MARCH 1976
75c*

electronics TODAY INTERNATIONAL

FM TUNER TO BUILD

$99.50 OFFER!

ADVANCED SCIENTIFIC CALCULATOR

Registered for posting as a periodical-Category C

electronics TODAY INTERNATIONAL

MARCH 1976, VOL 7, NO3.

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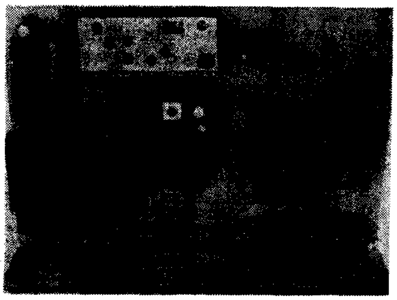


COVER: ETI'S state of the art FM tuner. Full constructional details of this fine new unit complete in this issue — page 27 onwards.

PROJECTS

FEATURES

PRODUCT TEST

NEWS & INFORMATION

A MODERN MAGAZINES PUBLICATION

NEXT MONTH SPECIAL FIFTH BIRTHDAY ISSUE

SEE PAGE 37

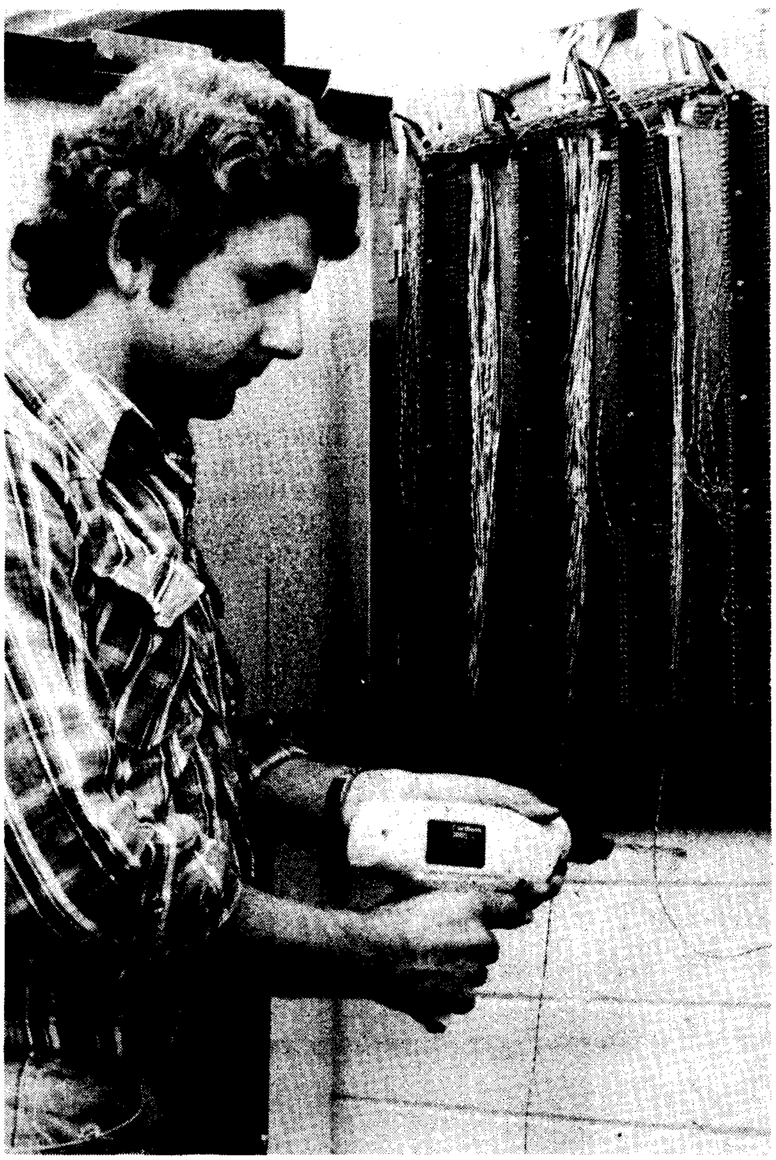
news digest

CORDLESS DRILL

One of the hardest jobs for the handyman or the professional tradesman is to shift a locked in or rusted nut, drive a screw into hardwood or metal, drill through steel or masonry when a conventional ac power source for electrical tools is a long way away. For a roadside running repair to car, caravan, or a hundred jobs around the home such as fixing or dismantling a TV antenna, the lack of a power tool usually requires the grip of a professional wrestler and the patience of Job.

Skil power tools have just released one answer to the problem. Their new Skil model 2002 cordless screwdriver drill is powered by rechargeable high-energy nickel cadmium storage cells. The batteries can be recharged overnight from any 220-240 volt ac power point.

The Skil Model 2002 operates at a fixed low-speed 300 rpm which makes it ideal for the heaviest work. Other accessories available at small, additional cost include a full selection of Philips and slotted bits for all practical applications and a seven piece socket set.



LASER ACUPUNCTURE

Chinese acupuncturists have for some time been using electronic skin-resistance sensors to help pinpoint the exact location of the various acupuncture points.

West Germany's Messerschmitt-Bolkow-Blohm have now developed a laser sensor which they claim is even more effective than the electronics devices (which really do work!).

MBB's new laser equipment consists of a helium-neon gas laser which emits a very narrow beam at a wavelength of 0.632 micrometres. Power output is approximately one milliwatt and can be pulsed at a rate raviable between 0.2 Hz and 200 Hz. It is not yet clear whether or not the device can be used for treatment as well as acupuncture point detection - the electronic devices are used in this way.

EFFECTS OF ELECTRICITY ON THE HUMAN BODY - REPORT

A publication entitled 'Report on Effects of Current Passing Through the Human Body' (MP 30) has been published by the Standards Association of Australia.

The report represents the findings of various authorities throughout the world in respect of the pathophysiological effects of sinusoidal ac. and sustained dc. currents on adult persons.

Its purpose is to give guidance to those persons and organizations who are concerned with electrical safety. The report is not to be regarded as absolute or mandatory.

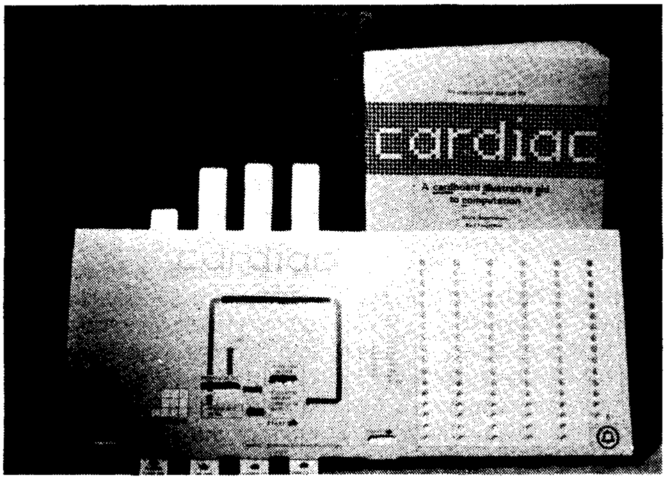
The data given in the report represent a purely medical aspect of the effects of electrical current passing through the human body and are intended to serve as a basis for establishing safety requirements from an engineering point of view, which is only one of the many aspects that have to be taken into account when fixing such safety requirements.

It is expected that alterations will be made to the report as results from the continuing investigations come to hand.

Copies of MP 30 ($1.60) may be obtained from the offices of the Association in all state capitals and Newcastle. (Postage and handling 50c extra).

news digest

COMPUTER TEACHING SYSTEM



Cardiac is an illustrated instruction manual developed for and copyrighted by Bell Telephone Laboratories U.S.A., which is supplied with a most effective teaching aid.

The device illustrates the working concepts of a basic computer. It is manipulated by six cardboard slides which display the contents of registers through windows. Control procedures are shown by a marked path that automatically switches with the sign of the accumulator. For simplicity, Cardiac is a decimal device with a "three byte" word consisting of a two digit address plus OP code. The ten OP codes are Read, Clear and Add, Test Accumulator, Shift, Print, Store, Subtract, Jump, and Halt-Reset. The contents of the 100 memory cells are entered and erased manually as indicated by an instruction decoder.

Loops, indexing, bootstrapping, double precision techniques and subrouting are all demonstrated by program exercises contained in the manual. The manual also contains sections on the distinctions between language levels and between macro and micro flowcharts.

Besides being a valuable training aid, scientists and business personnel who use computers only at the compiler level for occasional problem solving or information retrieval, will find Cardiac a painless and entertaining approach to understanding computer programming. Price of the system is $5.95.

Electro-Technics Pty. Ltd., 36 Park Street, South Melbourne 3205.

METRASCOPE

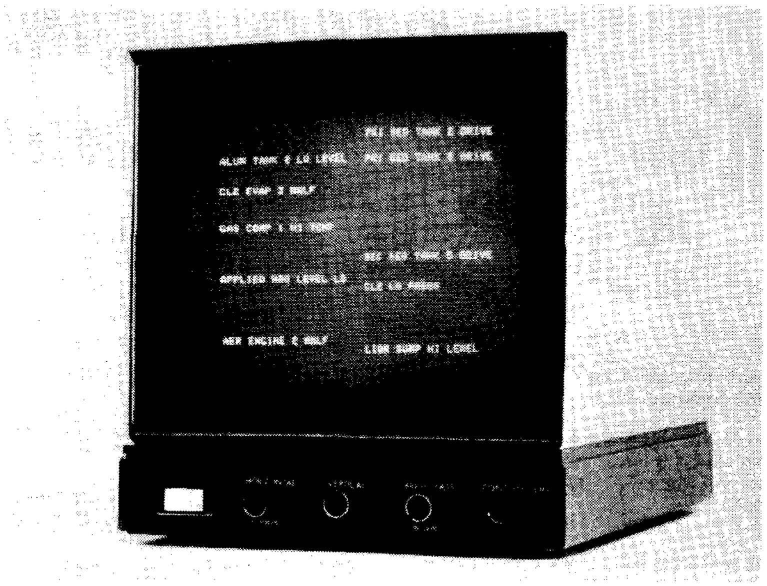
THE WHOLE PICTURE - in one display! A new design Metrascope (typically) displays pressure, vibration and temperature on a single CRT in bargraph form. Calibrations, for example, may be 0-100 PSIA pressure, 0-5 in/sec vibration velocity, 0-10 mils vibration amplitude and 0-500°F temperature. Individual high and low alarms are provided. A switch dials any channel for digital readout of the selected channel or of high or low alarm levels on that channel. The manufacturer, Metra Instruments Inc of the United States can provide alternate calibrations and various groupings of channels.

Available as optional equipment is a printer for the purpose of maintaining a permanent record of data displayed on the bargraph. Printing occurs in one of three modes according to a preset switch: (a) periodic all-challel printout on preset time cycle; (b) push button activation of printout, or (c) continuous printing of all channels in alarm. The printer will print 16 columns which may include day, hour, minute, channel number and signal level.

Other options such as high-high alarms for shutdown, more than four calibrations, computed alarm levels, alarm memory, etc are also available.

Typical applications are found in process control industries such as petrochemical plants or power plants. Other uses are in test installations such as windtunnels, nuclear test facilities or test stands. Monitoring engine operations such as with jet engines in a gas transmission station is also a constructive use.

John Morris Pty. Ltd.
PO Box 80, Chatswood, NSW 2067



news digest

TANDY LOSSES

Tandy Electronics' accumulated losses in Australia have risen from the previously reported $428,986 to $1,115,662 in the year to June 30.

A major part of the loss is due to payment of $230,541 interest to the US parent company.

Tandy's Australian operation has of course increased very considerably in size during this period as is shown by the value of stock which has risen from $1.38 million to over $10 million.

The US parent company has now made further loans to Tandy here - short term loans (previously $58,045) have been increased to $6,020,748 and there is a new long term loan of $497,714.

MINIATURE DIGITAL COMPASS

A miniature digital compass, developed for Australia's defence forces, has attracted wide interest in Britain and the United States. The compass, measuring only 65 mm by 50 mm and weighing 130 gm, uses the integrated optoelectronics to achieve outstanding accuracy with rugged construction and low cost.

Developed by the Microelectronics Division of Amalgamated Wireless (Australasia) Limited with support from the Australian Government, the compass has been supplied for use in Australian defence and scientific applications. It is also highly suitable for marine and land vehicle navigation, surveying, remote monitoring and surveillance, oceanographic work, and aircraft back-up operations.

Engineers at AWA, in developing the compass, had to choose between the three principles commonly used in direction finding - the north-seeking needle or card compass, the gyroscope compass, and the fluxgate compass.

The gyro compass, which uses a gyroscope instead of a magnetic needle to point to the north, is accurate and stable, but complex and expensive. The flux gate compass, which operates by the measurement of magnetic flux, has good dynamic characteristics and moderate cost but only fair accuracy.

Faced with the need to develop a low-cost, accurate compass which would be rugged enough for military use, the AWA engineers chose the north-seeking principle, because of its accuracy and simplicity. The miniature digital compass operates through a photo-electric cell reading the movements of a transparent, coded compass card or disc. This information is converted into a digital data stream which gives a four-digit numeric readout on an associated display unit. The readout is expressed in degrees relative to magnetic north.

A dual-magnet assembly is mounted on a shock-proof, single-pivot bearing. To this assembly is attached a photo-engraved code disc bearing a 10-bit cyclic Gray code on concentric tracks. The magnet, disc and pivot are enclosed in a sealed, fluid-filled cavity fitted with a compliant diaphragm.

An infra-red, light-emitting diode illuminates the disc through a collimating lens and a shadow of the code pattern falls on a 10-element, monolithic photo-diode array. This integrated circuit incorporates scanning and signal-processing circuitry which outputs a serial digital data stream corresponding to the code on the segment of the disc immediately below it. Thus, the position of the magnets relative to the case is encoded with a 10-bit (1 in 204) accuracy.

When the compass is coupled to a display unit, a four digit numerical readout of angular position is obtained. The display unit can be placed remotely from the compass, with repeater units if required.

The digital compass has a design life in excess of 10 years and, in conjunction with the display unit, can be powered from either inbuilt batteries or an external a.c. source.

!!##! ¶+!♦?* †‖ ‡§*!

London's Science Museum has recently opened a new gallery devoted to the history of computing science. Part of the display consists of a computer terminal and video display for visitors to experiment with.

The Science Museum staff, realising that the odd visitor might fill the display with various graffiti, loaded the computer's memory with a vocabulary of unsuitable words and phrases.

If any such words are entered via the terminal the computer discretely prevents them being displayed.

At least that was the intention.

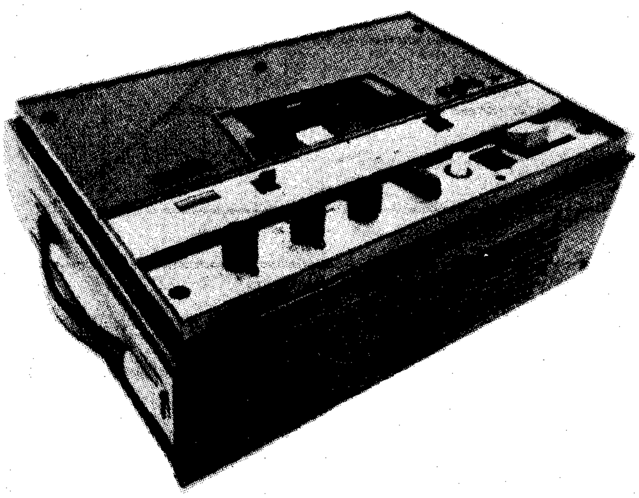
Apparently the system worked quite well for a time until one day a teacher with a large class of genteel girls was faced with a display totally filled with obscenities - the computer had somehow contrived to display it's vocabulary of bad words!

news digest

VARIABLE SPEED SPEECH

Variable speed speech facilities are now being incorporated in a number of cassette recorders - notably from Hitachi.

The unit shown here is made specifically for speech speed change: it covers a range of plus or minus 300%. The new unit known as the Varispeech II is made by Lexicon (60 Turner St Waltham, Mass. USA).

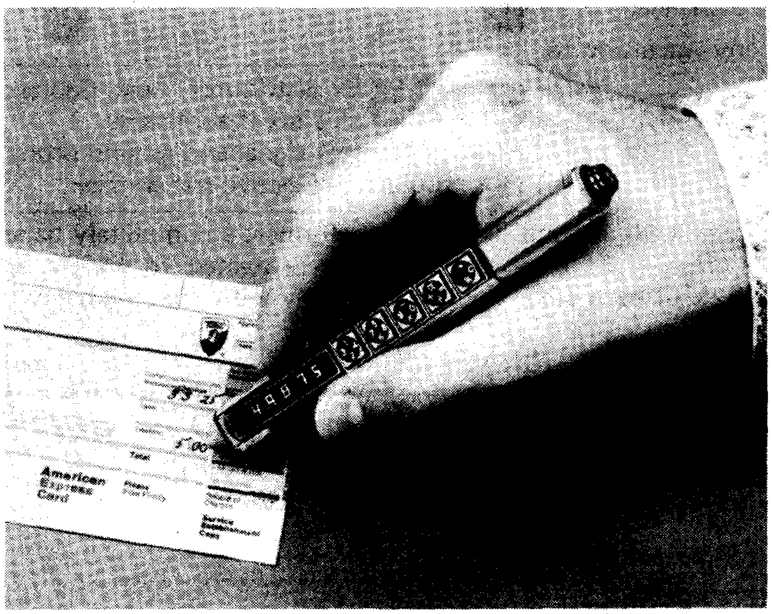


PEN CALCULATOR

Four function plus percentage calculator from Unitrex is also very effective ball-point pen. The calculator section has an eight digit floating decimal display. Price is about $80.
Unitrex Pty Ltd
414 Collins Street
Melbourne

HEWLETT-PACKARD ENTERS DIGITAL WATCH MARKET

Hewlett-Packard's Optoelectronics division has just started to market a range of LED display for digital watches. The company is also believed to be about to produce complete watches.



ARLUNYA DATA ACQUISITION RANGE

The Arlunya Data Acquisition range of equipment has been extended with the addition of a new Data Logger designed and manufactured in Australia. The unit is claimed to fill the gap between highly expensive test systems and chart or manual recording.

The system essentially comprises input scanner, measurement device, digital clock, controller and output device. Signals from transducers, having analogue, digital and event status outputs, may be scanned, measured, linearised etc., and the data outputted on to a wide range of peripherals.

The scanner mainframe may accept either relay or FET switching modules, each having ten channels allowing a 100 channel mainframe capacity with further expansion to 1000 channels using slave chassis.

The Data Logger is designed to accept a wide range of measuring devices such as digital voltmeters, digital multimeters, digital panel meters etc. having TTL BCD output with manual, automatic or programmable functions capabilities. These devices may be either an integral part of the data acquisition system or a free standing unit connected by a single multicore cable.

IMPROVING RADIO PERFORMANCE

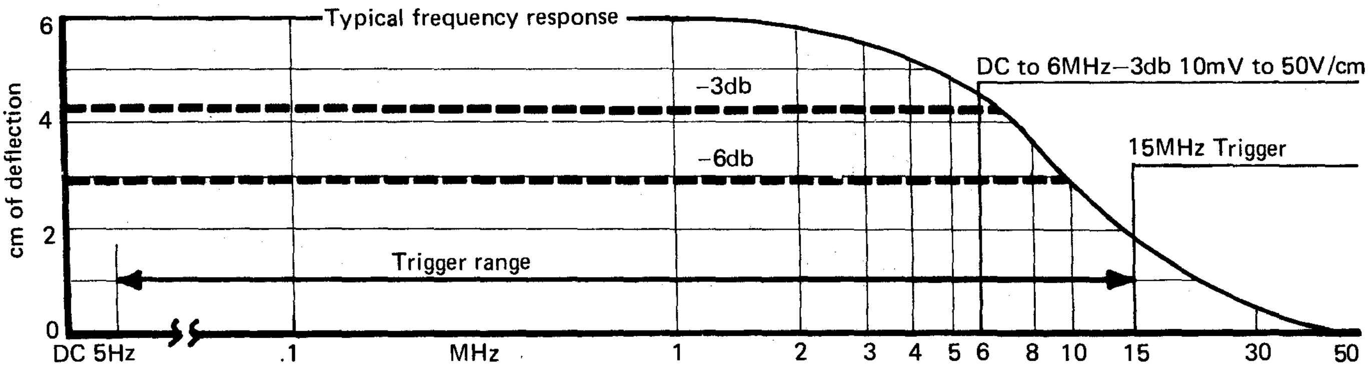
A technique claimed to improve the performance of portable-radio antennae has recently been patented by the Australian Post Office (British Patent 1 411 704).

Most portable and table radios have inbuilt antennae made of coils wound around ferrite rods. The rods work quite well but are very directional - so the radio must often be positioned to optimize reception.

Attempts are sometimes made to use a pair of such antennae mounted at right angles - but this is often not effective due to phase cancellation.

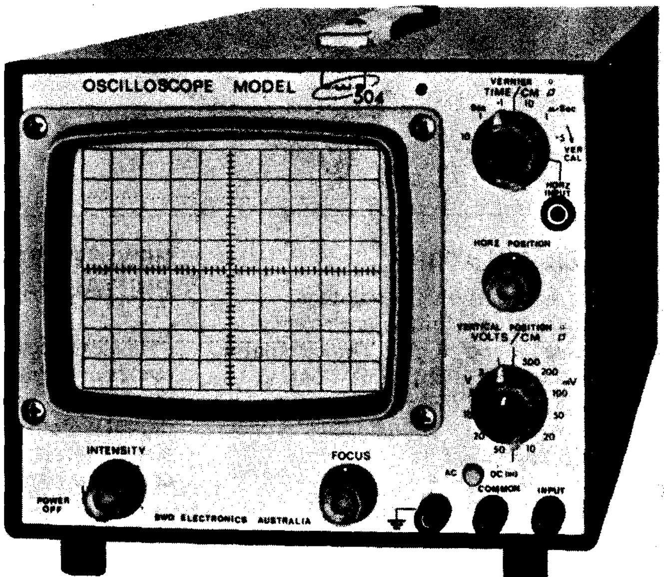
The APO's technique is to retain the two antennae but to add simple sensing circuitry which continually evaluates the respective signal strengths and switches the radio circuitry exclusively to that antenna which is producing the strongest signal.

A DC to 6MHz, CALIBRATED, TRIGGERED, OSCILLOSCOPE
FOR UNDER $200!



bwd 504

5.5kg of high performance with 12 months warranty.



JUST LOOK AT THIS SPEC

DC to 6MHz–3db	bandwidth
10mV to 50V/cm	sensitivity
5Hz to 15MHz	triggering
0.5μSec to 1sec/cm	time base
DC to 1MHz–3db	X–Y operation
8 x 10cm	CRT screen
1.6KV	EHT
±400V DC isolation	input ground

PLUS

5% calibration including effects of a 10% line change.

Completely automatic triggering of almost any waveform to 15MHz

Phase corrected X–Y operation to <3° from DC to 50kHz.

Usable frequency response to beyond 25MHz.

$195 Ex distributor, Aust. Capital City plus tax if applicable.
Price includes x1 signal and ground probes plus moulded protective transit pack.

AND LOOK INSIDE . . .

there's an all silicon solid state circuit, an astatically wound 'C' core transformer, a completely balanced vertical amplifier with excellent pulse response, a FET input stage fully protected to ±400V and a compensated 12 step attenuator accurate to 2% at each step. Built in reliability with conservatively rated high stability components throughout.

bwd 504 an AUSTRALIAN instrument for the INTERNATIONAL market.

MB7601A

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1955/1976 21 YEARS OF AUSTRALIAN DESIGN INNOVATION

B.W.D. Electronics Pty. Ltd.,
P.O. Box 325, Springvale, Vic., 3171
Please let me have full details on the bwd504 oscilloscope.

Name ....

Company ....

Address ....

news digest

WORLD TECHNOLOGY EXCHANGE SERVICE

The Australian section of a revolutionary computer-based technology exchange service known as Technotec has been set up in Melbourne by Control Data Australia Pty. Ltd. on its Cybernet time-sharing service.

Technotec, first introduced in the U.S. in September, is an interactive technology marketing service provided through Control Data Corporation's world-wide computer time-sharing networks.

Its operation is comparable with a newspaper classified advertising system with three sections. One section is technology wanted; another is technology for sale; and the third is technologist expertise available.

Subscribers to Technotec who want to market such information as ideas, processes, and patents can write descriptions of these into the data base. Other subscribers who seek information can explore the data base from terminals for solutions to their technological needs.

The data base also contains a list of individuals or organisations with particular expertise or know-how that may be needed in transferring technology. This file contains sources of financial, consulting, marketing and training assistance.

Control Data Corporation also has set up another service organisation, Worldtech, a world-wide organisation of individuals and organisations interested in offering their financial resources, training expertise or consulting and marketing services to promote technology exchange on a global basis.

Technotec customers search the data base by entering their own choice of keywords or phrases related to the information they are seeking. Computer retrieval techniques, pre-programmed into the system, perform the task of matching the customers' keywords with the subscribers' keywords existing in the selector file. When appropriate "hits" or "matches" are displayed by the system, the user may request the retrieval and printing of the pertinent Descriptors.

NEW WEATHER STUDY DEVICE FOR CSIRO

CSIRO has acquired a new device for studying the role played by clouds and atmospheric dust in determining the world's climate. The device, called lidar (Light Detection And Ranging) is similar to radar in concept, but uses light instead of radio waves. It is able to probe the heart of Australia's thickest clouds or to detect the thinnest haze layers which are invisible to the eye.

Head of the lidar project, Dr. Martin Platt of CSIRO's Division of Atmospheric Physics located at Melbourne, said the device would increase understanding of the factors affecting the world's climate, leading to further refinement of weather forecasting. This was imperative in view of the disastrous droughts and floods which occurred periodically, and because of recent apparent climatic changes around the world.

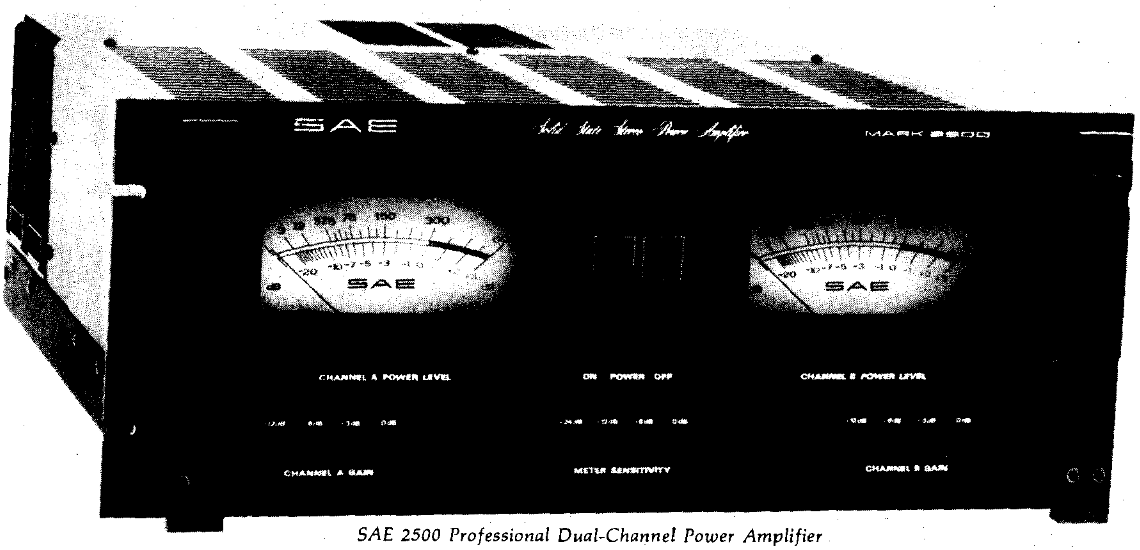
The lidar device sends pulses of ruby laser light into clouds or dust hazes, detecting light reflected back with an optical telescope. A device at the focus of the telescope then interprets the returning light as an electrical signal, which when displayed on a screen presents a "profile" of the cloud which could be related to the size and concentration of particles of which it was made.

Dr. Platt said the Earth's climate was controlled by the direct balance between incoming solar radiation and the amount of solar and heat radiation reflected or emitted back into space.

Low clouds cooled the climate by reflecting back into space up to 80 per cent of incoming solar radiation. High clouds could actually warm the climate, because as cold objects they lost less heat into space.

An infra-red radiometer to be used in conjunction with the lidar device would measure the cloud's heat radiation. Dr. Platt said the lidar device would also be used to measure cloud and haze heights, their internal behaviour, and at which heights the most solar and heat radiation was absorbed, reflected or emitted.

Powerful alternative.



SAE 2500 Professional Dual-Channel Power Amplifier

When you compare power amplifiers, you have to look at the hard facts. The SAE 2500 Professional Dual-Channel Power Amplifier has them—top power, specifications, reliability and features that make it the most "powerful alternative."

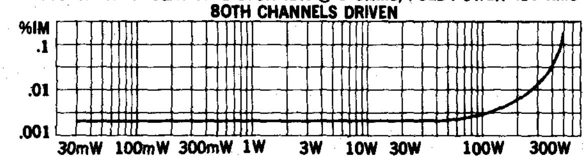
Power. 450 Watts RMS per channel, both channels driven into 4 Ohms from 20Hz to 20kHz at no more than 0.1% total harmonic distortion. Or, 300 Watts RMS per channel, both channels driven into 8 Ohms from 20Hz to 20kHz at no more than 0.05% total harmonic distortion.* Plus, a new, smaller wide-channel power transformer coupled to 4 computer-grade capacitors for a power supply that varies no more than 10% from no load to full load. (For extra protection, there are relay and thermal cut-out devices.)

Other Specifications:

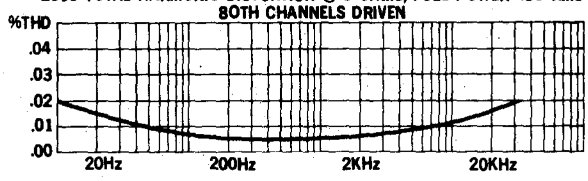
IM Distortion from 250mW to rated power at 4 or 8 Ohms with any 2 mixed frequencies between 20Hz and 20kHz at 4/1 voltage ratio .... 0.05 Max.
Frequency Response at rated power .... ±0.25dB, 20Hz to 20kHz
Noise .... Greater than −100dB below rated power
Transient Response of any Square Wave .... 2.5μsec. rise and fall time
Slew Rate .... 40V/μsec.
Dimensions .... Front panel: 19"Wx7"H, Chassis: 15¾"D (excluding handles, controls and connections)

*These specifications comply with FTC requirements for power amplifiers.

2500 INTERMODULATION DISTORTIDN @ 8 OHMS, FULL POWER 49V RMS 8OTH CHANNELS DRIVEN



2500 TOTAL HARMONIC DISTORTION @ 8 OHMS, FULL POWER 49V RMS 8OTH CHANNELS DRIVEN



Reliability. The SAE 2500 gives you high current capability with Parallel-Series-Output Circuitry (PSO)—without loss of wide power bandwidth, low leakage current or super-high slew rate. Sixteen triple-diffused output transistors have an electrical and thermal SOA 50% higher than maximum design requirements for reliable high demand capability. This configuration can handle anything from continuous full signals to highly reactive surge loads—all day long without failure or overheating. Dual relay disconnect circuits and plug-in board design further assure reliable performance.

Features. Feedback level controls assure a constant input impedance of 50k Ohms and reduce the noise figure to more than 100dB below rated output in all positions. Loudspeaker protection relay-activated circuit automatically disconnects speakers in case of ±DC outputs. Plus, direct power reading VU meters and forced air cooling.

The SAE 2500 Professional Power Amplifier weighs only 58 lbs. making it practical for portable sound reinforcement, public address, communications and recording applications.

The professional alternative.

For full details contact your nearest 'Leroya' office.

Sole Australian Distributors.

LEROYA INDUSTRIES PTY LTD

Head Office, W.A.: 156 Railway Pde., Leederville 6007. Phone 81 2930.

N.S.W. Office: 100 Walker St., North Sydney. 2060. Phone 922 4037

VICTORIA Office: 103 Pelham St., Carlton. 3053. Phone 347 7620

news digest

CSIRO ASSISTS HEARING STUDY

Despite the noise of industry, heavy traffic and low-flying aircraft, primary school children in Sydney's inner south-eastern suburbs have hearing just as sharp as that of pupils in the quieter outer suburbs.

This was the finding of a joint research project by the National Acoustic Laboratories, the Laboratories' special adviser, Dr. Volney Bulteau, and CSIRO's Division of Mathematics and Statistics, conducted during the past two years.

NAL psychologist Mr. Norman Carter, who was in charge of the project, said that no difference existed in the hearing acuity of children in low-noise and high-noise environments. It indicated that environmental noise alone was insufficient to damage hearing, at least in children up to the age of 12. Mr. Carter said studies elsewhere had shown if noise levels were sufficient to damage hearing, the effects would show within 10 years or not at all.

Mr Cliff Gray, a scientist with CSIRO's Division of Mathematics and Statistics in Sydney, helped prepare a special questionnaire seeking details of each pupil's health record, family hearing history and factors at and since conception which might have impaired hearing.

A total of 460 pupils aged between 10 and 12 were tested by NAL clinical audiologists on their ability to hear (with either ear) six pure tones of different pitch. The test was preceded by an ear examination to detect any infection which might have affected hearing.

Mr. Carter and Mr. Gray believe the study has brought research closer to defining the point where noise levels begin to damage hearing. They plan further studies in different environments, for adults in industry, for example, where hearing damage is known to occur.

ERRATA AND ADDENDA

MAGNAVOX MV-50 SYSTEM

February 1976 - page 38

The top, bottom and three sides may be cut from a 2400 x 300 mm sheet (old 8 x 1 feet size), not a 7 x 1 feet as specified in the article.

FM TUNER

January 1976

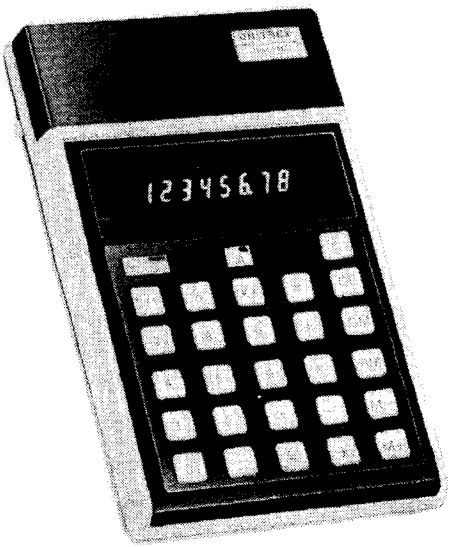
The LED spacing is 1.25 MHz not 800 kHz. Display is an UAA 170 not UA 170. Varicap stabilizer is a TAA 550 not a TA 550.

BWD WAVEMAKER

BWD advise us that the specifications of their new 'Wavemaker' — published in ETI page 13 December 1975 — contained an error. It was stated that "it can operate as a self-contained function-sweep generator over a 20 Hz to 50 Hz range . . . .". The 50 Hz figure which appears throughout the text should have read 50 kHz.

BWD apologize for the error and inconvenience.

CALCULATOR TO WIN!



THIS MONTH'S Unitrex contest features the model 901 PM calculator. This calculator handles virtually all commercial and arithmetic operations with speed and simplicity. For its size and recommended retail price of just under $25 it has tremendous calculating capability and convenience.

The 901 PM has the usual four functions of addition, subtraction, multiplication and division — plus square root and percentage calculations. It has a full accumulating memory, floating decimal point, constant and sequential mode operation etc etc.

Here's your chance to win one of these great little units. All answers received before March 21st will be put into a large barrel. These will be thoroughly mixed and entries drawn one at a time until a correct answer is found. That first correct entry will be the winning one. Right? Then here's the problem —

What is the (simple) interest due after 150 days on a principal of 765 talents 1095 drachmas 5 obols at a rate of 1 drachma a day for 5 talents?

Entries should preferably be sent on the official entry form printed on this page. If like many of our readers you'd sooner not cut up your ETI just copy the entry form on to a sheet of paper. Do please remember to include your name and address. Entries close March 21st 1976.

The winner will be announced in ETI as soon as possible.

Send to
Calculator Contest (March)
Electronics Today International,
15 Boundary St,
Rushcutters Bay,
NSW 2011.

Interest payable is . . . .

Name . . . .

Address . . . .

. . . .

. . . . Post code . . . . . .

Permit No. TC7296

Bang & Olufsen is far from being among the largest manufacturers of high fidelity equipment in the world. Yet, in recent years they have astounded the world with their products.

Within the past two years, B & O have put the only quadraphonic music set with ultrasonic remote control on the market: The Beosystem 6000. And the only gramophone with an electronically controlled tangential tone arm, which reproduces your records exactly the same way as they were cut.

These products have met with the unreserved acclaim of critics and music lovers throughout the world.

Now Bang & Olufsen is introducing a speaker series that will undoubtedly be received the same way: **The Beovox Uni-Phase speakers.**

It took Bang & Olufsen's best brains four years to create these speakers, plus some assistance from the largest computer in the world, at Cleveland, Ohio, which is also used by NASA in the American space programme.

Although at first sight the new **Beovox Uni-Phase speakers** resemble other pressure chamber speakers, they have little in common with them. In order to create these new speakers, B & O scientists have had to reject old established design theories and start from basic principles.

The results are just as revolutionary as their techniques: The new **Beovox Uni-Phase speakers are the only** pressure chamber speakers whose transient response lies in the same class as that of amplifiers. And **the only** ones in which all the units in the cabinet operate in the same phase even in the crossover range–**the only** speakers in which the sound from all the units reaches the ear simultaneously.

One of the secret developments which made all this possible is the "patent pending" Baekgaard Phase-Link crossover network combined with the dynamic impulse corrector.

As well, there are other developments–like the fact that here is a loudspeaker that can reproduce the sound of a whole orchestra yet takes up little space in your living room.

The main development, of course, is the entirely unique sense of reality the new Phase-Link crossover network brings to your music.

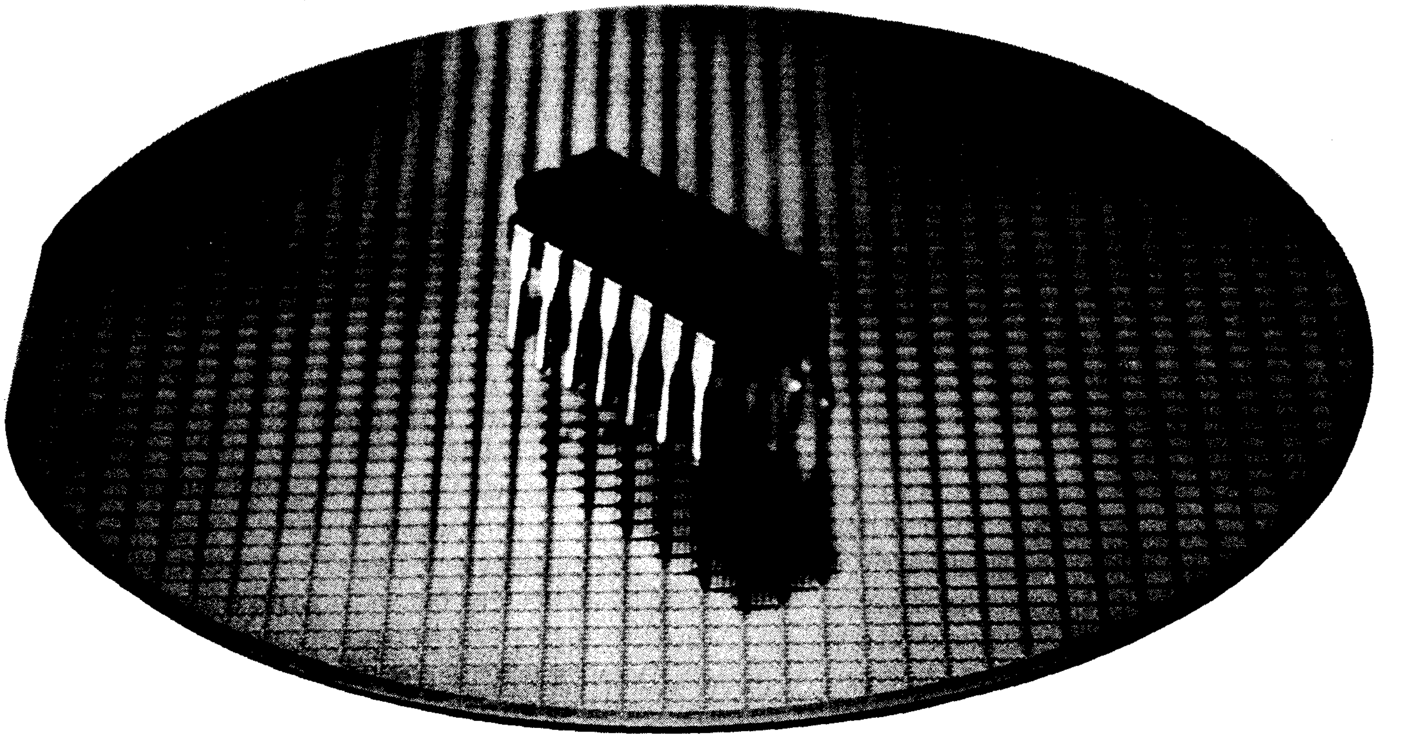
The purpose of this advertisement has been to let you know that speakers no longer need be the weakest link in the high fidelity chain.

BANG & OLUFSEN
BEOVOX UNI-PHASE SPEAKERS

With respect for true sound.

Victoria: Danish Hi Fi. Telephone 82 4839, 63 8930. **N.S.W.:** Convoy. 357 2444.
Queensland: Brisbane Agencies. 21 9944. **W.A.:** Danish Hi Fi. 71 0100.

U691/95



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AUDIO FACTS

CATACOUSTIC?

Anyone who has ever lived with a Siamese cat will tell of their extraordinary characteristics.

To such people it will be of no great surprise that there is in Britain a Siamese that can tell when a Yamaha CA 1000 amplifier is switched to class A from class B operation.

This admittedly neurotic Siamese apparently dislikes classical piano recordings — leaving the room whenever such a recording is played. But for some extraordinary reason the creature will remain in the room if the same recording is played with the amp switched to class A operation! We don't have any theories either. (The Editor who has *two* Siamese says he's not even remotely surprised).

(This event was originally reported in the UK magazine Hi-Fi for Pleasure).

TRANSIENT INTERMODULATION DISTORTION

Our article on transient intermodulation distortion in amplifiers published in our December issue raised a good deal of interest.

The article was particularly timely as there is now world wide interest in this phenomenon — together with phase and time distortion.

Until recently these effects have been very difficult to measure. Now such measurements will be easier to perform — Bruel & Kjaer Instruments Inc have just announced new systems specifically to measure these parameters.

The availability of the new measuring systems may well result in quite major improvements in amplifier performance. There is an ever-growing belief that transient intermodulation distortion, phase distortion and time distortion have a major part to play in the way amplifiers sound.

NEW PRODUCTS FROM NAKAMICHI

NAKAMICHI are about to release a number of new products — a preview of some of these was held in Sydney earlier this month.

Two cassette recorders have been produced which are truly portable. The two machines are intended to be used in under-dash mounting — in cars — or handheld as truly portable units.

Model 300 is the more elaborate of the two — it has both record and playback facilities. The model 200 has playback facilities only.

Maintaining their reputation for state-of-the-art products, Nakamichi have produced a three-head, console cassette recorder — the Model 600. Acknowledging that cassettes suffer from distortion more than open reel tapes, Nakamichi has developed a unique intermodulation distortion suppressor for this machine. Used on playback only, it will replace the DNL system that is found on the model 1000. Nakamichi claim that the IM suppressor reduces distortion from a typical value of 2% to less than 0.5% and also expands the useable dynamic range. In addition an improvement of 5 dB is gained in S/N ratio.

A matching console preamp — the Model 610 — is claimed to be the best in the world. Noise and distortion are claimed to be virtually unmeasureable. The 610 has mixing facilities and inputs for:— Five microphones, three tapes (input and output), two phono, two tuners, and outputs for three amplifiers with adjustable output levels for each.

The 610 will be ideal for professional and comparative uses. It has a built-in pink noise oscillator and three signal tone oscillators. Facilities are available for A-B-C comparisons of all inputs and all outputs so that speakers, amplifiers, tuners, cartridges, tape decks and so on may be compared at the same levels. Signal to noise ratio is claimed to be 93 dB.

Nakamichi have also developed a spectacular moving-coil cartridge — but unfortunately one that we are unlikely to see on the domestic scene. Design aims useable frequency response to 60 kHz and wide channel separation to more than 20 kHz. The cantilever is made of a single crystal which has to be specially made in Zurich, and it takes one month to adjust the cartridge correctly before it leaves the factory — one week in each of four separate chambers. Because of the care that is taken in adjusting the cartridge, it will not be provided with a removeable cartridge and must be returned to the factory if stylus replacement is desired.

The cartridge is aimed at high quality laboratory work where low distortion and a high degrree of accuracy to levels above 50 kHz are required.

CORDLESS HEADPHONES

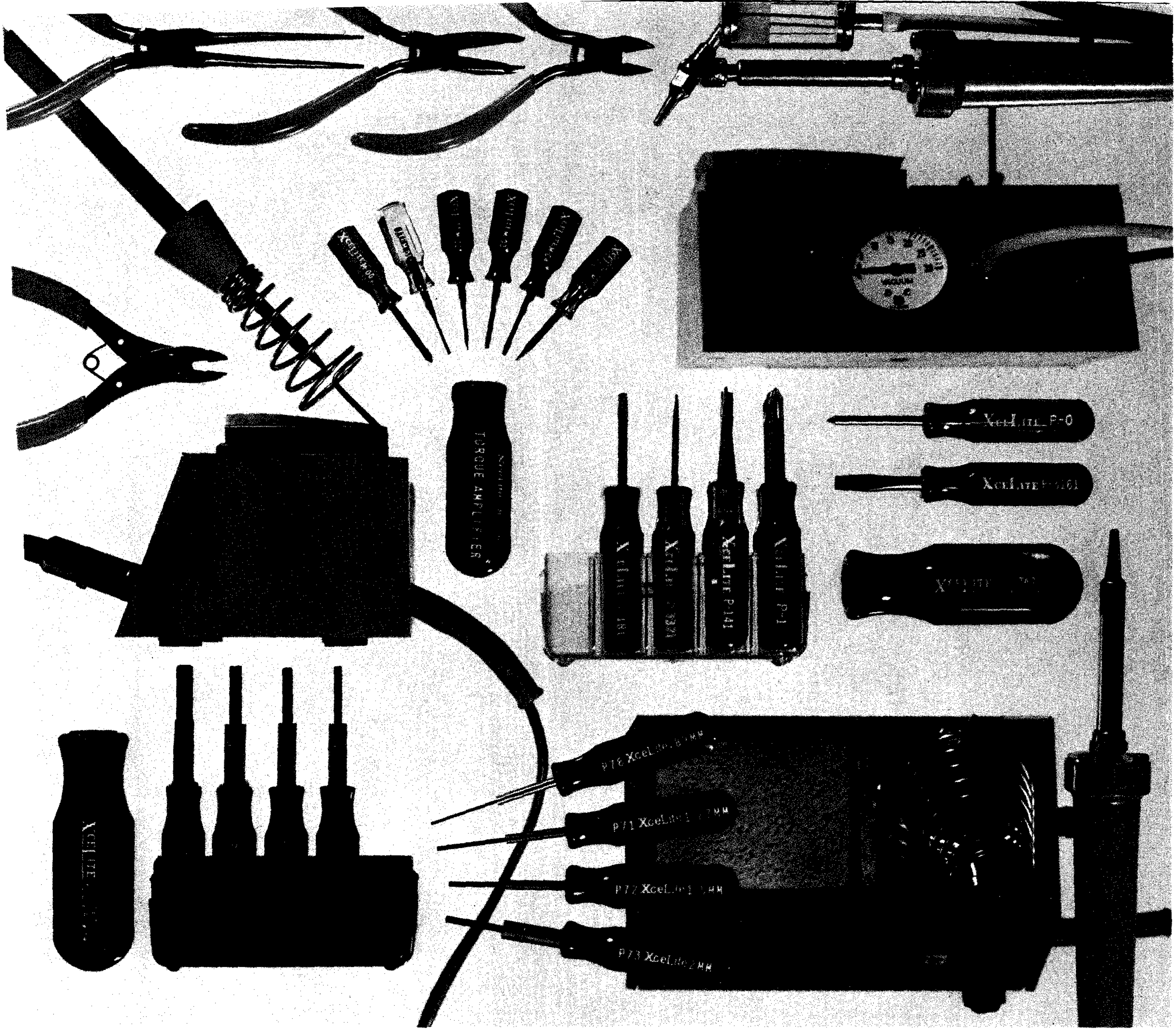
Those long trailing headphone cords may soon be a relic of the past. Sennheiser, Seimens and Beyer all have cordless systems either in production or under development.

Beyer's system is now available in the USA and that from Sennheiser should be on the market very soon.

In all these systems an infra-red transmitter is connected to the audio amplifier output and floods the listening area with harmless and invisible infra-red radiation.

The infra-red carrier is modulated by a frequency modulated carrier of about 90 kHz. The frequency modulated signal is of course multiplexed to accommodate the two separate channels of a stereo system. The infra-red signal is received by small sensors mounted on the individual head sets.

Range is said to be excellent — the system being usable in a large concert hall or film studio for example. Frequency response etc is fully to hi-fi standards.



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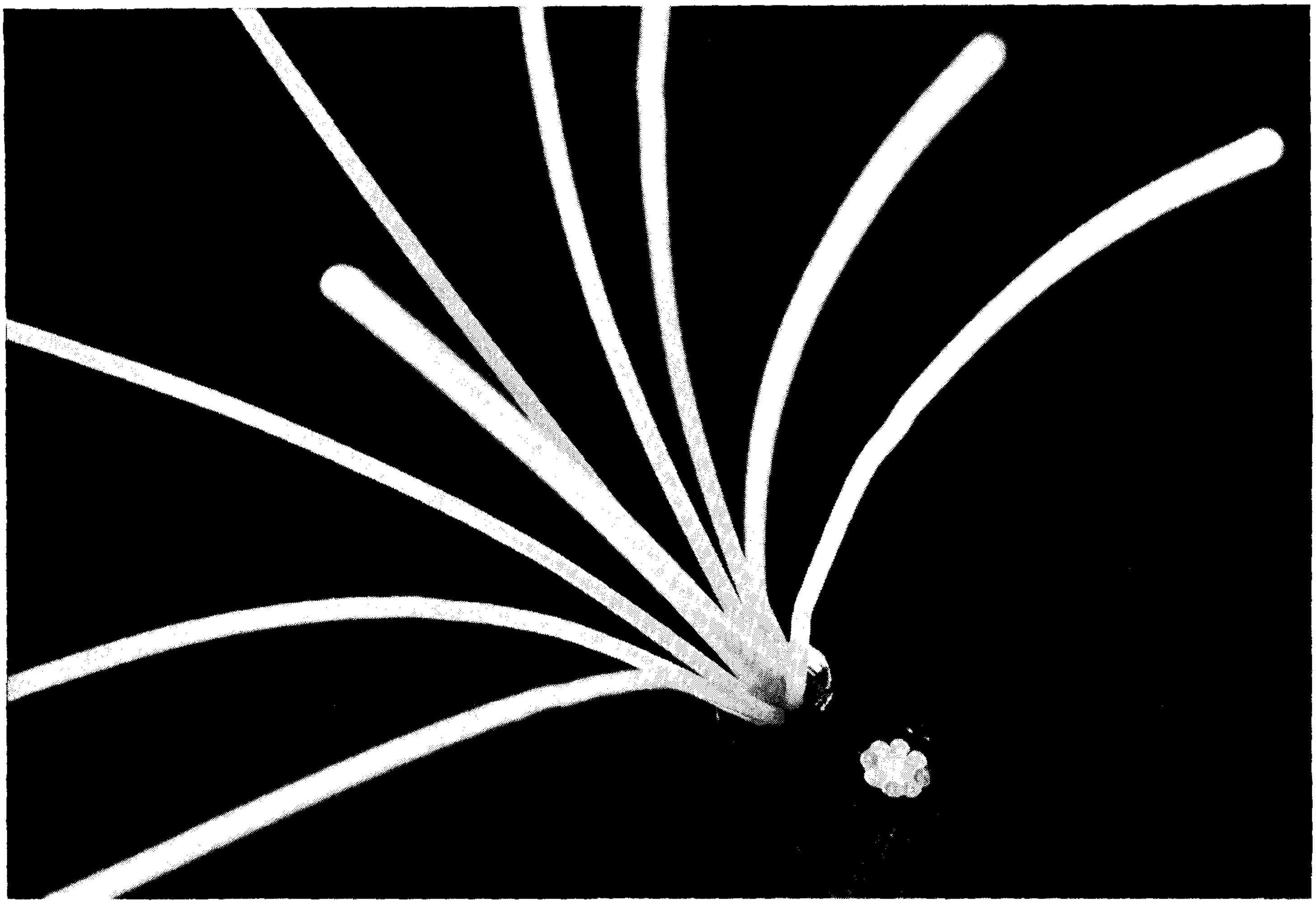


Optical fibre cable with eight cores. When made of the purest materials available, such a line is theoretically capable of carrying more than one million telephone channels simultaneously. The prototype seen here was developed by Standard Telecommunication Laboratories at Harlow (UK).

LASERS LIGHT AND TELEPHONES

Spectacular advances in the way that telecommunications can serve us are promised by the transmission of light along optical fibres instead of electricity along wires.

by Professor W.A. Gambling University of Southampton.

IN 1588, when the Armada was sighted sailing up the English Channel for the invasion of England, a warning signal was sent to the Queen by the lighting of bonfires on a chain of hilltops from Devon to London. This was a common method of sending important messages for many centuries, and the hills on which the fires or beacons were made came to be known as 'Beacon Hill' — a name which many of them still retain.

Although nowadays it seems a crude and clumsy technique, it represents one of the earliest forms of optical communication system. Only the simplest possible message could be sent, either a 'yes' or a 'no': absence of the fire meant 'No, the Armada has not been sighted' changing when the bonfire was lit to 'Yes, the Armada is coming'.

Only one 'binary digit' or 'bit' of information could be sent at a time and could not be repeated until the beacon had burnt out and was rebuilt. When one reflects that it takes nearly four million bits of information to make one frame of a colour television picture and the frames are flashed onto the screen fifty times every second, it is possible to appreciate just how sophisticated present-day communications systems have become.

An improvement on beacons is the heliograph, which consists of a mirror so adjusted as to reflect sunlight to an observer. By tilting the mirror a series of flashes can be sent in the form of Morse code, and the rate of transmission is increased from something like one bit of information per *day* in the case of the beacon to perhaps several bits or flashes per *second.*

The heliograph can only be used if the sun is visible but in the modern version an artificial light source is provided and, by means of a shutter or a dipping reflector, coded flashes of light can be sent, as with a naval signalling lamp. However, the rate at which messages can be sent is limited by two factors: firstly by the mechanical shutter and secondly by the fact that the human eye has a response time of about a tenth of a second. If the eye did not retain images for this length of time, then we would see on our television screen pictures flickering on and off at the rate of fifty times per second, instead of the steady image that there appears to be.

Thus the signalling lamp can send relatively slow and simple messages, such as those required between ships at sea when radios cannot be used, but it would take a long time, no less than 11½ days at 24 hours/day to send as much information with a lamp as there is in even a single static colour television picture.

SIMPLE OPTICAL SIGNALLING

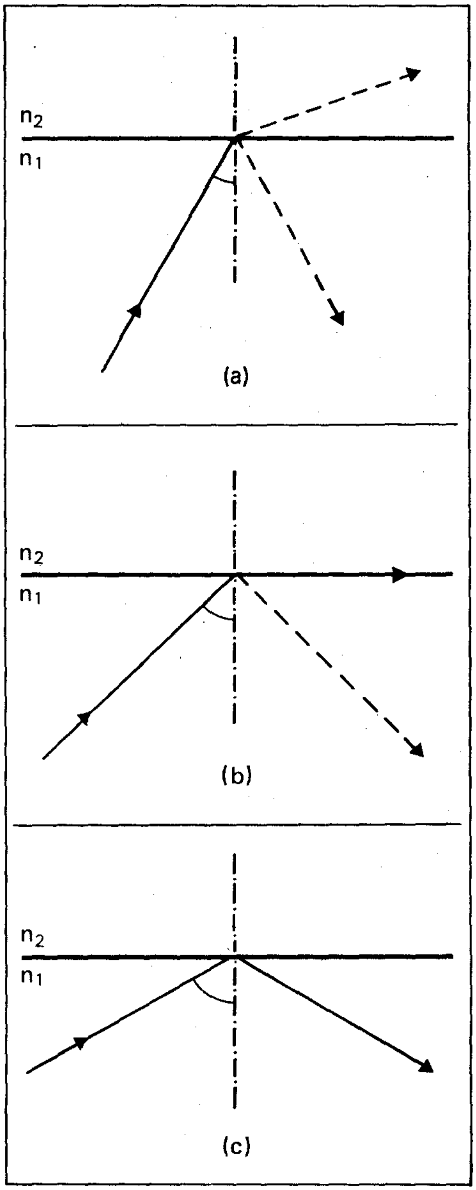
One way of speeding up the transmission of information is to replace the mechanical shutter by an electrical one which can be switched on and off much more rapidly. These came about with the development of transistors. Now certain semiconductor diodes emit light when an electric current is passed through them, and the intensity of the light varies with the strength of the current. These devices are called light-emitting diodes and some versions can be switched on and off by electrical pulses more than a hundred million times per second. The most common use of such devices is in electronic pocket calculators. The readout is produced by arrays of light-emitting diodes, seven to each figure.

Thus light-emitting diodes can replace the flashing light. The eye, in turn, can be replaced by a semiconductor diode detector which also can have a very fast response.

A light detector acts more or less in the opposite way to a light-emitting diode in that it can be so operated that, when light of varying intensity falls on it, an electric current of varying strength is produced. The combination of light-emitting diode and diode detector can be used to transmit more than a hundred million bits of information per second, which is enough to send many television pictures simultaneously.

Although a lot of information can be sent along such a light link it cannot be sent very far because the light from ordinary lamps and diodes, however carefully they are collimated, always spreads out. As a result, when the detector is far away the light is spread over a large area and not enough gets into the detector to give a usable signal.

Fig.1. Total internal reflection of a ray of light at an interface between two media of refractive indices $n_1 > n_2$.
a). A ray at a small angle to the normal to the interface is partially reflected and partially transmitted.
b). At the critical angle to the normal most of the light travels along the interface but the remainder is reflected back into the denser medium.
c). At a larger angle to the normal (a small angle to the interface) all the incident light is totally reflected within the denser medium.



THE LASER

What is needed therefore for long-distance transmission is a new type of light source producing very pure light that can be accurately controlled, so that it can be made into a narrow beam that does not spread much. Such a light source is the laser.

The laser is completely different from any other light source. The light it produces is very pure and bright (since brightness is defined in terms of power per unit area per unit solid angle). The laser behaves almost like an electronic oscillator which operates at a very high frequency, about 5 x 10^{14} Hz in fact. This has several consequences which are of great importance.

Firstly it is possible to collimate the output radiation very accurately. Even the smallest and cheapest laser produces a narrow pencil-like beam that can be sent over long distances without spreading too much. This directional property has been used in an experiment where a laser beam was directed at the Moon from a 60-inch (1.52 m) telescope, with the result that in travelling 400 000 km it only spread to a spot 0.8 km across. In other words the beam spreads by only 25 mm in every 16 km of travel. Incidentally the distance to the Moon was measured to an accuracy of plus or minus 25 mm!

Laser light can also be modulated, or switched on and off, very much faster than other light sources and can, in principle at least, be used to send more information per second, than any other method including radio, microwaves, etc. Thus if we can learn to use laser light, and to transmit it efficiently from one place to another, then we will have a greatly improved method of sending messages in the form of telephony, television and so on.

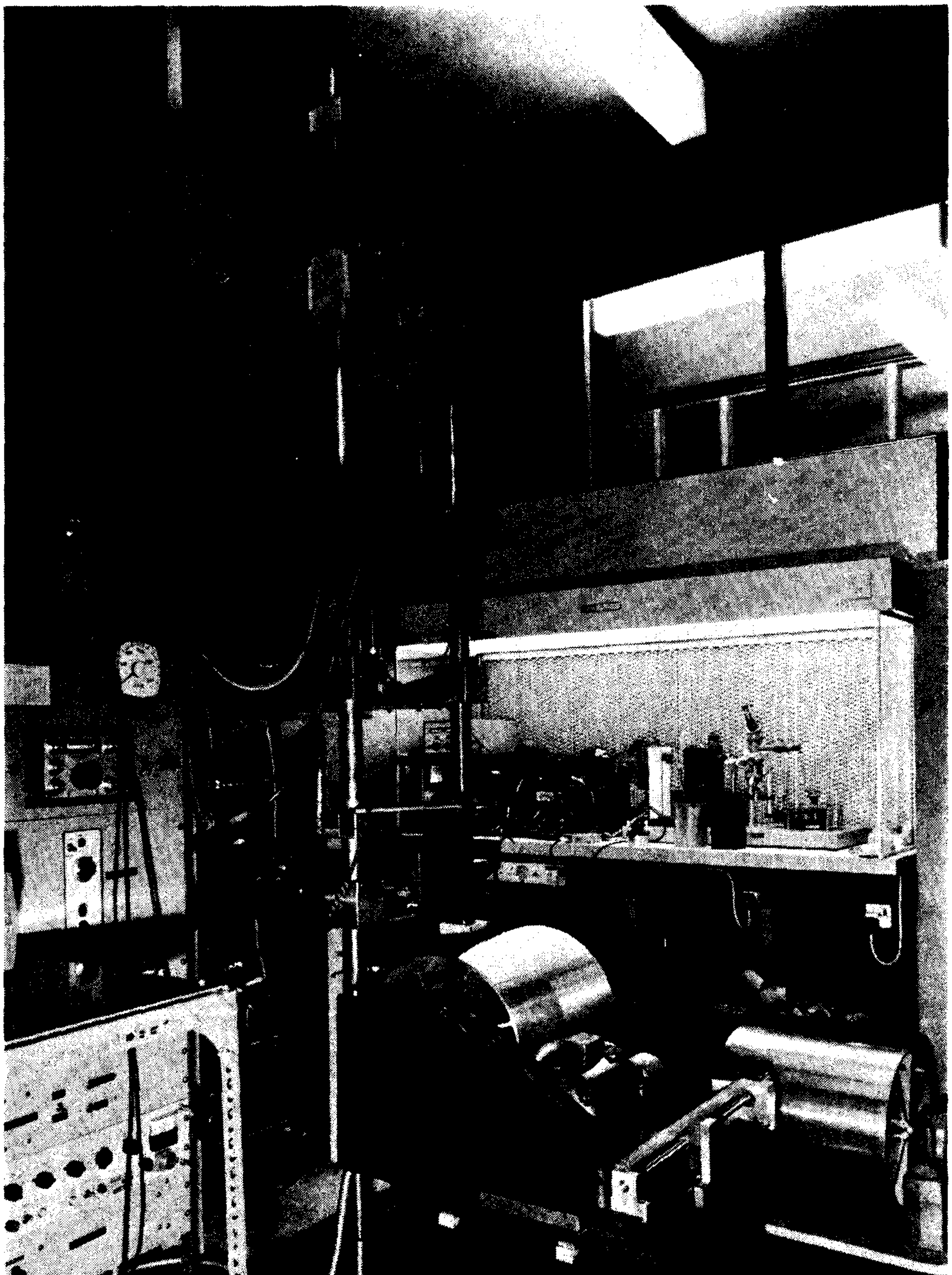
COMMUNICATIONS DEMAND

However, before looking into optical communication more closely let us ask the question 'Is such a new system needed and will it be of any practical value?' The answer is strongly in the affirmative and telecommunications authorities the world over are spending a lot of money on developing new systems. Many more connections are being made to computers over the telephone system, and computers are becoming bigger and more numerous, so that more and better telephone lines are required. Television programmes are increasingly sent over landlines, and there are other new and interesting possibilities. So let us consider how we might be able to use laser beams and light signals instead of electric currents in a wire.

LASER SIGNALLING

A simple way of sending a signal along a laser beam is to pass it through an electro-optic crystal which can act as an amplitude modulator to control the intensity of the beam passing through. Thus an ordinary electrical

LASERS LIGHT AND TELEPHONES



Fibre-drawing machine built at Southampton University. A glass preform can be seen entering a small vertical furnace; the resulting fibre is drawn onto the winding drum at the bottom. The precision is such that a fibre of diameter 100 μm varies by less than 1 μm over a length of several hundred metres. Several kilometres of fibre can be drawn in one continuous operation.

signal, such as that from a telephone or a television signal, when applied to the modulator causes the strength of the beam to vary in synchronism with the signal. If a light detector is placed at the other end of the beam it will pick out the variations in beam intensity and turn them back into electrical signals. These are amplified and used in the normal way.

With a technique such as that just described, signals can be sent on a laser beam over quite long distances and when the beam is protected there are no great problems. Out of doors, on the other hand, there are two big disadvantages. Firstly the beam can be blocked by rain, clouds and snow, but even in clear weather it will be bent and broken up by temperature gradients or turbulence in the atmosphere and therefore transmission is unreliable. Secondly, light beams travel in straight lines, making it difficult to turn corners and get in and out of buildings since it would be necessary to have a highly-reflecting and accurately-positioned mirror at every slightest bend.

GUIDING THE LIGHT

In 1966 two British engineers suggested a novel method of sending light over long distances. They said that if pure glass could be produced, glass fibres would be capable of guiding light over several kilometres at a time. Glass fibres have been known for many years but at the time they could send light over only a few metres because of the high transmission loss of nearly 1000 decibels/km; that is to say, half of the energy was lost in travelling only three metres.

To understand how glass fibres 'conduct' light it is necessary to recall some simple physics. If a ray of light is travelling in a dense medium and strikes the surface of a less dense medium at an angle near the perpendicular, as in Fig 1, then some of the light is reflected and some is transmitted through the surface. On the other hand, if the ray strikes the surface at a shallow angle, then it is all reflected; that is, there is no energy lost due to reflection. A perfect reflection of this kind is known as 'total internal reflection'. The angle to the perpendicular at which total internal reflection just occurs is known as the critical angle.

A light-guiding optical fibre consists of dense core material of pure glass surrounded by cladding material, also of glass but having a smaller refractive index. Thus if rays enter the fibre and strike the surface of the core at a large angle to the axis (a small angle to the perpendicular), they are partially reflected and go on to make another reflection at the same angle at the other side of the core, and then another and so on. However, some energy goes into the cladding each time, and after many reflections there is no light left in the core and the ray does not reach the far end of the fibre. On the other hand an input ray at a shallow angle to the axis is totally reflected with no loss of energy and, if it is not absorbed in the body of the core, it can keep on reflecting right to the end of the fibre. The beauty of this technique is that the fibre does not need to be straight.

As Fig 2 shows, the rays continue to reflect around curves and, within broad limits, the fibre can be bent as much and as often as required. In addition it can be very thin, as fine as a human hair, 50 micrometres (μm) in fact, thus becoming quite flexible; it behaves much as a piece of copper wire and can be wound around the finger without harm.

An unprotected fibre is rather weak, since surface flaws form very rapidly on exposure to air, but if suitably protected immediately after drawing, a glass fibre even as small as 100 μm in diameter becomes surprisingly difficult to break by hand.

A single fibre is so small that it is difficult to see easily and to handle, but bundles consisting of a large number of fibres contained in plastic tubing have been used for light transmission over distances of a metre or two for some years. Typical examples are fibre endoscopes for viewing internal cavities of the human body by surgeons. Several fibre bundles can be used to display patches of light in a particular configuration to produce display signs, the advantage being that only one simple light bulb is used, instead of many bulbs or expensive fluorescent tubing. In addition they are less easily damaged by vandals. Traffic signs on motorways are of this type.

COMMUNICATING BY FIBRES

While bundles of fibres can guide light, to send a signal we need only one fibre and a small amount of light which can be modulated in some suitable way. One fibre could guide laser light over distances of several kilometres. By using one of the techniques described earlier, the laser beam itself could be made to carry as beam itself could be made to carry as many as 100 000 telephone different colour television programmes. Thus a thin fibre could transmit more information than a telephone cable made of the rather expensive metal copper, and presently about 50-100 mm in diameter.

Since glass fibres have been used for conducting light for some years one might well ask why they have not been used for communications purposes before. The answer is that glass of sufficient purity has not been available. Ordinary window glass looks quite transparent, but if you look at a pane of glass edge on, it appears dark because very little light can come through a thickness of even half a metre or so. Even the best available optical commercial glass is not nearly good enough because, after going along a kilometre of it, the light would be ten thousand million times weaker!

This is because some of the light propagating along a fibre is lost by absorption due to impurities and some is scattered by even very small inhomogeneities. Some of the impurities are difficult to remove and they can have a serious effect even if present only as one part in every hundred million parts of glass. To ensure that the signal is not lost completely it has to be amplified when the power has fallen to a low value; each amplification being carried out in repeaters spaced at suitable intervals along the fibre. To keep the number of repeaters, and therefore the total cost, down to an economic level the transmission loss has to be as low as possible and certainly less than 20 dB/km (corresponding to a fall in signal power to 1 per cent of its original value after travelling 1 km).

FIBRE FABRICATION

At first it seemed that this low-loss transmission requirement would be very difficult to achieve but in the past four years tremendous advances have been made in several laboratories, including my own at Southampton University. Two years ago we held the world record for the best fibre, with a loss of only 5.8 dB/km, in a configuration consisting of a fine glass capillary tube as the cladding filled with a special liquid (hexachlorobutadiene) as the core. Other laboratories in the USA improved on this result using solid fibres consisting of silica doped with titania, germania or boric oxide as one component and pure silica as the other. Then a year ago we produced another new type of fibre using a rather unexpected material (because it is extremely difficult to make in bulk form), namely a phosphosilicate glass.

The fibre is made by passing vapours of phosphorous oxychloride ($POCl_3$) and silicon tetrachloride ($SiCl_4$), together with oxygen (O_2), down a silica tube (which need not be very pure), and heating to a temperature of about 1500°C in a furnace. Layers of phosphosilicate glass can then be deposited on the inside of the tube. The initial layers, which become the cladding, can be made to have a low refractive index by using a small concentration of phosphorous oxychloride (or by using boron trichloride instead) while the later layers of higher refractive index form the core. After deposition of the layers the tube is collapsed to a solid preform which is then drawn into fibre by the precision fibre-drawing machine shown in the photograph; the overall process is depicted in Fig 3.

The great advantages of the foregoing process are that the raw materials are cheap and, because they come in liquid form, they are easily purified. The resulting fibre is dimensionally very accurate and has the low attenuation of only 2 dB/km over the interesting wavelength range of 0.8 to 0.9 μm where gallium arsenide lasers and light-emitting diodes operate. Figure 4 shows that the transmission loss is low over a wide range; only one other fibre has been produced having a lower attenuation and that not, apparently, repeatedly.

BANDWIDTH

Another major factor of prime importance in the design of optical fibres for signal transmission, and indeed of any communications medium, is the bandwidth or maximum rate at which information can be transmitted.

The components of a modulated carrier wave cover a spread of frequencies and normally all travel at different velocities (an effect called dispersion) so that over a long length of fibre the components become separated in time, and distortion

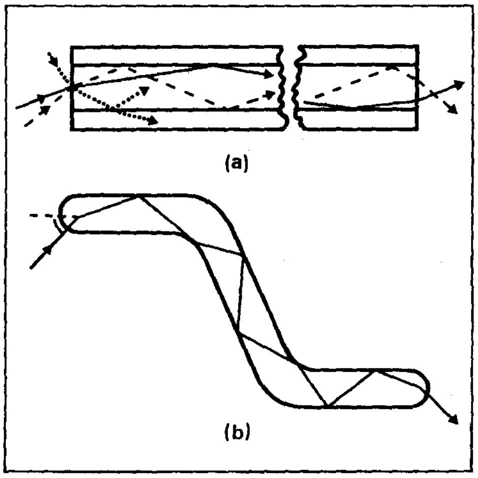


Fig.2. Ray propagation along a cladded multimode fibre.
a). Rays incident on the core/cladding interface at an angle greater than the critical angle are completely reflected (if core and cladding are lossless) and are guided by the core. The ray represented by the dotted line falls outside the numerical aperture of the fibre and loses energy at each reflection.
b). Providing a ray strikes the interface at an angle to the normal greater than the critical angle it will continue to be reflected along the fibre, even around bends.

LASERS, LIGHT AND TELEPHONES

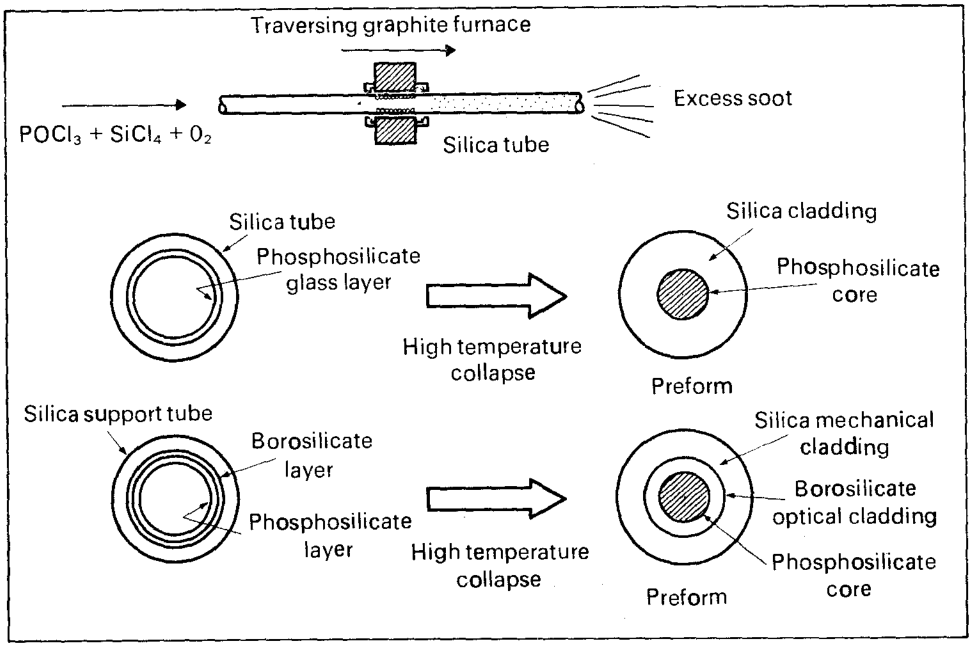


Fig.3. The manufacture of phosphosilicate fibres. In the two-layer process the silica tube acts only as a supporting structure.

occurs. In a single-mode fibre, that is, one with a very fine core, the limiting dispersion is that caused by the bulk glass and the particular surface wave mode and corresponds to pulse rates, or bandwidths, of several gigahertz over several kilometres. However, if a semiconductor laser source is used, the spread in its output would limit the overall bandwidth to about 1 GHz over 1 km or perhaps even less. There are problems with single-mode fibres because of the very small core diameter (about 1 μm), namely those of launching efficiently from semi-conductor lasers and jointing (especially at night in a trench in the rain!) between adjacent sections of fibre. To get fibre ends flat and accurately aligned to an accuracy of better than 0.1 μm is no mean problem.

MULTIMODE FIBRES

An alternative approach, begun in 1967 as a joint project between Britain's Signals Research and Development Establishment and the Department of Electronics at the University of Southampton, is to consider multimode fibres.

These have core diameters in the region 20 to 100 μm and are easier to manufacture than single-mode fibres. However, because of the large core diameter they are capable of supporting many modes and it was expected that the bandwidth would be quite small. For a thick-core fibre, instead of thinking of modes, it is more convenient to visualise energy propagation in terms of rays, as discussed earlier, which travel along the fibre by total internal reflection from the core/cladding interface. As long as the angle to the interface is not greater than that corresponding to the critical angle, given by $\cos^{-1}(n_2/n_1)$ where n_1, n_2 are the refractive indices of core and cladding respectively, no energy is coupled into the cladding, at least when the latter is lossless.

If an input beam is launched so as to fill the aperture of the fibre, or if scattering occurs, then the spreading of a transmitted pulse can become comparable with the difference in transmission times o' the axial and extreme rays which, for a length of 1 km and a typical fibre, is 0.5 μs. This is equivalent roughly to a bandwidth of 1 megahertz. However, careful measurements showed that if a narrow beam is properly launched into a well-made fibre, a pulse spread of as little as 0.3 nano-seconds (ns) occurs over 50 m with core diameters in the range 50–100 μm. It followed that if such a low dispersion could be maintained for greater lengths, a bandwidth exceeding 100 MHz over 1 km might be attained. This is greater than that currently available from coaxial cables, and the spatial multiplexing which is possible increases the advantage still further.

Later work has confirmed this result, and, by the introduction of a refractive index which falls gradually from the axis of the core, instead of having a step changed at the core/cladding interface, the phosphosilicate and other fibres can be made to have a bandwidth of 1 GHz over a 1 km length.

TELEVISION TRANSMISSION

As a result of these and other developments there is now a great interest in the use of optical fibres for communications. The major difficulties of attenuation and bandwidth have been solved but before fibres find widespread applications there are many other problems to be faced, such as jointing and cabling, but these are not likely to be difficult. The first use of fibres is likely to be for special links such as data or television transmission, with trial installations in the telephone network following by the end of this decade.

Equipment developed and built at Southampton University for the BBC was used in the first commercial application of optical fibre communications by any national network in January 1973, when an entire colour television programme from the Royal Institution was sent through 1.25 km of fibre before being broadcast. The electrical signals from the colour camera were taken to drive circuits feeding into a light-emitting diode, which turned the fluctuations of electric current into fluctuations in light intensity passing along the fibre. Light emerging from the fibre was directed onto a fast-acting light detector so as to reproduce faithfully the original electrical signal, and the output from the detector was amplified and fed to the television transmitter. Thus the pictures on all the domestic receivers had been transmitted through a long length of fibre. Needless to say there was no deterioration in the normal picture quality.

POTENTIAL

The simple but realistic demonstration described above showed that glass fibres can be used for long-distance communication. Various forms exist and while the ideal fibre has perhaps not yet been made, suitable ones are already available. Light detectors are no problem. Although present-day diode lasers are not yet reliable enough, they are getting better all the time and light-emitting diodes can also be used.

If optical-fibre transmission lines are put into use what effect will they have on our everyday lives? Initially the result would not be spectacular but it would mean that telephone system costs would not rise as fast as they would do otherwise, and telephoning might become easier. Videophones which require 300 times the frequency space of conventional telephones, might become feasible. Branches of banks are connected to a central computer to enable a rapid and up-to-date check to be kept of all accounts, a service so valuable that perhaps in the future offices and factories of most firms may be inter-connected in the same way, thus increasing the amount of data transmission throughout the country. Already attempts are being made to provide computerised references for research workers, and the logical extension of this would be to commit all journals and books to some form of computer store. It would then be possible to do away with most school, college, industrial and public libraries in favour of video links to a relatively few regional centres. The advantages would be many.

There are many other fascinating possibilities. If a glass fibre cable can be made as cheaply as the telephone wires that come into the home from the local exchange, then the meagre bandwidth we presently have could be greatly increased.

The private citizen could have a communication capability, or bandwidth, exceeding that of any commercial or private enterprise today. He could have direct access to a national or regional computing centre and could dial the computerised library of the future from his armchair, to have pages from books displayed on his own TV screen.

If we miss our favourite TV programme perhaps we could dial it from a video store at a time convenient to us rather than to the television authorities.

Viewed objectively the present method of disseminating news by means of newspapers is crazy. We cut down acres of forest, ship thousands of tons of wood pulp all over the world. When the papers are printed, trains and trucks and vans in every country carry hundreds of tons of newspapers in all directions and thousands of paper boys and girls deliver them to homes. After that there is the problem of disposing of them. Great damage is done to the environment and there is a great waste of natural resources. Sending news by electrical or optical means is easier and much more efficient. It would be more sensible to dial our newspapers from home and read them on the television screen.

There are lots of other exciting ideas — it has even been suggested that instead of *commuting* to work we will *communicate* to work. These developments will depend on our ability to understand, design and produce new and better materials, and to make communicating with light a practical reality. ●

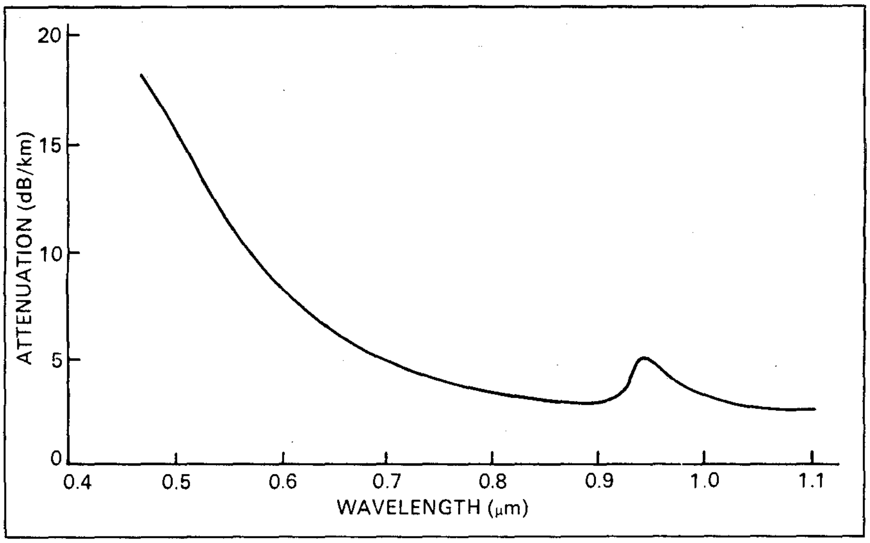
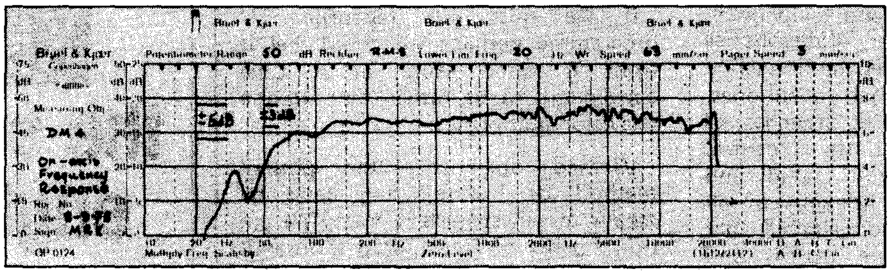


Fig.4. Spectral attenuation curve of a 1.2 km length of silica-cladded fibre with phosphosilicate core.

Lots of people tell you what their speakers will do.



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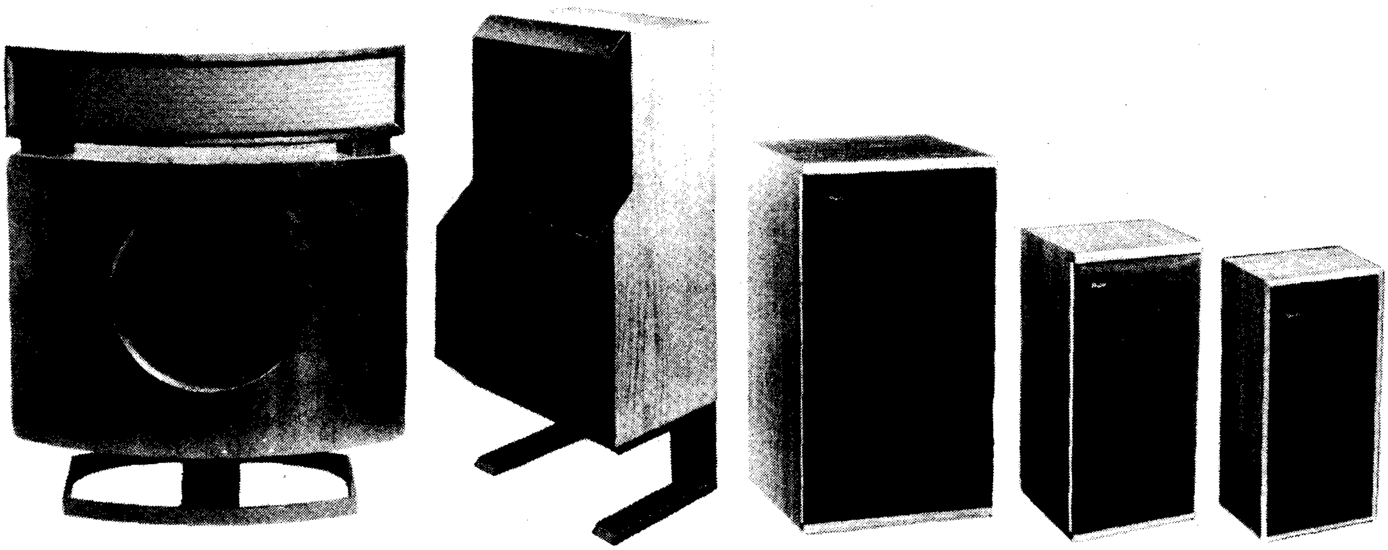

B&W DM70 Monitor Electrostatic.
A combination of dynamic bass unit and electrostatic mid and high frequency module. One of the best speakers you can buy.

B&W DM6 Monitor.
A brand new design. A high powered dynamic loudspeaker with low colouration and very high transient performance.

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A more conventional design, utilising B&W research into acoustic line rear loading. Brilliant clarity and lack of distortion.

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A speaker with large B&W Monitor characteristics; its performance surpasses speakers of much greater size.

B&W D5.
A speaker for small living areas. It has above average performance at moderate cost.

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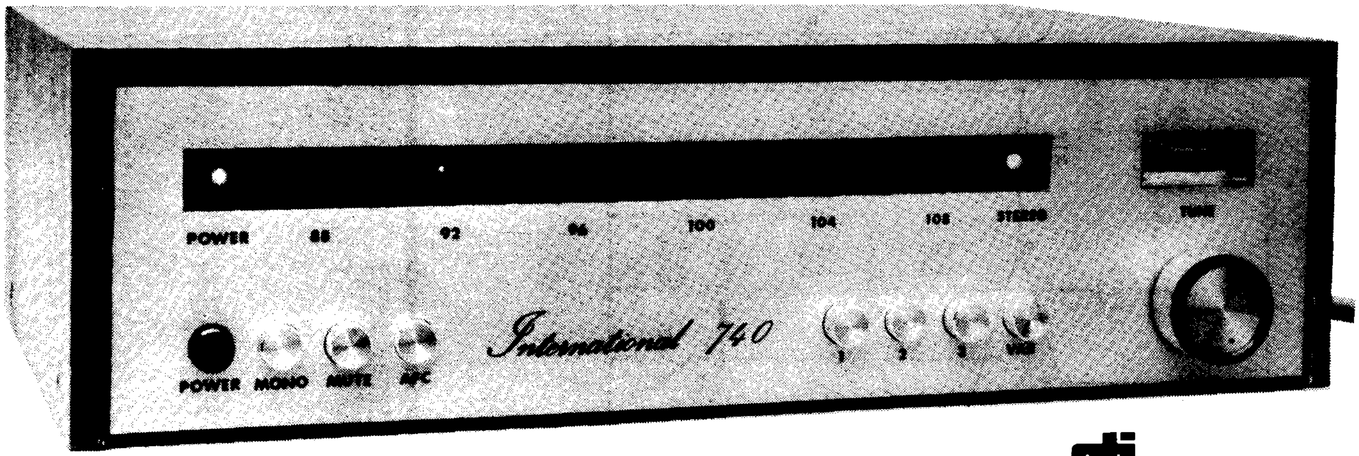
FM TUNER



Full constructional details.

PROJECT 740

> **KITS**
>
> All components, part kits and full kits for this project are available now from Applied Technology Pty Ltd, 109-111 Hunter St, Hornsby, NSW 2077. Tel: 476-4758.
>
> NOTE — The front panel supplied with project is now silver lettering on black — to match ETI440 amplifier — not as shown in our lead picture.

THE ETI 740 tuner has been designed with the aim of making it as simple as possible for the inexperienced hobbyist to build. The only components not mounted on the printed circuit boards are the fuse, input and output sockets, tuning meter and the tuning potentiometer. Interconnecting wires have been reduced to an absolute minimum. Whilst only two boards have been used, the main printed-circuit board has been laid out in such a way that it may, if so desired, be cut up if it is required to build the modules separately.

CONSTRUCTION

Components may be assembled on to the main circuit board in any sequence, but we recommend that the lowest height components, eg resistors and diodes, be fitted first followed by the larger components. Ensure that the diodes are inserted with the polarity as marked on the overlay and that integrated circuits are orientated correctly. The cbe connections shown on the overlay for the BC548 and BC558 transistors are correct for Philips devices. If other makes are used the connections may be different and should be carefully checked.

The tuner is installed by first securing it into position with a piece of double-sided tape. The terminals are then connected to the board by means of tinned-copper wire links. Pin 2 of the tuner module should only be connected to the main printed-circuit board if the main amplifier used in association with the tuner is not earthed. The transformer and the function switches are mounted directly onto the printed-circuit board.

Commence the assembling of the display board by installing the nine links shown on the overlay. To install the LEDs it is first necessary to cut a piece of fibre-glass board 230 mm long by 4 mm wide. By examining the photographs it is possible to see how this strip of fibreglass is used to align the LEDs and to correctly space them from the printed-circuit board. It will be noticed that some links pass beneath this strip and it is therefore advisable to file small notches for the links so that the strip sits down flat on the printed-circuit board. Do not force the LEDs over the strip, if they are tight, file the strip until they slip on easily. Note that all the LEDs are mounted so that the cathode lead, marked by the notch, flat or longer lead, is on to the top of the display board.

The rest of the components may now be mounted taking particular care to locate the trim potentiometer flush with the board. If desired, although not essential, a hole may be drilled through the display board so that the trim potentiometer may be adjusted from the rear after the unit is mounted in the chassis. If the hole is not so drilled the potentiometer must be adjusted before the unit is mounted into the case.

The two boards are joined together by tinned-copper links. This should be carried out by first soldering 20 mm long tinned-copper leads to the display board (nine leads required). Bend these leads so that they lie flush with the board and then thread them through the mating holes in the main printed-circuit board. The display board should be positioned behind the mounting surface of the function switches and secured to the switches by self-tapping screws or nuts and bolts.

The power switch and the mains transformer are both mounted directly onto the printed-circuit board and for safety sake we feel that it is necessary to insulate these areas of the board with a layer of epoxy cement as shown in the photograph. It is also necessary to insulate the terminals on the top of the power switch (both used and unused).

We advise that the completed module now be carefully checked for any errors in component installation. Also check that all joints have been correctly soldered. The unit may now be temporarily connected up to the tuning meter, potentiometer and power cord and then connected to an amplifier for testing before final assembly (see section below).

After testing is satisfactorily completed the module may be installed in the case and all the controls and power lead etc properly connected. The front panel is secured to the front of the chassis with a little contact cement and is also secured by the potentiometer nuts. The polarized plastic window in the front panel is

(Main text continues page 32)

FM TUNER

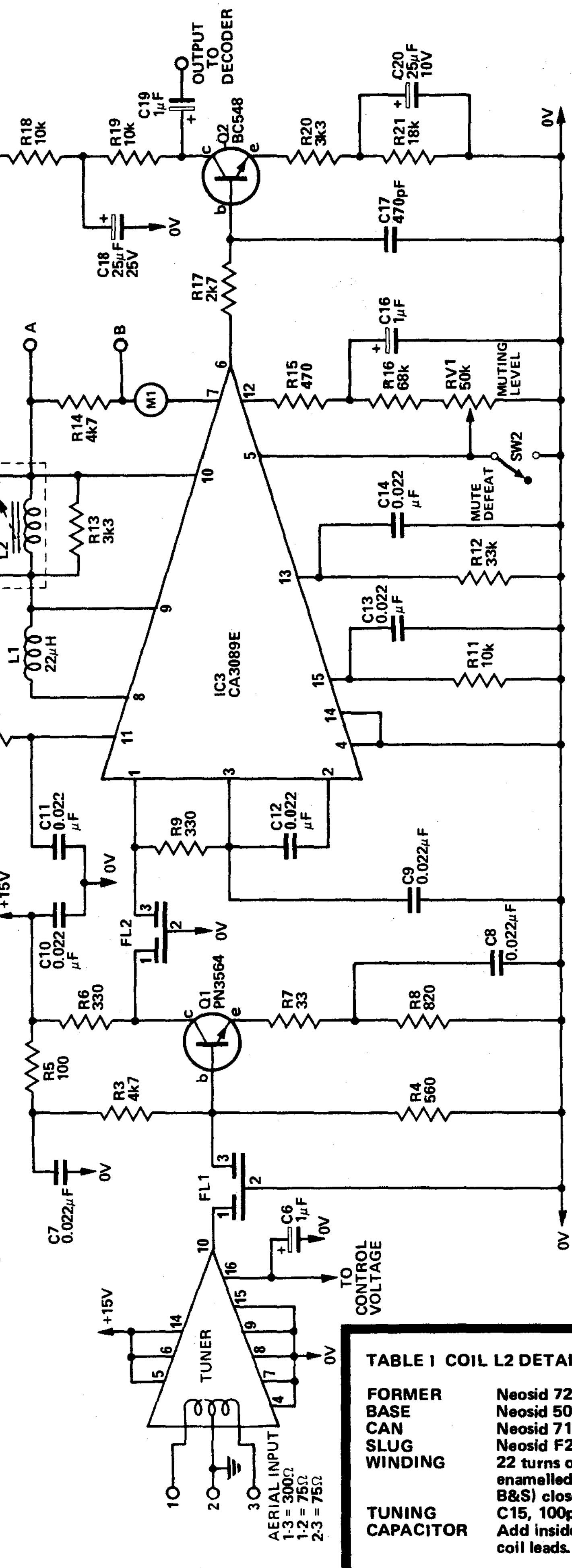


Fig. 1. Circuit diagram of the front end including the tuner and the CA3089E FM if stage.

TABLE I COIL L2 DETAILS

FORMER	**Neosid 722-1**
BASE	**Neosid 5027/6PLB**
CAN	**Neosid 7100**
SLUG	**Neosid F29**
WINDING	**22 turns of 0.63 mm enamelled wire (22 B&S) close wound.**
TUNING CAPACITOR	**C15, 100pF ceramic. Add inside can across coil leads.**

PARTS LIST ETI 740

R7	Resistor	33ohm	5% ¼ or ½W
R5,10,24	"	100 "	" " "
R6,9	"	330 "	" " "
R15	"	470 "	" " "
R4	"	560 "	" " "
R8	"	820ohm	" " "
R2,25,26	"	1k	" " "
R37,56	"	1k	" " "
R48,54	"	1k5	" " "
R17,50	"	2k7	" " "
R13,20	"	3k3	" " "
R1,3,14	"	4k7	" " "
R27,28,49	"	4k7	" " "
R53,55	"	4k7	" " "
R41	"	8k2	" " "
R11,18,19	"	10k	" " "
R33,34	"	10k	" " "
R23,38	"	15k	" " "
R21	"	18k	" " "
R29,30, 31,32	"	22k	" " "
R12,51	"	33k	" " "
R40	"	39k	" " "
R47	"	47k	" " "
R16	"	68k	" " "
R22,39,52	"	100k	" " "
R43,45	"	120k	" " "
R46	"	150k	" " "
R42	"	220k	" " "
R44	"	820k	" " "
R35,36	"	1M	" " "
RV1	Potentiometer	50k TRIM TYPE	
RV2,3	"	5k TRIM TYPE	
RV4,5,6	"	50k MULTI TURN TRIM	
RV7	"	100k 10 TURN ROTARY	
C15*	Capacitor	100pF ceramic	
C31,32	"	220pF "	
C17,21	"	470pF "	
C29,30	"	0.001µF polyester	
C27,28	"	0.01µF polyester	
C7,8,9	"	0.022µF Disc ceramic	
C10,11,12	"	0.022µF Disc ceramic	
C13,14	"	0.022µF Disc ceramic	
C1	"	0.033µF 250V ac	
C23	"	0.047µF polyester	
C24,25	"	0.22µF polyester	
C26	"	0.47µF polyester	
C6,16,19	"	1µF TAG Tantalum	
C33,34	"	1µF TAG Tantalum	
C35	"	4.7µF 10V electro	
C22	"	22µF 16V TAG Tantalum	
C20	"	25µF 10V electro	
C18,36	"	25µF 25V electro	
C2	"	47µF 63V electro	
C3	"	1000µF 25V electro	
C4	"	100µF 63V electro	
C5	"	100µF 35V electro	
L1	Inductor	22µH	
L2	"	see table 1	
D1-D4	Diodes	EM401 or similar	
D5,6	"	IN914 or similar	
LED 1,18	Light emitting diode GREEN		
LED 2-LED 17	Light emitting diode RED		
Q1	Transistor	PN3564 or similar	
Q2,3,4,5	"	BC548 or similar	
Q6	"	BC558 or similar	
IC1	Integrated Circuit	7815	
IC2	" "	TAA 550	
IC3	" "	CA 3089	
IC4	" "	LM 1310 (14 pin)	
IC5	" "	UAA 170	

TUNER — PHILIPS — AP 2157

SW1-4	Switch Module IRH	P/N TS0361
SW5-8	" " IRH	P/N TS0362
M1	Tuning meter 50µA-0-50µA	
T1	Transformer PL 30/5 VA (Ferguson) or similar	
PCB	ETI 740 A ETI 740 B	

Fuse holder and 500 mA fuse
3 core flex and plug
Rubber grommet
Cable clamp
2 Earth lugs
75 ohm socket
2 pin plug and socket McMurdo P/N 12-01-01, P/N 18
2 WAY RCA socket McMurdo P/N 1291-03-02
4 12.7 mm tapped spacers (1/8 whit)
16 Screws 1/8 whit 6 mm long R.H.
8 Nuts 1/8 whit
150 mm Twin coax cable
50 mm 300 ohm ribbon
Knob for tuning pot
Chassis to fig 11
Front panel to 10
Cover to fig 9
Rubber feet (4)
75 mm x 25 mm double sided tape.
10 pc board pins
250 mm x 35 mm circular polarized plastic

HOW IT WORKS – ETI 740

The AP2157 is a varicap tuner module which tunes frequencies within the range 88 to 108 MHz by means of a control voltage adjustable between 3.3 and 22 volts. The frequency tuned is not linearly related to the control voltage and a much higher increment of voltage per frequency increment is required at the high end of the band. The tuner operates on the heterodyne principle and hence the incoming signal is mixed with a local-oscillator frequency which is also varicap controlled so that a 10.7 MHz IF frequency (difference) is produced by the mixing process, the sum product of the mixing process being rejected by the following IF stages in the tuner.

The tuner is followed by an IF filter, FL1, and then by a transistor to compensate for the 10 dB loss in the filter. The transistor is followed by a further IF filter. The filters are followed by IC2, a CA3089 which is a complete IF amplifier, limiter and detector system. Thus from this chip we obtain an audio output, an output which can be used for muting, and an output voltage proportional to signal strength which can be used to control the gain of the RF stage (ie AGC).

The distortion introduced by this IC is dependant on the phase linearity of the quadrature coil L2. With a single tuned circuit the distortion is typically 0.5% whilst with a doubled-tuned circuit it is typically only 0.1%. However test equipment is needed to align the double-tuned coil and for this reason we have used the single-tuned circuit.

The output of IC2 is amplified by Q2 before being passed to the stereo-decoder IC3. The purpose of Q2 is to provide the gain necessary to obtain an adequate drive for the particular power amplifier used with the tuner. The gain is determined by the ratio of R19/R20 and may be altered by changing the value of R20.

The stereo-decoder IC, an LM1310, works on the phase-locked loop principle. The loop is locked to the 19 kHz subcarrier (if present) and decodes the stereo signal accordingly. The stereo outputs have the required 50 microsecond de-emphasis applied by R27/C27 and R28/C28. Each output is then taken through a low-pass filter (Q3 and Q4) which gives an added 4 dB rejection of the 19 kHz pilot tone (which is already 34 dB down) and an extra 20 dB rejection of the 38 kHz which is already 45 dB down. Additional filtering was not considered necessary. The stereo-defeat facility is carried out by raising the phase-lock loop frequency out of the lock range of the loop.

The +15 volt supply is derived from a full-wave rectifier followed by an IC regulator. The voltage required for the varicaps is derived by a voltage doubler which provides about 55 volts on C4. This is reduced to 32 volts by R1 and IC2. IC2 is an active zener specially designed for varicap supplies. The varicap supply is again filtered by R2 and C5 further to reduce the amplitude of any supply ripple which may still be present. This supply is then fed to the tuning potentiometers RV4,5,6 and 7, the end limits of these potentiometers being set by R48 and R49. In the AFC mode the AFC voltage derived by the CA3089 IF stage is used to control, via Q4 and Q5, the voltage at the top of the tuning potentiometers and hence provides automatic tuning within a small capture range.

The output of the station selector network is fed to IC5 as well as to the tuner. This IC is an analogue-to-one-of-sixteen decoder and LED driver. One of the 16 display LEDs will be alight – which one is on depends on the input voltage. The LEDs come on at sixteen equally spaced voltages between the limits of the two voltages as set on pins 12 and 13 of the UAA 170 IC. The input voltage to the IC is modified by a diode-resistor network (D5, D6 etc) to compensate for the non-linear relationship of frequency versus tuning voltage of the tuner. Thus this network provides a reasonably linear dial scale.

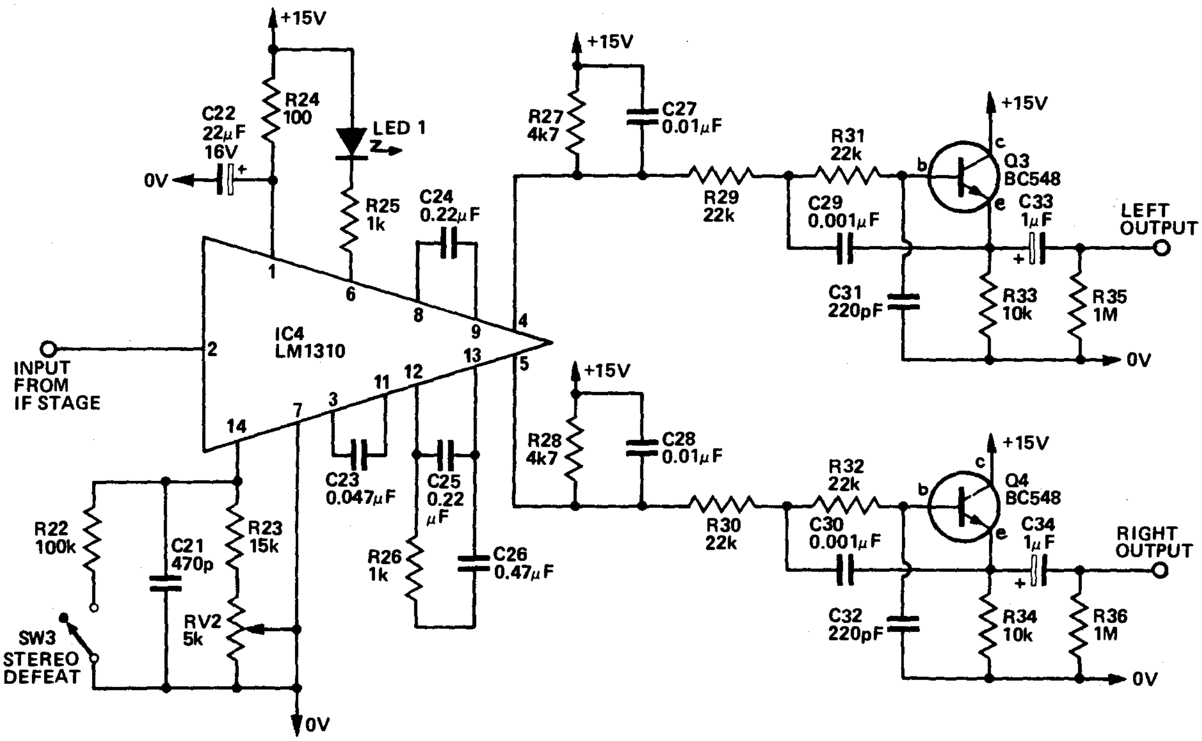


Fig. 2. Circuit diagram of the stereo-decoder stage.

FM TUNER

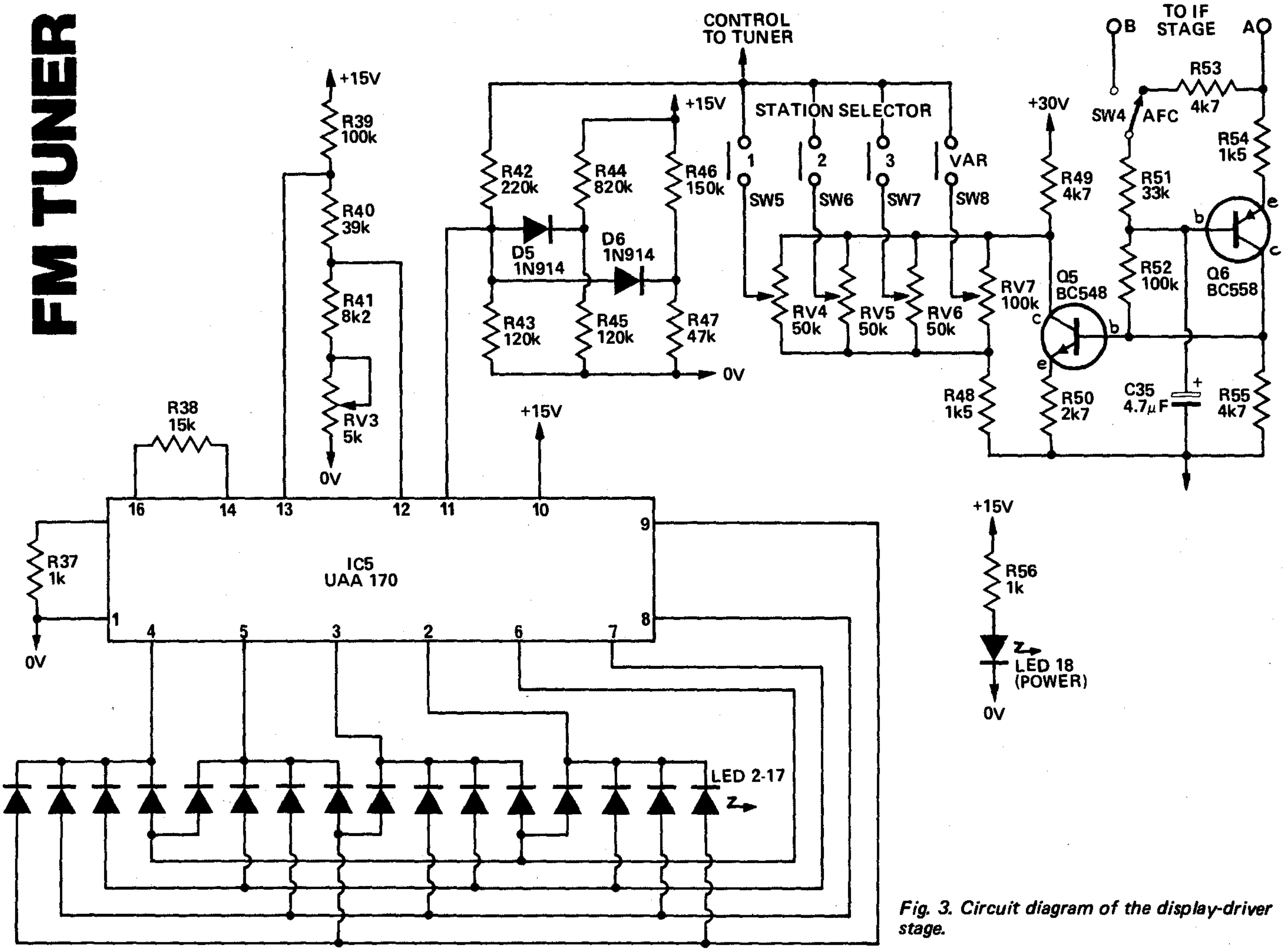
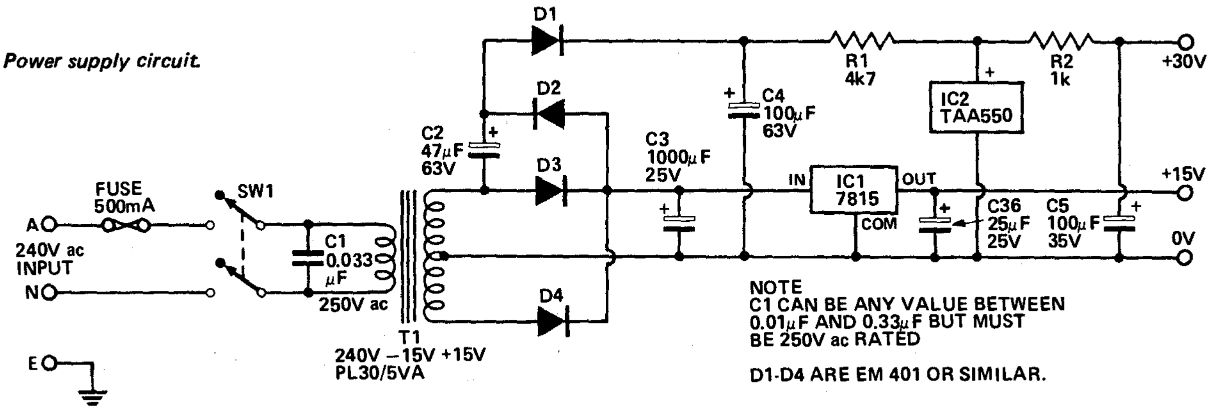


Fig. 3. Circuit diagram of the display-driver stage.

Fig. 5. Power supply circuit.



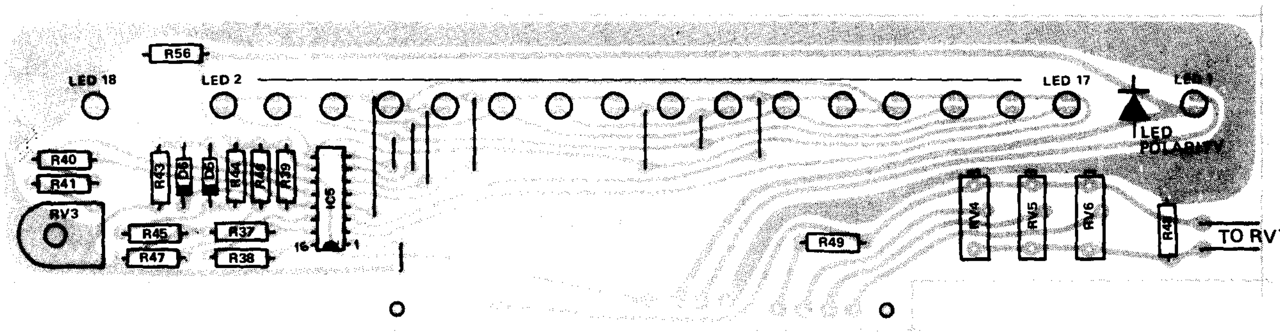


Fig. 4. Component overlay for the display board.

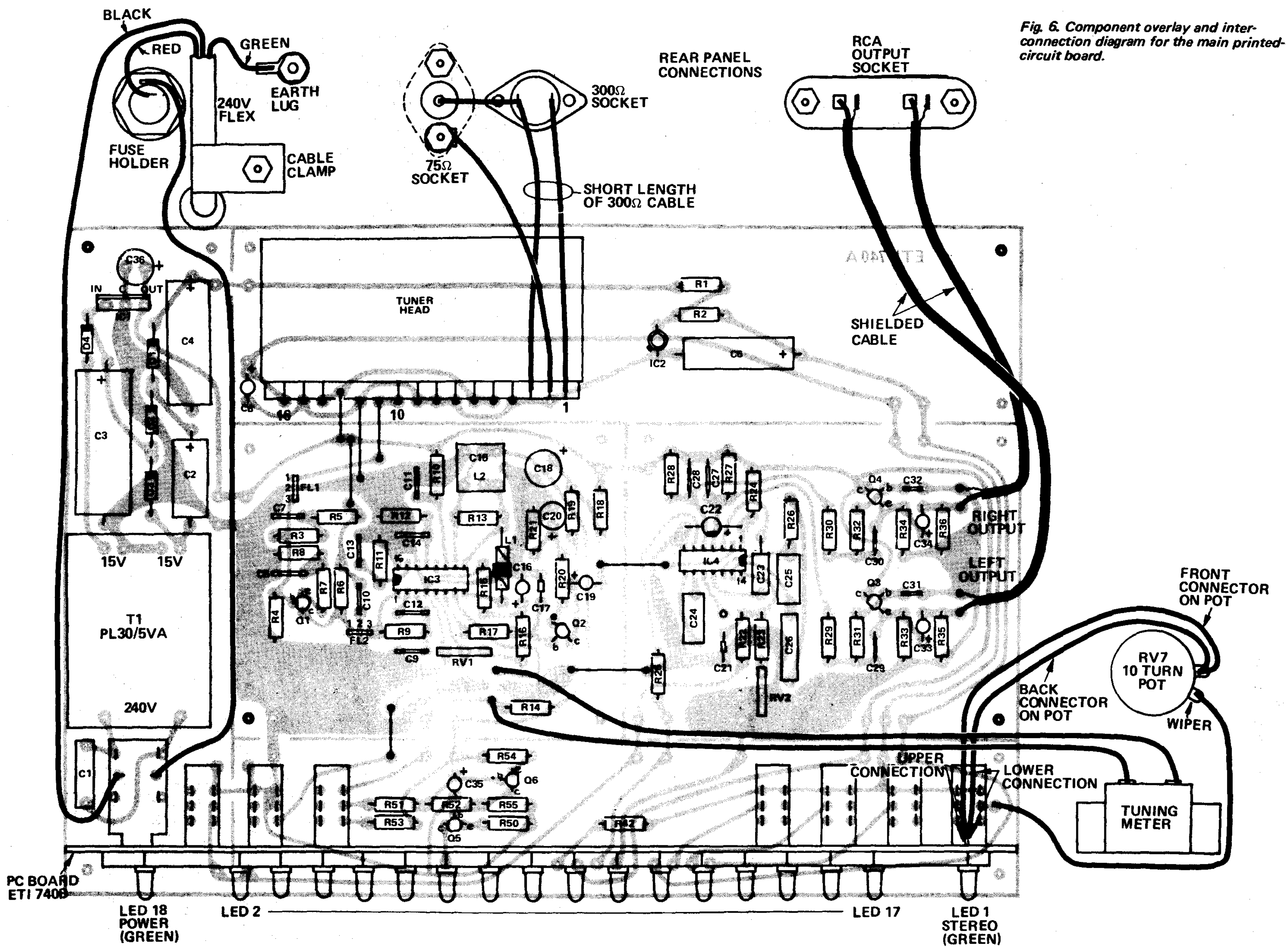


Fig. 6. Component overlay and interconnection diagram for the main printed-circuit board.

FM TUNER

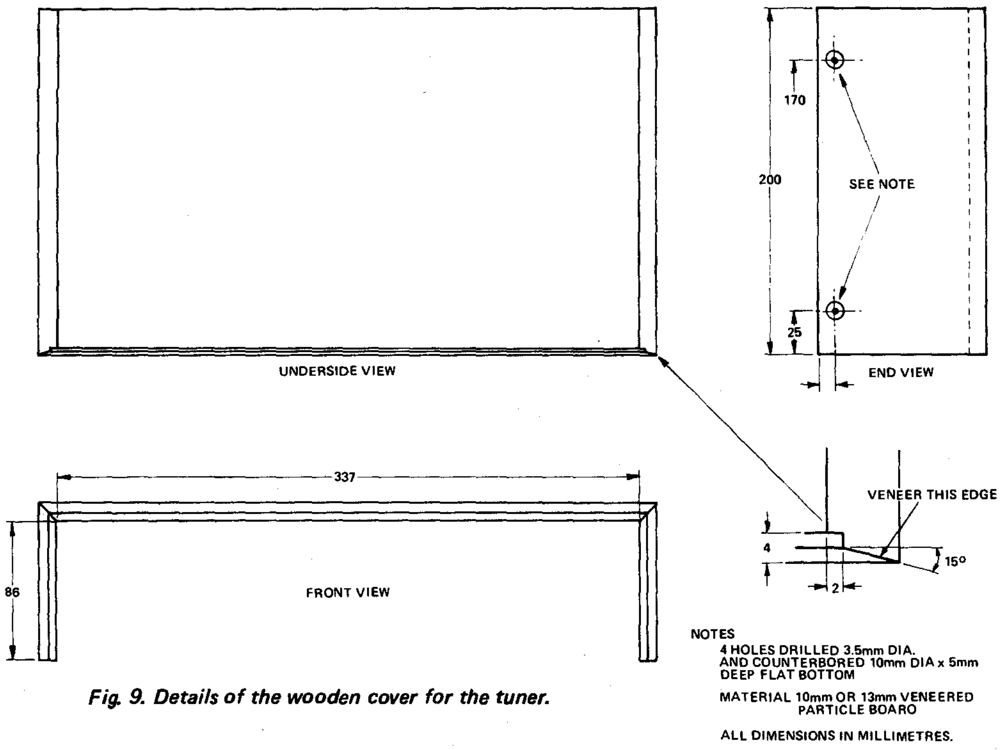


Fig. 9. Details of the wooden cover for the tuner.

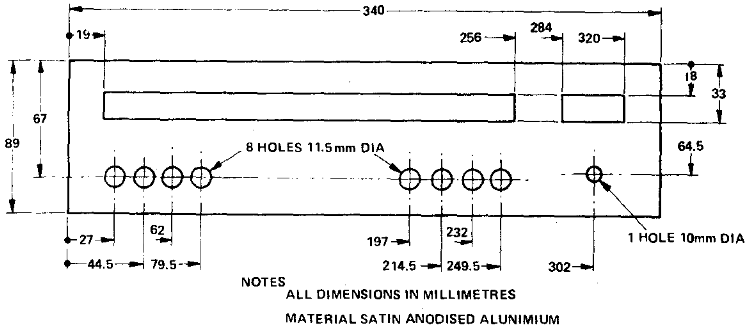
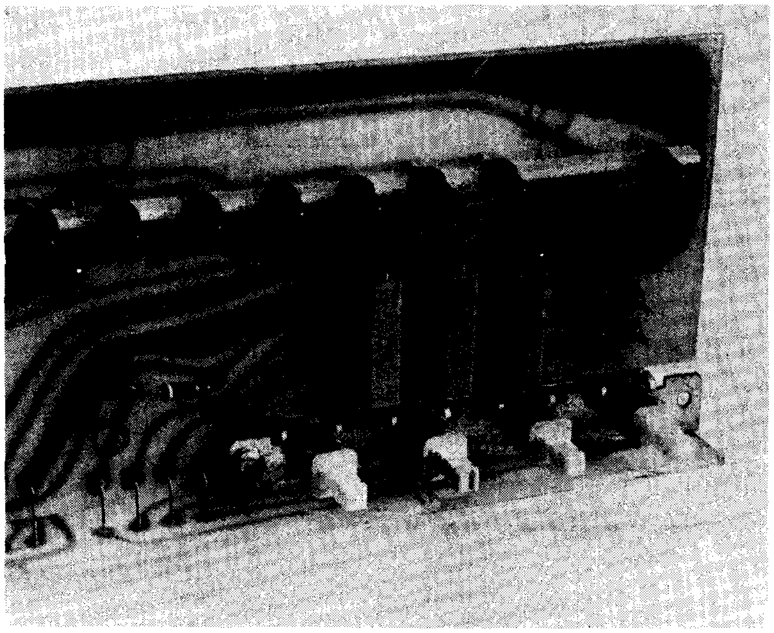


Fig. 10. Front panel metalwork.



secured to the inside of the front panel – again by contact cement. The tuning meter is held in position by epoxy cement to avoid having screws protruding through the front panel.

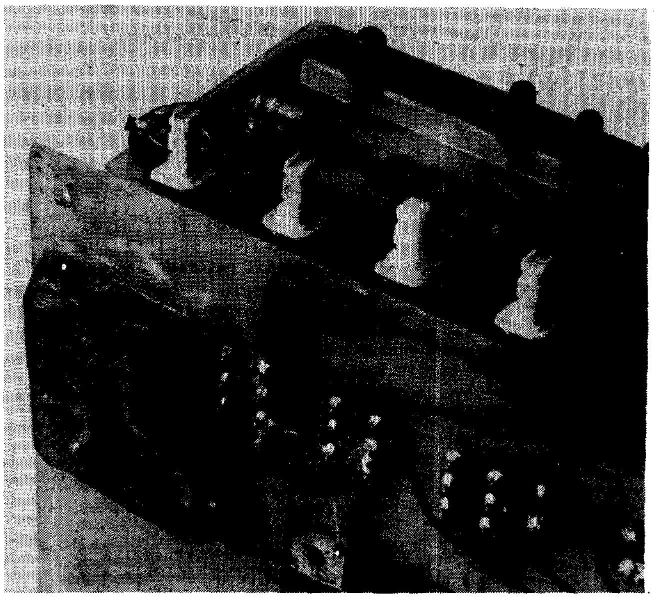
TESTING

Switch on the power and check that the +15 V and +30 V supplies are both operating correctly. The power indicator LED and one of the display LEDs should be alight.

Select STEREO MODE, MUTING OFF, AFC OFF and VAR. By rotating the tuning potentiometer it should be possible to sequentially vary the LED's illuminated.

Adjust the tuning potentiometer (RV7) so that its output is 3.5 volts from the slider with respect to 0 volts, and then adjust RV3 so that the first and second LEDs are both equally illuminated, (see below).

Connect an antenna and tune in a strong audible signal. Measure the voltage across R12 and adjust the tuning for maximum reading (voltage across R12 is proportional to signal strength). Now adjust L2 so that the tuning meter indication is exactly at centre. Next adjust the tuning so that the tuning meter indicates about half scale away from centre and press the AFC switch. The tuning meter should move back to centre indicating that the AFC circuit is working correctly.



▲
This view shows how the solder joints at mains potential are insulated with a layer of five minute epoxy. Note also RV3 on the display board.

◀ *This picture shows details of the mating of the main and display boards. Note the alignment strip for LEDs, the mounting of the switches and how the display board is secured to the switch bracket.*

Now move completely off the station. The noise level will increase suddenly. Press in the muting switch and adjust RV1 to reduce the noise level so that it is almost inaudible. Do not try to eliminate *all* the noise as this may prevent weak signals from being heard.

Finally tune to a station which is known to be transmitting in stereo. A zone will be found in the adjustment of RV2 where the stereo indicator is on. Position RV2 to the mid position of this zone. The light should go off if the MONO switch is pressed. Note that the noise behind a stereo signal is higher than when in mono.

In some parts of Australia, FM stations may be spaced only 800 kHz apart – and the same LED may be illuminated when either station is tuned. Separate LED indication may be obtained by slightly readjusting RV3.

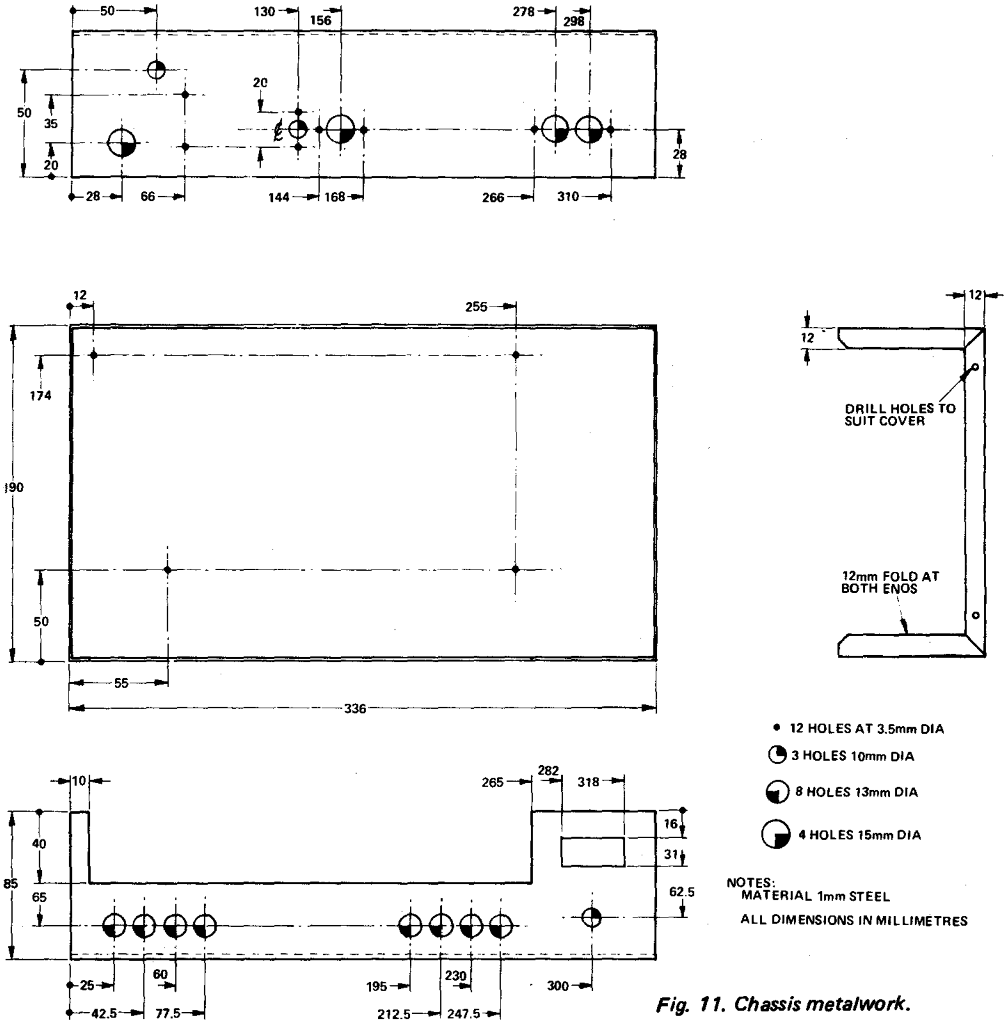


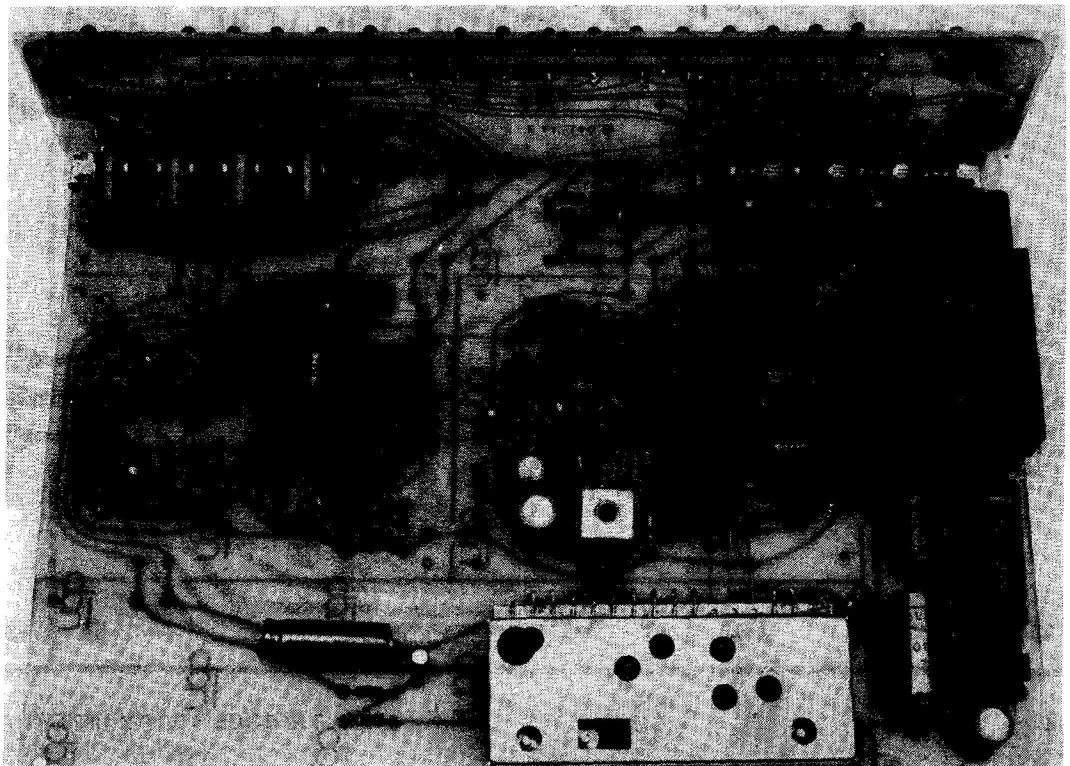
Fig. 11. Chassis metalwork.

TUNER MODULE

The tuner module as supplied to us had provision for either 75 or 300 ohm inputs as shown on the circuit diagram. Philips have advised that all the AP 2157 tuner modules in stock at the moment are fitted with both inputs. They cannot guarantee that future stocks will have the 300 ohm input. To check if your tuner has a 300 ohm input measure the resistance between pins 1 and 3 of the tuner module with an ohmmeter, a low resistance indicates that the tuner has a 300 ohm input. If the tuner does not have a 300 ohm input it will be necessary to use a balun when using it with a 300 ohm antenna. Of course if the feed from the antenna is 75 ohms it may go straight into the tuner 75 ohm input.

Note that the following errors occurred in the introductory article last month.

The LED spacing in the dial is 1.25 MHz not 800 kHz.
The display is an UAA 170 not an UA 170.
The varicap stabilizer is a TAA 550 not a TA 550.



Internal view of completed unit.

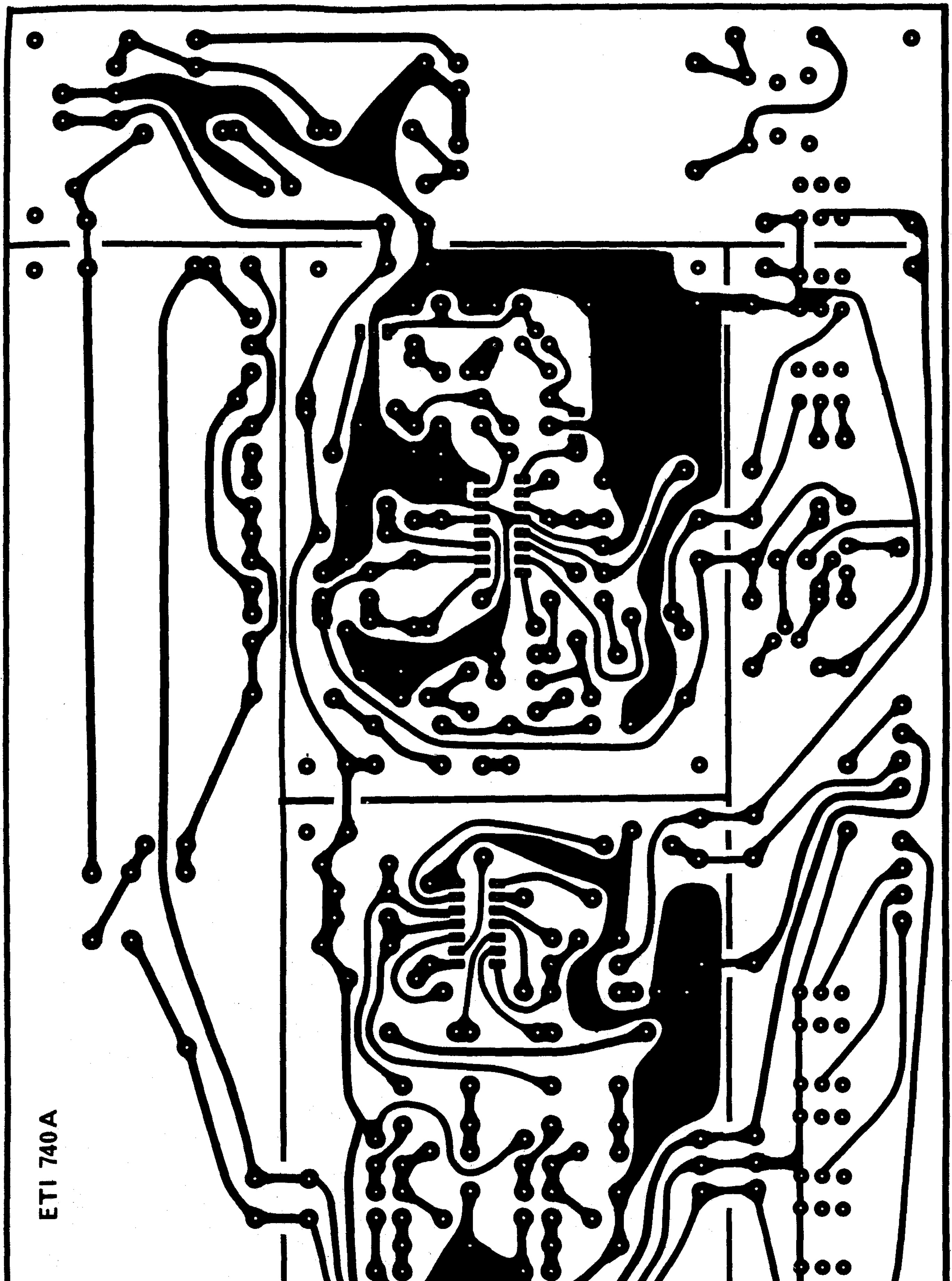


Fig. 7a. Main printed-circuit board artwork. 253 mm x 177 mm.

FM TUNER

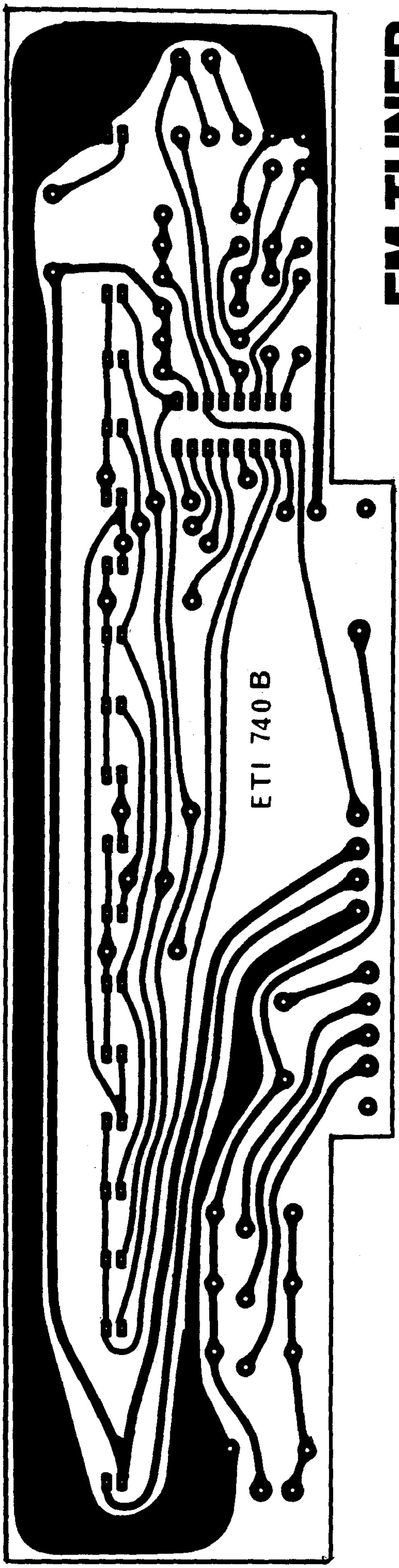


Fig. 7. Printed circuit layout for the display board. 253 mm long.

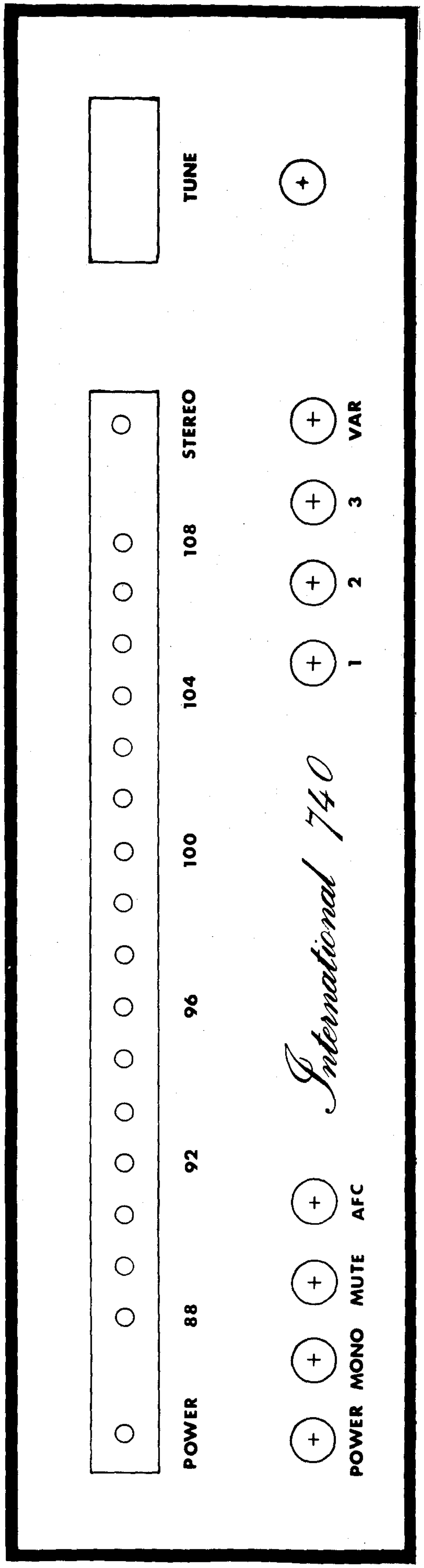
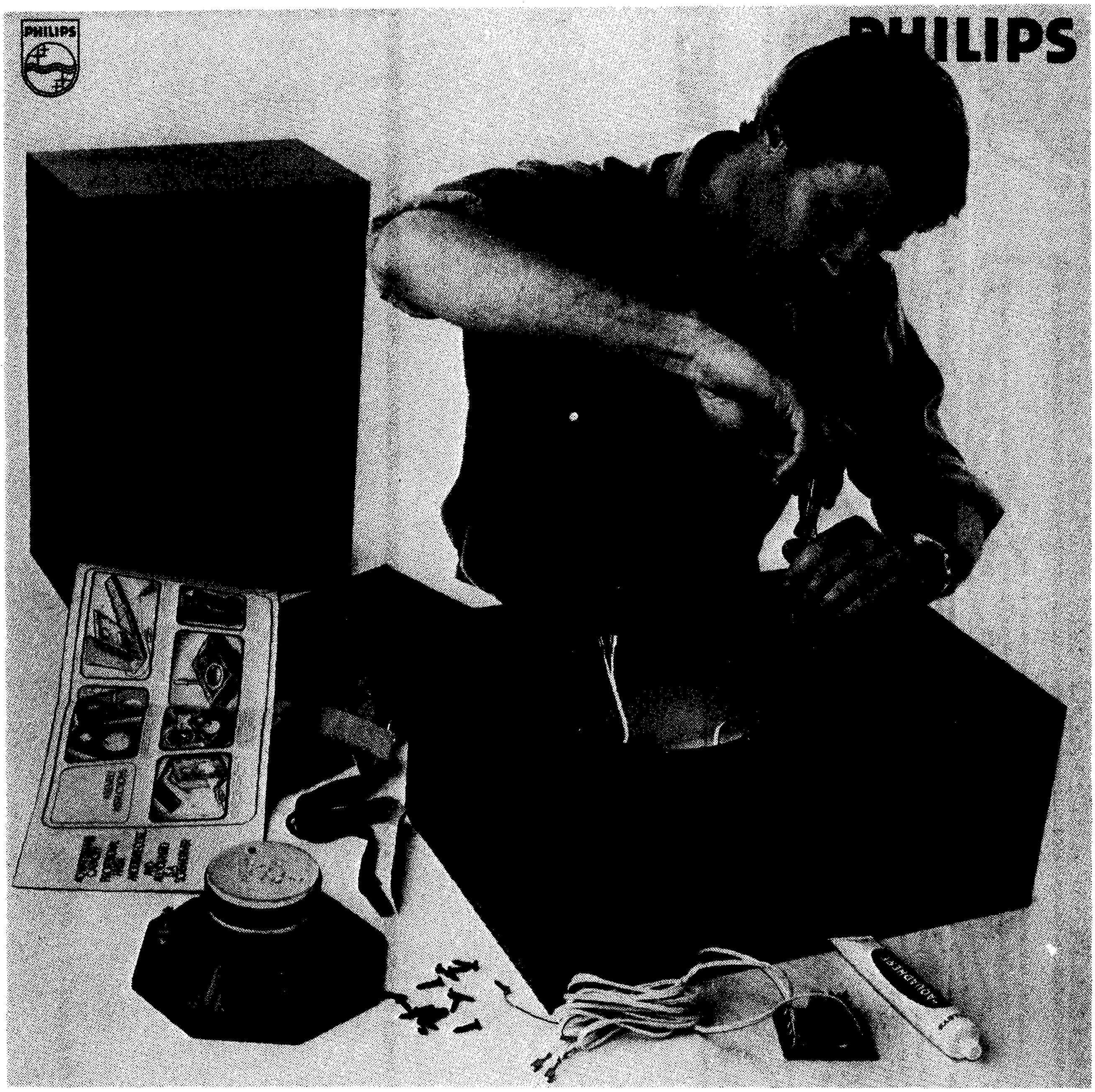


Fig. 8. Front panel artwork. Full size 340 x 89 mm.



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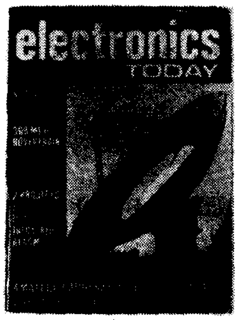
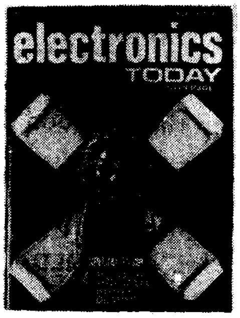
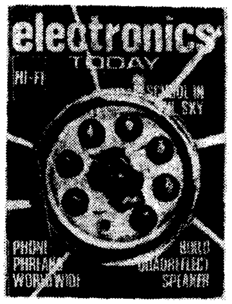






We're 5 years old next Month

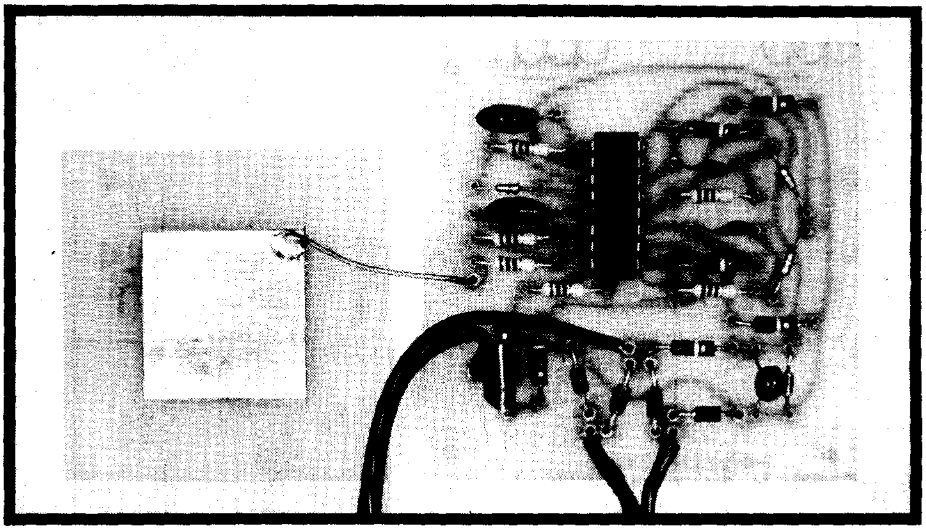
To mark the occasion we're making our April issue into a 'birthday special'.

FEATURES INCLUDE:

- Major contest – prizes three colour TVs.
- Special electronics data supplement.
- New feature series – 'Project Builder's Guide to Components'.
- High constructional project content.
- Plus – further special features with exceptional reader appeal.

The special content of this issue will ensure that it will be kept and referred to for years to come – and advertisers please remember that in ETI the advertisements are read as avidly as the editorial!

Thank you for your support and encouragement during our first five years – we look forward to publishing a page like this in 1981 – when we're ten!



New 240V design offers toggle action and complete safety.

TOUCH SWITCH

TOUCH switches are fascinating devices and have been in use for many years in lift controls. The circuit used in lifts usually consists of a high-frequency oscillator which has a touch plate connected to the tuned circuit. When the plate is touched the additional capacitance introduced either detunes the oscillator thus changing the frequency, or couples the oscillation into the detector and switching circuitry. This approach, whilst effective, is very expensive and thus touch switches of this type are not widely used.

Most of the touch switches published in electronics magazines to date have required the sensing element actually to be touched – usually via a series resistor of about one megohm or higher. Such circuits rely on body resistance to activate the switch, and are therefore not safe for use in controlling devices operated on 240 Vac.

In the touch switch described in this project, it was specified that the action of the switch should be touch-on touch-off and that no actual contact with the circuit be made (for safety reasons). These constraints led us to use a capacitive circuit. The touch plate is in effect a capacitor. When this plate is touched, the input of the first stage is capacitively referenced to earth, however as the supply rails to the control circuit are floating at rectified 240 Vac the 50 Hz waveform effectively appears at the input of the control circuit and initiates the switch action. The actual contact plate is a piece of single-sided printed-circuit board arranged so that the *non-copper side* is touched – the copper on the other side is connected to the control circuit. Thus a full 1.6 mm of insulation is always between the user and the circuitry at mains potential.

CONSTRUCTION

A touch switch may be constructed (and used) in many different ways. It may be mounted within the base of a lamp; fitted onto a conventional switch-plate to control overhead lights; or mounted in a piece of electronic equipment. It is however unlikely that the switch would be used as a separate unit and for that reason housing details have not been provided.

As stated above the touch plate is constructed from a piece of printed-circuit board as detailed in the drawing. The touch-plate need not be exactly as shown but can be any convenient shape or size. However make sure that the copper surface of the plate cannot touch any of the external metal surfaces and that it cannot be touched by the fingers. If the unit is to built into a lamp that has a plastic base a piece of aluminium foil may be glued to the *inner* surface of the base to act as the pickup plate.

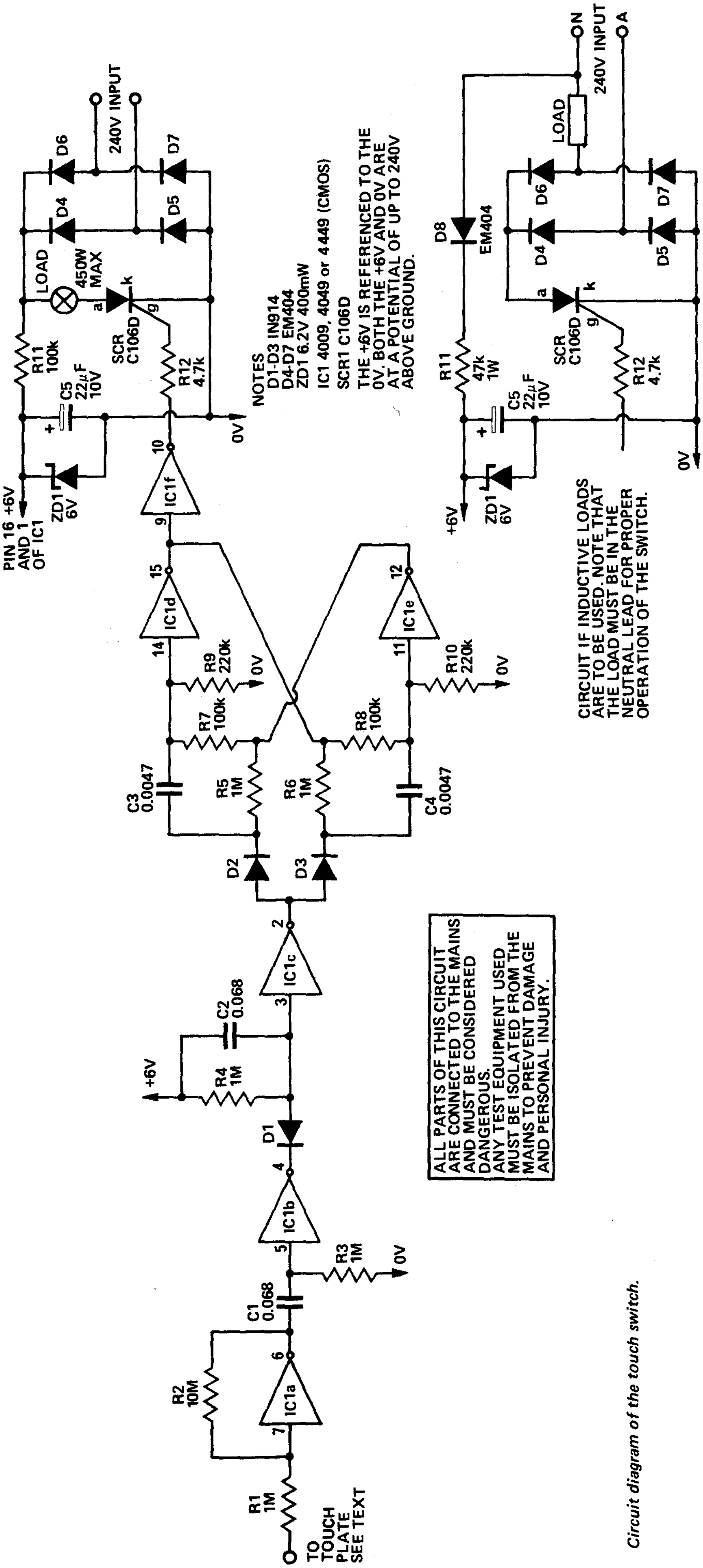
If the plate is too large or the lead connecting it to the circuit too long, stray capacitance to ground may be sufficient to prevent the switch operating. If the lead is more than about 50 mm long shielded cable should be used (shield connected to '0' volts not to ground). If a large plate is used the gain of the first stage should be reduced by changing the value of R2. (Try 3.3 M first and if this is not effective try 1 M).

The circuit given in the main circuit diagram supplies the load with pulsating dc and is therefore suitable to drive resistive loads (such as light globes) only. If an inductive load must be supplied the slightly more complex alternative circuit (shown in the insert) must be used. In this circuit the load must be inserted in the neutral lead if the switch is to operate correctly. Thus it is essential to ensure that the active and neutral are connected correctly. To make the changes required for inductive loads it is necessary to instal a link between D4/D6 and the anode of the SCR. The resistor R11 is removed from the board and D8 and the new R11 are glued to the board with epoxy cement.

SPECIFICATION

Mode of Operation	touch-on, touch-off
Triggering Mode	capacitance
Power	450 VA resistive 450 VA inductive*

*alternative circuit for load.

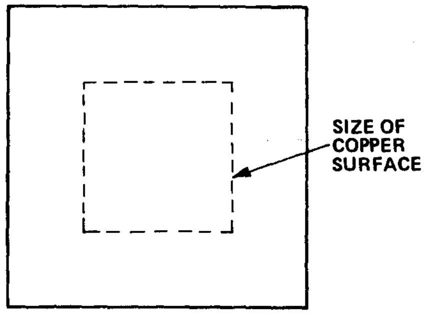


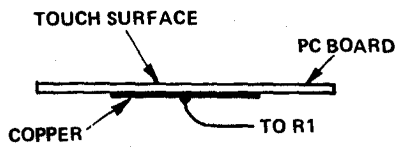
Circuit diagram of the touch switch.

PARTS LIST – ETI 539

R1,3,4,5,6	Resistor	1M 5% ½W
R2	"	10M " "
R7,8,11	"	100k " "
R9,10	"	220k " "
R12	"	4.7k " "
C1,2	Capacitor	0.068µF Polyester
C3,4	"	0.0047µF Polyester
C5	"	22µF 10V electro
D1-D3	Diode	1N914 or similar
D4-D7	"	EM404 or similar
ZD1	Zener Diode	6.2V 400mW
SCR	C106D	
PCB	ETI 539	
Case to suit		

For inductive loads change R11 to 47k 1W add D8 — EM404





We constructed our touch plate from a 50 mm square piece of printed-circuit board. The board was etched to leave a 25 mm square section of copper in the centre. See text if different sized plate or long connecting lead is to be used.

HOW IT WORKS

POWER SUPPLY

The 240 Vac is rectified by diodes D4 to D7. The output of the diode bridge is then reduced, smoothed and regulated to 6 volts dc by R11, ZD1 and C5. The load is connected after the rectifier and has power switched to it via the silicon-controlled rectifier, SCR. Note particularly that the load is supplied with pulsating dc and therefore the type of load used with this circuit must be resistive, for example, an incandescent lamp. For inductive loads such as transformers etc, the load circuit must be modified as shown in the small diagram.

DETECTOR

The detector is formed by one section of a CMOS hex inverter, IC1a, in which the gain is set by the ratio of R2/R1. The touch plate is connected to the input of the detector and touching it effectively adds a capacitor to ground. However the '0' volt line (due to the diodes D4 to D7) when referenced to ground is effectively 50 Hz 240 volt rectified. The touch plate capacitance introduced therefore couples this waveform into the input of the detector and over-drives the amplifier so that the output is a 50 Hz squarewave. If the plate is not touched the capacitance is very much lower and hence the output of the amplifier is very much lower in level. The sensitivity may be altered by changing the value of R2 (lower value gives less sensitivity).

LEVEL SHIFTER

The output of IC1a is centred about 3 volts, and C1, R3 and IC1b are used to provide level shift such that the output of IC1b is normally high at +6 volts until the plate is touched. When the plate is touched the output of IC1b oscillates between +6V and 0 V at a 50 Hz rate. The hex-inverter IC has diodes internally which connect each input to ground. Thus these diodes prevent the inputs from being driven below −0.6 volts.

PULSE STRETCHER

The 50 Hz output from IC1b is not in a convenient form and must be converted into a signal which is only high and stays high whilst the plate is touched. This is performed by a pulse stretcher and inverter consisting of IC1c together with R4 and C2. The output of IC1c is normally low and goes high and stays high whilst ever the plate is touched.

FLIP FLOP

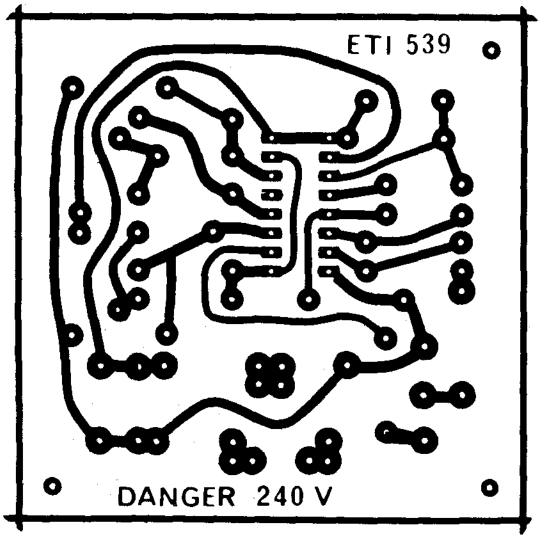
To meet our mode of operation requirement the circuit needs to be held on after the finger is removed from the plate and only switched off when the plate is touched a second time. Thus a toggle action is required and this is obtained by incorporating a flip flop formed by IC1d and IC1e. Cross coupling of gates normally provides an RS flip flop which may take up any state if both inputs are taken high together. For this reason the capacitors, resistors and diodes at the inputs to the flip flop are used to provide steering logic to ensure that correct toggle action is obtained.

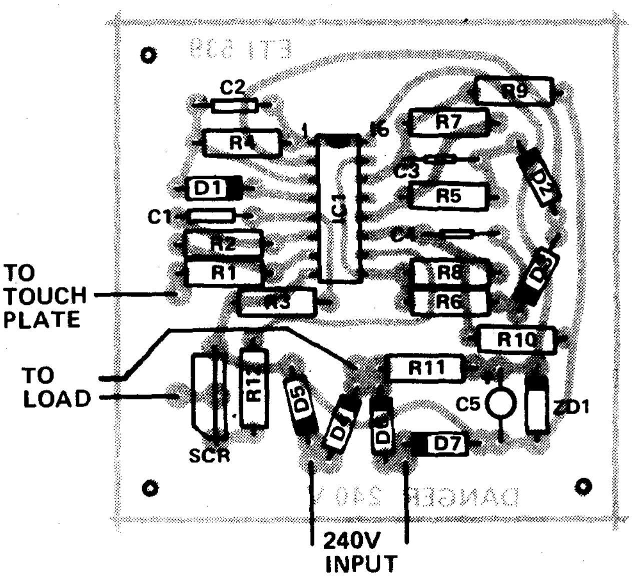
BUFFER

To prevent loading the flip flop, and because a spare section of the hex inverter is available, a buffer amplifier is inserted between the flip flop and the SCR. The SCR used is a C106D which is a sensitive gate type. This particular SCR will operate reliably with the 1 mA gate current provided. The SCR specified will be used – don't try substitutes.

TOUCH SWITCH

Printed-circuit board layout for the touch switch. Full size 68 mm by 68 mm.





How the components are positioned on the board.

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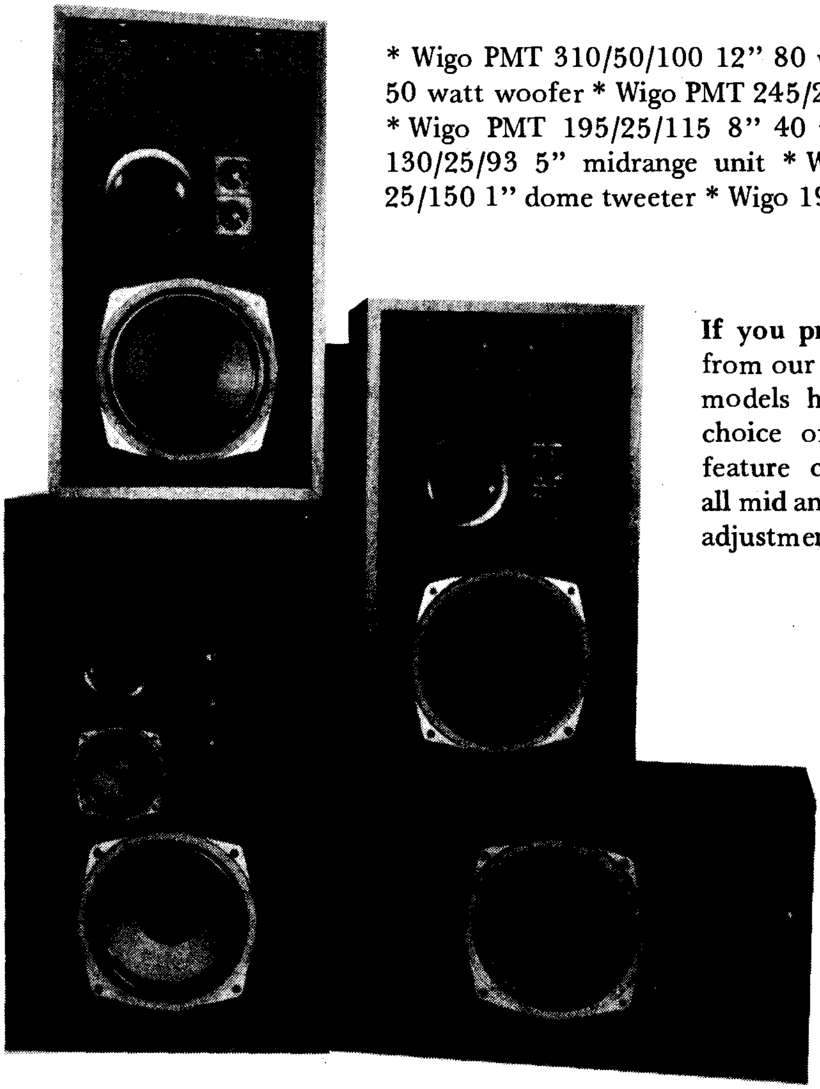

* Wigo PMT 310/50/100 12" 80 watt woofer * Wigo PMT 245/37/100 10" 50 watt woofer * Wigo PMT 245/25/115 10" 40 watt bass/midrange speaker * Wigo PMT 195/25/115 8" 40 watt bass/midrange speaker * Wigo PMM 130/25/93 5" midrange unit * Wigo 37/110 1½" dome midrange * Wigo 25/150 1" dome tweeter * Wigo 19/135 ¾" super tweeter.

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Wigo M132 2-way 40 watt 10" Bass/mid – 1" dome 25" (H) x 14½" (W) x 9¼" (D); **Wigo M133** 3-way 40 watt 10" Bass – 1½" dome – ¾" dome 25" (H) x 14½" (W) x 9¼" (D); **Wigo M203** 3-way 50 watt 10" Bass – 1½" dome – ¾" dome 25" (H) x 14½" (W) x 12½" (D); **Wigo M254** 4-way 50 watt 10" Bass – 5" mid – 1½" dome – ¾" dome 29" (H) x 17" (W) x 12" (D).

Wigo M504 4-way 80 watt. 12" Bass – 8" mid – 1½" dome – ¾" dome. 37" (H) x 19¼" (W) x 15¾" (D).

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"SPOT-O-LIGHT"
UAA170 LED DRIVER - Drives up to 16 LEDS with a moving pointer type indicator. Add 8 resistors to make voltmeters, frequency indicators, dial drives etc. etc. (Suitable LEDS readily available - 20c each). Supplied complete with socket, data and application notes. $3.50

"TACHOMETER" SAK140
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LM3909 LED FLASHER
A proven winner. This incredibly popular device can be built into low drain flashers, radio, electronic sirens. Supplied complete with socket, data and application notes. $1.60

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BC639	NPN 80V 1W Driver	.60
BC640	PNP 80V 1W Driver	.60
BD137	NPN 60V 8W Driver	.85
BD138	PNP 60V 8W Driver	.85
BD139	NPN 80V 8W Driver	.90
BD140	PNP 80V 8W Driver	.90
BF180	NPN High Frequency Pre Amp	$1.20
MU10	UJT General Purpose	.60
2N2955	PNP 114W Power Driver (T03) Metal	$1.70
2N3053	NPN 5W Medium Power Driving	.80
2N3054	NPN 25W 4A Power Switching	$1.50
2N3055	NPN 115W Power Driver (T03) Metal	$1.20
2N3638	NPN 500mA High Current Amp	.45
2N3643	NPN 500mA High Current Amp	.50
2N3644	PNP 500mA High Current Amp	.45
2N4220	FET	$1.20
MPF102	FET	.60
2N5459	FET MPF105	.65
2N5461	FET	.75
2N5485	FET MPF106	.80
2N6027	PUT D13T1	$1.20
2N2646	UJT	$1.40

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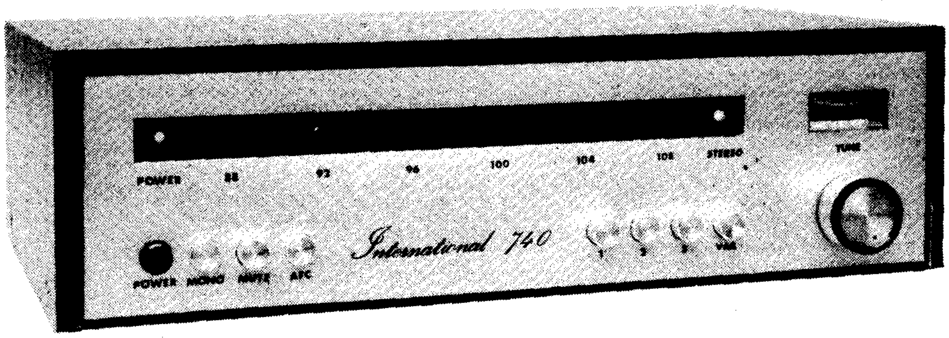
– high quality push button varicap FM stereo tuner sets new standards of performance.



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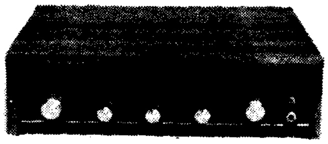

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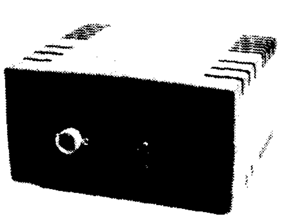

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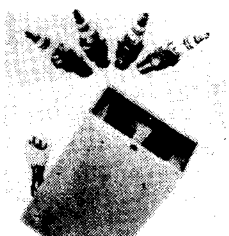

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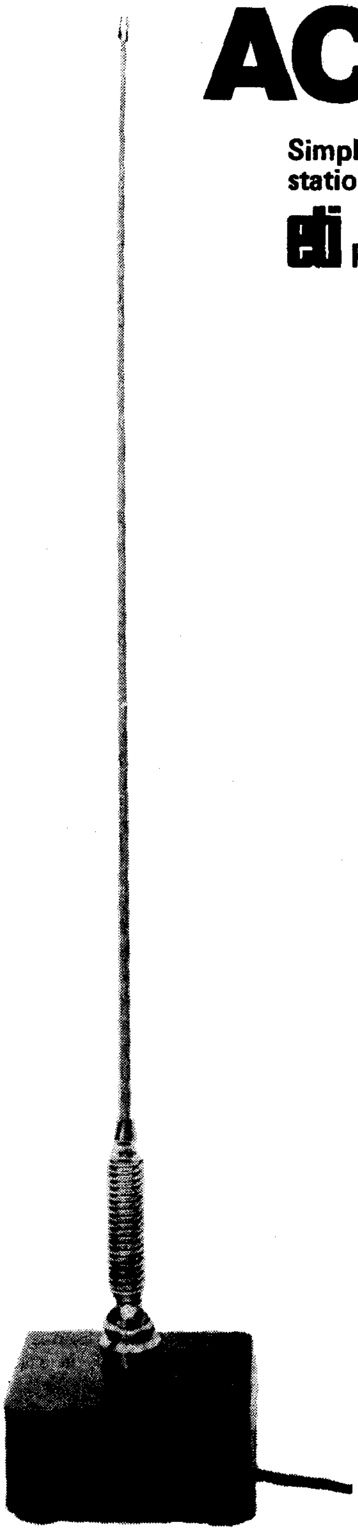
ETI 3/76

ACTIVE ANTENNA

Simple broadband antenna covers 0.5 to 30 MHz – or can be used to boost single stations in the broadcast band.

PROJECT 708



SHORT wave listeners often have difficulty in installing a suitably adequate antenna – especially if living in a flat or home unit. Parents and neighbours may quite justifiably complain about large and unsightly structures. In addition there are difficulties in building an antenna which adequately covers the whole range of 0.5 to 30 MHz and there is also the problem of antenna portability if required.

DESIGN FEATURES

An efficient system consists of the antenna itself together with a transmission line to carry the signal to the receiver. The antenna and transmission line must be matched to each other if the maximum amount of signal incident on the antenna is to be transmitted to the receiver. However since the size of an antenna is related to frequency, one particular sized antenna will only be suitable for a limited bandwidth. Fortunately very efficient antennas are not always needed on the HF band due to the excellent sensitivity of modern day receivers.

A rod antenna has an impedance of less than 50 ohms at its tuned frequency and can therefore easily be matched into a 75 ohm coaxial cable. However if a quarter-wave rod antenna is used at frequencies lower than its natural resonance its impedance increases so that it cannot easily be directly matched into a 75 ohm cable.

Our solution to the problem of obtaining wide band operation with a simple rod antenna is to feed it into an active impedance converter before the transmission line.

An active impedance converter must have a very high input impedance and low input capacitance. At low frequencies the effective input impedance is the value of the biasing resistor, whilst at high frequencies (above 1 MHz) the effective impedance is that of the input capacitance. The converter must have high linearity but no voltage gain. If voltage gain were incorporated the converter would have to provide a high power output to avoid the possibility of inter-modulation occurring.

The number of transistors used have been kept to an absolute minimum as each transistor adds its own noise contribution to the signal coming from the antenna. Two transistors are used and these are both low-noise RF types.

One particular application for the antenna was to boost the level of the Sydney station 2JJ which is very low in level and cannot be received by an average car radio when driving around the city. When using the converter in a straight broad-band mode the reception from 2JJ was greatly improved but other strong stations overloaded the receiver producing some rather unpleasant distortion. For this reason the alternative circuit was developed to allow one particular station to be handled at maximum efficiency whilst with other stations away from resonance the converter impedance is lowered, thus reducing the output from stronger stations.

It must be remembered that if the signal level from a station is below the ambient-noise level it is impossible to improve the signal-to-noise ratio with any type of active antenna. For the short wave listener an occasional burst of noise is not so objectionable and the active antenna will give good results over the entire 0.5 to 30 MHz band. It must be remembered that when operating in a car the signal level from shortwave signals will be improved but the apparent noise level may also increase if it is raised above the masking of the ambient noise level in the car.

CONSTRUCTION

The use of a printed-circuit will greatly simplify construction and the pattern provided will suit the car or broad-band version by simply adding some components or deleting others as required for the particular version.

Broad-band SWL version

After the printed-circuit board is assembled in accordance with the respective overlay it is fitted into a small metal box (a diecast box is best as it may be more easily sealed against moisture) upon which a commercial car whip antenna is mounted as shown in the photo. Lead was placed in the bottom of the box so that the unit will not tip over easily and rubber feet were fitted to raise it above surface water when used outside. The coax is fed in through a hole in the bottom of one side and a water seal is maintained by fitting the cable through a rubber grommet. Once the unit is checked out it is a good idea to spray the inside of the unit with clear lacquer to seal against moisture.

For those who do not wish to purchase a commercial antenna a length of ordinary hook-up wire taped to a light wooden support or even taped to the wall is adequate. Make sure however that the wall is non-metallic and that the antenna is not close to any electrical wiring or other metallic structures.

Car or broadcast version

From Table 1 determine the number

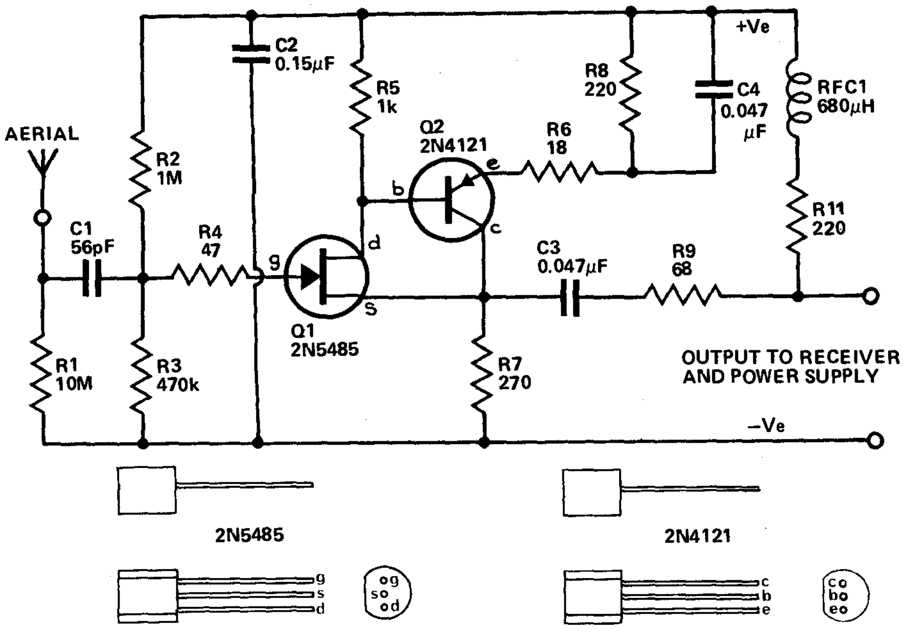


Fig. 1. Circuit diagram of the SWL version (0.5 to 30 MHz).

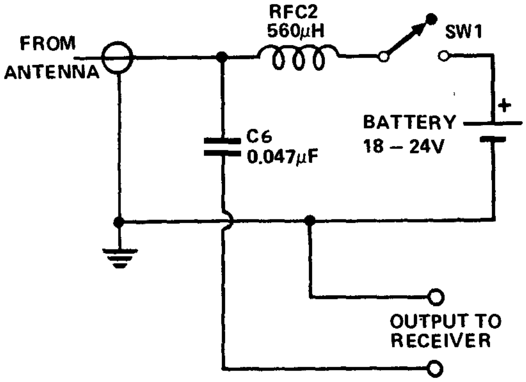


Fig. 2. Circuit for combining supply volts and antenna signal onto the coaxial feeder cable. Used with SWL version where long feeder cable is required.

PARTS LIST — ETI 708

R6	Resistor	18 Ω	¼ W	5%
R4	"	47 Ω	"	"
R9	"	58 Ω	"	"
R8,11	"	220 Ω	"	"
R7	"	270 Ω	"	"
R5	"	1 k	"	"
R3	"	470 k	"	"
R2	"	1 M	"	"
R1	"	10 M	"	"
R10	"	See text		
C1	Capacitor	56 pF	Ceramic	
C5	"	5-70 pF	Philips 2222 808 01001	
C3,4,6	"	0.047 μF	Ceramic	
C2	"	0.15 μF	"	
Q1	Transistor	2N5485 (FET) or similar		
Q2	"	2N4121 or similar		
RFC1	Radio frequency choke	680 μH		
RFC2	" " "	560 μH		
L1	See table 1			
SW1	Single pole single throw toggle switch.			
PC Board ETI 708				
coax cable				

of turns necessary for L1 and wind it as detailed in Table 1. The coil L1 must be mounted close to the base of the antenna so that it can be connected to the antenna by no more than 75 mm of wire. The earth connection to the chassis must also be kept short and C5 should be mounted so that it is accessible for tuning.

A good place to mount the antenna is on the rear mudguard with the base protruding into the boot. The converter may then be mounted to an aluminium bracket which is secured to the car with the antenna base retaining bolt.

The converter should be fed with a 12 volts supply obtained from the accessory fuse in the fuse box.

On cars with generators that produce hash (interference) on the 12 volt supply an 820 microhenry choke, in series with the supply lead, and an 0.15 microfarad ceramic capacitor to ground (from where the two RFC chokes meet) should help.

SETTING UP

The transistor Q1 has quite a spread in parameters from one device to another and some circuit adjustment may be required for optimum performance. The voltage drop across R7 should be approximately one third of the supply voltage to the converter. That is, four volts for a supply of 12 volts. If necessary adjust this voltage by adjusting the value of R3. No other setting up is required on the SWL version.

In the car version temporarily place a link across R10, tune the receiver to the station which needs to be boosted and adjust C5 for maximum volume. This is best done when the car is parked in an area where poor reception is encountered. Resistor R10 is best selected by experimentation. A good starting value is 1000 ohms. Adjust R10 so that the stations to which L1 and C5 are *not* tuned are received free of noise. Too large a value of R10 will reduce the effectiveness of the tuned circuit. (see text)

We found that an antenna length of two metres was suitable for the HF version and a one metre length was suitable for the broadcast band version.

HOW IT WORKS – ETI 708

In effect the active antenna consists of a rod antenna followed by a buffer amplifier which has a very high input impedance (to match the antenna) and an output impedance of 75 ohms to match the lead-in cable.

Signals picked up by the antenna are coupled to the amplifier via C1 the value of which has been kept small to attenuate any 50 Hz pickup on the antenna. Resistors R2 and R3 set the bias point for Q1 such that a four-volt drop is obtained across R7. The voltage gain is maintained at unity and the linearity improved by applying feedback from the collector of Q2 to the source of Q1. The function of Q2 is to provide a very low output impedance. Resistor R4 is used to suppress any parasitic oscillation which may occur to the high gain which both Q1 and Q2 have up to UHF frequencies. Resistor R9 increases the output impedance of the amplifier to match the 75 ohms of the coaxial cable.

In the broad-band version the supply current is fed to the unit via the coaxial cable – the shield being at earth. RFC1 and R11 appear as a very high impedance to the RF but as a low impedance of 250 ohm, to the dc. In effect it forms a low-pass filter in conjunction with C2. Capacitor C3 prevents the supply voltage from upsetting the bias conditions of the transistors. The signal is passed down the coax to the antenna circuit where C6 couples the signal to the receiver whilst blocking the dc, and RFC2 connects the dc supply to the coax whilst preventing the RF signals from entering the power supply.

In the broadcast version L1 and C5 form a parallel-resonant circuit that appears to one particular station in the broadcast band as a high impedance, and to the other stations as a much lower impedance. Thus the voltage developed at the input of the amplifier is a maximum at the frequency to which L1 and C5 are tuned, whilst the other stations are attenuated. Resistor R10, in series with the tuned circuit, sets a minimum value into which the short antenna works and so assures some response to the stations other than that tuned by L1 and C5. The value of R10 is best found by experiment as detailed in the text.

TABLE 1

L1	Frequency	No of turns
	below 700 kHz	45
	700 to 950 kHz	34
	950 to 1200 kHz	26
	above 1200	20

CORE Philips potcore P18 series material 3B7 or 3H1, μe = 220 Part No 4322—022—24280 or 4322—022—24080
FORMER 4322—021—30270
CLIP 4307—021—20000
one each of core, former and clip required to assemble one complete coil

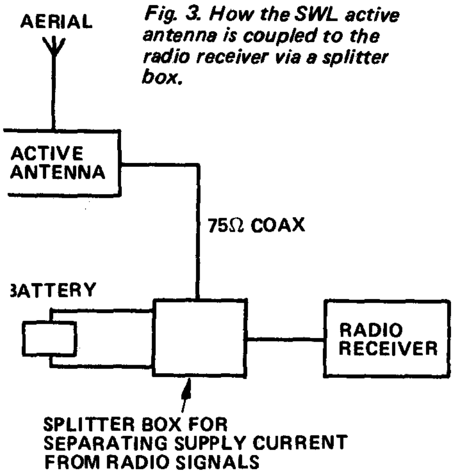


Fig. 3. How the SWL active antenna is coupled to the radio receiver via a splitter box.

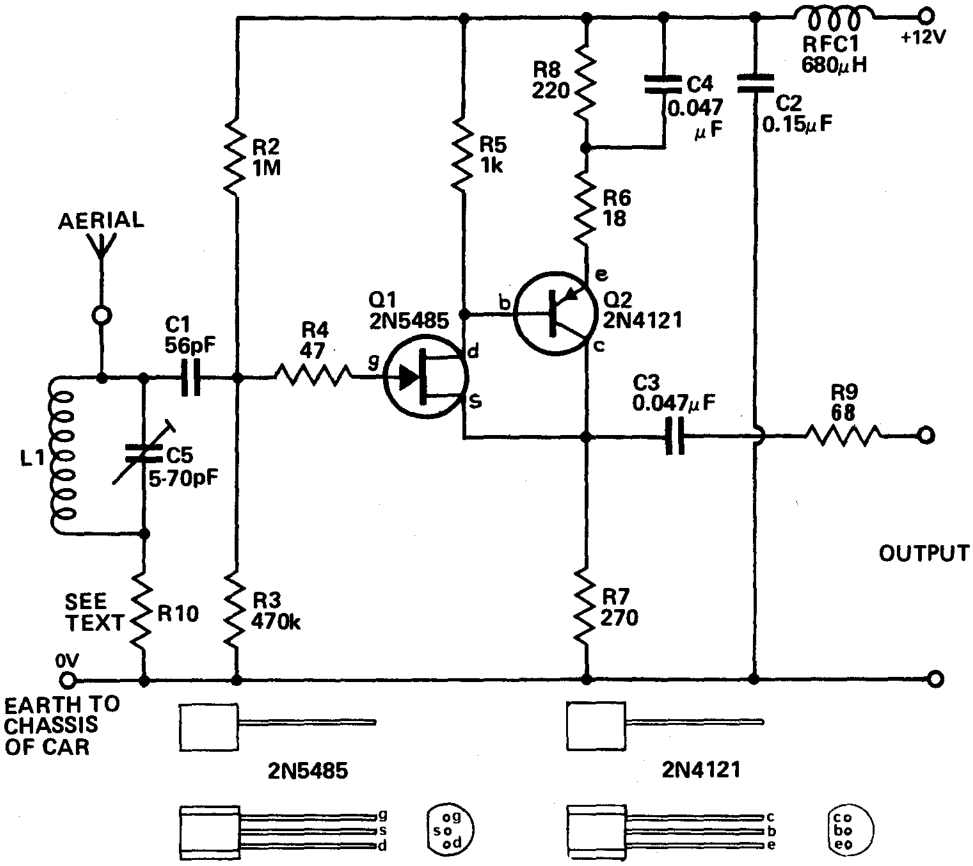


Fig. 4. Broadcast version has a tuned circuit, L1, C5 to attenuate stations other than the one tuned.

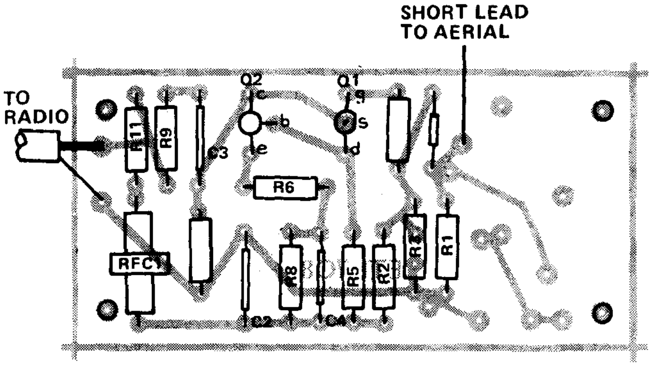


Fig. 5. Component overlay for the SWL version.

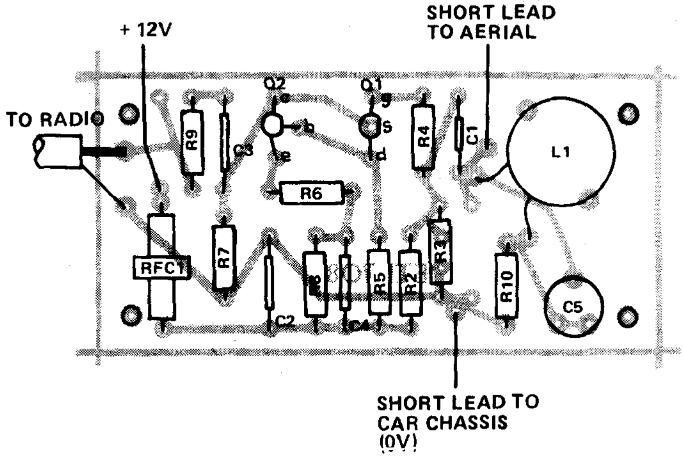


Fig. 6. The component overlay for the broadcast or car version. Note that the same printed-circuit board is used for both versions.

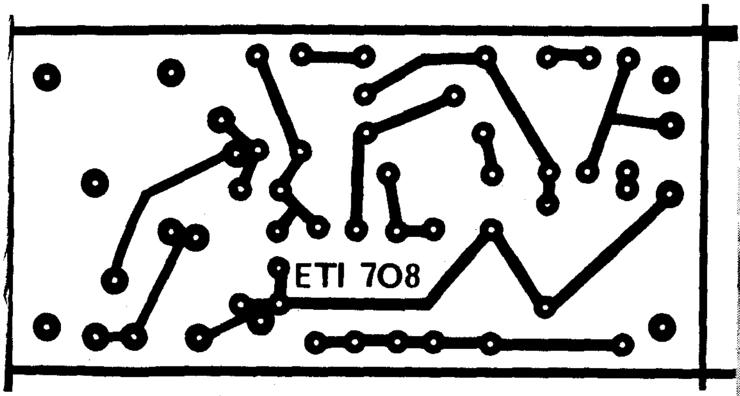
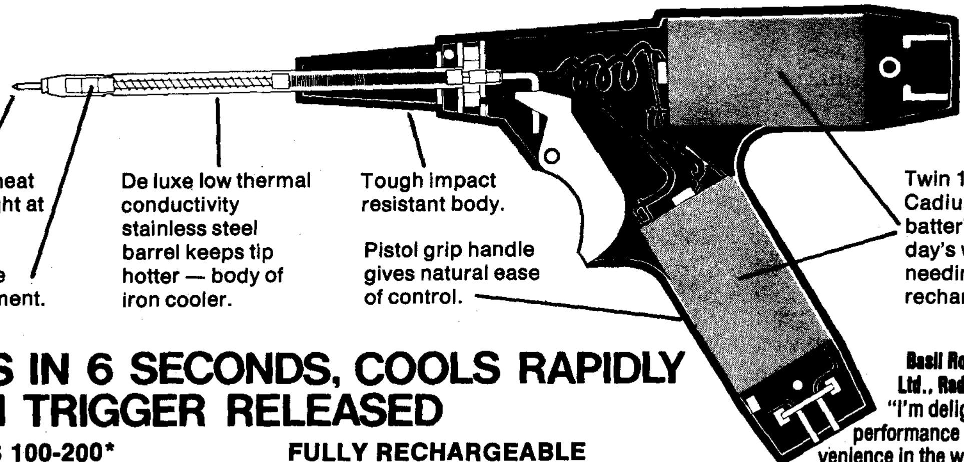


Fig. 7. Printed-circuit layout for both versions. Full size 92 x 46 mm.

How the finished board for the broadcast version appears. ▶

Scope Cordless 60w Soldering Tool



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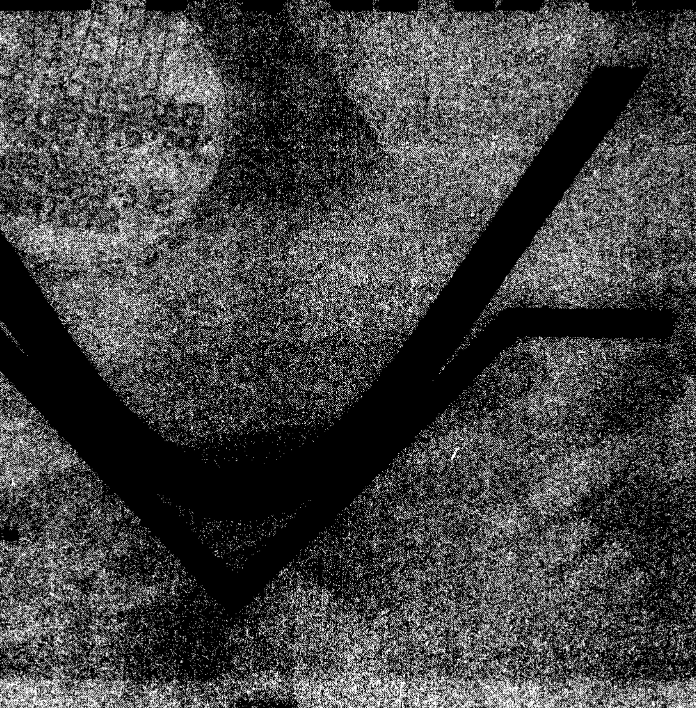
THE PARABOLIC



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Significant advantages in the search for true quality sound.

"THE MOST neglected, hard-worked and taken-for-granted item in a modern sound system is so small it can hardly be seen by the unaided human eye . . ." This is a quote from a pamphlet issued by Bay Road Electronics of Melbourne, and the text goes on to describe the role of the stylus with particular reference to problems of high-frequency, high-velocity tracking.

Bay Road Electronics has, for some time, been active in the development of a new stylus profile, designed to provide all the advantages of ellipticals but without the disadvantages. It would be easy to dismiss the significance of this new product, in view of the large number of new stylus profiles introduced during the past couple of years or so. Most of these have been designed for use with CD-4 records, where response to 50 kHz and beyond is needed to extract encoded information for derivation of four discrete channels from the normal recorded audio-frequency information.

In essence, the problems of CD-4 are simply an extension of those encountered with conventional two-channel stereo and 'matrix' four channel records. It's worth looking into these problems, since solutions may well lead to improved fidelity from all records.

The groove of a record is V-shaped and mechanically modulated with the audio information. Stereo records carry two sets of information, one set on each groove wall. Matrix-encoded records for four-channel provide further information from these two sets of information by use of deliberate differences in phase relationship between the two sets. With CD-4, each groove wall includes additional high-frequency information which is in the form of an FM carrier, and this can be extracted electronically using a straightforward detector essentially similar to the detector used in an FM tuner.

The overall problem lies in extracting this high-frequency information from the groove. As frequency increases, the physical length of each modulation decreases. A stylus must be sufficiently small to follow the tiniest modulation — an oversize stylus will simply ride over small modulations. A spherical stylus can have its high frequency response improved by reducing the radius of its tip — making it more pointed. But there's a limit to the reduction we can make, for if the tip is too small it will travel along the bottom of the groove instead of resting correctly between the groove walls.

Yet some of the modulations encountered on modern records (particularly those on the inner grooves close to the label, which are shorter than outer-groove modulations of similar frequency), are smaller than the stylus-tip radius. Result: the stylus rides over them, producing no response (at best) or distortion. There's also a tendency for such modulations to be completely worn away by the tremendous pressure of the stylus.

One solution to this problem is the elliptical stylus, the long axis of which lies across the groove. The radius either side is small enough to penetrate the void between modulation peaks, the stylus thus retaining more intimate contact with each groove wall at higher frequencies. However, an elliptical stylus with the same large radius as a given spherical stylus, both styli tracking with the same downward force, exerts greater pressure on the groove walls. This is why cartridges equipped with elliptical styli must be able to track at very low forces; some ellipticals exert two or three times the pressure on each groove wall compared with an equivalent spherical stylus tracking at the same force! The latest Shure V15/III exerts nearly as much pressure when tracking with a force of one gram as did the original spherical-tipped Decca FFSS tracking at three grams.

In reality, elliptical styli are unsuitable for the very high frequencies encountered on CD-4 records, even using tracking forces below two grams, because they wear these tiny modulations extremely rapidly. And of course, an elliptical stylus tracking high audio frequencies at too high a force on conventional two-channel stereo and matrix four-channel records will likewise just wipe out the modulations!

So if elliptical styli are to be used for the high-frequency reproduction demanded for CD-4, tracking force must be drastically reduced. And this at present, is almost completely impracticable, for reduced tracking force must be accompanied by a decrease in overall mass of the arm/cartridge system, together with a reduction of effective tip mass — the mass of the moving parts of the stylus and suspension as measured at the stylus itself. Compliance or yielding ability of the stylus suspension must be increased as effective tip mass is reduced, otherwise the intimacy of contact between stylus and groove walls will be degraded.

Overall arm/cartridge mass will continue to be an obstacle to low tracking forces until arms can be effectively servo-operated (as with the

STYLUS

PARABOLIC – of or like a parabola –
Parabola: a plane curve formed by the intersection of a cone with a plane parallel to its side.

B&O parallel-tracking turntable), or the weight of cartridges and associated counterbalance arrangements be significantly reduced.

Further problems here are arm pivot friction, and dust on records. Even with today's low-mass, low tracking force pickup systems, the tiniest particle of dust on a record surface is likely to cause audible noise.

A more practical solution than reducing mass is increasing the area of contact between groove and stylus. This cannot be done with spherical styli for reasons already given. We require a stylus with the characteristics of the elliptical variety but which doesn't cause significant wear to itself or to the groove.

Several new styli of this type have been introduced including the Shibata and the Ishikawa. The new profiles have a narrow radius at the contact area between stylus and wall, as with the elliptical, but this area is vastly extended in the vertical plane. Unfortunately most cartridges fitted with such styli have had inherent performance limitations, mainly as a result of the need to avoid serious resonances within their operating spectrum to be handled — from 20 Hz to 50 kHz and beyond. The net result has been an increase in required tracking force with an associated reduction of compliance.

When Shure introduced their V-15/III, many people were surprised and disappointed to find the new cartridge fitted with an elliptical stylus. Nor was a CD-4 stylus profile planned for later introduction. Shure's attitude being conservative, mention of CD-4 in the literature accompanying the V-15/III was conspicuous by its absence. Shure's chief sales engineer told us that the company policy was to produce a superior cartridge in every respect and the design compromises needed to produce a CD-4 cartridge with acceptable frequency linearity were too great.

And so we come back to Bay Road Electronics. This company has pioneered a new stylus, the Parabolic, so called because the tip is ground so that the small radius in contact with the groove curve round in parabolic form. This provides the desired increase of surface contact area.

A great advantage of the Parabolic stylus is that Bay Road Electronics can fit it to any type of cartridge. It would appear that, for the present, the Parabolic stylus is mainly intended for two-channel or matrix four-channel use, even though it would doubtless respond, mechanically, to the highest frequencies encountered on CD-4 records. However, there is no guarantee that the characteristics of the cartridge itself would provide satisfactory CD-4 performance, even after fitting a Parabolic stylus. What, then, is the point?

We mentioned earlier that an elliptical stylus was better able to track high-frequency groove modulations, with the disadvantage of exerting greater pressure on groove walls than a spherical stylus under similar conditions. The Parabolic, in common with the Shibata and others like it, avoids the problem of excessive pressure, but unlike Shibata (et al) can be fitted to any cartridge to give improved high frequency performance with less wear. Many hi-fi enthusiasts have declined the idea of using a CD-4 cartridge for stereo because of inherent performance limitations — such as the relatively high tracking force requirement, low signal output (a common failing with CD-4 cartridges) and non-linearity in the audible frequency range. The Parabolic is claimed (by implication) to avoid these difficulties simply because the basic performance properties of any cartridge so fitted remain the same, apart from the reduction of pressure on the groove walls.

The arguments in favour of fitting a Parabolic stylus to any chosen cartridge are extremely convincing, although for us, it remained to be proved that the reality could be as convincing as the theory. Cartridges in [illegible], and styli in particular, are precision components, the choice of a particular cartridge is a matter of precision engineering and, as a general rule, should only be replaced by the manufacturer's recommended assembly. Bay Road Electronics literature [illegible] considerable [illegible] performance. We were supplied with an [illegible] cartridge with its standard [illegible] stylus and a Parabolic [illegible] Shure V-15/III [illegible]

[illegible]

The best way to determine [illegible] strength of [illegible] both cartridges [illegible] followed [illegible] after fitting the Parabolic [illegible]. We devoted some time to [illegible] differences between each cartridge compared with the other, before and after fitting the Parabolic styli. We assumed that performance of the V-15/III would increase only marginally; it [illegible] that

STYLI
1977-1975

THE PARABOLIC STYLUS

is) but that the Elac would be vastly improved. Thus we expected that there would be less difference between the two after the Parabolics had been fitted.

Onward to the turntable!

The arm used was an SME 3009/II improved with detachable headshell — theoretically inferior to the fixed headshell 3009 but in practice having no serious differences, subjectively at least.

ELAC

The Elac cartridge had first wack of the whip and was duly fitted to the SME. Our first test involved the original Shure 'Audio Obstacle Course' recording — now superseded but still a daunting experience for an inexpensive, medium performance cartridge. Results are tabulated below. Tests were carried out using the Parabolic first, on the confident assumption that this stylus would be less likely to cause groove damage than the standard spherical stylus. This, we hoped, would make the results more meaningful; no stylus, however good, can remedy damage already done!

It was apparent from the outset that the Parabolic provided far sweeter treble than the spherical. Overall balance of sound using either stylus was little different. Eventually we resorted to a Revox A77 for checking out tonal balance: we simply recorded the signal from one channel of the cartridge, using one track of the tape. Halfway through, we switched from upper to lower track of the recorder. Next we replaced the spherical stylus with the parabolic, recording the same material from the same channel on the unrecorded tracks. The procedure was repeated for the other cartridge channel. By switching from track to track after the recordings were made, and using single-speaker mono (stereo tends to confuse one's assessment of tonal quality under circumstances of this sort), we were able to gain a fair idea of the parabolic's performance. Such differences as were noticed in bass performance could be attributed to very slight changes in level settings of the tape recorder — they were barely noticeable. Midrange performance using the Parabolic was more detailed and smooth, without the slight stridency produced by the spherical stylus. Careful listening indicated that with increasing frequency, the difference between spherical and parabolic stylii became greater, the latter being preferable at all times.

SHURE

And now for the V-15/III. This cartridge, introduced a couple of years ago, received world-wide acclaim by experts and laymen alike. It is without doubt a very fine performer, having better response linearity than its predecessor. Shure engineers dramatically reduced the effective tip mass of the new cartridge, whilst retaining a reasonably high output level primarily by redesigning the magnet structure.

Few cartridges can match the V-15/III's all-round clarity of fine recorded detail — so initially we doubted that the Parabolic stylus would make any real improvement in subjective performance — our cautious nature often makes us think it's better to leave a good product well alone.

Nevertheless we settled down to some very intense comparative listening (cicadas permitting) on a large selection of records — old and new — even a few early mono albums, these being rather 'dim' by modern standards.

We were genuinely surprised by the increase in definition provided by the Parabolic. Nor did this apply only to high frequencies; bass was even smoother than from the standard V-15/III. Good sound reproduction is characterised by a 'transparency' in which dozens of tiny details can be perceived — the difference, between good and poor reproduction is rather akin to that between moulded glass and crystal glass. Nothing is emphasised yet all is clearly defined. Transients become far more dramatic, providing to give a big, open sound. (In the writer's experience, newcomers to hi-fi have difficulty in adjusting to this kind of sound, having become used to the 'warmth' and apparent solidity provided by the average stereogram).

Returning to the bass performance of the Parabolic-equipped V-15; there was a complete absence of muddiness, and the differentiation between foot-drums and electric bass was the clearest we've ever heard. Bass from a standard V-15 is smooth and well-balanced; with a Parabolic, to judge from our sample, it is even cleaner and uncluttered.

Midrange was quite exemplary. On occasions, we've blamed the midrange drive-units in our reference speakers for slight edginess at times, especially with choral and operatic material. We're now thinking again, for an almost complete lack of stridency or harshness was evident using the Parabolic. Again, the wealth of detail the sample provided was surprising, and had our V-15 not had a new stylus a very short time ago, we'd have suspected this needed replacement. Brass sounded particularly delightful; beautifully subdued at times, dominant when it should have been, yet without obscuring quieter sounds from other instruments. Strings, massed strings particularly, sounded sweetly resonant and 'woody' but not overpoweringly so; simply natural-sounding — and the depressed sighing bloom of violin was there in what sounded like just the right proportion.

At this stage, we decided to abandon our test procedure using the tape-recorder. The differences wrought by the Parabolic sample were so obvious that we had no need to refer back directly, in A-B fashion, to the sound of a standard V-15.

TEST RESULTS: ELAC CARTRIDGE WITH SHURE TTR-101 TRACKABILITY TESTS RECORD.

STANDARD STYLUS.

	Side One (Mono)			Side Two (Stereo)							
				LEFT				RIGHT			
Level	OB	D&C	BD	O	P	A	H	O	P	A	H
1	1(1)	1(1)	1(1)	1(1)	1(1)	1(1)	1(1)	1(1)	1(1)	1(1)	1(1)
2	2(1)	2(1)	2(1)	1(1)	1(1)	1(1)	1(1)	1(1)	1(1)	1(1)	1(1)
3	2(1)	3(1)	2(2)	1(1)	2(1)	1(1)	1(1)	1(1)	1(1)	2(1)	2(2)
4	3(2)	3(2)	4(2)	1(1)	3(1)	1(1)	2(2)	1(1)	2(1)	2(1)	2(2)

KEY:
- OB orchestral bells
- D&C drum and cymbal
- BD bass drum
- O electric organ
- P piano
- A accordion
- H harpsichord

SCORING SYMBOLS:
- 1 — tracking correction
- 2 — slight mistracking
- 3 — mistracking
- 4 — crackles considerably

HIGH FREQUENCY PERFORMANCE

Orchestral bells, violins and so on, recorded at alarming levels on Shure's 'Obstacle Course' albums, didn't ruffle the Parabolic at all. Cymbals and other percussion sounds were delightful, but equally impressive to us was the integration of sounds from instruments producing large amounts of harmonics. There was no fragmentation of these sounds, and a happy by-product of such suberb tonal performance was a deeper, more stable stereo image — as if the proverbial window into the studio had been opened wider. It's often said that the wider you open the 'window', the greater the amount of 'dust' that can blow in. Agreed, but surface noise using the Parabolic diminished considerably, those annoying 'clicks' sounding muted and far less obvious than before. Nor could this be the result of high-frequency roll-off using the Parabolic; as far as we could judge from the subjective standpoint overall response linearity was as good as with a standard V-15. We also feel that separation was improved — though we've already attributed the improvement of stereo image to the sample's better HF definition. Possibly a combination of these two was responsible for the excellence of the stereo images we obtained.

It was clear to us that the Parabolic can give a very appreciable improvement in performance over spherical and elliptical stylii. Comparison of the Elac and Shure cartridges in standard form revealed vastly superior performance from the Shure. Yet when both cartridges were fitted with Parabolics, the differences were less apparent, more confined to response variations than anything else.

It would therefore seem that use of a Parabolic stylus in almost any cartridge, no matter what the price of that cartridge, can provide significant and sometimes dramatic improvements in fidelity. Some of our old mono records (with shame, we point out that some of these aren't in best condition!) seemed to take on a new lease of life, largely because of the reduction of surface noise when using the Parabolics.

On the face of it, there is something absurd about fitting a $20-$30 cartridge (such as the Elac sample) with a replacement stylus costing $37.50. Yet the improvement in performance brought about by using a Parabolic speaks for itself. We are not suggesting that the Elac sample supplied, fitted with a Parabolic, sounded better than the standard elliptical-equipped V-15/III. It didn't. Yet we feel any person intending to upgrade any reasonably good cartridge in the lower price-ranges by replacing it with a more expensive model would be advised to consider fitting a Parabolic instead — and this makes a good deal of sense if a lower-priced cartridge is used in a similarly low-priced arm. The results using a high-compliance, low-tracking-force cartridge in an arm not designed for the purpose are often disappointing, and because the Parabolic-equipped cartridge requires the same tracking force as in standard form, the problems otherwise caused by an unsuitable arm are nullified.

The Parabolic stylus offers significant advantages to the person wanting ultimate sound quality from stereo records. In theory, the Parabolic will also last longer than a standard spherical or eilliptical — and this also implies reduced record wear.

The improvement of sound from the Parabolic is in itself good enough reason to invest in this remarkable new product. We're certain many listeners will be at first surprised, and in the long-term, delighted by the increased listening pleasure a Parabolic can provide. ●

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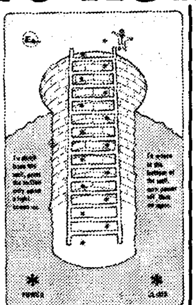

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(EA MARCH 1976)

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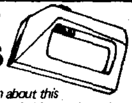

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Cat. K3340 .... KIT VERSION $ 27.50
FULLY BUILT AND TESTED UNIT $ 37.50

IDEAL BEGINNERS KIT ! START YOUR SON THE DENSHI WAY.

NEAR COST!

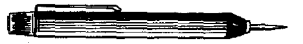
STI00 DENSHI KIT

Features a build it yourself radio. Comes with morse key, earpiece, & components for building alarm circuits and electronic gun.
Cat. K 2120 .... $ 19.95

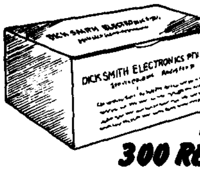
$19.95

SIGNAL INJECTOR $4.75

This Signal Injector (TE-101) uses a circuit designed to make blocking modulation for high frequency at low frequency of 1 KHz. Transistorised. Complete with battery.
Cat. Q 1270 .... $ 4.75



$5.90 PACK OF 300 RESISTORS



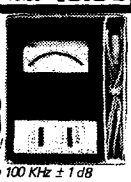
WHAT A SENSATION !!
Now we have improved our already famous computer resistor pack.
For example, in this pack you get 20 x 1 K ohm and only 2 x 560 K resistors - 300 useful values in all, as selected by a computer.
All resistors are 1/4 watt 5% tolerance carbon film high stability - not cheap composition types. They come in a compact neatly printed box 60 different values 10 ohms to 1 meg.
Box measures 2.7/8 "x 1.3/4" x 1.3/4"
There honestly isn't a hobbyist or serviceman who should not have a box
Cat. R7010 FANTASTIC PRICE OF $ 5.90

Less than 2¢ a part

AUDIOPHILES DELIGHT !!

SEE E.A. FEB. 76.

$36

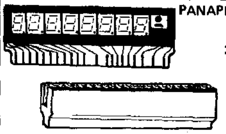


AC320
Millivoltmeter:
- 10 mV to 30V in 8 ranges !
- 52 dB to +32dB
- Frequency response 20Hz to 100 KHz ± 1 dB
- input impedance 1 Megohm
- Accuracy ±3% F.S.D.

The unit runs for ages off a 9V transistor radio battery and weighs only 300 grams.
Yes, now you can check the level of PMG lines, signal sources etc, easily.
You must have one of these for only——$36.00

DIMS: 92mm x 145mm x 42mm
EXCELLENT PRICE $36.00

FANTASTIC 8 DIGIT PANAPLEX READOUT

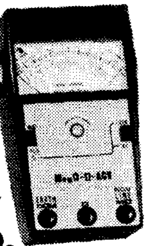


(Shown approx 30% actual size)

* 8 LARGE Digits for less than 90c each.

INCLUDING GOLD PLATED SOCKET. 180 Volt OPERATED IDEAL FOR CLOCK AND CALCULATOR PROJECTS.
ONLY $6.75
AVAILABLE SOON : Driver Transistors and Power Transformer to suit.
Cat. S 3890 .... $ 6.75

SOLID STATE INSULATION TESTER



MODEL SK-3000

* Compact, lightweight versatile insulation tester measures up to 1,000 Meg ohms.
* Low ohm measurements are convenient on two a ranges, X 1 and X 1K.
* Zero ohm adjustment can be made easily by Ohm ADJ. knob.
* With 250V AC range.

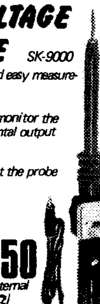
$66. SPECIAL

SPECIFI CATIONS

Meg Ohm	Rated voltage:	500 volts
	Rated resistance:	0 - 1,000MΩ (center 20MΩ)
Low Ohm	X 1 range:	0 - 1,000Ω
	X 1K range:	0 - 1MΩ
AC Voltage:		0-250 volts
Accuracy	Meg Ohm:	± 4% (of scale length)
	Low Ohm:	±4%(of scale length)
	AC Voltage:	±4%(of full scale)
Batteries:		UM3 X 4
Size and weight:		148 x 8 78 x 50mm, 540g
Accessories:		I pair Test leads and Vinyl leather case.

Cat. Q1430 .... ONLY $ 66.00

CRT HIGH VOLTAGE TEST PROBE SK-9000



- Built-in meter assures safe and easy measurements up to 30,000 volts DC.
- 600mA DC range enables to monitor the cathode current of the horizontal output tube of TV set.
- Barriers are installed to protect the probe handle from high voltage.
- The test probe is compact, light and easy to handle.

SPECIFICATIONS $30.50

DC Voltage:	30,000 volts (internal resistance 600MΩ)
DC Current:	600MA (450mV drop)
Accuracy:	± 3% (of full scale at 20° C)
Temperature coefficient:	±0.15 % per 1°C
Size and weight:	374 X 48 X 45mm, 240g
Accessory:	1 pair Test leads

Cat. Q1440 .... ONLY $ 30.50

MJ001 IC TEST CLIP

1 x RED & 1 x BLACK

DON'T PAY $1.40 EACH
PAY ONLY $1.00 for 2

A MUST FOR ALL MULTIMETERS
Cat. W4580 BARGAIN AT ONLY $1.00 For TWO

BELLSONIC CAR CONVERTOR $22.

Converts 6V D.C. to 12V D.C.
ideal for running 12V Car radios, car stereos etc. In any 6V vehicle.
Used to be $29.50
Cat. M95922 .... Only $22.00

$1.50 JUMPER LEAD KIT

J5119 Jumper Lead Kit
Here's ten 15" leads with croc. clips. Two each in five colours. Worth over $2.00.
Cat. W4570 ..... NOW ONLY $ 1.50

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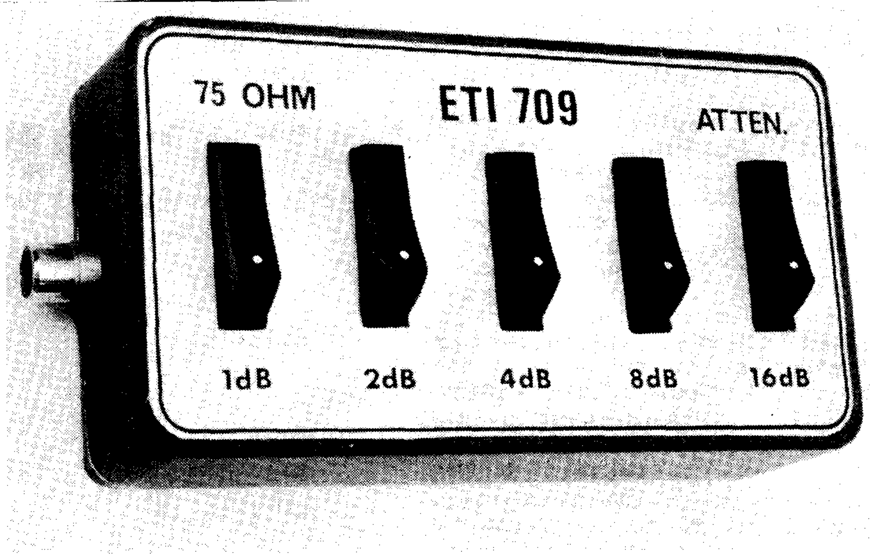
SPECIAL 5 for $1.

BAKELITE TO3 TRANSISTOR SOCKETS.
High Quality. SPECIAL PRICE !
Cat. P4023 30c ea.
Buy 5 for only $1

eti PROJECT 709



RF ATTENUATOR

0 to 31 dB attenuation in 32 steps of 1 dB — useable to more than 200 MHz.

EVERYONE experimenting with RF circuitry will sooner or later need an RF attenuator. Some of the typical uses of such attenuators are listed below.

- Checking intermodulation on HF, FM, and TV receivers.
- Checking if incoming signals are high enough to allow splitting — to feed more than one receiver.
- Changing signal levels when checking the performance of receivers.
- Evaluation of filters, RF amplifiers, and other electronic devices.
- To find the loss in coaxial cable by the substitution method (as well as the gain of amplifiers). This method is convenient as a calibrated detector is not required: merely one that will give the same reading for two successive inputs of the same level.

DESIGN FEATURES

An RF attenuator should have a useable frequency range of dc to 200 MHz. It is also necessary for the attenuator to be adequately shielded so that signals may only enter or leave via the coaxial connectors. For this latter reason a diecast box has been used to house the attenuator.

To obtain the wide frequency response required it is necessary to use resistors that have low inductance and capacitance — ¼ to ½ watt carbon types are the most suitable. If higher power handling is required one or two watt carbon types may be used but with these accuracy will start to fall off at around 100 MHz.

The switches should also have low inductance and capacitance but specially designed switches are prohibitively expensive. Many Japanese slide switches were evaluated and initially gave good results. However the ingress of dust and dirt was found to cause faulty operation after a time. The types specified were found to give good and reliable operation over a long period.

Many commercial attenuators have switched values of attenuation — such as 3, 6 10 and 20 dB. Although such values are commonly used this arrangement does not make maximum use of the switch capacity. In our attenuator we have used binary weighted values of 1, 2, 4, 8 and 16 dB. We can combine two or more of these switches to obtain values of attenuation from 0 to 31 dB in 1 dB steps. With the addition of one more switch and a 32 dB pad it would be possible to extend the attenuator to sixty four 1 dB steps. However at high frequencies the leakage of signal around switches becomes excessive and the accuracy at high frequency and large attenuation is thereby drastically reduced.

The sockets used for input and output are RCA types which are normally used with audio equipment. These are inexpensive and easy to obtain. These sockets are quite suitable for use in the low VHF region and are very rugged. Of course if proper 75 (or 50) ohm connectors are available they may advantageously be used instead.

Most RF systems are designed to work into 75 or 50 ohm with 300 ohms coming a poor last. Since TV and FM have standardized on 75 ohms we chose to design our attenuator for this impedance. Since other people may wish to work with 50 ohms we have included a chart showing exact and nearest preferred values for this impedance. It would pay to search with a multimeter to find the resistors having the value nearest to the exact value as specified.

CONSTRUCTION

Construction is simple and straight forward but to obtain optimum results we suggest that you follow our method as closely as possible.

Examine the photographs carefully, the method of construction may readily be seen from them. The unit is housed in an Eddystone diecast box having dimensions of 110 by 62 by 31 mm. The switches are mounted flush onto the bottom of the box. Those at either end of the box are mounted so that the centre pin of the switch is in contact with the centre pin of the socket. This allows the connection to be made without the use of hookup wire. Evenly space the remaining three switches between the two outer ones. Note that a thin strip of tin plate is run the full length of the box and is held in place by the lugs and screws at one end of each switch. To this strip are soldered the ends of the resistors which go to ground. The resistors are held in such a position by their leads that the metal body of the switch acts as a shield between the resistors mounted on either side of it.

The centre poles of the switches are interconnected by first bending the centre lugs of the switch outward towards the next switch and then by soldering lengths of 3 mm wide tinplate between them as shown in the photos.

For general purpose use we recommend the RCA type connectors but if the unit is to be used solely for FM and TV the Belling and Lee type would be more suitable.

If difficulty is experienced in obtaining the exact type of switch specified select one that has a minimum amount of metal internally so that capacitance between switch contacts is not excessive. Also ensure that the switch is of sealed construction so that dust and dirt cannot enter and interfere with the operation of the switch.

Continued on page 62.

[redacted]

		P&P
[redacted]	$14.00	$2.00
[redacted]	$29.50	$2.00
[redacted]	$22.50	$2.00
[redacted] tester	$17.50	$2.00
[redacted] generator	$ 9.75	$1.50
[redacted] state probe	$15.00	$1.50
[redacted] Dauble	$25.00	$2.00
[redacted] ETI 238	$ 5.95	$1.50
[redacted] ETI 438	$11.95	$1.50

[redacted]	Bulk Dis. Price	Qty in pack
[redacted]	$2.00	25
[redacted]	$3.25	25
[redacted]	$5.00	25
[redacted]	$6.00	10
[redacted] LED with [redacted]	$5.00	25
[redacted] 1A bridge	$4.60	4
[redacted] 1A bridge	$5.80	4
[redacted] 10A, bridge	$5.60	1
[redacted] 400V., 25A, bridge	$6.30	1
[redacted] 7 segment [redacted]	$2.30	1
[redacted] 7 segment read-out	$2.90	1
2N2646 Unijunction	$5.60	4
2N6027 Programmable Unijunction	$4.40	4
C106D1 400V., 4A. Thyrister	$5.60	4
C122D 400V., 8A. Thyrister	$7.80	4
C122E 500V., 8A. Thyrister	$4.80	2
SC141D 400V., 6A. Triac	$5.20	4
SC146D 400V., 10A. Triac	$4.40	2
ST2 Diac	$3.60	5
ST4 Assymetrical Diac	$4.00	5

Equivalent may be supplied, but in all cases they will have the same specifications and similar style cases. Prices may be slightly higher interstate.

NOTE: Mixed value packs of ½W, 1W, resistors, ceramics and greencaps are not available. Packs contain one value only. Other components available in any quantity subject to 20% surcharge on quantity not in standard pack. EXAMPLE: 7 double-gang slide pots: Pack of 5 = $6.00 plus 2 = $2.40. 20% surcharge on 2 = 48c. Sub-total = $8.88 plus 10% **P&P (88c) TOTAL $9.76.**

DIGITAL I.C.'s

	Bulk Disc. price	Qty. in pack
SD7400	$3.40	10
SD7401	$3.40	10
SD7402	$3.40	10
SD7403	$3.40	10
SD7404	$3.40	10
SD7405	$3.40	10
SD7408	$3.40	10
SD7409	$3.40	10
SD7410	$3.40	10
SD7413	$4.90	10
SD7416	$4.90	10
SD7420	$3.40	10
SD7430	$3.40	10
SD7438	$3.40	10
SD7440	$3.40	10
SD7441	$3.70	5
SD7442	$3.40	5
SD7446	$2.75	2
SD7451	$3.40	10
SD7473	$5.90	10
SD7474	$5.90	10
SD7475	$4.00	5
SD7476	$3.00	5
SD7483	$2.50	2
SD7489	$2.40	1
SD7490	$6.00	10
SD7491	$2.25	2
SD7492	$3.40	5
SD7493	$6.00	10
SD7495	$2.50	2
SD7496	$3.00	2
SD74107	$3.00	5
SD74121	$3.40	5
SD74123	$4.00	5
SD74141	$4.30	5
SD74151	$4.30	5
SD74153	$4.30	5
SD74160	$5.70	5
SD74161	$5.70	5
SD74162	$5.70	5
SD74613	$5.70	5
SD74164	$5.70	5
SD74165	$2.50	2
SD74175	$5.00	5
SD74192	$5.00	5
SD74193	$5.00	5

HI-POWER STROBE

Built and tested, simply plug in and use. **$25.50** plus P&P $2.00

DIGITAL DICE — LIMITED STOCK ONLY

Built and tested, 9v battery $7.95 [redacted]

[redacted] 10

[redacted] INPUT [redacted] MIXER

[redacted] two 100 mV [redacted] mixing, built and [redacted] plus P&P $2.50.

[redacted] CHANNEL [redacted] TO LIGHT DRIVER

[redacted] into mains, connect to [redacted] and plug in 4 external [redacted] lights (not supplied) — [redacted] you your own Disco show! [redacted] and tested **$49.50 plus P&P** $2.50.

Prices may be slightly higher interstate.

THE ELECTRONICS SHOPS:
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23 Russell St., Toowoomba, Qld. 32-6944
36 Station St., Booval. 82-2322

EDA DELSOUND
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30 Amelia St., Valley, Qld, 52-8694

HI-TEL RECORD BAR:
Shop 4 Skipton's Arcade, Penrith, NSW
Shop C Nepean Arcade, Penrith, NSW
Phone 21-0850

THE ELECTRONIC AND HOBBY CENTRE:
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K & A STEVENS
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KTRONICS:
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A. E. COOLING RADIO & T.V. SERVICE
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CALA ELECTRONICS:
Shop 5A, Village shopping centre,
High St, Coffs Harbour. 52 4035.

RF ATTENUATOR

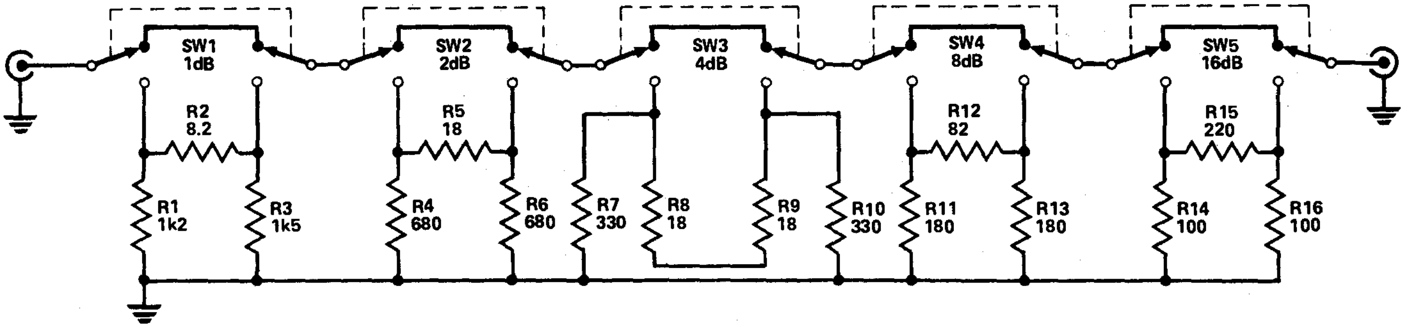


Fig. 1. Circuit diagram of the 75 ohm attenuator.

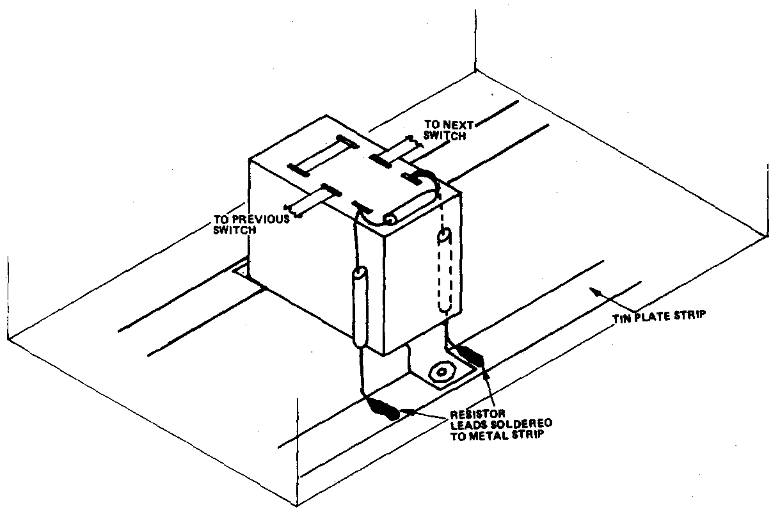


Fig. 2. How the switches are wired up.

HOW IT WORKS – ETI 709

The ETI 709 attenuator works by switching into the signal path a selected network or group of networks that reduces the signal strength by known amounts. The networks are specially designed so that they do not disturb the characteristic impedance of the line. That is, they appear to both the source and the load as a single parallel resistor equal in value to the respective source or load impedance. In our case the networks have been calculated to provide matching to 75 ohm impedance.

As can be seen from the circuit diagram each section of the attenuator has a characteristic shape that has led to the use of the name 'pi network' for this attenuator section.

The steps of attenuation are expressed in decibels. The voltage attenuation in decibels is equal to

$20 \log \frac{V_1}{V_2}$. Where V_1 equals the input voltage and V_2 equals the output voltage. Thus if the output is half the input voltage then $\frac{V_2}{V_1}$ equals 0.5 and 20 log 0.5 equals – 6.02 dB. (the minus sign indicating attenuation).

The use of decibels is very convenient as it allows the combined value of two or more attenuators to be found by simply adding their separate values rather than by multiplying the separate attenuation ratios.

Each succeeding attenuator is chosen to be twice that of the one previous. This binary form allows us to obtain a range of 0 to 31 dB in 32 steps with only five switches. Thus for example if we require 5 dB we depress SW1 and SW3 to give us 1+4=5 dB.

TABLE 1

ATTENUATION	R*	ACCURATE VALUES 75 OHM	ACCURATE VALUES 50 OHM	CLOSEST PREFERRED VALUE 50 OHM
1 dB	R1	1304	869.5	820
	R2	8.6	5.8	5.6
	R3	1304	869.5	820
2 dB	R4	654	436	470
	R5	17.4	11.6	12
	R6	654	436	470
4 dB	R7	331.5	221	220
	R8	35.8	23.9	12 + 12
	R9	0	0	0
	R10	331.5	221	220
8 dB	R11	174.2	116	120
	R12	79.3	52.8	27 + 27
	R13	174.2	116	120
16 dB	R14	103.2	68.8	68
	R15	230.7	154	150
	R16	103.2	68.8	68

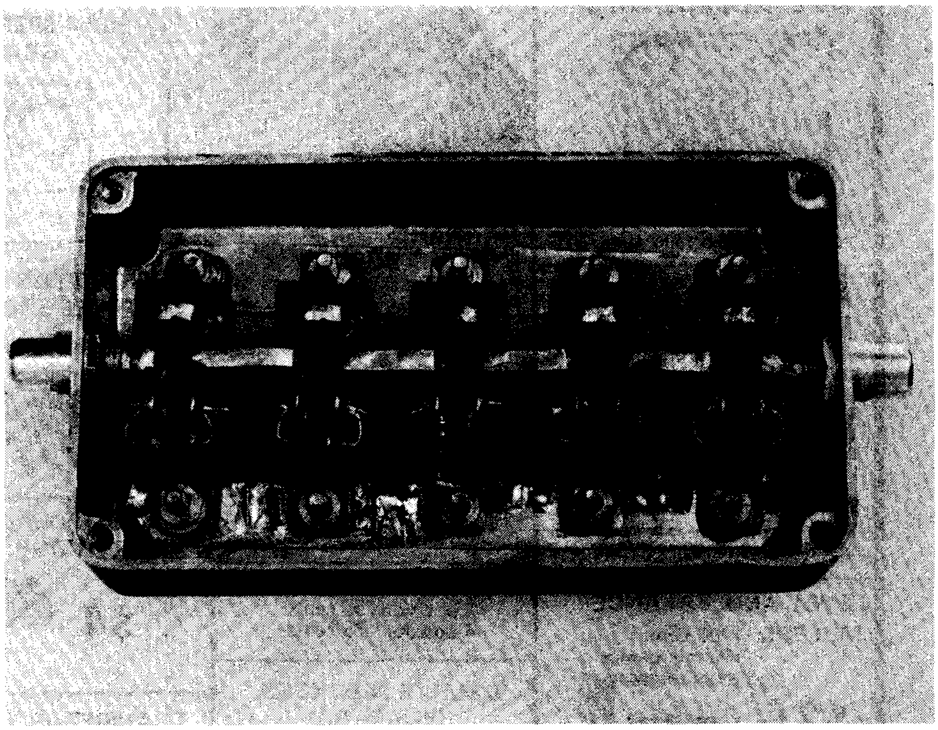
* All values in ohms

PARTS LIST ETI 709

R2	Resistor	8.2Ω	¼W	5%
R5,8,9	"	18	"	"
R12	"	82	"	"
R14,16	"	100	"	"
R11,13	"	180	"	"
R15	"	220	"	"
R7,10	"	330	"	"
R4,6	"	680	"	"
R1	"	1k2	"	"
R3	"	1k5	"	"

SW1-5 Slide Switch min DTDP

2 RCA Phono Sockets (see text)
Die cast box Eddy stone 7134P
110mm x 60mm x 30mm



Internal view of the attenuator illustrates the method of construction.

L.E. CHAPMAN

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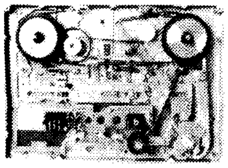
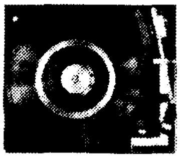
TAPE RECORDER DECK



7 inch reel to reel, complete except head and face plate. **$10**

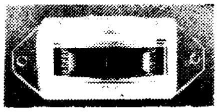
SUPER SPECIAL B.S.R. RECORD CHANGER

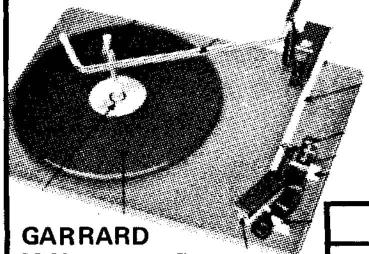


12 inch turntable balanced arm cueing device etc. **$35**, pack and post $1.50. Interstate $2.50.

LEVEL AND BALANCE METERS 1200 Ohm 100 microamps

$2





GARRARD MINI-CHANGER
Stereo **$19.00**
Pack and post $1.00
Interstate $2.50

SPEAKER SPECIAL

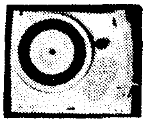
6½ inch Dual Cone 4 ohm

$5

WAFER SWITCHES
2 position: **50 cents**
4 position: **75 cents**

DELUXE SPEAKERS FOR CARS
5 inch 8 ohm in plastic cabinets. **$5.50 each**

BSR 4 SPEED 240V GRAM



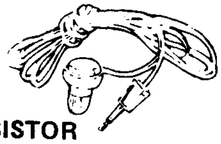
Motor and Pickup **$7.95**

PUSHBUTTON SWITCHES 5 POSITION
1/240 volts, toggle **50 cents**

BSR CERAMIC CARTRIDGE STEREO

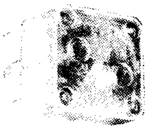
$4

TRANSISTOR 7 RADIO
Complete with 3½ inch speaker
No cabinet **$3.95**



TRANSISTOR EAR PLUGS 3 for **$1.00**

MINIATURE TUNING CONDENSORS



75 cents

VU METER
$3.00 pair

SPECIAL SOLID STATE STEREO AMPLIFIER AND TUNER
5 Watts RMS per channel, famous make **$30**. Pack and post $3 interstate, $1.50 NSW.

SPEAKER CABINETS
10 x 7¼ x 4 **$3.50**

BARGAINS BARGAINS BARGAINS BARGAINS

Hook up wire 30 mixed colours $1.
250 mixed screws with self tappers, bolts, nuts, etc. $1.25 + postage 50c.
100 mixed radio TV knobs including fine tune & channel change $5.00.
½ meg. double pole switch pots 50c.
100 mixed condensors, mic as polyester ceramic 50c.
Mixed pots 30 including ganged & concentric $5.
Morganite & IRC 33 useful valves fresh stock $2.00 + postage 50c.
Slide switch 3 position 50 cents.
50 ohm Pots ideal for ext. Speakers 50 cents. Transistor and Driver Speaker Transformers $1.00 pair.
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Pots 30 mixed values including ganged and concentric $5.
In Line Fuse Holders 20 cents
Stereo Speaker Wire 12 cents yard.
100 Mixed TV and Radio Knobs including Fine Tune and Channel Change $5.
Car radio suppressor condenser 30 cents.

100 mixed condensers micas polyester ceramic $2 per pack and post 45c.
Electros 3 in one 100-25-40, 24-250-300. 50-250-300 75 cents.
Screw in 6 Volt Pilot Lights $1.50 for 10. Plug-in type 10 for $1.00.
100 mixed condensers micas polyester ceramic $2 per pack and post 45c.
Indoor TV Aerials Vertical Spiral $1.
3.5 to 3.5 Jack Plugs 7ft Shielded Cable 75 cents; 6.5 to 3.5 Jack Plugs 7ft. Shielded Cable 75 cents.
Mixed Tag Strips 50 cents for Dozen.
Tape Recorder Heads Transistor — Top quality suit most recorders $5.00.
Jack Plug Sockets 6.5 mm 35 cents.
Morganite and IRC resistors 33 values $2 per 100 pack and post 45c.
Philips Gramo Motor and Pickup 4 Speed 6 Volt $7.75.
Crossover Condensers 2 mfd 60 cents.
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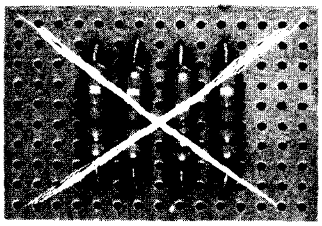
Switch Wafers: 11 position 20 cents.
Philips Pick-up Cartridges: mono female $2.50.
Pots: 50k 50 cents; 1M 50 cents.
Tape Spools: 7 inch 75 cents.
½ Meg Double Pole Switch Pots 50 cents.
Coaxial TV Feeder Cable 75 ohm 30 cents yard.
Jack Plugs 6.5 mm 50 cents; 3.5 mm 25 cents. R.C.A. Plugs 25 cents.
Battery Saver 240 to 6-7, 5-9 Volt, 6 Volt/300mA, 9V 200mA, $10.
Hook Up Wire 30 mixed colours lengths $1 bag.
Speaker 4 pin plugs 15 cents.
25 mixed 5 and 10 Watt resistors $2.00
250 mixed screws, BSA, Whit self-tapper bolts, nuts, etc. $1.25 bag plus 40c post.
BSR Stereo Player Model P-128 $52 pack and post $1.50. Interstate $2.00.
TV Aerials Complete Range Hills Colour $12 to $60.
Car radio aerials, lockdown, top quality extended 1600 mm $4.50.
Electros 3-in-one: 20, 400, 450; 10, 400, 450, 75, 50, 65 $1.00.

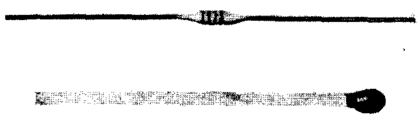
AWA 11 inch P.I. TV EHT transformers $5.00.
Car Converters: 12 volt to 6-7, 5-9 volt 500 MA $6.00.
Microphones — Dynamic 10k $3.50.
Valve Sockets: 7 or 9 pin 10 cents. Octal 10 cents.
Speaker Transformers: 6 Watt 7000 to 8 ohm $2.50; 3½ Watt 7000 to 15 ohm $1.75; 6 Watt 7000 to 1k $2.50; 500 to 27 ohm 50 cents.
Ferrite Rods 6 inch 50, 9 x ½ 75 cents.
Pots: 10K ganged log 50 cents; 1 Meg ganged log $1.25; ½ Meg ganged log $1.25; 2 Meg ganged log $1.25;
2 Meg double pole switch $1.50.
Sharp TV Flyback Transformers 8FT 604 $7.00.
Miniature Speaker Transformers, drive and output $1.00 pair.
Heat Sinks: 4 x 2 1¾ $1.50.
Universal Mono Pick-up Cartridges; fit most type record players $3.50.
Shure M 75/6 Magnetic Pick-up Cartridge $11.
Picture Tubes — New 110 Deg 17 inch $15.

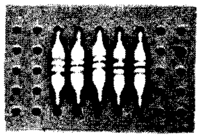
SPEAKERS SPEAKERS SPEAKERS

6½ inch Dual Cone 4/OHM	$5.00
4 x 2 8 OHM	$1.50
12 TACX in 8 or 15 ohm 10 Watts	$11.00
8 TACX 8 ohm	$8.00
6 x 9 in 8 or 15 ohm	$6.00
5 x 7 in 8 or 15 ohm	$5.00
6½ inch 8 or 15 ohm	$4.50
8 x 4 8 or 15 ohm	$4.50
6 x 4 8 or 15 ohm	$3.50
5 x 4 15 ohm	$2.50
4 inch 8 ohm	$2.75
3 inch 3.5 ohm	$2.50
5 inch Tweeters 8 ohm	$3.50
6 inch Dual Cone Tweeters	$6.00
5 x 3 80 ohm	$3.00
5 inch Magnavox dual cone 8" 27 ohm	$6.00
8 inch National built in Tweeter	$14.00
Rola custom kit 63G x Tweeter C60 woofer cross over and pot	$19.00
MSP 2¾ inch 8 ohm	$2.00
3 inch 8 ohm	$1.50
Magnavox 5 inch 4 ohm 8 Watts	$5.00
Magnavox 5 inch 15 ohm	$4.00
Pioneer 3½ inch 8 ohm	$1.50
Magnavox 5 inch dual cone Tweeter	$6.00
Magnavox 10 inch 8 ohm	$8.00
Pioneer horn type Tweeter 3 inch	$9.50
Pioneer horn-type Tweeter	$12.00
Pioneer midrange 5 inch	$9.50
MSP 6 x 2	$3.50
MSP 4 x 2 5 ohm	$2.50
MSP 6 x 4 47 ohm	$3.50
ROLA 5 x 7 47 ohm	$6.00
ROLA 6 x 9 47 ohm	$6.00
Magnavox 5 inch 8 ohm	$4.00
Magnavox 10 Watt	$12.00
Pioneer 3½ inch 45 ohm	$3.50
MSP 3 inch 8 W 15 ohm	$3.50
MSP 8 inch Woofers 8 ohm, 30 Watt	$12.00
MSP 12 inch 12 VAX 8 ohm, 20 Watt RMS	$17.50
MSP 4 inch 120 ohm	$3.50
4 inch 120 ohm	$4.50

How to cut costs on your valuable P.C. board real estate...







use type GLP miniature resistor.

IRH Components introduces the Metal Glaze type GLP resistor, a miniature ½ watt, with a maximum surface temperature rise of 50°C, the physical dimensions of many other ⅛ or ¼ watt resistors but a full ½ watt rating at 70°C ambient.

The smaller size allows .4" (10 mm) lead spacing as standard for horizontal printed circuit board mounting — reduces demand on expensive PC board real estate. Even greater packaging density can be achieved by vertical mounting.

Another IRH "FIRST," the Australian made GLP is a result of extensive research, development & testing for Australian conditions.

STOCK THE GLP resistor and you automatically stock ⅛ watt, ¼ watt and ½ watt and significantly reduce your resistor inventory. USE IT with confidence.

GLP FEATURES INCLUDE:

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- **Small size. Length 5.5 mm Diameter 2.0 mm.**
- **⅛, ¼, ½ watt rating.**
- **Thick film reliability.**
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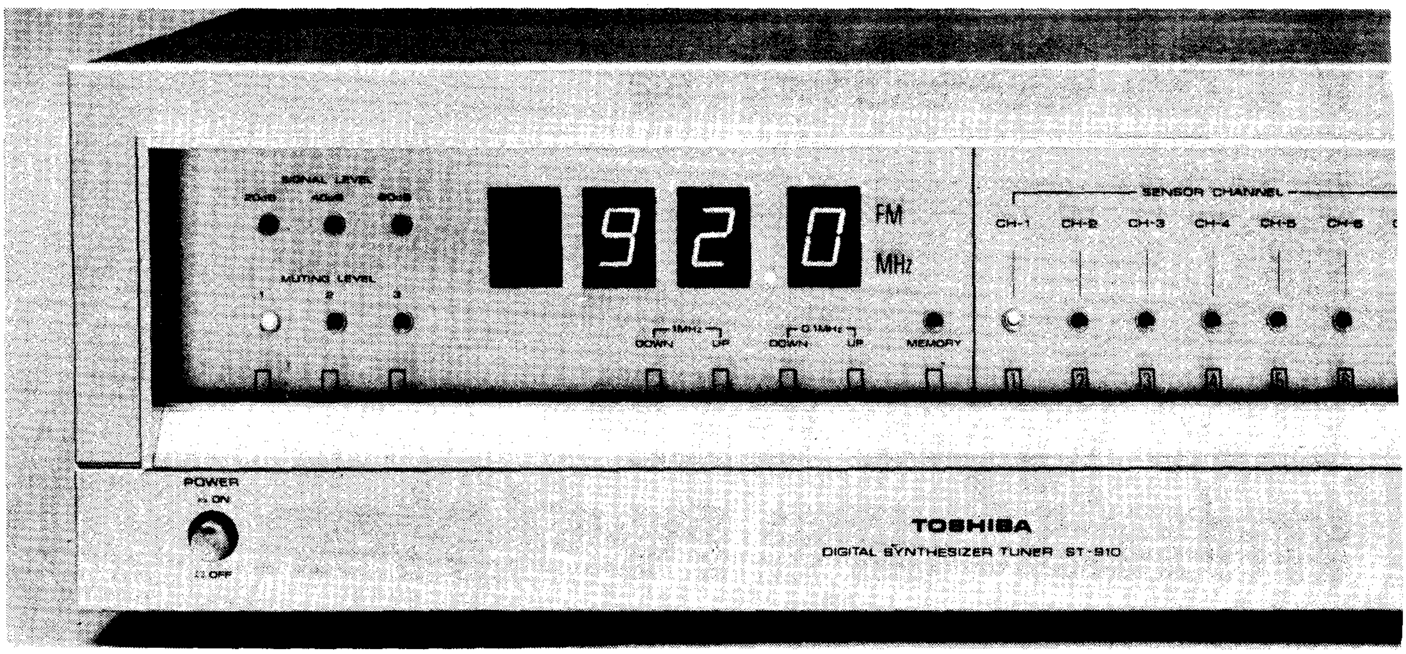
GLP/76

TOSHIBA DIGITAL SYNTHESIZER



Recommended retail price $1000+.

ALTHOUGH the invention of FM is rightly accredited to the USA's Major Armstrong, most post World-War II research has been done in West Germany. Apparently the victorious allies restricted Germany's broadcasting companies to using medium and high frequencies for internal communications — only VHF and UHF could be used for broadcasting.

The rationale behind this was strange and devious. It is commonly accepted that the purpose was to complicate and inhibit Germany's ability to produce and transmit her own broadcasting programmes. But if this really *was* the reason it largely failed, for German engineers soon developed VHF and UHV broadcasting to previously unparalleled heights of quality and technical excellence.

Americans and others were not slow to grasp the significance of the German research and it was not long before high quality FM broadcasting stations were set up, not only all over Europe, but also in America.

With the advent of stereo records in the mid 50's new pressure on our broadcast medium was created, in order to provide stereo broadcasts of comparable quality to the then fledgling stereo recording industry. Many of us will remember the early AM experiments using two broadcast stations at different frequencies.

Stereo FM broadcasting has been in general use for many years in overseas countries but it was not until just over a year ago that *stereo* FM broadcasting began in Australia.

Despite the still limited choice of FM stations a surprisingly large number of FM tuners and receivers are currently on sale in Australia — our recent survey of FM tuners published in our associated magazine Hi-Fi Review covered some 125 of them!

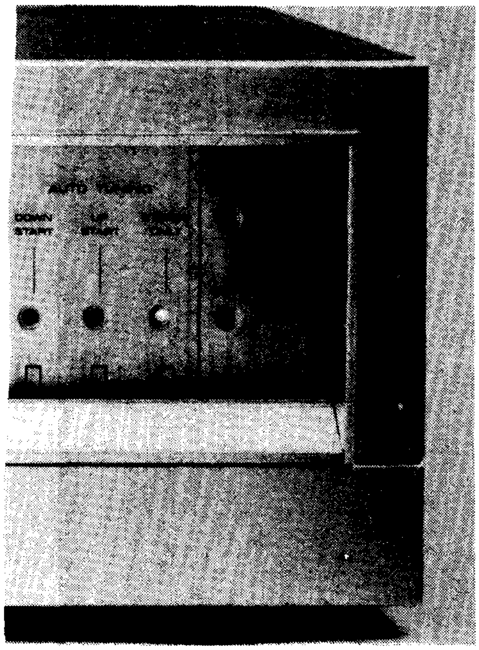
Several manufacturers have now produced very high quality units — one American-made device costs well over US$3000. The unit tested here costs less than that — but it's still a hefty $1000 plus and that's at least twice the price of many other FM tuners — three times the price of most.

The Toshiba ST910 is quite unlike any other piece of hi-fi equipment that we have previously seen. To start with there's not a single visible control apart from an ON/OFF switch. All other control functions are effected via capacitive touch switches, the positions for which are marked on the rear of the front glass panel forming most of the unit's front face.

The glass panel itself is divided into six sections which are from left to right; a signal level-indicating section consisting of six LED's, the top three being red LED's indicating signal level at +20 dB, +40 dB and +60 dB re 1 μV; whilst the lower three LED's (which are green in colour) indicate the muting level that has been selected as the threshold level for the receiver to respond to. These are activated by touching the capacitive switches indicated below them. To the right of this section is a four digit display of FM frequency. This uses 7-segment LED displays for showing the frequency to which the receiver is tuned. The first three digits indicate the frequency in MHz, whilst the last digit indicates the frequency in

88 · 90 · 92 · 94 · 96 · 98

TUNER ST-910



MEASURED PERFORMANCE OF TOSHIBA ST-910 FM TUNER S/N 52530001

Sensitivity (IHF Method)	1.5 μV
Distortion Factor (500 Hz & 100% Modulation)	< 0.3%
Signal Noise Ratio	> 60 dB
Frequency Response	20 Hz – 15 kHz ± 0.5 dB
Selectivity	> 80 dB
Image Rejection Ratio	> 80 dB
IF Rejection Ratio	> 80 dB
Capture Ratio	> 1.5 dB
FM Stereo Separation	≫ 30 dB
Dimensions	450 mm x 135 mm x 340 mm
Weight	8 kg

100 kHz increments.

Immediately below the digital display are two capacitive touch switches which enable the frequency to be increased up or down by 1 MHz steps. Two further capacitive touch switches allow the frequency to be increased up or down by 0.1 MHz steps. Immediately to the right of these is a memory switch which allows subsequently required stations to be preset by a series of IC devices. When this switch is touched the green indicator lamp is turned on. It is also necessary to touch one of the adjacent sensor panel capacitive switches, whose indicating LED is turned on by the process. Thereafter, all that is necessary to recall the memorised frequency is to touch one of the seven selected sensor channels switches. We found however that the memory would only 'hold' preselected stations for about two days.

To the right of the sensor channel switch positions is the auto-tuning section. This has a down-start capacitive selector switch, an up-start capacitive selector switch, and stereo-only capacitive selector switch. The down-start starts the receiver searching down in frequency till it finds a signal the level of which is above the muting level (or sensitivity level) which has been pre-set. The up-start button does the same, but in the reverse direction. The stereo-only selector accepts only those stations having a 38 kHz or 19 kHz sub-carrier signal in their format.

At the extreme right hand end of the escutcheon is the stereo/monophonic indicator. When the capacitive touch switch is activated the green monophonic light comes on, the red stereo light is extinguished and the tuner looks for monophonic stations only.

The back panel is a little different from other FM receivers in that as well as input terminals for either 300 Ω feeder cable or 75 Ω co-axial cable, it provides output terminals for left and right channels; a multiplex output terminal to facilitate four channel reception in the unlikely event that somebody proposes introducing it; a remote control DIN plug to facilitate the use of special remote control offered as an optional extra; an output level control which allows the setting of the audio line output levels; and a scanning speed control knob which allows the automatic tuning operation to vary between approximately 0.05 MHz/sec. to approximately 3 MHz/sec. scanning rate.

Another most interesting facility are two terminals which can be respectively connected to the horizontal and vertical axes of an oscilloscope to measure and minimise multi-path reception and thereby optimise signal quality. The handbook describes very simply yet practically, how this should be carried out.

DIGITAL FREQUENCY SYNTHESIZER

The heart of the ST910 is a digital frequency synthesizer based on a quartz crystal oscillator. This provides accurate and stable frequencies, replacing the normal variable frequency oscillator, to provide extremely accurate signal tuning. When used in conjunction with the phase locked loop, this provides an extremely precise and stable frequency

100 · 102 · 104 · 106 · 108

TOSHIBA DIGITAL SYNTHESIZER TUNER ST-910

tuning section. The great advantage of such a combined system is that the tuner receive frequency is extremely accurate (without the need for automatic frequency control) and nearly equal to the precision provided by the quartz crystal oscillator used in the original transmitting station.

Frequency stability claimed for the synthesizer section is better than 50 parts per 1 000 000 — subject to the period of operation and thermal conditions in which the receiver is used.

The inside of the receiver is more reminiscent of communication receiver construction and design than a piece of consumer electronics. Firstly, it makes use of a 300 mm x 240 mm mother card which is connected by plug-in sockets to the front circuit board on which are located the digital frequency display, the LED's and the capacitive touch switches. On the main section of the mother board are additional vertically mounted plug-in cards comprising the power supply, the digital memory sections, the frequency synthesizer and its crystal ovens and three cards on which are mounted the very high quality FM receiver.

An input pre-filter reduces the effect of unwanted high level AM signals on the following electronic circuitry.

The complete unit contains 32 transistors, 9 FET's, 100 diodes, 11 linear integrated circuits, 85 digital integrated circuits and 24 LED's. With a line up like that one would expect superlative performance — and that is exactly what we found.

Toshiba claim a frequency response of 20 Hz to 15 kHz ± 0.5 dB. And that is exactly what we found in our testing.

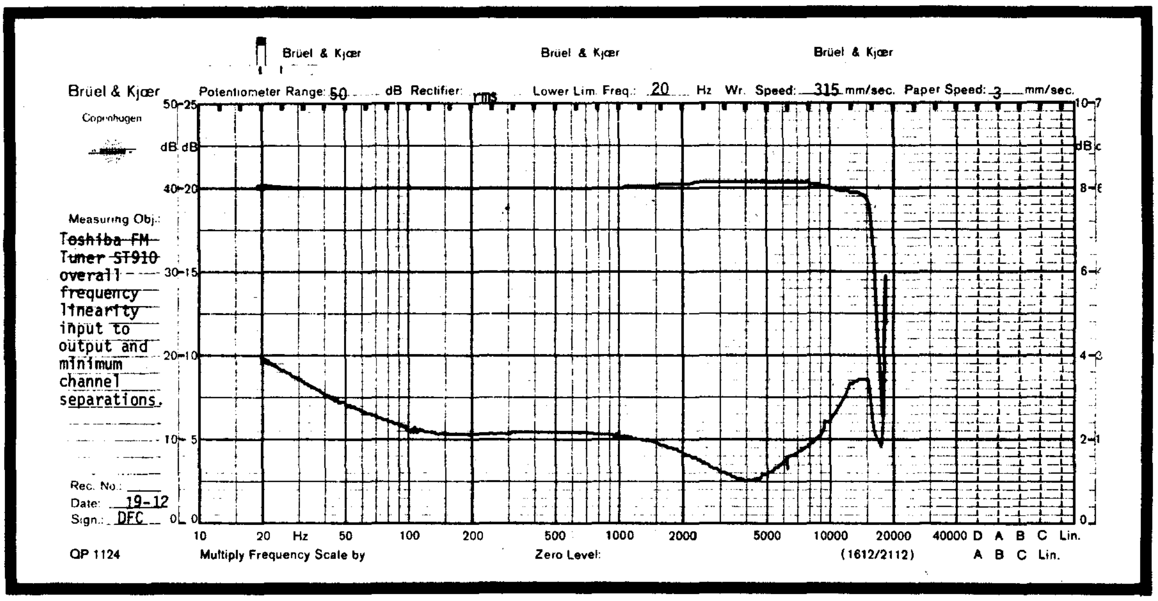
Image rejection ratios and IF rejection ratios of 100 dB are also claimed, we couldn't confirm that these *were* 100 dB but they were certainly better than 80 dB. Toshiba claim a capture ratio of 1.5 dB, we found it to be slightly better than this. They also claim a FM stereo separation of 40 dB in the range of 100 Hz to 8 kHz — we certainly measured better than 30 dB, and if allowance is made for the performance of our signal generator the claim of 40 dB separation would be very near the mark.

The calibrated sensitivity signal level LED's which are supposedly 20 dB, 40 dB and 60 dB re 1 μV are spot on at the 20 dB and 40 dB levels, and 57 dB for the 50 dB indicator. The major sensitivity on monophonic signals was 1.5 μV which is better than the manufacturers' claim. Total harmonic distortion was (delightfully) less than 0.3% which is as good as one could ask for.

After all this one might well ask how does the unit perform. We found it child's play to use and each time my children came into the laboratory that is exactly what they did, for this type of receiver is more resistant to abuse than any other we have ever seen and quite apart from its many features, attracts attention! Its listening performance is Grade A. We could in no way fault it, except for the minor possible criticisms that with digital frequencies set at 0.1 MHz intervals, one could possibly find oneself in a situation where the receiver was not tuned *exactly* to the station one was looking for and that on our review unit at least the preset tuning was effective for only a day or so before it needed to be reset.

We listened to all the available programme content we could find, the performance was in all respects almost perfect.

Is it really worth $1000 plus? This is for you to decide — but you'll buy nothing approaching it for less. ●



DRAKE R.L. DRAKE COMMUNICATIONS GEAR

DSR2 Digital readout communications **RECEIVER** 10 kHz-30 MHz continuous coverage, fully synthesized, for AM-USB-LSB-CW reception. **$3495.**

SPR4 communications **RECEIVER** for AM-USB-LSB-CW reception. Direct frequency dialling 150-500 kHz plus any 23 x 500 kHz ranges between 0.5 and 30 MHz. **$697**

R4C Amateur **RECEIVER** covers H.F. ham bands plus any 15 x 500 kHz ranges between 1.5 and 30 MHz except 5.0 to 6.0 MHz. **$640.** (transceives with T4XC)

SSRI Synthesized communications **RECEIVER.** Provides continuous coverage 500 kHz to 30.0 MHz for AM-USB-LSB reception. Operates from A.C. Mains or internal batteries. **$375**

TR4C sideband **TRANSCEIVER** full amateur band coverage 10 through 80 meters. **$630**

T4XC sideband **TRANSMITTER** full amateur band coverage 10 through 80 meters plus 160 meters accessory crystal plus 4 fixed frequency positions. **$609** (Transceives with R4C).

MN4 and **MN2000 MATCHING NETWORKS** – enable Feedline SWR's of up to 5:1 to be matched to the Transmitter. Built in Wattmeter. MN4 Handles 200 Watts. MN2000 Handles 1000 Watts continuous and 2000 Watts PEP MN4 **$115** MN2000 **$230.**

TV – 42 – L.P. FILTER for Transmitters below 30 MHz – 100 Watts continuous. **$11.50**

TV – 300 – HP FILTER – TV Set protection from transmitters 6 – 160 meters. **$9.00**

TV – 3300 – LP FILTER 1000 Watts continuous to 30 MHz with sharp cut off above 30 MHz. **$24.00.**

RP500 – Receiver **PROTECTOR** for Receiver front end protection from close proximity high power transmitters. Less than 0.5 dB Insertion Loss to 30 MHz. **$77.00**

W4 WATTMETER/SWR METER 2 – 30 MHz with 200 Watt and 2000 Watt ranges. **$65.00.**

WV4 WATTMETER/SWR METER 20 – 200 MHz with 100 Watt and 1000 Watt ranges. **$78.00.**

AC4 POWER SUPPLY for mains operation of TR4C or T4XC. **$175.00**

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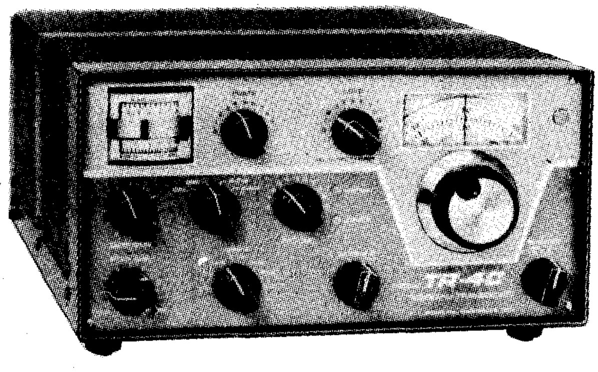
NIPPAN FC FREQUENCY COUNTER 15 Hz-250 MHz. Operates from mains or battery. **$258.00**

MINIPET LARGE DISPLAY 10 DIGIT MAINS OPERATED 4 FUNCTION CALCULATORS with floating decimal and constant. **$30.00**

PRICES shown include Sales Tax

T-4XC TRANSMITTER



TR4C TRANSCEIVER

ELMEASCO

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HERE'S WHAT YOU GET IN THE BANG & OLUFSEN 50TH ANNIVERSARY SYSTEM.

1. The Beomaster 901 Stereo Tuner/Amplifier A stereo amplifier combined with a stereo FM and Medium Wave radio tuner. The Beomaster 901 includes AFC (Automatic Frequency Control) which keeps the radio tuned in to the desired FM station.
The stereo amplifier has a 2 x 20 watts RMS output, which is more than sufficient in most homes.
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There are, of course, inputs for turntable and tape recorder, and outputs for headphones and two pairs of stereo loudspeakers.

2. The Beogram 1203 Record-Player A fully automatic stereo record-player with high fidelity specifications. With its single press-button control, nothing could be easier to operate. The turntable and pick-up arm are mounted on a separate floating sub-assembly preventing vibrations effecting the tracking of the pick-up cartridge.
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3. The Beovox Uni-Phase S.30 Loudspeakers From Bang & Olufsen's new range of Uni-Phase loudspeakers, a pair of S.30's with a power handling capacity of 30 watts RMS each. The most outstanding features of the Uni-Phase S30's is that they take up much less room than conventional pressure chamber loudspeakers of a comparable power handling capacity. As well, they produce sound more accurately than most commercial loudspeakers on the market to date.

4. The Bang & Olufsen Guarantee Your B & O 50th Anniversary System is covered by the normal one year guarantee for both parts and labour.

The Bang & Olufsen 50th Anniversary Offer is a genuine price reduction made possible by Bang & Olufsen of Denmark celebrating 50 years of designing and producing the world's most advanced sound equipment. As a result, this complete system which normally retails for $1,015.00 is offered at $695.00 for a period limited to three calendar months from December 1st, 1975.

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ELECTRONICS —it's easy!

PART 28

Digital instruments and test equipment.

IN THE previous two sections we discussed the basic building blocks of digital systems. We are now in a position to study how these blocks are assembled into specific types of general-purpose instruments and test equipment.

Digital instruments may be defined as those in which the major proportion of the circuitry is digital rather than analogue. The circuitry of such instruments is seldom all digital, as few of the natural processes we require to measure are in digital form (a notable exception is counting — a digital procedure). Hence the digital instruments that are used to measure real-world variables usually have an analogue-to-digital converter at the input. However there are many modern instruments designed to 'see' into logic circuitry — such instruments (having direct digital inputs) are truly digital.

Many test procedures could be implemented using solely analogue circuit techniques. However, there now exists a definite trend to replace analogue techniques with much more complex, but cheaper, digital equivalents.

Digital measuring equipments range in size and complexity from the simple panel meter for measuring voltage, current or resistance, Fig. 1, through medium complexity, portable and highly-flexible digital instrument systems, Fig. 2, to large automatic testing plants, Fig. 3, which operate on the commands of in-built computers.

Today, many testing instruments (even quite small units) possess self-testing facilities, in-built diagnostic ability and other advanced capabilities such as the automatic readjustment of the circuit under test to bring it within quoted specifications.

SOME HISTORY OF DIGITAL INSTRUMENT DEVELOPMENT

We have seen in Part 21 that most analogue signals can be converted to a digital equivalent. This concept first found serious economic application in computational systems, as was briefly explained in Part 22.

In the early days of digital systems even simple equipment had to be built using large numbers of thermionic valves and electro-mechanical relays. In the early 1940's the power requirements and the sheer bulk of such systems severely restricted the application of digital techniques to computers. Hence the early uses of digital systems in testing and evaluation first appeared in applications where portability was not required.

The need for an adequately-fast training simulator for aircraft pilots led to the development of the 'Whirlwind 1' computer by MIT in 1946. This evolved from work

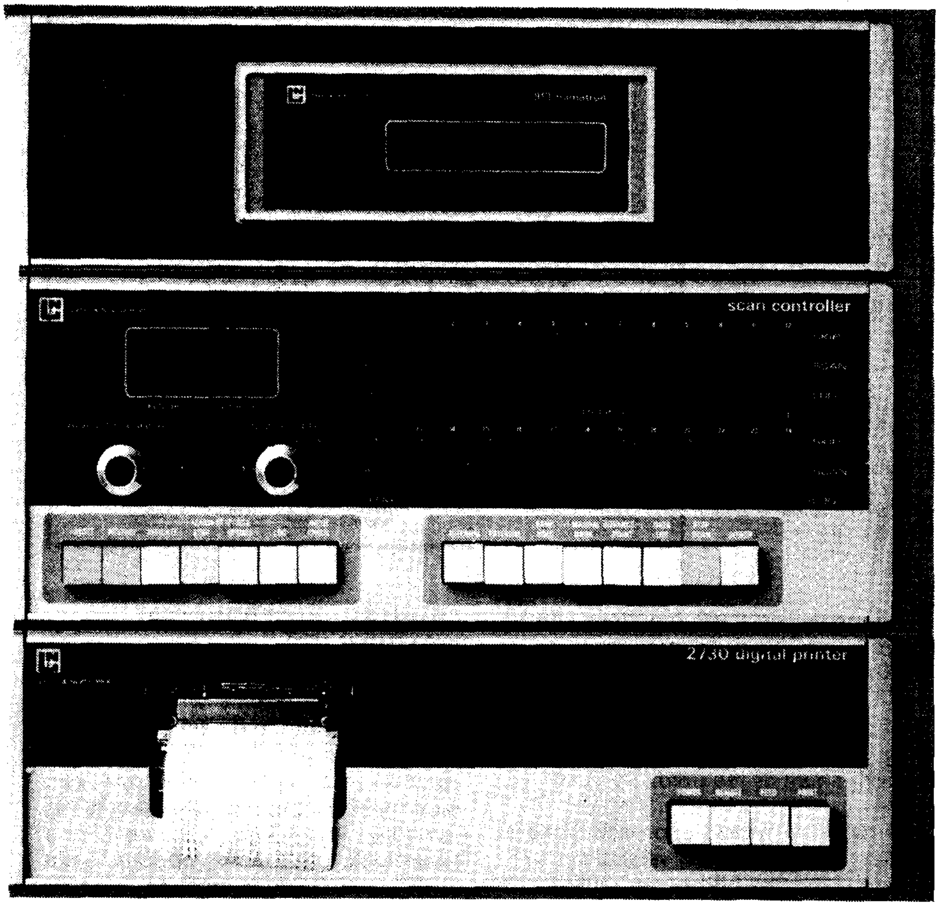


Fig. 1. Digital panel meters are extensively used in equipment, often replacing the moving needle indicator meter.

Fig. 2. The H.P. 3470 series measuring system consists of modules that clip together to form the digital multimeter instrument system required.

previously done on the use of digital techniques in the fire control of guns.

Digital voltmeters first appeared in the mid fifties and at least two companies, Non Linear Systems and Schumberger, lay claim to being first in the field. In the period 1955 to 1960 new skills, developed in the manufacture of computers, were used to build smaller cheaper and more effective instruments thus commencing the swing from analogue to digital instrumention. The introduction of transistors enabled large-scale digital process control to be realised — Texaco Refinery at Port Arthur, 1959, was the first. They also allowed portable digital instrumentation to be made.

In the early 1960's integrated-circuits were conceived. The cost and space savings gained with their use removed any doubt that digital techniques were not competitive with traditional analogue methods.

THE DIGITAL MULTI-FUNCTION METER

We have already dealt with the basic sub-systems used to form most digital instruments. They usually comprise various assemblages of digital displays, A/D and D/A converters, counters, registers, gates and sources of precise frequency signals.

A digital multi-meter, for instance, consists of analogue input, function and range selection stages which feed an A/D converter; this drives the digital readout form of display. They are marketed in a wide range of forms — from the neat compact fixed purpose units like that of Fig. 4 to systems such as shown in Fig. 2, in which modules are interchangeable to suit the very wide range of possibilities that the common power supply and digital readout allow. Functions offered (by choice of appropriate modules) may include more than the traditional multi-meter measurements. Frequency measurement, timing, counting, totalizing, and ratio measurement may all be offered. Readout of any physical variable is possible provided a sensor exists that may be correctly interfaced with the digital end of the measurement system.

The simplified block diagram of the very compact H.P. 970A a hand-held digital multimeter, is given in Fig. 5. The circuits are of analogue form until the comparator stage after which

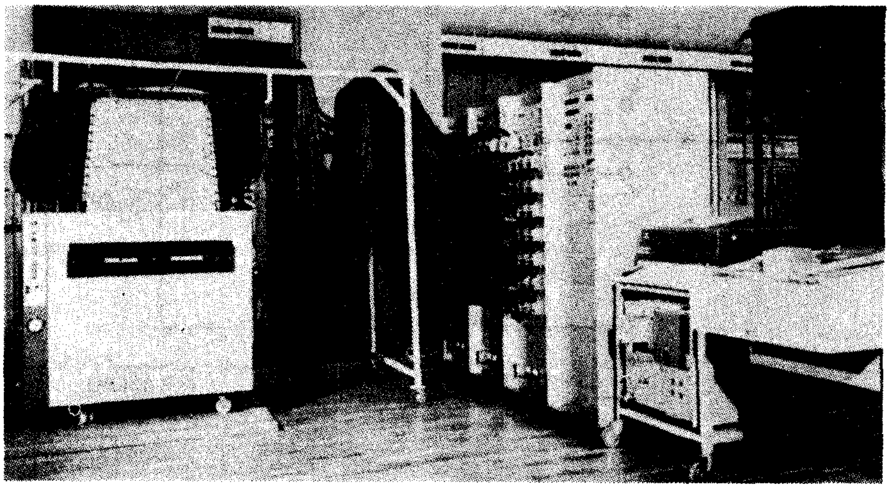


Fig. 3. Automatic Wiring Tester VD30, by Siemens — it handles 12,000 connections.

ELECTRONICS–it's easy!

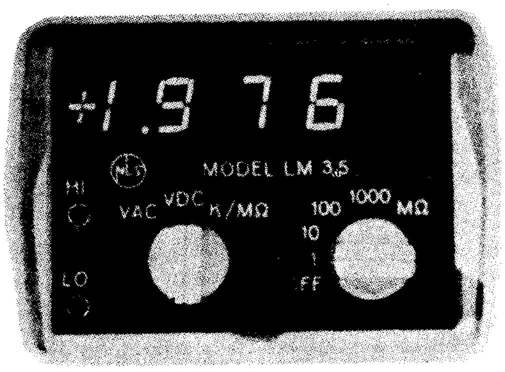
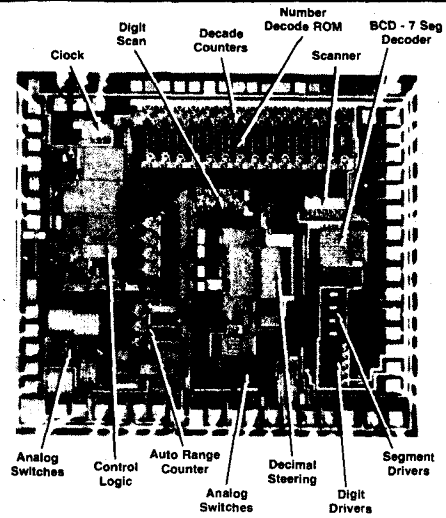


Fig. 4. This digital multimeter, by Non-Linear Systems, fits in the palm of the hand.

Fig. 6. Digital instrument circuits are often manufactured as custom-built chips. (a) Digital chip of HP 970A is just 3.9 by 4.3 mm in size.



digital signals are used. This unit uses the dual-slope integration method to convert from analogue to digital. Most of the circuitry is manufactured on just two custom-made monolithic IC chips — Fig. 6a shows an assembly with 40 flip-flops, 19 MOSFET switches and some 3500 bits of ROM (read only memory); Fig 6b shows the chip which carries the bulk of the linear circuits used.

Multimeter measurements of alternating current or voltage are only meaningful if the waveform is sinusoidal. If the waveform is complex it is necessary to use an oscilloscope to gain knowledge of the ratio of peak to average or rms as measured by the multimeter. There are instruments available which incorporate the multimeter and CRO functions within the one case. Such an instrument is the Tektronix type 213 unit as illustrated in Fig. 7. This instrument displays either the waveform or the scan-generated multimeter measurement as required.

A modular system approach is more expensive but gives versatility and continued flexibility to adapt to changing needs by not-so-expensive additions. Figure 8 shows one maker's modular approach — it retains the aesthetic shape of a complete portable set regardless of the number of modules needed at one time. The wasted space and extra weight penalty of the slide-in modular package is thereby avoided.

COUNTER–BASED DIGITAL INSTRUMENTS

Combining a display with a suitably gated counter and timing system provides the ability to count events; totalize and indicate elapsed time; determine frequency and period of periodic waveforms or provide a time-clock. In these options little analogue circuitry is involved, the unit either generating its own digital signals (a clock) or operating on input signals that are already in digital form.

We have dealt with the internal operation of counters in Parts 24 and 25: here we expand their use by studying the various modes of operation possible with a basic counter.

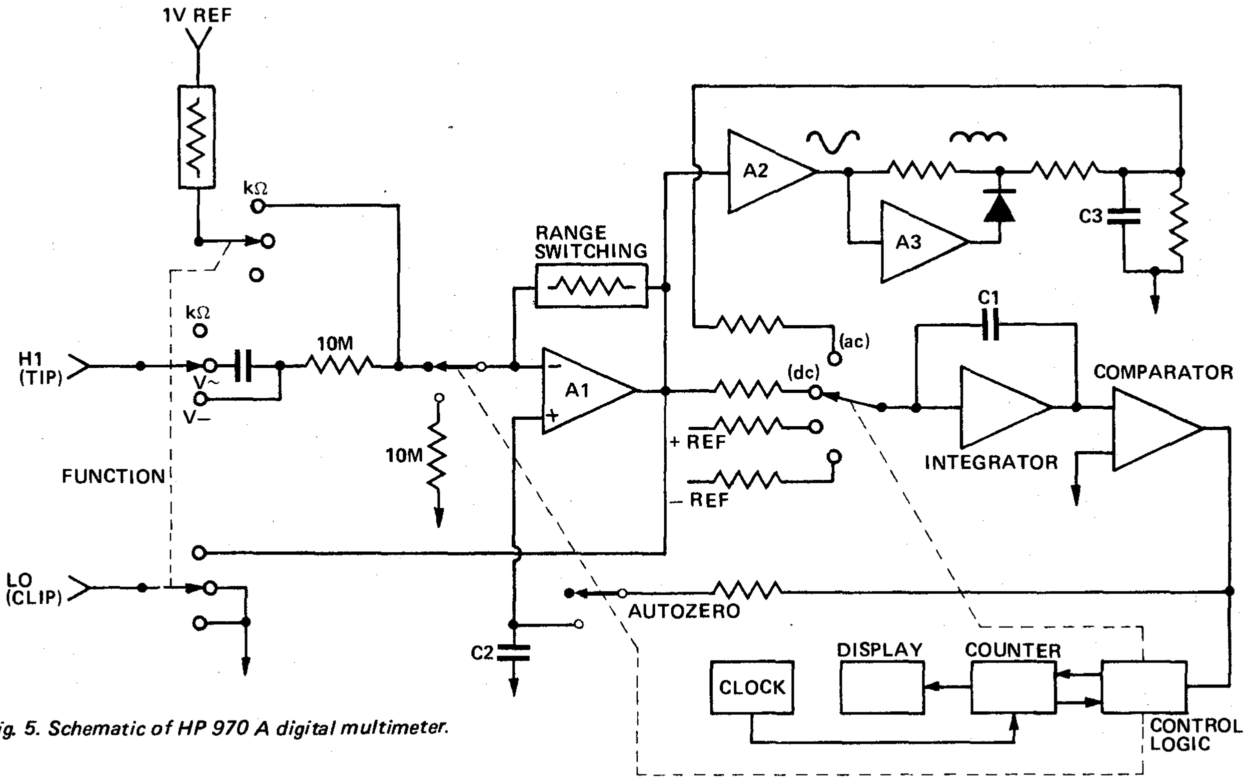


Fig. 5. Schematic of HP 970 A digital multimeter.

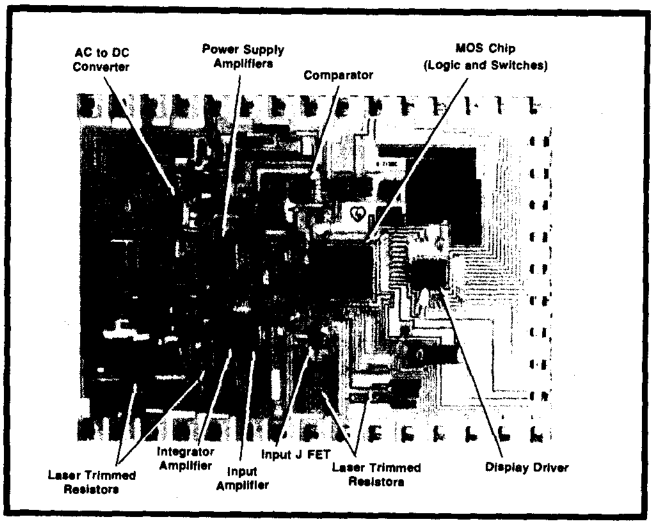


Fig. 6(b). Thin-film hybrid of HP 970A carries much of the analogue circuit on its 28 x 38 mm substrate.

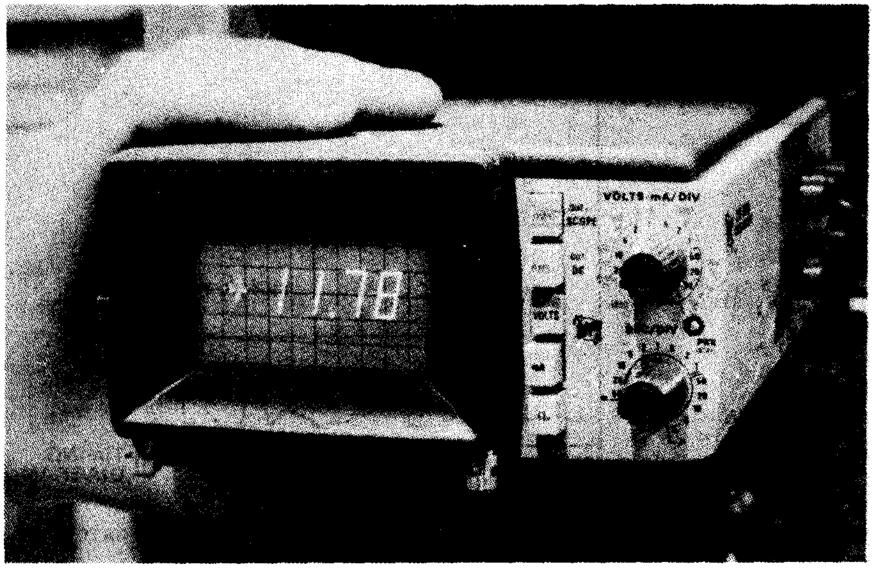
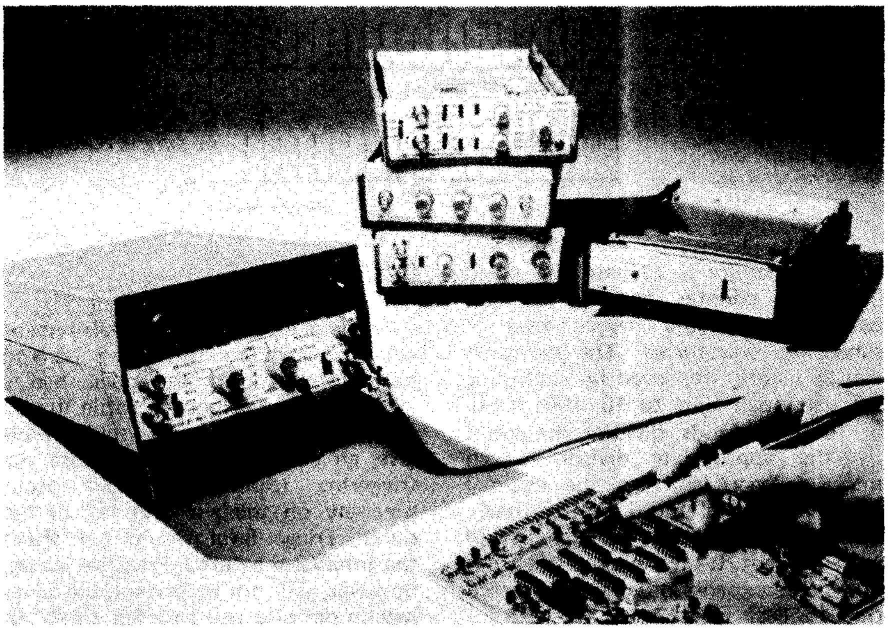


Fig. 7. The digital multimeter function is combined with a C.R.O. facility in the Tektronix 213 unit.

Fig. 8. Compact HP5300 series of modules allows many counting/timing measurements to be made.



TOTALIZING AND BATCHING

This is the simplest use of a counter. Events to be counted (for example packages on a conveyor belt may intercept an optical link, thus causing an electrical pulse to be generated each time the beam is broken). These pulses enter the counter, (Fig. 9) and are shaped into clearly recognisable counting pulses. Whether or not an event is counted is decided by the condition of the input gate which can be opened or closed on electronic command. In many applications the gate is quite simple, but its design can be a major problem when very fast signals are to be totalized to high-accuracy.

A batching counter goes a little further in that it counts to a predetermined value. When this is reached it provides an output command to the process being batched (for example, tins being counted into cartons) which causes some change in the process. At the same time, if the process is repetitive, the counter is reset to the starting value ready to count the next batch. It is sometimes more convenient to count downward from the number required, operating the batch command at the zero value. More complicated batching systems may have a stored program that sets each batch sequence to varying count values.

TIME INTERVAL MEASUREMENT

It is possible to measure the time-interval between two events by feeding pulses of known time separation into the input of the counter, as shown in Fig. 10, where a clock drives the counter. An example is the timing of a race. The gate is opened at the starting signal and stopped at the end. Counts accumulated represent the time interval. Obviously there is an advantage in choosing a pulse repetition rate that suits the units of time being used. The choice of clock frequency therefore depends on the resolution needed. For example, to measure one second with a resolution of 1 in 10^6 a pulse frequency of 1 MHz is needed to gain 1 μs discrimination.

In some applications a common gate — control input is suitable — where the on and off event reproduces the same situation such as in period measurement of a sine-wave signal. Often, however, two separate input channels are needed so that each can have the specific pulse conditioning needed by different signal sources. Race timing, for example, might initiate the count on the sound of the starter gun and stop it on the signal from a pressure-pad sensor.

ELECTRONICS–it's easy!

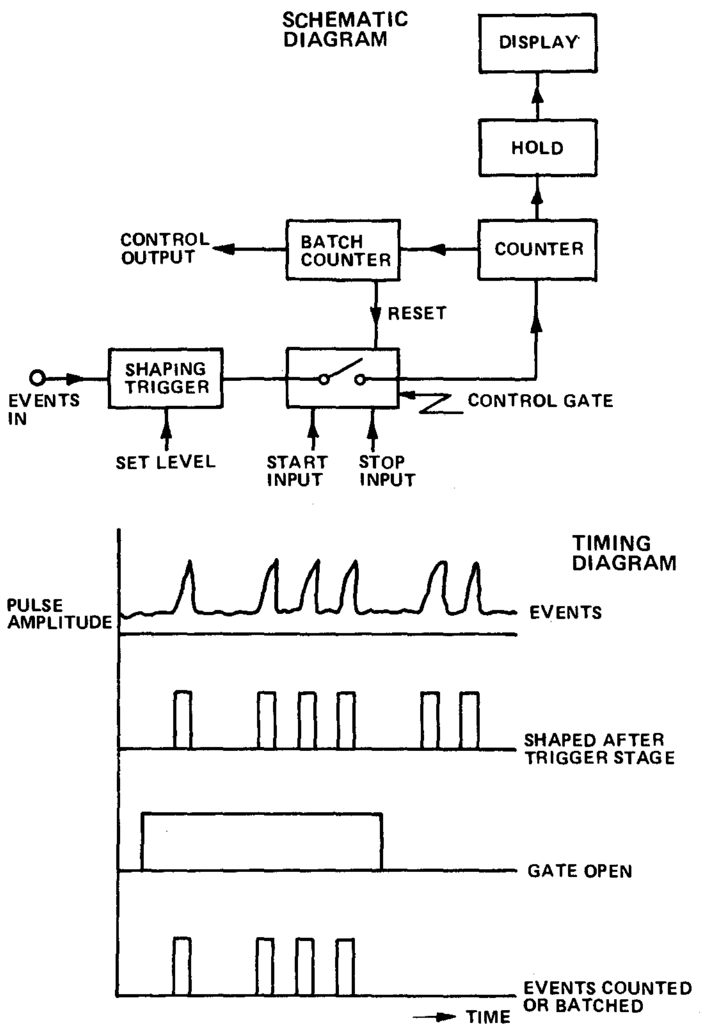


Fig. 9. Schematic diagram of totalizing and batching use of counter with display.

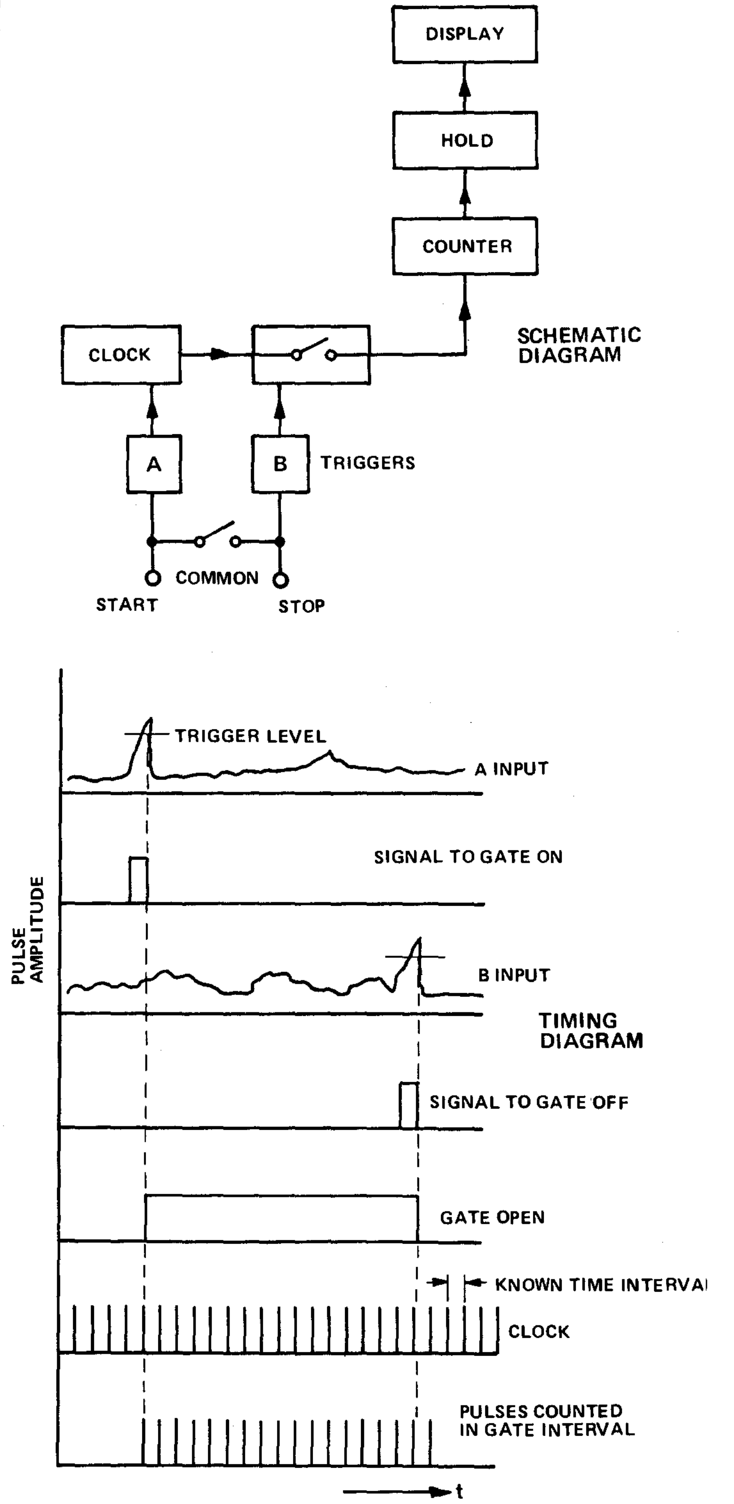


Fig. 10. Addition of a clock to the totalizer yields time-interval measurement with this configuration.

Because many triggering signals are ill-defined in time, most counter/timers have input stages that trigger at preset adjustable levels – Schmidtt triggers or comparators are used. This enables the operator to discriminate the events to be counted from relatively noisy backgrounds that have a lower peak value – see later. Another reason for selective-level triggering is to allow the counter to operate at different points on a waveform – a sinewave input can be used to produce pulses of varying widths in this way. The counter output may also be used to trigger an event so as to provide automatic timing sequences, this being similar in priniciple to batch counting.

PERIOD OF REPETITIVE SIGNAL

The time interval measurement arrangement also enables the period of a wave-form to be measured. The most basic procedure is to gate the clock into the counter for the interval between the same trigger level of successive waveforms. The precision can be greatly improved by extending the gate-open time to 10, 100, 1000, or 10 000 periods, dividing the count by the appropriate divisor (which means a mere shift of the decimal point if decimal multiples are used). This is referred to as multiple-period measurement, it gives greater precision but at the expense of greatly increased time for each measurement.

PULSE WIDTH

A special case of period measurement occurs when the width of a pulse is to be determined. If the pulse had a perfect square response profile the on and off gating points would always give an accurate answer because the triggering transitions would occur precisely on the rise and fall of the pulse. Trigger-level would not affect the interval measured. Practical pulses, however, will not be perfect, the edges having definite rise and fall times. In this case the trigger-level becomes critical in width determination, as is depicted in Fig. 11. Counters usually provide a slope selection control. This decides whether the trigger operates on the positive or negative slope, that is, a or b slopes respectively (Fig. 11).

PHASE DIFFERENCE

Two identical waveforms can be regarded as two separate inputs for the start-stop inputs. If both trigger at the same point on each waveform (preferably at the zero-crossing to gain maximum precision) the ratio of the time-interval between the two crossings to the period of the waveform is the phase shift in terms of a fraction of one cycle.

FREQUENCY MEASUREMENT

The frequency of a repetitive signal is defined as the number of cycles (events) per unit time. A digital frequency meter, therefore, can be made with controlled gate-on period of precisely known time interval. In other words, it is the same combination as the interval timer (i.e. oscillator counter with display, gate control and precision) but with the difference that the clock now controls the gate (not the counter) through a precision divider that scales the basic clock frequency down to obtain the gate duration needed. Gate periods range from 1 μs to 1 s. A simplified schematic is given in Fig. 12. The input signal is often sinusoidal; the input stage shapes this into a square wave to enhance individual cycle detection by the counter.

NOISE ERROR REDUCTION

The above descriptions give the basic operating modes of the various counter/time/frequency-meter combinations. In practice a number of refinements may be incorporated to obtain better practical performance.

Noise can be reduced by incorporating a fixed amount of backlash in the trigger circuit; this produces what is called the trigger window. On the way up the trigger level is at a higher level than on the way down, as shown in Fig. 13. Provided the noise added to the signal has an amplitude smaller than the window width, the counter will only trigger once on the way up and once on the way down. This method works well for high-frequency measurements where the noise is usually a small percent of the signal-plus-noise signal amplitude.

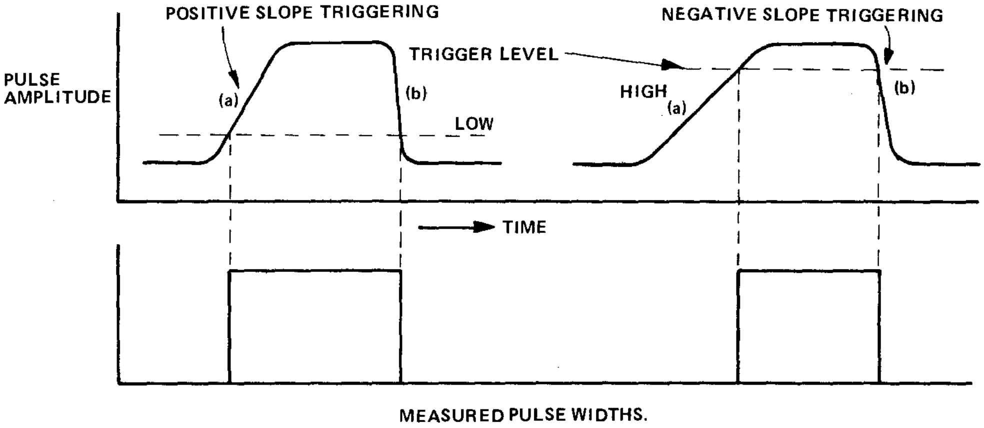


Fig. 11. Trigger level must be considered in pulse width measurement to obtain the parameter required.

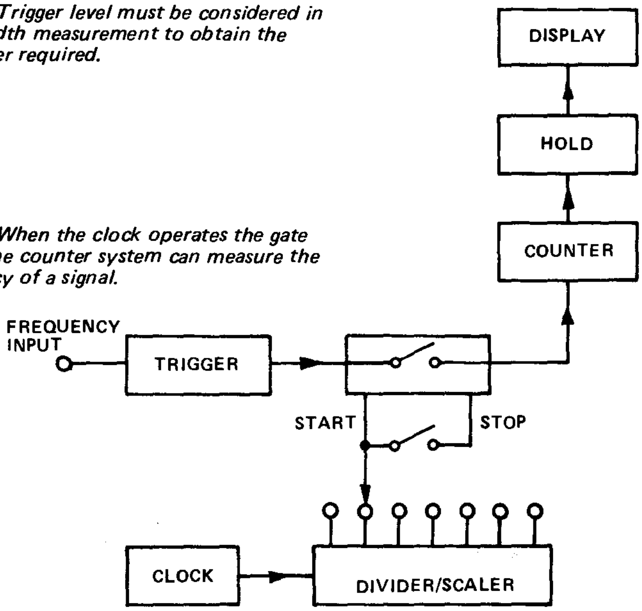
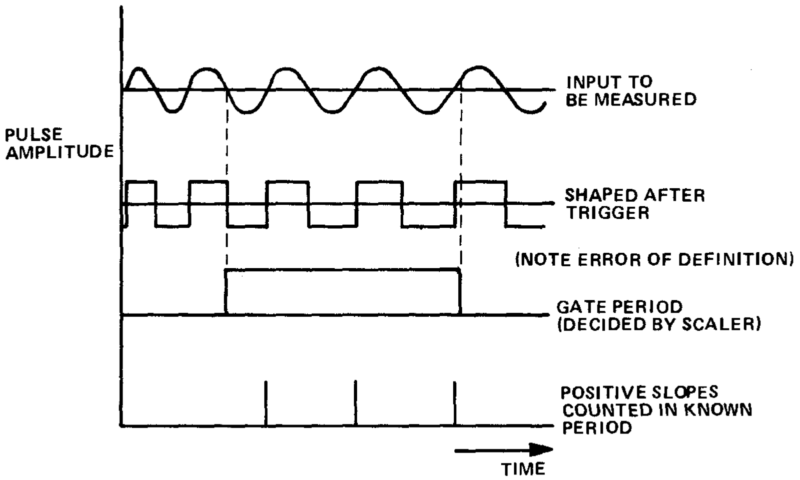


Fig. 12. When the clock operates the gate length the counter system can measure the frequency of a signal.



Low frequency measurements can often involve interference sources that produce rapid spike transients. One simple method of reducing this is to use filters. Advanced designs contain filter systems that reject all frequencies higher than that being tested, the appropriate filter being automatically selected by the counter itself after it has made a determination of the frequency of the signal.

A recent approach to the noise problem is to set up a time-window (as opposed to the trigger height window) that, once the counter gate is on, inhibits the off-state chance until after

(continued on page 84)

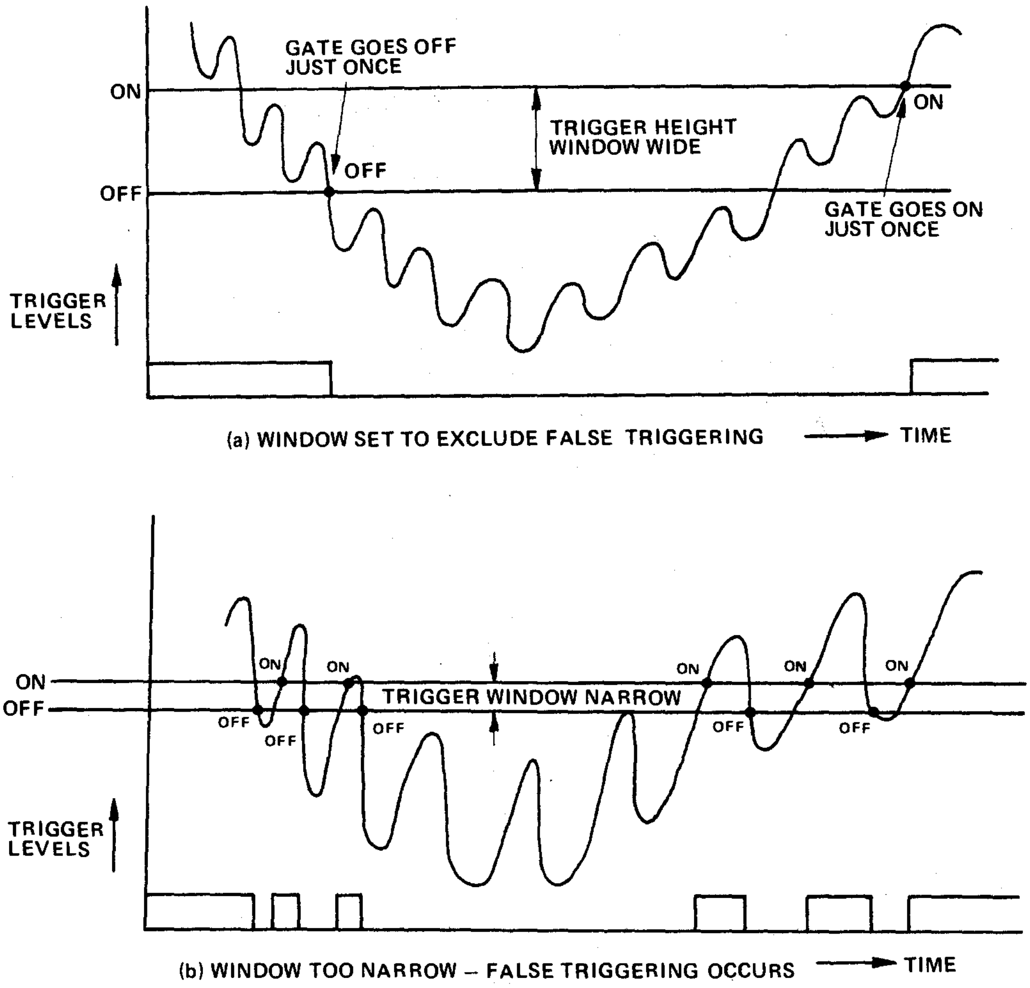


Fig. 13. Noise reduction in counting by use of a trigger height window.

a time just shorter than the expected interval. This is known as trigger masking. It is very useful in eliminating contact-bounce retriggers.

Before using a counter/timer on an unknown waveform it is, where feasible, good practice to study the waveshape on an oscilloscope in order to decide the best strategy for trigger-level and height-window width settings. Figure 14 illustrates the differences between window level settings on various waveshapes.

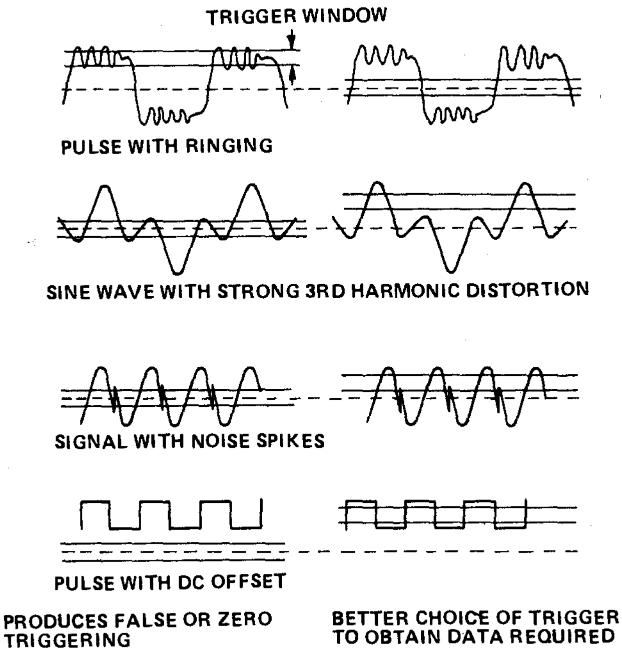


Fig. 14. Trigger height for the window must be chosen to suit the wave shape.

As the readout is in digital form it is necessary to hold the display at the determined value for a period long enough to allow the value to be read. Some units incorporate a control that gives the operator a choice of hold time.

The following part of this series will continue with this general discussion of digital instruments, covering physical variable transducer systems, the various kinds of analysers and correlators, waveform generators and computer-controlled testing systems.

Further Reading:

Varies issues of Hewlett Packard Journal contain many detailed articles on a wide range of digital instruments.

"Digital Instrument Course – Pt. 2", A. J. Bouwens, Philips Industries Holdings, Sydney, is useful to have. This booklet describes the practical use of counter/timer instruments in many varied applications.

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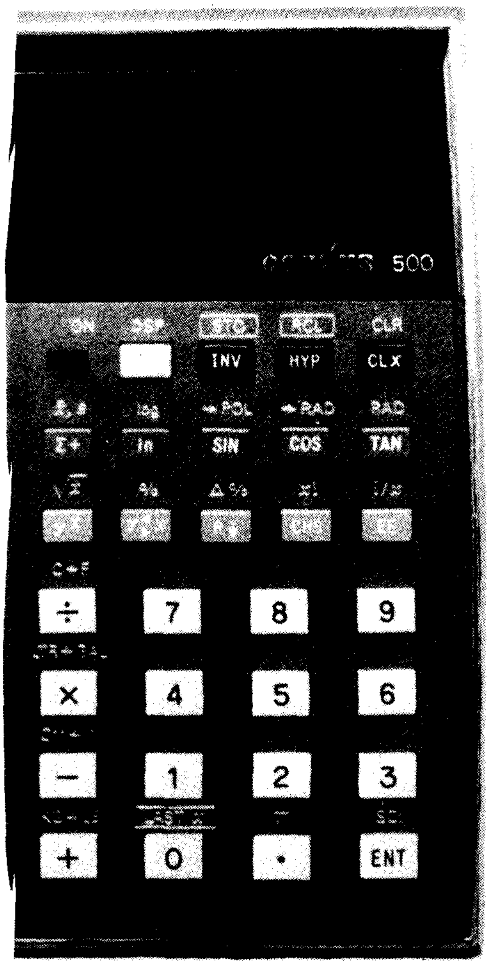

CORVUS 500

"THE SCIENTIST/ENGINEER'S PROBLEM SOLVER"

WITH REVERSE POLISH NOTATION

...this new entry to the scientific field offers the ultimate package—the efficiency and simplicity of Reverse Polish Notation, a powerful 4-register stack with nine memory registers, a 12-digit display for exacting accuracy, (scientific format of 10-digit mantissa, 2-digit exponent), total capability in scientific functions plus additional capabilities in statistics, conversions, and business.

Clear
Clear display
Add. subtract, multiply, divide
Scientific display format:
  10-digit mantissa,
  2-digit exponent,
  floating decimal
Mode set to radians
Fix decimal point (0-9) in display
Sine
Cosine
Tangent
Hyperbolic sine
Hyperbolic cosine
Hyperbolic tangent
Memory store, 9 registers

Memory recall, 9 registers
Memory exchange, 9 registers
X ↔ Y exchange
Common log
Natural log
4-stack register
Rotate stack
Recall last X

Y to the X power
Reciprocal for all values, exponent range from +199 through −200
Pi
Change sign
Square root
Factorials

Summation plus (adds X and Y to memory for vector addition; recalls sum of X and sum of Y)
Percentage
Percentage difference (Δ%)
Mean
Standard deviation
Centigrade to fahrenheit
Liters to gallons
Centimeters to inches
Kilograms to pounds
Degrees to radians
Set radian mode for trigonometric functions
Trigonometric rectangular to polar
Hyperbolic rectangular to polar

THESE FUNCTIONS ARE OBTAINABLE THROUGH THE INVERSE CALCULATION SEQUENCE:

Business display format, 12-digits, floating decimal point
Arc sine
Arc cosine
Arc tangent
Arc hyperbolic sine
Arc hyperbolic cosine
Arc hyperbolic tangent
Xth root of Y

Gross profit margin percentage
Summation minus for vector subtraction

Anti log. natural (e^x), for all values from −230 through +230
Anti log. common (10^x), for all values from −99.9 through 99.9

Trigonometric polar to rectangular
Hyperbolic polar to rectangular
Set degree mode for trigonometric functions
X^2
Fahrenheit to centigrade
Gallons to liters
Inches to centimeters
Pounds to kilograms

OTHER FEATURES:

Display number (X) times 10 to −100 power, as 0.X-99
Display indicator for radian mode (decimal in right most LED)
Trig/Hyperbolic accuracy near angle 0 (and 90 degrees)

Anti-logarithm and logarithm accuracy near 0 and 1 respectively
Nickel-cadmium rechargeable batteries; AC adapter/charger, carrying case included. Six hours operation on full 12-hour charge.

*** plus $2.50 post and packing**

Corvus calculators are marketed in Australia by Unitrex Pty Ltd, 414 Collins St., Melbourne.

NOTES

The Corvus 500 is warranted for a period of 12 months from original purchase date — under normal use and service — against defective materials or workmanship. Defective parts will be repaired or replaced at Unitrex's option when the calculator is returned prepaid to Unitrex of Australia Pty Ltd., 414 Collins St, Melbourne, Vic 3000. The warranty is void if the calculator has been damaged by accident or misuse. Removal or alteration of serial number or repair by unauthorised personnel also voids warranty." The warranty contains the entire obligation of Unitrex of Australia Pty Ltd and no other warranties, expressed, implied or statutory are given — this warranty does not exclude limit restrict or modify any condition or warranty implied by the Trade Practices Act 1974, or other State laws or Acts . . .

We regret that we cannot arrange to supply these special-offer units against a sales-tax exemption.

The units can only be obtained as below. Electronics Today International cannot supply directly nor can undertake to demonstrate or discuss details of the units offered.

All units will be thoroughly inspected before despatch. The package should be carefully inspected before accepting delivery. Acceptance should be refused if the package is damaged.

Orders must be addressed exactly as per the coupon. Due to postal delays, readers should expect a delay of between three to four weeks between posting an order and obtaining delivery.

Finally — in the event of the unit not working — please return it directly to Unitrex, 414 Collins St, Melbourne, Vic 3000. NOT to ETI. This offer closes on March 31st 1976.

Corvus Offer

Name . . . .
Address . . . .

Please forward . . . . Corvus 500 Calculator/s. My cheque/postal note for . . . . is attached. Make cheque/postal note payable to Corvus Offer. Please forward $102 (i.e. $99.50 plus $2.50 postage and packing) per unit.

Send to Corvus Calculator Offer
c/- Electronics Today International
15, Boundary St., Rushcutters Bay, NSW 2011.

Special Readers' Offer

CORVUS

Advanced Scientific Calculator

$99-50*

THE CORVUS 500 is an advanced scientific calculator similar in many ways to Hewlett-Packard's HP-45 and Texas Instruments' SR 51. This is understandable as Corvus was the calculator division of Mostek — the people who made the microprocessor chips for the HP 45 and HP 35 calculators.

A comparison of the three calculators is contained in Table 1 below. As can be seen the Corvus has quite remarkable capabilities for its (special offer) price. In addition the Corvus 500 is one of the most attractive and well styled units we have yet seen.

The Corvus 500 uses Reverse Polish notation and a four level stack to perform its calculations in either fixed point (number of decimal places displayed is selectable) or scientific display mode (10 digits plus two digit exponent).

In addition 12 digit floating operation is possible — which automatically changes to scientific notation if 12 digits overflow. Thus sin 20^{o} is calculated as 0.342020143328!

The valid exponent range in scientific notation can extend from +199 to -200 whilst still obtaining a correct answer in the mantissa (leading figures of exponent not displayed). When exponent overflows the display flashes cyclically. The flashing warning may be deleted by pressing the clear flag once — whence calculations can be continued with the calculated number, or the x register may be completely cleared by pressing the clear key for a second time.

The Corvus 500 has flexible statistical functions. It is possible to sum two sets of data simultaneously (x and y registers). The sum and standard deviation of the x sum are called up by keyboard command, as well the number of x entries can be found in memory 7, the sum of x^2 in memory 8 and the sum of x in memory 9.

The percentage calculations offered are very useful. The two keys % and Δ% may be used to calculate percentage difference, percentage mark-up or discount and gross profit margin. The Reverse Polish mode of operation makes these calculations particularly straightforward.

CRITICISMS

The handbook supplied doesn't really do justice to the machine's capabilities. Like most of its kind it's almost adequate but has a few surprising omissions.

The machine's 62 functions are controlled by 30 keys. Because of this it is necessary to use the calculator fairly frequently to remember the various sequences. This criticism is of course applicable to other machines of this type.

Because the display reads out to 12 digits, transcendental and log functions take about three seconds to complete — it's a trade off between time and accuracy.

SUMMARY

The above criticisms relate to only minor drawbacks in a calculator which is flexible, extremely accurate and much less expensive than others with similar capability.

We thoroughly recommend this powerful advanced scientific calculator. It is excellent value for money.

COMPARISON OF ADVANCED SCIENTIFIC CALCULATORS

FEATURES	CORVUS 500	T.I.SR 51	HP 45
Type of Display	LED	LED	LED
Digits in Display	14	14	14
Fixed Decimal	to 9 places	to 8 places	to 9 places
Rechargeable	Yes	Yes	Yes
Type of Logic	RPN	Algebraic	RPN
No. Keys	30	40	35
+, −, X, ÷	Yes	Yes	Yes
Trig	Yes	Yes	Yes
Inverse Trig	Yes	Yes	Yes
Range of Trig	Full Circle	Full Circle	Full Circle
log x, LN x	Yes	Yes	Yes
e^x	Yes	Yes	Yes
10^x	Yes	Yes	Yes
Hyperbolic Functions	Yes	Yes	Yes
Degrees/Radians	Yes	Yes	Yes
Grads	No	No	Yes
Y^x	Yes	Yes	Yes
$x^n \sqrt{\ y}$	Yes	Yes	No
x^2 x $\frac{1}{x}$ nx	Yes	Yes	Yes
x!	Yes	Yes	Yes
x ex y	Yes	Yes	Yes
%, Δ %	Yes	Yes	Yes
Gross profit margin	Yes	No	No
Σ + Σ −	Yes	Yes	Yes
Mean/standard deviations	Yes	Yes	Yes
Variance	No	Yes	No
Random No. Gen	No	Yes	No
Linear Regression	No	Yes	No
Slope/Intercept	No	Yes	No

FEATURES	CORVUS 500	T.I.SR 51	HP 45
Vector Addition/ Subtraction	Yes	No	Yes
No. Memories	9	3	9
Memory Exchange	Yes	Yes	No
Permutations	No	No	
Scientific Notation	Yes	Yes	Yes
π	Yes	Yes	Yes
Change Sign	Yes	Yes	Yes
Stack Operation	Yes	No	Yes
Rotate Stack	Yes	No	Yes
Recall Last x	Yes	No	Yes
CONVERSIONS			
Degrees — Radians	Yes	Yes	No
Degrees — Grads	No	Yes	No
Polar — Rectangular	Yes	Yes	Yes
Deg/Min/Sec — Decimal	No	Yes	Yes
Litres — Gallons	Yes	Yes	Yes
Centigrade — Farenheit	Yes	Yes	No
Centimetre — Inches	Yes	Yes	Yes
Kilograms — Pounds	Yes	Yes	Yes
Mils — Microns	No	Yes	No
Feet — Metres	No	Yes	No
Yards — Metres	No	Yes	No
Miles — Kilometres	No	Yes	No
Miles — Nautical Niles	No	Yes	No
Acres — $Ft.^2$	No	Yes	No
Fluid Oz. — Litre	No	Yes	No
Fluid Oz. — CC	No	Yes	No
Ounces — Grams	No	Yes	No
Short Ton — Metric Ton	No	Yes	No
8TU — Calories	No	Yes	No
Voltage Ratio — dB	No	Yes	No

Data supplied by manufacturers of Corvus unit.

NEW BOOKS & NEW EDITIONS

Radio, Valve and Semiconductor Data Tenth Edition 1975 *A.M. Ball*

Characteristics of 1,000 Valves, monochrome and colour Cathode Ray Tubes, 9,800 Transistors, Diodes, Rectifiers and Optical Semiconductors. The continuing development of semiconductor technology and rapid obsolescence of many valves have necessitated a new edition of *Radio Valve and Transistor Data*, a book which sold over 450,000 copies in its Nine Editions. The new title reflects the widening range of solid-state devices, from simple diodes and transistors through to thyristors, triacs, light emitting diodes, etc. A comprehensive list of semiconductor comparables and valve equivalents has also been included.

Foundations of Wireless and Electronics Ninth Edition 1975 *M.G. Scroggie*

Since *Foundations of Wireless* was first published in 1936 it has helped thousands of students and amateur enthusiasts as they encountered the principle of radio and electronics for the first time. This book covers the whole basic theory, assuming no previous knowledge and using only a minimum of mathematics. The Ninth Edition has been updated to emphasize printed and integrated circuits, ceramic filters, single-sideband radio and the increasing range of photoelectric devices.

Audio on Wheels

Vivian Capel

1975 **240 pages**

Although there is a tremendous and growing enthusiasm for 'in-car entertainment', surprisingly little information has been published to help in choosing and installing mobile audio equipment. The radio engineer, the motor mechanic and the amateur DIY man who needs comprehensive information on mobile audio will find this book an essential source.

Contents: Audio Amplication; Principles of Radio Reception; Sound Recordings; Power Supplies; Loudspeakers; Car Aerials; Car Radios; Stereo and Multi-speaker Systems; Cassette Players; Cartridge Players; Motor Control Circuits; Disc Systems; Installation; Interference Suppression; Mobile Public Address; Setting up a Workshop; Repairs and Maintenance; Index.

Also Available

110 Operational Amplifier Projects for the Home Constructor – R.M. Marston
128 pages **1974**
This book should have considerable appeal to the enthusiast who has not yet given serious attention to the operational amplifier. In fact, to anyone not yet familiar with this device, this book would seem to be as good a place as any to make its acquaintance. Whether you need to solve a particular problem, or just want to learn about operational amplifiers, this book will give you a good start – and a lot of fun into the bargain.
–*Electronics Australia*

110 Thyristor Projects Using CSRs and TRIACS – R.M. Marston
148 pages **1973**
A chapter on basic principles and simple projects opens this useful book, with other sections on power switching, alarms, time delays, lamp heater and motor control, and miscellaneous projects. In all, a book to be recommended to anyone interested in electronic means of power control, whether on a hobby basis or as a professional.
–*Electronics Australia*

110 Semiconductor Projects for the Home Constructor – R.M. Marston
136 pages **1969**
The purpose behind this book is that of presenting information on established and new semiconductor devices by way of circuit design rather than by long-winded theory. The technique . . . is to be commended, and the considerable amount of information provided by the 110 working circuits in this book make it excellent value at its price. All circuits have full component values and are accompanied by brief but very explicit descriptions of their operation.
–*The Radio Constructor*

110 Integrated Circuit Projects for the Home Constructor – R.M. Marston
136 pages **1071**

50 Photoelectric Circuits and Systems – P.S. Smith
92 pages **1072**
Most of the circuits use cadmium sulphide cells, with a few circuits for photo-transistors and photo-diodes. Circuits for flame-failure and detection use the 155UG a non-polarised photo-emissive cell sensitive only to ultraviolet. Summing up, I feel that the book would have wide appeal, not only to students and experimenters but to those engaged in the professional field.
–*Electronics Australia*

20 Solid State Projects for the Car & Garage – R.M. Marston
124 pages **1970**

20 Solid State Projects for the Home – R.M. Marston
114 pages **1969**

Transistor Pocket Book – Hibberd
312 pages **1965**
The Transistor Pocket Book is a comprehensive guide to the characteristics and uses of the various types of transistor that have been developed in recent years. It is based on the junction type but deals with planar transistors, FETS, MOSTs, and thin film types.

Radio and Electronic Laboratory Handbook 8th Edition – Scroggie
628 pages **1971**
This practical handbook has been completely revised, and covers techniques used in both radio and electronics. The opportunity has been taken in this edition to cover the ever growing use of transistors in instrumentation, and there is a useful chapter on the choice and care of equipment.

Principles of Transistor Circuits 5th Edition – Amos
320 pages **1975**
Provides a clear and comprehensive account of the circuit applications of transistor devices and has been revised to include important trends in the use of FETs and ICs in sound, television and digital equipment.

Guide to Broadcasting Stations – 17th Edition – B.B.C.
206 pages **1973**
This edition contains useful fundamental information on radio receivers, aerials and earths, propogation, signal identification and reception reports in addition to listings of stations broadcasitng in thelong, medium, and u.h.f. bands, by both frequency and geographical location.

Newnes Radio Engineer's Pocket Book – 14th Edition – H.W. Moorshead
188 pages **1972**
An invaluable compendium of radio facts, figures and formulas. This edition contains new tables on radio and television frequencies and channels, and information on metric wire sizes.

Radio Servicing Pocket Book – 3rd Edition – Vivien Capel
256 pages **1975**
This is essentially a practical book for the radio serviceman, so most space has been devoted to workshop planning and practice, test equipment, repair techniques and hints, as well as fault finding and quick, economical repair and alignment practices.

Rapid Servicing of Transistor Equipment – 2nd Edition
Gordon King
184 pages **1973**
Though biased towards fault-finding this book provides a simple introduction to electronics and some useful practical advice.
– *S.R.L. Practical Electronics*

Wideband Voltage Amplifiers
C.W. Davidson
112 pages **1974**
Published by International Textbook Co.
The emphasis of this concise text is on practical circuits, which illustrate typical circuit characteristics, and which can form the basis for more complex designs.

Beginner's Guide to Colour Television 2nd Edition – King
198 pages **1973**

Beginner's Guide to Electronics – Squires & Deason
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Questions and Answers on Colour Television 2nd Edition – Reddihough & Knight
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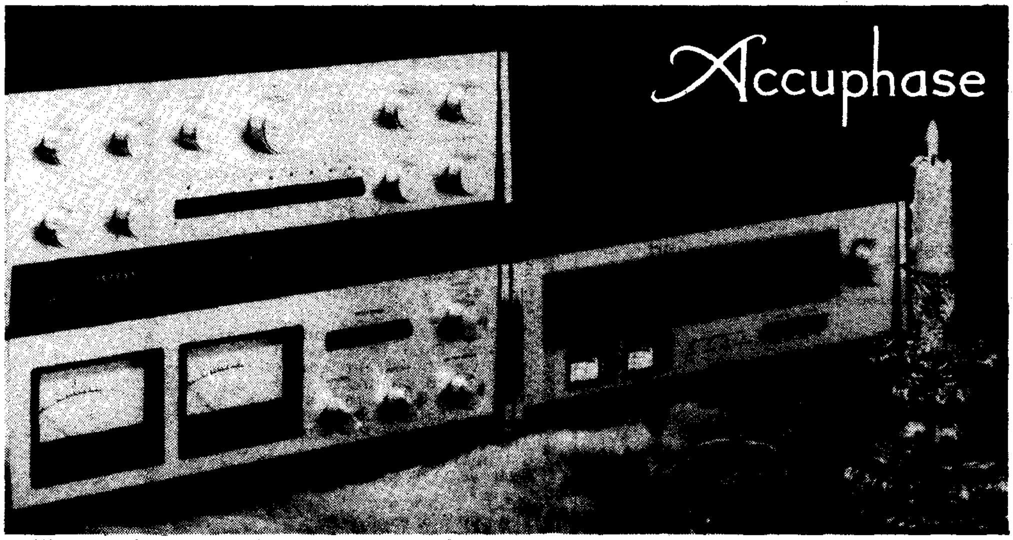

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ACCUPHASE T-100 TUNER	PERFORMANCE	COMMENT
FM Section (tests at 95 MHz and signals PD 75 ohms)		
IHF: least usable sensitivity	1.4 μV	Towards the ultimate attainable.
30 dB quieting	0.8 μV	Towards the ultimate attainable.
50 dB quieting	2.2 μV mono; 20 μV stereo	Excellent.
Full limiting	1.5 μV	Excellent.
Ultimate S/N ratio	78 dB mono; 75 dB stereo	Excellent.
Ultimate hum and noise	−62 dB	Mostly ripple content (See S/N ratio)
Output 30% modulation	540 mV fixed; 0-540 mV var.	Two pairs of outputs.
Muting threshold	(1) 5 μV; (2) 20 μV	Two positions and off.
Tuning accuracy	within 1%	Excellent.
Rated IHF capture ratio	less than 1.5 dB	Excellent.
Rated IHF alternate ch. selectivity	80/100 dB	Outside range of test equip.
Front-end selectivity (figure of merit)	> 100 dB	Test equipment limits.
Image rejection ratio	100 dB	Outside range of test equip.
Repeat spot suppression	100 dB	Test equipment limits.
AM rejection ratio	60 dB	At 1 mV imput. Excellent.
Distortion factor	0.05% mono; 0.2% stereo	30% modulation and 1 kHz.
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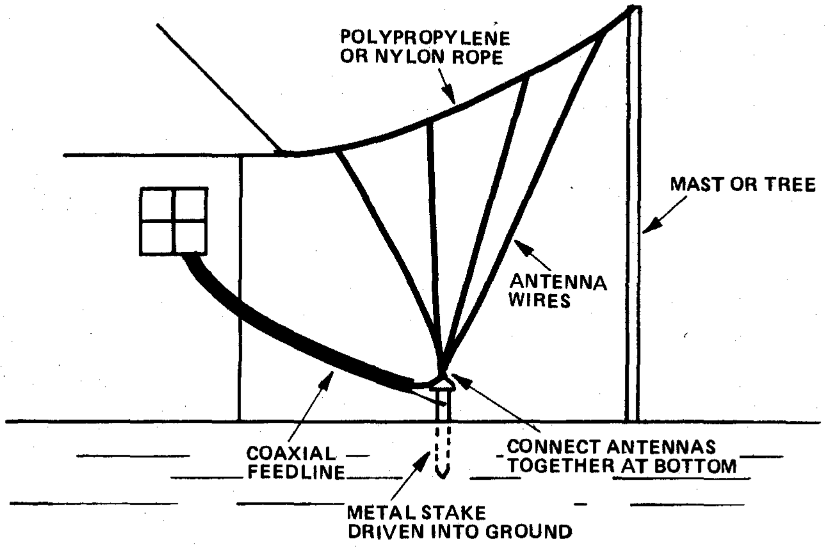
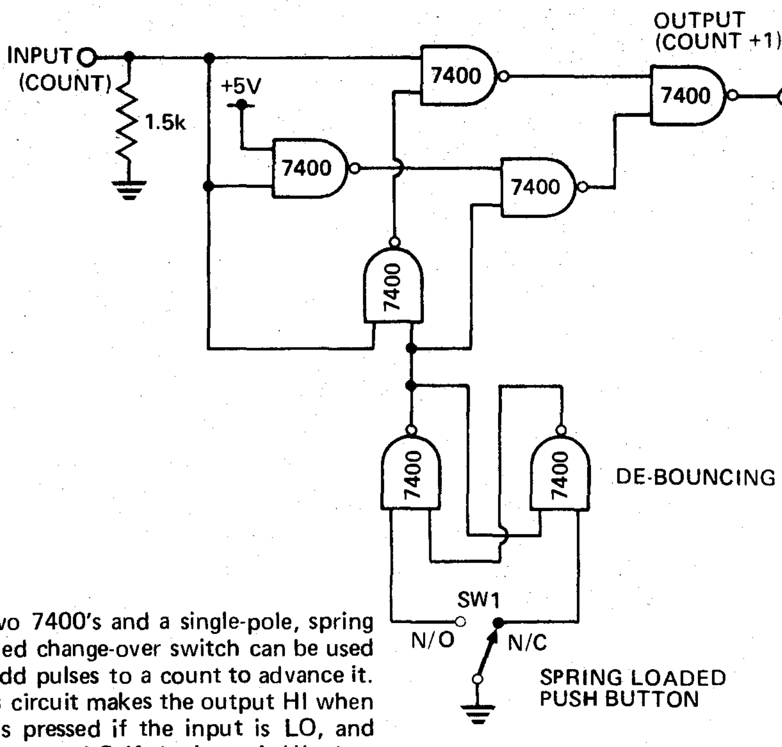
SIMPLE EFFECTIVE SHORT-WAVE LISTENING ANTENNA



The simple shortwave listening antenna illustrated here is inexpensive and very effective. A poly-propylene or nylon rope is strung between a high support such as a suitable erected mast or perhaps a tree, and a low point such as the edge of a house roof or a fence. Keep the low end above head height or away from where people can walk. Four odd lengths of hookup wire are attached to the rope at different points prior to putting the rope up. Lengths are not too important. At a convenient point below the rope a metal stake is driven into the ground for several feet. On the above-ground end is mounted an insulator to which are tied the ends of the antenna wires, the ends being connected together. A ceramic cone insulator or something similar is good. A piece of bakelite or fibreglass is also suitable. A coaxial feedline is connected with the centre conductor to the ends of the antennas and the outer braid connected to the metal stake which acts as a ground.

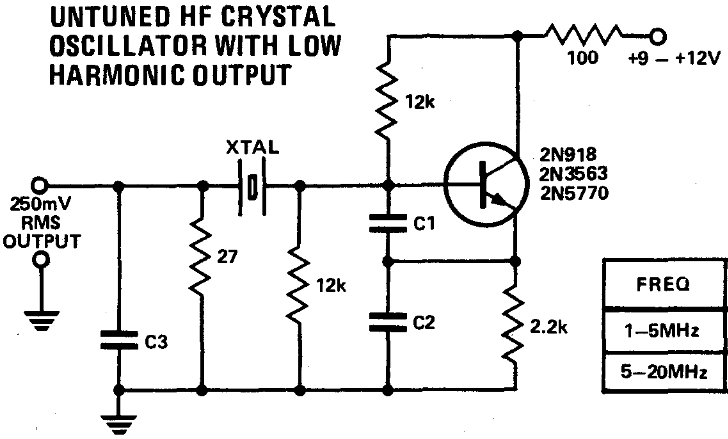
ADDING PULSES TO A COUNT



Two 7400's and a single-pole, spring loaded change-over switch can be used to add pulses to a count to advance it. This circuit makes the output HI when S1 is pressed if the input is LO, and the output LO if the input is HI when S1 is pressed momentarily. It is only useful for slow speeds of about 2 pps or less.

IDEAS FOR EXPERIMENTERS

UNTUNED HF CRYSTAL OSCILLATOR WITH LOW HARMONIC OUTPUT

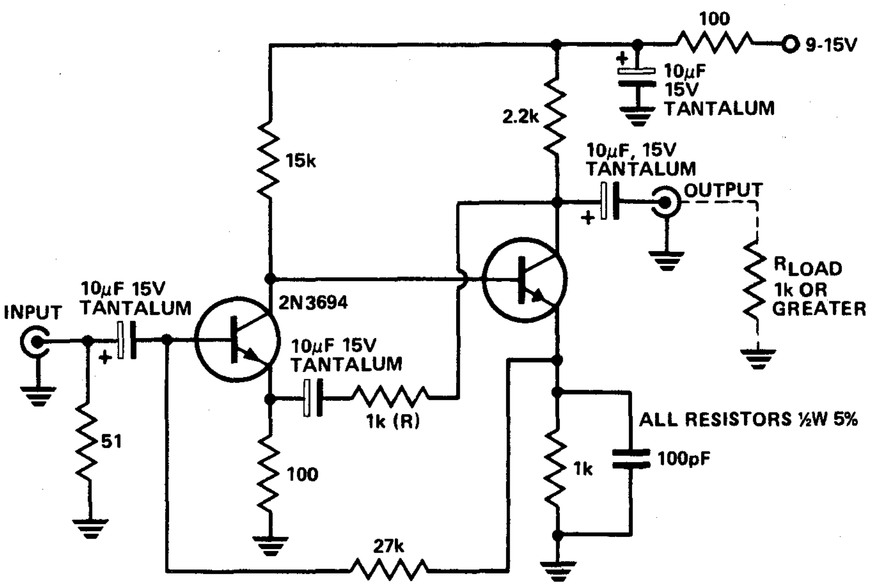


FREQ	C1, C3.	C2
1–5MHz	0.0022μF	560pF
5–20MHz	390pF	10pF

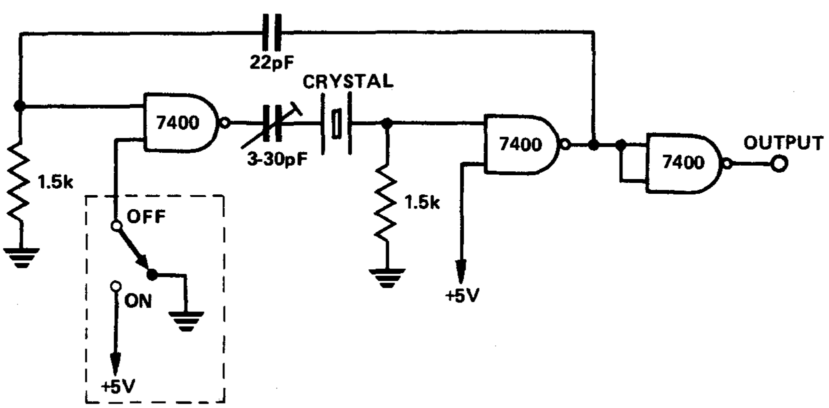
This untuned version of the familiar Colpitts crystal oscillator will accept crystals in the range 1 to 20 MHz and provide an output with the second harmonic content (usually the highest amplitude) attenuated by 60 dB, or sometimes more. The crystal oscillates in the series resonant mode on the fundamental frequency. (Note that this frequency will differ from its parallel mode frequency). Parallel mode operation is achieved by placing a 5-6 pF trimmer in series with the crystal and trimming to frequency.

WIDEBAND AMPLIFIER

The wideband amplifier illustrated above provides a gain of 20 dB from below 10 kHz to above 100 MHz, flat within 1 dB. Gain at 200 MHz is about 3 dB. Several amplifiers can be cascaded but remove the 51 ohm input resistor on following stages if this is done. Shielding may be necessary to prevent instability. Maximum output level is about 1 V peak-to-peak before overload, greater gain can be realised by increasing R. Maximum gain is about 40 dB, however, bandwidth is reduced and the top cutoff frequency drops to about 30 MHz. The output load impedance should not be less than 1 k. A source follower using a MOSFET can be used to transform to lower impedances without significantly affecting the frequency response.



GATED TTL CRYSTAL OSCILLATOR



Gating a TTL crystal oscillator on and off with a digital signal is easily accomplished with the above circuit. The bracketed portion shows a switch that connects the spare input of one gate to LO to turn the oscillator off and H1 to turn it ON.

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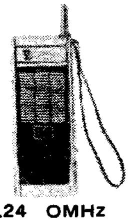


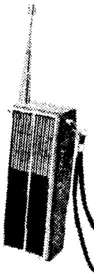
MODEL NC-310 DE LUXE 1 WATT 3 CHANNEL C.B. TRANSCEIVER

- **WITH CALL SYSTEM**
- **EXTERNAL AERIAL CONNECTION**

SPECIFICATIONS, NC-310

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

$49.00 each or $95 a pair.
Post & pack $1.50 per unit.



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

SPECIFICATIONS: Transmitter — Crystal Controlled: 1 Watt input power to RF stage. Operating frequency — Any 2 channels in the 11-meter Citizens Band. Receiver — Crystal-controlled superheterodyne circuit with 455 Kc IF. Antenna — Built-in 60" telescopic whip antenna. Audio Output — 0.8 Watt maximum. Power supply required — 12 volts DC (Eight 1.5 volt DC battery cells). Loudspeaker — 2¼" PM type (built-in) function as microphone on transmit.

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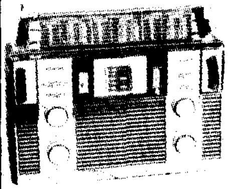

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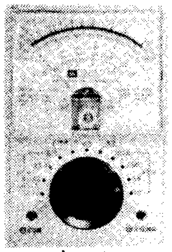
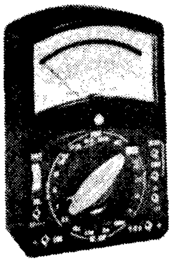
When not in use or for carrying, the top meter/megahertz scale flips down flush with the case and clear of the handle.



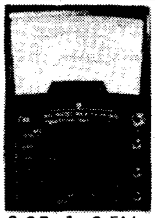
MODEL C1000M MULTIMETER Compact, handy and versatile, the C1000M is the ideal low cost pocket meter, Mirror Scale. **Specifications:** 1,000 Ohm/Volc DC; 1,000 Ohm/Volt AC; DC volts — 10; 50; 250; 1,000; AC volts — 10; 50; 250; 1,000; DC amps — 1 mA; 100 mA; Ohms — 150 KΩ; Centre scale — 3 KΩ; Decibel — 10 dB to 22 dB; Dimensions — 3-1/2" x 2-3/8" x 1-1/8" 90 x 60 x 30 mm.

$6.95 Post Free.



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

$27.95
P&P $1.50.



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

$22.50 P&P $1.50.

MODEL AS100 D/P MULTIMETER. This meter features double zener diode meter protection and 3½" full view easy to read 2 colour scale. It is fitted with polarity reversing switch and housed in a strong moulded case with carrying handle. **Specifications:** 100,000 ohm/volt DC. 10,000 ohm/volt AC. DC volts — 0.3; 12; 60; 120; 300; 600; 1,200. AC volts — 6; 30; 120; 300; 600; 1,200V. DC amps — 2 KΩ; 200 KΩ; 20 MΩ; 200 MΩ. Centre scale — 20Ω; 2,000Ω; 20,000Ω; 200,000Ω; 20 MΩ. Decibel — —20 to +57 dB. Dimensions — 7-3/5" x 5-2/5" x 2-3/5" 193 x 137 x 66 mm. Carrying case available model I.

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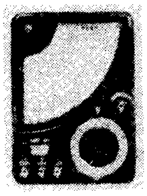
P&P $1.50.



200-H, p.p. 75c. 90 quadrant meter. Pocket size. AC V: 10V, 50V, 100V, 500V, 1000V (10,000 ohm/V). DC/V: 5V, 25V, 50V, 250V, 500V, 2500V (20,000 ohms/V). DCA/A: 50uA, 2.5 mA, 250 mA. OHM: 60k ohm, 6M ohm. Capacitance: 100pF to 0.1 uF, .001uF to .1uF. dB: —20 dB to +22 dB. Audio Output: 10V, 50V, 120V, 1000V AC. Approx. size: 4½" x 3¼" x 1-1/8"

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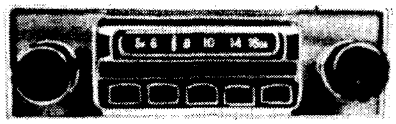

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THE STATE OF THE ART

New moon-bounce record.

A TEAM of nine radio amateurs has succeeded in breaking their old record of contacts via the moon. A 45 metre dish antenna located in Northern California, U.S.A., was used to beam 432 MHz signals to the moon, where they were reflected back to earth with a time delay of 2½ seconds. On November 23, 1975, during an 11 hour operating period, the team made 84 two-way contacts with radio amateurs in 20 states, 11 countries, and five continents. Fifteen of these contacts were on voice (ssb).

The communications test was made by a group of SRI amateur radio society (WA6LET) and UHF radio society (W6GD) members to encourage world-wide interest in moonbounce communications.

Use of the dish and various transmitting and receiving equipment was furnished by SRI (Stanford Research Institute), an independent non-profit research institute based in Menlo Park, California. Participants furnished UHF receiving converters, a backup transmitter, and "put it all together". The event was recorded by them on audio tape (four receivers), video tape, and 16 mm film, with the intention of producing a record of the test that may be shown at radio amateur conventions.

In addition to the two-way contacts, the group conducted two one-way variable-power tests to determine the lowest power level that each station could receive. Some stations with antennas having only 7 dB gain could detect the full power transmissions; while stations having better antennas could copy code groups sent at power levels as low as 25 watts.

The operators for this test were (in alphabetical order) Bruce Clark, K6JYO; Victor Frank, WB6KAP; Arne Gjerning, K7CAD/6; Bob Sutherland, W6PO; Bob Sutherland, Jr., WA6QCD; Edward Teyssier, WA6LCZ; Brian Westfal, K6OJm; Douglas Westover, K6TZX; and dish operator Bob Foss, WN6DIA. Assisting with photography and video camera were Jim Taylor (unlicensed) and Loren Hodapp, WA6BMR.

The 45 metre parabolic dish is a San Francisco mid-peninsula landmark. It is owned by the United States Government, and was built by and is operated by SRI. The dish rides on top of a circular railroad truck. The 432 MHz feed was a built-in horn with left-hand circular polarization for transmit.

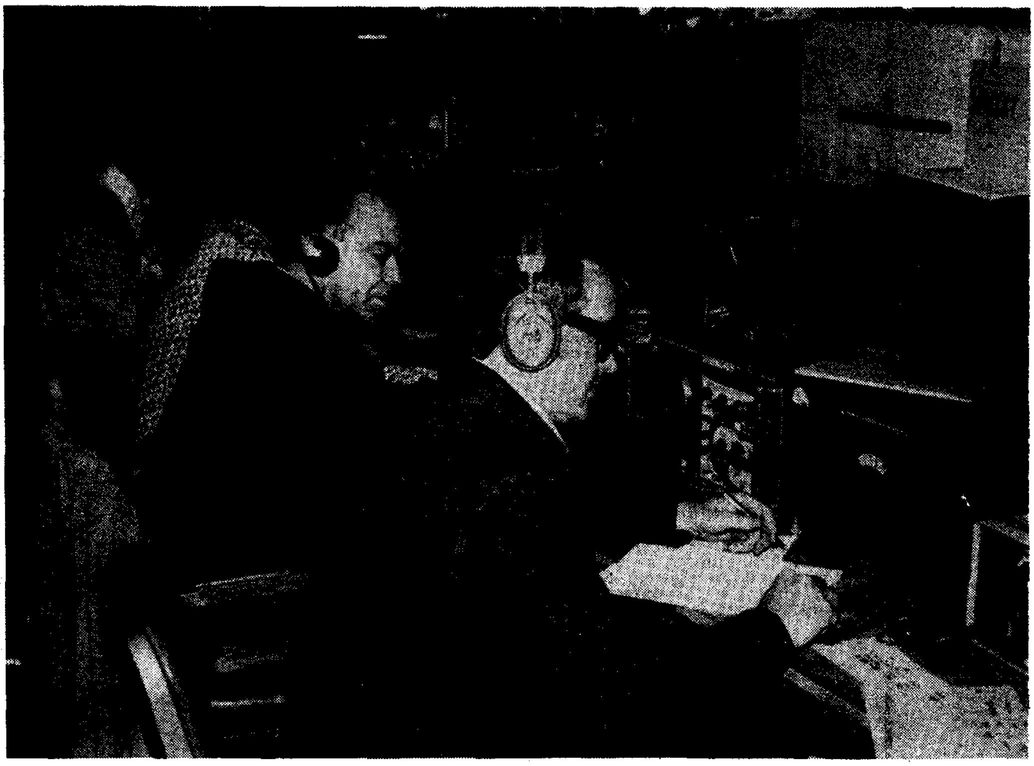
The most successful receiver polarization was right-hand circular. The preamplifier mounted at the feedhorn showed a noticeable improvement over one connected to the other polarization at the transmitting end of a run of 75 metres of 150 mm rigid coax and nine metres of 22 mm coax. Together, the transmit cable loss was about 1 dB. Although the transmitted polarization was nominally circular, a number of observers noted that the moon-reflected signals had a large linear polarization component.

Transmitting equipment belonging to SRI was used for most of the test. It consisted of a Collins KWM2, Carmichael transmitting converter, 4X150A driver amplifier, and 7213 final amplifier. A backup transmitter was used briefly, consisting of an Eldico SSB100F and transistorized converter/driver furnished by WA6QCD and a K2RIW-type 4X250B amplifier lent by W2GN of ARCOS. Receiving preamplifiers and converters were provided by K6OJM and K6JYO.

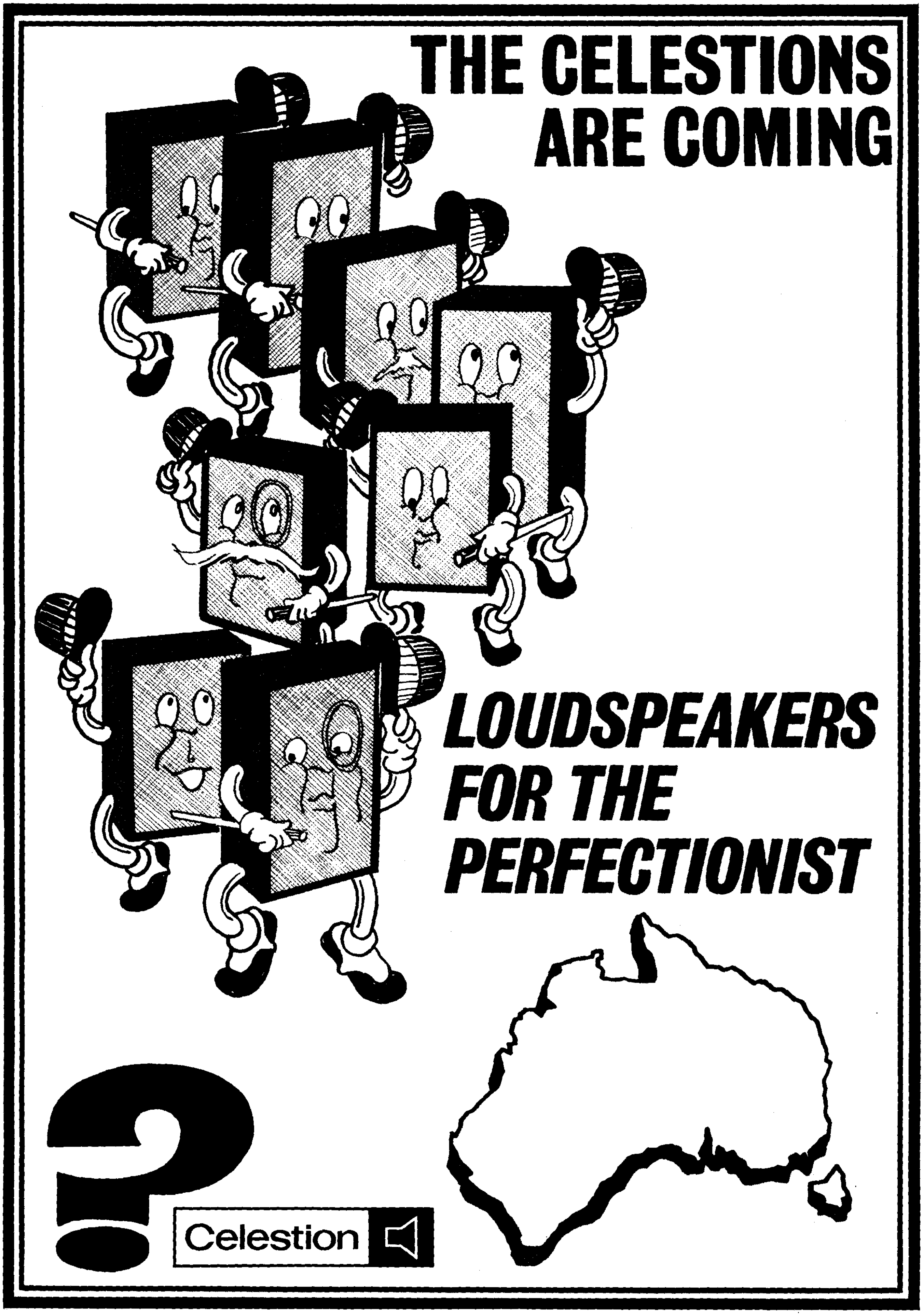
A shakedown test on October 31 netted seven contacts with six stations in just over one hour of operating time. During the November 23 test most of the amateurs contacted were in Europe and North America. One each was contacted in Asia (Japan), Australia, and Africa (Rhodesia).

The team is gratified by the response of the VHF amateur fraternity to these tests. A number of stations, having heard or contacted them, have found that it does not take an impossible improvement beyond what it takes to hear the group, to that necessary to hear and work others. The team would like to continue this stimulation of amateur EME activity. The SRI 45 metre dish is useable for moonbounce communication from 50 MHz to 1296 MHz. It has been used for amateur EME communications only on 144 and 432 MHz.

The team would like to use it on 222 and 1296 MHz, and are presently looking at the possibilities of getting suitable equipment going for 1296 MHz, possibly by late spring 1976. ●



Station WA6LET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