds two fast-response spring-tensioned wire-drum length transducers at a fixed distance. The wires join to form the apex of a triangle by connection to two large-bore ball races. These effectively project the wires to form the triangle apex while allowing a tool to be placed at the intersection, thus observing Abbes principle of direct measurement as closely as possible. On the right is the electronic unit that derives two-axis cartesian coordinate error signals from the trilateral wire error signals. These are then used to control the axes movements of the portable tooling head. *(Continued on page 78)*

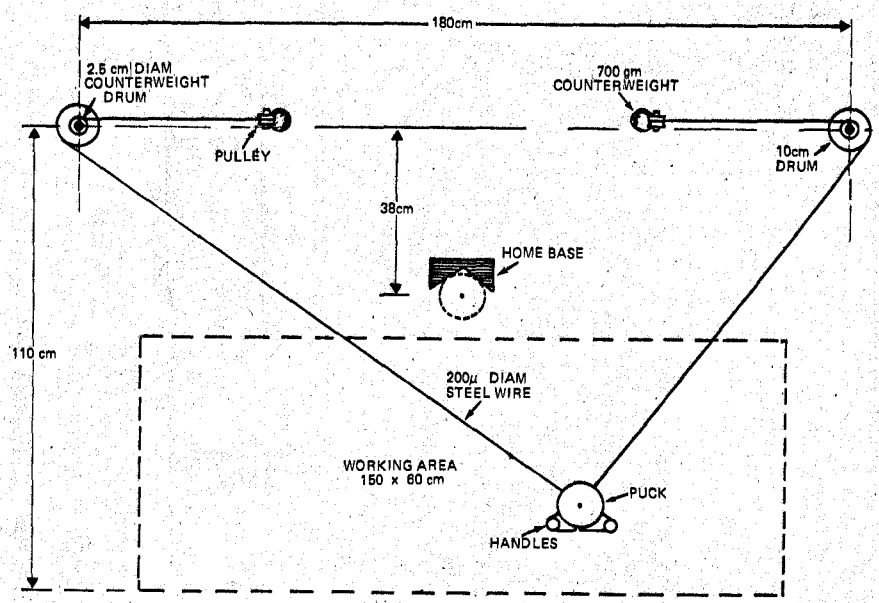

Fig. 8. Schematic of the "Super Mangiospago" of the Brookhaven National Laboratory.

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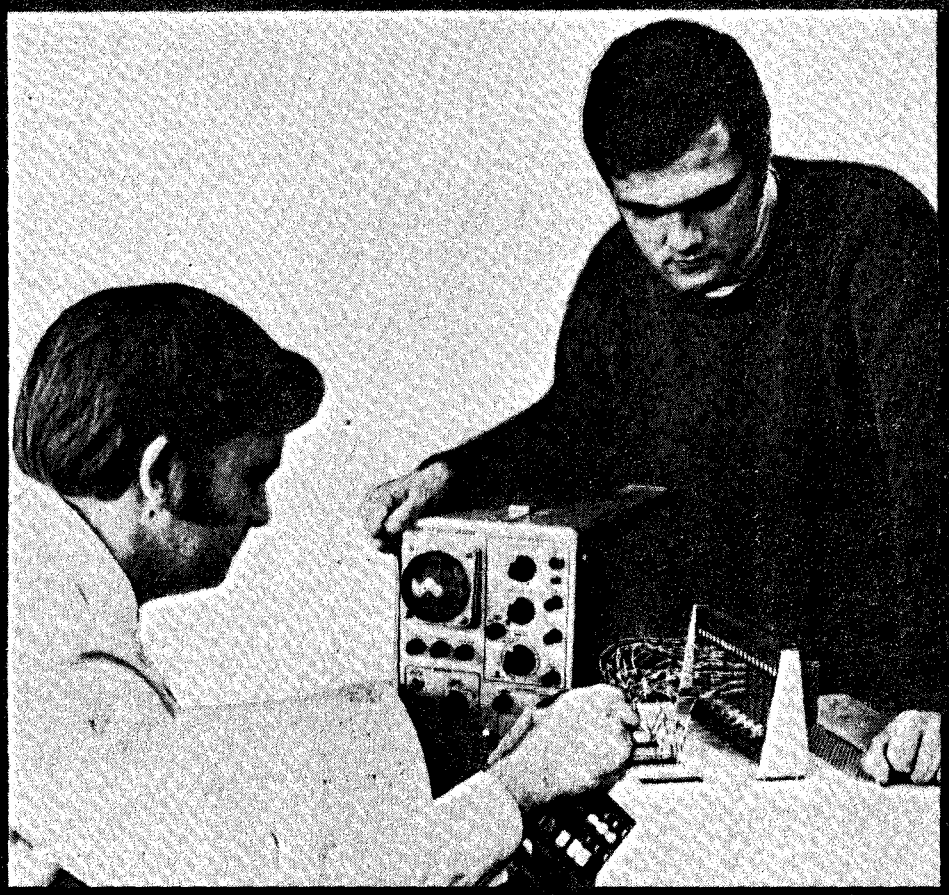

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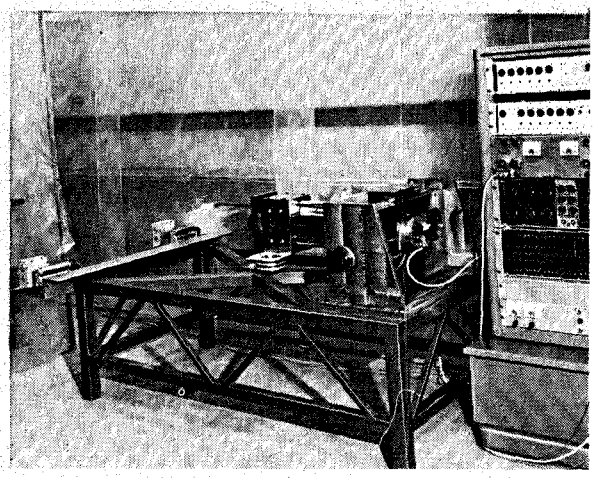

Fig. 9. Automatic position control system using tri-lateral co-ordinates.

The shape of some large engineering structures dictates a need for non-cartesian methods due to sheer size and immobility. Radio telescopes are good examples of cases needing extreme accuracy shape measurements. The Arecibo telescope in Puerto Rico is over 300m in diameter, and proposals were recently under study for resurfacing it to an accuracy of 3mm. Smaller, but still large, units such as the steerable 210ft. Parkes telescope in Australia have a surface accuracy of 0.2in. The accuracy of the shape largely decides the upper frequency of operation and the antenna gain, so it is most important. Absolute shape is initially obtained using conventional surveying methods, but special devices have been produced using triangulation formed visually with pentaprisms and ruled scales. Shape changes under various loading conditions were measured in Australia using a central scanning camera that photographed the relative positions of hundreds of reflective targets placed over the dish surface. To date it has not proven economic to build automated measuring systems for the dishes. Photogrammetry has proven useful but this also is not completely automatic. This method is outlined later.

Surveyors rarely use rectangular co-ordinates, for they are inappropriate due to the difficulty of defining the x, y, z axes lines from which a line is projected to the point of interest. Instead tapes and electromagnetic distance (EMD) measuring instruments (discussed in Part 2) are used to define distances between triangulated bench marks, in conjunction with angles measured by manual or digital recording theodolites. In geodetic survey, trilateration (lengths only) is now used predominantly as greater precision is possible with E.M.D. devices for a given amount of effort.

Satellites have also been employed for accurate global measurement. Reflecting balloons 41m in diameter, and known as Echo, are spotted on film from stations located around the Earth. Data derived from the time-correlated satellite and star image background enables the position of the Earth stations to be determined relative to each other. An observation station in Canada is shown in Figure 10. These methods are able to measure to within a part in a million over intercontinental distances. The photographic plates are measured with small x-y digital readout co-ordinate tables.

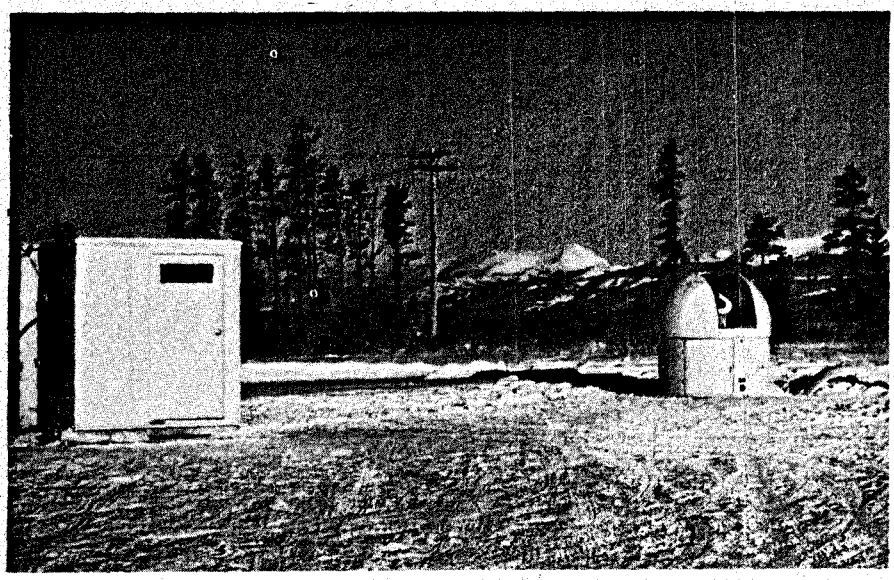

Fig. 10. The Whitehorse satellite tracking station in the Yukon. Precision cameras photograph the relative positions of the satellite and its star background.

But what if observation between ends of a line is not possible, such as inside a mine? In these cases inertial navigation can be used. The gyroscope, shown diagrammatically in Figure 11, provides a fixed direction reference in space. Boeing 747 superjets, Mace and Titan missiles, space vehicles, marine vessels and the military, each use inertial guidance. In the Boeing Carousel IV navigational unit, three accelerometers measure the magnitude of the aircraft acceleration components from which velocity is obtained by integration and position by a second integration. Three gyros hold the accelerometers in the same spatial directions. These units operate with a reliability equal to running a colour T.V. set for forty years without failure. For an hour of flying, the navigational error is less than 2 nautical miles.

Gyros are also used in conjunction with theodolites in surveying situations where triangulation is difficult. The unit shown in Figure 12 has a gyro reference in the underhung cylinder below the theodolite. This unit can define directions to within 1 min of arc for a 15 min observational period. If longer observations are made, it is possible to obtain 10 arc second accuracy.

PHOTOGRAMMETRY AND AUTOMATIC MAP-MAKING

Until recent years, photogrammetry was confined to use in topographical mapping. An aircraft flying at constant speed is used to take aerial photographs of over-lapping areas of ground as it flies. Successive, high-quality photos are then viewed together in a special way as a stereoscopic pair, producing a three-dimensional scene to the observer. Stereoplotting machines convert the pictures to maps. With these machines, the operator controls the movement of a floating point in the 3-D view and moves it over the contours of the 3-D image as though following a path in reality. Photogrammetry is a way to scale down (or up) a 3-D object and reconstitute it somewhere else. The x, y and z co-ordinate values are either recorded or plotted as maps via mechanical or electrical links. The equipment is costly as can be realised from the illustration in Figure 13 — but map making is a big industry.

In the last decade, photogrammetry has been used for other purposes; in medical research for physiological shape change assessment, for checking radio dish and car body shapes and even for recording car accident scenes.

(Continued on page 81)

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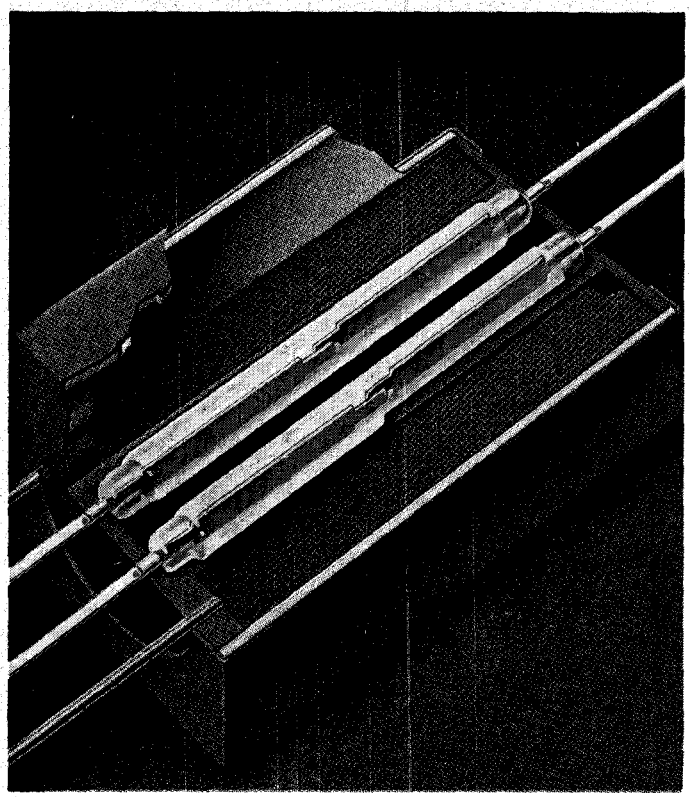

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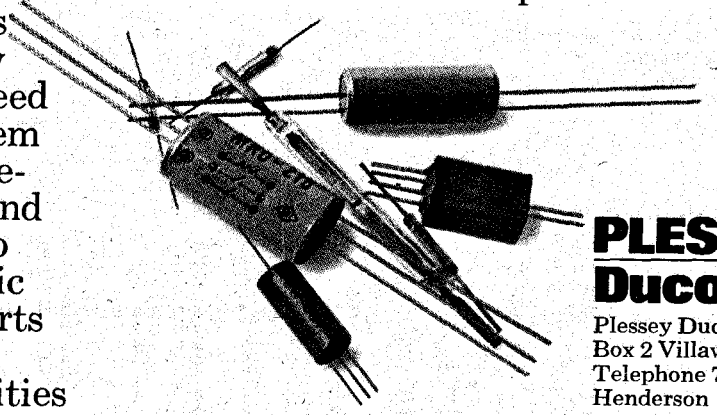

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AD52

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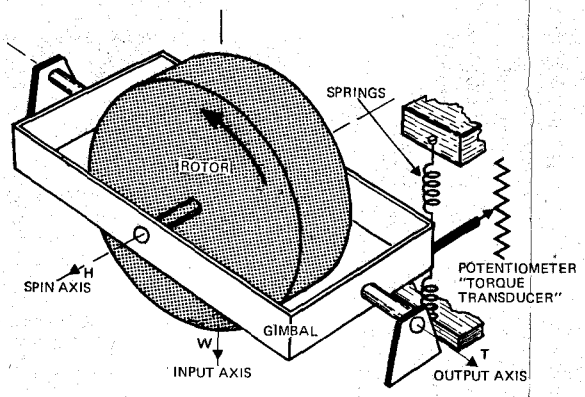


Fig. 11. Schematic illustrating the gyroscope as a reference direction producing device.

Fig. 12. A surveyor measuring underground with a gyro-assisted theodolite.

In Australia, B.H.P. use it for monitoring the stock piles of ore, etc at the end of each day's operations. In the States it has been used to map the sea floor by lowering cameras to the bottom.

As can be guessed, operating the stereo plotting machine is an exacting task requiring a skilful operator, and in recent years research has been directed at automating the process from photo-pairs to finished maps. The difficulty is that although the human computer is not fast or reliable compared with electronic computers, it does have the power to handle vast numbers of variables and come up with a decision using unknown methods. Machines have difficulty in deciding what to do in mapping tasks, so maps made automatically still have a lot to be desired because of the limited rules that can be programmed in.

HOLOGRAPHY

Twenty-two years ago Gabor proposed a method known now as holography. In this, coherent radiation is used to illuminate an object. Some of the original radiation is optically mixed with that reflected from the object, thus forming a two-dimensional interference pattern which looks nothing like the object. This is recorded on film as a hologram. If the hologram is viewed with rear illumination from a coherent source, the object is apparently reconstructed as a 3-D image having depth and form. In a way the hologram is akin to a stereo pair of photos as they both have recorded a 3-D shape on a plane medium for easier viewing elsewhere. Holography, however, operates on an interference basis using short wavelengths and, therefore, has extreme resolution. For example, in time-resolved holography, an exposure of the object is made. The developed picture is the combined pattern of two holograms and exhibits moire-fringes representing surface errors of small magnitude.

The method has been used with visible radiation, for testing cylinder liner accuracies, turbine blade stresses, optical mirror blanks, for studying how insecticide falls on insects and for car-tyre inspection.

I.B.M. have a computer programme that produces holograms without an object to start with. These kinoforms, therefore are synthesised visual experiences.

Holography is not confined to the visible. Microwaves and radio frequencies can be used for seeing in the fog or in darkness or for looking into opaque materials. Ultrasonic radiation has been used for mapping the geology and sands of the sea floor in exploration uses.

SCANNING SYSTEMS

At the smaller end of position measurement is the electron microscope which magnifies the size of an object so that it can be more readily observed and measured by the unaided eye. The most recent technique is called scanning electron microscopy for it uses a scanning principle to build up a two dimensional picture of an object with only a single-point intensity determining detector. A block diagram of the Cambridge Stereoscan instrument is given in Figure 14. The electron beam is focussed to an ultrafine probe on the specimen. Scanning coils deflect this beam to sweep it in a line across the surface of the object. Emitted (or transmitted) electrons are collected as a current related to the reflectance (or absorption) of the specimen. Successive scan lines are placed side by side on a C.R.O. tube to build up a 2D picture. This concept of scanning is common to conventional television cameras, remote-sensing thermal radiation scanners, ultrasonic prospecting and physiological diagnostic instruments.

Ultrasonic distance transducing techniques usually use the pulse return method so are able to measure at only one place at a time. In the Sonogram instrument used in livestock fat assessment, a curved frame is held over the live animal's body. The measuring head moves automatically along the frame producing various reflection echoes at each position. A camera also slowly tilts in synchronism and the photographic plate is exposed where reflections occur. The composite picture produced shows the position of the junctions of the various layers of fat and muscle enabling the quality of, say, chops to be determined

(Continued on page 118)

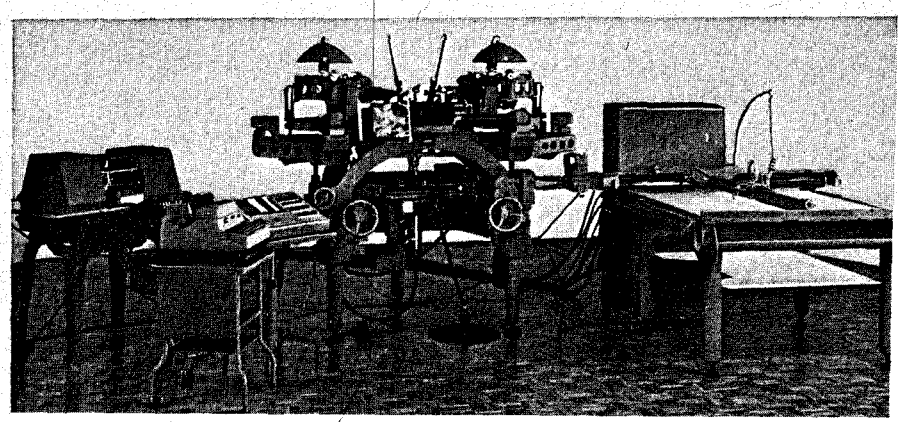
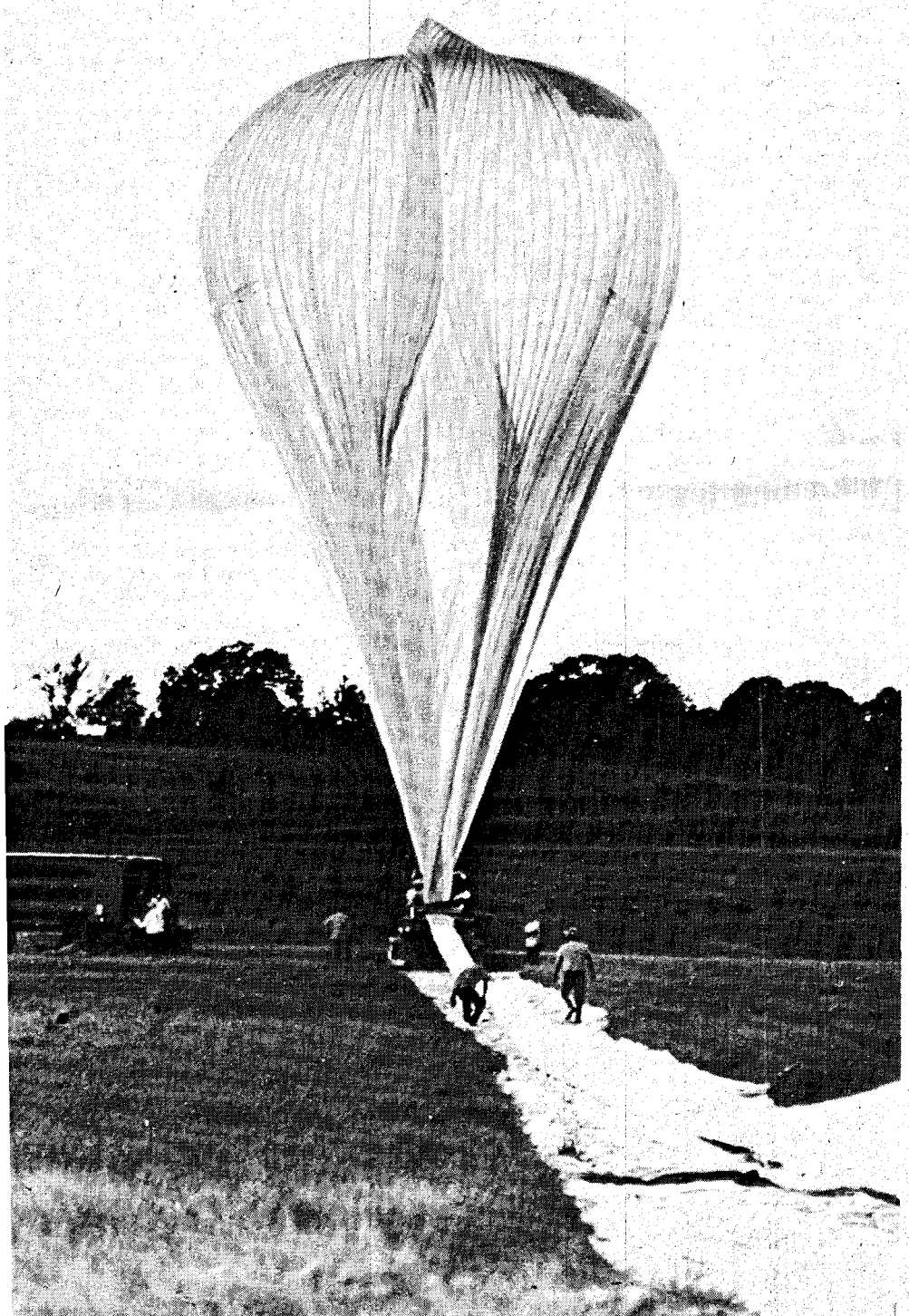


Fig. 13. This machine complex is used to plot maps and other contours from a stereo pair of photos.

GAMMA-RAY STAR GAZING

High altitude balloons lift instrument packages in latest astronomy techniques. Here, Dr. Jocelyn Burnell of Southampton University discusses the technique with Electronics Today International correspondent Dr. Peter Sydenham.



DOCTOR Jocelyn Burnell is one of Britain's leading authorities on gamma ray astronomy — a new and difficult area of observational science.

To find out more about her work Electronics Today International went to Southampton University where Dr Burnell has a teaching fellowship, and works with a team continuing research into celestial sources of gamma rays.

Dr. Burnell came to prominence at the end of 1967 as the person who first discovered pulsars while working at the Mullard Radio Astronomy Observatory. From those days she has moved from strength to strength having identified additional pulsars.

Pulsars are single stars within our galaxy. They emit RF broadband noise pulsating with an extraordinary stability. The period is stable to a few parts in 10^8. Pulsars should not be confused with quasars which are thought to be of galatic size — well outside outside our own galaxy — at distances on the limit of our comprehension.

Gamma ray astronomy started about 20 years ago when theoretical studies predicted the existence of gamma ray sources in outer space. It was not until 1962 that meaningful measurements were achieved. The process of measurement involves many complications that make progress slow, so results were often negative.

Gamma (γ) rays are short wavelength x-rays having high energy. They are more difficult to observe in space than radio sources because the frequencies are immensely higher and the signal strengths lower. To add to the problem of basic detection, the Earth's atmosphere screens ground-based telescopes from the source emissions, so observation must be made from the top of the Earth's atmosphere.

Fig. 1. The high altitude balloon unfurles in readiness to carry its instrument package.

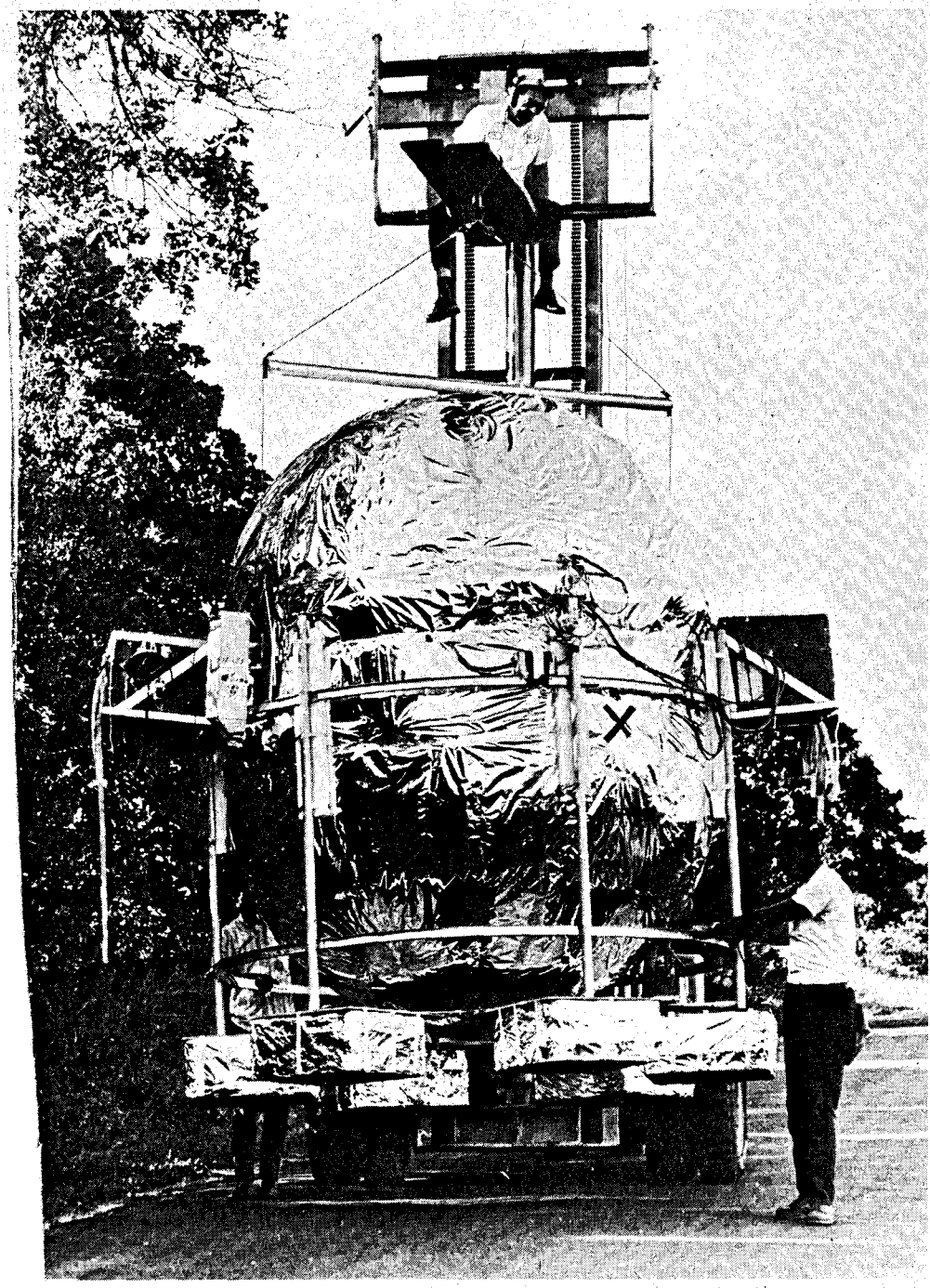


Fig. 2. The complete observatory ready for use.

making recovery potentially impossible.

The altitude reached by balloons released at the Texas site is in the region of 40 kilometres. Recovery is quite a procedure. At Palestine a spotter plane is used to locate the balloon on its descent. The pilot has the ability to accelerate the balloon's drop velocity when it is in a suitable location. Vehicles are then guided to the package by the pilot.

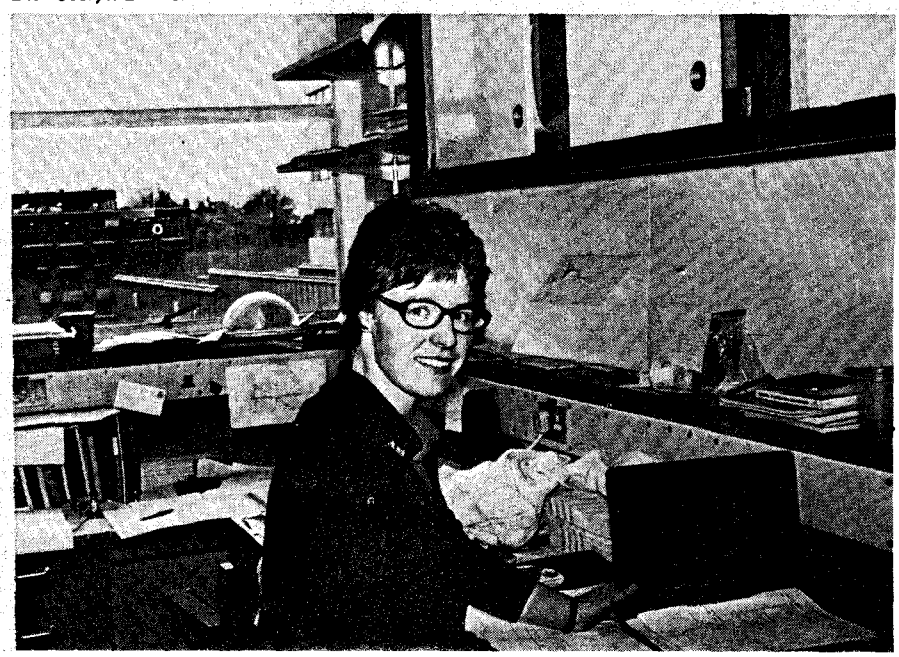
Initial experiments were required to detect the presence of sources without real need for mapping information. Now things are more sophisticated and the one ton packages sent up by Southampton have servo-controls to point the telescope at predetermined portions of the sky.

The system is controllable from the ground using two main telemetry links. One controls the telescope tracking altitude, the other is a data channel.

The process of instrument and package development is by necessity slow. Modifications and repairs cannot be carried out on-site and viewing can only be entertained where visual conditions suit balloon recovery. For these reasons the team consider themselves fortunate to obtain a few hours observation every six months. By contrast, radio astronomy can operate most of the time.

Current aims are to evaluate the feasibility of doing gamma-ray astronomy from balloons and one of the major problems is the noise background created in the atmosphere vicinity of the balloon. Part of the measurement design task is to sort out just what is signal and what is noise. Several designs are used, a typical arrangement being as shown in Fig. 3. A number of flights have been

Dr. Jocelyn Burnell



The Americans launched a satellite (called UHURU – SWAHILI for freedom) as a platform for an x-ray telescope but not all groups can support such an expensive technique, and whilst the Southampton group also found the need to use high altitude telescopes they have chosen to use balloons to carry their equipment.

The balloons are launched at Palestine in Texas (USA) where a suitable serviced site is operated by other groups, (a launch in progress is shown in Fig 1.). The pre-flight path of a balloon necessitates a remote site to avoid danger to aircraft. Also important is the wind pattern, for too violent an area could cause the balloon to drift hundreds of miles – thus creating a navigational hazard and

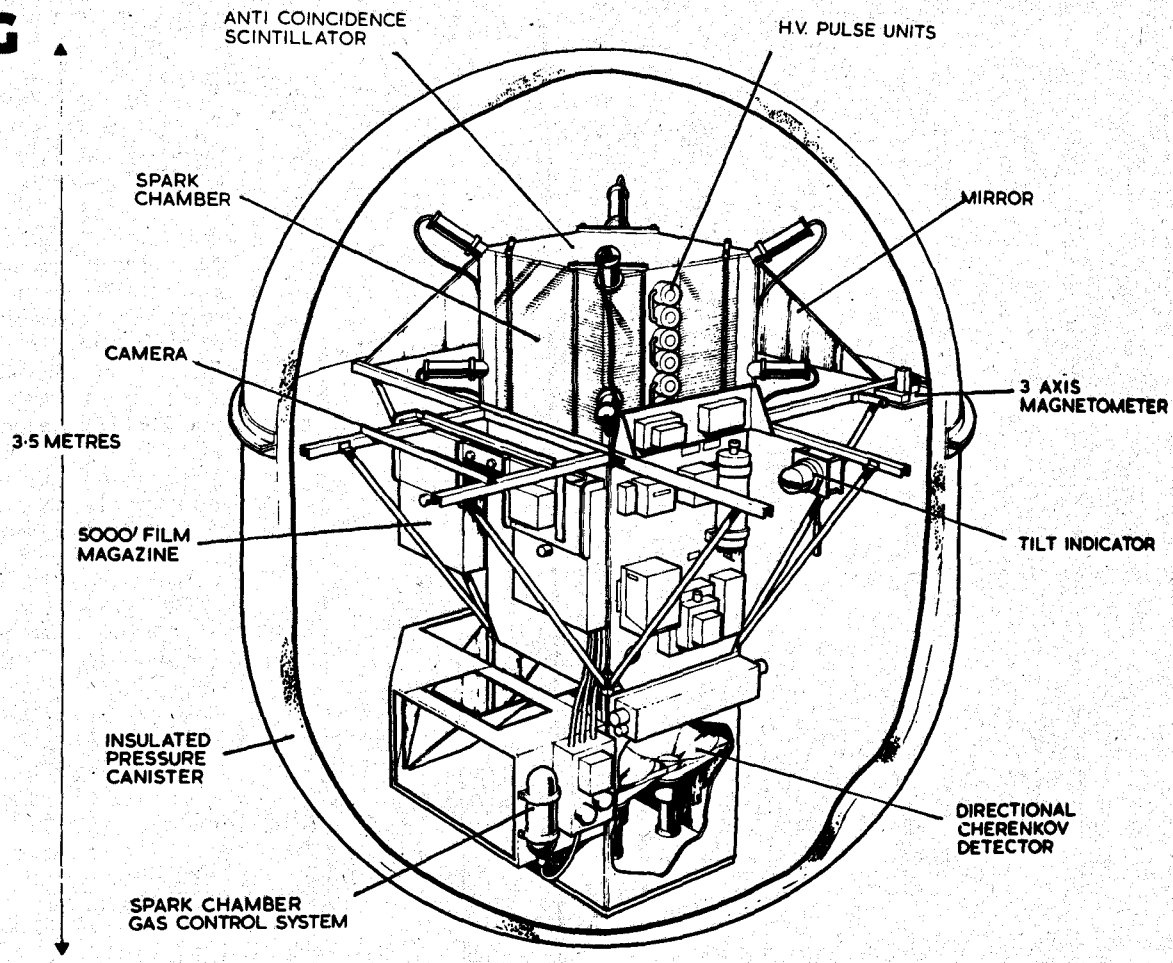


Fig. 3. This schematic drawing shows the contents of the insulated pressure canister used to house the guidance and measurement systems.

completed and the group are currently engaged in analysing the most recent data, much of which is recorded in the package on magnetic tape and film.

HOW THE TELESCOPE IS CONTROLLED

In order to point the telescope at a particular piece of sky the astronomers need to know precisely where the unit is aimed relative to the star-field. Currently, guidance is achieved using multi-axial, fluxgate, magnetometers that sense the Earth's magnetic field giving a crudely reliable sense of direction. The magnetic field, however, is subject to large excursions — of up to several degrees — in an unpredictable manner. Now they are developing an optical star-field sensor that will lock onto a known star. It then is relatively easy for the astronomer to steer the telescope as desired. This is standard practice in optical astronomy. It is only possible to steer within half a degree by the magnetic method. The optical technique should better this.

There are three main types of detector available to detect x-rays and the group have used all at various times. The first is a scintillation counter in which the energy of the gamma rays (1 MeV for the 10^{20} Hz sources of interest) is changed in wavelength to visible frequencies by a suitable crystal. The resultant scintillations are detected by a photo multiplier as electrical current outputs which can be recorded with relative ease.

The second detector is the spark chamber. In this, a series of plates having alternating positive-negative charges are subject to the gamma-ray stream. The energy of the radiation causes the gas between the plates to breakdown thus producing a visible spark which is recorded photographically.

The third method is the Chevenkov detector which also relies on the wavelength change effect. In this, the radiation is guided into a liquid. The path of individual rays causes the trace to become luminous for fractional microsecond periods. With a large enough number of x-rays entering, the glow is a measure of intensity. This also is photographically recorded. Each type can be identified in Fig. 3.

Fortunately the balloon and package structure are transparent to gamma rays so the telescope need not have an optical vision path. The telescope itself is unlike optical or radio structures in so much that it is more of a collimator than a gain device (a lead tube is used) being designed to have a restricted field of view within the star field.

As many of the radio amateurs amongst our readers are keenly interested in radio astronomy, we asked Dr. Burnell whether she felt that this was a field for the amateur researcher. However Dr. Burnell thought that this area of study was not really for the amateur due to the high cost of obtaining the airborne platform from which the observations are made. ●

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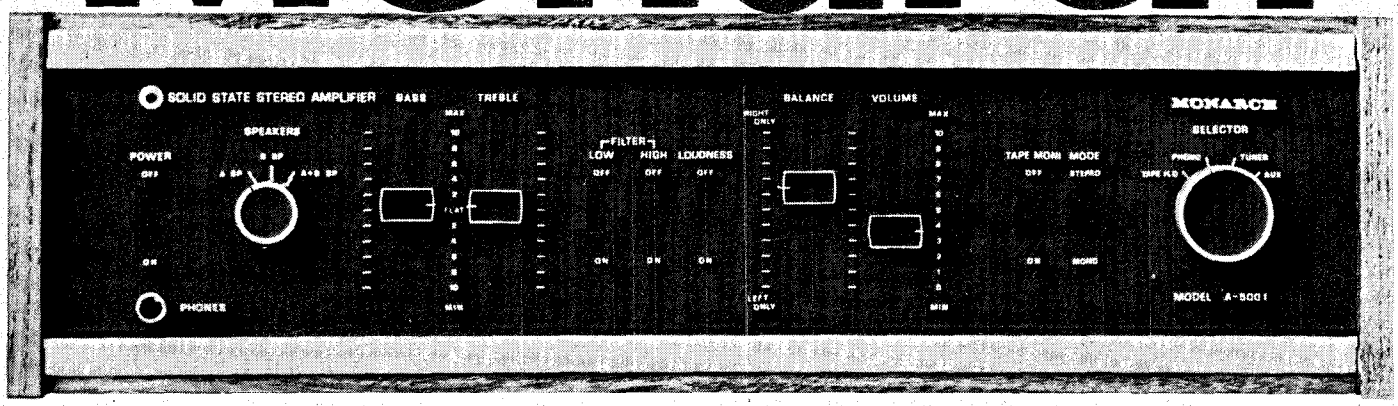

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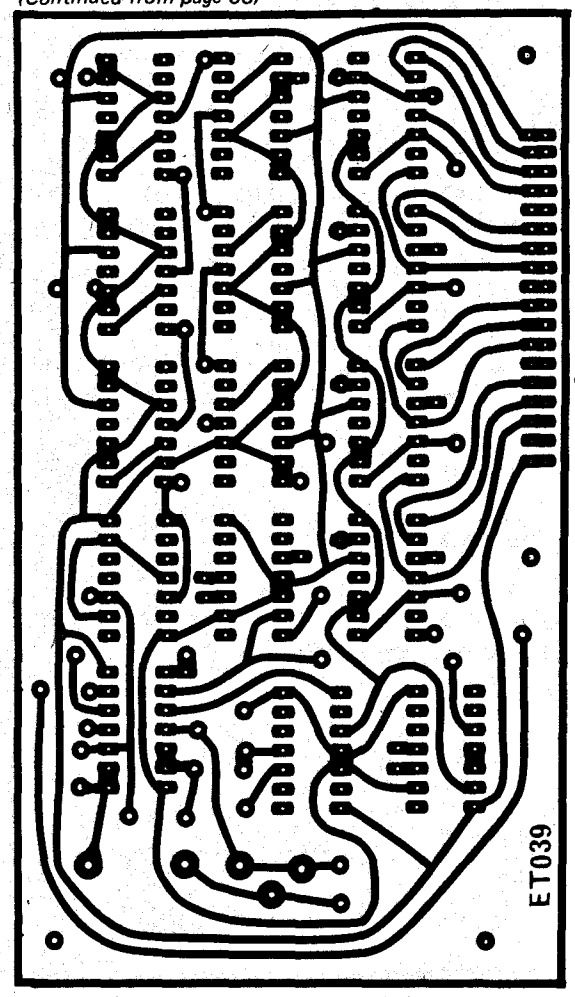
(Continued from page 68)

Fig. 10. Logic board PC diagram (full size).



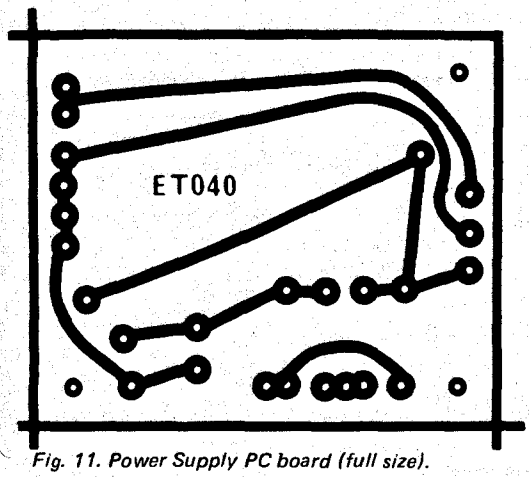


Fig. 11. Power Supply PC board (full size).

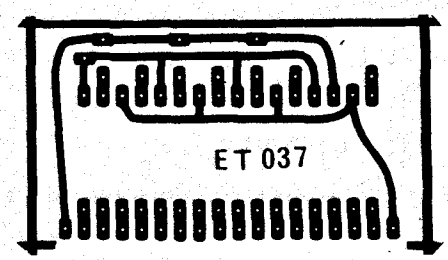


Fig. 12. Display panel PC board (full size).

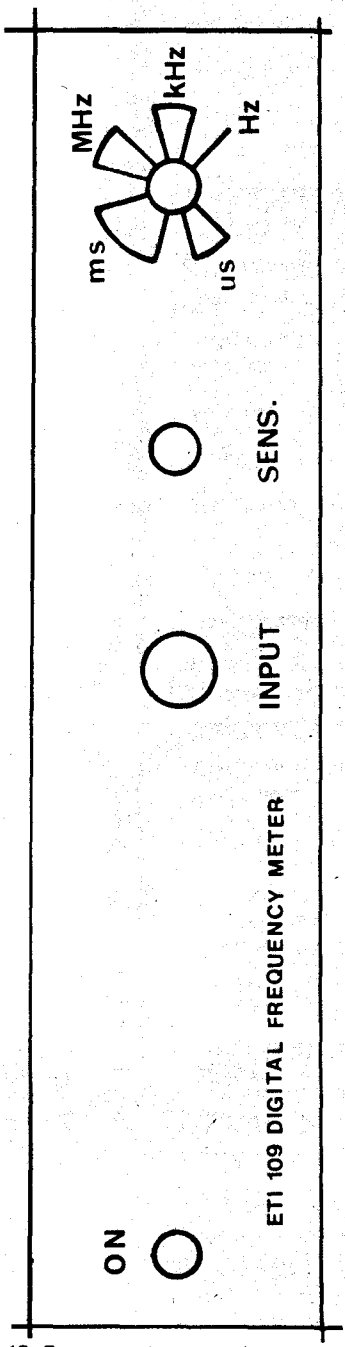


Fig. 13. Front panel artwork (full size).

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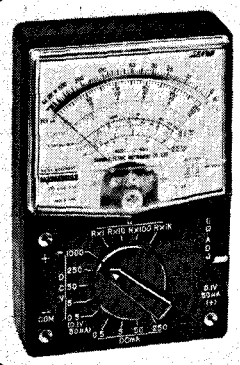

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Resistance:	Rx1, Rx10, Rx100, Rx1k
dB:	−20dB ~ +62dB
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AC Voltage:	3V, 12V, 30V, 120V, 300V, 1.2kV.
AC Current:	1.2A, 12A.
Resistance:	Rx1, Rx10, Rx100, Rx10k (Max 50MΩ)
dB:	−20dB ~ +63dB

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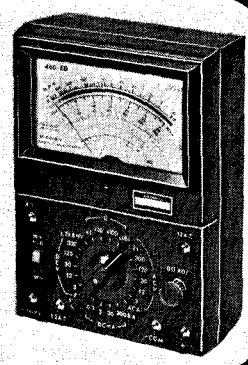

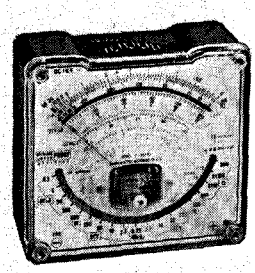

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DC Current:	40μA, 0.5mA, 5mA, 50mA, 500mA.
Resistance:	Rx1, Rx10, Rx100, (Max. 50MΩ)
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DC Current:	60μA, 3mA, 30mA, 300mA, 1.2A, 12A.
Resistance:	Rx1, Rx100, Rx1k, Rx10k, (Max 50MΩ)
dB:	−10dB ~ +63dB
LI:	60mA, 600μA, 60μA
LV:	1.5V

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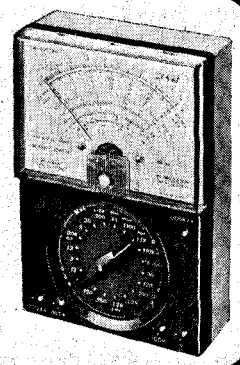

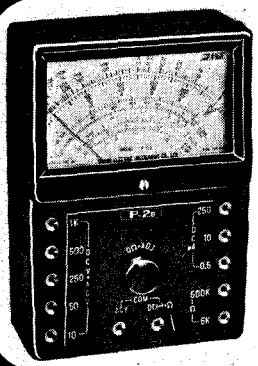

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AC Voltage:	2.5V, 10V, 50V, 250V, 1000V
Resistance:	Rx1, Rx10, Rx100, Rx1k, Rx10k. (Max 20MΩ)
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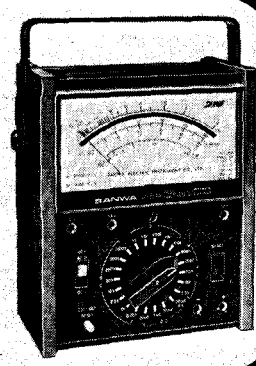

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EQUIPMENT NEWS

NEW NOISE GENERATER

The Schlumberger/SAIP Noise Generater model GPB 1 delivers Binary (two levels 0-1), Analog (continuous time function) and Pulse (pulses with constant duration) signals.

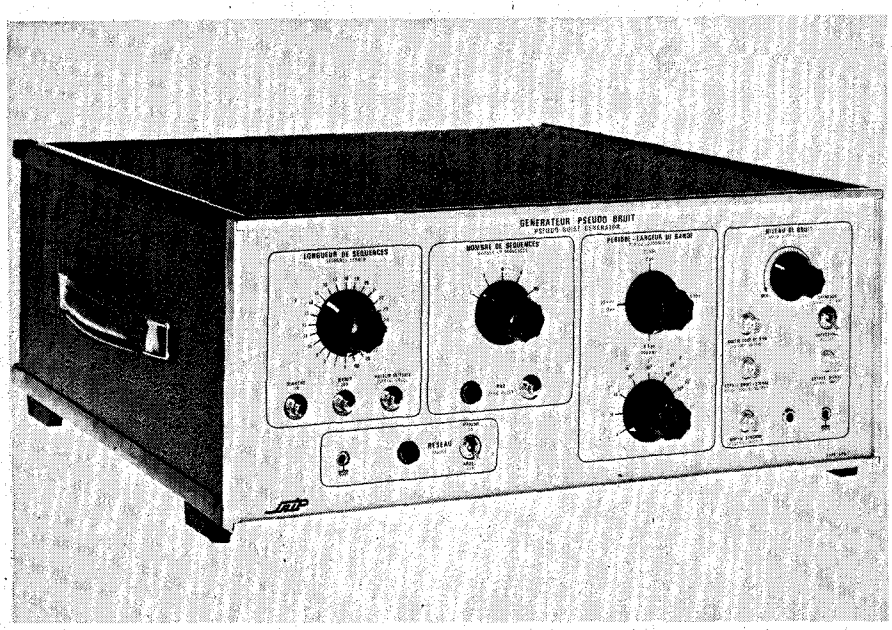
These signals may be either random or pseudo-random as selected.

In the case of pseudo-random signals the sequence length is equal to $2^n - 1$ where n has selected values from 6 – 28 and the clock frequency may be varied from 0.0025 Hz to 2 MHz allowing a large degree of control over the energy spectrum of the signals.

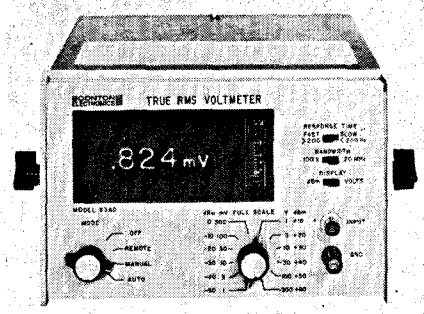
Analog signals are obtained from smoothing the binary signals through a digital low pass filter. The bandwidth of these signals, it is claimed, may be varied between 0.000125 Hz and 100 KHz.

Facilities for external programming and signal mixing are also available.

Further details from: Schlumberger Instrumentation Australia Pty. Ltd., P.O. Box 138, KEW. VICTORIA. 3101.



TRUE RMS DIGITAL VOLTMETER



The Boonton Model 93AD True RMS Digital Voltmeter measures 300μV to 300V in 12 programmable ranges of 1mV to 300Vfs. Frequencies from 10Hz to 20MHz are covered with a claimed accuracy of ±1% rdg ± 1 digit over a large portion of the frequency band.

The 3-1/2 digit indicator uses numeric indicator tubes for clear, unambiguous readings. A small edge-meter mounted beside the display is calibrated in dBm; it is also convenient as a peaking or nulling indicator.

Use of a solid-state rather than a mechanical chopper in this instrument contributes to its excellent reliability.

Bandwidth may be restricted to 100kHz when rf response is not desirable. A longer response time may be selected to increase stability when making low-frequency measurements. Selection of both bandwidth and response time is programmable.

BCD outputs are standard with the Model 93AD: a linear dc output (up to 10Vfs) is also provided. Standard positive TTL-compatible logic is employed. Input impedance is 2MΩ in parallel with 25pF or less, at all frequencies within the specified range.

An unusual option provides a digital dBm readout that indicates dBm (600Ω) directly from −70 to +50dBm. Other optional features include autoranging, high-impedance probe, and rear signal input.

Compactly packaged in a 5½" high half-rack case, the Model 93AD may also be rack-mounted if desired, using a standard single or dual rack-mounting kit.

Further details from: Scientific Devices Australia. 2 Vautier Street, ELWOOD, VIC. 3184.

DIGITAL MULTIMETER

The new S-D Model 7004 is a full 4-digit precision digital multimeter offering 25 pushbutton-selectable measuring ranges of dc voltage, dc current, ac voltage, ac current, and resistance.

The instrument utilizes a Dual-Slope Integration design together with a fully guarded and isolated input circuit. These features combine to provide, it is claimed, high accuracy and stability plus exceptional immunity to the effects of both common mode and normal mode noise.

All function and range selection is made from front panel pushbutton controls. Polarity selection for dc voltage and current measurements is automatic with display of minus polarity indicator. The readout features autopositioned decimal point and a non-blinking display.

The 7004 is lightweight and completely portable. Power consumption is said to be 10 watts and the instrument will operate at line frequencies from 48 to 440 Hertz. The multimeter may be fitted with an optional built-in battery pack with no increase in size. Optional DTL/TTL compatible digital outputs can also be included for remote printout, digital limit comparison, or other automatic data system requirements.

Further details from: Scientific Devices Australia, 2 Vautier St., ELWOOD, VIC. 3184.

INFRA RED VIEWERS

A range of new Infra-Red viewers and light sources has been recently announced by John Hadland (Aust.) Pty. Limited. The viewers, known as the IRV-M and the IRM-M.O.D(A), are active image-converter viewers with an 3-1 photocathode. The optical system has a field of view of 28° with a closest viewing distance of 150mm (6"). Resolution of the photocathode is claimed to be 50 line pairs/mm, the phosphor peaks at 5600° A and is a P20 type. The power requirements of 12KV are generated internally from a 1.35V Mercury cell which has a life of about 100 hours.

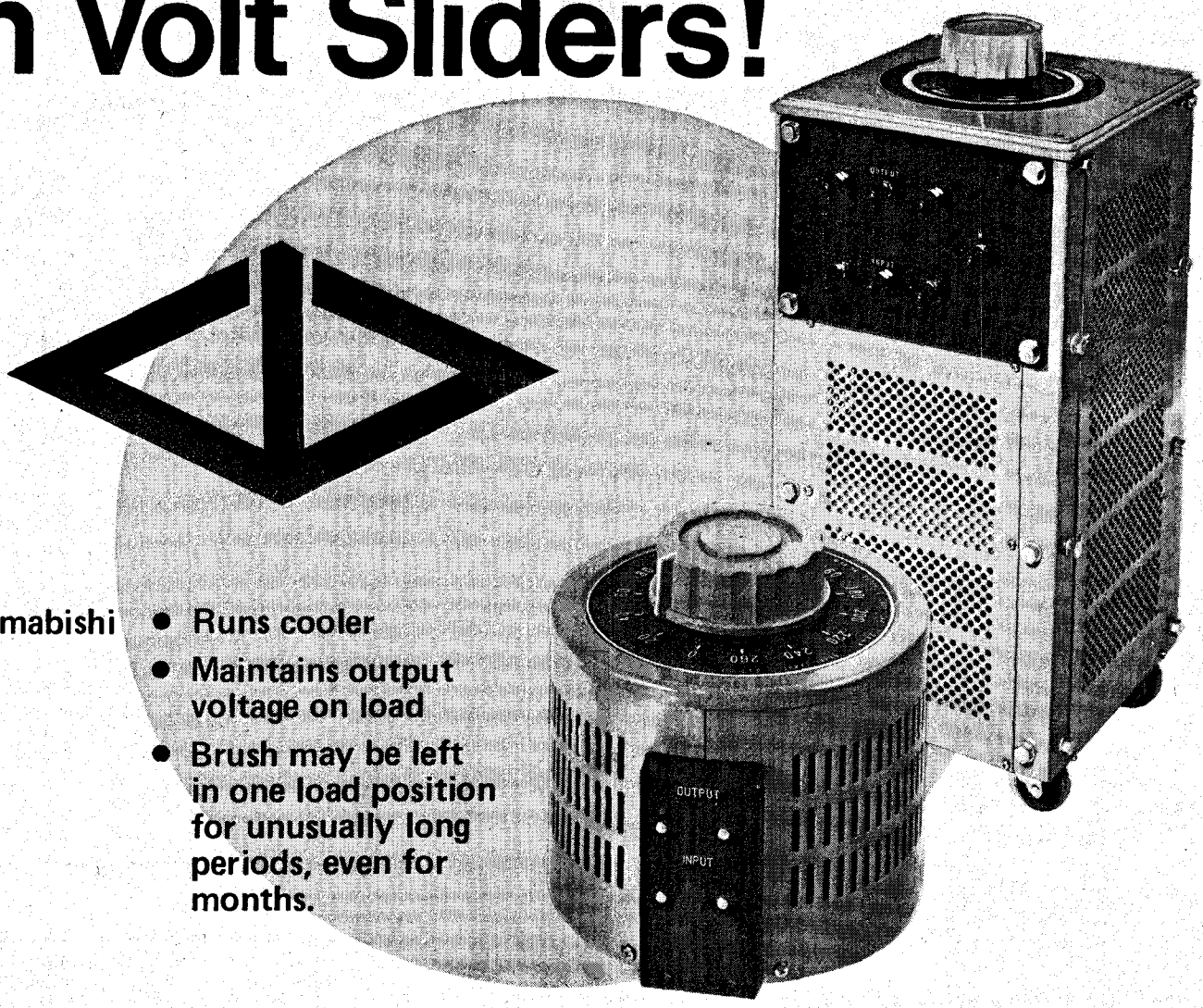
The unit is 134mm (5¼") long by 70mm (2¾") wide and 41mm (1-5/8") deep. The weight, including battery is 500g (18oz) and the units are claimed to operate over the temperature range −20° to +55°C.

Also available for use with these and other infrared viewers is a range of I.R. light sources.

The SL1 is a hand held torch. The SL2 is a mains operated 40W general floodlight and the SL3 is a portable hand held 50W Searchlight having rechargeable batteries.

Further details from: John Hadland (Aust.) Pty. Limited, 28 Chester Street, OAKLEIGH, VIC. 3166.

Yamabishi - real value in Volt Sliders!



Yamabishi

- **Runs cooler**
- **Maintains output voltage on load**
- **Brush may be left in one load position for unusually long periods, even for months.**

Yamabishi Volt Sliders are toroidal wound auto transformers with a sliding contact which enables the output voltage to be smoothly adjusted from zero volts up to the supply voltage and slightly over.

The iron core is made of a continuously rolled strip of silicon steel which is subsequently annealed in an atmosphere of gas. This process produces magnetic characteristics which keep no-load currents down to low levels. The brush gear is designed to keep heating and wear to a minimum and to provide good contact and reliable operation.

Yamabishi Volt Sliders are conservatively rated and have extremely good voltage regulation. They can be satisfactorily operated on supplies from 50 Hz to 400 Hz

Australian Stocks include a comprehensive range of single and three phase models, which are made up to 150 Amps.

Some of the uses of these Continuously Variable auto-transformers are—

- *Control of any alternating current supply*
- *Adjustment of supply voltage for electrical equipment*
- *Electrical test benches in laboratories/workshops*
- *Control of electrical heating/lighting.*

Also available from Yamabishi—

Resistive/Reactive Loads, Rheostats, Induction Voltage Regulators, Specialized High Voltage/Current Supplies, Inverters, Electronic Training Equipment, etc.

H. ROWE & CO. PTY. LTD

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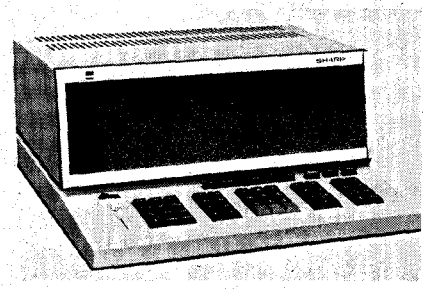
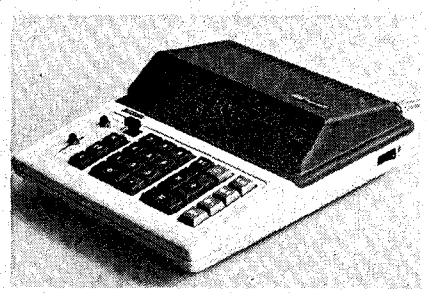
EQUIPMENT NEWS

TWO NEW SHARP CALCULATORS





The new models, designated CS-421 and CS-224V both have unique features which enable them to perform an amazing complexity of calculations.

The model CS-421 is a Scientific Calculator, designed for use by scientists, technologists, engineers and surveyors as a personal computer.

It has fourteen different built-in functions such as co-sines, logarithms, Pi and a range of algebraeic functions efficient to ten digits. Its capacity in the case of a floating decimal system is twelve digits in the mantissa and two in the exponent, giving a calculation range of from 10^{-99} to 10^{99}.

The CS-421 Scientific Calculator can perform four arithmetical calculations, has square root extraction and can make use of a register of twelve memory banks in its stored programme system. It has an external memory using magnetic cards as well. It can perform 144 steps and has 33 pairs of unconditional jump, conditional jump, non-zero jump and sign jump.

Sharp's model CS-421 has a logical application in the fields of mathematics, statistics, surveying, architecture and dynamics but it also can function as an easily-used computer in commercial and university laboratories, and is ideal for processing calculations in the field.

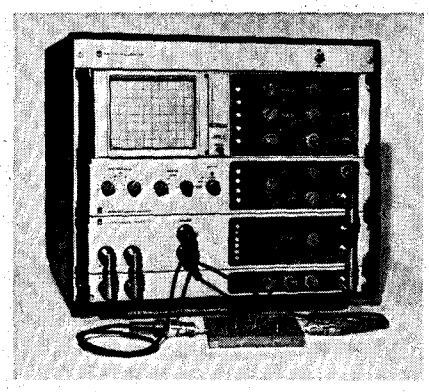
Sharp's other new calculator, the CS-224V, is said to weigh no more than a telephone, yet can carry out complicated calculations with speed and efficiency.

The CS-224V uses three working registers and two memories to carry out calculations such as the sum of products, the product of sums and power calculations.

The three working registers of the CS-224V enable full twelve digit calculations such as twelve digits multiplied or divided by twelve digits equals twelve digits – one register keeps the read-in number and answer and the other two are for calculations.

Further details from: Sharp Corporation of Australia Pty. Ltd., 22 Burrows Road, ST. PETERS, NSW. 2044.

WIDE-RANGE RF NETWORK ANALYZER



The General Radio RF Network Analyzer model 1710 provides precise measurements of transmission and reflection properties (including magnitude, phase, group delay, and S-parameters) over a broad frequency range of 400 kHz to 500 MHz. It also features, it is claimed, a full 115dB dynamic range, 0.005dB resolution, and the ability to operate into 50 or 75 ohms, without performance degradation.

The analyzer provides systems capability – a tracking sweep generator, tracking detector, processor, and display scope are completely integrated into a single unit. Polar-display and group-delay capabilities are offered as low cost options, and five measurement accessories are available to tailor the system to specific needs. These accessories include 50 ohm and 75 ohm transmission tees, 50 ohm and 75 ohm transmission-reflection bridges and, an S-parameter measuring set.

Three channels are standard (a reference and two unknowns) so that simultaneous displays of the characteristics of both unknowns are available together with simultaneous displays of transmission and reflection characteristics or of magnitude and phase. The frequency range is covered in three bands with a continuously adjustable sweep over the full 500 MHz range, or a portion of it, and continuously adjustable sweep speeds from 10 ms to 100 s per band.

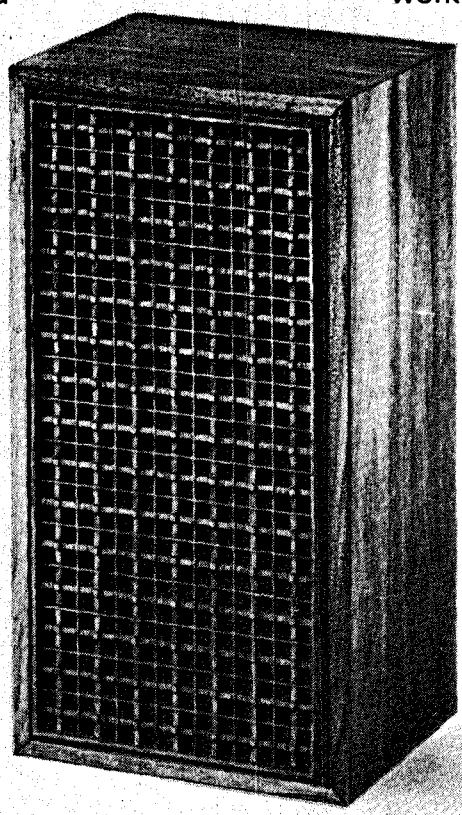
The RF level to the unknown, it is claimed, can be accurately set from 0 to -66 dBm and can be displayed on the scope as a constant monitor for gain measurements or for other reference purposes. The processor provides a choice of measurement band widths (10 kHz to 100 Hz) to reduce the effects of noise when necessary, and extremely low residual fm helps assure accurate measurements.

Further details from: Warburton Franki, Adelaide, Brisbane, Hobart, Melbourne, Perth and Sydney.

Ever thought about efficiency?

You buy a twenty watt amplifier and go looking for a pair of speakers. You choose a pair that sound fine in the showroom but disappointing at home. Could be that they are low efficiency speakers and your twenty watt amplifier is overloading and distorting on the loud bits.
So you trade your twenty watt amplifier for a forty watt job . . . and you blow your speakers.
You're caught between the devil and the deep blue sea.

Unless of course you buy Rectilinear . . . . The high efficiency loudspeakers that flatter your amplifier because they don't make it work so hard.



Put 10 watts in and they sound fine. Put 40 watts in and they sound fine. Put 100 watts into the big ones and they still sound fine.
For once you're free of the low efficiency devil, and the low-power-handling deep blue sea.

Investigate Rectilinear—the problem solver.

Solve the money problem too—they start at $139.
(that's the $139 model XI above)

SOLE AUSTRALIAN DISTRIBUTORS

Leroya Industries PTY. LTD.

266 Hay St., Subiaco, Western Australia. 6008

VIC. Douglas Trading Co., 191. Bourke St., Melbourne, 3000.

QLD. Brisbane Agencies, 72 Wickham Street, Fortitude Valley, Qld. 4006

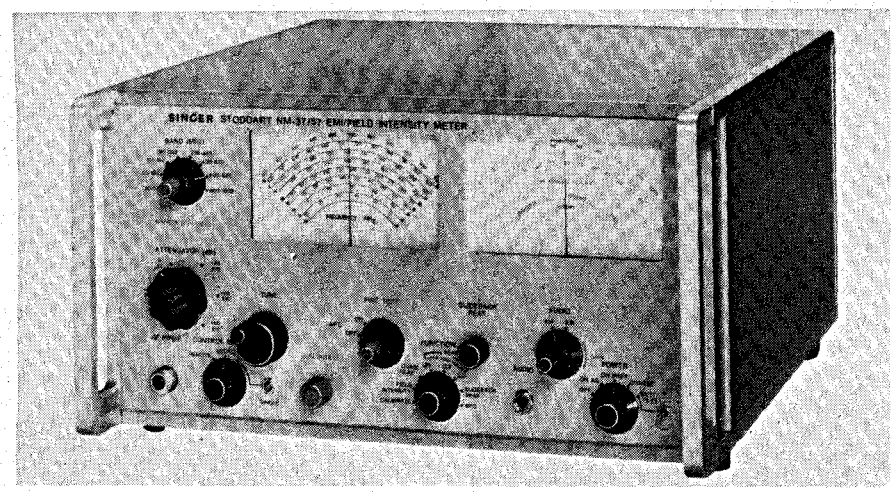
N.S.W. Sydney Hi-Fi Centre, 83 York St., Sydney, N.S.W. 2000.

S.A. Sound Spectrum, 33 Regents Arcade, Adelaide, S.A. 5000

LER 025

EQUIPMENT NEWS

EMI/FIELD INTENSITY METER



DC Electronics Pty. Ltd. has just released its newest, most sophisticated EMI/Field Intensity Meter.

The instrument Model NM-37/57, performs programmable EMI measurements from 30 MHz to 1 GHz and is said to meet both commercial and military standards including MIL-STD-461A/826A for all automatic and semi-automatic testing. It is portable, battery or mains operated and brings together a wide range of capabilities not usually found in one instrument.

Although the NM-37/57 is designed primarily for measurement of EMI in accordance with military and commercial standards, its other applications include: high performance general purpose receiver; field intensity meter; electromagnetic compatibility (EMC) analyzer; spectrum surveillance analyzer; laboratory, frequency-selective microvoltmeter.

Further details from: D C Electronics Pty. Ltd., 32 Smith St., COLLINGWOOD, VIC. 3066. 19 Berry Street, NORTH SYDNEY, NSW. 2060.

PORTABLE MONITOR AND SERVICE CRO

To meet the need for a portable television monitoring and servicing oscilloscope Schlumberger CRC have recently released the OCT 569A/TV.

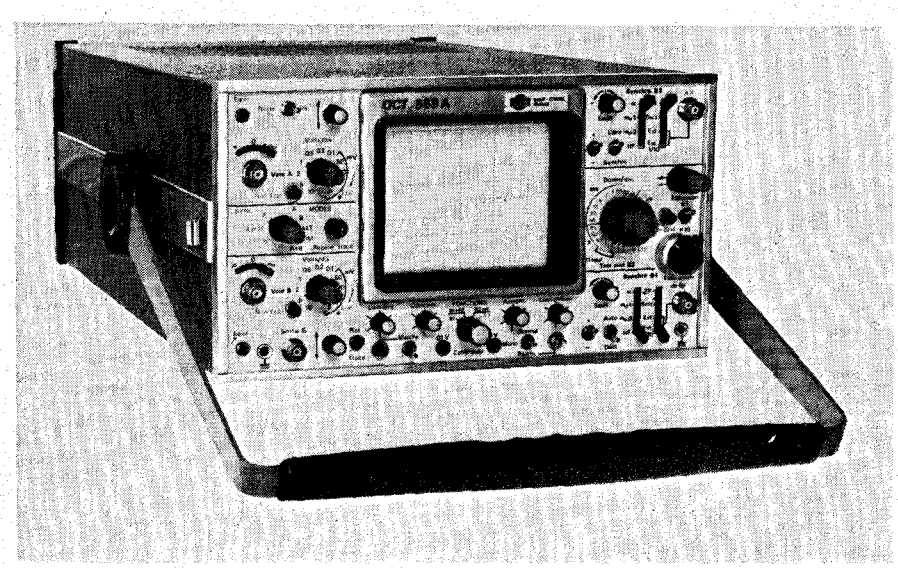
The unit is said to offer two channel operation at up to 60 MHZ with a maximum sensitivity of 500μV/cm at 20 MHz.

The sweep delay timebase employs a sophisticated sync separator which is claimed to trigger stably in the presence of colour subcarrier and sound in sync modulation.

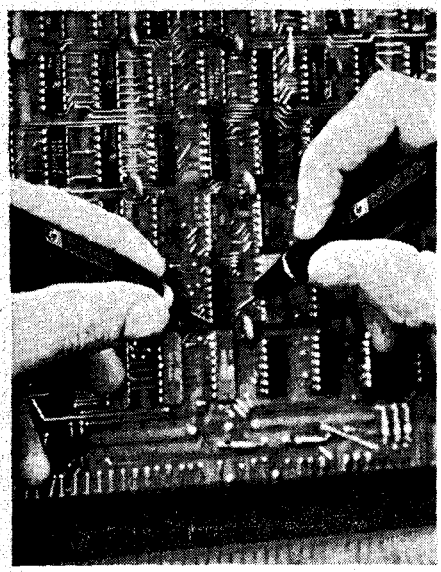
Compatibility with 819, 625, PAL and SECAM standards is provided as standard.

While particularly suited to television applications the oscilloscope maybe used for any other application requiring high writing speed and wide bandwidth.

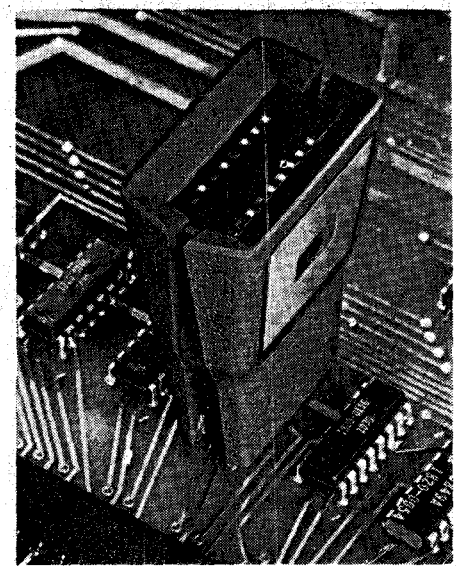
Further details from: Schlumberger Instrumentation Australia Pty. Ltd., PO Box 138, KEW, VICTORIA. 3101.



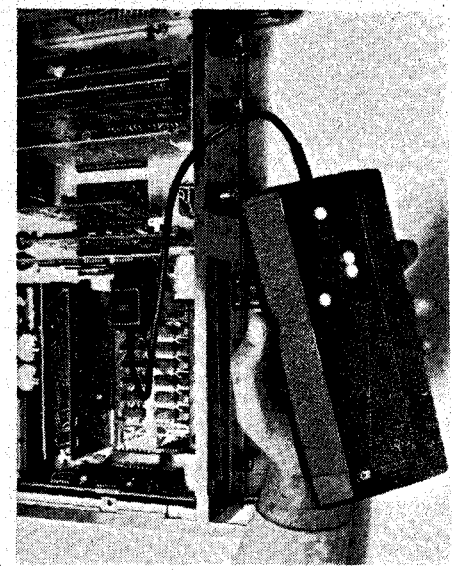
THE WORLD'S LEADING
IC Troubleshooters



Logic probe and pulser



Logic clip



Logic comparator

Model 10525T Logic Probe
- Dynamic indicator of logic activity
- Pulse stretching for pulses down to 10 ns
- Bad level detection
- No adjustments required
- Indicator at finger tips
- TTL/DTL compatible
- Safe overload protection

Model 10528A Logic Clip
- Displays IC logic states at a glance
- Self-powered, self-contained
- No adjustments required
- Compatible with TTL/DTL logic levels

Model 10529A Logic Comparator
- Dramatically cuts troubleshooting time
- In-circuit IC testing with no unsoldering
- Simple to use with no adjustments
- Dynamic errors stretched and displayed
- Compatible with TTL/DTL logic levels
- Self-powered

10526T Logic Pulser
- In-circuit stimulation without unsoldering
- Automatic injection of proper polarity pulse
- Greatly simplifies digital troubleshooting
- Output protected against overload
- TTL/DTL compatible
- Enhances utility of Logic Probe and Clip

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☐ PLEASE SEND FURTHER INFORMATION

☐ PLEASE MAKE APPOINTMENT TO DEMONSTRATE THE IC TROUBLESHOOTERS

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TELEPHONE NO. ET90222A

EQUIPMENT NEWS

CAMERA WILL GUARD HOMES AND STORES

A tiny camera designed to safeguard homes, factories and stores has been introduced to the Australian market.

Called "Watchguard," the combined camera and intercom unit is distributed in Australia by Philips. It weighs only about ½lb. But despite its size, the "Watchguard" can perform some big duties.

"Watchguard" can be installed by any layman, it is claimed, and will enable mothers to keep a close watch from the kitchen on children in the backyard swimming pool, or even check up if the children are awake or asleep in their bedrooms.

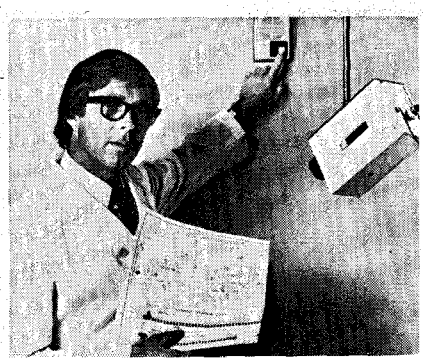
Store, bank and factory owners can install "Watchguard" to prevent pilfering, and it can be utilised by hospitals to keep a close watch on patients.

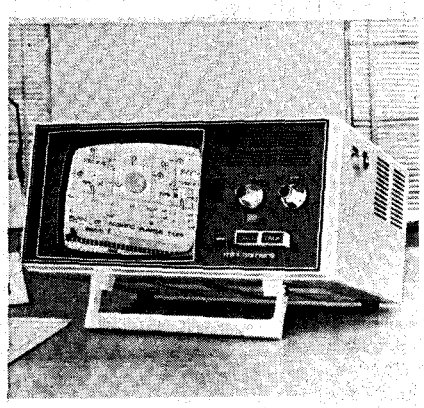
When the call button of the interphone unit adjacent the camera is pressed, a buzzer sounds and automatically turns on the television monitor, which in turn displays the image.

If the "talk" button is pressed on the monitor television, a conversation to the interphone unit can be made while viewing the screen, which provides a "video phone" effect.

About 30 seconds after the conversation is finished, the monitor television turns off automatically. If there is no response when the "call" button of the interphone is pressed, the television screen is turned off automatically in about 30 seconds. "Watchguard" has a quick-start system which enables the picture to appear instantaneously on the screen when the switch is used.

Price of the "Watchguard" is about $450 which is well within the financial scope of





people with a need for this type of camera. It is also said to be extremely economical to run as power consumption during operation is negligible.

Adjustments of either camera or monitor television on the "Watchguard" are said to be simple and limited to focussing, brightness, contrast and volume.

Further details from: Philips Industries Holdings Limited. Sydney, Melbourne, Brisbane, Adelaide, Perth, Canberra, Hobart.

MULTIPLEXER/A-D CONVERTER

The Schlumberger/SIS Multiplexer/A-D Converter TH 5611 multiplexes and samples up to 64 inputs. The sample rate, number of input channels, etc., can be selected manually by front panel controls or can be selected automatically by a central processor or remote control device. The TH 5611 can be integrated into an automatic data processing system.

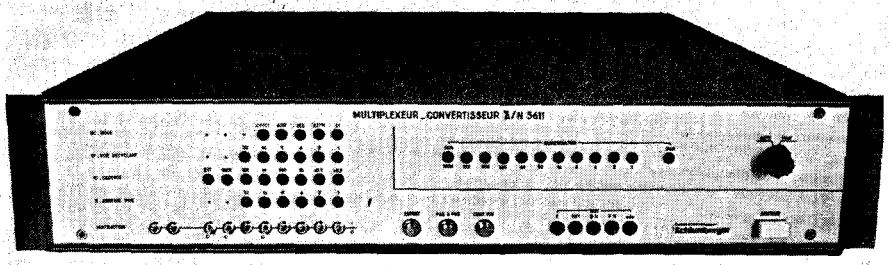
The multiplexer can include up to eight plug-in cards, each including eight FET analog switches. The multiplexed output is routed via an imput amplifier for impedance and level adaption.

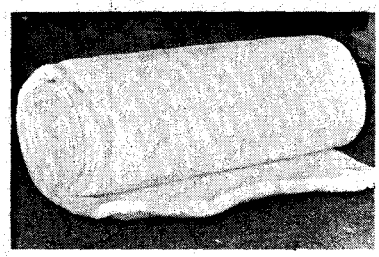
The conversion time for 11 bits is claimed to be less than 5μs, irrespective of the selected sample rate.

The output of the analog to binary converter is transferred to two buffers: one for the serial output, and the other for the parallel output.

The commands can be programmed manually by controls on the front panel, or remotely by a central processor or remote control device, permitting modification of operating parameters.

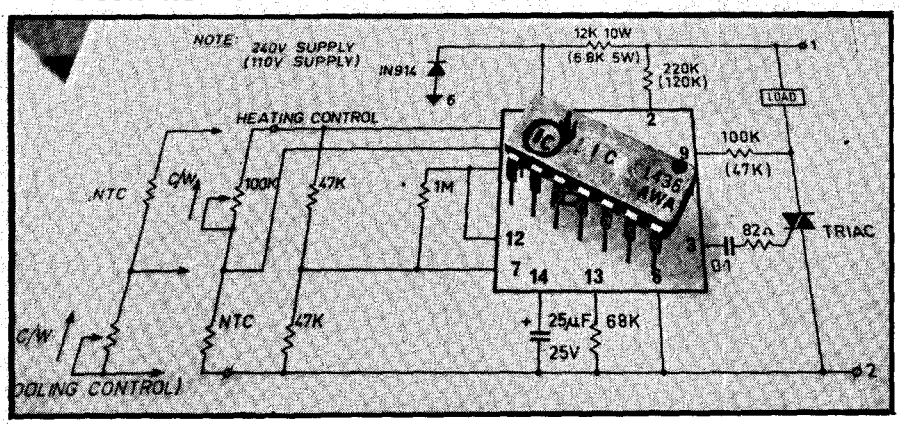
Further details from: Schlumberger Instrumentation Australia Pty. Ltd., PO Box 138. KEW VIC. 3101.





COMPONENT NEWS

PHASE CONTROL IC



The IC1436 is a flexible integrated circuit providing phase controlled triggering of silicon controlled rectifiers and triacs. In addition, it contains an operational amplifier for use in closed-loop control or zero crossing switching applications.

The device is packaged in a standard 14-pin DIL ceramic package and may be supplied direct from the 240V mains with the IC common connected to neutral.

Continuous conduction angle control from 7° to 173° is said to be possible and the device features dc isolation from the gate of the SCR or TRIAC.

The IC was developed by AWA for International Combustion Australia Limited and is available only from them.

Also available from International Combustion are heats sinks specifically designed for high power SCRs. They are the HS-200 (200 watt rating) and the HS-300 (300 watt rating).

Further details from: International Combustion Australia Limited, South St, Rydalmere, NSW 2116.

RSV02 PROXIMITY SWITCH

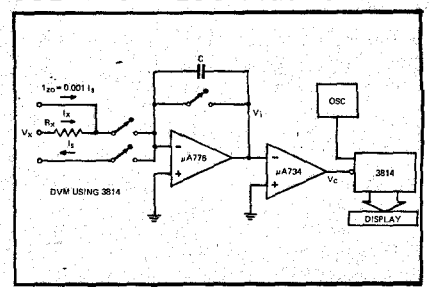
FR announce the addition of a vane switch to their range of magnetically operated proximity switches.

The RSV02 is housed in an aluminium casting and is intended for use in rugged environments. Actuation of the device is effected by movement of a piece of ferrous material within the slot in the casting, allowing both active components to be fixed rigidly.

The unit is available with either changeover contacts or two normally closed contacts with electrical ratings up to 100VA.

Further details from: NS Electronics Pty. Ltd. Telephone Melb. 729-0731; Sydney 476-1586; Adelaide 46-4571; Perth 25-5722; Brisbane 71-3366; Auckland 469-450.

4.5 DECADE DIGITAL VOLTMETER LOGIC ARRAY



Fairchild Semiconductor Components Group has introduced a silicon gate MOS integrated circuit that combines the functions of a 4.5 decade digital voltmeter in a single logic array.

A new addition to Fairchild line of standard silicon gate circuits, the 3814 Digital Voltmeter Logic Array, is said to operate from dc to 600 kHz and to interface directly with TTL logic with no external components.

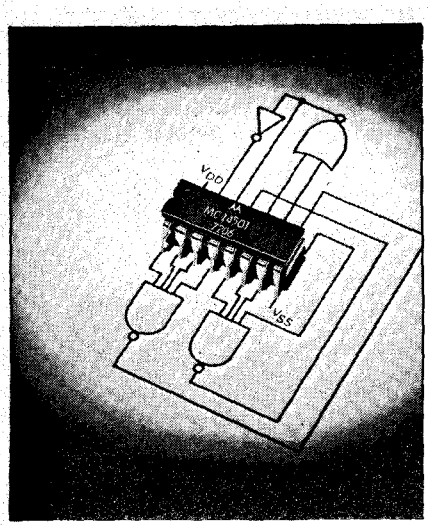
Thus the 3814 can drive multiplexed displays directly. A 4-bit BCD output can drive either a single decoder/driver such as the 9315 TTL BCD to 1-of-10 decoder or the 9347 or 9337 BCD to 7-segment decoder. The 3814 has five outputs which can drive external transistors to strobe the displays.

The 3814 also has a 10-count "pause" feature which eliminates switching transient problems when using the logic array in dual slope conversion applications.

Storage temperature is said to be -65°C to 150°C, and operating temperature is 0°C to 70°C. Operation up to 125°C is said to be possible with low power TTL output loads and a maximum frequency of 400 kHz.

Further details from: Fairchild Australia Pty. Ltd, 420 Mt. Dandenong Road, Croydon.

NOR/OR and AND/NAND FUNCTIONS IN A SINGLE PACKAGE



The MC14501AL/CL Triple Gate provides a feature not often found in a single digital integrated circuit package. This CMOS logic device has both a 2-input NOR/Invert gate and two 4-input NAND gates.

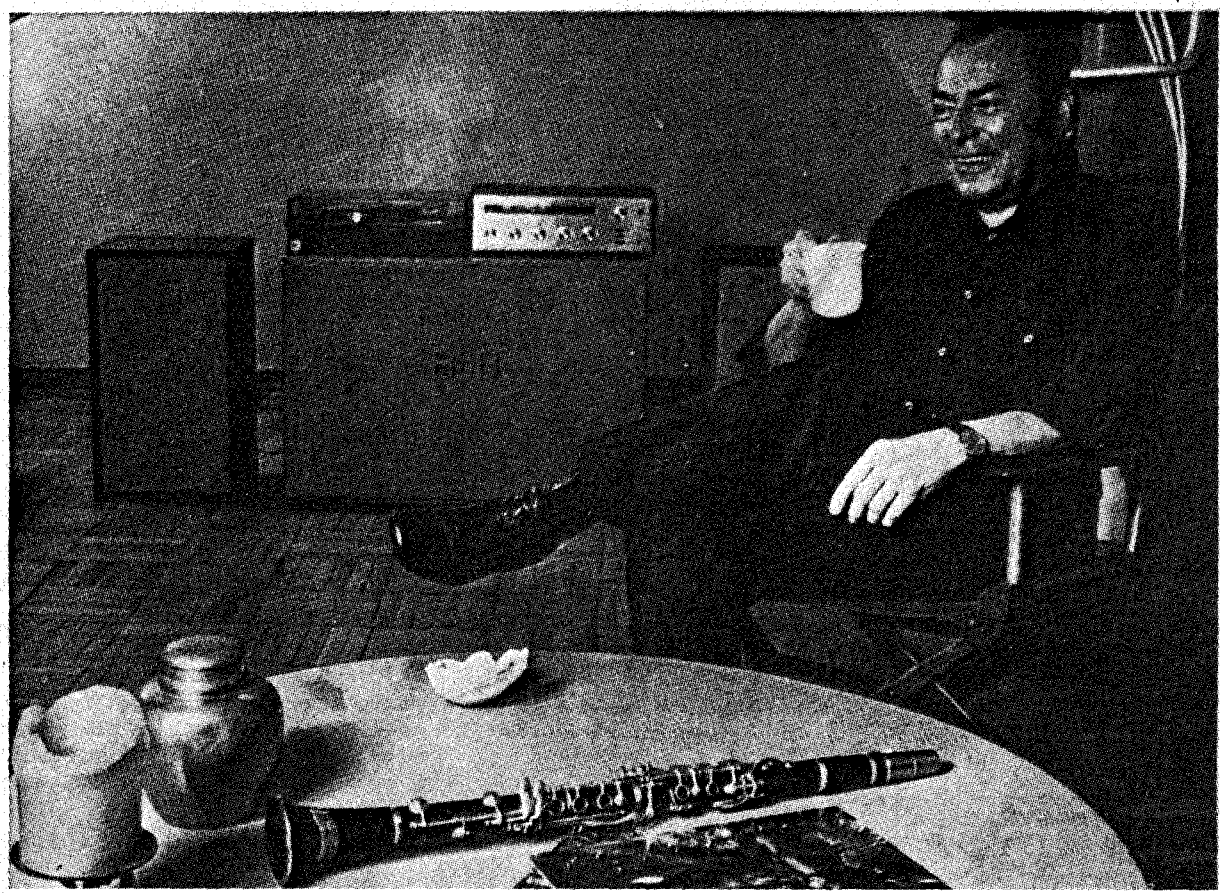
More complex functions can be derived from the MC14501AL/CL Triple Gate by interconnecting some of the device pins externally. By properly biasing the gate with one external pin interconnection, a 2-, 3-, or 4-input AND function is available. Using two external pin interconnections, up to an 8-input AND/NAND function can be implemented.

The MC14501AL/CL Triple Gate is characterized with uniform specifications that are given for all of Motorola's CMOS (McMOS) family devices. These uniform specifications provide for ease of system design. They are said to include a high fanout, >50; a typical noise immunity of 45% of supply voltage, V_{DD}; operation from a single supply voltage, positive or negative; and a symmetrical output resistance, 500 ohm, typical.

The MC14501AL/CL Triple Gate is unique to the McMOS family of devices. The MC14501AL version is said to operate from a supply voltage of 3.0 Vdc to 18 Vdc in the temperature range of -55°C to +125°C. The MC14501CL Gate is said to operate from a supply voltage of 3.0 Vdc to 16 Vdc in the temperature range of -40°C to +85°C.

Further details from: Motorola Semiconductor Products, Suite 204, Regent House, 43 Alexander Street, Crows Nest 2065.

Woody Herman chose AR-2ax speaker systems for his listening at home. The sound of live music, be it rock or big band, is reproduced accurately on AR equipment.



The accuracy with which AR speaker systems reproduce music serves as a valuable tool for many notable musicians. Among the most notable is Woody Herman, whose big bands have long enjoyed great success. His secret seems to be an ability to stay in tune with the evolution of musical styles, as is documented by the Herd's latest recordings. In spite of a schedule of more than 200 concerts every year, Mr. Herman can sometimes relax in the seclusion of his Hollywood home. Here, he listens to a high fidelity system consisting of an AR receiver, AR turntable with Shure V-15 type II cartridge, and a pair of AR-2ax speaker systems.

The low frequency speaker cone of the AR-2ax uses a newly developed material and process of manufacture which makes its absorption of high frequencies very high, suppressing a form of colouration frequently found in conventional cones its size. The circular suspension ring around the cone is also of a new material, silent and highly stable. The voice coil is a new high temperature design, triple insulated and wound on a former of Du Pont Nomex. The mid range speaker is a small, high dispersion cone type. The high frequency unit is the same miniature hemispherical device as is used in the AR5 and AR3a and is the best high frequency speaker we know how to make.

The workmanship and performance in normal use of AR products are guaranteed from the date of purchase; 5 years for speaker systems, 3 years for turntables, 2 years for electronics. These guarantees cover parts, repair labour and freight costs to and from the factory or nearest authorised service station. New packaging if needed is also free.

The AR catalogue and complete technical data on any AR product are available free upon request.

AR-2ax recommended retail price $285

AR

Acoustic Research Inc.
Massachusetts, U.S.A.

All AR audio equipment is on demonstration at the AR *Music Room* in the Sydney showrooms of the Australian Distributors.

Australian Distributors

W. C. Wedderspoon Pty. Ltd.

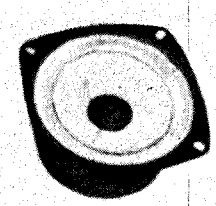
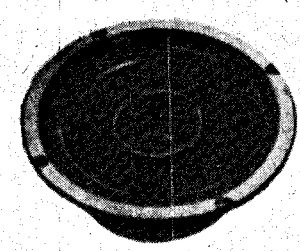
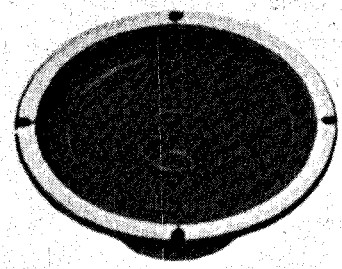
193 Clarence Street, Sydney. 29-6681

AR sound equipment may be purchased from the following Australian Dealers:

N.S.W.: Magnetic Sound, Sydney. 29-3371. Sydney Hi-Fi, Sydney. 29-1082. **VIC.:** Brasch's, Melbourne; Douglas Trading, Melbourne. 63-9321. **S.A.:** Sound Spectrum, Adelaide. 23-2181. **A.C.T.:** Homecrafts, Canberra. 47-9624. **W.A.:** Leslie Leonard, Perth. 21-5067. Alberts T.V. & Hi-Fi Centre, Perth. 21-5004. **QLD.:** Brisbane Agencies, Brisbane. 2-6931.

KALTRO HI FIDELITY SPEAKERS

FR4 4" FULL RANGE **FR65 6½" TWIN CONE** **FR8 8" TWIN CONE**

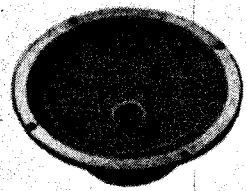




HI COMPLIANCE FULL RANGE SPEAKERS

- Powerful ceramic magnet combined with an acoustically suspended cone for remarkably low resonance and undistorted response over the entire audio spectrum.
- High quality cone to bring out the highs.
- Newly designed and epoxi-bonded voice coil for extra heavy program input.
- Compact size and shallow width make these speakers ideal for use with bookshelf type cabinets.
- Double diaphragm suspension.

	FR4	FR65	FR8
Nominal size:	4 inches	6½ inches	8 inches
Power Handling Capacity:			
rms.	4 watts	8 watts	10 watts
program:	15 watts	25 watts	35 watts
Flux density: (minimum)	10,000 gauss	11,000 gauss	12,000 gauss
Sensitivity:	95 db/W	96 db/W	97 db/W
Voice coil impedance:	8 Ohms.	8 Ohms.	8 Ohms.
Frequency range:	65 16,000 hz	35 18,000 hz	30 20,000 hz
Weight	1¾ lbs.	2¾ lbs.	2¼ lbs.

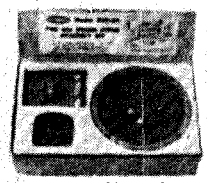
FR8A 8" WOOFER



The Kaltro FR8A 8" Woofer is a special version of our FR8 full range speaker which has been praised by audio enthusiasts for its supreme tone quality and performance.

Frequency Response .... .. 20-5,000 Hz
Resonance Frequency .... . 25-50 Hz
Power Handling Capacity 10 Watts RMS
Sensitivity .... 27 dB/W
Voice Coil impedance .... . 8 ohms
Flux density ....over 12,000 gauss.
Baffle Opening .... 6¾"
Overall Depth .... 3⅛"

KALTRO SSK84 2-WAY SPEAKER SYSTEM ASSEMBLY KIT



This woofer, tweeter and network speaker system assembly kit has been designed for the sophisticated Hi Fi listener who wants to make their own enclosure. Complete instructions for building a cabinet come with each assembly kit.

WOOFER 8" Diameter

Frequency Response ....30-5,000 Hz
Resonance Frequency .... ..30-45 Hz
Voice Coil impedance .... .. 8 ohms
Power Capacity ....20 Watts (Music)
Baffle Opening .... 6¾" dia.
Depth 3½
Mounting .... 4 holes, 3 13/16 radius

TWEETER 2¾" Diameter

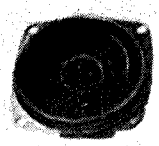
Frequency Response ... 1,000-20,000 Hz
Voice Coil impedance . 8 ohms
Baffle Opening .... 3⅛" Diameter
Mounting .... 4 holes, 1 9/16 radius
Depth .... 1¾"

CROSSOVER NETWORK

Crossover Frequency ....3,500 Hz
Matching Impedance .... 8 ohms

DT3 DOME TWEETER

Designed to compliment the FR8A 8" Woofer with the use of an MX31 or MX5 Crossover network. Frequency Response 1,000 to 20,000 cps. Voice Coil impedance, 8 ohms.

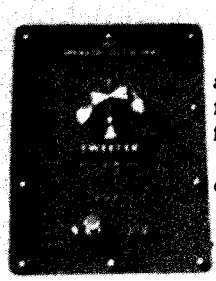


HTM2 HORN TWEETER

Power handling capacity .... 10 Watts RMS
Frequency Response .... 30-21,000 Hz

This horn tweeter has been designed to achieve perfect high tones when mounted in the correct enclosure.

MX31 2-WAY CROSSOVER NETWORK



This network features an adjustable volume control for the tweeter. Crossover frequency is 3,000 cps.

Also available MX5 Crossover without volume control.

radio parts

City Depot: 157 Elizabeth Street Melbourne, Vic. 3000. Phone 67-2699

Southern Depot: 1103 Dandenong Road East Malvern, Vic. 3145. Phone 211-6921

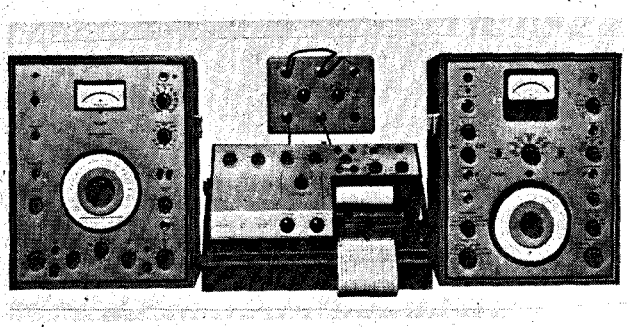
GROUP

562 Spencer St., West Melbourne, Vic. 3003
Phone 329-7888. Orders 30-2224

OPEN SATURDAY MORNINGS

AUDIO NEWS

NEW HI-FI SERVICE



Douglas Trading, the Melbourne based Hi-Fi dealer is offering a new and timely service to enthusiasts.

They have been astute enough to realize that the average buyer has to select equipment in accordance with a sometimes slender budget, and he needs some assurance that what he buys is good value for money.

To fulfill this need, Ben Douglas has installed $6000 worth of Bruel & Kjaer test equipment as used by Electronics Today consultants Louis Challis and Associates. Printouts of frequency response and distortion are thus available to the customer for any of the equipment on sale.

This new service will make the task of buying equipment a little easier and remove the fear of buying a pig in a poke.

HEAD CASSETTE RECORDER

A new cassette tape recorder with a three head assembly will be introduced soon by Japan's Nackamichi Research Inc.

The playback head will use a thin foil high-mu metal and will have a 0.5 micron gap in comparison to the 2.0 micron gap of a conventional cassette recorder head. The record and erase heads use high-mu ferrites.

The construction of the playback head is claimed to give vastly improved performance. Over-all frequency response for the model SLX (a portable unit for the quality consumer market) is claimed to be 40 Hz to 22 kHz ±3dB, with Dolby switched in, and using chromium dioxide tapes. The high frequency response is maintained to 18kHz on conventional tape.

Wow and flutter is said to be less than 0.12% and the signal to noise ratio better than 58dB.

Marketing details for Australia are not yet known.

NEW AMPLIFIER

Audiosound Electronic Services jave released a new-look LD30 series of amplifiers which replace the previous models.

Whilst the most significant change is in appearance, the new models have an additional technical feature, an 18dB per octave low-pass "Butterworth" filter for removing high frequency noise from tapes and records.

The new amplifiers have all the usual desirable features such as direct coupling, no electrolytic capacitors in signal circuits and low peak distortion etc.

In addition plug-in module construction has been used to facilitate rapid servicing.

Further details from: Audiosound Electronic Services, 35 Heather St., Collaroy Plateau, NSW, 2098.

NEW TURNTABLES

A new range of precision turntables known as the "APAN Music Maker" series have been released in Australia by Ralmar Agencies.

There are three units in the range, the BMU121 manual operation, the BRU-121 semi-automatic (pictured above) and the BFU fully automatic unit.

All units are belt driven, supplied complete with precision tone arm and Ichikawa magnetic cartridge. The Ichikawa cartridges are fitted with diamond stylii and will be marketed under the "Jelco" brand.

Also available are two styles of plinth which are precut to accept any of the three basic turntable assemblies, and may be teak or walnut veneered as required.

The units have a professional and attractive appearance and are believed to be competitively priced.

Further details from Ralmar Agencies, 431 Kent St., Sydney.

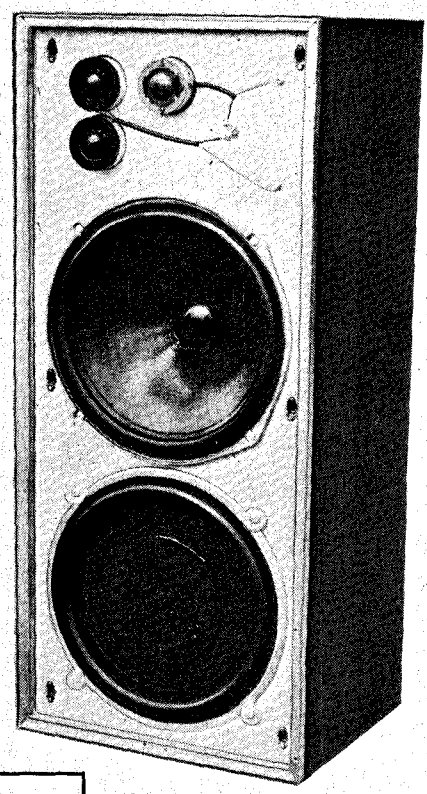
(Turn to next page)

what would you expect to pay for a pair of

CELESTION DITTON 25

speakers?

$800? $900? $1,000? $1,200?



Not at all. Prices in these areas are for the "Joneses" with whom we feel we have to keep up. But you can not only keep up with the Joneses — you can surpass them with a pair of Celestion Ditton 25 speakers under $550.

Pleasant surprise?

But an even more pleasing factor than the price is the performance! Celestion Ditton will produce all musical frequencies with the utmost realism. Five drive units cover the range from 20Hz to 40kHz.

Electronics Australia said: "One of the most stringent specifications on any speaker regardless of price. Probably one of the finest loudspeakers ever introduced to the Australian market".

The design utilises the highly successful Auxiliary Bass Radiator to extend the low frequency response so that even organ pedal notes etc., are reproduced with superb realism.

Technically:	Size 32" x 14" x 11"
Overall Frequency response:	20Hz to 40kHz
Power handling capacity:	25 watts RMS, 50 watts peak.
Impedance:	4-8 ohms
Drive units:	12" Auxiliary Bass Radiator, 12" long throw bass speaker, 2 pressure type mid and high frequency units, 1 pressure type ultra high frequency unit.

Write for reviews on Celestion Ditton 25, and Ditton 10 Mk II (under $160 pr.), Ditton 15 (under $240 pr.), Ditton 120 (under $180 pr.), or hear them at specialist Interdyn agents:

N.S.W.: Encel Electronics Pty. Ltd. 260 Elizabeth St., Sydney. Tel. 212 3722.
Q'LD.: Stereo Supplies, 95 Turbot St. Brisbane, 4000.
S.A.: Challenge Hi-Fi Stereo, 6 Gays Arcade, Adelaide.
TAS.: Audio Services, 72 Wilson St., Burnie.
VIC.: Encel Electronics Pty. Ltd., 431 Bridge Road, Richmond. Tel. 42 3762.
W.A.: Albert TV-Hi-Fi, 282 Hay St., Perth, 6000. Tel. 2-5993.

SOLE AUSTRALIAN DISTRIBUTORS:

INTERDYN

To: International Dynamics (Agencies) Pty. Ltd.
P.O. Box 205 Cheltenham. Vic. 3192.

AUDIO NEWS

BRENELL AGENCY TO PLESSEY

Plessey Electronics has been appointed Australian agent for the well known English "Brenell" range of general purpose and professional tape recorders.

The new equipment will complement the existing Plessey range of professional recorders, the models 66, 77 and 700.

The Brenell range includes the popular ST400 quality domestic stereo unit, the Mark 6 (mono and stereo) units, the Mark 6 Deck and the Tape Link Amplifier for Hi-fi constructors.

The Type 19 Tape Deck is also available as a separate unit. Used with the Tape Link Amplifier it is claimed to meet the most demanding hi-fi constructors requirements, or can be used to build up specialised systems where particular applications and specifications are required.

Plessey Electronics currently markets its own Model 77 at the top end of the bracket to radio and TV stations, recording studios and other professional users. The Plessey Model 66, which has been popular for many years with universities, schools, hospitals and recording studios, will be supplemented by the Brenell Mark 6 range.

Brenell Engineering commenced operations as a specialist communications firm in London, in the late 1940's, and developed into the recorder business with its highly successful do-it-yourself "Soundmaster" kit when tape records were still in the development stage.

Current production is running at 5,000 units per year, with 90 per cent going to fulfil export orders. Several hundred units have been sold recently to (mainland) China, and applications range from the broadcasting studios of the BBC, to schools, hospitals, film studios and domestic use.

Notably, several Brenell machines are in use in the Australian outback and in the jungles of Borneo where the Brenell reputation for ruggedness and reliability has been severely tested.

Further details from PLESSEY ELECTRONICS in Melbourne, Sydney or interstate agents.

Douglas Trading seals the deal nobody else can match!

2,000 SONY STEREO TAPE RECORDERS AUSTRALIA'S BIGGEST ORDER, EVER!

SAVE $75

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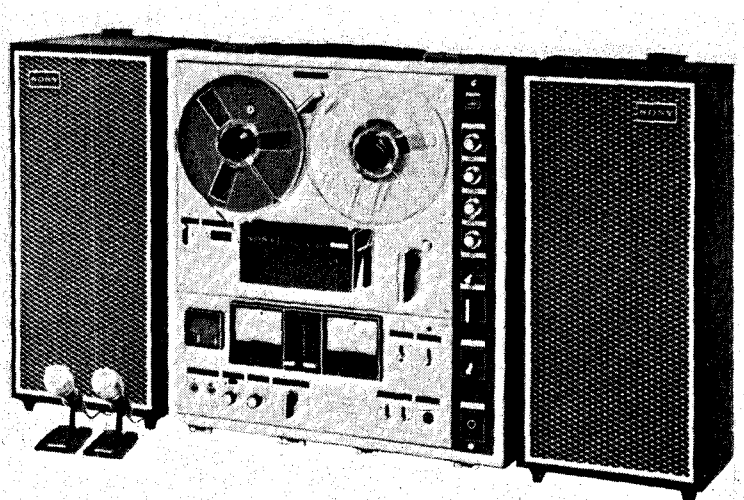
ONLY $199

Old price $622 Our price $399

SONY 3 SPEED, 3 HEAD STEREO TAPE RECORDERS

Another deal nobody else can match. New shipment. Brand new in sealed cartons and backed by SONY 12 months warranty. Features multiple inputs for microphone, magnetic player, tuner and auxiliary. Functions independently as recorder, amplifier or tape deck. 40-watt total dynamic power output (20 watts per channel). Solid state circuitry. Bass and treble controls. Echo effect recording, sound-on-sound recording, 3 heads, 3 speeds. Easy-read VU meters, noise suppressor, digital tape counter with reset button, sliding-type volume control, recording button for each channel. Easy threading, auto shut-off, self release instant stop. Two microphones included in our price!



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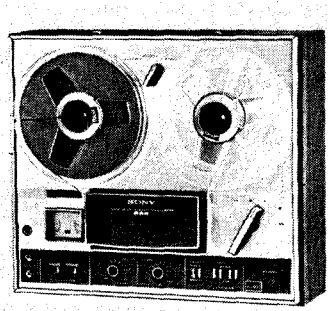


RECORDINGS... CLASSICAL

REVIEWERS: John Clare, John Araneta, C.M. Wagstaff.

THE EIGHT YEAR OLD MOZART IN CHELSEA, Neville Marriner, Academy of St Martin-in-the-Fields, Philips Sal 6500 367

I sometimes feel there is scant intelligence in the remark one should never listen to any Mozart with particularly low Kochel numbers. On the other hand, playing every Mozart and liking it in the same way is also indiscriminate. Erik Smith has taken some of the best movements from the so-called Chelsea notebooks and arranged them into Divertimenti. A piece has also been included that is not from the notebooks at all.

What can one say about this record except that arrangements are stylish, and intelligently done. None of the music is important but Mozart after all also wrote just to entertain.

To be quite frank, I find this a rather beautiful record and it almost goes without saying that the playing is equally fine. – J.A.A.

MOZART – Piano Concertos, no.19 K.459, no. 23 K.488. Brendel, Marriner, Academy of St. Martin-in-the-Fields. Philips Sal 6500 283.

Let us hope this disc is the start of a series that will ultimately comprise the whole cycle of the piano concertos. Brendel's renditions of six of the concertos have long been justifiably well known, but notable as those recordings were for their pianism, the orchestral support and engineering on these records left much to be desired.

Brendel and Marriner? The combination seems too good to be true. I must confess the results on this record are not quite what I would have expected, although to be quite objective about this I hasten to remember that neither Brendel nor Marriner have recorded either of these concertos before. On first hearing, I felt that Brendel's previous recordings were not so poised, and doubtless Marriner's collaboration enforces that feeling. I rather expected Marriner to sound more lush, or even at times as precious as his other Mozart can be. What we have in these performances is hardly the Mozart one often hears these days. These performances are certainly poised but by that I do not mean they are artificial in any way, rather there is a remarkable balance between sponaneity and calculation, always a seemingly unattainable ideal in any Mozart. I cannot hesitate to say that the playing here does come very close to that ideal.

Of the two concertos here, K.459 seems to impress me more, perhaps because so many other renditions unduly emphasize the "coronation" aspects performers usually imagine in this music. One can hardly help remarking the unusually fine orchestral playing: the opening tutti is brilliant but not overpowering and certainly precise.

While Marriner is suitably light-hearted, and melancholy accents are also made to seem not just in the foreground of this music (note those oboes). How preferable it is then to have a smaller orchestral ensemble for this music. From his entry on, Brendel sings, and just as important his rhythms are crisp and almost danceable. Speaking of singing, I have seldom been more forcibly reminded of the operatic qualities of these concertoes as here.

Brendel goes into the cadenza in the first movement naturally; one is simply not treated to virtuosity but a graceful flourish. The final trill here (and in K.488) is beautifully calculated and phrased. The tone of Brendel's playing begins not too loudly and builds up, but I was amazed how nothing ever seems to just happen in this performance, control is never lost sight of. Much the same things can be said of the K.488 here and I find myself once more pointing out the cadenza just because Brendel integrates the section so well with the rest.

Perhaps the most strikingly played section in this concerto is the second movement. Both Brendel and Marriner deliver a true opera scene of great beauty: I can almost hear some of the piano passages as vocal ornamentation, but note, not the least trace of show. A beautiful record.

The engineers have also done well – the piano, for once, does not sound swamped or too formidable. Justice must make me record some slight pitch changes in the second movement of K.459 and I do not think the musicians had anything to do with it. But the damage is slight and I can easily overlook it. – J.A.A.

MOZART – Symphony no. 25 in G minor, K.183 – Symphony no.29 in A major, K.201 – Marriner, Academy of St. Martin-in-the-Fields – ARGO ZRG 706.

Mozart's first two remarkable essays in symphonic form receive from the Academy typical performances, which is to say that one cannot help but remark immediately on the precise delivery and the splendid tone which seems to suit Mozart so well. Phrasing is always obviously well considered (note the excellent opening of K.201 always a difficult moment). Rhythms are energetic – nothing static here. At the same time nothing just pretty, but rather fiery playing without seeming overly romanticized.

In the G minor, the Academy is especially bent on pointing out the work's affinities with K.550, a valid veiwpoint since Mozart did have the earlier work in mind while composing the latter. The Minuets are particularly striking moments in these interpretations. One senses in the melancholy the evolution from dance to pure statement.

If you do want these symphonies (you should) I feel this record will do very well indeed. Recording is clear with good separation but there is some distortion from the horns in the tuttis, on my copy. – J.A.A.

G.F. HANDEL – Music for the Royal Fireworks – Water Music – Academy of the St. Martin-in-the-Fields, directed by Neville Marriner – Argo ZRG 697.

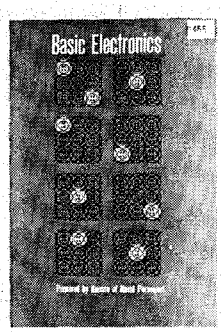
Well it's about time that someone has had the sense to put both the "Royal fireworks Music" and the "Water Music" onto a single disc. And it's about time that the Academy of St. Martin-in-the-fields recorded these two works, undoubtedly two of Handel's greatest compositions, for after hearing most of its other performances of Handel I was just waiting for the day. Did the record fulfil my expectations? Well, yes and no. As regards performance, the playing is simply first class (one should really to careful about being Marrinated) but interpretation is another matter – particularly with regard to the Fireworks Music.

Apparently Marriner takes the view that Handel recruited strings to build up the numbers for a particular performance of the Fireworks and also that he undoubtedly used strings for a later concert version (is this version supposed to be an improvement?). This might well be the case but it does not dispell the fact that it was primarily music to precede the fireworks display and used wind, brass and percussion. In any case Marriner has changed the original orchestration quite extensively so that now the strings are the central focus.

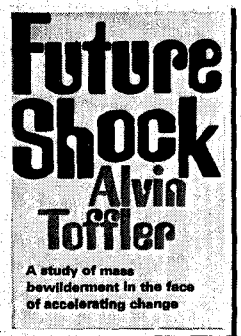
MAIL ORDER BOOKS

FOR BEGINNERS AND SPECIALISTS

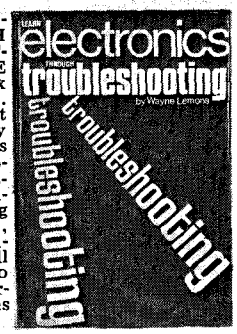
BASIC ELECTRONICS — PREPARED BY BUREAU OF NAVY PERSONNEL. 9½" x 6", 538 pp $4.55. This covers every important aspect of applied electronics using no more advanced material than principles of applied electricity and elementary maths. This course is as valuable to hobbyists as to beginning students of electronics.

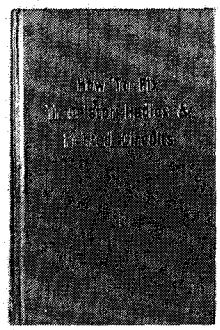


FUTURE SHOCK — ALVIN TOFFLER 8½" x 5½" $6.90. Future shock is the most startling survey on the present weakness of our society and its future yet written. It is about change and how we adapt to it. It is about the future and the shocks that its arrival brings.

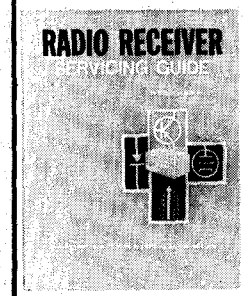


LEARN ELECTRONICS THROUGH TROUBLESHOOTING — WAYNE LEMONS. 8½" x 5½", 576 pp $12.75. In this excellent book, illustrated by many photographs and drawings, the subject matter is presented in terms of practical troubleshooting situations and simple, reproducible examples. These facts will be indispensable to the technician entering the electronics field.





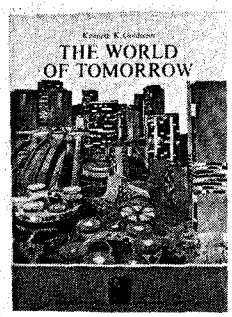
HOW TO FIX TRANSISTOR RADIOS & PRINTED CIRCUITS — LEONARD C. LANE. $6.15. Semiconductor Fundamentals, How Transistors Work, Basic Amplifiers, RF and IF Stages, Detectors, AGC, and Audio Amplifiers, Auto Radios, FM Radios, Facts, Tools, and Testing, Servicing Methods, Printed Circuits, Troubleshooting Charts.



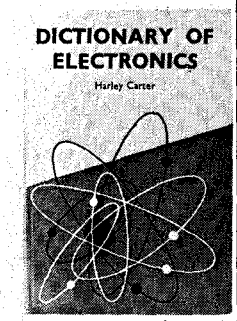
RADIO RECEIVER SERVICING GUIDE — ROBERT G. MIDDLETON 96 pages, $6.45. General Troubleshooting and Isolating Procedures, Troubleshooting in RF and Mixer Stages, Servicing Intermediate Frequency Amplifiers, Troubles in the Audio Section, Automatic Volume Control Troubles, Troubleshooting Power Supplies, Restoring Antique Radio Receivers.

104 ONE TRANSISTOR PROJECTS — 192 Pages. $4.95. Circuits are offered to the student who wants to set up and test typical circuits for his own instruction. For the designer who wants ready made building blocks and for the hobbyist whose amateur interests will be served by pre-designed pre-tested circuits.

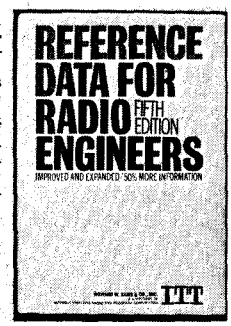
THE WORLD OF TOMORROW — K. GOLDSTEIN. 10" x 7½", 128 p.p. Well illustrated in colour, $3.95. Board a Time Machine and travel a century into the future. Explore the oceans and outer space. Imagine creating and living in tomorrow's world! An excellent gift book for budding young scientists and engineers.

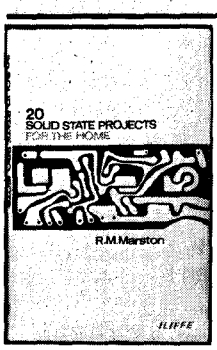


DICTIONARY OF ELECTRONICS — HARLEY CARTER. 410 pages, many illustrations. $5.95. Contains concise but explanatory definitions from many branches of Electronics, including radio, television, communication, radar, electronics instrumentation and industrial electronics,. Essential information for engineers, students, technicians and apprentices.

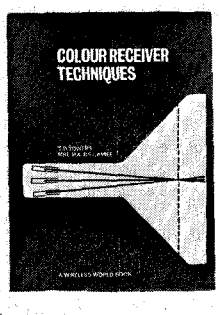


REFERENCE DATA FOR RADIO ENGINEERS — Fifth Edition. $25.00. More than 100 engineers have helped create this edition which contains the wealth of data needed in electrical and electronic engineering. Written by professionals for professionals.

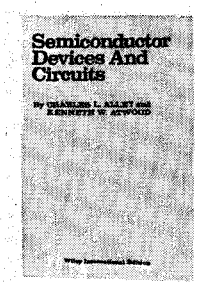




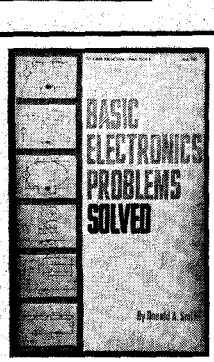
20 SOLID STATE PROJECTS FOR THE HOME — R.M. MARSTON. 96 pp. $5.50. Well detailed with clear and concise circuit description. Projects include automatic light, two station intercomm., lamp dimmer, baby alarm, electronic battery, electronic timer, model train controller.



COLOUR RECEIVER TECHNIQUES — T. D. TOWERS $6.50. Students and especially bench engineers will find this book of great value in understanding and servicing colour T.V. Receivers. Book is simple and clear with minimal use of maths and a logical "painless" guide on the PAL System.



SEMICONDUCTOR DEVICES AND CIRCUITS — ALLEY AND ATWOOD. 490 pages. $8.50. Semiconductors, Junction Diodes, Junction Transistors, Common-Emitter Amplifiers, Device with High Input Impedance, RC-Coupled Amplifiers, Transformer-Coupled Amplifiers, Small-Signal Tuned Amplifiers, Direct-Coupled Amplifiers, Multistage Amplifiers, Power Amplifiers, etc.



BASIC ELECTRONICS PROBLEMS SOLVED — 190 pages. $6.15. Known as a "cheat book". Helps clarify basics encountered in any electronics course. Particularly for those without extensive maths background. Explains how to get the job done in logical simple steps, with rules, aids and directions.

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ET9

CLASSICAL

Whether you prefer your Fireworks Music this way depends, of course, on taste. Personally I prefer the original orchestration with all those antiphonal batteries of fiery trumpets and horns, and the rows of percussion (for this type of performance listen to Piallard: Erato, W.R.C.). Sometimes the current performance seems a little too precious, a little too lush, particularly when the strings alone are playing. But enough of this. Let me now speak of performance.

The Acedemy's playing is exactly what one would expect from this orchestra – very rhythmic, beautifully phrased (perhaps sometimes a little too overphrased for Handel) cleanly articulated, incredibly precise and radiantly warm. Some very fine trumpet playing here – listen to how it soars with apparent ease in the Fireworks Music eg. the small cadential cadenza of slow sections (rather unusual for trumpet). Mention should also be made of Colin Tilney's imaginative harpsichord playing with his funfilled interplay of themes. The harpsichord used (Goble) sounds on the whole rather subdued (although is sounds well balanced in the Air of the F major – Water Music suite) – perhaps it could be brought into the fore very slightly.

Ornamentation is plentiful and generally tasteful (even though it seems rather carefully premeditated). Some of the quavers have been dotted effectively and this could perhaps be even more developed in say the last movement of the Royal Fireworks Music. The double dotting at the opening of the Fireworks music is interesting but not all that convincing. Some of the cadential elaborations at the end of slow movements (in Water Music) are simply gorgeous.

Very clear and well spread sound. If one listens hard the sound of someone saying "right" may be heard at the beginning of the Air of the F major Water Music Surto.

Superb musicianship and probably the finest recording of the Water Music available. – C.M.W.

BARTOK – Mikrokosmos (Excerpts). Contrasts for Violin, Clarinet and Piano. CBS SBR 235389 (distributed in Australia by Avan-Guard Music) Rechannele stereo. Bela Bartock, piano; Joseph Szigeti, violin; Benny Goodman, clarinet.

It is always pleasurable to hear Bartok and Szigeti playing Bartok's music, even when they are somewhat muffled by indifferent recording quality. Goodman again demonstrates his fine feeling both for the clarinet and for the music he is interpreting.

Contrasts was commissioned by Goodman and Szigeti. It was written, and this recording made, in 1940. In mamy ways it is a minor work, but it is a very pleasing one, employing many of the devices of the String Quartets (and one of two of the actual phrases) whilst lacking most of the harrowing intensity of those major achievments. One is tempted to wish during Goodman's superb playing of the first movement cadenza, that all his jazz solos were written for him by a master.

The Mikrokosmos was written as a series of exercises in piano technique and musical conception. The selection here ranges from No 94, to No 153 which was the last in the series. They make pleasant listening in their own right. If the recordings, on which one can hear Bartok play, were superior in quality one would have a clearer indication of the dynamics of his conception. As far as one can gather, though, it would seem that many pianists play his music more dramatically, more percussively and less fluently than he intended it to be played.

It goes without saying that this record is a collector's item. – J.C.

ANTON BRUCKNER – MASS IN E MINOR (1882) – Gachinger Kantorei; Figuralcher der Gedachtniskuche; Stuttgart Spandauer Kantorei; Wind instruments of the Stuttgart Bach Collegium. Conducted by Helmuth Rilling. Three Centuries of Musick (Dryz) 3C 320.

Of Bruckner's three masses the second is perhaps the most striking – both in its orchestration and overall conception. Scored for 8 part chorus (without soli), and woodwind and brass, it is strongly reminiscent of the great era of Palestrina and his contempories (with the use of strict polyphonic structure) but it is no less Brucknerian in its choralicism and expressiveness. This unusual combination gives the work quite a distinct character. The mass is undoubtedly conceived in "a capella" style; the wind instruments being used only incidentally, although they do reveal their full glory in some of the sweeping crescendos or when leading up to climaxes by the use of sustained chords – most effective.

The work has here been given a well deserved rendering. Indeed one may find it quite difficult to find fault with. What strikes one most on first hearing is a warm, and even sensous, radiance together with a lovely sense of spaciousness. The three choirs used here have the bulk of the work and they sing with refinement and conviction leaving quite an impression.

Mush is to be commended in this performance in the care taken over fine details. For instance many of the modulations are prepared for with a very slight pause – the pause that seems "just right," and this gives the work quite a steady sense of progression. Likewise, mood changes (there are many) are presented with similiar assurance (the opening mysticism of the Ryrie) and are poised quite beautifully, capturing one's attention immediately. Balance is generally good (perhaps the bass line could be slightly reinforced in places) and the interweaving of thematic material is clear. One can often become quite awed by some of the dynamics – build ups, especially when reinforced by the brass, can be quite exciting, though they never seem forced. The performance seems to have been recorded in a large church with the result of often achieving a quite warm ethereal quality so suited to Bruckner.

A beautiful disc. – C.M.W.

RECORDINGS... JAZZ

REVIEWER: John Clare.

ERROL GARNER – The Piano Magic Of Erroll Garner. CBS 52065. Full Moon And Empty Arms, The Way Back Blues, Old Man River, Girl Of My Dreams' But Not For Me, Passing Through, Time On My Hands, Alexander's Ragtime Band etc.

Although I can become as enthusiastic as anyone else, in the right mood, about the seemingly unlimited possibilities of sound and image which modern technology has made available, it also occurs to me that with ease of access to a multitude of effects a certain element of 'art' can just as easily be forgotten: that of evoking images and emotions with a finite range of materials. Appreciation of this art is just as important as part of our total satisfaction as the final mind blowing impact of all the sounds and colours that are hurled at us.

I can remember going to an underground concert (remember them?) and being swamped by films and slides and massively amplified sounds; moving from fascination to excitement to ultimate boredom. So what! I thought, as I stumbled out into the night. Then on the footpath I heard a kid getting such a distinctive and joyous feeling from a cheap toy flute, which didn't even have a complete scale. Now that's art, I thought.

Of course this is not meant to be any all inclusive theory. It sure falls apart when I listen to what Miles Davis is doing with electric sounds, but I think it's as well not to forget such things as the art of getting a distinctive 'sound' from a traditional instrument such as the piano. This is all the more an art for being an illusion. A piano key can only be depressed one way; straight down. No man can do more than hit it harder or softer than another, but through choice of notes and harmonies, through variety of attack, some artists are able to make the piano sound, or seem to sound, completely different. Thelonius Monk is one, Duke Ellington is another and Cecil Taylor yet another. Count Basie seems, oddly enough, to make the piano 'sound' different when he is playing single notes rather than chords.

Errol Garner must also be counted among the great piano magicians, so that in a sense the trite title of this album is an apt one. Garner is instantly recognisable (even before you hear him grunting to himself – and, man, he's got a different grunt to Oscar Peterson) for his sound as well as his distinctive rhythmic feel. His richly orchestral and buoyantly swinging style has been likened to a vast syncopated music making machine. When he plays rattling cascades way behind the beat with his right hand against relentlessly tromping chords in the left, it's rather like a machine with eccentric spindles which gives the impression that it's about to fly apart.

If he really exerts himself, the effect is hair-raising. When he doesn't try too hard, he can sound dangerously like a cocktail pianist using a lot of rubato.

On this record he's about half way between the two. It's no Concert By The Sea – which has also been re-released, though we've yet to get a review copy – but it's good average Garner, with one stand out: The Way Back Blues. Here, big chiming chorded figures in both hands and beautifully controlled trills contribute to a memorable blues with all the classic ingredients – plus the distinctive Garner sonorities. – J.C.

This Is Artie Shaw. RCA Stereo VPM-6039. Two record set includes such original performances as Frenesi, Moonglow, Begin The Beguine, Indian Love Call, Any Old Time, Back Bay Shuffle, It Had To Be You, Donkey Serenade, Summit Ridge Drive, Star Dust, Don't Take Your Love From Me, Deep Purple, Smoke Gets In Your Eyes.

Of the generally excellent double albums of famous swing bands which RCA has released lately, this is the most disappointing from a jazz point of view.

Shaw's was often one of the most overtly commercial of the big name swing bands, but there were times when it could get a deeper jazz feeling than most. There were times when its personnel included some of the very great jazz men, both white and black.

Shaw's best clarinet work was reserved for occasional informal sessions, which were rarely recorded. He once bowled some of Australia's best modern jazzmen over by sitting in at Sydney's EL Rocco and wailing for chorus after chorus of "How High The Moon" without ever repeating himself.

In most of his recorded work, Shaw is intriguingly ingenious, but rather slick and almost off hand. Nevertheless, his sound is a delight in itself: clear and flutelike, but sharp and woody in timbre. I would think that he exerted some influence on players like Buddy De Franco and Jimmy Hamilton, perhaps even Tony Scott.

Absent from this collection are the recordings Shaw made with people like Roy Eldridge, Leo Watson and Hot Lips Page. Absent too are those with drummers George Wettling and Dave Tough.

The set is a pretty good representation of the popular Artie Shaw and as such is of considerable interest. For those less inclined to nostalgia there are a few valuable items.

The best thing here is "Any Old Time" which has Billy Holiday at her most rhythmic and precise. Her accuracy, easy but fervent swing and unforced emotional projection is in marked contrast to the cloying, and sometimes technically shaky, singing of Hellen Forest, who is almost the archetypal commercial swing singer.

Also of great interest is "Don't Take Your Love From Me," which has Henry Red Allen on trumpet and a vocal by an almost unrecognizable Lena Horne.

On "Stardust," Billy Butterfield gives Harry James an object lesson in how to play unabashedly sweet trumpet without making the listener's toenails curl.

Out and out Artie Shaw fans should be happy. Jazz fanatics will be a bit disappointed. – J.C.

BIX BEIDERBECKE – The Bix Beiderbecke Story Vol 2: Bix and Tram. CBS 6237 Miff Mole, trombone; Jimmy Dorsey, clarinette; Frank Trumbauer, C. Melody sax; Eddy Lang, guitar; Joe Venuti, violin; Pee Wee Russell, clarinet; Adrian Rollini, bass sax; etc. Singin' The Blues, I'm Comin' Virginia, Clarinet Marmalade, Way Down Yonder In New Orleans, For No Reason At All In C etc.

Bix Beiderbecke is probably one of the least heard of the great jazz musicians, despite the fact that his short, tragic and pretty alcoholic life (he died of pneumonia in 1931 at the age of 28) makes him something of a popular archetype. The explanation is that everything he ever recorded, as far as I know, is on the three volumes of The Bix Beiderbecke Story, which Avanguard have just re-released, and on many of these tracks he either does not solo at all, or his solos are extremely brief.

As understatement is such an important element of Bix's approach, it is not surprising that many listeners hearing one of his brief excursions for the first time wonder what all the fuss is avout. That element of understatement also explains why true Bix buffs treasure every note as a rare and subtle gem.

Bix worked within a relatively small dynamic range when compared to a trumpet or cornet player like Louis Armstrong. Where Armstrong's climaxes were soaring physical and emotional outpourings, Bix's were more like a series of sudden sharp strokes form a silver hammer.

Bix's basic sound was rather small, perfectly modulated and with very few brassy overtones. Very small variations in tone were sufficient to create extremely poignant effects. A sudden increase in volume was enough to stir a quick and

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JAZZ

unforgetable excitement. Many modern trumpet players who have mastered some of Bix's unhurried deftness and understated lyricism – the influence was probably strongest on the West Coast school of the Fifties – seem to have overlooked this sudden cut of emotion.

This volume covers Bix's association with musicians such as Frank Trumbauer (Tram), Joe Venuti, Effie Lang and Jimmy Dorsey, before joining the Paul Whitemen Orchestra (Vol 3). It contains Venuti, Eddie Lang and Jimmy Dorsey, before joining the Paul Whitemen Orchestra (Vol 3). It contains (it's my opinion that Jazz Me Blues from Vol 1 should be ranked with these).

All the elements of Bix's style are perfectly displayed in his solo on Singin' The Blues. Take note of the way he runs lazily down hill in his two bar unaccompanied break, then produces a ripping note between the first and second beat of the next bar which starts a stiffened strutting rhythmic emphasis.

It's often been said that Bix played with inferior musicians, but everyone plays on these tracks with a beautiful relaxed feeling though none is as inspired as Bix. Anyone who has read the beautiful references to Bix, Tram, Venuti and Lang in Malcolm Lowry's 'Under The Volcano' will want to enter this magic little world themselves. Here's your chance. – J.C.

BILL EVANS – The Bill Evans Trio Live. Verve 2304 057. Chuck Israels, bass; Larry Bunker, drums; Bill Evans, piano. Nardis, Someday My Prince Will Come, Stella By Starlight, How My Heart Sings, 'Round Midnight, What Kind Of Fool Am I?, The Boy Next Door, How Deep Is The Ocean?

Bill evans's musicianship and inventiveness have never been in dispute, but many find his approach too cerebral and restrained. Dudley Moore has in fact gone on record as saying that Evans is "playing death." Although I generally lean towards the hard, "black" feeling in jazz, I've always been strongly pro Evans. I find his fluid lyricism and light buoyant rythmic feeling much more satisfying than the funky cliches of many of the superficially more jazzy pianists.

Evans has also shown himself to be in tune with the thinking of many of the musicians who have at one time or another in their careers been considered avant-garde. He has recorded successfully with Miles Davis, John Coltrane, Eric Dolphy and Ornette Coleman – circumstances in which many another reputable pianist would be ineffectual, if not absolutely lost.

That said, this album, recorded in 1964 at the Trident in Sausalito, California, is a good but not outstanding example of Evans's work. Basically it just lacks the crispness which distinguishes his best playing, though the recorded piano sound may have something to do with that. Nor is the sound bad for a live recording; it just lacks edge.

Many of the tunes are played in three four, and Bill doesn't get a real chance to develop the breathless momentum he can achieve at up tempo. One of his specialties is to mount phrase on immaculate phrase and then, with a sudden glassy glitter of grace notes in the treble, create the impression that the notes have momentarily begun to trip over themselves. This only happens during the eight bar exchanges at the end of Someday My Prince Will Come.

Still, Evans never fails to develop a solo logically and with unfailing poise and beauty. Certainly it's an album well worth acquiring. – J.C.

CHAMPION JACK DUPREE – When You Feel The Feeling You Was Feeling. CBS SBP 233969. See My Milk Cow, Mr Dupree Blues, Yellow Pocohontas, Gutbucket Blues, Street Walking Woman, Income Tax, Roll On, I've Been Mistreated, A Racehorse Called Mae, My Home's In Hell.

Jack Dupree must be about 63 by now. He often refers to himself as the last of the barrelhouse piano players, but his blues singing is generally considered to be more important than his piano playing, which is solid and effective in accompaniment, but too limited to maintain interest on its own.

Judged on one or two of his very best records, Dupree might just make it as one of the great blues singers, but much of his recorded work is only of average quality. He has a fine, rich voice, but only occasionally does he project it with riveting force. His phrasing is fairly straight forward so that when he coasts, as he often does, one is left with a good strong voice, some routine blues piano and a certain rogueish humour. One or two tracks are enough.

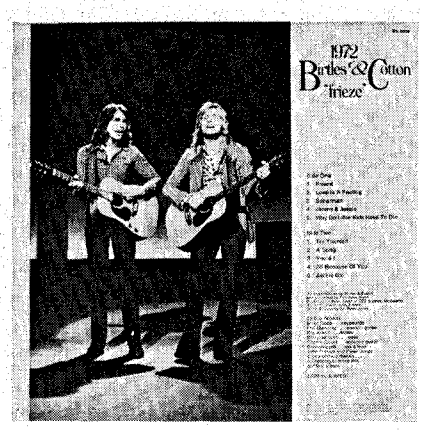
On this record he doesn't really take off, but he gets a pretty solid boogie-blues groove going, particularly on Gutbucket Blues and Street Walking Woman. He also talks quite a bit, revealing himself as a rather engaging old blatherskite.

On side one he plays some atrocious drums, and is joined by Christopher Turner on harmonica. Side two has Duster Bennett on harmonica, plus the full rhythm complement of guitar bass and drums. All in all it's quite a good record.

The nickname Champion came form the days when Jack fought in the prize ring. I imagine he was a good honest pug, who on a good day could give anyone a rough time. There must be something phlegmatic in his nature which keeps his best so often in reserve – like the sea captain in Conrad's 'Typhoon'. – J.C.

RECORDINGS... POP TRENDS

REVIEWER:
Michael Delaney.



"1972 B.C." – Darryl Cotton & Beeb Birtles. Kinney. Stereo. WS. 20006. – Friend – Love Is AFeeling – Superman – Jimmy & Jessie – Why Do Little Kids Have To Die – Try Yourself – A Song – You & I – All Because Of You – Jackie Girl.

It's a shame that Frieze had to split because they made a lot of people happy. The music wasn't anything out of the bag but – at least – they knew how to use it to entertain their audience. And that's the main objective if you like to see everybody smiling and having fun. And pop is basically concerned with having fun despite how fashionable it's become to put it down as trivia.

Darryl and Beeb were good because they didn't pretend to take themselves seriously as musicians. They had fun by playing up the star bit – the super personality routine. And it worked. It worked very well until they got tired and the whole thing turned into a drag. And then Frieze went sour wasting a good deal of energy on bustling around promoting clothes in your local department store. It was a real shame because they had so much potential – a talent that should've been spent consolidating the ground covered by Zoot with songs like "Eleanor Rigby". It's even a greater shame because the longer Frieze kept hanging around waiting for their contracts to expire the less magical they became. And the one thing you've got to have in pop is magic. Frieze lost out.

"1972 B.C." is a lovely record. The songs are simple and well-constructed: most of them good and some even gems. It's not very distinctive as far as a style goes but then it doesn't really need to be because it's so pleasant. And pleasant music is the type that sells if you've been aiming at the same market as Frieze. Boob's "Friend" and "Why Do Little Kids Have To Die" – the first solo single from Darryl – are the two best tracks because they're the most poignant. Surprisingly enough not one of the songs is terribly cute: they're too sophisticated and sometimes too emotional i.e. "You & I". The album is a predominantly acoustic job with a strong Graham Nash/Hollies influence running right the way through: "All Because Of You" and "Try Yourself" being the most obvious. And – if nothing else – it's a fine first take for both artists as individual songwriters. But they had to go and split and spoil it all. Production is crumby. – M.D.

"STEPHEN STILLS – MANASSAS" – Stephen Stills & Manassas. Kinney. Stereo. SD. 2-903. – Side One: The Raven – Side Two: The Wilderness – Side Three: Consider – Side Four: Rock & Roll Is Here To Stay.

Stills never really enjoyed working as a soloist because he couldn't achieve the rapport needed between his material and the session musicians. The chief fault was in the rarefied atmosphere: his first two albums lacked feeling; the songs just weren't relaxed enough to hang loose and sting the way they would've done with Buffalo Springfield and – to a lesser extent – Crosby, Stills, Nash & Young. And then there was this nagging elitist attitude in the music that made you doubt whether he'd even spared one thought for his audience. Songs like "Love The One You're With" and "Change Partners" ended up so technically excellent that all their fire had been sapped in the process. It was quite ironical: the harder he worked for studio quality the less immediate and impactful was the result. His music had become a little too remote and there wasn't anything that excited or made you sweat. Stills seemed to be directing all his energy towards sound reproduction without caring that much about its emotional values.

"Stephen Stills – Manassas" is the best thing he's done so far simply because he's realized the need for a good band. And Manassas is a real dynamo. Stills has always been a musician and nothing else and that's where the group comes in. He's never been able to cope with the 'star' syndrome and probably never will. And Manassas gives him the security of knowing that within the band format he's just another guitarist/songwriter/singer along with the rest: not the fulcrum and not the focal point. Stills is the kind of person who really must feel secure. And if he doesn't then the whole musical outlook starts to fall out of perspective a la the two solo jobs where he surrounded himself with 'super-star' friends just to feel a bit more comfortable. So the music suffers.

Manassas have the insight to make Stills fully aware of his own capabilities. They put the spunk back into his songs and bust them wide open spilling out most of the soul missing from things like "Marianne" and "Sit Yourself Down". They're red hot and funky and spontaneous and sometimes bitter-sweet like real homely romance. They give Stills the solid foundation he's been searching for on which to design and build and juxtapose ideas. It all gets together so well: Manassas elaborate the theme and Stills embroiders it even further with help from Chris Hillman former Byrd and Flying Burrito Brother.

It'd be pointless to start describing their music in detail because the range takes in so many different forms and influences – so many in fact that the packaging has been developed into four separate suites all of which incorporate varying styles from blues clear through to acoustic folk. The pick of the bunch would probably be "The Wilderness" – a six track country piece taking in Bluegrass and Hillbilly as well as the more conventional Nashville stylings. It's here that Hillman shows himself to be an equal to Stills due to his remarkably fluent mandolin/guitar leads which almost overshadow the entire band. This is really quite a superb double-set. It's so good to hear that Stills has found his element again. – M.D.

"SOMETHING/ANYTHING?" – Todd Rundgren. Kinney. Stereo. 2BX. 2066. – Including: I Saw The Light – It Wouldn't Have Made Any Difference – The Night The Carousel Burned Down – Hello It's Me – Marlene – Dust In The Wind – You Left Me Sore – Wolfman Jack – Song Of The Viking – Black Maria – Couldn't I Just Tell You – Torch Song.

Rundgren wants to sell records and excite little girls and make those too old to scream wish to God that they could. His biggest problem in view of this is trying to get everybody to acknowledge that he's a star – that he has always been a star. Most likely he'll succeed on the strength of his ego simply because you don't rule the roost in pop by being humble. And that's the clincher. Rundgren understands his medium to the point where he can see both sides of the fence as musician and idol justifying each on its comparative merits. So – for the time being – he's gone very big on image in an attempt to meet the kids half-way mainly so he can concentrate more on the music without having to prove anything to anybody. And that's the way Rundgren wants it because he intends to be a full on rock 'n' roll Messiah.

"Something/Anything?" is quite probably the one that's going to make it for

POP TRENDS

Rundgren. And – as in the past – it just does more to show that what ego wants ego eventually gets. He formed Nazz because he wanted to have fun like in Beatlemania post "A Hard Day's Night" and it only took two albums full of his songs for everybody to realize that they were one of the few potentially great American pop bands never to have made it. He then went into production supervising discs for folk like Ian & Sylvia and the Band and Badfinger and Gordon Lightfoot as well as his own personal outlet in the form of Runt – a funkier Rundgren with hits like "We Gotta Get You A Woman" to his credit.

All this reflects heavily through-out his latest double set – the first of his three solo albums to be released in Australia. Rundgren handled everything from the backings right the way on to the production. And it's good – real good. The only drawback about the whole thing is possibly his self-indulgence. Rundgren is very much prone to letting his own sense of worth run haywire as in cuts like "Sounds Of The Studio" – a bit of stoned prattle that doesn't do much outside taking up space. But apart from this he seems to keep it all together even though he does sometimes strive consciously for musical effect – the sum total of which just goes to confuse his own direction.

Perhaps the most difficult thing to accept with Rundgren is his lack of immediate originality. He mades his mark not so much from his own style but by condensing his influences and siphoning them out when it seems most appropriate: "Song Of The Viking" is Beach Boys; "Black Maria" is David Crosby circa "Almost Cut My Hair"; "Couldn't I Just Tell You" is Beatles post "I Feel Fine"; "Wolfman Jack" is every uptempo Stevie Wonder/Marvelettes track issued since "I Was Made To Love Her"; "Torch Song" is unmistakeably Graham Nash along the lines of "Simple Man"; "I Saw The Light" is George Harrison complete with cascading guitar technique. But this doesn't matter much in the long run because they're only superficial mannerisms and Rundgren's talent goes a whole lot further than that. They're just used to make you realize that little Todd is your veritable whiz-kid once it comes to getting the low down.

The most important aspect about "Something/Anything?" is the way Rundgren can get around his limited range. And in this you can find both the highlight and – at times – most obvious flaw: his music is essentially slight by nature and this doesn't leave room for too much hard rocking – a thing that Rundgren does often mostly to his benefit. But there are occasions when he oversteps the point like with "Some Folks Is Even Whiter Than Me" and "I Went To The Mirror" – both of which bomb out completely due to the lack in guts. And guts is the message if it's a question hinged on rock 'n' roll.

When he sticks to writing shamelessly commercial nonsense like "Dust In The Wind" or "Hello It's Me" he comes pretty close to rivalling McCartney – otherwise he just sounds mediocre i.e. "Little Red Lights" despite the good riff. Fortunately, though, he knows what he can do the best. And it's all to do with sounding cute – something that he lays on thick and fast and furious; sparing no-one. That's probably why this double set has so much impact purely because there's still nothing about to beat good pop. And Rundgren writes some of the best stuff you're going to hear: "Marlene" and "You Left Me Sore" being the pick. Production is a bit thin in places. – M.D. ●

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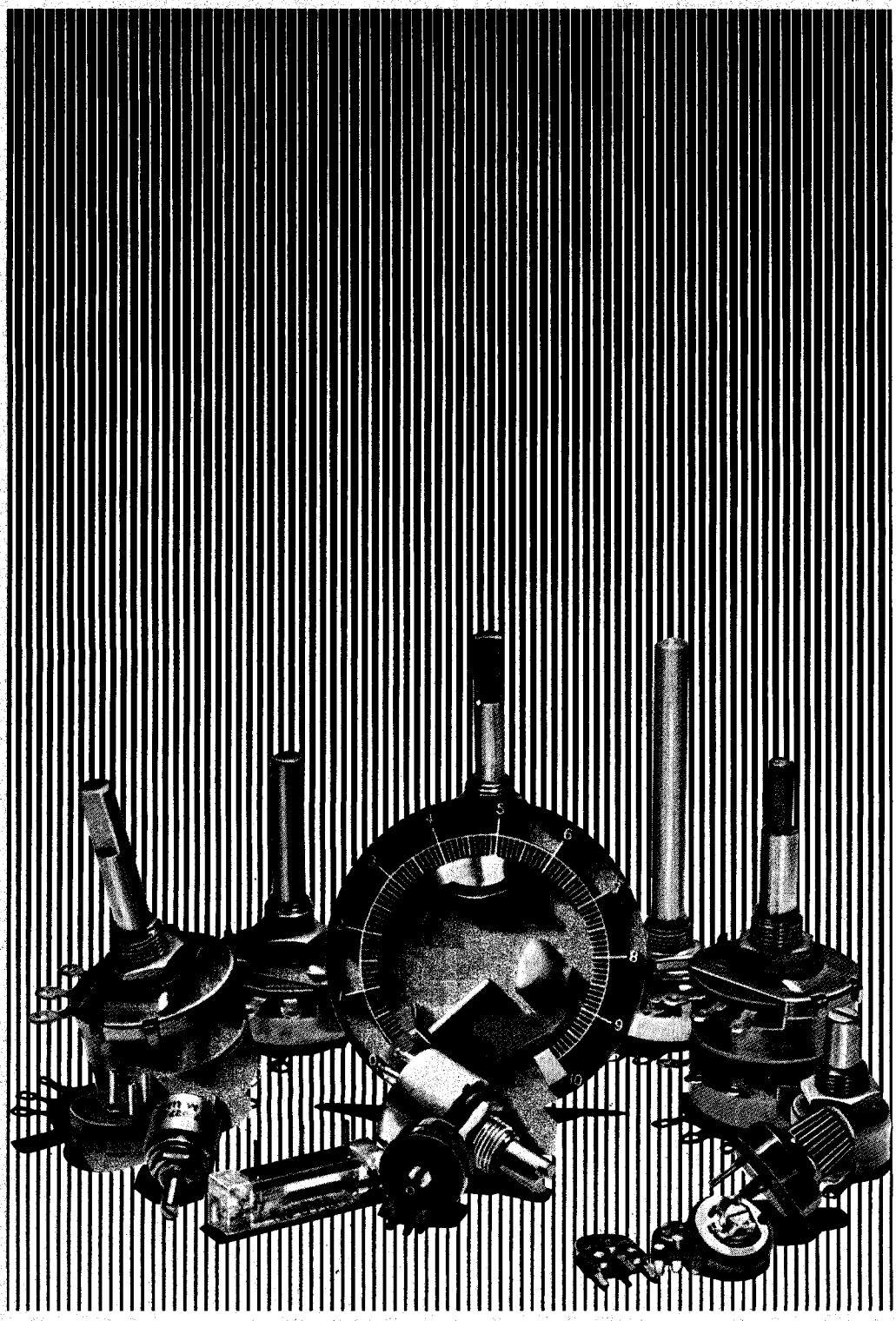

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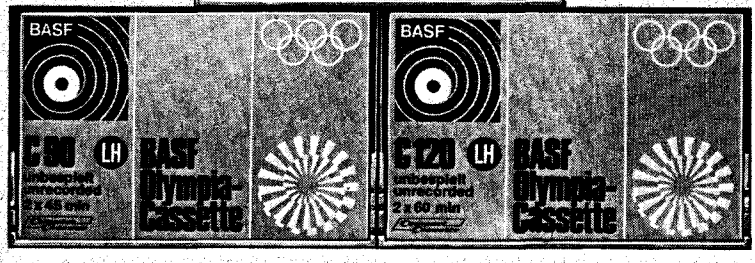

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BOOK REVIEWS

REVIEWER: Brian Chapman

FEED BACK AMPLIFIERS AND OSCILLATORS by Robert E. Sentz and Robert A. Bartkowiak. Published by Holt, Rinehart and Winston Inc. New York 1968. 218 pages 9" x 6", soft covers. Review copy supplied by Holt, Rinehart and Winston Inc. Australian price $4.40.

This text is one of a dozen titles in the publishers Electronics Technology Series which are specifically designed for use as standard texts in conjunction with courses taken at technical colleges and institutes.

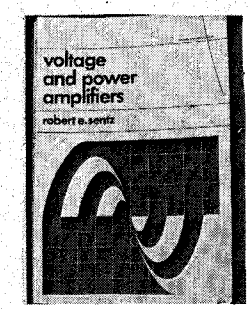
The treatment of the subject is thorough, but the mathematics is kept down to a level appropriate to technical colleges, that is, simple algebraic equations with some complex algebra and no calculus. The book does however assume a prior knowledge of dc and ac circuits, network theorems and basic transistor and valve devices.

The opening section examines fundamental types of feedback and methods of analysis, and this is followed by a section on single stage amplifiers with feedback, and another treating stability, phase shift and frequency response.

The next five sections treat oscillators in considerable detail, beginning with the simple oscillatory circuit and then separately treating crystal, negative resistance, RC phase shift, VHF and microwave oscillators.

The text is clearly written, well illustrated and as well as providing textual examples, poses questions at the end of each chapter, gives a number of problems and a list of references.

In all the format of the book is ideal for classroom use. Excellent value. – B.C.



VOLTAGE AND POWER AMPLIFIERS by Robert E. Sentz. Published by Holt, Rinehart and Winston Inc. New York 1968. 282 pages 9" x 6", soft covers. Review copy supplied by Holt, Rinehart and Winston Inc. Australian price $4.40.

This book is a companion volume to that reviewed above and is by the same author. Hence most of the remarks regarding presentation, format and clarity of that volume, also apply to this.

After an introduction to voltage and power amplifiers, the A,B,AB classification system and methods of coupling, the book deals with the effects of interstage coupling on gain and bandwidth and then discusses factors affecting the input impedance of an amplifier.

The effects on frequency response of incomplete bypassing are followed by sections on the gain – bandwidth product pulse response of wide band amplifiers and frequency compensation techniques.

The remainder of the sections deal with specific forms of amplifier in detail. Again each chapter is followed by an adequate number of questions and problems which are vitally necessary to the student.

A 40 page appendix provides transistor and valve data for use in conjunction with the text.

Again excellent value for money. – B.C.

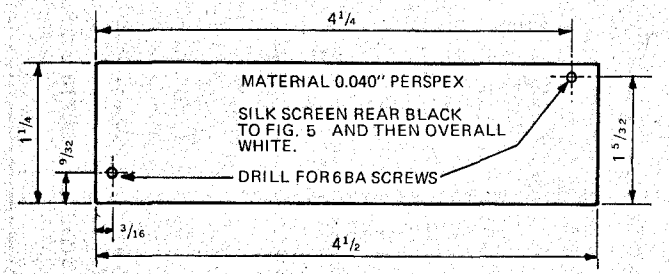


Fig. 3a. Bottom dial glass (silk screened on rear).

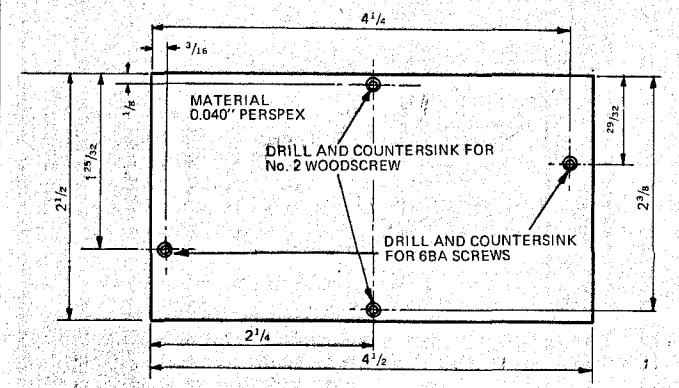
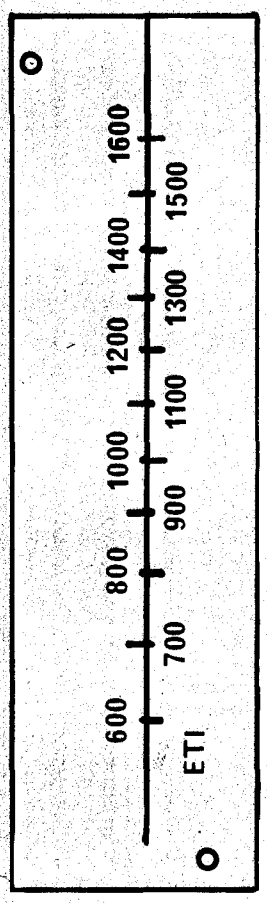


Fig. 3b. Top dial glass panel.



INTEGRATED AUDIO SYSTEM-ETI 425

(Continued from page 71)

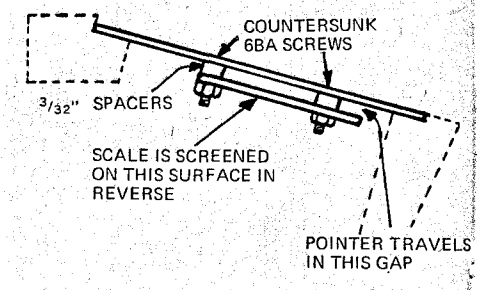


Fig. 4. Dial glass assembly.

Fig. 5. Dial markings (full size).

PARTS LIST

1 dial pulley 58mm diam	John Carr type TE – 1401/1 No 4 or similar
5 pulleys	nylon ¼" diam.
1 dial cord drive spindle	
1 dial scale	as per Fig. 3a and 3b.
1 tuner chassis	as per Fig. 1.
1 tuning spindle support panel	as per Fig. 2.

dial cord, tensioning spring, screws, brass tubing and spacers etc.

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TRANSDUCERS IN MEASUREMENT AND CONTROL

(Continued from page 81)

without the need for slaughtering. Similar instruments are used in medical diagnosis for they give different information to the X-ray picture which yields a contrast proportionate to absorption rather than distance information. Although the end result of scanning is a cartesian picture construction, the physical conversion is formed by using a combination of lengths and angles.

It has taken many parts of this series to cover dimensional measurements for these are the most commonly and widespread transduction. In Part 6 we shall discuss how to measure temperature and other parameters concerned with heat. ●

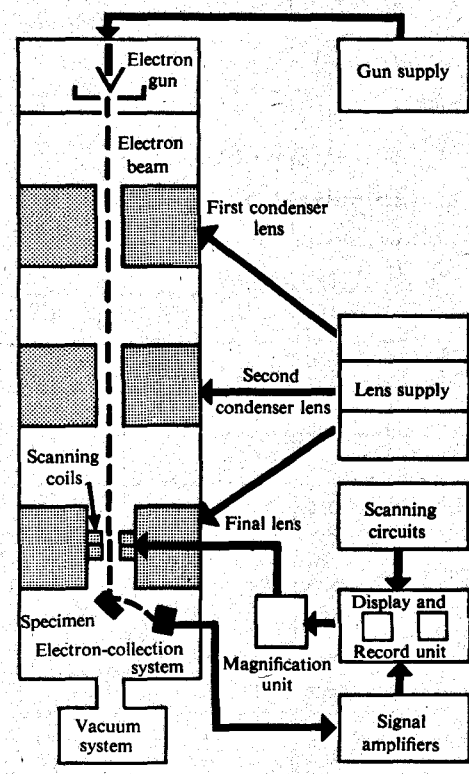
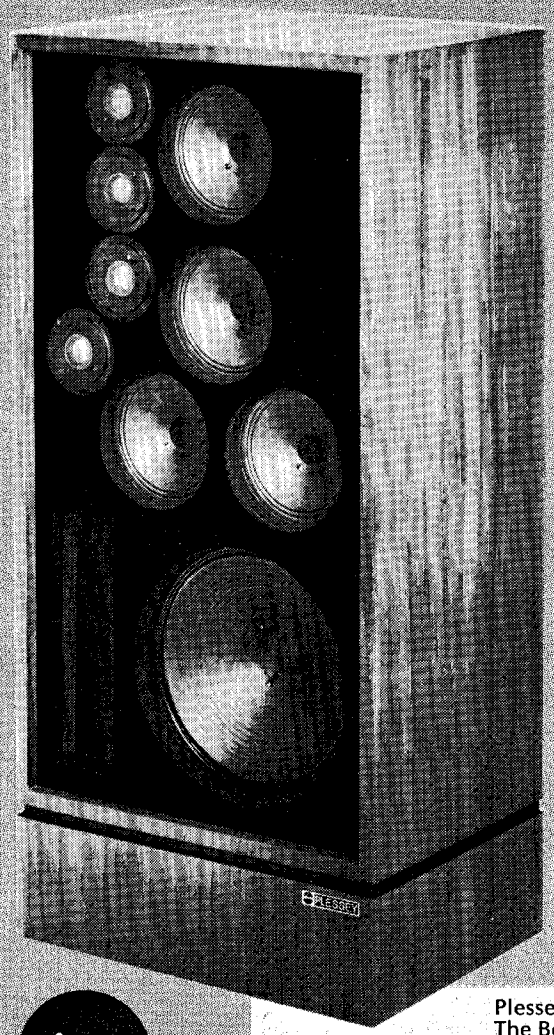


Fig. 14. Block diagram of Cambridge stereoscan electron microscope.

Lend us your ears!



There are times when words and pictures are not enough. That's why we ask for your ears. Take them to your Hi Fi dealer and use them to judge the quality and performance of the new Plessey Sigma multi-speaker system. It is a bass reflex enclosure handling 50 watts RMS with a 12" woofer, four 6" mid-range speakers and four dome tweeters. You must hear it to appreciate its superb performance.

The Sigma is the biggest of the Plessey Corinth series of Hi Fi speaker enclosures which include 2, 3 and 4 speaker systems in various sizes and power handling capacities. They are all designed as elegant furniture with pure wool grille cloths in plain or coloured styles.

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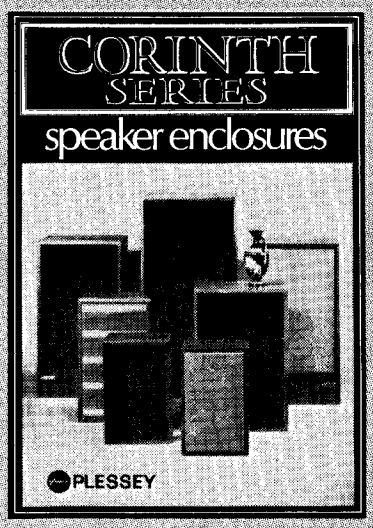

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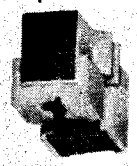

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Tracking Force: .7 gram
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Compliance: 35 x 10^{-6} cms / dyne
Elliptical Stylus Tip: Contact radius: .0003"; lateral radius: .0007"
IM Distortion: Less than ½"% — 400 & 4000 Hz at 14.3 cms / sec. recorded velocity
Vertical Tracking Angle: 15 degrees
Recommended Load Impedance: 47000 ohms nominal

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ADC 220XE. Type: Induced Magnet; **Output:** 6 mV at 5.5 cms / sec. recorded velocity; **Tracking Force:** 1 to 2½ grams; **Frequency Response:** 10 Hz to 18 kHz ± 3 dB; **Channel Separation:** 20 dB from 50 Hz to 10kHz; **Compliance:** 20 x 10^{-6} cms / dyne; **Elliptical Stylus Tip Radii:** Contact radius .0003". Lateral radius .0007"; **Vertical Tracking Angle:** 15°

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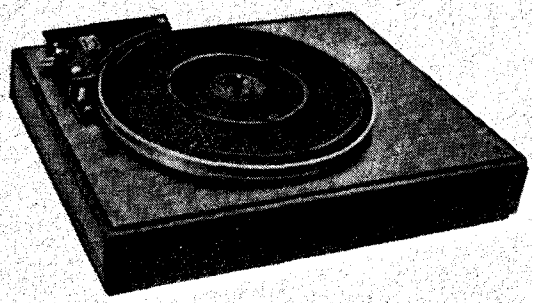

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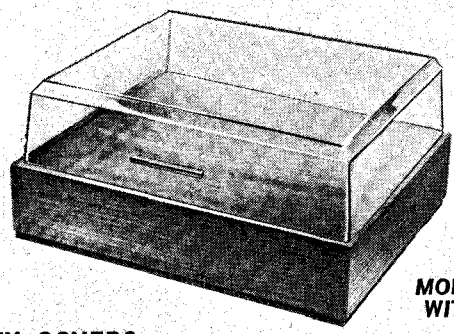
INSTROL PLAYER STANDS & PERSPEX COVERS



MODEL 45 STAND WITH 415 COVER

MODEL 65 STAND

An attractively designed de-luxe stand which is complete with hinged perspex cover. Styling of the stand includes raised side panels (2½" above player panel) and a raised rear panel (1¾" above player panel). The grey tinted perspex cover features a perspex knob and measures (internal) 16⅜" x 13¾" x 4¾". Below shelf clearance is 3".

Maple/Walnut stand $28.50
Teak stand $29.00

PERSPEX COVERS

MODEL 315. Size 14¼" x 15¼" x 3¾" outside measurements. This sleek MOULDED cover in grey tinted perspex is for use with the model 35 stand and any record player. Complete with attractive perspex knob.

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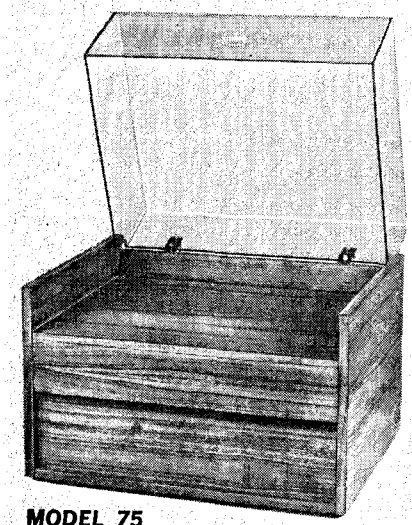
MODEL 415. Size 17¾" x 14¾" x 3¾" outside measurements. This attractive MOULDED grey-tinted cover is for use with the model 45 stand and any record player. Complete with sleek perspex knob.

MODEL 425. Size 17¾" x 14¾" x 4¾" outside measurements. A fabricated grey-tinted cover, ideal for changer models in conjunction with our No. 45 stand. Complete with attractive perspex knob.

Model 315 ..... $10.00 Model 415 ..... $11.00
Model 325 ..... $11.00 Model 425 ..... $12.00
(Extra for set of stay-up type hinges ..... 80c)

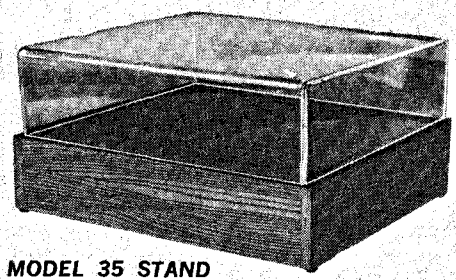


MODEL 75 COMB' STAND

COMBINED AMP/ PLAYER CABINET

This model 75 cabinet combines a player stand, attractive tinted perspex cover and amplifier cabinet (4½" x 17¼"). Perspex cover comes complete with attractive perspex knob and a pair of stay-up type hinges. Cover measures 16⅝" x 14⅛" x 4¾" inside dimensions. The cabinet comes as an easy-to-assemble kit of parts, both saving you money and facilitating transport. (Player panel cut to template is $1.00 extra).

Kit of parts in Maple $30.00
Kit of parts in Teak $31.00



MODEL 35 STAND WITH 325 COVER

PLAYER STANDS

MODEL 35 STAND. Size 14½" x 15⅜" x 3¼". Complete with masonite base, rubber legs, fully veneered on all surfaces. Features attractive side panels raised by ⅛" from player panel.

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Teak $11.50

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INPUT GATE

LETTERS FROM OUR READERS

COLOUR TV

Many readers like myself must be interested in building a colour TV receiver. Do you intend to run one as a constructional project?

— R.K. Adelaide, SA.

Not at the present time. We fully appreciate that there are many readers with the necessary skill to assemble a project of this complexity, but it would be practically impossible to ensure that all the necessary components were readily available.

There is a definite trend however toward the use of linear integrated circuits in colour TV receivers and if these become generally available we may well revise our present thoughts.

THE BLANK LOOK

It is pleasing to find that, associated with all your constructional projects, there is a full size layout of the printed circuit board. This is in contrast to certain other magazines of my acquaintance who only produce scaled down versions which can not be reproduced on laminate board by direct means.

With full size drawings one can simply contact print onto "ortho" paper and expose the board through the resulting transparency. All very easy until one realizes that there is something printed on the other side of the page making contact printing impossible.

Thus it would seem a good idea to print all PC board drawings on a back page of the magazine, and leave the other side of the page blank, allowing direct reproduction. — J.F. Uni of NSW.

An excellent idea J.F. but unfortunately economics and space restrictions make this idea impractical. However we appreciate the problem and will see what we can come up with to make things easier for the "roll your own PC board" people like yourself.

ELECTRONIC ORGAN

Have you at any time published information on the building of an electronic organ and if so — could I purchase circuits of same — V.P.D. Forster, NSW.

As yet there has not been an organ project in ETI and therefore we are unable to supply any circuit diagrams. It is intended to provide such a project in the future, and a prototype is being designed for us by a leading authority on such instruments.

This project will not appear until early 1973 but will be worth waiting for as nothing like it has ever been published before.

THE BIG SOUND

I have been reading your magazine for about a year now, I'm impressed with the objectivity of your equipment reviews. You gave a test on an enclosure using magnavox 8-30 speakers and from listening to the speaker, and from friends, I know that this speaker is just as good as any other 8" speaker available in this country.

I was wondering however, that as you people have the technical know-how and access to testing equipment why don't you design an ALL AUSTRALIAN speaker system based on a 12" woofer that will sound better than the magnavox 8-30 setup. You could test this system and suggest an optimum cabinet size etc.

I really don't expect such a speaker to sound as good as say some American ones like AR, Bose, Advent, etc. but as it would be from Australian material etc there would be no import duty, and therefore speaker should be very much cheaper than imported speakers of comparable sound quality — let's face it — not many people have 300-500 dollars to spend on a speaker but if this speaker sounds NEARLY as good as the best imported systems at a much cheaper price it would, I feel prove just as popular as the magnavox 8-30 enclosure. — A.S. Lake Heights, NSW.

There is no reason why such a speaker system as you describe could not be built and we do have this in mind. So keep watching these pages A.S. and you will not be disappointed.

ERRATA

The article "Mini Magnavox 8-30 Enclosure" in the August issue has an error on page 62. The number of turns on the crossover network coils should be 190, not 109 as stated.

Also in the August issue, Integrated Audio System page 44, parts list. T1 aerial coil part number is S203 and T2 oscillator coil part number is S201.

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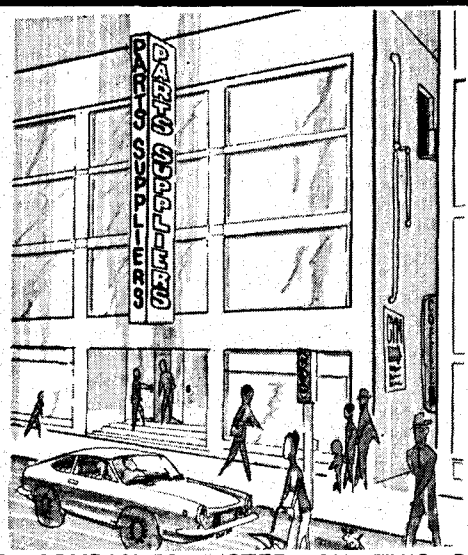

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SN7420N	.90c	UA709C	$1.10	LM372	$4.80
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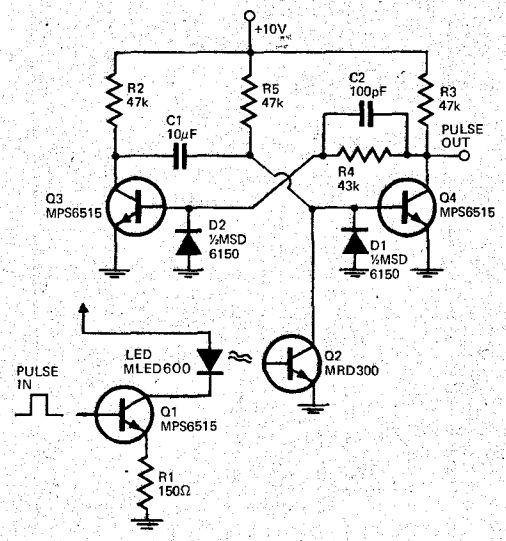
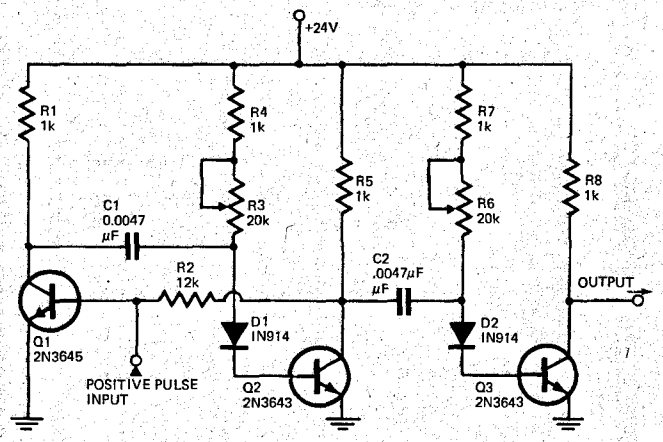
TECH-TIPS



OPTICALLY COUPLED PULSE LENGTHENER

An LED and phototransistor optical-coupler system may be used to lengthen a three microsecond pulse to 55 milliseconds by using the values shown in the diagram. This allows complete isolation between input pulse circuits and the lengthener to be obtained.



ECONOMICAL PULSE DELAY

The circuit shown is of an economical pulse delay which utilizes only three transistors instead of the four normally required for a pair of one shots.

Initially Q1 is off, and Q2, Q3 are on. When an input pulse arrives it turns Q1 on, and Q2 off via C1. Transistor Q2 remains off for a time determined by the time constant of C1, R3 and R4, and when it reverts to the 'on' condition it also turns off Q1. Transistor Q3 which is triggered by the output of Q2 stays off for a time determined by R6, R7 and C2, and thus produces a delayed pulse whose duration is approximately 10μsecs, and is adjustable by R6.

Delay time is adjustable by R3 and for the values shown, is about 10μsecs.

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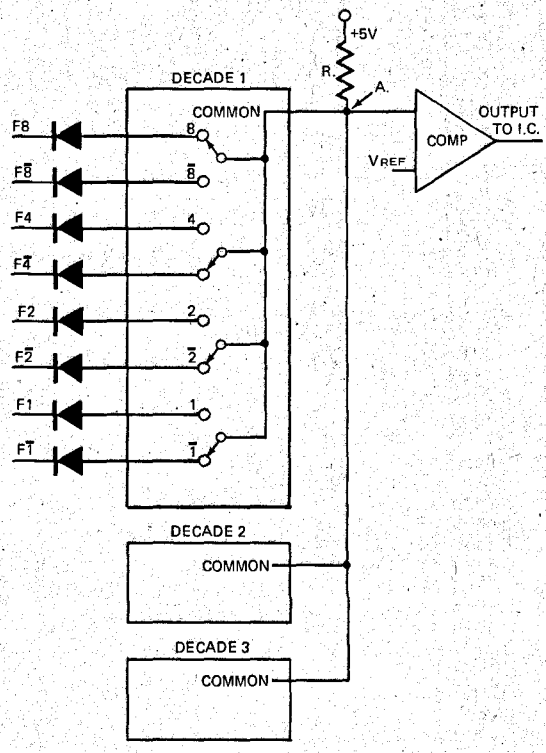


LOW COST DIGITAL COMPARATOR

A simple thumbwheel-switch/digital-counter comparator may be constructed by using the thumbwheel switch and diodes to form an AND gate, and driving this combination with the output of the counter. The output will be high only when the outputs of the counter and the switch coincide, and low for all other conditions.

Use of a voltage comparator will considerably reduce the possibility of erroneous operation. As many other decade counter-switch combinations as desired may be paralleled to the input of the comparator which should have a reference voltage of at least 2 or 3 volts.

Bi-directional record and playback tape deck
Model A-4070
● 4 Ferrite heads (6 head function) ● Reel size 7" ● Tape speed 3¾ ips and 7½ ips ● Triple motor mechanism ● Wow and flutter .06% at 7½ ips ● F/R 25 to 24,000 Hz at 7½ ips ● S/N ratio 58dB

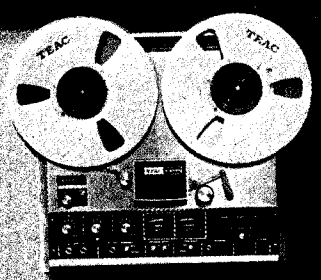
Make music– not noise

You may not realise it, but until now, even the best tape decks allowed a degree of noise during recording and playback. This may have been all right for conventional tapes, since they were far from perfect.

But with the recent introduction of the low noise/high output tapes, it's no longer permissible.

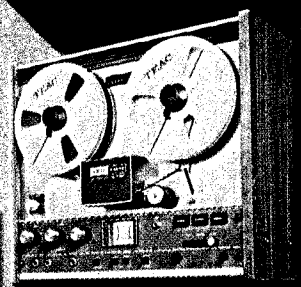
Which brings us to a new generation of decks by TEAC. And TEAC calls them Superior Sound/Low Noise decks: decks designed to get the most out of the low noise tapes as well as the conventional types.

Five of these new generation decks are described here. If you'd like to know more, write to us and we'll send you further information (catalogue, dealer list and price list) on the unit(s) that interests you.



Stereo Tape Deck
Model A-3300
● Reel size 7" ● Tape speed 3¾ ips and 7½ ips ● Triple motor mechanism ● Wow and flutter .06% at 7½ ips ● F/R 25 to 24,000 Hz ● S/N Ratio 55dB

Stereo Tape Deck
Model A-1230
● 3 heads-4-head function ● Reel size 7" ● Tape speed 3¾ ips and 7½ ips ● Triple motor mechanism ● Wow and flutter .08% at 7½ ips ● F/R 30 to 22,000 Hz at 7½ ips ● S/N Ratio 55dB



Automatic Reverse Stereo Tape Deck
Model A-1250
● 3 heads-4-head function ● Reel size 7" ● Tape speed 3¾ ips and 7½ ips ● Triple motor mechanism ● Wow and flutter .08% at 7½ ips ● F/R 30 to 22,000 Hz at 7½ ips ● S/N Ratio 55dB

Combination Head Stereo Tape Deck
Model A-1030
● Reel size 7" ● Tape speed 3¾ ips and 7½ ips ● One motor mechanism ● Wow and flutter .08% at 7½ ips ● F/R 30 to 22,000 Hz at 7½ ips ● S/N Ratio 55dB ● Auto. Shut-off

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