Electronics Today

INTERNATIONAL MAY 1980

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8080A	8 bit cpu	~~$ 6.49~~ 5.99
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Z80A	8 bit cpu	~~$16.95~~ 15.50

6800 SUPPORT DEVICES

6810P	128x8 static ram (450ns)	$ 4.19
6820P	peripheral interface adapter	~~$ 4.99~~ $3.96
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8080A SUPPORT DEVICES

8212	8 bit I/O Port	$4.65
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8216	bi-directional bus driver	$2.59
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1802 SUPPORT DEVICES

SCP1824LE	32x8 static ram	$4.55
SCP1852LE	byte I/O Port	$1.95
SCP1854LE	U.A.R.T.	$9.05
SCP1856LE	bus buffer/separator (mem)	$2.55
SCP1857LE	bus buffer/separator (I/O)	$1.75
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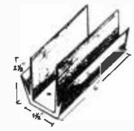
TMS2716 (2Kx8 EPROM)...$ 41.65



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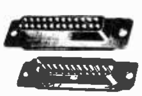
DB-25



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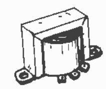

27-1006 #1. sec.voltages: 9V, 300mA; 80V, 300mA; 115V, 150mA.
27-1009 #2. 6.3V, 500mA; 65V, 500mA

* MOTOROLA TRANSISTORS *

2N3055	NPN Si PWR.80V/15A/115W	99¢
MJ2955	PNP Si complement to 2N3055	$1.75
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MPS-A05	.30	MPS6514	.30
MPS-A55	.35	MPS6515	.45
MPS-A06	.32	MPS6516	.35
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MPS-A70	.30	MPS U55	1.00
MPS-A42	.50	MPS U06	1.25
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2N3819	.75	2N5458	.75

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TIP30C	PNP Si complement to TIP29C	$1.19
TIP31C	NPN Si 100V/3.0A	$1.25
TIP32C	PNP Si complement to TIP31C	$1.25
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TIP2955	PNP Si complement to TIP3055	$1.50

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ITT2222	(TO-92)	.20	2N2219A	(TO-5)	.50
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2N3906	(TO-92)	.20	2N4403	(TO-92)	.25

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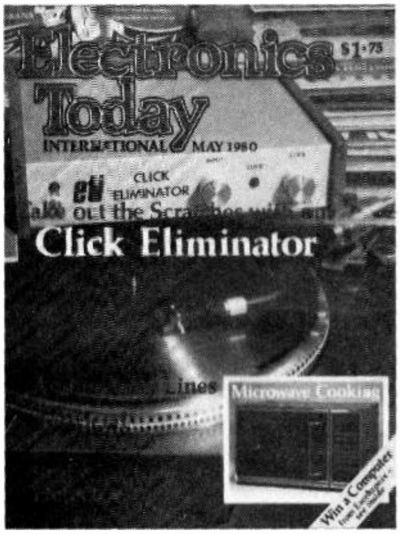
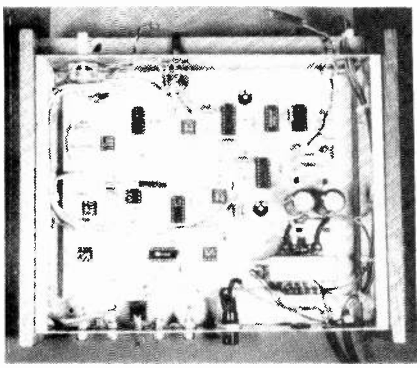
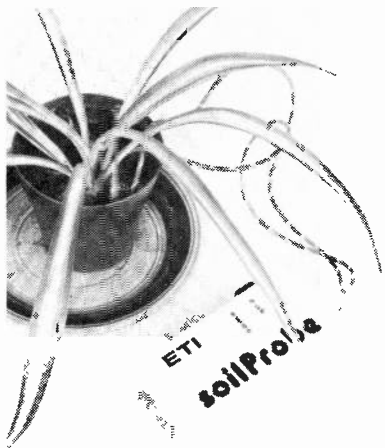


FEATURES



PROJECTS



Due to production difficulties QRM was not included in this issue. Our apologies to readers, Bill Johnson will be back next month.

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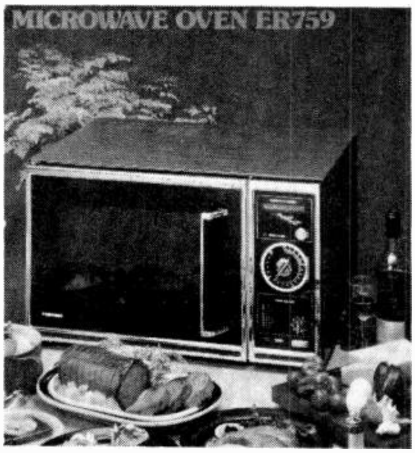

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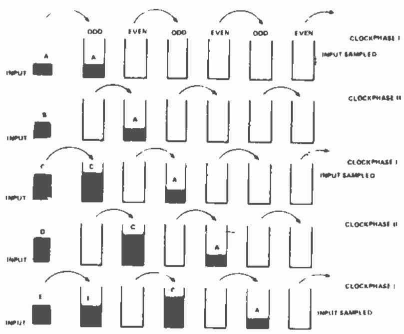

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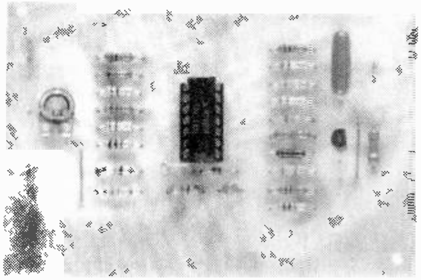

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Whilst every effort has been made to ensure that all constructional projects referred to in this edition will operate as indicated efficiently and properly and that all necessary components to manufacture the same will be available, no responsibility whatoever is accepted in respect of the failure for any reason at all of the project to operate effectively or at all whether due to any fault in design or otherwise and no responsibility is accepted for the failure to obtainingany component parts in respect of any such project. Further no responsibility is accepted in respect of any injury or damage caused by any fault in the design of any such project as aforesaid.

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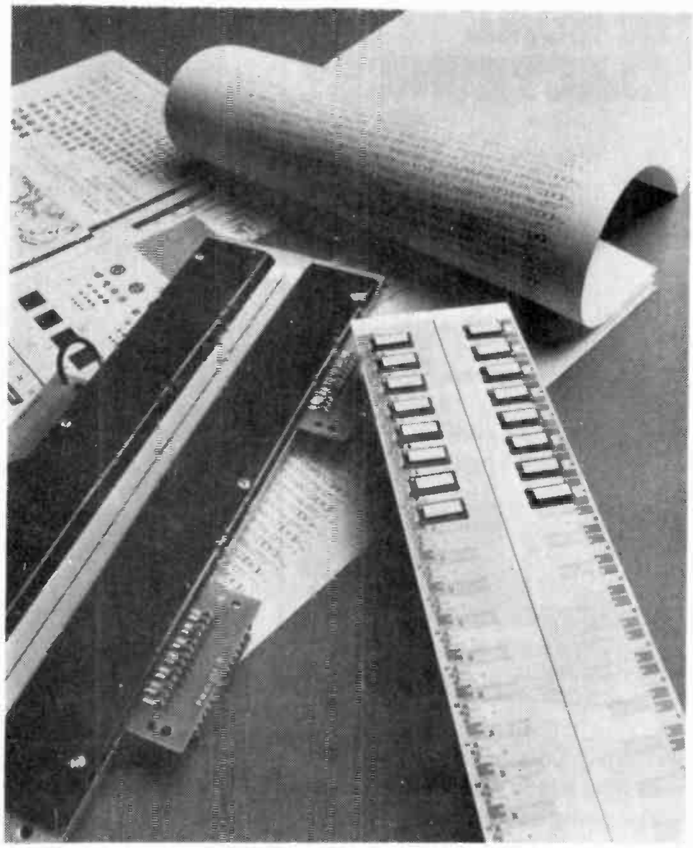
SELL ETI
ETI is available for resale by component stores. We can offer a good discount and quite a big bonus, the chances are customers buying the magazine will come back to you to buy their components Readers having trouble getting their copy of ETI could suggest to their component store manager that he should stock the magazine.

COMPONENT NOTATIONS AND UNITS
We normally specify components using an international standard. Many readers will be unfamiliar with this but it's simple, less likely to lead to error and will be widely used sooner or later ETI has opted for sooner!
Firstly decimal points are dropped and substituted with the multiplier, thus 4.7uF is written 4u7 Capacitors also use the multiplier nano (one nanofarad is 1000pF). Thus 0.1uF is 100n, 5600pF is 5n6. Other examples are 5.6pF - 5p6, 0.5pF 0p5.
Resistors are treated similarly: 1.8M ohms is 1M8, 56k ohms is 56k, 4.7k ohms is 4k7, 100 ohms is 100R, 5.6 ohms is 5R6

PCB SUPPLIERS
Currently the following companies actively supply all or some PCBs for ETI projects. Write for complete ordering information
B&R Electronics, P.O. Box 6326F, Hamilton, Ontario L9C 6L9, Spectrum Electronics, Box 4166, Stn 'D', Hamilton, Ontario L8V 4L5; Wentworth Electronics, R.R. No. 1, Waterdown, Ontario L0R 2H0; Danocinths Inc., P.O. Box 261, Westland, MI 48185, USA

NEWS



Solid State Printer

R-Ohm Corporation has introduced a new generation of solid-state thick film thermal printheads– the first to incorporate all required circuitry mounted directly on the substrate.

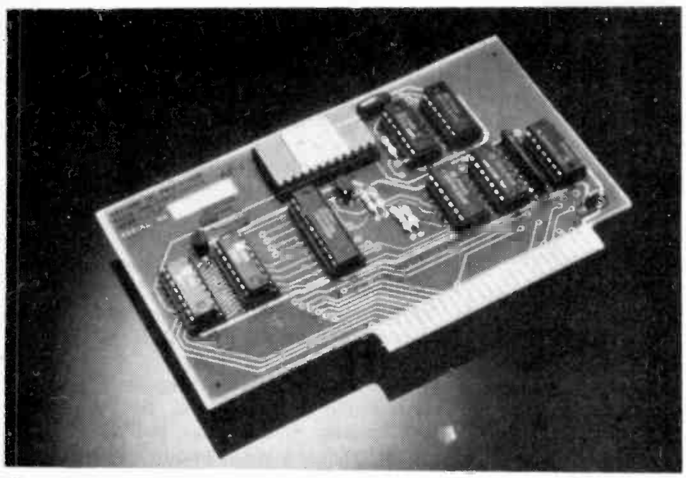
32-bit, I^2L drive circuits, as well as shift registers and diode arrays, are provided in 40-pin flat pak chip-carriers which are mounted directly to the printhead substrate adjacent to the printing element.

Utilizing this new technology, thermal printheads can now be supplied with single element print widths of up to 10 inches. Line speeds of 2 milliseconds can be achieved, and dot densities have been increased to as many as 8 dots per millimeter. Another advantage is the fact that both graphics and alphanumeric readouts can be achieved from the same head.

This new construction technique plus the elimination of external drivers, diode matrices, shift registers, and their associated cabling has greatly improved reliability and head life, according to R-Ohm. A minimum MDLBF of 100×10^6 is guaranteed. To accommodate these discrete devices in the past, the printhead designer has had to cope with a large PC board surface, possibly a layered board plus copious quantities of difficult-to-align flexible cable.

Applications include facsimile equipment, ticketing machines, electronic scales, instrumentation, portable instrumentation, plotters and graphic displays, data processing terminals, medical diagnostics, weather map printouts, typewriters, point-of-sale terminals, etc.

For additional information, contact R-Ohm Corporation, P.O. Box 19515, Irvine, California 92713.



'Nother Apple Add-On

California Computer Systems latest product is the Model 7811B Arithmetic Processor Unit, designed to increase the execution speed of Applesoft II programs as well as to increase the number of math functions available to the programmer. The increased speed allows the Apple II to produce more sophisticated high resolution graphics.

The card employs the AM9511 APU, a hardware floating point unit powerful enough to decrease program execution time by up to one order of magnitude. This arithmetic processor provides high performance on fixed and floating point arithmetic operations and on floating point trigonometric operations, and greatly enhances the mathematical capabilities of the Apple II.

The board will execute all Applesoft II arithmetic functions, plus additional functions not available in Applesoft II. These additional functions include ASIN(x), ACOS(x), LOG10(x), SINH(x), COSH(x), TANH(x), INVERSE(x) and PI.

Test Your Logic

In a convenient benchtop package, are forty precision-threshold, high speed, high impedance logic state indicators, combined with a unique and highly flexible triggerable latching circuit. CSC's LM-3, with its 40 easy-clips connected to the IC pin, test point, breakpoint or bus line combination you select, the LM-3 40-LED display accurately follows the data. Or freeze the display in any of a number of ways: In RETRIG mode, LATCH mode, or RUN mode.

The LM-3 offers unprecedented flexibility in logic family compatibility through a unique threshold-selection scheme. Three methods of determining logic threshold levels are provided: A fixed +2.2VDC threshold, a variable threshold, and a supply-dependent threshold.

For further information contact: Len Finkler Ltd., 25 Toro Road, Downsview, Ont. M3J 2A6.

Old PCBs

Wentworth Electronics informs us that they can now supply pcbs for ETI Projects dating back to our first in February, 1977.

Enquiries should be sent to Wentworth Electronics, R.R. No. 1, Waterdown, Ontario L0R 2H0.

No. 1 Returns

Seven years ago Volker-Craig Ltd., Waterloo, Ontario, Canada-based computer terminal manufacturer, came into being. The first terminal produced was purchased by Dr. Barry Wills, systems design (engineering) professor on the University of Waterloo campus, and a computer software expert. He's had it ever since. In the meantime the company has become the largest computer terminal manufacturer in Canada and is competing successfully in international markets as well (80 per cent of its sales are out of Canada). Recently Volker-Craig's 10,000th computer terminal came off the line. Because the first computer has become of considerable sentimental and historic value to the company the president, Mike Volker offered to swap No. 10,000 for No. 1. The exchange was recently completed in the company's 14,000 square foot new head office in Waterloo.

Cat News

The 1980 Component Data Catalog is now available from Intel Corporation.

The catalog contains device specifications and functional descriptions for the company's commercial, industrial and military devices, support products and services. Listings include data on the newest Intel products, including the one megabit bubble memory device and support chips, the 2920 signal processor and the 8089 16-bit I/O processor and peripherals.

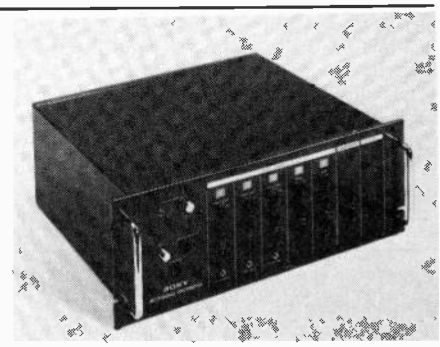
The catalogue costs $7.50 and may be paid for with Visa or Mastercharge. Copies may be ordered from the Literature Deparment, Intel Corporation, 3065 Bowers Ave., SC3-3, Santa Clara, CA 95051.

New Look ETI

Yes, we're the same magazine but we've done a bit of spring cleaning. We couldn't let such major changes in print quality and design go without mentioning it. Those of you who purchase copies on the newsstand will also have noticed that extra quarter on the cover price.

As most of you will notice, we've gone over largely to glossy paper – this reproduces pictures much better than the paper we have used until now; at least that's the theory. By the time we see the first copy it'll be too late to alter this piece! The extra cost is considerable – like a 50% increase – and we've only been able to hold the rise to 16.7% because our sales have been increasing recently. We must also thank the advertisers for their support – they've shown a lot of faith in these changes.

The new design has been introduced to make for a 'cleaner', less cluttered appearance: we hope it works.



Multisignal Distributor

Sony of Canada Ltd.'s Industrial Division has announced the addition of the MD-1210 Multisignal Distributor to its line of video products.

This multi-function unit features a NTSC color sync generator, sync distributor, subcarrier phase shifter, cable compensator, tally/intercom and return video facilities – all in one unit.

The MD-1210 accepts up to five color cameras (three studio and two portable). Each camera output has both composite out (VBS), so a video monitor can be connected directly.

For more information, contact Sony of Canada Limited, Industrial Division, 411 Gordon Baker Road, Willowdale, Ontario M2H 2S6.

More Cupertino Counters

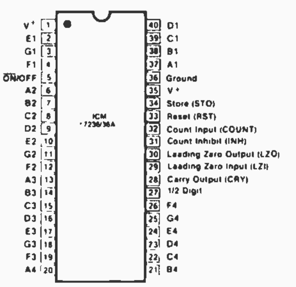
Two new high-performance CMOS counter/driver chips with 4½ digit capability and direct interface to non-multiplexed (static) vacuum-fluorescent displays have been announced by Intersil, Inc. The ICM7236 decade counter provides a maximum count of 1999, while the ICM7236A is intended for timing purposes and provides a maximum count of 15959. Both devices include on-chip decoders, output latches, count inhibit, reset, and leading-zero blanking circuitry, in addition to 29 high-voltage open-drain P-channel transistor outputs.

High frequency counting rates are guaranteed to 15MHz, with typical rates of 25 MHz at 5 volts. Low-power operation is at 100uW quiescent drain current; devices are fabricated with Intersil's proprietary high-density MAX-CMOS process for high-performance, low-power applications.

Applications include counting instrumentation, automobile tachometers/speedometers, and laboratory timers. The ICM7236 and ICM7236A are available from stock in standard 40-pin plastic packages. Price is $4.25 (US funds) each in 100-unit quantities.

For more information, contact Lenbrook Industries Ltd., 1145 Bellamy Road, Scarborough,Ontario M1H 1H5.

CONNECTION DIAGRAM



Video Generator

Hickok Electrical Instrument Company has an inexpensive, compact video generator of special interest to the industrial video and security maintenance world. Designated as the Hickok Model 240 Video Generator, it is designed for CCTV and monitor applications as well as VTR and regular TV adjustment and repair.

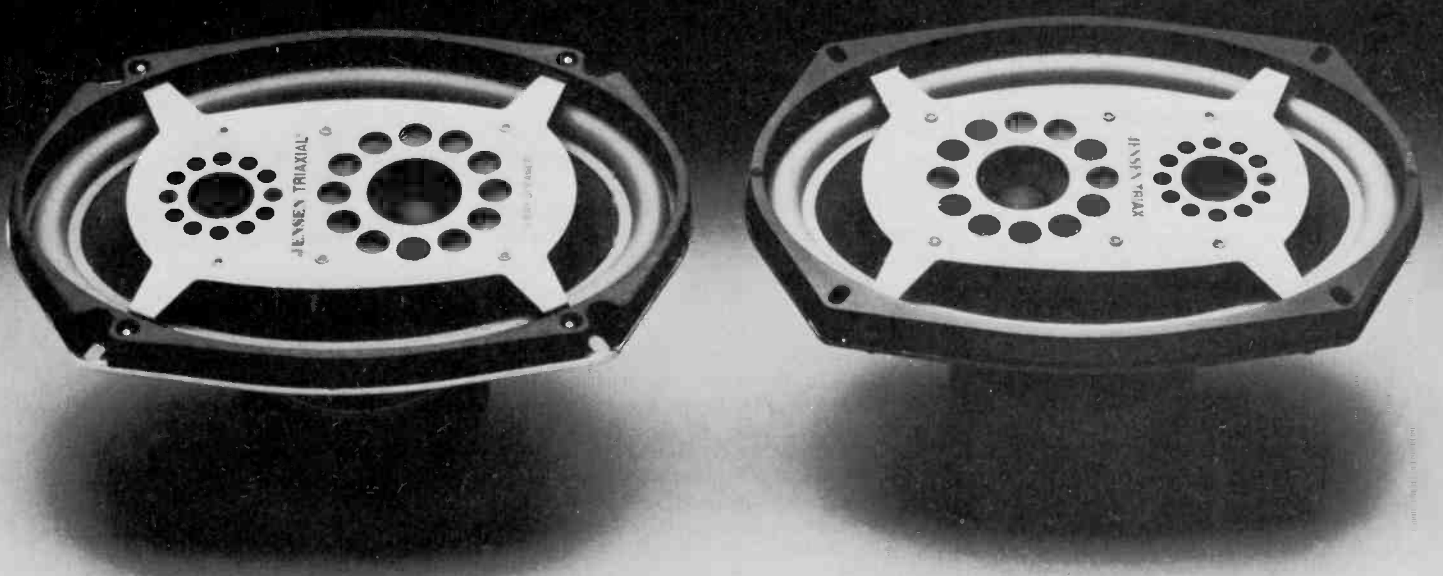
Features of the new unit include both video and adjustable RF output, a 10 step gray scale staircase, 3 and 10 bar gated rainbows, a trigger output for use with scopes and a built-in battery check position.

Controlled by a single, thumb operated, integrated slide switch, the new Model 240 generates 11 video or RF patterns. It can operate off of an AC adaptor (included with unit) or two easily installed 9V batteries (not included). Two output leads provided with the unit are conveniently stored in its snap-on protective thermoplastic cover.

The ten gray scale staircase simplifies detection of video compression, poor band width and other problems in almost any stage. The three gated rainbow permits fast, easy chroma checks and is especially useful on vectorscope measurements.

Hickok Instruments are available from H. Rogers Electronic Instruments, P.O. Box 310, 595 Mackenzie Ave., Units 1 & 2, Ajax, Ontario, L1S 3C5.

Same looks. More guts.



The speaker on the left is the best selling, most popular car stereo speaker ever. The Jensen Triaxial® 3-way speaker system.

The speaker on the right is the one that's replacing it. The new Jensen Series I Triax.® The one with even higher efficiency. More power. More guts.

Sure, they look alike. But the similarity ends there.

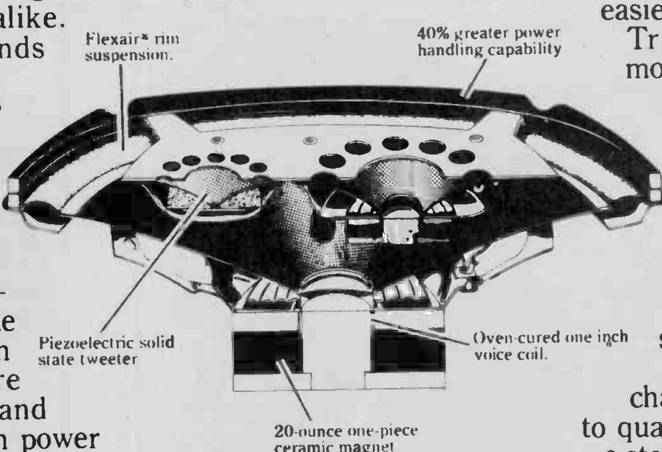
Higher power handling.

Believe it. The new 6" x 9" Series I Triax is rated at 50 watts continuous average power, compared to 30 watts for the old Triaxial. Which means it'll take more power—more heat—and more abuse from high power car stereo units, without sacrificing musical accuracy at the expense of high volume levels.

Why can it take more power? Because of its new, larger oven-cured one inch voice coil. It offers 66% greater power handling for superior durability. And because the special piezoelectric solid state tweeter is virtually indestructible, yet sensitive to every musical nuance.

The efficiency expert.

Like all of the new Jensen Series I speakers, the Triax is more efficient than ever, thanks to our special high compliance cones with Flexair® rim suspension, 4 Ohm impedance and new, more efficient motor structures. Which translates to very high efficiency that lets



Jensen Series I speakers play louder with less power for smoother, distortion-free music in your car.

JENSEN

The thrill of being there.

For the name and location of your nearest Jensen dealer, write:
len finkler limited
25 Toro Road
Downsview, Ontario M3J 2A6
Telex: 065-24010

More improvements.

The Series I Triax features an improved, 20-ounce ceramic magnet structure for deep, well-defined bass. Also a new, rugged gasket for a tight acoustic seal. Black zinc chromate plating insures corrosion resistance.

We also designed it to be easier to install than the old Triaxial with the stud-mounted grille.

Some things don't change.

There are some things we just couldn't improve. Like the idea of an individual woofer, tweeter and midrange balanced for accurate sound reproduction.

We also haven't changed our commitment to quality. And to back it up, we steadfastly support our full line of Jensen Series I speakers with an excellent one year limited warranty.

"But they still look the same..."

You say you still can't *see* any difference between the old Triaxial on the left and the new Series I Triaxial on the right. Maybe not. But you sure will be able to *hear* the difference. And after all, that's the guts of the matter.

"Triaxial" and "Triax" are the registered trademarks identifying the patented 3-way speaker systems of Jensen Sound Laboratories. (U.S. Patent No. 4,122,315)

Circle No. 30 on Reader Service Card.

Mini-Size Indoor Antenna

Winegard Company has introduced a new mini-sized VHF-UHF-FM antenna designed to replace and outperform "the rabbit ears" in apartments and homes where an outdoor antenna is not feasible.

Designated AT-5001, the an-gold-coloured adjustable (7'6" to 8'3"floor to ceiling pole. It readjusts from 7'6" to 8'3". It receives channels 2-69 in colour and black and white plus FM stereo stations. Recommended for city and suburban locations.

Package includes antenna, wire, VHF-UHF-FM band separator and two plant hanger hooks. Nothing else to buy, installs with a small screwdriver. Suggested retail is $44.75 (US). Available at many discount department stores and through TV service dealers. For details write to: Winegard Company, 3000 Kirkwood, Burlington, Iowa 52601.

(In Canada, Omnitronix Ltd. see ads in this issue for address.)

Motorola Amplifiers

Two new Motorola hybrid power amplifiers designed for conventional and cellular mobile radio communications – the MHW820 – which provide 20 watts and 7.5 watts, respectively, of wideband power between 806 and 870 MHz, have been introduced by Motorola.

The MHW820 has three common emitter amplifier stages, and provides a minimum of 19 dB gain at 20W output power. At full power output, input power is 250 mW (max.) and harmonic distortion is -58dB below the carrier or greater.

The MHW808 has two cascaded stages, a Minimum gain of 14.8 dB, and a maximum harmonic output of -52 dBc.

The modules use a copper heatsink; the circuit substrate material is beryllium oxide for excellent thermal conductivity, and the circuit conductors are gold.

Each module can be used as an output stage or as an output stage driver. Input and output impedances are already matched to 50 ohm systems. A 30:1 VSWR does not damage the output stage regardless of phase angle.

The amplifers are stable over an input power range from 0 to 250 mW, with supply voltages from 10 to 16 V and a load VSWR = 4:1. In addition, spurious signals are held to -70 dB or better in a 50 ohm system, the amplifiers' input impedance will not create a VSWR greater than 2:1, and a quiescent current drain of 125 mA or less.●

Calendar Dates

The National Planning Committee for Electrical Electronic Showcase announces a new Regional format for future shows as follows:

1981 –Toronto, Feb. 19, 20, 21
1982 –Winnipeg, March 4 & 5
–Calgary, March 17 & 18
–Vancouver, March 31st & April 1st.
1983 –Montreal, dates to be announced.
–Maritimes, dates to be announced.

Chairman of the National Planning Committe, Andy Durban explained that this new Regional concept "conforms to the recommendations of exhibitors as expressed in the post '79 Show surveys as well as at numerous industry meetings.

For more information contact:
A. Durban, Electrical Electronic Showcase, 14-395 Berry Street, Winnipeg, Man. R3J 1N6.

Salon International de l'Ordinplace at Montreal's Place Bonacomputer industry event will take place at Montreal's Place Bonadventure, from June 4-6, 1980.

In terms of attendance and the number of exhibitiors, it will be the largest and most authoritative computer show and conference ever held in the Province of Quebec.

More than 200 of the computer industry's leading suppliers of systems and related equipment will exhibit in the show – an eloquent testimony of the growing importance of the computer market in Quebec.

The show and Conference is managed by Industrial Trade Shows of Canada Ltd. and sponsored by the Canadian Information Processing Society. For more information contact: Reg Leckie, Show Manager, 36 Butterick Road, Toronto, Ontario. M8W 3Z8.

The Board of Directors of the Ontario Electrical League has ratified plans to hold an Electrical Showcase on February 19, 20, 21, 1981. The show location has been moved to the newly renovated Automotive Building in Exhibition Place, Toronto.

The rationale for changing from proposed May, 1982 date to February, 1981, was to avoid the very busy spring timing when most electrical contractors in Ontario are too busy to attend, and the conflict with the A.M.E.U. Equipment Show which is scheduled for 1982.

Industrial Trade Shows of Canada, has again been appointed to handle space sales, attendance promotion, and show production.

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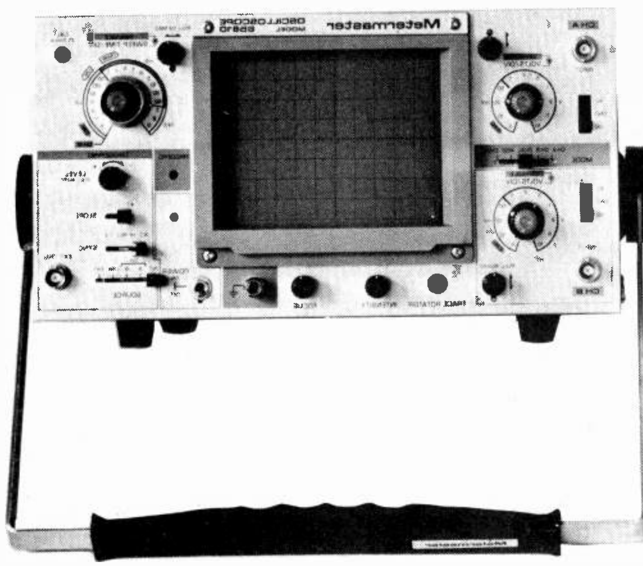
THE BEST BUYS AVAILABLE!

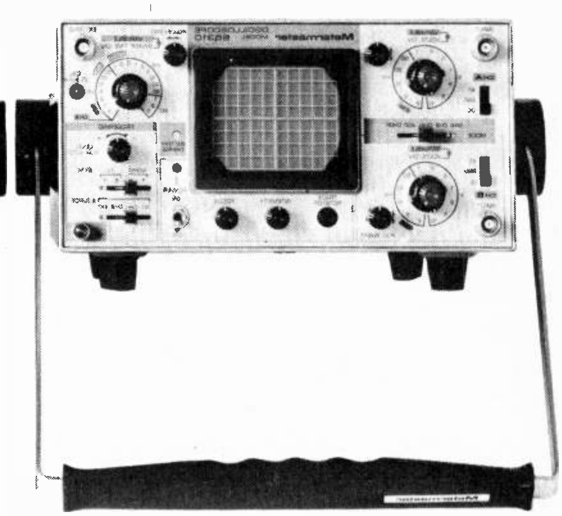
15MHz Oscilloscopes

CHARGEX VISA

$695. each

F.S.T. INCLUDED





The Model 65310 is a truly portable, dual trace, 15MHz scope offering battery operation as a standard feature. This is an ideal oscilloscope for the service - man who needs a combination bench and portable instrument. This scope is packed with features:

* Operates from 3 power sources:
  1) Rechargeable NiCad batteries
  2) 120VAC line (also charges batteries)
  3) 11 – 30VDC
* 3" High Brilliance CRT
* Fully Automatic Triggering
* Built-in Calibration Source
* Trace Rotator
* 2mV Vertical Sensitivity
* Operating Modes CH-A, CH-B, Dual, Add/Sub Chop, and X-Y

WEIGHT: 13.5 lbs.

OPTIONAL ACCESSORIES: Combination 1:1 and 10:1 switchable probes(compensated). Priced at $39.00 F.S.T. included.

Vinyl carrying case for Model 65310 only, priced at $62.00 F.S.T. included.

The New METERMASTER Model 65610 scope employs an extremely bright 5" rectangular CRT with internal graticule. External DC operation permits floating measurements. Take a look at the features this scope has to offer:

* Operates from 2 power sources:
  1) 120VAC line
  2) 11.5 – 30 VDC
* Frequency Response 15MHz(-3dB)
* Fully Automatic Triggering
* Built-in Calibration Source
* Trace Rotator
* HF Rejection
* 5mV Vertical Sensitivity
* Operating Modes CH-A, CH-B, Dual, Add/Sub Chop, X-Y, and Z modulation.

WEIGHT: 16 lbs.

OPTIONAL ACCESSORIES: Combination 1:1 and 10:1 switchable probes(compensated) Priced at $39.00 F.S.T. included.

Call one of our offices (below) for a no obligation, free of charge evaluation.

Metermaster

R.H. NICHOLS

Toronto (416) 661-3190 • Montreal (514) 337-0425 • Edmonton (403) 432-7746 • Ottawa (613) 238-7007

Circle No. 7 on Reader Service Card.

PROJECT

CLICK ELIMINATOR

The Cat Sat On The Mat: or was there one of your favorite records on the mat? Never mind — ETI steps in to rescue your valuable vinyl from those evil clicks and pops.

EVEN THE MOST fastidious of record collectors must have some records in his collection which during their career have picked up the odd scratch or two. Perhaps your record collection dates back to the time before you obtained that second mortgage, sold the wife or whatever, to get the latest in laser controlled fluid damped, tangential tracking phonograms, sorry turntable, and the previous system has left it's mark on these early platters.

In the Click of Time

However, the scratches got there they are bound to be obtrusive on any reasonably Hi-Fi set up and even if you don't qualify for the title Hi-Fi purist — someone who listens, not to the music, but to the defects, real or imagined, in Hi-Fi chain — the clicks will distract from your enjoyment.

Enter ETI — we can help. The click suppressor described here will remove or greatly reduce the audible transient sounds — nice phrase — resulting from scratches on the record's surface.

Design Decisions

When designing a click suppressor it is fairly obvious that we have to be able to tell the click from the cacaphony as it were. Fortunately a click has several unique characteristics which set it apart from a music signal. For instance it will have very fast attack and delay times — even high frequency percussive sounds will delay slowly although attack will be fast. A click will also be of a very short duration—again musical sounds are in general of a longer duration.

Once we have spotted our click, it is necessary to remove it. In our case we substitute a short period of silence — subjectively unnoticable — a place of the clicks.

As our click detection cicuit requires a finite time in which to operate, we also have to provide some sort of delay for the music signal within the system. Our circuit, and all the commercially available units, use a CCD delay line to provide this delay. It is the recent availability of this device that has made the click suppressor possible, or rather brought it within the financial reach of the constructor.

Taking Aim

The aim then, as now, was to present a design for a unit which would remove the clicks and scratches from music material contained therein.

Operation was to be indicated by an LED, and threshold of operation was to be variable to make the Eliminator flexible in use.

HOW IT WORKS

The full circuit of the right pre-amp and delay line block is shown in Figure 2, the left channel circuit block is identical.

The input signal from the pick-up is fed to IC1a, which is wired as a x10 inverting amplifier with an input impedance of 47k. The output of this stage is fed to the click detector circuit and to IC1b, which is wired as a second order low pass butterworth filter with a turnover point of about 18 kHz. This stage also has a small amount of gain in its pass band.

The output of the Butterworth filter is fed into input pin-5 of IC2, which is a TDA 1022 512-stage charge-coupled delay line. The R9-RV1-R11-R12 and R10 network at the input of the IC is used to set pin-13 at about 1 volt above ground to ensure maximum dynamic range on the delay line, and to bias pin-5 into class A at minimum distortion. The delay of about 1 mS.

The output of the delay line is taken via C4, to another second order Butterworth filter (IC3), which removes the unwanted high-frequency clock signals that are imposed on the audio signal by the delay line, and the cleaned-up signals are then passed on to the click blanking circuit via volume control RV2.

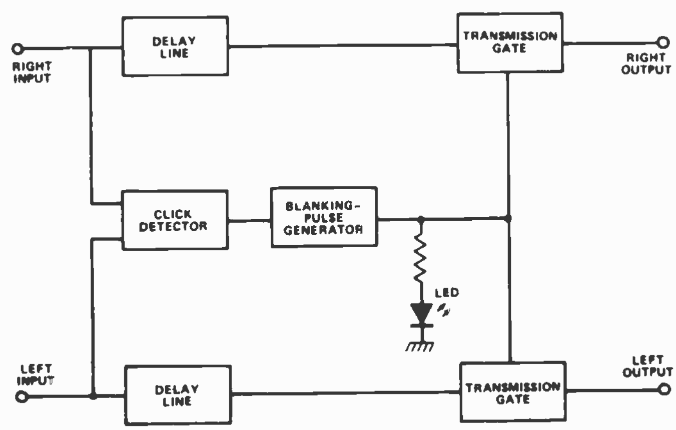
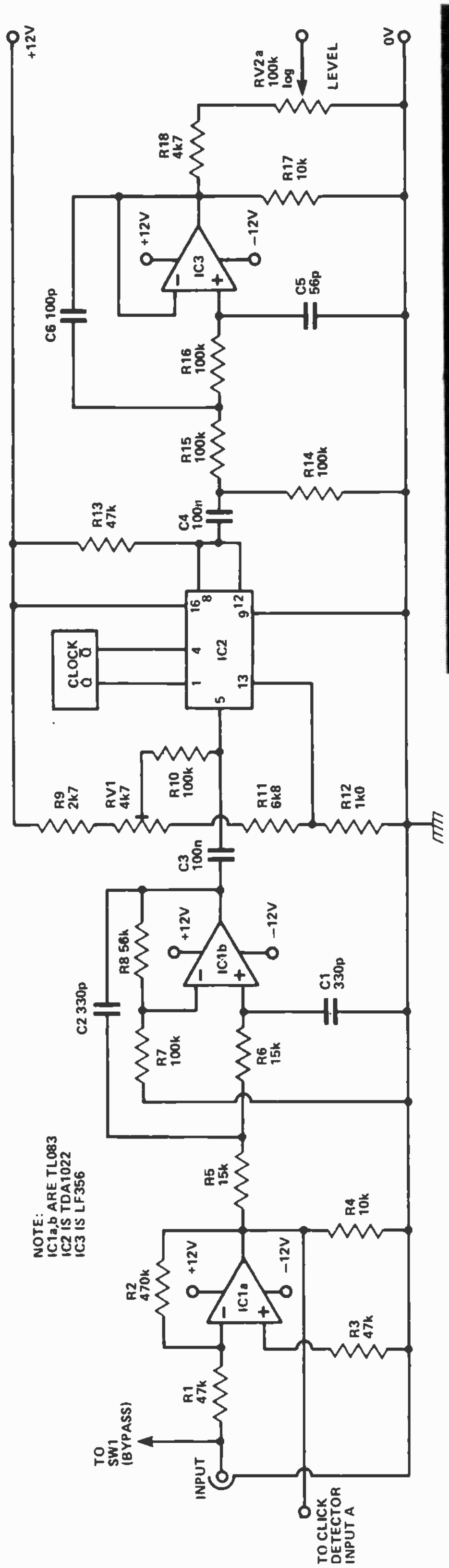
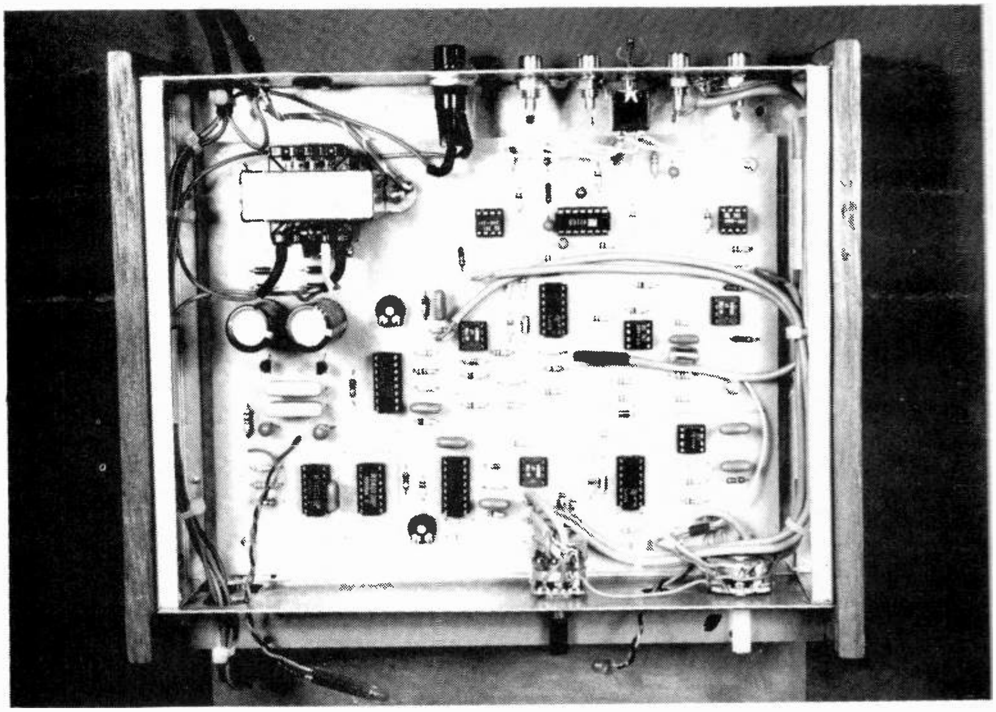


Fig 1. Basic block diagram for Click Eliminator MK 2.

Fig 2. Circuit diagram for the audio pre-amplifier and delay line sections of the Eliminator unit. Note that only one channel is shown, but both are identical.





Circuits and Components

Figures 2-6 show the schematic for the Click Eliminator. Figure 2 is the audio input and delay line circuit. Figure 5 shows the click detection and blanking pulse generation components. Inputs A and B come from points A and B marked on the left and right audio inputs respectively.

Circuits 5 and 7 are the output blanking (and bypass) and system clock respectively. The latter is referred in the audio circuit simply as Q and Q.

Construction

The unit is assembled onto a single PCB, and so construction is really quite straightforward. Assemble the board carefully, remembering to fit resistors and capacitors first, and ICs last. Sockets are best used for these devices, especially the high cost items. This will facilitate checking and servicing should this be needed.

The easiest place to make a mistake is in fitting the polarised components — electrolytics, diodes ICs etc so check these carefully. It is best to build up the PSU first and check this before connecting to the rest of the circuit.

Next assemble and check the audio circuitry. Make sure a signal is present at the level control RV2a and RV2b. Normally IC8 gates will be 'open' and so an audio output should be present at the phono sockets if all is well.

If no output is present, check the audio through to RV2, and if a signal is present here, the fault probably lies with IC6 and Q1. Disconnecting the base of Q1 will restore output if this is the case.

Over the Threshold

In use, the unit is connected between the output of a record player pick-up and the input of a stereo amplifier. Volume control RV2 should be adjusted so that no perceptible difference occurs in audio sound levels when the bypass switch is switched in and out. Pre-sets RV1 and RV101 should be adjusted for minimum distortion on the Right and Left channels respectively. Threshold control RV3 should be adjusted in use so that LED 1 just operates in the presence of a 'click'.

It should be noted that the relative amplitude of a 'click' is proportional to the velocity of the record track past

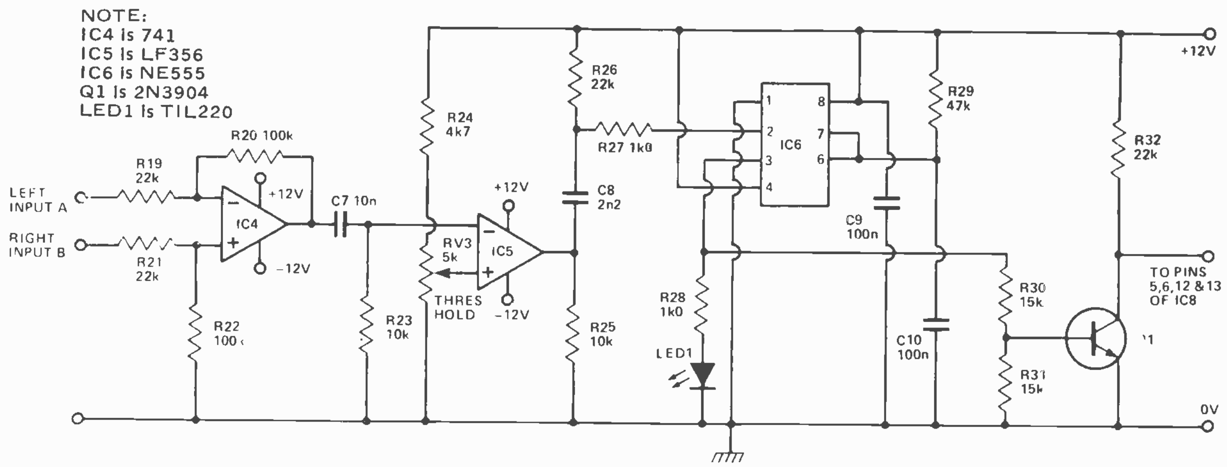


Fig 3. Circuit of the click detector section of the Click Eliminator. The LED flashes to indicate operation.

control, RV3 from its minimum setting until the click is removed. This is the correct setting.

LED 1 will indicate the unit operation, and if it flashes on musical peaks, chances are you have the threshold control set too high and are removing some of the signal as well. the pick-up head, and decreases as the head moves towards the centre of the disc: the threshold control may consequently need occasional readjustment as the record progresses through its play.

There is no equalisation circuitry within our design, and so it cannot be used in place of the preamp in your system, it must be used in front of it instead.

When playing damaged LP's simply advance the Threshold

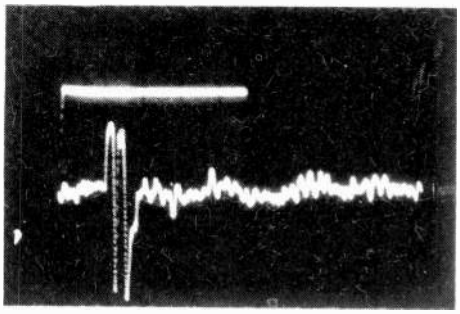
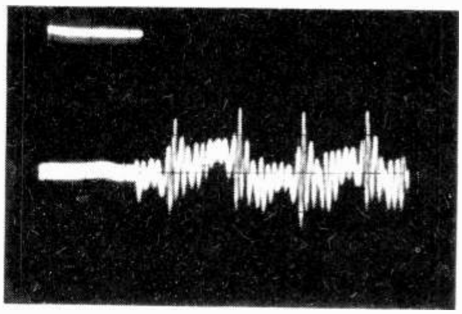


Fig 4 (a). Above: the waveform of the Click Eliminator blanking pulse straddling the click waveform, which includes some ringing. Fig 4 (b). Below: the combined waveform showing the blank period inserted into the music.



HOW IT WORKS

The full circuit diagram of the click detector block, which incorporates a "click identifier," a threshold detector, and a blanking pulse generator, is shown in Figure 3.

A "click" or scratch has a number of unique characteristics. It has fast attack and decay times, and its output is consequently rich in high frequency components. Also it appears to a stereo pick-up head as a set of recorded ant-phase signals, since it causes purely vertical displacement of the stylus, whereas normal recorded signals tend to be in phase and cause predominantly horizontal movement of the stylus. The ETI Click Eliminator uses these unique phase characteristics to provide its primary means of click indentification.

In the circuit, the amplified pick-up signals are taken from the outputs of the two-channel pre-amplifiers (IC1a, Fig 2), and are passed to one or other of the two input terminals of IC4 in Fig 3 IC4 is wired as a differential amplifier or "subtractor," and has a gain of about five on each input. The action of this IC is such that it amplifies the anti-phase "click" signals. but tends to cancel the predominantly in-phase recorded signals, so that the output of the IC consists of an audio signal with greatly emphasised "clicks". This signal is passed to threshold detector IC5, which is wired as an open-loop voltage comparator, with its output normally at positive saturation.

The "threshold" level of IC5 can be adjusted via panel-mounted control RV3, so that the output of the IC is just held high throughout the passage of a "clean" record. Then each time that "click" arrives the output of IC5 switches to negative saturation, to produce a large negative-going pulse. This pulse is to trigger monostable multi-vibrator IC6, which has a period of about 5 mS, and which drives "click indicator" LED 1 on and drives output transistor Q1 to saturation for the duration of the 5 mS pulse. The output of Q1 appears as a blanking circuit of Fig 4.

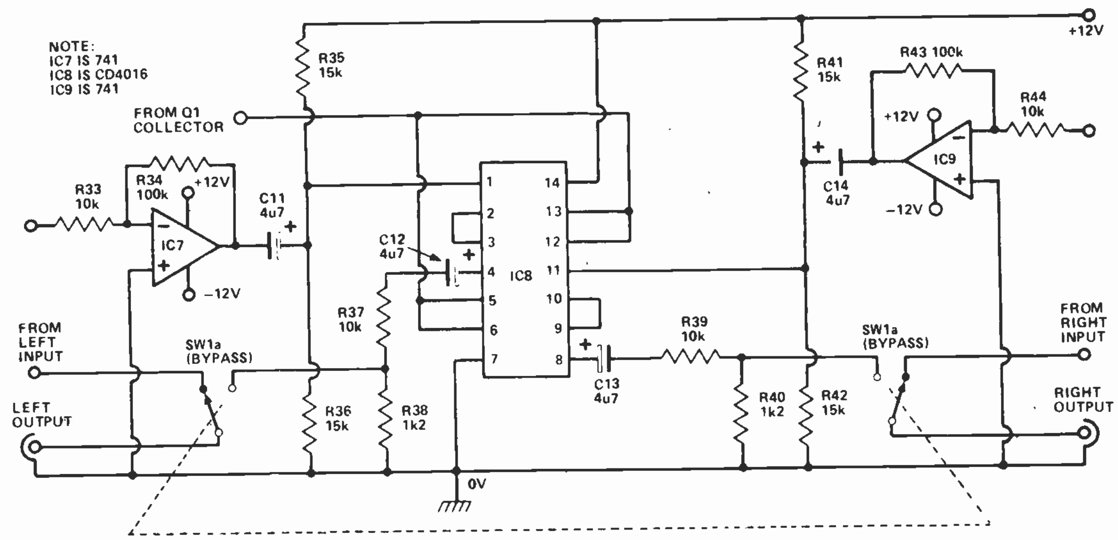


Fig 5. Click blanking circuit. Note That SW1 is the bypass switch.

HOW IT WORKS

The circuit of the click blanking block is shown in Figure 5. Circuit operation is fairly straightforward. The output of each channel is taken from its volume control (Fig 2) and is fed through a times-ten inverting amplifier (IC7 or IC9), and is then passed to one half of IC8, a 4016 quad bilateral switch. In each channel, two of the internal "switches" of the 4016 are wired in series, and are normally held on by the high control signal from the collector of Q1 (Fig 4), but turn off from 5 mS when a blanking pulse arrives from the click detector circuit. The output of each channel is then passed on to the outside world via a divide-by-ten (approx) attenuator network.

Thus, during "clean" parts of the record the output signal from the delay line is passed through the click blanking circuit of Fig 5 via the two series-connected on switch of IC8 with negligible loss or gain, but in the presence of a "click" the two series-connected switches of IC8 open 1mS bedore the arrival of the click and remain open for about 5 mS, thus replacing the click with an imperceptible "blank".

Note in the circuit that the inputs of IC8 are biased at half-supply volts to enable the IC to pass signals with a minimum of distortion when operated from a single-ended power supply. The 4016 IC suffers from a certain amount of control-signal breakthrough; by using the times-ten amplifier before the input and a divide-by-ten attenuator after the output of the IC, this breakthrough is reduced to insignificant levels relative to those of the basic audio signal.

The power supply is a straight-forward design based on a pair of thiee-terminal IC regulator, which provide plus or minus twelve volt outputs. LED 2 is a panel-mounting component, which indicates the power on state.

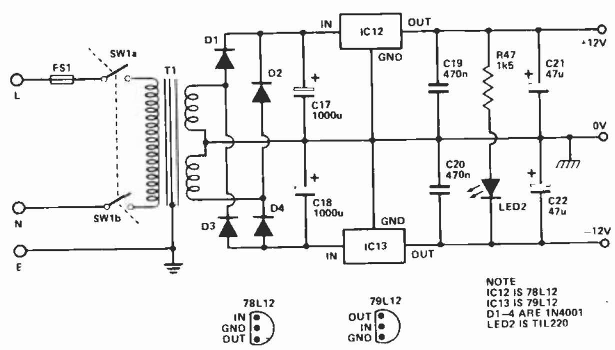


Fig 6. Power supply for the unit.

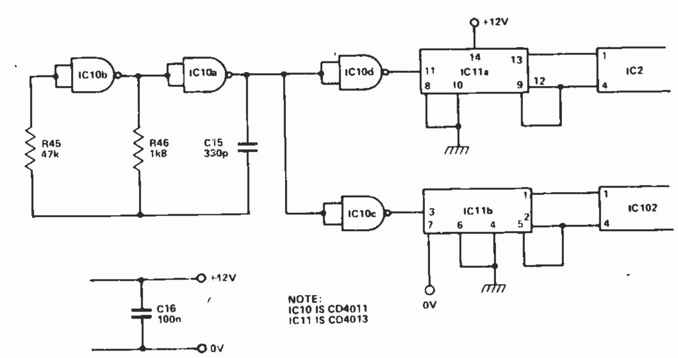


Fig 8. Clock generator circuit.

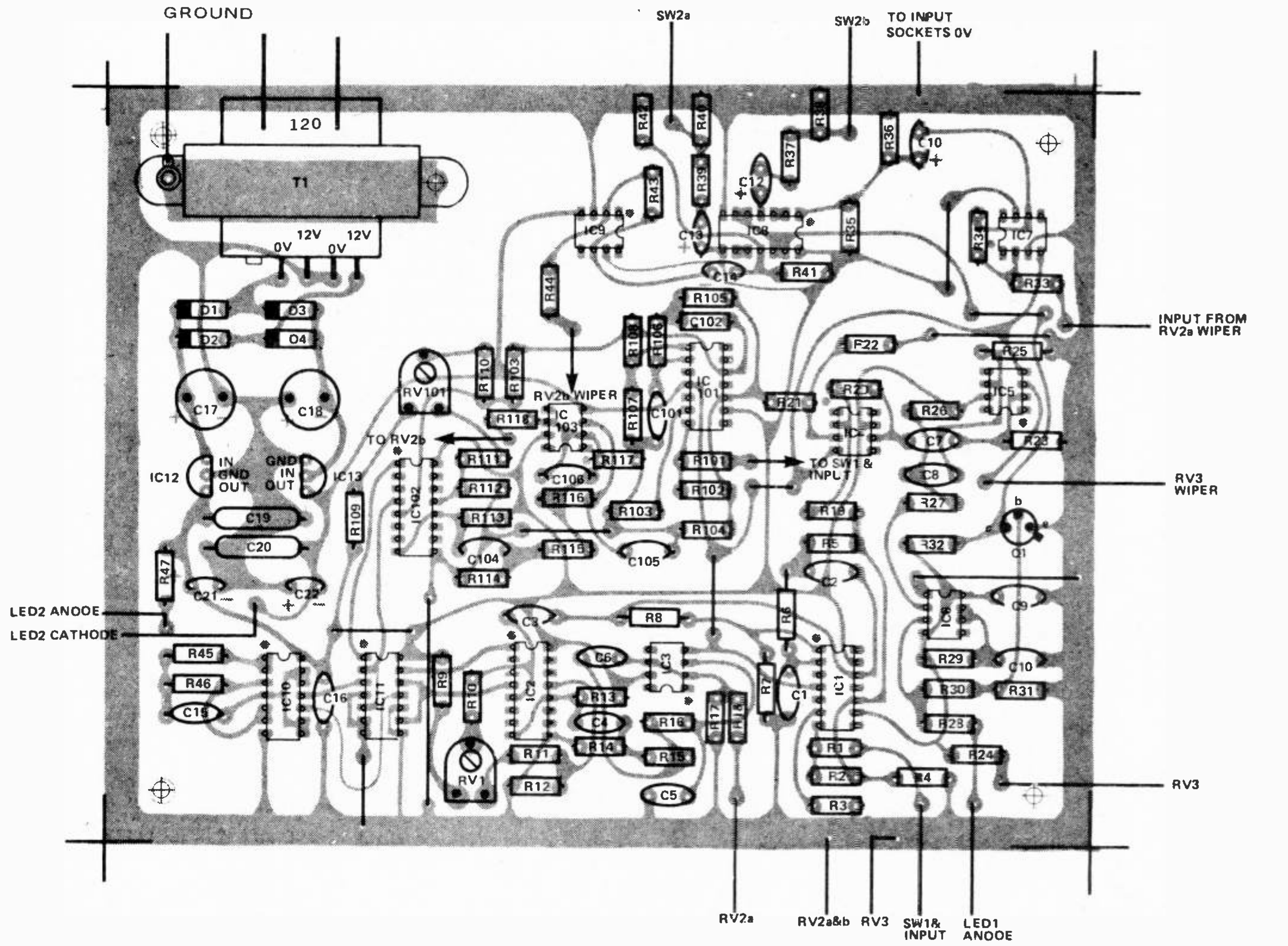


Fig 7. Component overlay for the Click Eliminator unit. Note that all the components bar the potentiometers mount on this PCB. The operation LED is also best front panel mounted.

PARTS LIST

RESISTORS (all ¼W 5%)

R1, 3, 13, 29, 45	47k
R2	470k
R4, 17, 23, 25, 33, 37, 39, 44	10k
R5, 6, 30, 31, 35, 36, 41, 42,	15k
R7, 10, 14, 15, 16, 20, 22, 23, 34, 43,	100k
R8	56k
R9	2k7
R11	6k8
R12, 27, 28,	1k
R18, 24,	4k7
R21, 26, 32,	22k
R38, 40,	1k2
R46	1k8
R47	1k5

Resistors 101-118 for RH channel identical to R1-18

POTENTIOMETERS

RV1	4k7 preset
RV2	100k log twin gang
RV3	5k Lin

CAPACITORS

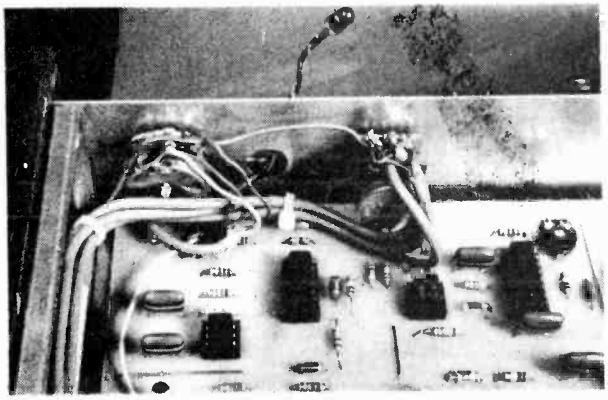
C1, 2, 15,	330p polystyrene
C3, 4, 9, 10, 16,	100n polyester
C5	56p ceramic
C6	100p ceramic
C7	10n polyester
C8	2n2 polyester
C11, 14,	4u7 25V electrolytic
C17, 18,	1000u 25V electrolytic
C19, 20	470n polyester
C21, 22	47u 25V electrolytic

SEMICONDUCTORS

IC1	TL083
IC2	TDA1022 Mullard/Signetics
IC3, 5	LF 356
IC4, 7, 9,	741
IC6	555
IC8	4016
IC10	4011
IC11	4013
IC12	78L12
IC13	79L12
Q1	MPS6515
D1-D4	1N 4001
LED 1, 2	TIL 220

MISCELLANEOUS

120/12-0-12 transformer (100mA), fuse (3A) and holder, case to suit, DPDT switch control knobs, PCB.



Close up of the socket wiring for the Click Eliminator. Keep these as close to the boards as possible.

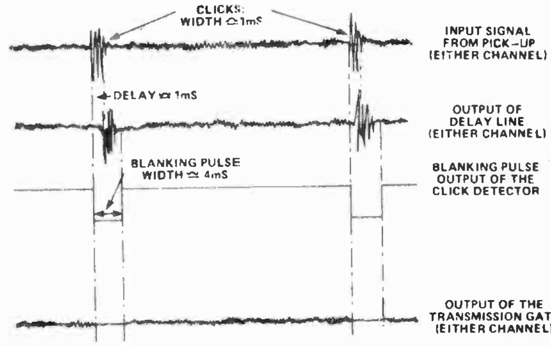
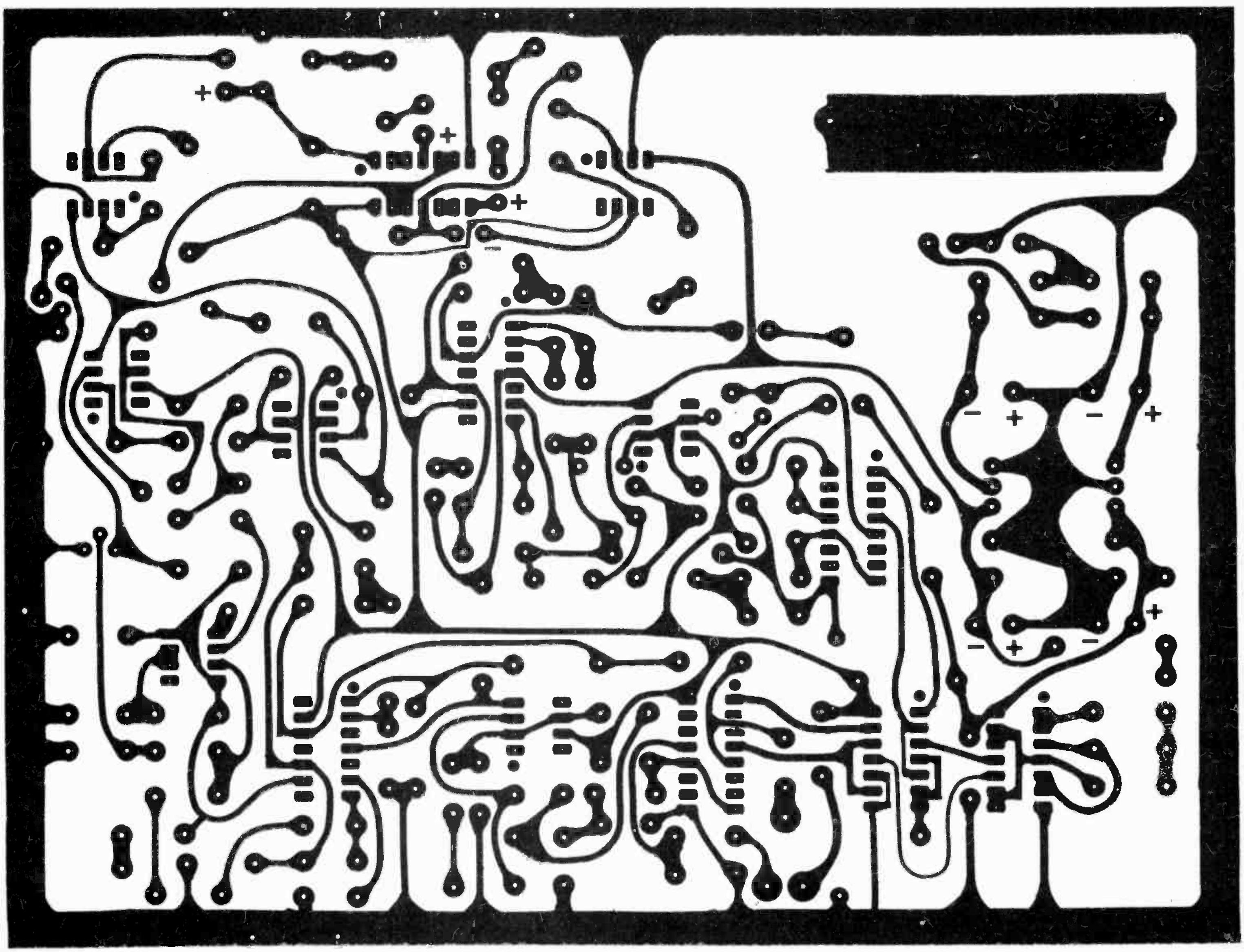


Fig 9. Some typical waveforms which illustrate the timing of the circuitry within the general block of the Click Eliminator. Blanking pulse width is fixed.

HOW IT WORKS

Pin 1 and 4 of the TDA 1022 delay line IC must be presented with symmetrical anti-phase clock signals for correct operation. The basic clock signal of a few hundred kHz is generated by a CMOS astable multi-vibrator formed by IC10a and IC10b. The clock signal is taken to each channel via a buffer stage (IC10d or IC10c) and a D-type flip-flop (IC11a or IC11b), which provides the required anti-phase drive signals (from Q and Q outputs) for the delay line. The clock generator has RF decoupling provided by C16, which is mounted close to the supply pins of IC10 and IC11.

Click Eliminator board.



FEATURE

AUDIO DELAY LINES

Don't do now what you can put off for a few milliseconds. Need to delay a signal? Tim Orr shows you how to do it and suggests some applications for analogue delay lines.

THERE ARE MANY natural phenomena which are 'caused' by time delays. All acoustic instruments and, in fact, everything in acoustics is time related. It is, therefore, hardly surprising that several manufacturers produce electronic time delay integrated circuits. These are called analogue delay lines or sometimes, 'bucket brigade delay lines'. as this accurately describes their operation.

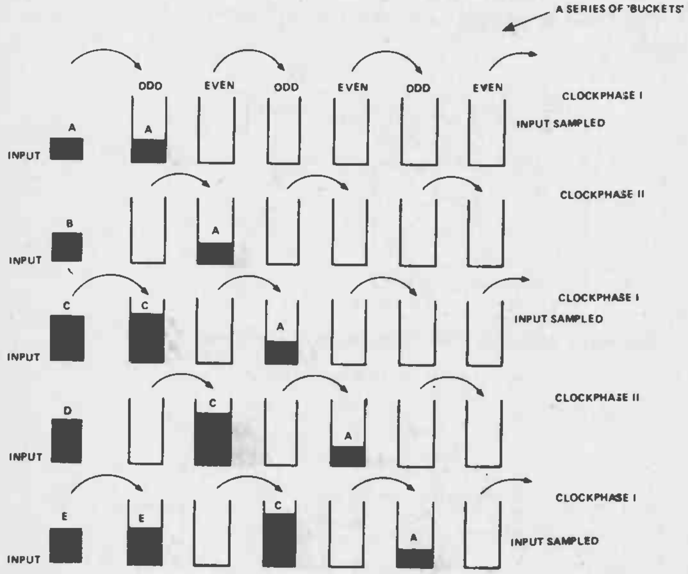


Fig. 1. Bucket Brigade delay lines.

Quantum Buckets

The device can be thought of as being a series of buckets containing water. (Actually it is a series of capacitors containing charge.) The signal presented to the input fills up the first bucket to the level of that signal. This occurs on phase I of a controlling clock signal. On the second clock (phase II), all the *odd* buckets tip their water into the *even* buckets. No input sampling occurs on clock phase II. On the next clock phase (phase I) the input is sampled and all the *even* buckets tip their water into the *odd* buckets. In this way a signal propogates down the delay line which represents the input signal as a series of 'samples'. The buckets are really analogue sample and hold units and the tipping is done with electronic switches. This technique is a cross between analogue and digital processes. The cross between analogue and digital processes. The charge stored (which is proportional to the input voltage) is truly analogue, but it is quantised into small units of time and so, in that sense, it is digital. If the delay line is, say, 512 stages long and the clock frequency is 512 Hz, then the delay time will be:

$$\frac{\text{number of stages}}{2 \times \text{clock frequency}} = 0.5 \text{ sec}$$

That is, after 0.5 sec a waveform representing the input signal of 0.5 sec earlier will appear at the output. In the example shown in Fig. 1, this signal would only appear at the output for the duration of clock phase II. To fill in the gaps, a second delay line connected in parallel with the first, but clocked in antiphase, is used, so that a delayed output signal appears on both clock phases.

Delay lines would seem to solve a myriad of electronic problems but with every solution comes a host of new problems. First, the maximum bandwidth of the delayed signal is proportional to the clock frequency. As the signal is sampled, then the 'sampling theorem' says that the signal bandwidth must be less than half the sampling frequency, which, for practical purposes, means about one-third. So, if you want to delay an audio signal of 10 kHz bandwidth by 1 second, then the number of stages. delay needed is 60,000. This will cost you a few hundred dollars in delay lines. If you choose a lower clock frequency requiring fewer delay lines then you will have to make do on a reduced bandwidth. If this bandwidth is not controlled by use of an external lowpass filter, then a phenomenon called aliasing occurs which makes the delayed signal sound as if it has been 'ring modulated'. A typical delay line structure is shown in Fig. 2. A lowpass filter is used to band limit the input signal which prevents the aliasing effects. A second filter is used to recover the quantised output from the delay line by rejecting all the unwanted high harmonics.

The input signal level is always larger than that of the output signal because the buckets are leaky, although the leaks occur in both positive and negative directions. Also, the slower the clock frequency the longer the leakage time is and so the loss is greater. This is a major noise generating mechanism. The noise is broad band, being strong in low frequencies (just the area you are listening to), and becomes louder and more bassy as the

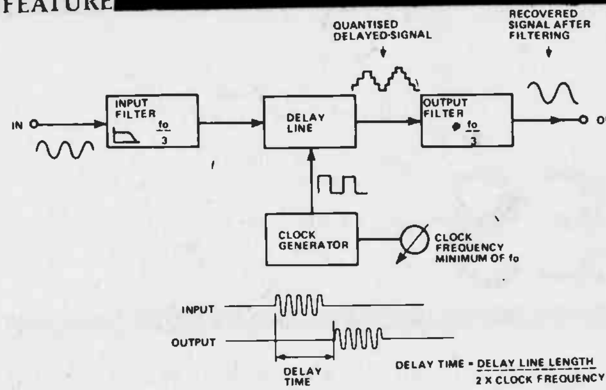


Fig. 2. Block diagram of a typical delay line system.

clock frequency is reduced. This results in signal to noise ratios of about 70dB for maximum frequencies. To overcome the poor performance at low frequencies a noise reduction system such as a compander can be used. The distortion caused by delay lines is typically about 1% and the overload characteristics are not at all good. Heavy overloads can cause the delay lines to stop producing any output at all. The solution is to limit the input level, with some simple sort of diode limiting. One other gremlin is that the output DC level varies with clock frequency which causes some awkward break-through effects. However, once you are fully aware of the limitations of delay lines, it is possible to design a wide range of interesting devices. Delay lines work surprisingly well when you consider that they move a very small packet of charge through several hundred memory stages with a corruption of only one part in 10,000 to 100,000!

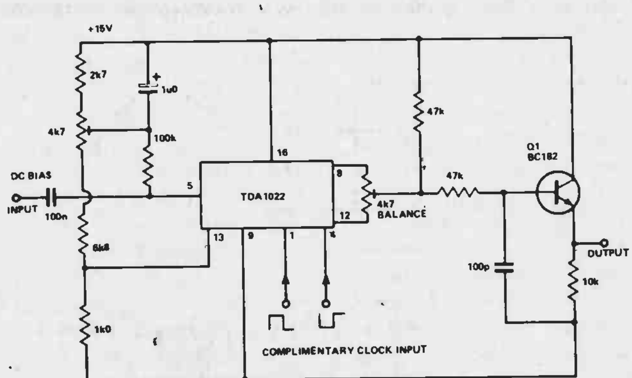


Fig. 3a. A delay line circuit based on the TDA1022.

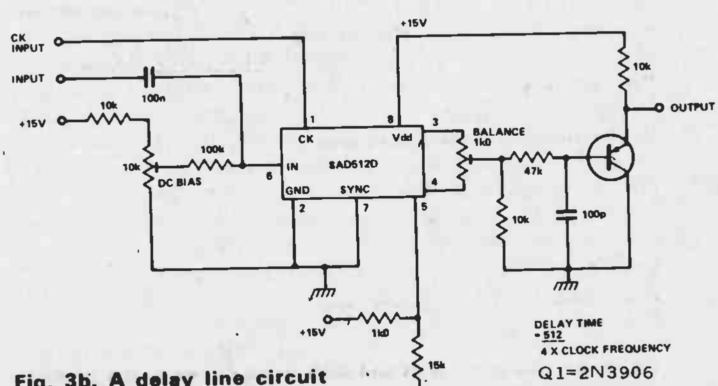


Fig. 3b. A delay line circuit based on the SAD 512D.

Some Delay Line Circuits

Two delay line circuits are shown in Fig. 3. The top one uses a delay line made by Mullard/Signetics. A two phase clock is needed. A preset adjusts the input DC bias so that when the device is overloaded, the clipping is symmetrical. A balance control on the output balances the two outputs for a minimum clock breakthrough. This preset is particularly useful when long delay times with audible clock frequencies are used.

The second delay line is the SAD512D made by Reticon. This device has the same two preset controls but only requires a single clock signal. There is a complementary clock generator (a divide by two flip flop) on the actual IC. The input clock must therefore be twice the calculated frequency.

If long delay times are needed, then there is the Reticon R5101 which will give you a 1 second delay at about 500 Hz bandwidth. This device gives a superb automatic double tracking effect (50 mS at 10 kHz bandwidth) but unfortunately it's rather expensive.

Clock Generators

A selection of clock generator circuits is given in Fig. 4. Circuit A is a standard CMOS relaxation oscillator. The IC costs only about 50¢ and generates complementary square waves; the minimum frequency of operation is about 1 MHz (with a suitable timing capacitor) and the manual control range is about 50 to 1. It is not very practical to voltage control the frequency of this oscillator.

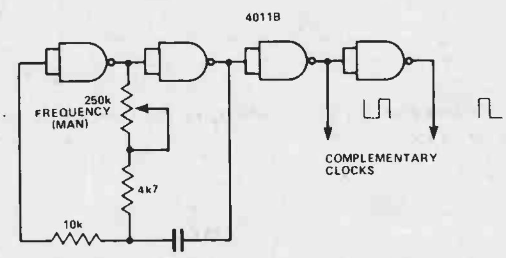


Fig. 4a. A standard CMOS relaxation oscillator.

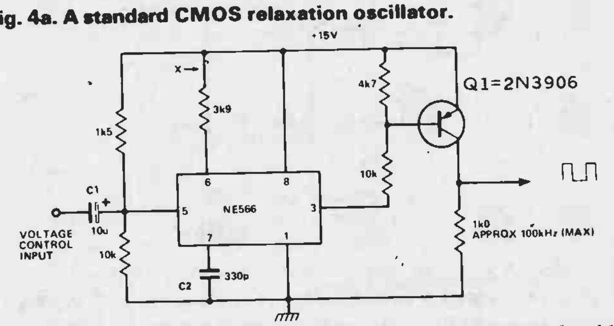


Fig. 4b. The frequency of this clock generator is determined by C1.

Circuit B uses an NE566 which is a voltage controllable oscillator IC. The frequency may be controlled via the capacitor C1 or by interposing a potentiometer or a controlled current source at point X. The output square wave needs to be level shifted and this is done with Q1. The maximum frequency using this circuit should be limited to about 100 kHz. For higher operation up to 1 MHz, a faster level shifter is needed.

Circuit C uses a CMOS Schmitt trigger and a couple of transistors. This oscillator can readily be controlled by a current generator. The output waveform is a short positive going pulse. A divide by two flip flop converts

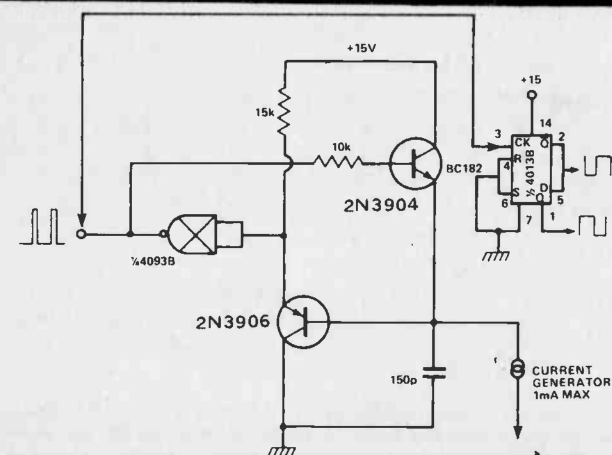


Fig. 4c. This clock generator uses a CMOS Schmitt trigger. The flip flop produces a pair of complementary square waves.

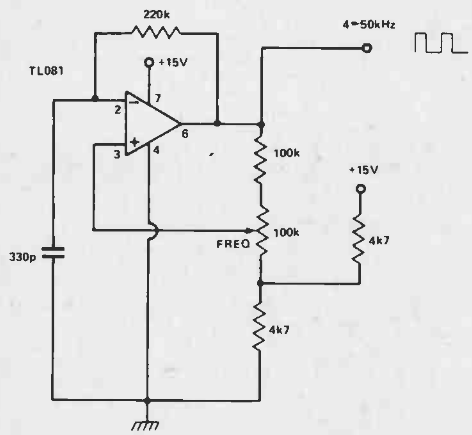
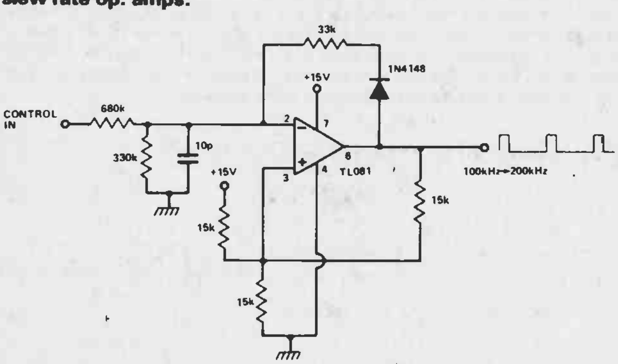


Fig. 4d. (above) and Fig. 4e. (below) show circuits using fast slew rate op. amps.



this pulse into a pair of complementary square waves.

Circuits D and E employ the fast slew rate (13 V/uS) of the Texas BI FET Op Amp range. This enables them to oscillate at high frequencies and to generate square waves with fast edges. Circuit D is a manual control device and circuit E is voltage controllable.

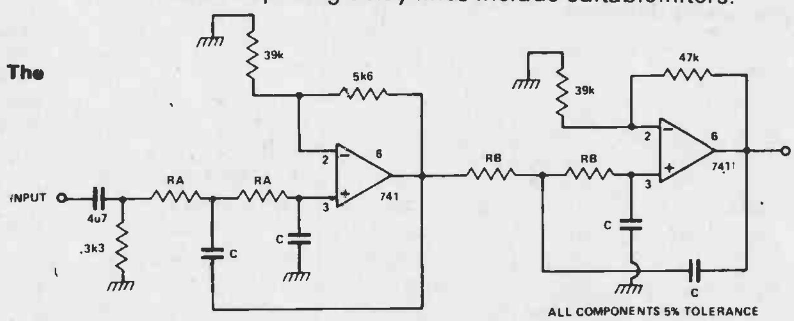
DIY Design

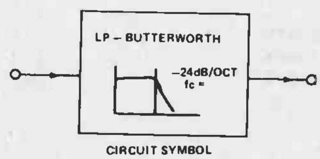
A 'do it yourself' lowpass filter chart is shown in Fig. 5. This filter is a 4th order Butterworth design. The roll-off slope is 24 dB/octave. This means that signals one octave above the cut-off frequency are attentuated by 24 dB (×0.06), at two octaves the attenuation is 48 dB (×0.004), etc. Also the filter has a pass band gain of 8.3 dB (×2.6).

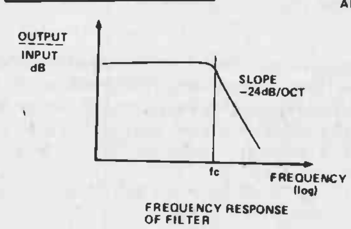
The design procedure for constructing delay line systems is as follows.

1. Select the correct length delay line for the job in hand. Decide on the signal bandwidth needed.
2. Design the low pass filters to have a cut-off frequency equal to the signal bandwidth.
3. Select a suitable clock oscillator that will generate the correct output (single or complementary) at a high enough frequency. Select a voltage controlled design if it is needed. Calculate the required clock frequency.

The following examples show delay line systems. The boxes depicting delay lines include suitable filters.

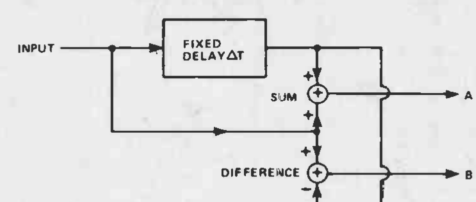






Cut off Frequency fc	RA & RB Calculated value	E12 value	C
250 Hz	40k64	39k	15n
500Hz	20k32	22k	15n
1kHz	10k66	10k	15n
2kHz	53k3	56k	1n5
4kHz	26k65	27k	1n5
8kHz	13k35	12k	1n5
16kHz	6k62	6k8	1n5

Fig. 5. A do-it-yourself design for a fourth order Butterworth filter.



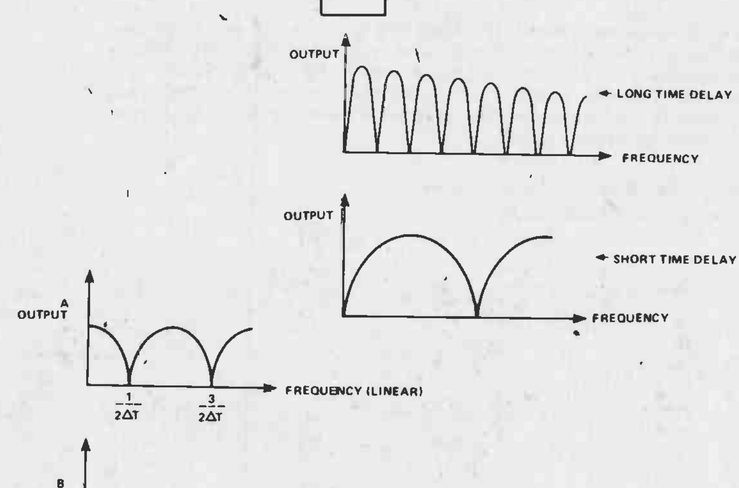


Fig. 6. By taking the sum and difference between the original and delayed signal, a comb filter response is generated. The noteches are spaced at 1/(AT) Hz, where AT is the delay time.

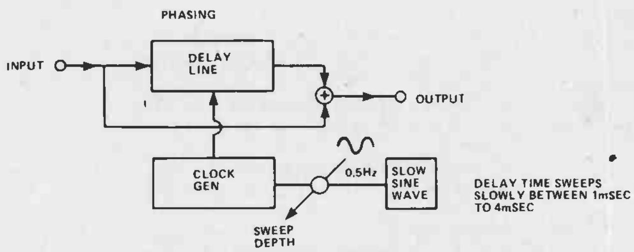


Fig. 7. Note that a long time delay produces lots of notches, a short time delay, only a few. A very popular musical effect is phasing. This uses a slowly sweeping comb filter. That is, the delay time, and hence the notch spacing, are modulated with a slow moving sine wave.

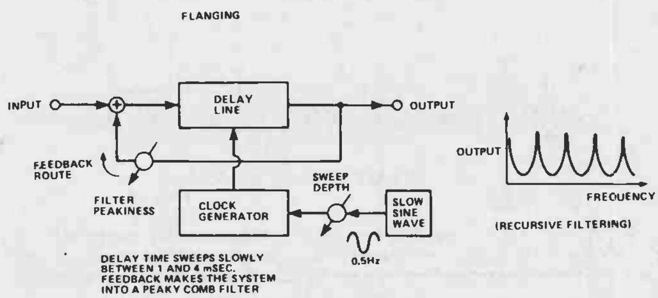


Fig. 8. Flanging is another similar effect, except that feedback is applied around the delay line. When this feedback is in phase with the input, a peak in the frequency response is generated. A pot is used to control the feedback and hence the amount of 'peakyness' of the filter. Flanging produces very strong colouration of the sound.

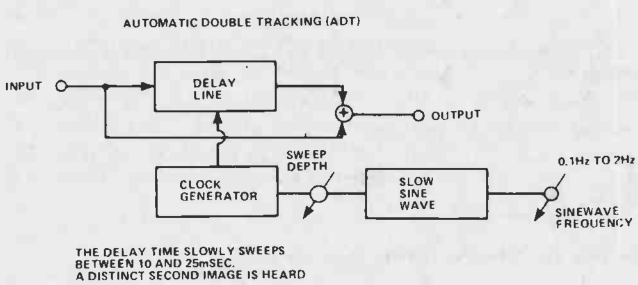


Fig. 9. Automatic double tracking (ADT) is used to add depth and a chorus quality to solo singers and musicians. The delay time is relatively long so that a distinct second image is heard. This image is slowly swept backwards and forwards in time thus adding to the chorus quality. It is such a useful effect that even my singing sounds good!

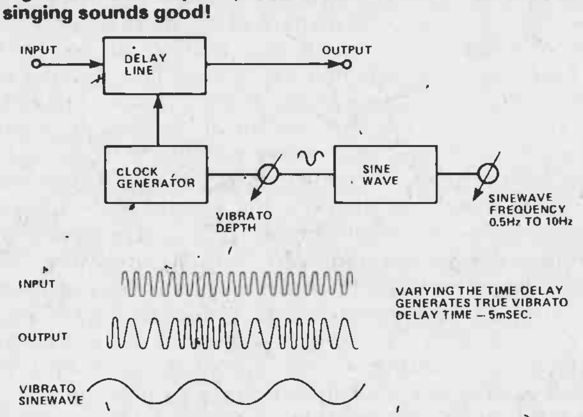


Fig. 10 shows a 'true vibrato' system. This produces a real frequency modulation acting upon all of the input signal. By rapidly modulating the clock generator frequency the time delay is similarly modulated. This causes the output signal to be compressed and expanded in time, resulting in vibrato.

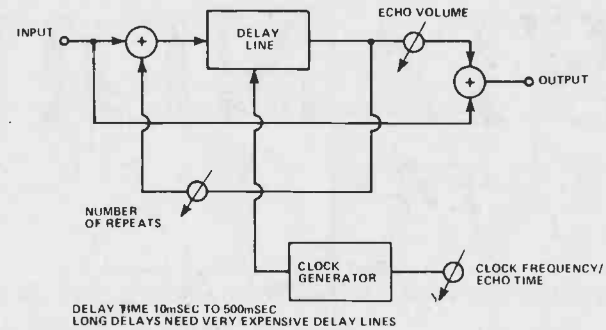


Fig. 11. All electronic echo is obtainable using long delay lines, although you generally have to trade off bandwidth for echo time. Electronic echo systems usually have three controls: time delay, echo volume and repeat level. This last control enables you to vary the echo from a single slap back echo to a long series of repeats.

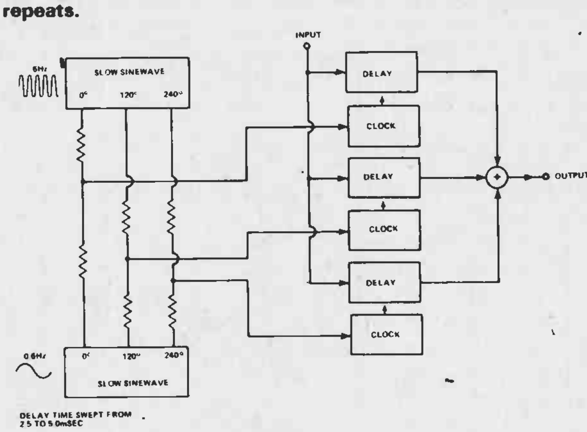


Fig. 12. Electronic string machines nearly always have a chorus/ensemble generator. This is a device that causes complex phasing on the string signal that converts it from a rather flat electronic signal to a rich string-like sound. This is done with three delay lines that have their delay times modulated by three low frequency sine-waves.

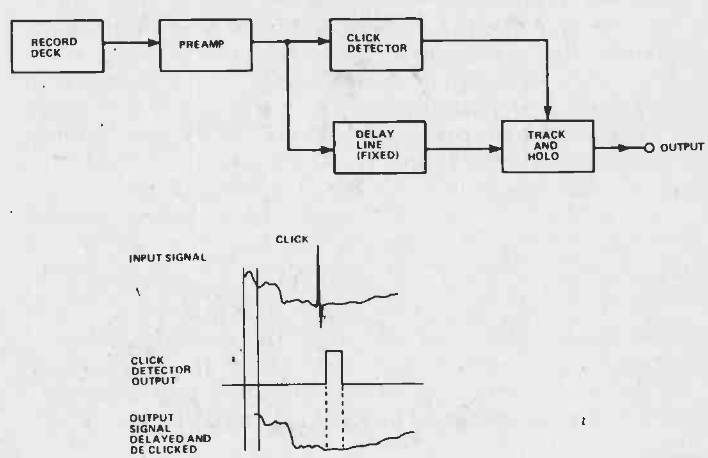


Fig. 13. It is possible to remove record scratches and clicks using a delay line. A scratch on a record is a relatively easy signal to discriminate from the music. However, once the scratch has been detected, the sound of the scratch has already left the loudspeakers and so it is too late to do anything about it. However if the sound is delayed then the scratch can be 'snipped out' using a track and hold circuit. The resulting gap is far less objectionable than the original scratch.

STANDING WAVES

A standing wave has nothing to do with goodbyes at a railway station

YOU KEEP COMING across that phrase, don't you, and it seems a bit odd. Waves wave, after all, they don't stand about. Or do they? Depends how you look at it and what you're looking at.

Pick a wave, any wave, radiating off an aerial into space. When this happens, the wave is radiating out from the aerial in all directions. The wave is an electromagnetic wave but since we only usually detect the electric part we can forget about the magnetic part for the moment. Let's just remind ourselves of what a wave like this is and does.

Equating With The Problem

A radiated wave of this type is a travelling wave. If we intercept it with an aerial attached to a sensitive oscilloscope what we would see on the screen (Fig. 1) would be the familiar sine wave trace, so that we could measure the time between peaks of the wave. This time between peaks is called the period or periodic time (T) of the wave, and is the quantity we measure by making use of the calibrated time base of the oscilloscope. This time period is related to the frequency of the wave: f=1/T with T in uS frequency f is in MHz. For example: if the period is 0.4 uS, then the frequency is 1/0.4 =2 5 MHz.

The wave is travelling, though, so that places a distance apart will get a different phase of wave. In the drawing, of Fig. 2, A will receive a peak of the wave earlier than B, simply because A is nearer the transmitter. The distance between two places which receive peaks which are just 360° out of phase is the distance we call the wavelength.

In the time of one complete cycle, the wavelength is the distance that a wavepeak travels, so that the speed of the wave is simply frequency wavelength. For an electromagnetic wave (radio wave) in space, the speed is a constant 300 million metres per second (3×10^8m/S), so that this is the quantity equal to frequency × wavelength. For a 1 MHz wave, the wavelength is $3\times10^8/1\times10^6=300$m.

For a 1000 MHz wave, though, the wavelength is just $3\times10^8/10^9=0.3$m — hence the alternative title of 300 mm wave This frequency × wavelength business applies also to sound waves, incidentally, except that sound waves crawl along a lot slower, about 330 m/S. A 1 kHz sound

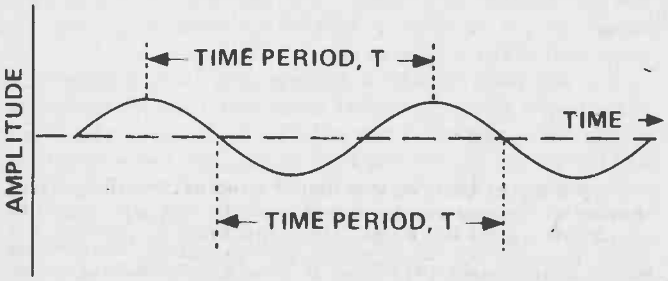


Fig. 1. Time period. This can be measured between neighbouring peaks or from one zero-crossing to the next-but-one, as shown.

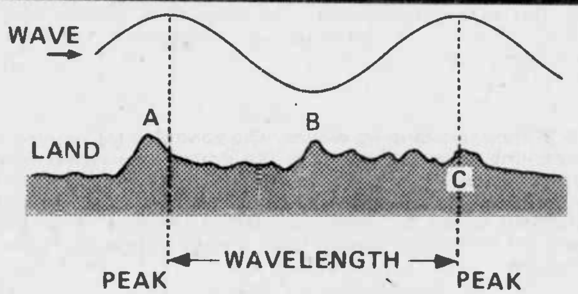


Fig. 2. Wavelength. Imagine the wavepeaks moving from left to right. At the instant shown, a peak is at point A, and a trough at point B, but the previous peak has reached point C. The distance between points A and C is one wavelength of this wave.

has a wavelength of 330/1000 metres, which is only 330 mm, almost the same as a 1000 MHz radio wave.

If we're in the business of beaming waves into space or testing loudspeakers in open fields, this is as much as we need to know about waves, but we find nearly always that there's some reflections around. Now the effect of a wave reflection meeting a wave is the same as the effect of two waves meeting each other — if the wave and the reflection are in phase, then the result is a large amplitude wave, if they are out of phase the result is a reduced wave. We can expect to find some variations in wave amplitude, then, if a wave meets its own reflection.

Reflecting On The Problem

The easiest example to sort out is when a wave meets a reflection of the same size travelling in the opposite direction. Now the mathematicians can do this without drawings, simply by fiddling with equations, and those of us who play with programmable calculators can sort it out that way — the fortunate owners of computers can watch the whole thing — play it out in slow motion. We have to do it the hard way — using imagination with the help of a few drawings. Fig. 3a shows a forward moving wave meeting a reflection — it's a diagram frozen at an instant in time because what is plotted is wave amplitude against *distance*. Fig. 3b shows the same picture an instant later, both waves have moved an identical distance in their opposite directions. A few more stills from this exclusive movie, and we begin to see glimmerings of something interesting. The combination of the forward wave and its reflection travelling in the opposite direction has produced a new wave pattern. At some points along this pattern, there is always complete cancellation — the forward wave and the reflected wave are always in antiphase so that there is no signal at this place — ever. At other places there are varying amounts of signal right up to a whopping great peak whose amplitude is about twice as much as either of the travelling waves. This pattern is what we call a standing wave (Fig. 4) — there is still a wave present, because a graph of voltage

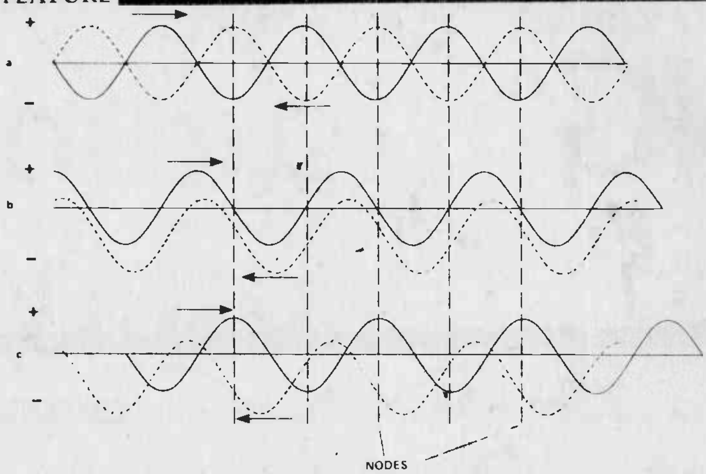


Fig. 3. Setting up standing waves. The solid line (a) represents a wave moving from left to right, the dotted line represents its reflection moving in the opposite direction. At (b), each wave has moved about ¼ cycle, and at (c) ½ cycle along in its own direction. The positions where the waves cancel (because they are equal and opposite, or both zero) remain fixed though. These positions are called nodes.

plotted against time shows a wave, but there's no movement of phase. In any standing (or stationary) wave like this there will be nodes — places where there's no wave signal at all — which are half a wavelength apart and antinodes — where there's a maximum wave signal — which are also half a wavelength apart but out of phase with the nodes.

How To Find Them

Standing waves can exist on a wire as well One of the old classic methods of measuring the wavelength of a high-frequency radio oscillator is called Lecher Lines. The Lecher lines are two parallel metal bars of thick wires which are connected to the oscillator output. A shorting bar is fitted with a detector, which might be a neon lamp (for high voltage signals) a small lamp-bulb (for low voltage signals) or a diode/meter circuit Sliding the bar along the lines (Fig. 5) results in the detector indicating points of no signal, the nodes; and points of maximum signal, the antinodes. The distance between two neighbouring nodes, or two neighbouring antinodes, can be measured — this distance is half a wavelength.

The wavelength of a sound wave can be measured in the same way. One classic method of measuring the wavelength of a sound along a pipe was to sprinkle powder on the pipe. When the sound wave set up standing waves, the powder would gather into piles at the nodes of the standing waves, and spray away from the antinodes, so that the half-wave distance between nodes could be measured. It's equally easy to measure the wavelength of standing waves in a room by moving a microphone attached to an AC voltmeter and noting the position of nodes — once again the distance between two neighbouring nodes is equal to half a wavelength.

Leaving Loose Ends

If a length of coaxial cables connected to a circuit is left either open circuit or short circuit, standing waves can be set up in it, with a node at the short circuit or an antinode at the open circuit end. If the length of the cable is just right, that's fine. If it's not, then signals will reflect to and from along the cable, arriving at the circuit and with a time delay equal to the time taken to travel along the cable and back. Because of this effect, we seldom cut cables to a length which will permit standing waves — instead we terminate each end of the cable in a resistance value which will prevent reflections — this value of resistance has to be equal to a quantity called the characteristic impedance of the cable (calculated from the inductance and capacitance per metre of cable). With an open or shorted cable, on your telly, you can expect to see 'ghost' images — several edges to each object.

Advantages And Disadvantages

We do, however, encourage standing waves in aerials. TV and FM aerials are cut to a total of half a wavelength so that a standing wave is set up on them. This allows us to do two things which would not otherwise be possible. One is to extract the maximum energy from the signal — the aerial responds like a tuned circuit to the correct wavelength; the other is to match the aerial to its cable. At one end of a half wave aerial we have an antinode — maximum wave amplitude. At this point we have maximum voltage, but no current. At the centre of the aerial there is a node — zero voltage but maximum current. We can select a point along the aerial to connect the cable so that the ratio of voltage to current is just right — 75 ohms for most coaxial cables, and

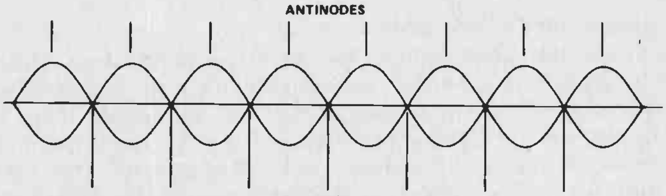


Fig. 4. Representing a standing wave. The standing wave has the same wavelength as the moving waves which cause it, but the nodes and antinodes are at fixed points, quarter of a wavelength apart from one another.

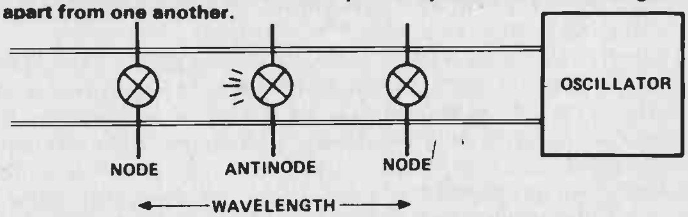


Fig. 5. Using Lecher lines. A high-frequency oscillator attached to parallel wires can display standing waves, using a small light bulb to detect the positions of nodes and antinodes.

in this position there will be the maximum transfer of signal from the aerial to the cable.

At the tuner, standing waves create another sort of problem the problem of how to ground conductors. Ground one point of a conductor and there will be a node at that point — but there will also be an antinode (maximum signal) just ¼ wavelength away.The result is that grounding a conductor may have just the opposite of the effect you expect unless you ground at just the right place. Move any of the conductors in a tuner, and you disturb the standing wave pattern — even a dent in the metal case of a UHF tuner can make a difference.

It's not always such a happy story. The greatest difficulties with standing waves arise when we try to design a loudspeaker cabinet. Each solid surface and cracks or gaps will behave as a short circuit or an open circuit respectively. A loudspeaker cabinet will be a mess of standing waves, therefore, unless we do something to absorb them. The room we use for listening will also have standing waves at some frequencies (depending on its dimensions) and in some directions — this is particularly noticeable in an empty room stripped of all its furniture. All in all, standing waves are all around us — we have to live with them!●

Audio Today

Wally Parsons reviews current developments in Audio.

A CLICHE SAYS that great minds think alike. If this is true, perhaps it's just as well that there aren't many great minds in the world; aside from the fact that it would be dull, I should hate to think that the gang of intellectual mediocrities in places like Ottawa might be mistaken for great minds simply because they appear to think as if they had been cloned from the same Orwellian ostrich.

Nevertheless, there is some legitimacy to the concept that ideas have a life of their own and that people, as individuals, do not conceive them so much as act as receptacles in which they are contained and developed and from which they are eventually propagated. Sometimes they fall on barren ground and die, but, at times a concept takes root and grows. And if the first attempt at germination is unsuccessful, the process may be attempted at a later date when conditions are better.

History is filled with examples of this phenomenon, from the imaginative inventions of Leonardo da Vinci, to the Wright brothers, the 1926 invention of the transistor, or the long period of near dormancy of the Diesel engine. Strangely enough, I even read, recently, an example of the kind of speculation so common in the fifties dealing with the future automation of society. Frankly, I don't believe that this brave new world will come about, at least within the lifetime of anyone alive at the present time, largely because the stupid, the intellectually perverted, reproduce at a greater rate than the rest of us, and will probably destroy society, if not the entire human race first.

This phenomenon occurs with most of us from time to time, such as when encountering a television programme or newspaper or magazine article dealing with some matter with which we are concerned at the moment.

And, if you're wondering where this metaphysical excursion is leading, wonder no more; we have arrived.

Cross-Field Thinking

Although the idea for last month's column was influenced by contemplation of the upgrading project of my brother's amplifier, the idea of dealing with parts replacements at that time, and doing a column on it came out of the blue.

Imagine my surprise, then, when two days later I picked up the then current (February) issue of Audio magazine and read the first of a two part series on capacitors, written by Richard Marsh, of the Laurence Livermore Labs, University of California, and Walter Jung.[1] Of significance is the examination of the mechanism involved in several characteristics of various capacitors, and consideration of one mechanism in particular. So, for the benefit of those loyal readers who say they have cancelled their subscriptions to all magazines except ETI, I thought it might be instructive to stay with the subject a little longer, and relate it to an experience of my own.

A Few Fundamentals

First, let's look at some of the fundamentals of capacitance and some of the characteristics of capacitors, at least as far as they are of concern to audio applications.

Essentially, a capacitor consists of two conductors spaced a finite distance apart and separated by an insulator. If an electrical potential is applied across the conductors an electrostatic field is set up, current flows through the capacitor, that is, one in which the plates are separated by a perfect insulator and the conductors, or plates, are perfect conductors, this energy can be stored indefinitely, and if the charging source is removed, the capacitor will remain charged forever. If a conductor, with or without series resistance, is then connected across the plates, the stored energy will be delivered to the circuit in the form of current.

If the separating insulator, called the dielectric, is not a perfect insulator (which is true for any dielectric except a *perfect* vacuum), this charge will be dissipated through the dielectric, until the capacitor is discharged.

When an AC voltage, including an audio signal, is applied to the plates, the voltage rises in one direction, charging up the capacitor, or putting energy into it. A voltage thus is developed across the capacitor which can be amplified, or can cause current flow into a load. When the applied voltage drops to zero, the stored energy is returned to the source, and the process repeats itself with opposite polarity. Notice that no power is dissipated, unless there is resistance between the plates. In that case, part of the charge is dissipated in that resistance and if it is the dielectric, power is dissipated as heat. In terms of signal transfer, the effect is the same as connecting a resistance across the capacitor.

In Fig. 1, the equivalent circuit of a real capacitor, this leakage appears as Rd.

Rs is the resistance, in series, of such things as the lead wire and actual resistance of the plates. L is the inductance of the lead wires and any inductance which results from the manner in which the capacitor is fabricated. For most capacitors, other than electrolytics, this value, as is Rs, is sufficiently small as to be of little significance except at RF frequencies, but in wide-band designs it still may be important to the stability of the final circuit.

Electrolytics—A Difficult Compromise

The value of a capacitor is a function of the area of the plates, the spacing between the plates, and the characteristics of the dielectric, specifically, the dielectric constant, *k*. This is the

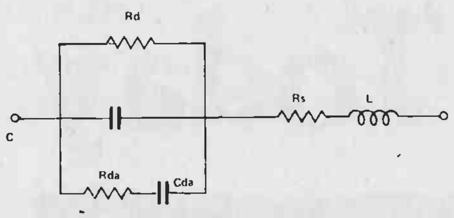


Fig 1. What a real capacitor looks like.

measure of the permittivity of the material, as compared with a vacuum, which has a *k* of unity. Permittivity is a measure of the ease with which an electrostatic field can be established in a dielectric. The higher the dielectric constant, or the larger the plate area, or the closer the spacing, the higher the capacitance. Obviously, the larger the capacitance, the larger the capacitor's physical size. To obtain large values with reasonable size requires a high value of *k* and/or close spacing. But to achieve close spacing the dielectric must have high resistance if we also require a high voltage rating.

The dielectric of an electrolytic capacitor consists of a film of either aluminum or tantalum oxide, formed by electrolytic action which occurs when forming voltage is applied across the plates in the presence of an appropriate electrolyte. The oxide thus formed has much lower resistance than other materials, such as mica, polystyrene, etc, so leakage is greater, while the electrolyte usually displays much higher resistance than a direct connection. This is why I've taken what might appear to be an almost fanatical stand against their use in loudspeaker cross-over networks. This resistance dissipates power in the capacitor instead of the load. Even in a signal circuit with negligible power to handle, the device does not behave entirely as a capacitor. The large winding of the electrode introduces considerable inductance, so that impedance may fall as frequency goes up, but at some frequency the capacitive reactance and the inductive reactance meet and resonate. Then, as frequency goes up, so does impedance, due to inductive reactance. I kid you not, depending on the type, and the manufacturer, this can be well withing the audio pass band.

The junction of an oxide and a conductor *can* form a semiconductor, as, for example, the point-conductor crystal instead of electrolyte for reduced value of Rs. Needless to say, I'm withdrawing my recommendation of last month for tantalums, but would suggest selecting an aluminum of high quality, which usually means high Rd and low Rs.

Where electrolytics *must* be used, many of these effects can be minimized by bypassing the unit with a high quality unit of smaller value such as polystyrene.

Tight-Fisted Dielectrics

Cda and Rda, in Fig. 1, seem to be seldom considered. They refer to what is known a dielectric absorption, defined as "the absorption of a charge by a dielectric when subjected to an electric field by other than normal polariation".[2] This charge is not recovered instantaneously, and is the source of the "memory effect" observed in electrolytic capacitors carrying substantial voltage. If the capacitor is discharged by shorting it out, a gradually increasing voltage appears after the short is removed. The dielectric is unwilling to give up the entire stored charge, and is equally unwilling to accept the entire charge. Electrically it behaves as if a pure (or even leaky, for that matter) capacitor were shunted by a series RC network. On an AC signal the result is a delayed after-signal especially apparent on transients, with a kind of smearing sound. The problem seems to increase with the dielectric constant. Since it is common practice to use capacitors characterized by high *k* dielectrics, in order to minimize size, the problem is usually more severe with high values. A vacuum would be the best choice, followed by air, but these are obviously impractical so that the best choices would be Teflon (k=2.0) polypropylene (k=2.1), or, more practically because of better availablity, polystrene (k=2.5) or polycarbonate (k=2.9).

Ceramics are out of the question, as I mentioned last month, but even micas, despite their great stability, are particularly prone to high DA problems.

A Practical Demonstration

To get a feel for the validity of these principles, I set about modifying the preamp described here in October '79. C1, in Fig. 3 of that issue, was originally a tantalum unit, a good quality one made by ITT.

The immediate audible effect was like replacing a pickup which is almost mistracking most of the time, particularly the sort of mistracking due to nonlinearity of suspension (some pickups do this on record warps and when tracking force is a little on the high side), with one which is not. Less grit at low levels and increased dynamic range noticeable on peaks. This is without adding any additional bypass in the form of a polystyrene unit, yet. How to do this will require some thought, because of board layout.

C2 was already a Mallory polystyrene unit so it was left alone, but C3, a silver mica with 1% tolerance, was replaced by a Philips 279 Series polystryene.

Input and output capacitors (left out of the original drawing, and nobody caught it) were already large value polycarbonates and were left alone. That just left the 270p input shunt, and the capacitors in the infrasonic filter (not shown) which were ceramic. The 270p was replaced (temporarily) by micas, because that's all I had on hand, and the infrasonic filter removed (also temporarily). Again the results were clearly audible, particularly with regards to that subtle quality known as "transparency". Even gross problems like cymbals and sibilants on certain pops discs which might be thought to break up because of poor recording quality, are cleaned up.

Even more interesting, is the absence of the so-called "Integrated Circuit" type of transistor sound I often heard attributed to the LM381A. Makes me almost consider rebuilding my old tube cascode preamp for comparison.

Say, that may not be a bad idea.

References:
1 *Jung, Walter G., and Marsh, Richard, "Picking Capacitors", "Audio" Feb., March, 1980.*
2 *Reference Data for Radio Engineers, 5th Edition, P. 5-16.*●

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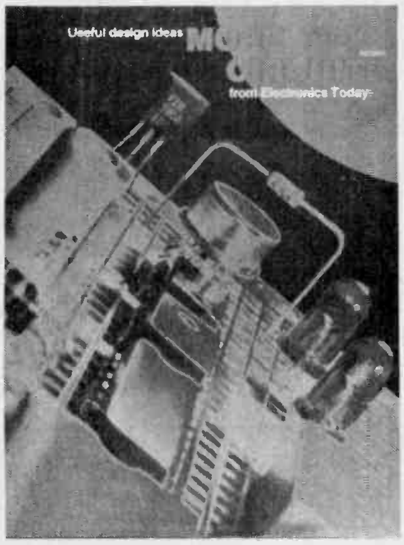

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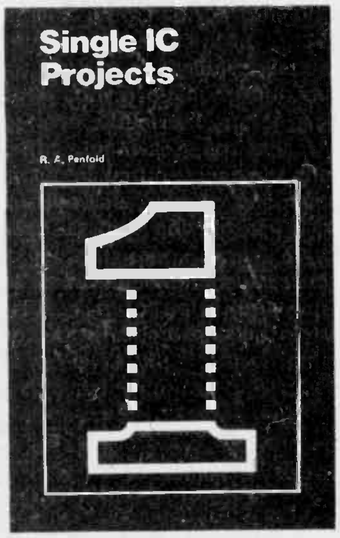

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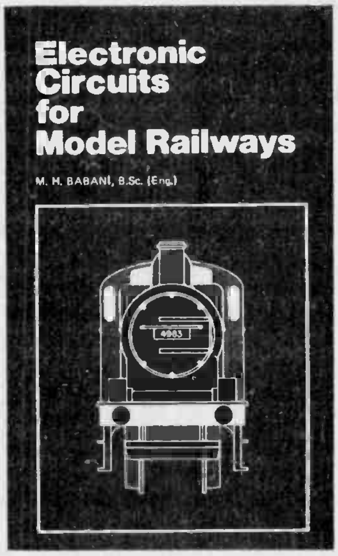

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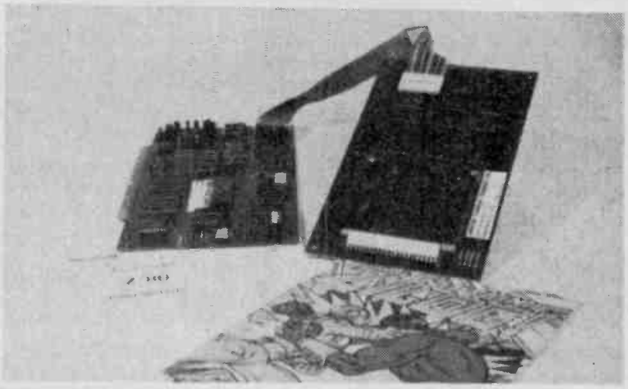

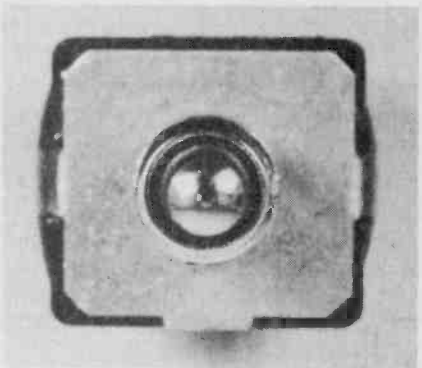

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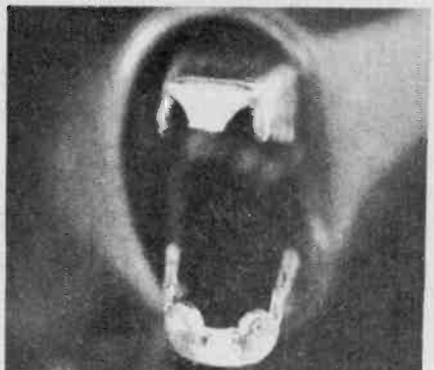

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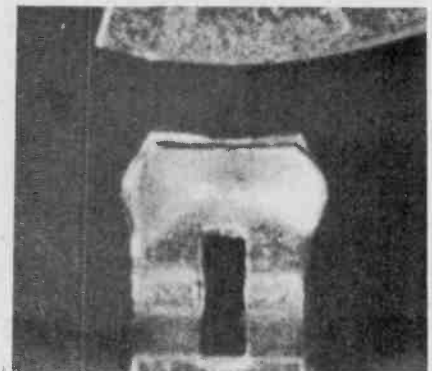

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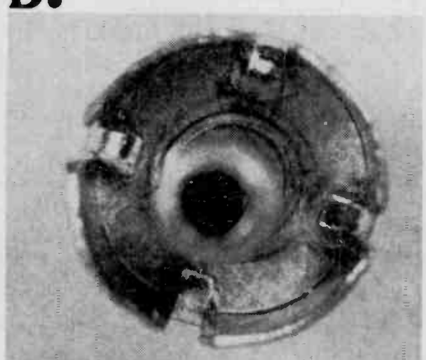

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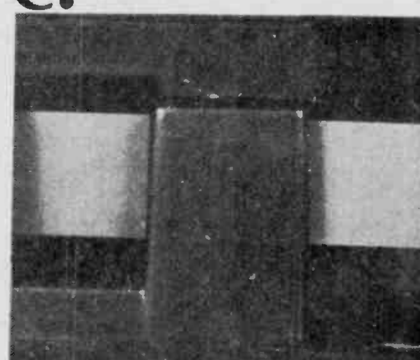

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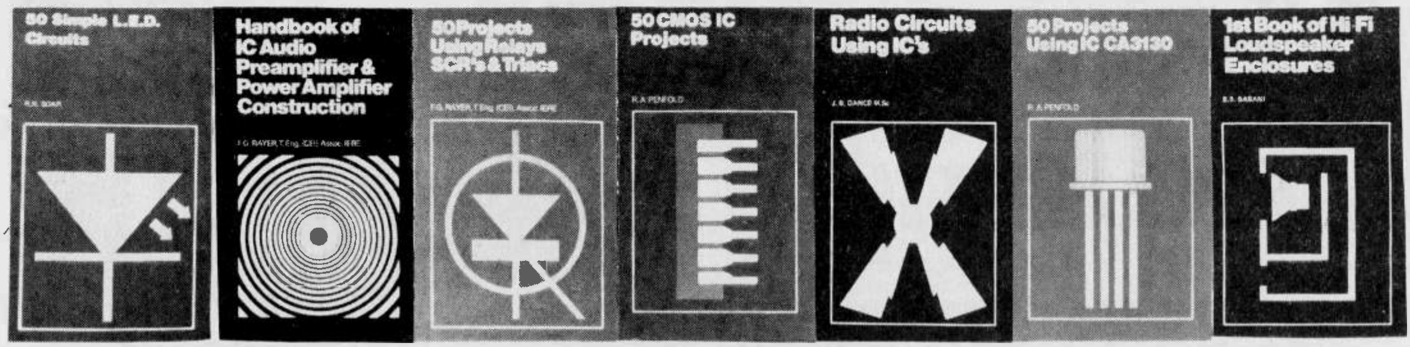

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FEATURE

Microwave Cooking

Much has been said lately on the subject of Microwave Cooking, is it safe, are they cheaper and quicker than ordinary methods of cooking? Find out for yourself. Dr. B. Minakovic takes the lid off the world of microwaves.

The main advantage of cooking by microwaves is speed — anything from two to four times faster than by conventional means. This does not mean that one can improve very much on an electric kettle to boil water, but certainly it will cook a chicken faster than a gas or an electric cooker, despite its lower power rating.

Cooking by microwaves requires some change in cooking habits. For instance, there is no need to warm up a microwave oven before food is put into it, as it is often done with an ordinary oven. Also, there are no more temperature settings to worry about because all cooking is controlled by time.

In contrast to radiant heat, microwaves penetrate almost instantaneously into food and produce heat by agitating the atoms and molecules. The result is fairly uniform heating through the food, but without a crust or surface browning. This may be a desirable feature in some cases, for instance, when warming up or preparing pre-cooked food. When, however some crust or surface browning is necessary the cooking has to be finished off in an ordinary oven.

Browned Off

To obviate the necessity of transferring the food from one oven to another some ovens are fitted with radiant electric elements. In others one can now use a so-called "browning-dish" which is designed to absorb microwaves and hence produce sufficient radiant heat to cause some browning. It should be noted that ordinary glass and pyrex dishes are not heated, being poor absorbers of microwaves. The oven, usually made of stainless steel, is also not heated because metal walls are good reflectors of microwaves. Metal utensils or dishes behave similarly and must not be used in a microwave oven. Apart from screening food from microwaves, they could produce spurious reflections which could adversely affect operation of the microwave source (magnetron) and even damage it.

Condensation on the cold oven walls is prevented by ducting into the oven the hot air from the magnetron cooling circuit, so the vapours are blown out as quickly as they are formed. As a result an oven never gets really dirty and occasional wiping with a soapy cloth is all that is usually necessary to keep it clean.

Defrosting of frozen food is possible, too. This process, however, must not be regarded just as warming up. Ice, unlike water is a poor absorber of microwaves so will take somewhat longer to heat up. If heating is too rapid, water pockets which are formed will enhance local heating, causing hot spots or even burning. This can be prevented by switching the microwave power off and on, so that the heat has time to diffuse from hot spots into the frozen region and there produce more thawing. Typical times are 7-15 sec for "off" and 5-10 sec for "on," the exact timing being determined by the power rating of the oven. The switching sequence is controlled electronically and all that a user has to do is to set the timer according to the quantity of food and depress the defrost button.

Bacteria

The practice of defrosting food by letting it stand overnight at room temperature is rather dangerous, because, once a certain temperature is reached bacteria will start to multiply and food poisoning is possible. This cannot happen with microwave defrosting simply because the time is too short. In any case, there is some evidence that in fact microwaves tend to kill bacteria as most of them are good microwave absorbers. It is important to remember that any kind of food processing involves a certain degree of risk from bacteriological infection, so all food should only be handled in scrupulously clean conditions.

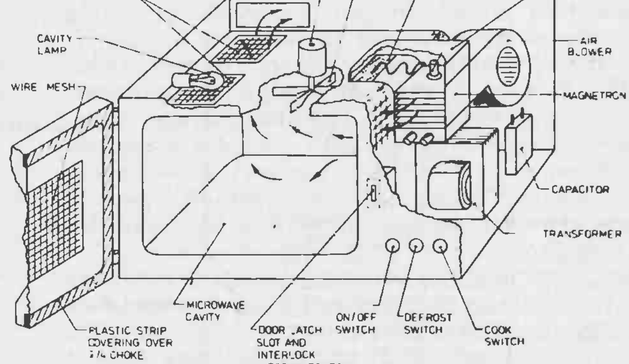


Fig 1. Basic feature of a microwave oven.

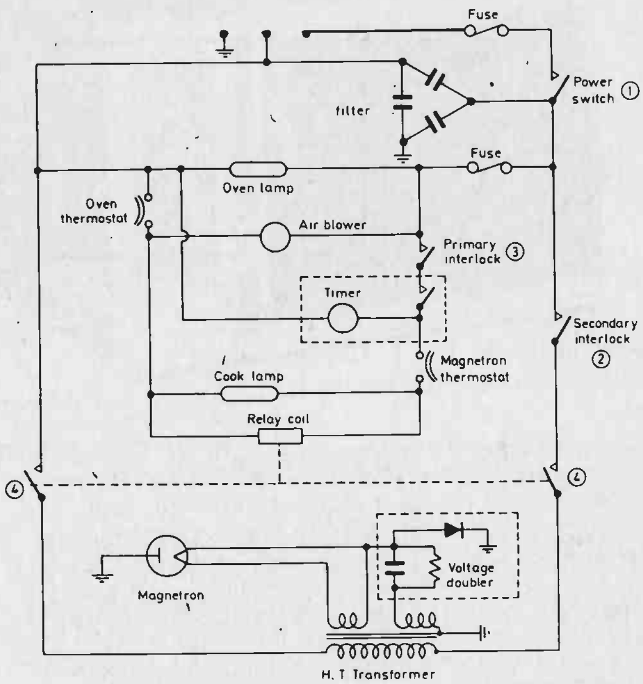


Fig. 2 Simplified circuit diagram of a microwave oven. Magnetron HT of 4.5kV is produced by stepping up the line input to 2.3 kV and a half wave doubling. The doubling circuit, consisting fof a capacitor and a diode, generates a square wave at line frequency. The polariyt is negative so that the anode (magnetron body) can be grounded. The effect of voltage fluctuation is reducedby operating the transformer core near full saturation. the interlock switches 2 and 3 are operated by the door latches and therefore the magnetron is only energized whilst the door is closed.

For clarity, the defrosting circuit has been omitted from the diagram.

How Does It Work?

Radio waves, microwaves, heat, light and X-rays are examples of electromagnetic waves. Although identical by their nature, they exhibit many different properties simply because of their vastly different wavelengths (frequencies). Microwaves, developed during World War II were named so because in comparison with ordinary radio waves, their wavelengths are very small, 100mm or less.

When food or some non-metallic material is placed in a microwave field, the electric field penetrates into it and forces electrons, protons and ions into oscillations along the direction of the field and at the same frequency. Internal friction then produces heating. The rate of heat generation depends on the field strength, its frequency and a parameter tan δ which characterises the "lossiness" of a material. Materials with low tan δ like quartz and PTFE cannot be heated by microwaves. An electric field propagating through a lossy material decays in amplitude at a rate inversely proportional to the square root of frequency.

A microwave field can penetrate several centimetres into the food before it becomes very weak. This distance is known as the depth of penetration. Infra-red radiation (heat), on the other hand, penetrates less than a millimetre and thus heats the surface only and from there the heat spreads inwardly mainly by conduction, a relatively slow process. So, the essential difference between microwave and ordinary heating is that microwaves penetrate deeply into food whereas the ordinary heat radiation is absorbed at the surface.

The internationally allocated frequency band for microwave cooking is centred at 2450 MHz corresponding to a wavelength (λ) of 12.24cm (use $f\lambda = c$, c is the speed of light, 3×10^{10}cm/sec). There is no special reasons why it should be exactly 2450 MHz. A few hundreds of MHz up or down would hardly matter as far as the cooking or the depth of penetration is concerned, and equally the rate of heat generation would be hardly affected. The main reason for this allocation is that this band is not much good for anything else and it does give a reasonable depth of penetration.

Magnetron

The essential features of a typical modern microwave oven are show in Fig. 1. The microwave cavity, as the oven itself is usually called, is a rectangular metal box, large enough to accommodate an oversized chicken. Microwave power is fed in at the top through a large slot via a short waveguide with a magnetron antenna at the other end.

On entering the cavity microwaves spread out in all directions and undergo a series of reflections from wall to wall, passing through the food on each transit. The situation is analogous to a beam of light in a closed box with mirror walls.

Furthermore, as in the case of light, destructive or constructive interference will take place between the overlapping waves and providing the cavity dimensions are the multiples of the cavity half-wavelengths, there will be set up a three-dimensional standing wave pattern. In technical terms, the cavity is said to be resonant. Fig. 3 shows such a standing wave pattern of the electric lines of force.

Food or any other object in the cavity will distort the standing wave pattern, but nevertheless the cavity may remain resonant simply because the Q factor will be reduced too, and so the resonant range will be widened.

The heating pattern of a cavity corresponds to the electric field pattern: strong heating in the regions with strong electric field and no heating at all where the electric field falls to zero. Clearly, an oven producing an array of cold and hot spots whould not be very satisfactory for cooking. Fortunately, the heating pattern can be smoothed out by perturbing the electric field with a small metal propeller or "the mode stirrer" as it is usually called. As the name suggests, the mode stirrer moves the electric field standing wave pattern to and fro, so the cold spots at one instant become hot at the next and so on. Of course, in addition to this heat will also spread out by the ordinary conduction process. The mode stirrer is always mounted on the ceiling of the cavity and protected from accidental damage by a plastic sheet of low tan δ. Some manufacturers prefer a turn-table for the food to a mode stirrer, the others fit both.

Power for a microwave oven comes from a magnetron. Typical microwave power rating is 500 W for a small domestic oven, increasing to around 2000 W for a catering model. The nominal guaranteed life of a small megnetron is 1000 hours, but experience shows that with careful use, this can be doubled or even trebled. In any case, bearing in mind that a microwave oven runs only for relatively short periods, 1000 hours can be equivalent to about 3 years of normal use.

Efficiency

The efficiency of cooking magnetrons ranges from 50% for small units to about 75% for bigger ones. Although cooking magnetrons are designed to tolerate large load variations, an oven must not be run empty because microwaves would be reflected back into the magnetron and cause damage by overheating the cathode or the ceramic seals. Some microwave ovens are fitted with a manual power control for reducing the power output when the loading is very light — otherwise the loading should be artificially increased by putting into the oven a small cup of water.

Microwave leakage from an oven occurs mainly through the door seals and the window wire mesh. There may be also some leakage through the poor joints in the box due to poor shielding of the magnetron HT terminals.

The leakage between the door and the cavity flange is prevented by incorporating into the door frame $\lambda/4$ chokes, see figure 4.

When a wave leaking through the small gap between the door and the cavity flange reaches the slot B it is almost completely reflected back because of the discontinuity. By the time it reaches again the input plane A the wave will have travelled a total distance $\lambda/2$ and therefore it will be in the antiphase with just incoming wave and hence cancel it. In terms of impedance, the input plane A behaves as a short circuit. A small fraction of the wave that leaks past the discontinuity at B

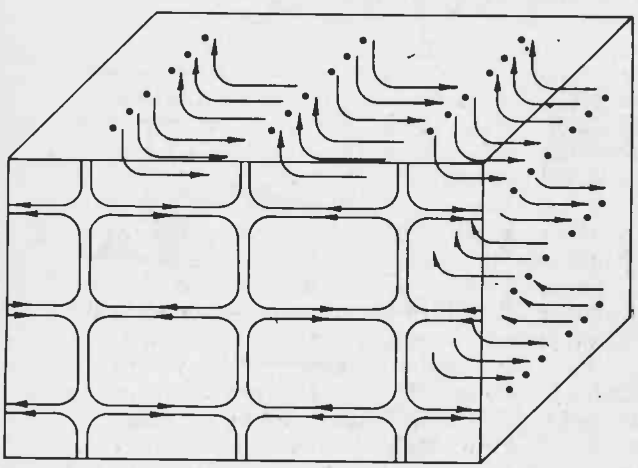


Fig 3. The electric field standing wave patterns in a microwave oven.
The arrows indicate the direction of the electric field at an instant of time – they are reversed once every cycle, 2450 million times per second!

continues to the short circuit C where is reflected back to B. Any leakage from B to the outside is suppressed by the lossy rubber strip, mounted along the edge of the metal box. The $\lambda/4$ choke slot is normally covered with a plastic insert to prevent accumulation of dirt.

The door window is not absolutely necessary but it does help one to follow the progress of cooking in the lit-up oven. A wire mesh is used to prevent radiation through the window. The mesh is protected from accidental damage and from dirt by plastic sheets on both sides of the window.

The interlocks operated by the door latches are another very important safety feature. They ensure that the microwave power cannot be switched on whilst the door is open even if the cooking switch is depressed.

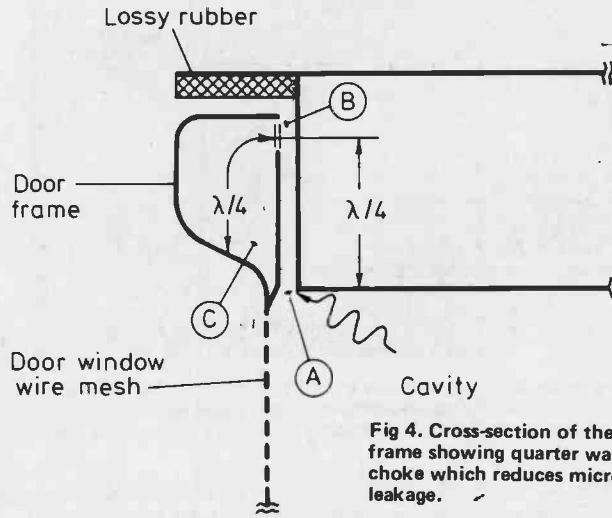


Fig 4. Cross-section of the door frame showing quarter wave 4 choke which reduces microwave leakage.

Microwave hazards arise mainly from internal heating and should not be confused with radio-activity which is far more dangerous. Eyes and genital organs are very sensitive to microwaves and can be damaged by fairly small doses. Prolonged exposure to microwaves can result in eye cataract, a condition in which the lens of the eye becomes clouded.

There is considerable disagreement as to what is the safe power density. The generally accepted figure is about $10mW/cm^2$, although some sources claim that this is still too high. Microwave ovens are normally designed for $1mW/cm^2$ or less and if necessary this could be even further reduced by another factor of 10 — at a marginal increase in the price.

Of course, a damaged door flange can increase the leakage above the permitted level and there is no way of detecting it without a leakage meter. A good practice is never to put one's face into the door window and to operate the oven from an arm's-length distance. Then, even if something does go wrong one will be fairly safe.

Testing Microwave Ovens

Power test — Pour exactly 1 litre of water into a plastic beaker and having measured the water temperature, heat it in the oven for exactly 4 minutes. On removal, stir the water lightly with the thermometer and again measure its temperature. Calculate the temperature rise from the two readings (in °C) and multiply it by 17.5 to obtain the microwave power in watts.

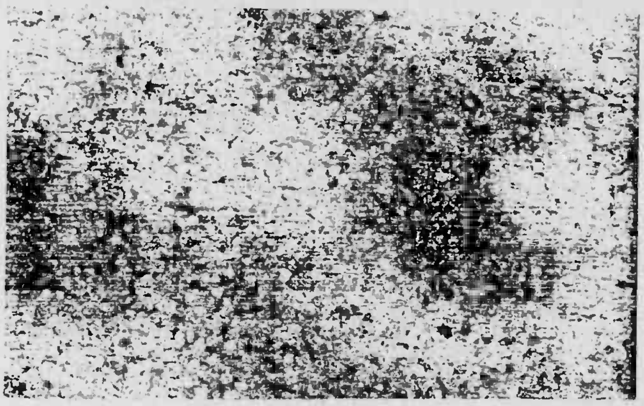
If the measured temperature rise is too large for the thermometer available, use two litres of water or half the heating time — in either case use 35 as the conversion factor.

Checking Uniformity Of The Electric Field

When a small neon lamp is put into a microwave field it glows bright red if the field is strong enough to ionize the gas in it. This fact is used here to sample the electric field in a microwave oven.

Bed the neon lightly into a lump of plasticine, its leads pointing upwards to act as an antenna. Normally the leads are too long and should be reduced to about 2cm or less, so that the lamp is not overheated.

If necessary, sensitivity can be improved by bending the leads apart, to form a Vee. This type of an antenna is



Heating pattern in a microwave oven (recorded in a horizontal plane 4 in. above the cavity bottom). Dark areas indicate strong heating, light areas weak or no heating. (Courtesy Western Dynamics Ltd.)

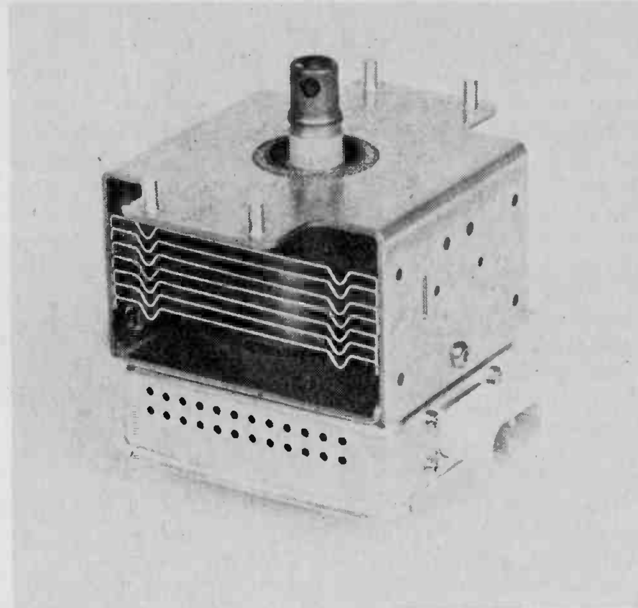
directional, so try various orientations and positions.

If several neons are available stick them on a strip of perspex, about 2cm apart. An oven must never be run empty so do this test with a cup of water in it.

The leakage field outside an oven is far too weak to ionize the gas in a neon lamp and no glow will be observed.

Warning

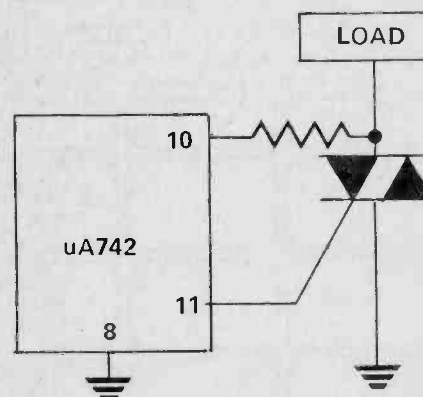
In operating a microwave oven always follow the maker's instructions. Do not remove the covers because this will not only expose high voltage terminals but also increase the microwave leakage.



Output power 840W. Peak operating voltage 4.5 kV. Average anode current 350 mA. Cooling by blowing air through fins. Focussing by ferrite magnets.

Also do not poke wires or sharp objects into the door seals or cavity perforations for this can significantly increase the microwave leakage.●

FEEDBACK



In your position I'm sure you must have access to a schematic for a Fuzzbuster S/N M144799. I realize this is an unusual request, but quite often I have read unusual articles in your magazine. I enjoy these very much and have for 3 years now. I certainly hope you can do something for me.

L. Brassard
VE6LE
Leduc, Alberta

Sorry, it's too unusual a request. Assuming you want to build one yourself, the material in the article and a copy of the ARRL Amateur Radio Handbook should be sufficient to design your own (Microwave Associates would be a good source of antennas).

If you're still hot on a schematic, we suggest you either write direct to the firm or buy a unit and take it apart.

I noted your letter regarding the Philips LP1186 FM tuner module. I have a number of these left over from a project our students built some time ago. If anyone is interested in obtaining any they can write to me at the College.

D.B. Hutchinson,
Chairman, Dept. of Electronic & Electrical Studies.
Mohawk College
Box 2034
Hamilton, Ontario L8N 3T2

I would like to inform you that the Circuit on Page 56 – Figure 34 of February ETI is wrong in connecting the Sync Input Pin 10 directly to the load. Not only would the circuit not work but, also this would destroy the I.C. instantly.

Sam Del Giudice
Brampton, Ontario

You're right! Somehow, the synchronization resistor, Rsyn, was left out. Typical values for Rsyn are 10k for 110V input and 22k for 220V work. Thank you for bringing this to our attention.●

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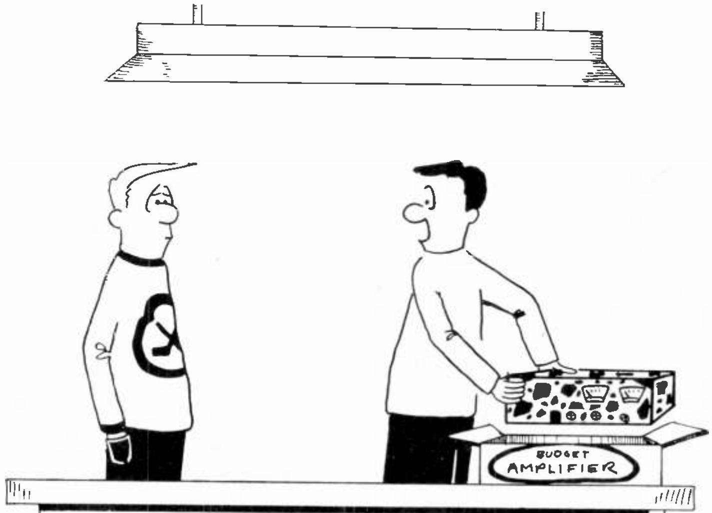
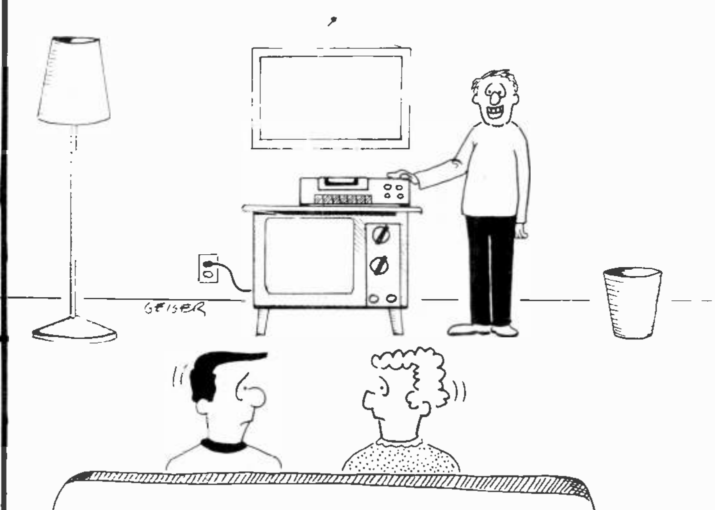
THE FUN OF ELECTRONICS

By Geiger.

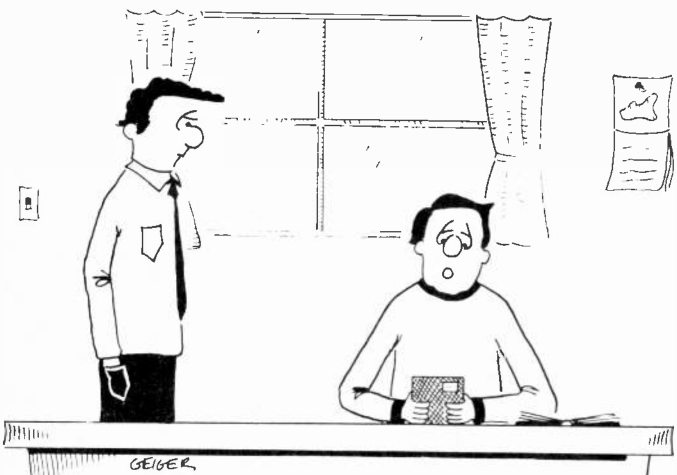


I can't wait to check out this new amp; the salesman said it had great specs.

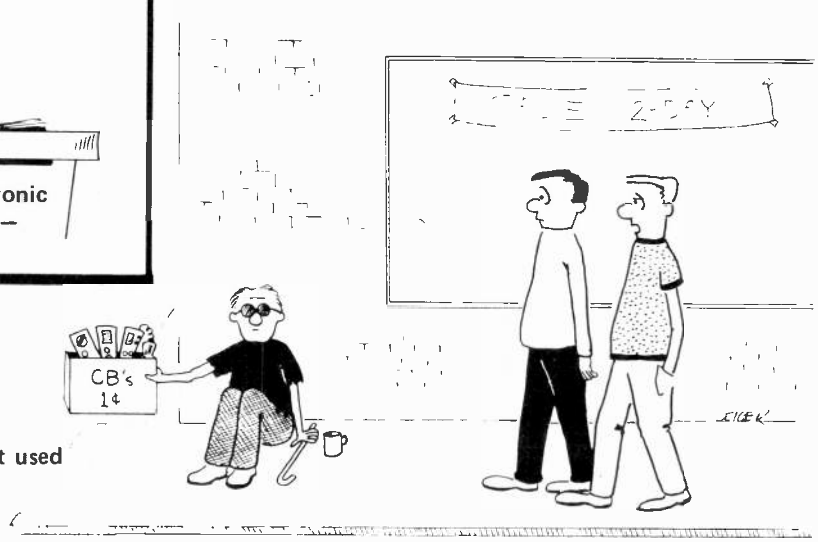
It's my home made version of a bubble memory — I get 16 kilobytes of ROM for every box of "Mr Suds" I throw in.



Well, Bob and Harriet, true to my word, I'm not going to bore you with any more dull home movies. Now, sit back and enjoy these videocassettes I made of little Alan Jr. waving hello.



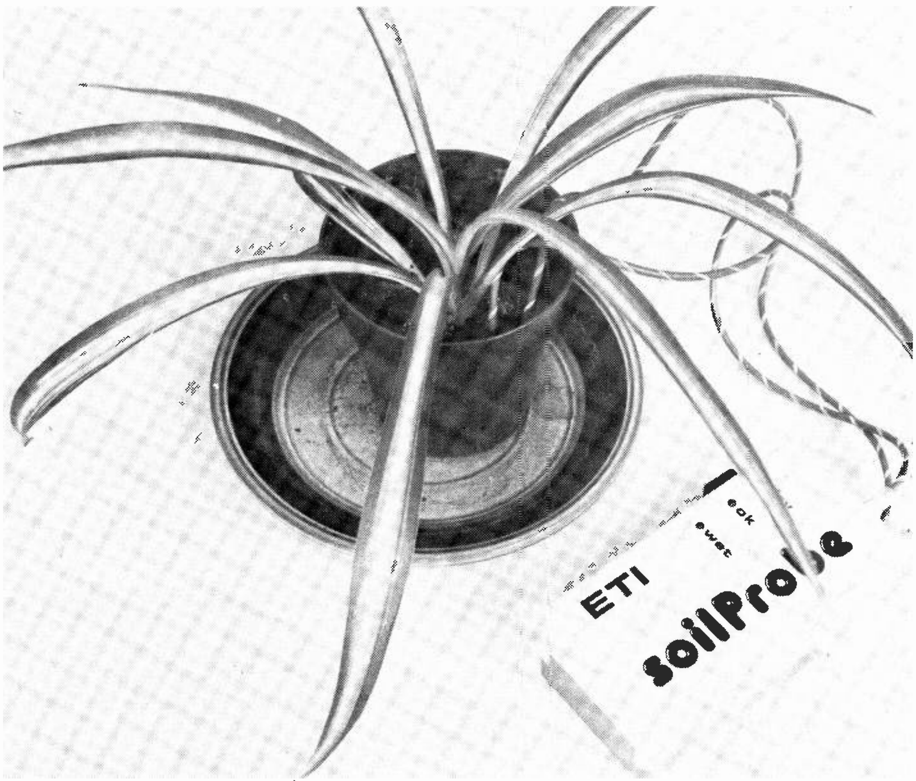
I bought one of these French — English Electronic Translators, but I don't know how to use it — the instructions are in Japanese.



Yessiree — The CB industry isn't what it used to be.

SOIL MOISTURE DETECTOR

Check out the roots scene with this ETI soil probe and have happier, healthier plants.



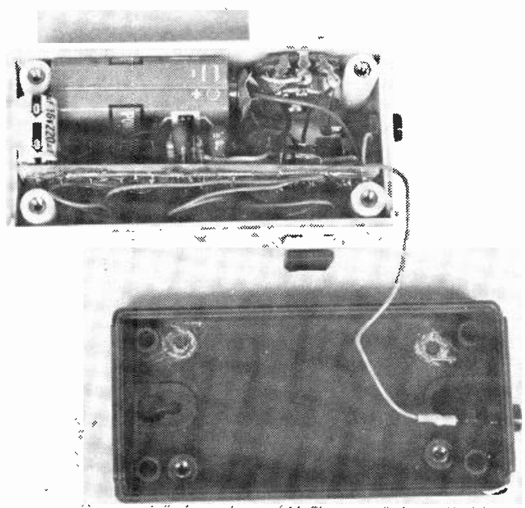
THIS COMPACT UNIT enables you to accurately check the moisture content of your plants' soil in one simple operation. Its range and sensitivity may be adjusted to complement the most fastidious horticulture and horticulturist. The unit works by measuring the resistance of the water in the soil between two probes and comparing it with a previously selected internal resistance adjustable between 1k and 250k.

A Better Buzz

A small 9 volt battery powers the circuit which is built around a few cheap CMOS chips and a low power quad op-amp. To avoid undesirable electrolytic effects at the probes, the resistance bridge is AC energised. We don't known if the plants like this but we have had no complaints. The probes may be made of any conducting material or just tinned copper wires placed in the soil a few inches apart and a couple of inches deep. The circuit will tolerate wire leads up to a few feet in length and no special screening is required. A three level comparator whose pass range is internally preset indicates whether the soil is too wet, dry or OK and the required resistance is set by adjustment of a case-mounted potentiometer.

Construction and Use

Construction is straightforward provided care is taken and attention paid to the polarity and orientation of the diodes and capacitors. Wire links should be inserted first, note that some of these are mounted under the integrated circuit sockets, followed by the sockets



What is it that is on the inside. ETIs Soilprobe exposed themselves, resistors, capacitors, transistor and diodes. The ICs should be inserted last after the off-board components have been connected. Also ensure that the flying leads have all been soldered into place and that the LEDs are connected correctly. A short lead, indent or flat on the plastic encapsulation usually indicates the cathode. We used miniature LEDs, two red and one green. However, any desired colour may be used. 2mm sockets were used to connect the probe leads and the power source was a 9V battery.

Some difficulty will be encountered in inserting Q1 as the base and collector leads have to be reversed. Use spaghetti insulation to prevent shorts.

In use, the unit is turned on; the probes plugged in, and RV2 adjusted until the OK LED lights. This setting may be noted and recorded on a calibrated scale. As the probes are simple and cheap to make they may be left permanently buried in the soil and a set made for each plant, facilitating the repeatability of measurements.

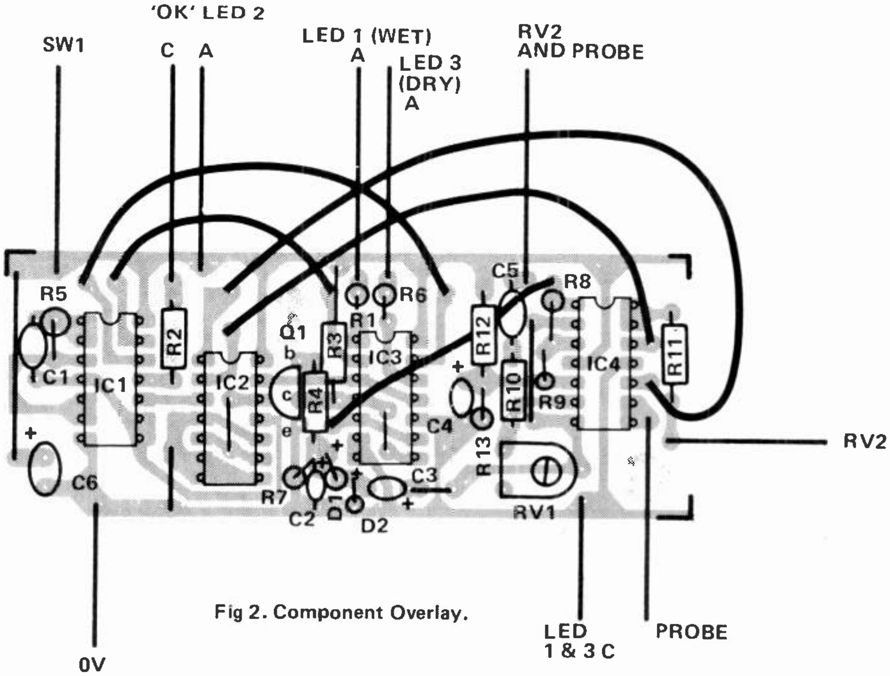


Fig 2. Component Overlay.

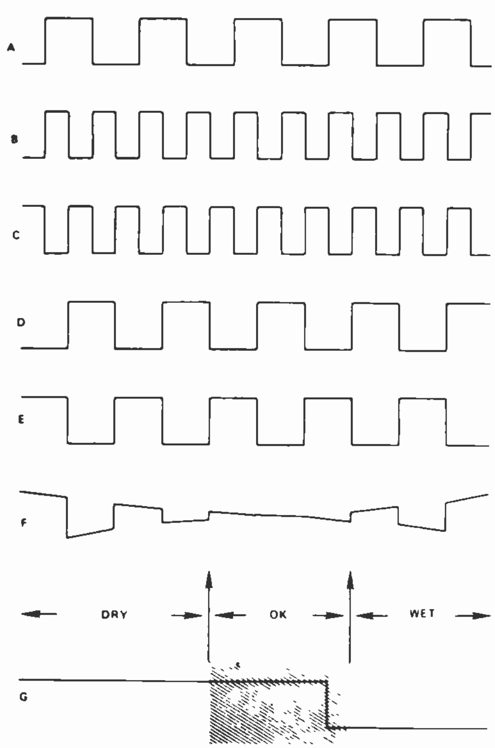


Fig 1. Waveforms associated with the ETI Soil Moisture Indicator, resulting in an LED display of whether the soil is wet, OK or dry.

HOW IT WORKS

The circuit consists of an AC energised bridge whose two active arms are formed by R11 plus RV2 and the soil resistance between the probes. Its operation may be best understood by reference to the circuit diagram and Fig.1. IC1a and IC1b are configured as an astable oscillator whose squarewave output (Fig. 1b) clocks IC2a. This signal, inverted by IC1c (Fig.1c), clocks IC2b.

The antiphase Q and $\bar{Q}$ outputs of IC2b are buffered by IC4a and IC4b whose outpits (Fig. 1d and 1e) drive the resistance bridge formed by R11 plus RV2 and the soil resistance between the probes. R11 protects the amplifier outputs against inadvertent short circuits.

The output of IC2a (Fig. 1a) is a squarewave of the same frequency, phase shifted by 90 degrees. This means that the edges of the waveform are coincident with the centre of the squarewave from IC2b (Fig 1d and 1e) and facilitates phase detection by IC3a and IC3b. When the soil resistance measured between the probes is equal to the resistance of R11 plus RV2, the signals from IC4a and IC4b will cancel out. However, when an imbalance occurs, there will be an error signal whose phase will depend on whether the soil has a greater or lesser resistance than the other arm of the bridge. The amplitude of the error signal will also diminish as the bridge approaches balance (Fig. 1f).

This signal is coupled via C5, R10 to amplifier IC4c and squared up to provide CMOS input levels by schmitt trigger IC4d, where it is input to IC3a and IC3b and clocked in by the signal from IC2a. The outputs of IC3a and IC3b will follow the phase of the input; reflecting the state of imbalance of the bridge, and either LED 1 or LED 3 will be lit (Fig. 1g).

The amplified signal from IC4c is also fed via C3, D1 and D2 to C2 which will acquire a charge proportional to the level of the input. This drives Q1 which controls the direct, clear, and set inputs of IC3a and IC3b respectively. When the input signal is insufficient to turn on Q1, these inputs are driven to their active high state by R3.

This causes both LED 1 and LED 3 to extinguish and the condition (shown shaded in Fig. 1g) is detected by nand gate IC1d whose output goes low causing LED 2 to light. The sensitivity of the circuit to this condition is preset by adjustment of RV1 which controls the gain of IC4c. The required soil resistance is set by RV2. The circuit is powered from a 9V battery decoupled by C6. A mid voltage point is provided by R12 and R13 decoupled by C4.

PARTS LIST

RESISTORS		POTENTIOMETERS		SEMICONDUCTORS	
		RV1	470k preset	IC1	4011B
R1, 2, 6	820R	RV2	250k lin	IC2, 3	4013B
R3, 4, 10	100k			IC4	LM324
R5	10M	CAPACITORS		Q1	2N3904
R7, 12, 13	10k	C1	1n	D1, 2	IN4148
R8	1M	C2	4u7	LED 1, 2, 3	0.125"
R9	100R	C3	10u	MISCELLANEOUS	
R11	68R	C4	22u	PCB	
		C5	220u	SW1	SPST

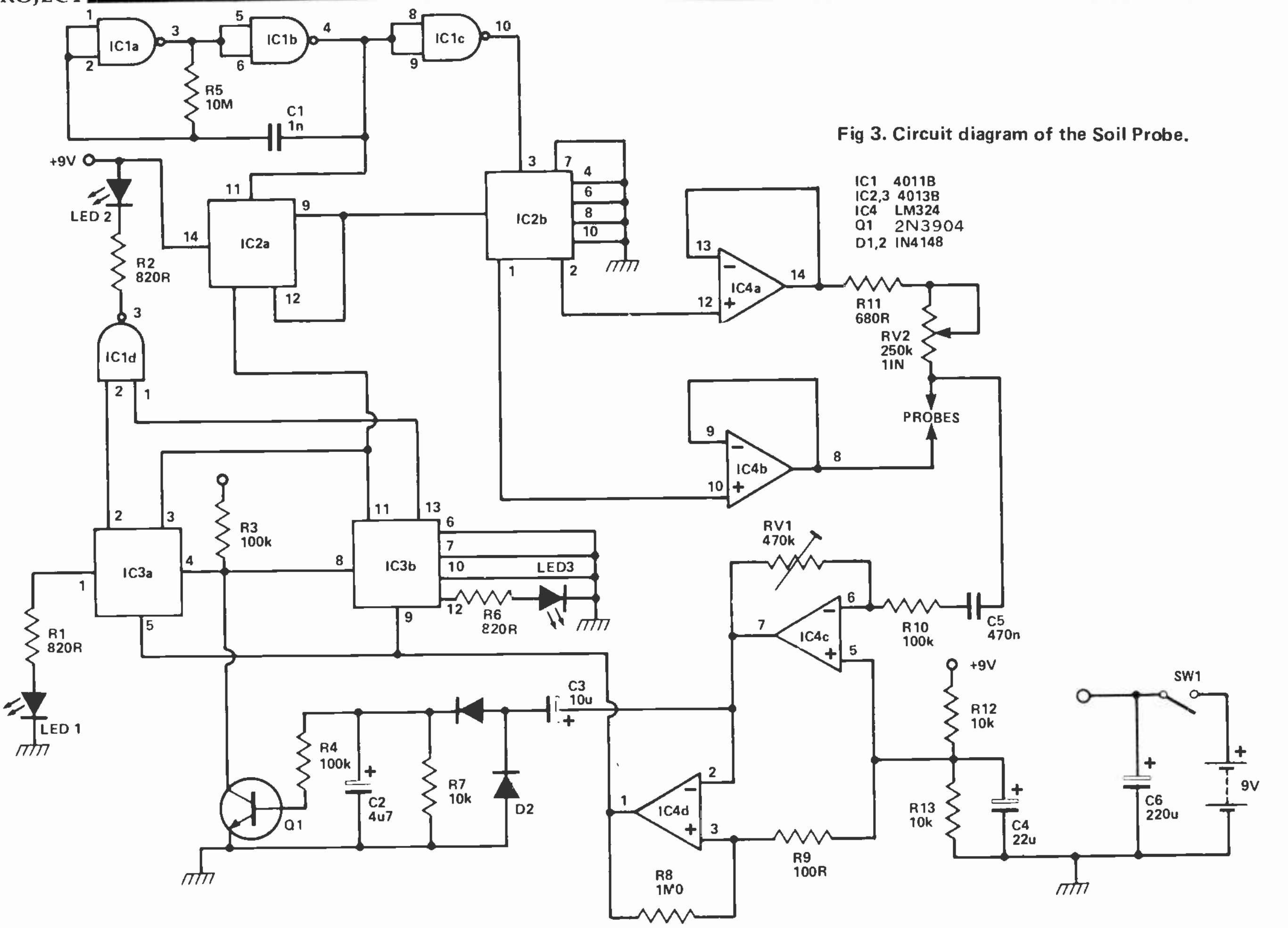
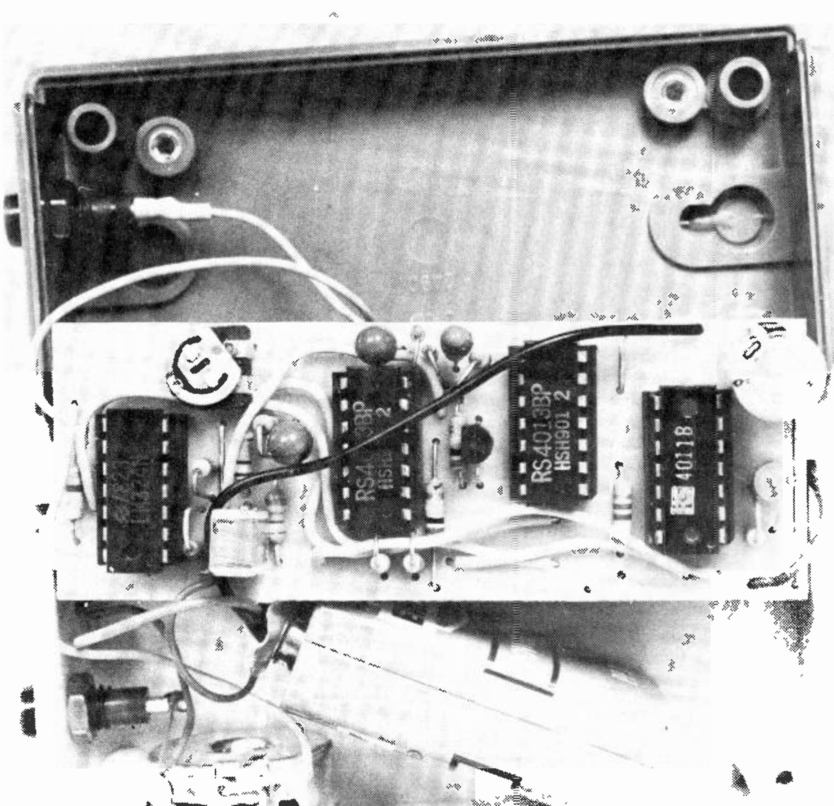
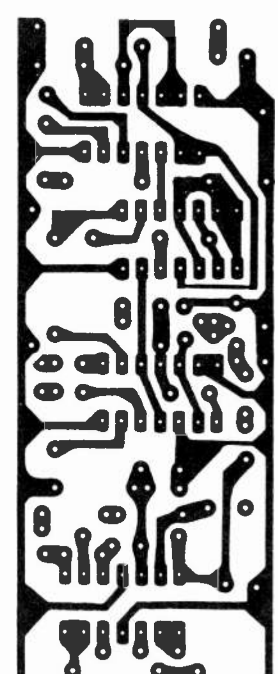


Fig 3. Circuit diagram of the Soil Probe.





An internal view of the Soil Moisture Indicator, showing the position of the four IC's.

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CSA

IN 1914, THE WORLD was at war and although Canada did not field an independent armed forces, we did send troops overseas as part of the British effort. Canada also contributed to the material and equipment aspect of the war effort. It was essential that British and Canadian equipment be built to the same standards and specifications to ensure compatibility so the British Government on behalf of the British Board of Trade and the British Engineering Standards Committee, requested the formation of a Canadian Engineering Standards Committee. This was formed in 1917 at an informal meeting in Montreal with representatives from both the private and public sectors. By the following year the war had ended, thus proving the effectiveness of the committee.

The value of agreed-upon standards had been established and on January 21 1919 Letters Patent were issued by the Secretary of State incorporating the General Meeting held in Ottawa on June 4 1919 chaired by Sir John Kennedy, the first chairman.

In 1920, the Association published its first standard, No.1920-1, a Specification for Steel Railway Bridges.

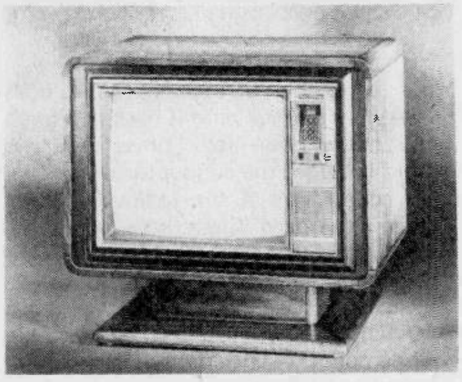
Diversification

CESA may have been born in war and made its debut dealing with the railways but in no time found itself dealing with cement, electrical power, welding, bricks, bomb shelters, elevators . . . just about everything you can imagine.

1927 saw the publication of the Canadian Electrical code, dealing with power operated radio devices. At this time only a handful of radio stations were on the air and electrical recording was only three years old.

CESA standards were adopted in 1933 by the Department of Public Works, Canada, stipulating that these standards were to be adhered to in all government contracts.

By 1939 we were again at war and CESA formed a special committee to deal with material substitution in War Office contracts, primarily in the area of steel ordnance and aircraft construction. It was also during the war that the Approvals Division was established to deal with electrical equipment for sale or installation in Canada. Although the Association did not have its own testing laboratories, the Hydro-Electric Power Commission of Ontario shouldered this function.



All consumer equipment today carries the CSA seal of approval.

The war years also saw specifications on bomb-proof shelters, aircraft, wood screws, plus work in the area of conservation of strategic materials. In 1944, the Association's name was changed to "Canadian Standards Association" and two years later the familiar trademark of the large letter "C" enclosing the letters "S" and "A" was registered and has continued in use, unchanged, ever since.

What It Is

CSA is a non-profit independent, voluntary organization engaged in the developing of standards and essentially provides what it describes as *"Services in support of Standardization".* It is funded by the sale of standards – that is books or booklets, specifying a standard – membership fees and fees charged for product testing. That's right, a manufacturer who wishes to have his product tested pays for the service, just as he would any other testing laboratory. A standard is any technical document which outlines specific product charateristics such as safety and/or quality.

Membership is open to manufacturers, governments, and individuals.

What It Does

CSA is active mainly in two areas. The first involves the writing of standards. These are written by committees consisting of experts in the area to which the proposed standard will apply, as well as users and, where applicable, regulatory authorities. These committee members are all volunteers. They are not compensated for their time.

A committee may be formed when the Association is approached by an organization such as a consumer group, government department, or trade association requesting the formulation of a standard. If, upon investigation, a need becomes apparent, the appropriate committee is formed.

What It Isn't

Let's clear up some misconceptions about CSA's function. There is a widely-held belief that CSA is some kind of regulatory body with the power to permit or deny the right to manufacture and/or sell some product in this country. Some people believe that CSA certification is an indication of performance quality, much like Good Housekeeping Seal of Approval. Neither is true.

In Ontario, for example, it is unlawful to sell any device intended for operation from power lines unless that device is approved by Ontario Hydro. Ontario Hydro will inspect any product upon request, and for a fee. But this is not too practical for mass produced goods. Ontario Hydro authorized CSA to write its electrical safety code, or, to be more precise, adopted the Canadian Electrical Code, as written by CSA. Therefore, any equipment which has been certified by CSA is approved by Ontario Hydro.

Similarly with other products such as Hockey Helmets, and automobile seat belts. Some hockey leagues have stipulated that only safety equipment which has been CSA approved may be used.

If a product is unsafe, or otherwise does not conform to CSA standards, CSA has no power to order its withdrawal from the market, nor can it prosecute the seller or manufacturer, except inasmuch as any private citizen or corporation may have that right, even when the sale of such a product is unlawful because of non-compliance. The only power CSA actually has is that afforded under the Copyright Act if the CSA symbol is used, or if approval is fraudulently claimed or implied. This is a right of any copyright holder, and is no different from anyone using, for example, the ETI logo, or an ETI Project circuit board pattern (which is protected by copyright). At the same time, a complaint to CSA can result in an investigation and recommendations to the appropriate authorities.

Although CSA will not certify something which does not work, or is obviously grossly defective, the Association's concern is not really with the general quality of a product, except inasmuch as it affects the safety of using it. Many products which wouldn't make state-of-the-art status if they brought back bustles may still meet standards and will be approved. If they're not very good, the market-place can deal with them. Even if specifications are, shall we say, optimistic, there are other government agencies to deal with misrepresentation or misleading advertising.

CSA does not, for example, tell a manufacturer that he may or may not use polystyrene capacitors in an amplifier, or that a moving coil preamp may or may not use an input transformer. It does, however, impose standards as to whether a shock hazard exists, and whether such devices may be used in a particular way, based on whether or not such a hazard will result, or whether either a shock or fire hazard would result from the component's failure.

The essence of all this is safety. In the case of electrical equipment, concern is whether or not a shock hazard exists, or whether a fire hazard results from the use of a given design or manufacturing technique, or materials.

In the case of safety devices such as crash helmets, seat belts, safety glass, etc, product quality is an integral part of the primary function of the device: to protect. Obviously, a hockey helmet which shatters or indents in such a way as to result in a head injury if struck by a puck is not doing its job, and is clearly unsafe.

Testing

Imagine a group of men in white coats, earnestly studying a panel of meters while some device applies specified pressure against a piece of plastic of specified thickness and shape, then noting the pressure in p.s.i. at which penetration occurs. Or, at the other extreme, pouring gasoline on a television set, then attacking it with a blow-torch to see whether it will catch fire. Both extremes are samples of some of the images of CSA testing procedures which I have heard from time to time. After seeing the labs in operation, I can attest to the fact that, although such routines would look great on the Second City Revue, and Professor Waynegartner would have a great time with them, that ain't how it's done, Jack.

How, for example, do you find out how resistant a power cable is to flexing? Well, you and I would probably try bending it back and forth and count how many times we can bend it before the conductor(s) open(s). How does CSA do it? They bend it back and forth and count how many times they can bend it before the conductor(s) open(s). Of course, it's a bit tedious to have someone sitting there bending a wire back and forth, and, besides, he might lose count after fifty-thousand bends, or so, so the cable is attached to a machine which does the bending, all the while counting automatically and monitoring continuity.

A lamp is intended for use underwater in a swimming pool. Is it waterproof? How do we find out? Simple: put it at the bottom of a tank full of water, at the depth of a swimming pool, then check for water entry, and leakage resistance.

Or how about bullet-proof glass. It would be possible to measure surface strength and plot it against the momentum of a bullet of specified mass at a given velocity. But a simpler and more reliable approach is to set up the glass, and shoot bullets at it from a gun. If it's supposed to withstand a .44 Magnum at twenty feet, then that's what you use. One refinement is to provide the means of measuring the bullet's velocity at a particular distance from the muzzle.

In other words, standards are established which take into consideration the real world as much as is humanly possible, and tests are carried out under conditions which resemble real in-use conditions as closely as possible. For this reason, standards and testing methods are constantly undergoing re-evaluation and modification so as to conform more closely with real world changes. Which is why, for example, you can now buy power tools with two-terminal power plugs and double insulation, and yet only a few years ago all power tools had to have a U-ground connector.

Certification Procedure

In order to be CSA Certified, its compliance with the appropriate technical standard must be ascertained.

The applicant, who may be the manufacturer, or the importer, or even a distributor, makes application on an official form, on which he outlines details about all products which the application is to cover, the name and address of any manufacturing plant which will produce certified versions, and the name and address of the company which will be responsible for the Certification contract. This latter provision would apply to the manufacturer who might subcontract the actual manufacture.

Foreign produced goods require certification also.Often this can be obtained in the country of origin.

An estimate is made as to the cost of processing the application, and a deposit is paid with the application. Charges are made for services rendered, calculated on a time/cost basis.

The applicant supplies a representative sample of all products to be covered by the application. These are used for test purposes.

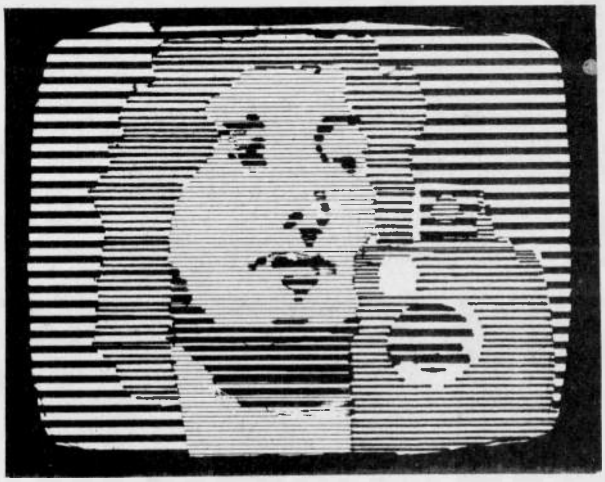
In addition, CSA may wish to inspect the manufacturing facilities to ensure that the applicant is able to maintain standards on a continuing basis, and from time to time may select production samples for testing to ensure that standards are maintained. This may be simply a spot check, or the result of consumer complaints. It is quite possible for a product to be de-certified.

At the present time CSA maintains standards and certifications facilities in Rexdale, a Toronto suburb, and Ottawa, with regional offices throughout Canada. To make life easier for importers and their suppliers, there are agencies in Great Britain, the Netherlands, and Japan, as well as inspection offices in Taiwan, Singapore, Hong Kong, Korea, India, Australia, and New Zealand. This allows for certification at the place of manufacture, ensuring easier access to the Canadian market.

CSA also publishes a quarterly bulletin for members called CSA + The Consumer containing information on product safety, new standards, updating, etc. More information can be obtained by contacting Peter James, Canadian Standards Association, 178 Rexdale Blvd., Rexdale, Ont., M9W 1R3.

And if you don't like a particular standard, don't stand around bellyaching about it. Write to CSA and say so, stating your criticisms. It might result in a revision.

Many thanks to Peter James, director of Public Relations, and especially Tom Higgins, Manager CSA Laboratories, for the time spent showing me around the labs. Including areas Tom was ordinarily reluctant to tour. I took a lot of time out of his busy schedule.●



WHAT'S ON

Befuddled by video cassette software copyright. Steve Rimmer rationalizes. . .

THIS IS A FABLE, which is to say that while it represents within itself supposed truths, it in its entirety, is not represented as being true. In other words, it's a lie, but a true one.

This fable goes:

Some time ago, it seems that there was this Roman soldier, who had been charged with carrying a message from Carthage to Tiberias (the city, not the person). He was trotting briskly along, when he came upon a Samaritan, who, because fables are largely rigged, happened to be bound for Tiberias as well (again, the city, not the person). Thus it was that the soldier and the Samaritan were on the road to Tiberias (see above if you're still confused), when they came upon a cave, and, outside this cave there was a sign which read, "Danger, Monster Within. All who enter will be dismembered, clawed to death, and devoured", or words to this effect. This rather upset the soldier, who inquired of the Samaritan what sort of monster could be so fearful, in the cave of which we have been speaking. The Samaritan scratched his head, and admitted that no one actually knew what the monster was like, because, with that sign by the entrance, no one with any sense would go inside to check it out. It would seem that this did not exclude the soldier, for he declared that no monster was a match for a soldier of Rome, rushed inside, and was never heard from again.

Now, there is an appendix of sorts to this fable. There was, of course, no monster in the cave. There was the back door to a harem, which the local potentate had never seen any good reason to lock, because of the wonderfully clever sign. The soldier died about a month later of exhaustion.

The harem, sad to say, has vanished with time, as has the road, the Samaritan, most of Rome . . . strangely, though, the sign remains. It's a bit weatherbeaten, and the characters are somewhat indistinct so they now seem to read "Warning. This recording is protected by copyright. Unauthorized duplication prohibited by law".

This is of course, only a fable, and, as stated previously, is a lie.

Users Beware!

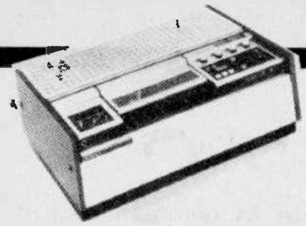
This month's topic is a rather untechnical one; the slimy and most untractable problem of copyrighting video software. It's unpleasant because, unlike something really simple, like building a satellite downlink, there is not a huge number of finite, "nail down-able" quantities in the situation . . . it is largely comprised of murky grey areas. Furthermore, as we shall see, for the individual software consumer, "we what buys de tapes", the question is not so much one of copyright law as one of consumer ethics. This last phrase may seem like a contradiction in terms; consumers, we have come to believe, can afford no ethics. However, as this thing develops, I hope it will become at least muddily apparent that, in this case, imposing upon ourselves a "moral" type of code is almost mandatory, in an area where, for several pragmatic reasons, the law is ineffective. One may look on the situation in that the law keeps one from getting away with something, but ethics keeps one from getting caught.

Ya, me slithy toves, 'tis time fer a big frosty mug o' vile, viscous philosophy. Down th' 'atch wi' it.

Let's begin all this stuff with a proper, analytical approach. It will dissolve shortly, I'm sure. In a "state of nature" environment, we will have a fellow create a video taped programme, let's say a documentary on the migratory habits of electric eels. It's a fairly good tape, as such things go, and he offers it to the waiting world at $50.00 a shot. The waiting world, itching with curiousity about the innermost secrets of eels buys the tape. One alumnus gets it, and makes a basketful of dubs, which he begins flogging at $30.00 each. In the end, everybody gets a tape, but most have come from the fellow with two VCRs and a set of patch cables, not the chap with a head for eels. This latter poor unfortunate has a gross of unsalable documentaries, and two hundred and fifty dollars. There is, evidently, no fortune to be made in tape, so he frys his eels in bread crumb batter, and goes in for chiropractic medicine.

Now, of course, it would seem that the only loser is the artist, but, in fact, he is the least burned of the lot. He can erase his tapes, and get all the re-runs of Mary Hartman preserved for posterity. It is really the people who bought the bootleg recordings that have done themselves in, because, very shortly, everyone with a gift for producing tapes will have hocked their cameras, and there will shortly be no tapes at all. Mary Hartman is nice now and then, but a steady diet of broadcast TV only will unstick the Crazy-Glu of your mind.

Hence, we have copyright laws, which prohibit bootlegging and "unauthorized duplication". This means, essentially, that "thou shalt not copy", fini. There are no exceptions, at least as far as the owner of such a copyright is concerned, because authors are in the business of selling art, and the art they sell is mass art, multiple copies . . . and every time one makes an unauthorized copy, one causes the artist to lose the



sale of a copy. This is the way the producer views the situation, and, perhaps, this is how we should, as well, given full understanding of the intent of copyright. However, even as things stand now, there are all sorts of loophole-type ways around this seemingly rock solid edict, and as the ground-rules become clearer over the next few years, no doubt more will emerge.

Consider, for example, the outcome of the rather heavy MCA-Disney vs. Sony trial. I can't conceive of Walt Disney suing anyone, but none the less, the studios sued Sony for having offered to the consumer world a device designed and marketed to perform a wholly illegal function. Yes, Herman, we speak of nothing less than the Betamax VCR. Broadcast TV programmes are copyright and recording them is a technical violation of this copyright. Yet, the fiasco was settled in favor of Sony . . . and MCA is presently marketing quite a bit of home video software.

While there have been no court cases, to my knowledge, involving copyrights of pre-recorded material, there are a number of quasi-legal question which could be brought to bear on the issue. A few follow. I should point out, though, that these points are argued on an ethical basis only, and do not reflect any existing laws. We can have at the question in this informal manner because, for practical purposes, an individual dealing with pre-recorded tapes within a sphere occupied by only his immediate family and friends does not have too much to fear from the long arm. I can make a copy of my tape of the Greatful Dead Movie for ol' cousin Max, as illegal and wicked as it may be, and not have to worry for one zot about the mounties smashing down the door and dragging us both off to the jug. The amount of money our clandestine operation is costing the copyright holders would probably pay their legal team for about sixteen milliseconds.

However, whether or not we should feel miserable and wretchedly guilty remains to be seen.

Copywrongs

If all you own is a VCR, most of the arguments we're about to get in to won't seem important to you. Most home VCR owners with whom I've come in contact will usually copy anything they can find. Such may not be the case if you own a camera as well. Such will most certainly not be the case, as I myself have discovered, if you've produced anything, and discovered at a later date that it was being used without your consent . . . and without you being paid for it. There is, then, a very moving and simplistic argument in favour of copyright adherance in the simple fact that the medium of copying can also be the medium of creation, and if a universal standard of respect for other artist's work is maintained, one's own will also be safe.

However, in trying to nail down what "safe" means, we will shortly have several arguments for dispensations of the copyright notion, at least, in specific situations. For, by safe, first of all, we would seem to mean safe from copies that do not generate the artist's revenue. But, perhaps it would be better to say that we wish to safeguard works from copying which robs the artist of potential revenue . . . which is not exactly the same.

Let us say that there is a small hairy troll in San Francisco making psychadelic video tapes, which are actually pretty good. However, this sub human has been doing magic mushrooms for so long that he's lost all sense of the true and righteous course of captialism, so he confines his advertising to graffitti on the walls of bus stations. Nonetheless, I get one of his tapes, and check it out. I am rather impressed with it, so I tell Max about it. Max is, aside from being a kindred soul of the artist . . . usually stoned . . . really quite cheap, so he wants me to make him a dub of my tape rather than sending money to the guy who originally created the work.

Now, I can do this, if only to get Max out of the place for a while, and I need not feel guilty, because I have . . . an argument! Suggestive of one or another Pythonesque sketch? Yes, I suppose it is.

Consider, for a moment, the nature of esoteric programming such as this. In the past few years, the amount of material of this sort, generated by individuals or small groups, distributed out of basements, and aimed at highly specialized audiences, has outstripped the more legitimate sounding operations of the major motion picture turned video distributors. These little fellows don't all advertise with spray paint, but most are not far from it. Thus, it is safe to suggest that one can have such a tape, and, if one does not choose to tell a friend about it, said body will most likely never know. Thus, in recommending a tape like this to another person, you have created a demand that would not have otherwise existed. Inasmuch as there was no clause in the agreement to purchase your copy of the tape insisting that you market the author's wares . . . probably all that was involved was "send $39.95 plus $1.50 to bribe the mailman" . . . having once created the demand, you are free to fill it. If you hadn't created it, it wouldn't have existed, and the owner of the copyright would have sold no tapes. Since you have, it does . . . but he still won't sell any tapes. In short, you are not robbing him of any revenue by supplying friends with dubs.

This argument has a defined limit. However flakey his notion of advertising, the author of a tape can expect to reach one in "n" people, and, conceivably, could sell everyone of them a copy. Thus, as soon as your sphere of friends, to whom you have bestowed dubs, exceeds "n", you have violated the author's copyright. The argument has a pragmatic limitation which is somewhat smaller; the RCMP will find out about you far sooner. (They busted a band of marauding bootleggers out here just the other day).

In a limited sense, this argument also applies to feature films. Video cassettes of movies are very, very expensive, and, as such, most VCR owners only own a few. Furthermore, it is fairly safe to say that they will not buy a cassette unless the material on it is exceptional. One might buy a tape of Star Wars, but certainly not of Saturn 3. Therefore, if one's friend has a tape of Saturn 3, there would not seem to be any harm in getting a copy of it, again, because one would not go out and buy it if a dub was not available. It would only be in copying tapes that one would otherwise obtain commercially that there would be a clear infraction of the rights of authors.

Perhaps the most important question involved in video software is: what do you buy when you buy a pre-recorded tape? Obviously, the value is not in the tape itself, as pre-recorded cassettes cost much more that regular, blank ones. It is the data on the tape, but, it is intended to be made available for purchase in only a limited sense. The manufacturer does not want you to reproduce it for profit, such as in a theatre, nor does he want you to copy it and sell the dubs. It is purchase for personal use only. This would seem like a very strict guideline, and very limiting for the buyer . . . but it does offer a few specifications for the limits of software copyright.

If one is purchasing data . . . software . . . as one buys it on a video tape, as opposed to renting it, for a predetermined time, one is buying the right to examine the data . . . look at the tape . . . as many times as one chooses. This would seem, intuitively like a reasonable hypothesis, as the manufacturer of the tape imposes no limits on its use under the circumstances proscribed. However, tape is an inherently volatile medium. It wears out, can be erased, crumpled, torn, and as such, is a carrier of finite life for this infinte data. This being the case, the purchaser of a tape, while entitled to infinite use of the data, is limited by inadequacies in the hardware.

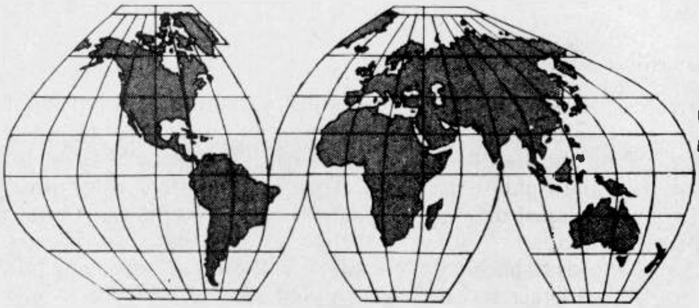
It would therefore seem that the owner of a tape, in order to insure his continued possession of the hardware he has purchased, had the right to be able to make as many copies of the original as are required to do so.

Now, this argument leads to another, which covers a somewhat larger scope. What if the owner of a tape is a public library? With tape so easily damaged, the library cannot be expected to loan out the original copies of its cassettes. And, once again, it is only using the software it paid for. The data is still being used in a serial fashion; only one viewer can have the cassette at a time, and whether that cassette is an original or a dub would seem to be of little importance. I don't suppose that the author of a tape enjoys the notion of a library loaning his work around, and wiping out a group of potential customers, but to deny this option is to forbid individuals the right to loan their property, in essence . . . a public library is really just an organized pool of a community's resources (or property, from a hardware point of view).

This, lastly, offers us another argument in favour of the right of software owners to give dubs to friends. One could, without in any way violating copyright, pass a tape back and forth between two households. The tape would thus be used serially. This might deprive the author of the sale of one tape, but it is the right of the owner of the specific copy to dispose of it as he wishes.

Largely intuitively, then, it would seem justifiable to dub the tape. It is stretching things a bit, but the software will still be used pretty well serially . . . after all, both households can not be expected to watch the tapes continuously. The result of this apparent infringement on copyright would be the same as the result of moving one tape back and forth . . . although it would save on gas . . . leading us to suspect that it might be justifiable, at least on a small scale.●

COLUMN



SHORTWAVE WORLD

No frequencies this month, John Garner cleans up a few odds and ends.

WITH THE COMING of summer, many shortwave listeners leave their radios for the great outdoors; this is a pity, since International Broadcasters continue throughout the summer with much interesting programming.

Of course there is no reason to give up shortwave listening during the summer months; why not buy a portable receiver? You can then enjoy both — listening and sunning.

There are many good portable receivers available today. Check the Shortwave Receiver Survey in the October issue of ETI. Among the better sets are the Barlow-Wadley XCR30; Grundig Satellit 2100 and 3400; Nordmende Globetrotter 808; Panasonic RF2200, RF2600 and RF2900; and a number of Sony models. I was especially impressed by the Sony ICF-7600 model which is about the same size as a soft cover pocket book and includes not only the shortwave bands but also AM and FM bands. The sound quality is amazing for such a small unit, however, because of its small size, tuning some of the weaker stations is a bit difficult.

I bought a Panasonic RF2800 two years ago and have found it to be very reliable. It came complete with Panasonic batteries which I'm still using; it also has a power cord for use indoors. The digital readout makes it very easy to tune stations in the shortwave bands. I was very surprised the first time I tried the FM band; I was able to pick up FM stations 200 miles away with just the built in whip antenna and battery power! The RF2800 has now been replaced by the RF2900 which is identical except that the digital readout now extends to all bands instead of just the shortwaves. This receiver retails for about $400.

SWL Conference

At this time of year, most of us are thinking about our summer vacations. How about taking a holiday in Southern California in July and take in the 1980 ANARC Convention? ANARC is an umbrella organization with member clubs all over North America. ANARC '80, to be held July 18, 19 and 20 (Friday to Sunday) at the Irvine campus of the University of California, appears to be consolidating the momentum gained through the outstanding ANARC Convention held in Minneapolis, last June.

Leading DXers and SWLs throughout North America have already indicated that they will attend. It is hoped that many overseas SW radio broadcasters, as well as those from the US and Canada, will attend also.

ANARC Congresses are traditionally "all-wave" in scope, for both guys and gals, and all DXers/SWLs are cordially welcome to attend. You do not have to belong to a club to attend.

The registration fee for the convention is $10.00. The annual Saturday night banquet is $10.50. Accomodation is available at the University Townhouses at the following rates: $23.00 per person per day single occupancy; $20.00 per person per day double occupancy; $28.00 per person per day suite occupancy. Meals are included in these room rates. For further information on the convention, write to Stewart MacKenzie, ANARC 1980, 16182 Ballad Lane, Huntington Beach, CA 92649 USA. Note — payments should be in US funds. When writing for information, please enclose a self addressed stamped envelope (if you have an American 15¢ stamp) or a self addressed envelope and 25¢ to cover postage. These are all volunteer workers and don't get paid. The same applies to all clubs and individual listeners — if you ask for a reply you should include return postage.

Receiver Popularity

Since the Shortwave Receiver Survey was published in the October, 1979 ETI, a number of people have asked me "What receiver should I buy?"

I don't like to recommend any one receiver over another that I am not as familiar with. I try to point out some of the good points and weak points of receivers in the price range they are considering and suggest they take a good look at all and then decide for themselves.

To give new buyers a bit of a guide, I looked over the shortwave loggings contributors to three shortwave clubs' recent bulletins and made a review of the receivers they were using. These results came from several issues of CANDX, SPEEDX and FRENDX (the club bulletins of Canadian S-W-L International, SPEEDX and the North American Short Wave Association). A total of 355 members reported over this period and the following is the tabulation of the receivers that they used:

Another survey being carried out worldwide by the European DX Council in cooperation with ANARC showed in an early report that the Yaesu FRG7 was also the most popular receiver by far among over 900 listeners. Among German speaking listeners, the Grundig receivers were the most popular (Grundigs are, of course, manufactured in Germany). A recent issue of the South African Listener shows that the South African manufactured Barlow Wadley XCR30 is most popular there.

The above is only meant as a guide. Some of the newer receivers haven't been around very long and are not in such common use as the FRG7 and therefore are much further down the list.

Digital frequency readouts on the newer models seem to be very popular and are a great help in tuning as compared to the analog tuning dials on receivers such as the FRG7.

The DX150 and its newer version the DX150 by Radio Shack were always a very popular receiver among newcomers to the hobby. Many of us, including myself, had one of these and then eventually graduated to something a little

better. It now appears as if Radio Shack are discontinuing this model. It does not appear in the 1980 catalog in Canada although their US catalog still lists it. They are intending to come out with a replacement for it called the DX200 but I have no information on this at present. Radio Shack have also had many problems with their DX300 receiver and I've now heard that it too is being taken off the market.

Another fairly recent receiver, the Kenwood R1000 also had some early bugs which the manufacturer has reportedly corrected.

Another useful guide in choosing a table model receiver is contained in a 22-page article in the 1980 issue of the World Radio and TV Handbook (available in Canada from Heathkit and a number of bookstores of from Gilfer in the USA). Larry Magne reviews in depth the following receivers: Panasonic RF4900, Realistic DX300, Sony ICF6700W, Sony ICF6800W, Trio-Kenwood R1000, Yaesu FRG7, Yaesu FRG7000, Drake R7/DR7, Japan Radio NRD505, Japan Radio NRD 515, McKay Dymek 33C. Also included are the Gilfer and Radio West modified versions of the FRG7 and FRG7000. Larry does a thorough testing of each of these receivers and points out the good and bad points of each.

Note – in the 'others' category there were a total of 60 different models. Many of these are no longer manufactured or are not readily availble in Canada. Where two models are listed together, the second model has replaced the first one but is basically the same – perhaps a few small improvements have been incorporated in the newer model.

Canadian Scanner Frequencies

This 16-page book (8½" X 11") published by CRB Research and edited by Alex T. McKendrick, contains over 3300 frequencies between 30 and 470 MHz which are used in Canada. Included in the listing are locations where each frequency is active, callsign

A variety of shortwave receivers are available. These are a few of the ones reviewed in October 1979 ETI.

FRG7	77	R4B/R4C	6
DX150/160	43	SSR1	6
RF2800/RF2900	25	XCR30	5
SPR4	19	ICF6700W	5
DX300	18	ICF5900W	4
FRG7000	18	SW4A	3
RF2200	13	R392	3
RF4800/RF4900	13	SW717	3
SX190	11	R300	3
R390	8	CRF320	3
		Others	69

where known and the type of service. Looking through the book I see such services listed as Mobile telephones and operators, Radio astronomy, RCMP, OPP, local police departments, fire departments, taxis, power companies, aero marker beacons, airport towers, aircraft frequencies, space, bus companies, government departments, civil defense, radio news, penitentiaries, business, maritime service, towing, national harbors and more.

Communications frequencies for stations located in Canada have long been eargerly sought by monitoring and scanner enthusiasts. In some nations of the world such data on in-use frequencies is readily available from the agencies which license telecommunications in those nations. Such is not the case in Canada. Over the years there have been some excellent efforts by individual monitors to piece together available data, however such have never produced results consisting of more than a smattering of local listings.

In this publication a relatively extensive compilation of data relating to in-use frequencies between 30 and 470 MHz in Canada has been assembled. This has been accomplished by a concentrated and co-ordinated monitoring effort by many Canadian monitoring interests and scanners users. This massive data input has been supplemented with additional information from various other sources, including access to the files of Z-Tech Enterprises (P.O. Box 70, Hauppange, NY 11787), which has long been a leading crystal supplier to Canadian scanner owners. Wherever possible as much information as has been available on the exact use of the frequencies has been included.

A special callsign supplement is included with each copy of this book. This 2-page supplement lists callsigns of about 380 Canadian ships (Royal Canadian Navy, Government, RCMP, Coast Guard, ferries, even a fireboat), 179 RCMP base stations, 22 RCAF and Royal Canadian Navy bases, and 125 maritime coastal stations (including Canadian Coast Guard). This rounds out the publication to a very useful addition to the hobby for the many shortwave listeners who have added these higher frequencies to their listening activities.

The "Registry of Canadian Scanner Frequencies" is available from CRB Research, P.O. Box 56, Commack, NY 11725, USA for $5.00 (US funds) including first class postage. Canadians should send a money order payable in US funds.

Have a good summer and don't forget to take along a portable short wave receiver and listen to the world. Until next month all the best and good listening. ●

Electronics Today INTERNATIONAL JUNE 1980

NEXT MONTH

Electronics in Warfare

Since its big break in WWII, electronics plays an increasingly vital role in modern warfare. Next month we take a look at what's happening at the front.

Phase Locked Loop Synthesis

Often one is required to arrive at a frequency that is not a convenient multiple of an available standard. Andrew Jaremko describes the principles of PLL synthesis and how they apply to his hobby, film making.

Canada's Sound Archives

Historical Societies across the country have thousands of pictures of days gone by. Jim Essex reports on an agency that saves valuable recordings of Canada's past history.

When In Doubt, Thevenize!

Hundreds of books on electronics expound the virtues of Ohm's Law. Next Month, a look at two equally important circuit analysis techniques, Thevenin's Theorem and Superposition.

Dynamic Noise Reduction System

While it is impossible to remove tape noise from program material, there are a number of tricks to make it less noticeable. Our Dynamic Noise Reduction System cuts the signal (and noise) during quiet periods for more enjoyable listening.

Overspeed Alarm

Do you often find yourself absentmindedly barreling down the highway at Warp 9? The ETI Overspeed Alarm is designed to keep tabs on your engine speed and save you from embarrassing tickets.

The articles listed here are in advanced stage of preparation. Circumstances, however, may alter the final contents.

ARTIFICIAL INTELLIGENCE

Some very exciting research is being carried out by the Computers and Cybernetics Group at the University of Kent in England. This research could lead to a better understanding of the human brain— or a better computer. By M.C. Fairhurst.

ARTIFICIAL INTELLIGENCE, the imitation of artificial systems of human characteristics which we describe as intelligent, is a field which has attracted an increasingly large amount of research effort in recent years. While acknowledged as an academic discipline now, artificial intelligence is often used interchangeably with bionics, robotics etc., with the result that the layman becomes confused and the purist indignant!

Whatever its precise terms of reference, artificial intelligence embraces concepts and theories from many different disciplines including mathematics, cybernetics, computer science, psychology, biology and others.

The philosophy for the design of an artifically intelligent system (for example, to provide the "brain" of an industrial robot) requires a general purpose digital computer to be programmed in such a way as to accomplish the desired task, or that some special purpose computing system is explicitly designed to achieve the same result.

While such a computer program or electronic design does not necessarily preclude the possibility of future self-programming or adaptation of behavior, the essence of this approach to the design of an intelligent machine is that the "intelligence" is somehow imposed by means of external intervention or manipulation.

This is by no means the only design philosophy. An alternative approach becomes immediately attractive if it is recognised that certain types of systems possess inherent, as opposed to externally-imposed, intelligent characteristics. The problem of constructing an intelligent machine or robot then becomes one of exploiting these existing characteristics in a meaningful way rather than one of creating them.

Intelligence from Chaos?

Let us look for an example of intelligent behaviour in what, at first sight, may seem to be an unlikely situation. Figure 1 shows a network made up of interconnected electronic cells, each of which receives and generates binary signals. The operation of a cell may be easily represented by a table such as Table 1. This lists all possible signal combinations at the input of the cell and the corresponding output signal in each case. Note that the variables Q0, Q1, Q2 . . . can each be either 0 or 1. The precise values given to these variables for any element define the *function* of that particular element and determine exactly how the element will operate. For a cell with K inputs there are exactly 22K different functions which could be defined.

The electronic cells described are examples of logic gates, although here we assume that any function may exist and not only the more ususally-encountered functions such as AND, OR, NAND etc. As an illustration, Table 2 shows a complete set of possible functions f0-f15 for a cell with two inputs.

How may we usefully describe the behavior of the overall network of cells? At any instant we list the output signal value of each cell in the network in order. This list, which will consist of a string of 0s and 1s, defines the *state* of the network. However, because the elements are interconnected the output of one element may cause the input to another element to change, while this in turn may cause the output of the next cell in the chain to change, an so on. In other words, at successive instants the state of the network may change.

After a sufficient length of time, because there are a limited number of possible states which exist (000 . . . 00, 000 . . . 01, 000 . . . 10, . . ., 111 . . . 11), a state or a group of states must repeat. We can summarise the network behavior by drawing a *'State transition diagram'* which shows the changes from one state to the next in the network at successive instants in time. Part of one such state diagram is shown in Figure 2.

Note that in order to get a general picture of what is happening in the network it is not necessary to label each individual state at this stage. We can see that, in this example, the network has just three modes of activity which may be said to be stable – two of these stable modes correspond to the two cycles (repeating groups) of states of three and five states respectively in length. The third corresponds to the single stable state – the state which recurs once reached. It can be seen that all other states, after a sufficient length of time, are ultimately drawn in to one of these stable areas of activity.

The crucial question which we now ask concerns the sort of state transition diagram which we might expect for any particular configuration of elements in the network. For example, suppose that we connect together in a totally random way a number of elements whose functions are selected completely at random from the set of all possible functions. How will this network behave?

Experimental Results

In general terms, our intuition leads us to believe that a system whose specification is random will give rise to disorganized, unstable, possible chaotic, and certainly unintelligent behavior.

For example, let us consider a parallel with the random network situation taken from everyday life. Suppose I arrange my filing cabinet in such a way that I allow some of Mr. Jones' letters to be filed under 'S' and others under 'T', while Mr. Brown's letters are put into a file marked 'Mr. White' on odd days and a file marked 'Mr. Green' on even days. Suppose that I further compound the disorganization by putting all the P files in the A drawer, and so on. Surely I should not then expect my filing system to be even intelligible, let alone efficient!

To go back to the case of my random network of electronic cells, I should

Input 1	Output 2	Input 3	Output
0	0	0	Q_0
0	0	1	Q_1
0	1	0	Q_2
0	1	1	Q_3
1	0	0	Q_4
.	.	.	.
.	.	.	.
.	.	.	.
1	1	1	Q_i

Table 1: Showing the association between possible sets of inputs to the cells at right and thier corresponding outputs.

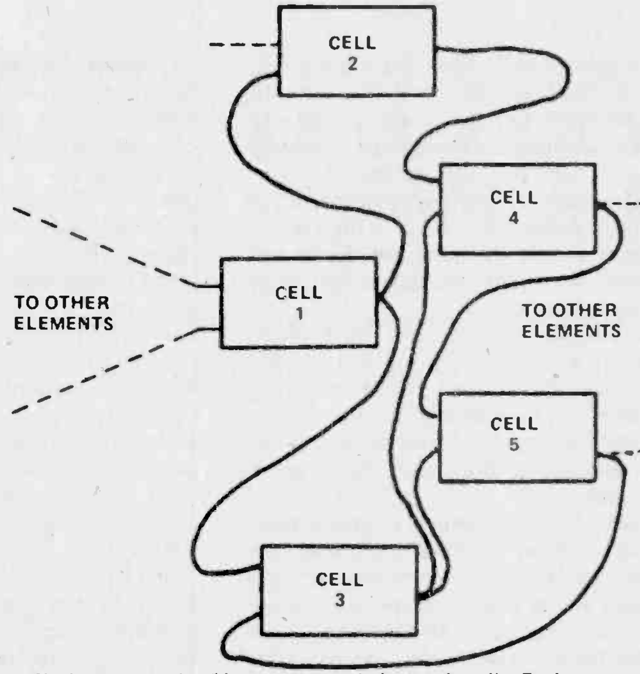


Fig 1: A network of interconnected electronic cells. Each can receive and generate binary signals.

expect the randomness of the situation to give rise to unstable and unintelligible activity in the network, such random behavior being characterised by the existence in the state diagram of many long strings of meaningless states and cycles containing a large number of states.

It is at this point that a surprising, but most interesting and highly significant, observation can be made. In a large number of experiments on many different networks it has been found in practise that rather than the unstable chaos one might expect, a random network exhibits highly stable and ordered behavior, represented by the existence of very few repeating cycles of states, each cycle in itself comprising very few states. For example, a random network of 100 electronic cells — with the potential for existing in any one of 2100 states — was found typically to generate only about 10 cycles, each consisting of no more than about 10 states.

After a sufficient length of time the network will be found to exist in one of only relatively few state cycles, we may say that the system has a restricted and manageable number of different modes of activity and is, therefore, stable.

This inherent ability of the network to organize its behavior into one of a well-defined number of modes of activity leads us to attribute to the network a pre-disposition for intelligent behavior, in just the same way that we might feel inclined to attribute intelligence to our "chaotic" filing system if we opened a drawer to find out, despite our lack of coordination all the files on "Mr. Brown's interview" had ended up together in one place.

Three further points need to be made clear in the context of intelligence in networks of electronic processing cells. First, we may allow the network to interact with its environment by allowing some of the element input channels to be connected to the external world rather than to other cells. In this way the network can be made to respond to some stimulus by following a trajectory of transitions to some state cycle. Second, if we arrange for the element functions to be variable (ie. we allow them to change if some appropriate

Input 1	Input 2	Output															
		f_0	f_1	f_2	f_3	f_4	f_5	f_6	f_7	f_8			f_{11}	f_{12}	f_{13}	f_{14}	f_{15}
0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
0	1	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1
1	0	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1
1	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1

Table 2: All sixteen possible functions for a cell with two inputs.

signal is received)) then the state structure is itself variable, and the network can be made to learn, making meaningful associations between external events and its own possible modes of major significance — all the required properties of the electronic cells utilizing cheap random access memory devices to implement the electronic cells which make up the network.

Although the idea will be pursued later it is worth pointing out at this stage that the overall structure of the electronic system as described is not unlike the structure of the brain. It has two extremely important features in this respect.

First, the intelligence of the system is not localized in any specific area, but distributed over the entire network. As a result the system is much less susceptible to localized damage than more conventional electronic systems, in much the same way that our memory traces can often be retained despite severe disruption of the brain's activity. Second, the system processes its data in a *parallel* rather than *serial* mode, (all the cells operate simultaneously) with a consequent ability for high processing speeds!

Let us suppose that we wish to construct a device which will automatically read and identify letters of the alphabet (clearly a task requiring 'intelligence' whether carried out by a man or a machine). A simple scheme for accomplishing this task is shown in Figure 3. A TV camera is used to sense the image which is then encoded (or "digitised") by means of suitable circuitry into a binary representation, and this coded version of the input fed to a network of adaptive electronic cells as described.

We now exploit the natural intelligence of the network by modifying the element functions — "teach" the network — in such a way that it will respond to examples of a particular pattern class (e.g. the letter "A") by entering a particular state cycle, the equivalent of executing just one of the possible modes of activity. The classifier is then required to identify the cycle entered and hence signal the identity of the pattern which was received at the input.

It is easily seen that the system is making use of the natural stability of the network in so far as the number of states which need be identified is dramatically smaller than the total number of possible input patterns which may occur. It is exactly this property of the network which transforms the problem from one of identifying a potentially very large set of inputs to the much simpler problem of identifying one out of a much smaller number of possible cycles.

Intelligence and Models of the Brain

The human brain is a cellular structure whose processing units are biological computing cells called neurons. Although the computational mechanisms of electronic cells and biological neurons are very different, there are nevertheless similarities in terms of the respective functions performed. For example, both types of cell operate on signals which are essentially binary in nature — in terms of voltage levels in the electronic case and the generation or non-generation of voltage pulses in the biological case — and both compute a function relating an output signal to the pattern of signals appering on their input channels at any instant. Structurally at least the type of electronic network described above is a closer model of the brain than is a conventional computer system.

Furthermore it is possible, in principal at least, to characterize brain activity in terms of a state diagram. Although a complete state diagram of the brain if it could be plotted exactly would contain about 2^{1010} states (since it is estimated that the brain contains about 10^{1010} neurons), a model of neural network, which could of course be physically realized using our familiar electronic network structure, can be a very versatile means of characterizing and formalizing the brain mechanisms which underly human behavior.

In such a model, the transitions from one state to the next correspond to "thought processes", while learning is embodied in the fact that the element functions can change in response to information received by the network. It is possible, using this approach, to describe many psychological and physiological functions in terms of state-to-state activity, and processes such as recognition of environmental

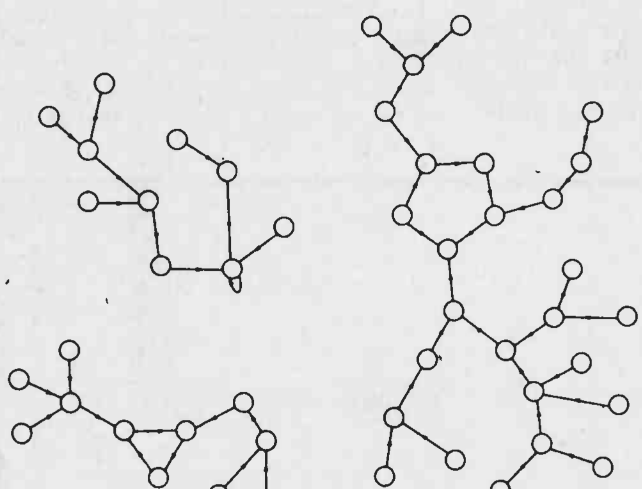


Fig 2. Part of a 'state Transition Diagram' summarizing the behavior of a network of cells, showing the changes from one state to the next at successive instants.

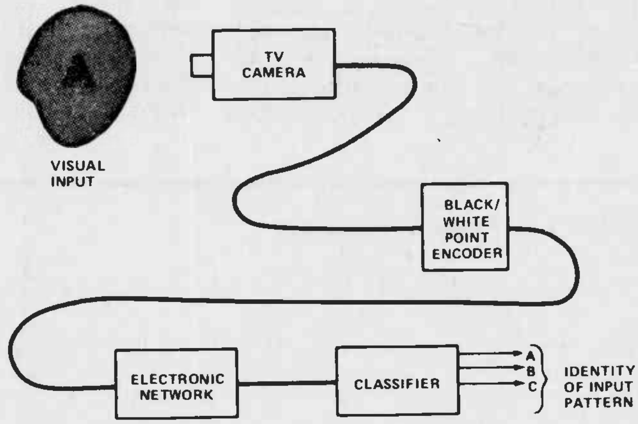


Fig 3. A simple method of recognizing visual patterns.

events, recall of stored information, long-term and short-term memory processes, and a mechanism of speech production are but a selection of functions which may be described and characterized in this way. The benefits likely to be obtained in this area are twofold since, not only can such endeavours lead towards a clearer understanding of brain function itself, but such a characterisation of intelligent behavior can give insight into the design of intelligent machines for may different purposes and applications.

What of the Future?

One thing is certain, the search for machines with a capacity for intelligent behavior will continue and increase.

One of the most encouraging features of the approach described here is that it focusses as a unified entity the work of engineers, physicists, mathematicians and even psychologists. It may be that the current trend towards cheaper and more readily available computing facilities and electronic components will provide exactly the right stimulus for even more widespread and interdisciplinary cooperation, and allow significant progress in this area.●

THE SYSTEM described in this article is still in an early stage of development but Kent University does have a less advanced system working. This is a computer simulation of a 'learning net'.

In the example in these diagrams, the machine is learning to recognise typewritten characters. Figure 4 shows the digitised picture information being fed into the array at the top left of the diagram (the pattern shown is a letter T).

There are several blocks of RAM attached to this array, each organised as 16 x 1 bits. The address lines are fed from different parts of the array, the entire array being covered all in all.

This entire network (i.e.: the part of Figure 4 inside the dotted line) is dedicated to recognising one character. During the 'teaching' mode, the letter to be recognised is fed into the array. The 'teach enable' and the 'teach data' of the network are held high and a '1' will be fed into the location of each RAM which is indicated by the input pattern.

A variety of other patterns (i.e. other than "T") are then fed into the array and a "0" is fed into the locations indicated by the new patterns.

During the run mode, an 'unknown' pattern is fed in and the network which has been 'taught' to recognise it will produce a lot of "1's" at the RAM outputs.

The system will see which network is producing the most "1's" and will output the character that that network (the one with the most "1's") is trained for (see figure 5). In this way the system can cope with 'noisy' patterns — they will still (hopefully) produce more "1's" in their network than in any other.

At Kent University they are using the system on data supplied by the GPO. The data consists of arrays derived directly from typewritten material. The result is a very 'noisy' pattern, difficult for a human to identify. However the system is managing well.

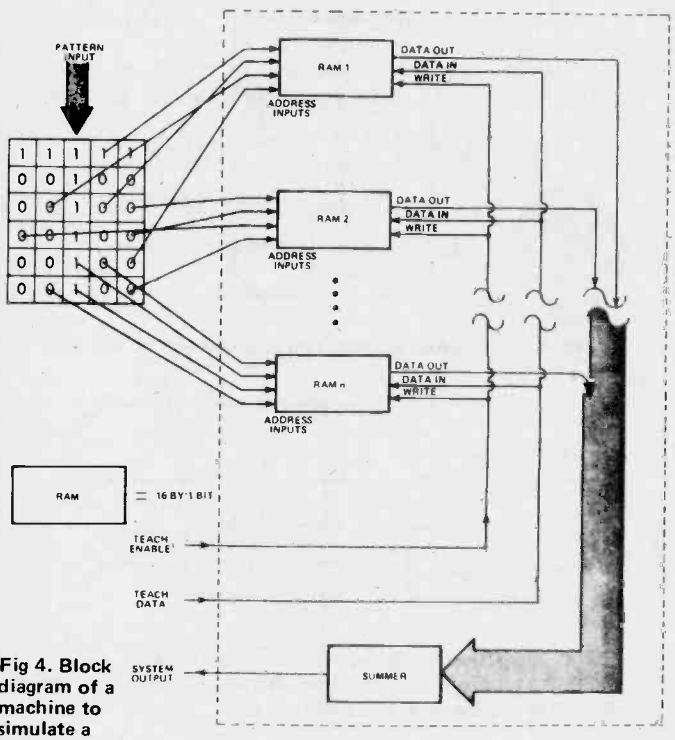


Fig 4. Block diagram of a machine to simulate a network.

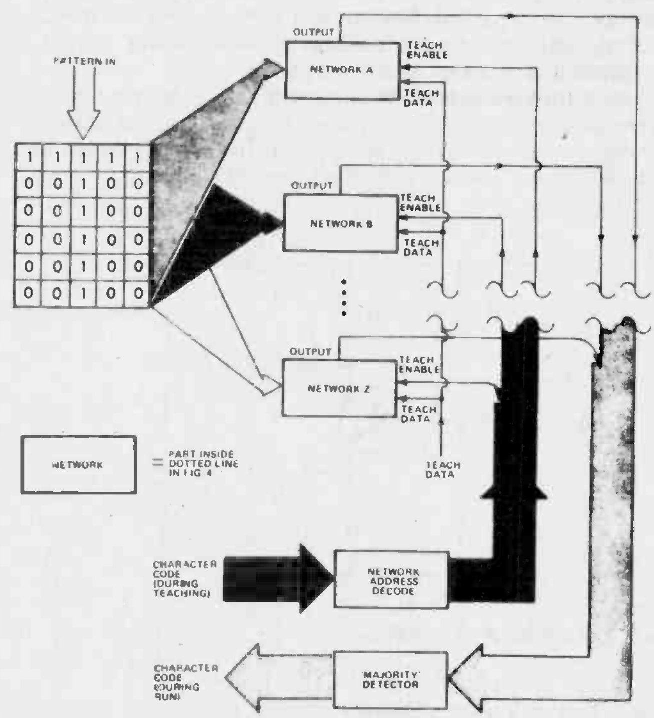


Fig 5. Several networks connected to recognize a character.

TEACHER'S TOPICS

This month we present a few more quickie transistor applications.

LAST MONTH we looked at a few novel applications of transistors. Our next step is to consider simple but some times overlooked configurations.

Phase Splitting

This is an example of using a transistor to match impedances, like a transformer. The other impedance — transforming circuit is, of course, the well known emitter follower, with a high input impedance and low output impedance. If you need the phase splitter action of a transformer, but don't have a suitable transformer, don't get wound up, just try the circuit of Fig. 9. If you're driving signals into a low impedance of course, you may find that the difference between the impedance level at the collector and at the emitter causes bother (the impedance at the collector is equal to the collector load resistor, the impedance at the emitter is only a few ohms; roughly 25 ohms when the steady bias current is 1mA). In that case, another transistor added to the circuit equalises things a bit, as shown in Fig. 10.

You might think that the possibilities of the transistor were about exhausted; but we've only been using them in ones so far. When we start using transistors in twos and threes, we can substitute a lot more devices.

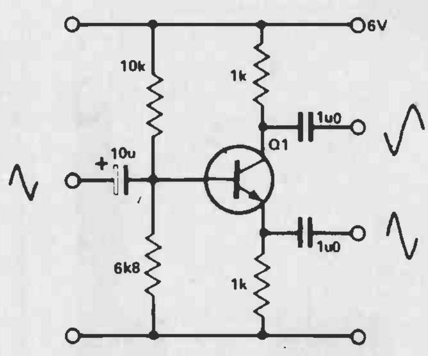


Fig 9. The transistor phase-splitter.

Unijunctions

Unijunctions, for example. Who's got a set of unijunctions around? Useful little devices. In circuits like Fig. 11 they provide an oscillator which gives a pulse output ideal for firing thyristors. The wiley experimenter doesn't worry if the unijunction drawer is empty, though. He connects up the circuit of Fig 12, which does pretty well all that a single-package unijunction will do, with the additional advantage that the firing voltage can be variable.

The action is like this. Point B, where the base of Q1 is connected to the collector of Q2 is connected to a potential divider, resistors R1 and R2. For most applications, these resistors will be equal, using (typically) 47k to 10k values. The circuit will pass no current while the voltage at point A, the emitter of Q1, is less than the voltage at point B, because Q1 is cut off (PNP,

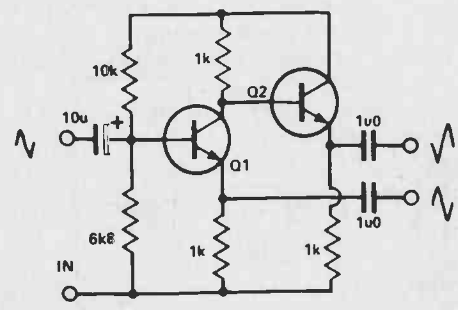


Fig 10. Modified phase-splitter with equal output resistances.

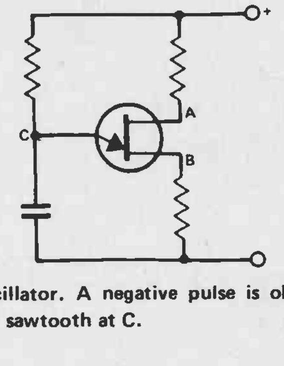


Fig 11. A unijunction oscillator. A negative pulse is obtained at A, a positive pulse at B, and sawtooth at C.

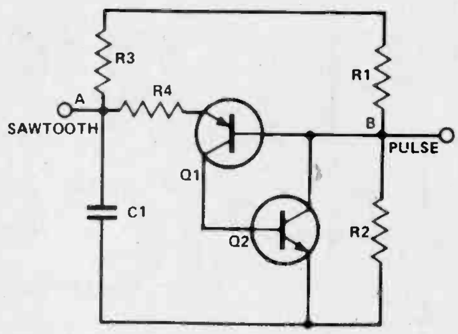


Fig 12. A two-transistor equivalent of a unijunction.

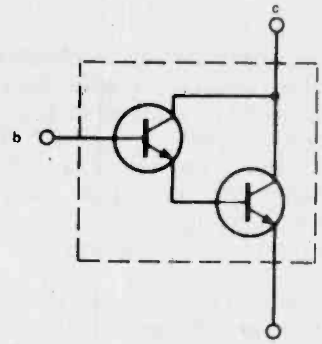


Fig 14. The Darlington pair circuit — this behaves like one single transistor with a very high value of current gain.

remember), and it holds Q2 cut off as well. When point A reaches a voltage around 0.5 V higher than the voltage at point B, though, Q1 starts to conduct, and current starts to flow into the base of Q2, causing Q2 also to conduct. With Q2 conducting, the extra voltage drop across R1 causes the voltage at B to drop, dragging the voltage of point A with it. If the base current of Q1, is likely to be exceeded (as usually happens if there is a capacitor connected to point A), a small series resistor R4 (about 100R) is a good protective system. Note, by the way, that when a unijunction or this replacement is used in a timebase circuit, the value of the charging resistor, R3, must not be too low, otherwise the circuit can 'stick', not oscillating. A value of around 47k is usually regarded as a safe minimum, so that if the frequency is controlled by a variable, a 47k should be connected in series. The firing point of the unijunction substitute can be varied to some extent by making the voltage at point B variable, using a preset potentiometer, in place of R1, R2.

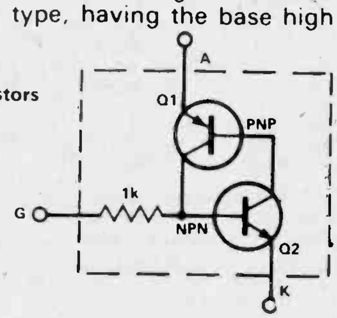
There is a limit, however, to the voltage range which can be used — if the voltage is too high, the circuit may not fire, if it's too low the circuit passes current continuously.

Another advantage, of course, of the circuit of Fig. 12 is that power transistors can be used. In this way, higher current pulses can be obtained than we can get from small unijunctions.

DIY Thyristors

You don't have to be stuck for lack of a thyristor, either. The circuit of Fig. 13 simulates the action of a thyristor, with the anode, cathode and gate connections as marked. With the 'gate' at cathode voltage, Q2 is shut off, so that its collector voltage is high. With the collector voltage of Q2 high, the base voltage of Q1 is also high. Since Q1 is a PNP type, having the base high means

Fig 13. Using two transistors in place of thyristor.



keeping Q1 shut off. Now when the 'gate' lead is made more positive, so that Q2 starts to draw current, the current through the collector of Q2 is drawn through the base of Q1, ensuring that Q1 conducts. This in turn means that the base of Q2 is connected to the positive supply through the collector of Q1, keeping the pair of transistors switched on.

Don't expect to replace a large thyristor with this circuit, because the current between 'anode' and 'cathode' all passes through the base-emitter junctions. For medium-power transistors, such as the 2N2219 or BFY50 the absolute maximum base current is about 100 mA, and 50 mA is a safer limit. Power transistors such as the 2N4920, BD132 will stand up to 0.5 A through the base-emitter junction. The circuit will, incidentally, switch off if a negative pulse is applied to the 'gate' from a low impedance. In this respect, the circuit is similar to that of a small thyristor, most of which can also be switched off in the same way.

Changing Bias

Transistors in bunches can also be used to solve awkward problems. Suppose you want to substitute a transistor with another type which needs much more bias current. One way round, of course, is to adjust all the bias circuits. A much easier method is to make use of two transistors, with one emitter driving the base of the

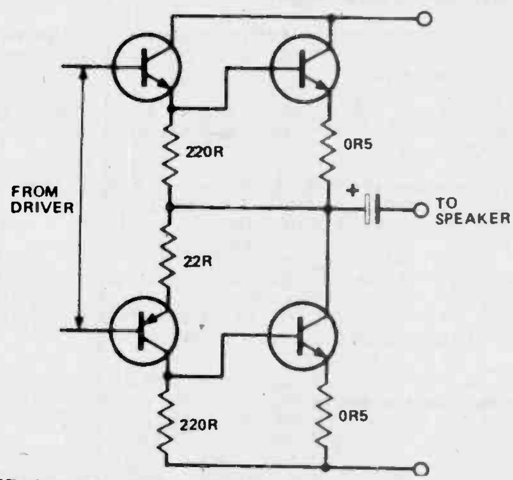


Fig 15. A quasi-complementary output stage. The power transistors can both be NPN types.

next (Fig. 14). If the two share the same collector lead, this circuit is called the Darlington pair, but if the collector of the first transistor is returned directly to the power supply the circuit is simply an emitter follower feeding a common emitter amplifier. The difference between the two is that in the Darlington pair circuit, signal can feedback from the collector of Q2 through Q1 to the base of Q2, so reducing the voltage gain of the circuit considerably.

A two-transistor circuit can also be used to 'create' a PNP power transistor from an NPN one. The circuit uses a PNP medium power transistor (such as the 2N2905) coupled to the NPN power transistor, so that the combination behaves like a PNP power transistor. Like all two-transistor circuits, though, there is a penalty in the form of a change in DC levels. When two NPN's (or 2 PNP's) are coupled in a Darlington circuit, the voltage between the first base and the second emitter is more than 1V, when the circuit is correctly biased, instead of the 0.55 — 0.6 V we assume for a single transistor. For the PNP — NPN pair, the voltage is *less* than that for a single transistor — the base voltage of the power transistor will be 0.7 V or so above its emitter voltage, but the base voltage of the PNP transistor will be 0.6 V or so *less*, so that the DC input to the base of the PNP transistor is very close to the DC emitter voltage of the NPN one. The base-emitter voltages of these two will never be identical because the NPN power transistor will always be passing a much larger current than the PNP transistor.

Tapehead Drivers

We're still not finished with the two-transistor arrangements. Fig. 16 shows what is called a cascade circuit, with a common-emitter transistor Q1 driving a common-base stage Q2 directly coupled to it. This arrangement can also be treated as if it were one single transistor with the high gain of a common emitter transistor and the very high output resistance of a common-base transistor. It's an ideal arrangement for driving tuned circuits (because the high output resistance places very little load on the circuit) or tapeheads (because the high output resistance can ensure that the current signal into the tapehead is almost constant over a wide frequency range).

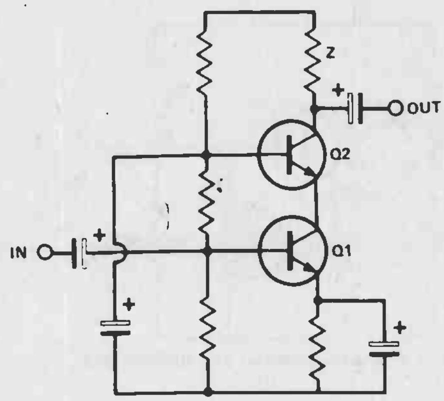


Fig 16. A cascade stage. The load Z can be a tuned circuit or a high-value resistor provided the bias

Circuits such as these described here make full use of transistors, exploiting more of their potential than the usual run of common emitter and emitter follower circuits. Make them work harder! ●

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FUEL LEVEL MONITOR

ETI's medically approved ulcer generator. It's designed to make you WORRY for half an hour before you finally get stranded through lack of gasoline.

THE ETI LOW-FUEL-LEVEL ALARM is designed for use in modern vehicles fitted with 12 V electrical systems only. It is driven from the vehicle's existing fuel gauge system, and activates when the fuel level falls below a pre-set value.

When the alarm activates, a LED and a low-frequency oscillator switch on. The output of the oscillator can be used to activate the unit's own audible warning device, or to activate the alarm generator of the 'audible repeater' project described elsewhere in this issue.

The alarm system is provided with a mute switch, which lets you disable the low-frequency oscillator 'warning' circuit, but not the LED circuit, once the alarm has been activated. The mute switch automatically turns off when the vehicle's ignition is first switched on.

The Low-Fuel-Level Alarm is a genuinely useful unit to have in any vehicle and is inexpensive and easy to construct. The unit is, however, fairly difficult to fit into most modern cars, typically taking 2-3 hours to install. Installation usually involves the partial dismantling of the vehicle's instrument panel. (You have been warned!).

Construction

Construction of the unit is perfectly straightforward and should present no problems. Note that the PCB is provided with Veropin terminals for making external connections, including those to the off-board mute switch and the LED.

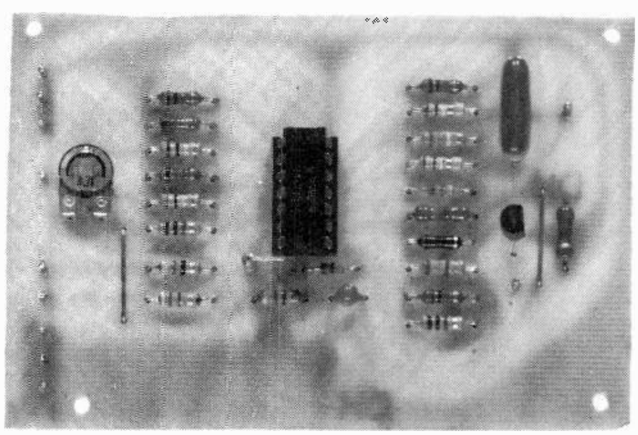
The load that is fitted in series with Q1 emitter can take a variety of forms, but must have an impedance greater than 100R. It can, for example, be a relay or a self-contained audible warning device. Alternatively, if the unit is to be used in conjunction with the 'audible repeater' project described in our April issue, the load can simply be a 4k7 resistor, and Q1 emitter can be connected to the auxiliary input (D15) of the repeater.

Installation

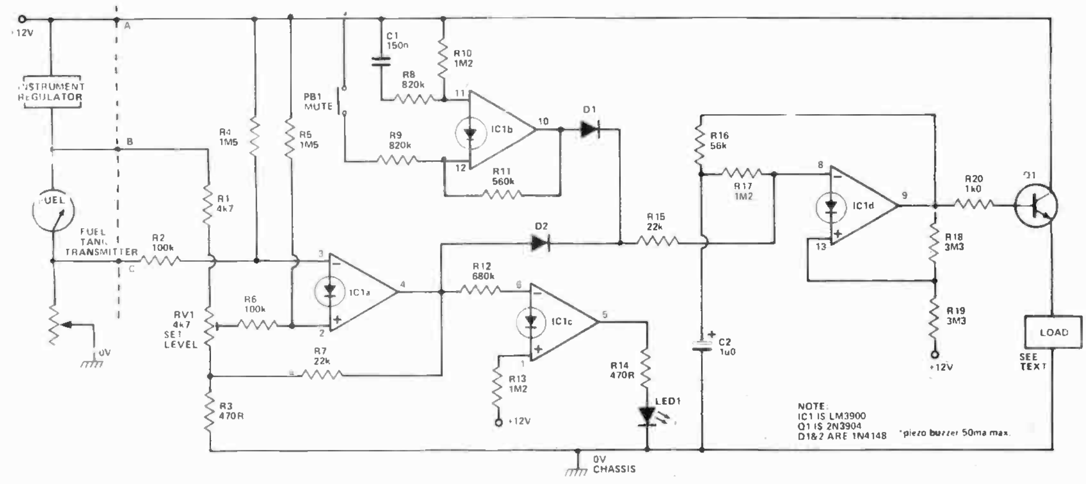
Installation is, in theory, simply a matter of connecting the unit's zero volt line to chassis, point 'A' to the +12V side of the vehicle's instrument regulator, point 'B' to the output of the instrument regulator and point 'C' to the junction of the vehicles fuel gauge and transmitter unit, as shown in the main circuit diagram.

In practice, the implementation of these connections will probably involve the removal of the vehicle's instrument panel, and perhaps the PCB that is attached to the back of that panel. Make sure you disconnect the vehicle's battery before starting the installation work.

When using the alarm unit, note that, because the fuel in the tank tends to slop around a fair bit under actual driving conditions, and thus generate a fluctuating voltage across the tank's transmitter, the alarm system will operate intermittently as the fuel level approaches the pre-set 'mean' warning level, thus giving the driver an advance warning of the danger condition.



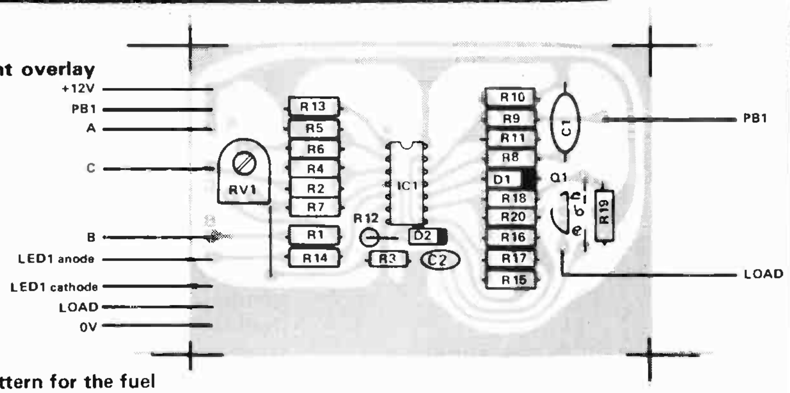
The complete Fuel Level Monitor.



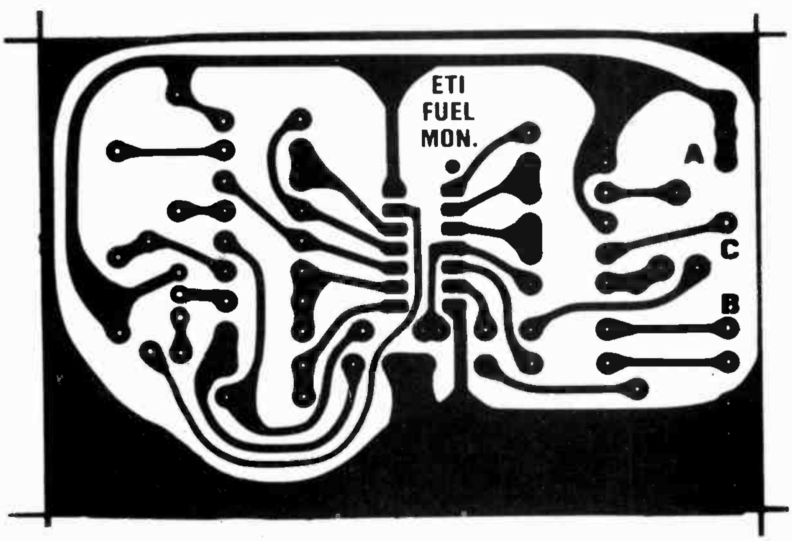
PARTS LIST

RESISTORS		R20	1k0
R1	4k7	**POTENTIOMETERS**	
R2, 6	100k	RV1	4k7 Preset
R3, 14	470R		
R 4, 5	1M5	**CAPACITORS**	
R7, 15	22k	C1	150n polyester
R8, 9	820k	C2	1u0 tantalum
R10, 13, 17	1M2		
R11	560k	**SEMICONDUCTORS**	
R12	680k	IC1	LM3900
R16	56k	Q1	2N3904
R 18, 19	3M3	D1, 2	1N4148

The component overlay



Full size foil pattern for the fuel level monitor project



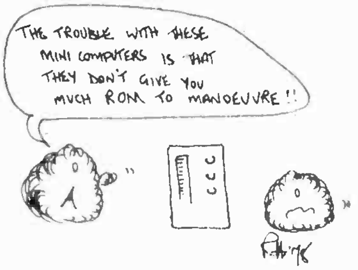
HOW IT WORKS

The fuel-level indicating system of a modern car consists of a float-driven rheostat 'transmitter' in the fuel tank, which governs the magnitude of current flow through a hot-wire type of meter that is used as the fuel gauge: to ensure calibration reliability, the voltage supply to the system is controlled by a simple regulator (see main circuit diagram). A characteristic of this system is that the voltage across the transmitter rheostat increases as the fuel level falls, typically reaching 3 to 4 volts when the tank is empty.

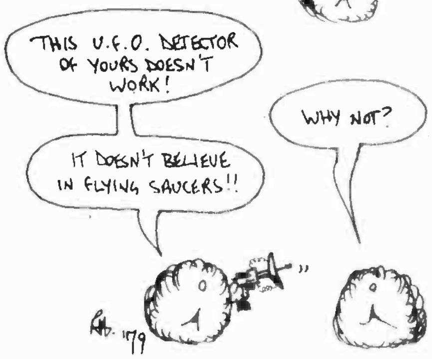
The ETI Low-Fuel-Level Alarm works by monitoring the voltage across the transmitter rheostat (at one side of the fuel gauge), and activating an LED and a low-frequency oscillator when this voltage rises above a pre-set value (when the fuel level falls below a pre-set value). The oscillator can be used to drive a variety of types of load, including an audible warning device. The circuit is provided with a 'mute' facility which can be used to disable the oscillator but not the LED circuit. The 'mute' system turns off automatically when the vehicle ignition is first switched on. A brief resume of the circuit's elements is as follows.

IC1a is wired as a voltage comparator, with a small degree of regenerative hysteresis applied via R7 and R3. The trigger level of the circuit can be pre-set via RV1, which is driven from the same 'regulated' supply as the fuel gauge. The output of IC1a is normally high, but goes low when the input voltage rises above the pre-set trigger level. Under this condition LED 1 is driven on via IC1c and a stable multivibrator IC1d is enabled via D2-R15. The output of the astable is fed to an external load via emitter follower Q1.

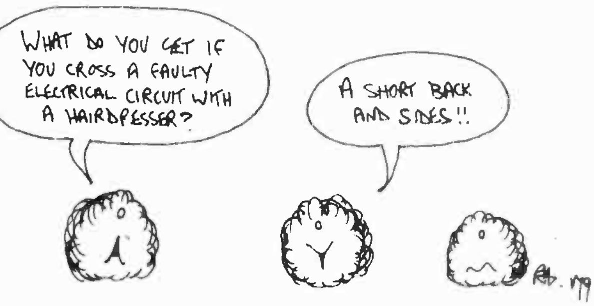
IC1b is wired as a simple bistable, which is automatically set to the output-low state at ignition turn-on via C1-R8. The output can be latched high, thus disabling the astable multivibrator (and hence the external load) via D1-R15 by momentarily closing MUTE switch PB1.



THE TROUBLE WITH THESE MINI COMPUTERS IS THAT THEY DON'T GIVE YOU MUCH ROM TO MANOEUVRE!!



THIS U.F.O. DETECTOR OF YOURS DOESN'T WORK!
WHY NOT?
IT DOESN'T BELIEVE IN FLYING SAUCERS!!



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SPECIFICATIONS:

DC VOLTS (5 RANGES): 0.1 mV to 1000V; Accuracy ±0.5% rdg ±0.5% f.s.; Input imped: 10M ohm; Max. input 1kV except 500V on 200mV range. AC VOLTS (40Hz to 5kHz): 0.1V to 600V; Accuracy: ±1.0% rdg ±0.5%f.s. (–2db max. at 5kHz); Max. input: 600V.

RESISTANCE (6 LOW POWER RANGES): 0.1 ohm to 20M ohm; Accuracy: ±0.5% rdg ±0.5% f.s. (±1.5% rdg on 20M ohm range); input protected to 120 VAC all ranges.

DC CURRENT (6 RANGES): .01nA to 100mA; Accuracy: ±1.0% rdg ±0.5% f.s.

DIMENSIONS AND WEIGHT: 5-7/8" x 3-3/8" x 1-3/4", 8 oz.; POWER: 9V battery (not included) or Hickok AC adapter; READ RATE: 3/sec.

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PROJECT

16K EXPANSION

NOW THAT a single chip 16384 bit memories are readily available, even if still a little (I almost wrote bit) expensive, the possibility of using only eight chips to produce a 16k byte memory would seem to be a possibility. Even at the current price of $150 for eight devices this price compares favourably with the 128 devices required if IK static memories were used. Further price reductions are certain, as shown by the 4K memories which were similar price less than a year ago and are now available for around $8 each. Dynamic memories also have the advantage of power savings, and equivalent static memory array (128 x 2102's) would consume nearly six amps at five volts compared with the mere three tenths of an amp of the dynamic array. A dynamic memory can often be added without uprating the power supplies, this would obviously not be the case if IK static devices were used.

Advantages And Disadvantages

If dynamic memories have these obvious advantages why are they not used more widely. The answer is that there are disadvantages as well. To understand how these disadvantages arise the way in which dynamic memories function requires some explanation. In a modern device each storage cell consists of a single MOS transistor and a capacitor (Figure 1), whether the capacitor is charged or discharged indicates whether the bit is a '1' or a '0'. The charge on the capacitor gradually leaks away and must be topped up or refreshed at regular intervals. Additional circuitry must therefore be used to ensure that each storage cell is refreshed at least every 2 mS, this may be effected either by a normal read or write cycle or a special refresh cycle which does not enable the chip. Also, until recently, dynamic memories required special high voltage (12V) circuitry to drive the clock inputs (chip enable).

Overall the added complexity of the refresh circuitry means that unless large memory arrays are being built it is far easier to use static devices. The 16K bit dynamic RAM now makes this effort well worth while. These devices are only available in a 16 pin package and all inputs and outputs are compatible with TTL levels so that standard TTL chips can be used throughout the refresh circuitry.

Squeezing A Quart Into A Pint Pot

Fourteen address lines are required to access 16384 bits, four pins are required for power supplies, two pins to get data in and out and one to indicate whether data is to be read from or written to the device. This makes a total of 21 lines,so how are they squeezed into a 16 pin package? The ingenious answer is to split the 14 address lines into two sets which then require only seven pins. The first seven bits, known as the row address, are stored internally by a signal on the row address strobe (RAS). The remaining seven bits can then be applied to the same pins and again stored by the column address strobe (CAS). This switching or multiplexing of the address lines adds further complication to the circuitry but not as much as might be expected because the refresh addresses also have to be multiplexed onto the same pins. (See Fig.2.).

One advantage of this arrangement is that similar pin configurations can be used for the 4K, 16K and even the much publicised 64K memories.. The last of these only used a single voltage power supply and therefore has two spare pins for the extra address bits. Motorola's version even has provision for automatic refreshing which would eliminate this major disadvantage.

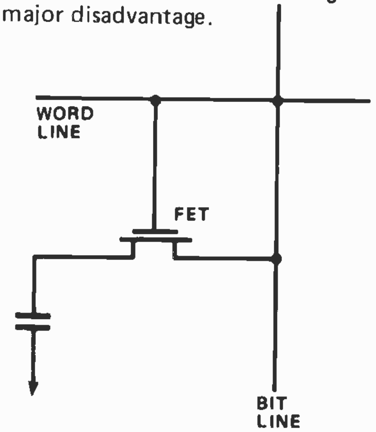


Fig 1. A typical memory cell circuit.

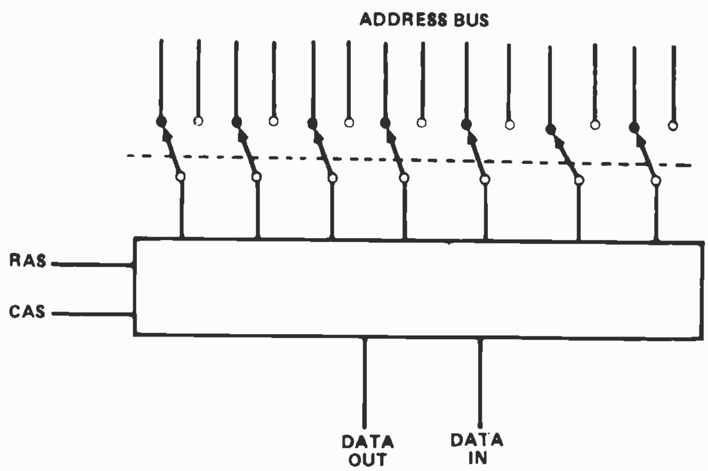


Fig 2. How the chip multiplexes 14 address lines onto 7 pins. The switches are incorporated in the IC itself.

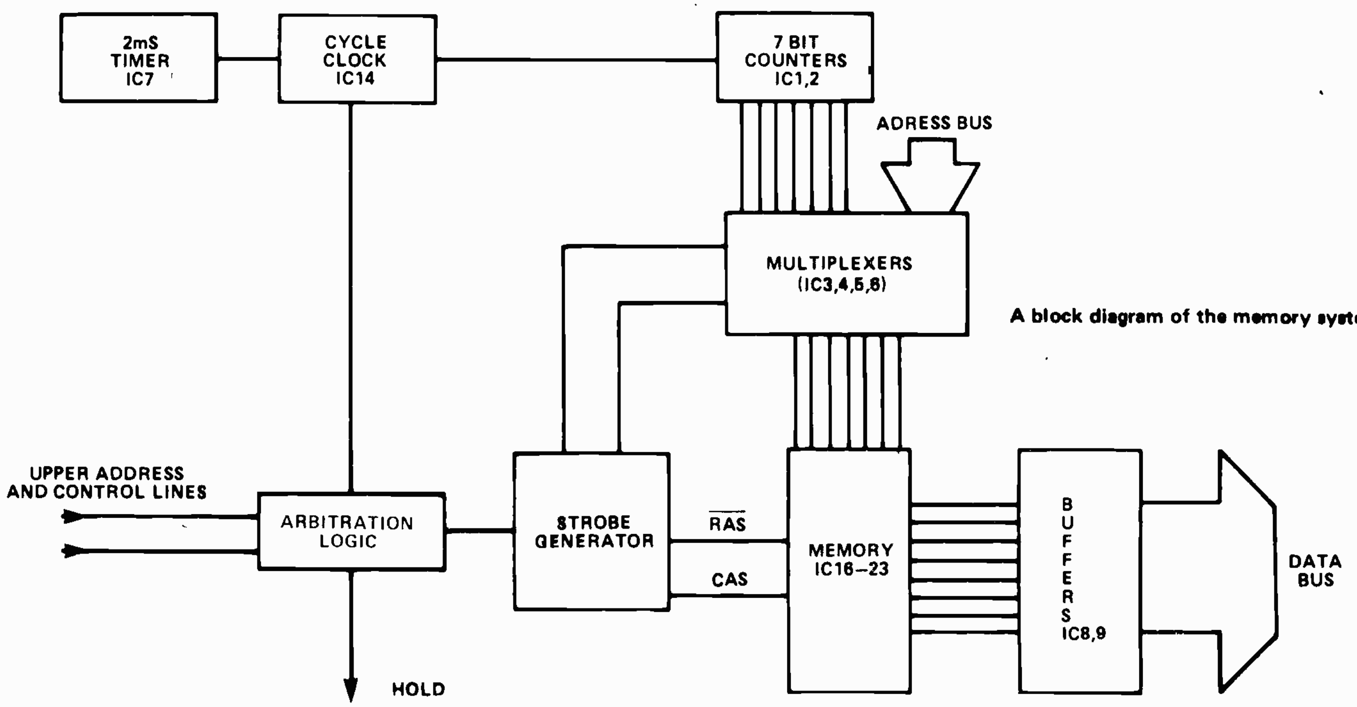
Refreshing

The refresh sequence can be carried out in one of three modes. The first is the burst mode in which normal read or write operation is prevented while all of the 128 combinations of the row address are accessed. The second method is to periodically steal a single cycle from the microprocessor's normal operation to refresh a single row. The third method does not affect normal operation of the microprocessor as the refreshing takes place when the memory is not being used, and is said to be transparent.

Once a refresh, read or write cycle has been started it must not be terminated prematurely. That is another cycle cannot start until the current one has finished otherwise a whole row of data will be lost. This means that either the refresh cycles must be synchronised with the microprocessor clock or logic must be provided to decide whether sufficient time has elapsed since the previous cycle.

Construction

The layout of dynamic memory boards can be critical as nearly all the power is consumed when the CAS and RAS



A block diagram of the memory system.

inputs change state. Efficient decoupling is a must to prevent the transients produced from causing some interesting and unexpected errors. Each chip should be decoupled by at least one ceramic capacitor and the power supply lines especially ground should be as thick as possible. Other signal lines should be kept short. If these precautions are taken veroboard can be used to produce prototype boards but a double sided printed circuit board is highly recommended, and a prototype PCB is shown in Fig.4.

Memory Operation

Outside the burst refresh period the output of the most significant bit of counter IC2 remains high and inhibits the oscillator formed by IC 14 c,d by forcing the output of IC 14c high. When a valid read or write signal occurs the output of IC 12c also goes high. This pulse appears in its inverted form at the output of 14a which in turn enables either the input buffer IC8 or the output buffer IC9 and, after the delay imposed by the RC network and IC 11e, produces a negative going pulse (RAS). This latches the row address supplied by the multiplexers IC3-6. After a short delay produced by IC 13b and IC 10b the multiplexer is switched to the upper seven address bits (column address). The column address is latched into the RAM by the slightly later pulse delayed by IC 13c and IC 10a. The relative timing of these pulses is shown in the figure. At the end of the access period the data is written to or read from the data bus via the buffers IC 8/9. Every 2 mS this process is interrupted by the 10 uS pulse produced by the astable multivibrator formed around IC7. This resets the counters ICI and 2 unless a read or write cycle is in progress in which case the counters are reset only when the cycle is completed. As a result the most significant bit output of IC2 goes low which in turn inhibits the production of the CAS pulses (IC 10a/b), starts the oscillator (IC14 c/d) and produces a hold signal to halt the microprocessor only if it attempts to access the memory during the refresh period (IC 12b, 11f). It also switches the multiplexer from the address bus to the output of the counters ICI/2. The oscillator output provides the clock for the counters and is also delayed by IC 11b, 13a, 14b, 11c to provide the RAS pulse for refreshing the memory. Thus each

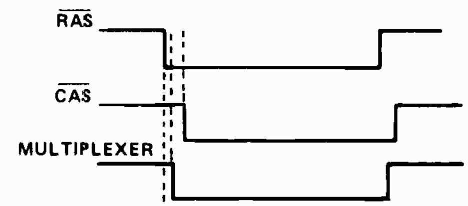


Fig 3. Typical waveforms of the row and column address strobes.

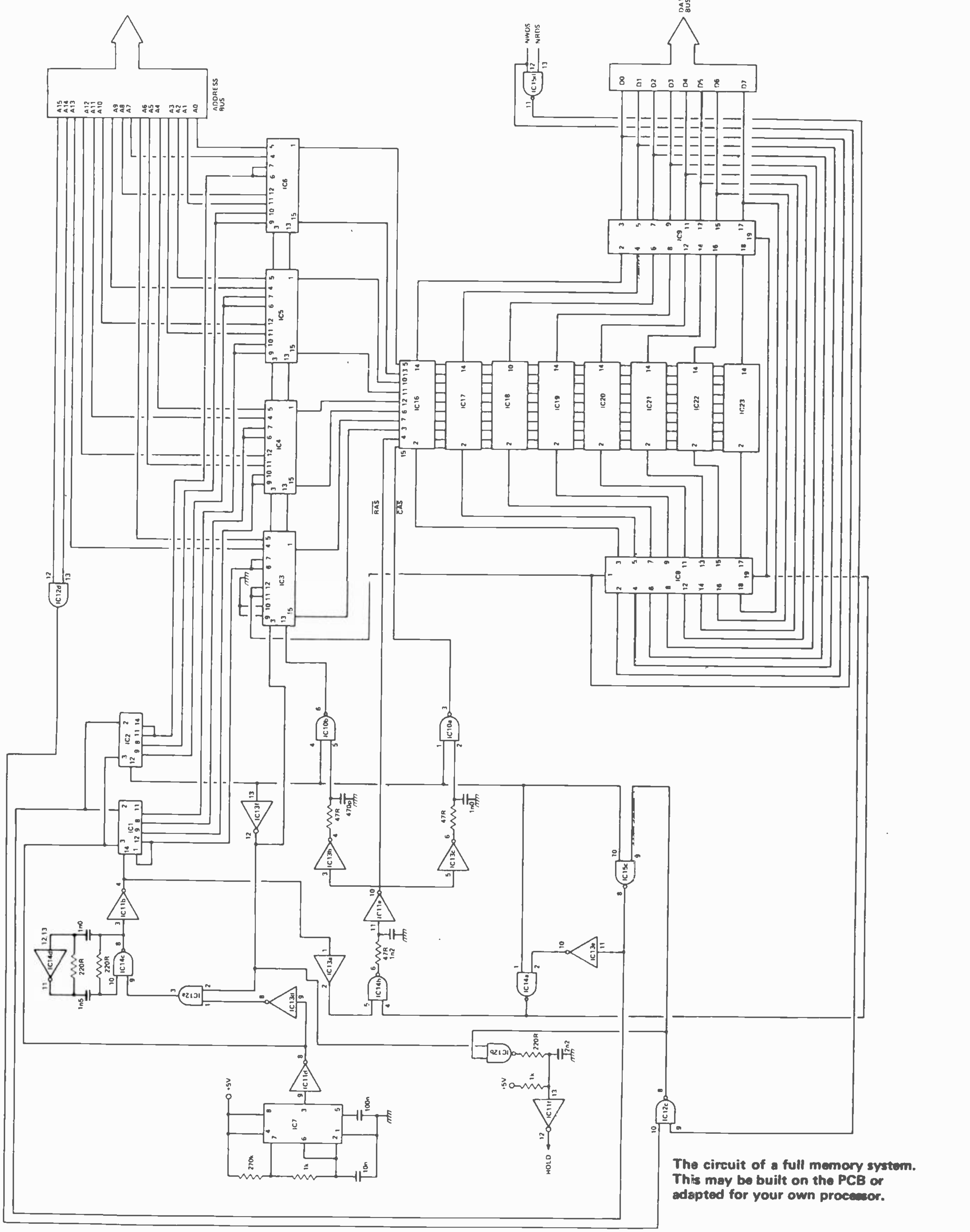
of the 128 row addresses are refreshed by the RAS only method (CAS is inhibited) before the most significant bit of goes high. The circuit then reverts to normal read or write operation.

If the microprocessor attempts to access the memory during refresh it is halted and the read or write cycle is resumed as soon as the burst refresh finishes. The Hold signal remains low until this cycle is complete.

The other gates in the system arbitrate in the case of a request for read or write arriving at the same time as the timer requests a refresh.

Prototyping Board For Dynamic Memories

Ideally a double sided printed circuit board should be used for the construction of reliable memories. One way to overcome this problem is to use the board shown in Fig. 4. This has two thirds of its area devoted to housing 32 memory chips that is, the board could contain 64K bytes of memory if the 16384 bit chips are used or 16K bytes if the cheaper 4096 bit ones are preferred. The remaining portion of the board is laid out to accept a wide range of 0.3" and 0.6"



The circuit of a full memory system. This may be built on the PCB or adapted for your own processor.

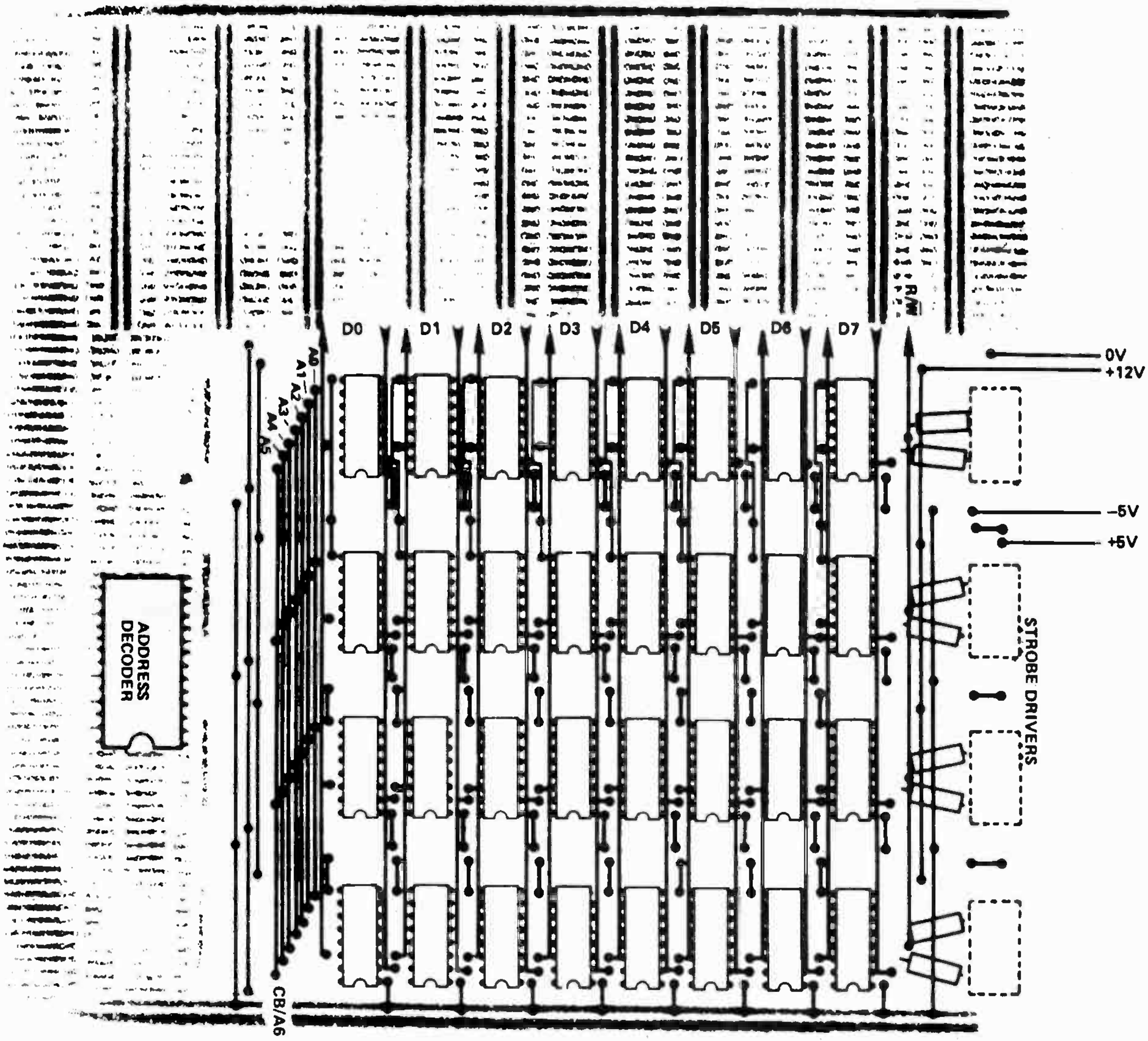


Fig 4. The overlay for the prototyping board.

Please note, Spectrum Electronics will not be supplying the breadboard pcb. For a list of other suppliers, see table of contents.

PARTS LIST

		+5 V	0 V
IC 1,2	7493	pin 5	pin 10
IC 3,4,5,6	9309	pin 16	pin 7
IC 7	555	pin 8	pin 1
IC 8,9	81LS95	pin 20	pin 10
IC 10	74132	pin 14	pin 7
IC 11	7414	pin 14	pin 7
IC 12	7408	pin 14	pin 7
IC 13	7404	pin 14	pin 7
IC 14,15	7400	pin 14	pin 7
IC 16 – 23	F16K	pin 9	pin 16

(-5 V pin 1, +12 V pin 8)

devices. As the two memories differ only in the function of pin 13 it is possible to build a 16K board initially which can then be upgraded to 64K as the price of the larger device falls. Obviously address decoding would have to be altered to take account of the different memory size but apart from this pin 13 can be tied to the column address strobe for chip selection (4K chips) but must obviously be used for the most significant address bit in the 16K devices.

Layout is not critical for most of the ancilliary circuitry except for the drivers for address and strobe lines. These drivers should be located at the ends of the arrays as shown in Fig. 5. If the multiplexer/refresh counter (3242) is used this is capable of driving the high capacitance load provided by thirty two devices, otherwise each row of eight should have its own TTL driver. In view of the ease with which it is possible to interchange the 4K and 16K devices it is recommended that the 16K multiplexer/refresh counter (Intel 3242) is used rather than the 4K version (3232) especially as the difference in cost is minimal. In high performance applications where the required cycle time is very short 22

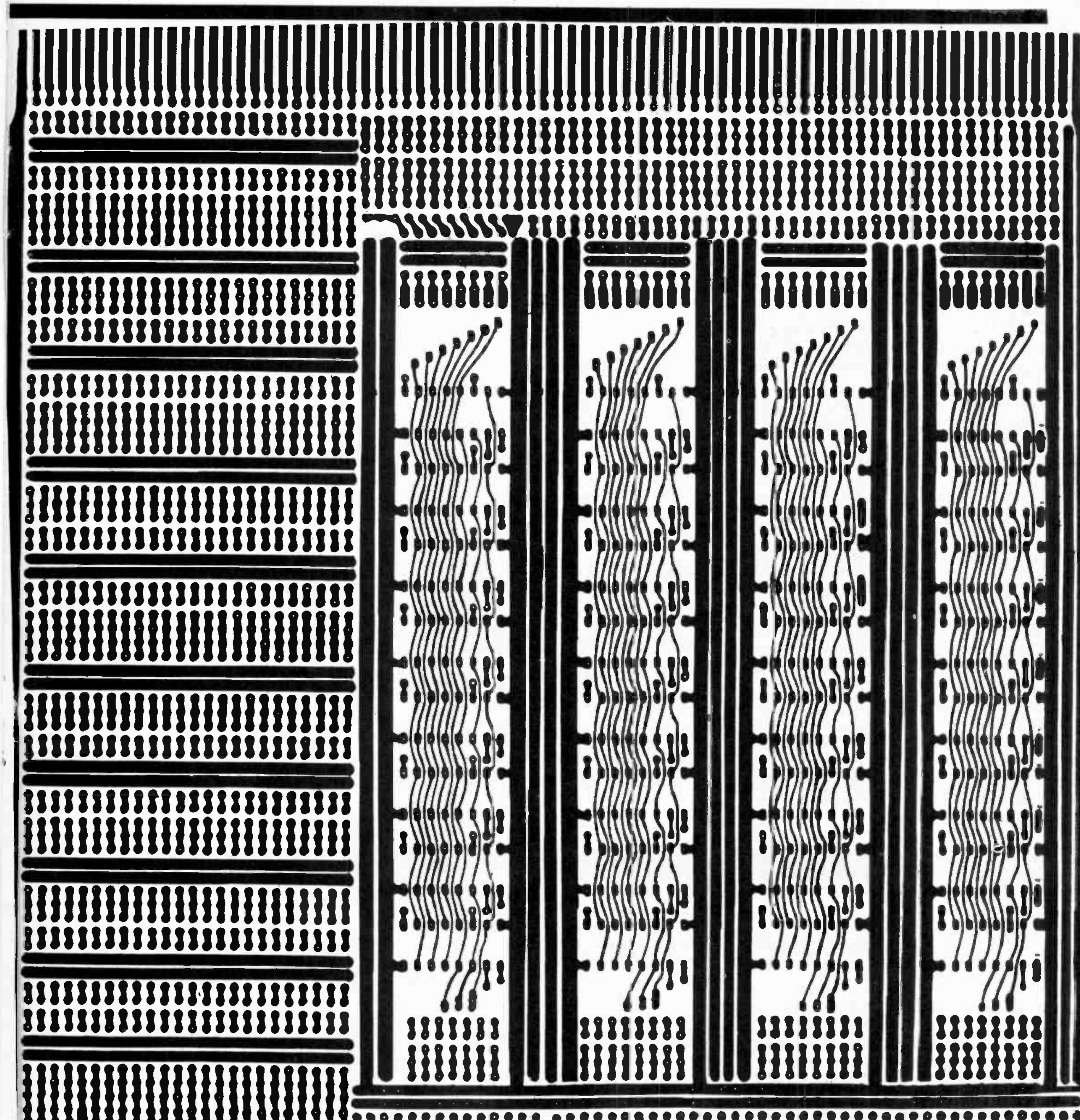


Fig 5. The prototyping PCB foil pattern.

ohm resistors should be put in series with the output of the strobe drivers to reduce transients in these lines (as shown in Fig. 5.).

Care should be taken with decoupling and with the layout of the power supply lines. It is easy to add 0.1 uF ceramic capacitors to decouple the +12 V and –5 V to ground every other device, as close as possible to the pins of the devices. The +5 V supply should be decoupled every eight devices and electrolytic capacitors (4.7 uF) should be used on all three power lines at similar intervals. In addition +12, –5 and O V lines should be strapped by connections not only at each end of the array but at least twice inbet–ween using 0.6mm wire although 0.25mm wire is adequate for the rest of the wiring.●

Service News

A look at the service scene by David Van Ihinger.

THE TV SERVICE industry is on the decline, so said Frank White Jr., President of a large Canadian electronics distributorship, at the meeting of O.T.E.A. at Airport Holiday Inn in Toronto recently. Should this statement discourage shop owners and technicians? I think not. Our trade will require more quality in the '80s. We are now in a transition period between the time when a large number of semi-skilled technicians were required to make frequent repairs, to a time when a smaller group of highly-skilled individuals will make fewer, but more-complicated, repairs to the most sophisticated home entertainment devices ever imagined.

As the older tube-type television sets gradually make way for those that were transistorized, then modular, then IC'd and now computerized; where multi-contacted tuners and controls are giving way to contactless electronics; and high voltage circuits contain more safety devices than functional components, it is obvious that the future of the technician and shop has only one way to go. Up.

Now let's add video cassette recorders, video disc, large-screen TV, flat-screen TV*, Velocity Modulation scanning in larger-screened sets, home computers, Toshiba's voice command TV, multiplex audio TV (in Japan two years already), computer colour with 330 lines of resolution, and the burgeoning cable converters; Where will it end?

There is plenty of room for the technician and shop that is prepared to handle developments as they come along. More time will be required by technicians to take special training, the cost of which will add to the repair bill. More-precise equipment will push costs up and more-complex faults will take more time. So although the frequency of breakdown may be on the decline, we cannot expect the average cost of TV maintenance to decrease.

Now the news.

I would like to quote the New Year's Resolutions of the Professional Electronics Technicians Association, as listed in their newsletter "Association News, E.T.A." January 1980:

1. To reach a membership of 1,000.
2. To certify 500 new techs.
3. To certify 20 MASTER techs.
4. To certify 50 SENIOR techs.
5. To form six new Local Chapters.
6. To form six Student chapters.
7. To produce 10 regional workshops similar to Hastings.
8. To publish the ETA Technical Directory.
9. To help 50 techs locate in higher-pay positions.
10. To help 10 shop-owner members find financial solvency.
11. To help 200 shop-owner members become more profitable.
12. To produce 12 monthly Training Programs—with 12 new authors.
13. To establish a Communications Division of ETA.
14. To establish an Industrial Technicians Division of ETA.
15. To begin a program to distribute "techni-tip" type repair and service "fixes" applicable and distributed to our members on a division basis.

Go to it fellas!

Ontario Television and Electronics Association (O.T.E.A.) Annual Convention May 30, 31 and June 1st at Prince Hotel Toronto. Contact Len Longman, 136 Fenelon Drive M3A 3K6. Phone (416) 444-9291.

Send me your news releases. So far they all go in.

David Van Ihinger

I need at least 2½ months lead time to get them published in time.

* *Channel 1 Newsletter Feb. '80, Missouri Electronic Service Dealers Assoc. NESDA. "Look for a breakthrough in the '80s if flat screen is possible & feasible."*

SPEAKER KIT WAREHOUSE SALE!

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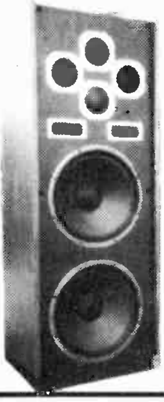

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Rings & meshes are optional at $25.00 ea.

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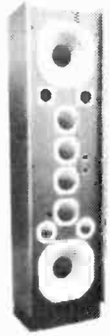

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- Two 3½" Horn Tweeter
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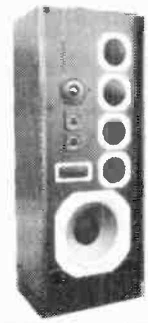


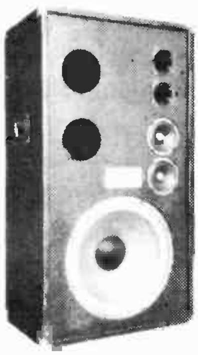
- 20"W, 46"H, 16"D

$112.00 ea.

Kit—A103 *
- One 15" Woofer
- Four 5" Midrange
- One 1" Dome Tweeter
- One 2X5 Horn Tweeter
- Cross over net work (L.C.)
- Terminal, Plan Wire

Rings & meshes are optional at $25.00 ea.

15"—300 Watts RMS ea. System

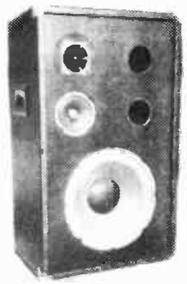


- 21"W, 39"H, 15"D

$149.00 ea.

Kit—A104 *
- One 15" Woofer
- Two 5" Midrange
- Two 3½" Horn Tweeter
- Cross over net work (L.C.)
- Terminal, Plan.

12"—150 Watts RMS ea. System



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$89.00 ea.

Kit—A105 *
- One 12" Woofer
- One 5" Midrange
- One 3½" Horn Tweeter
- Cross over net work (L.C.)
- Terminal, Wire, Plan

15"—150 Watts RMS ea. System

- 18"W, 32"H, 16"D

$99.00 ea.

Kit—A106 *
- One 15" Woofer
- One 5" Midrange
- One 1" Open Dome Tweeter
- One 3½" Horn Tweeter
- One high range Control
- Cross over net work (L.C.)
- Terminal, Plan Wire

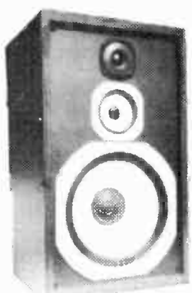
15"—100 Watts RMS ea. System

- 18"W, 28"H, 15"D

$79.00 ea.

Kit—A107 *
- One 15" Woofer
- One 5" midrange
- One 3½" Horn Tweeter
- Cross over net work (L.C.)
- Terminal, Plan Wire

12"—100 Watts RMS ea. System



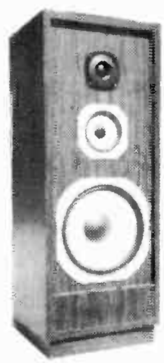
- 15"W, 25"H, 12"D

$60.00 ea.

Kit—A108 *
- One 12" Woofer
- One 5" Midrange
- One 1" Dome Tweeter
- Cross over net work (L.C.)
- Terminal, Plan Wire

Rings are optional at $7.00 ea.

10"—60 Watts RMS ea. System



- 15"W, 25"H, 12"D

$49.00 ea.

Kit—A109 *
- One 10" Woofer
- One 5" Midrange
- One 3" Phenotic Tweeter
- Cross over net work (L.C.)
- Terminal, Plan Wire

* Enclosure (Box) Not Included

WOOFER	
15", 54 oz, 200 Watts	$69.95
15", 30 oz, 100 Watts	$49.95
15", 20 oz, 80 Watts	$42.95
12", 30 oz,150 Watts	$44.95
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12", 20 oz, 80 Watts	$34.95
12", 30 oz, 60 Watts	$29.95
10", 16 oz, 60 Watts	$27.95
8", 18 oz, 80 Watts,	$29.95
8", 10 oz, 30 Watts	$14.95
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5", 5.3 oz, 60 Watts	$7.95
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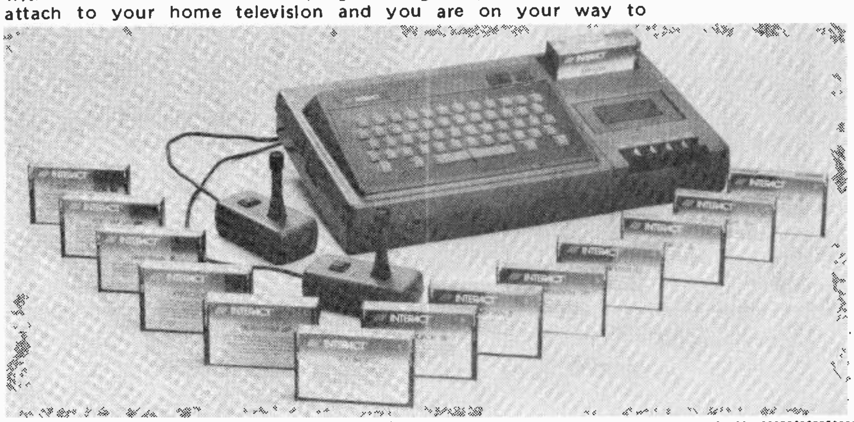

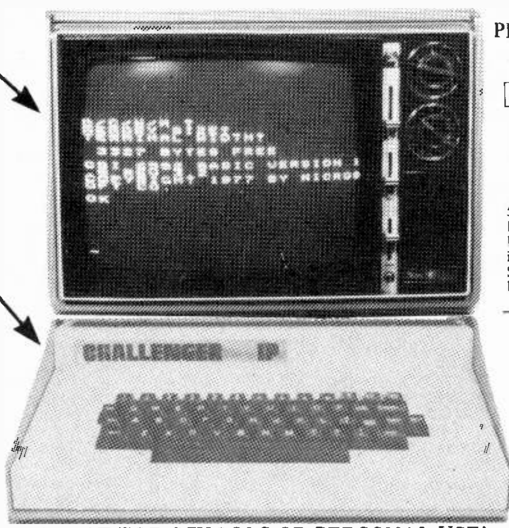

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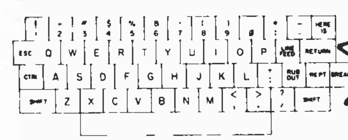
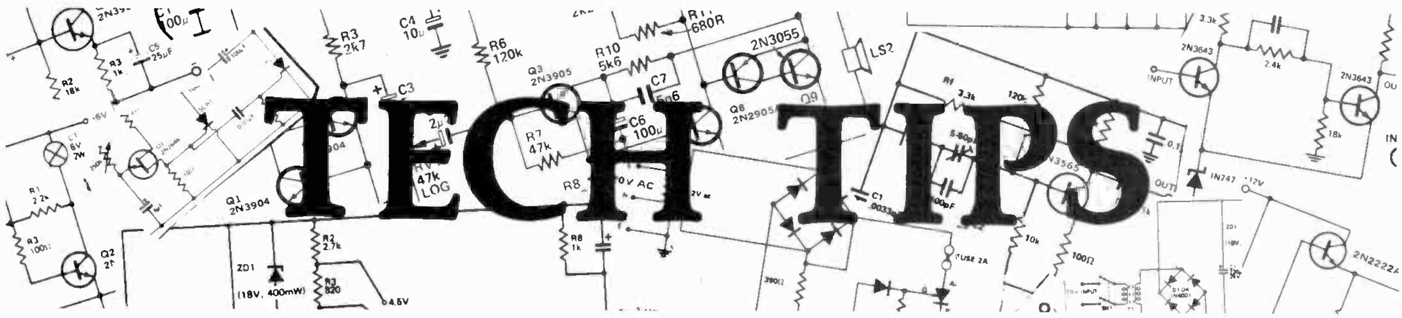




Anti-Acoustic Feedback System For Group or Disco

G.T.Edwards

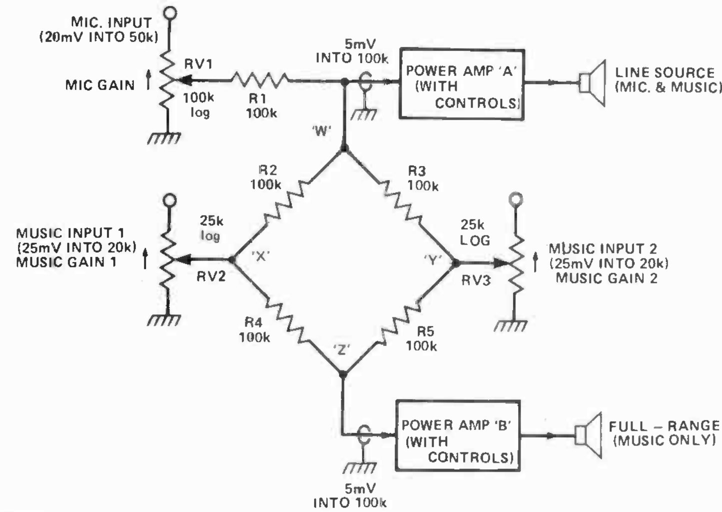
The directional properties of Line-Source Loudspeakers are best for minimising acoustic feedback ("Howl-Round"); unfortunately their bass response is usually inadequate for the full musical range. The ideal system would consist of a completely separated amplifier system for microphone inputs terminating in line-source loudspeakers, the "music" being amplified independently and fed at suitable power levels to less-directional full-range loudspeakers. However, as this is costly and increases transportation problems, a system was evolved in which a full-range non-directional loudspeaker would respond to "music" inputs only, a line-source being used at the same time responding to both "music" and "mic." inputs.

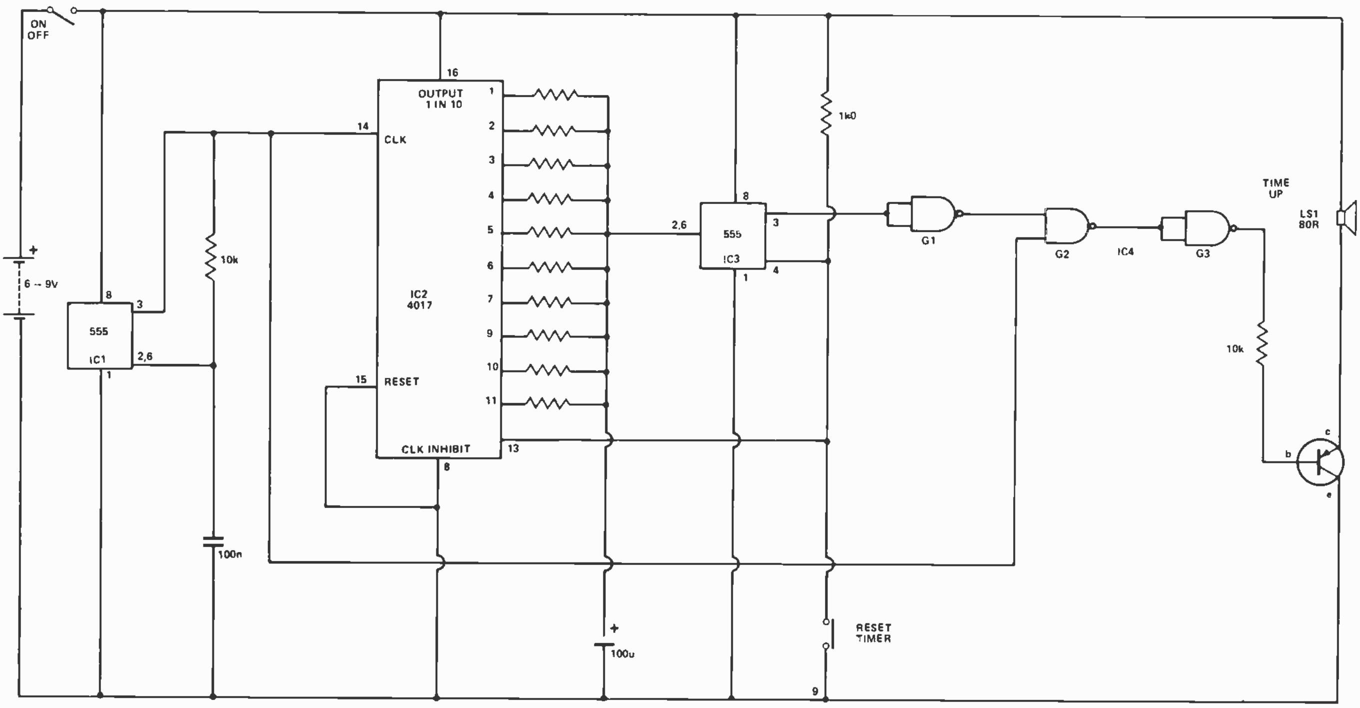
The principle has been proved in practice using the passive network shown in the diagram. As the microphone input is attenuated successively by three potential dividers before reaching the full-range loudspeaker system, the risk of feedback from this speaker is negligible. Typically there is at least 26 dB reduction in microphone signal voltage between the input to amplifier 'A' and the input to amplifier 'B'.

The circuit is easily adapted to other signal levels and impedances by modifying component values on a proportional basis; a more elaborate "active" system is possible using virtual-ground summing amplifier stages.

Simulated stereo is possible from monophonic programme material by connecting a capacitor (about 2n2) between point 'Z' and ground; another capacitor (about 1n0) being connected in series at 'W'.

An inherent advantage of the system is that a "music" output is obtained even if one of the power amplifiers, or one of the loudspeakers, should go faulty during a performance.





Random Delay Timer

This circuit is designed to add to the excitement of many board games. Players must make their moves within a random unknown time. The delays can be adjusted and the circuit uses only four ICs and a few passive components.

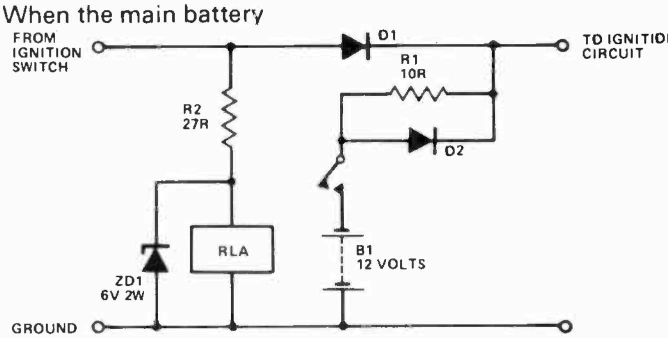
The 555 (IC1) provides a clock frequency for the 4017 and the 'time up' tone frequency. Normally the 4017 clock is inhibited as the clock inhibit pin 13 is high. However, when the 'reset timer' button is pushed, pin 13 is grounded and counting starts. The high output moves wildly between the outputs until the switch is released. Only one output will then be high, which one being entirely a matter of chance. The resistor connected to this high output determines the charging time of the capacitor. For the 100 u capacitor shown, 10 k should be allowed for each second of delay. When the capacitor has sufficiently charged up, IC3 switches off. This is inverted by G1 and appears high. The tone from IC1 is gated by this high signal to drive the loudspeaker via Q1.

Pressing the switch at any time clears the monostable and selects a random delay resistor. The delay resistors can be of any value selected by you. G1-3 are any NAND gates from a single 4011/7400. If the battery voltage is greater than 6 V a 4011 must be used.

Cold Start Ignition

M. C. Polgreen

The heart of the circuit is a small auxiliary battery with a capacity of one or two amp hours. If a nickel cadmium battery is used then R1 should be increased in value so that the maximum trickle charge current is not exceeded. R2, ZD1, and RLA connect B1 into circuit when the ignition is switched on, thereby reducing the amount of additional wiring. Any small 6 volt relay with a contact rating of 5 amps will do, and ZD1, R2 ensure that the relay will remain energised when the starter motor causes the main battery voltage to drop. When the main battery voltage falls, D1 becomes reverse biased and D2 forward biased, therefore allowing B1 to supply current to the ignition circuit. When the engine is running, the main battery voltage rises, forward biases D1 and reverse biases D2. Therefore the ignition current comes from the main battery, and B1 is trickle charged via R1. The two diodes D1, D2 should be rated at 50 V, 10 A.●



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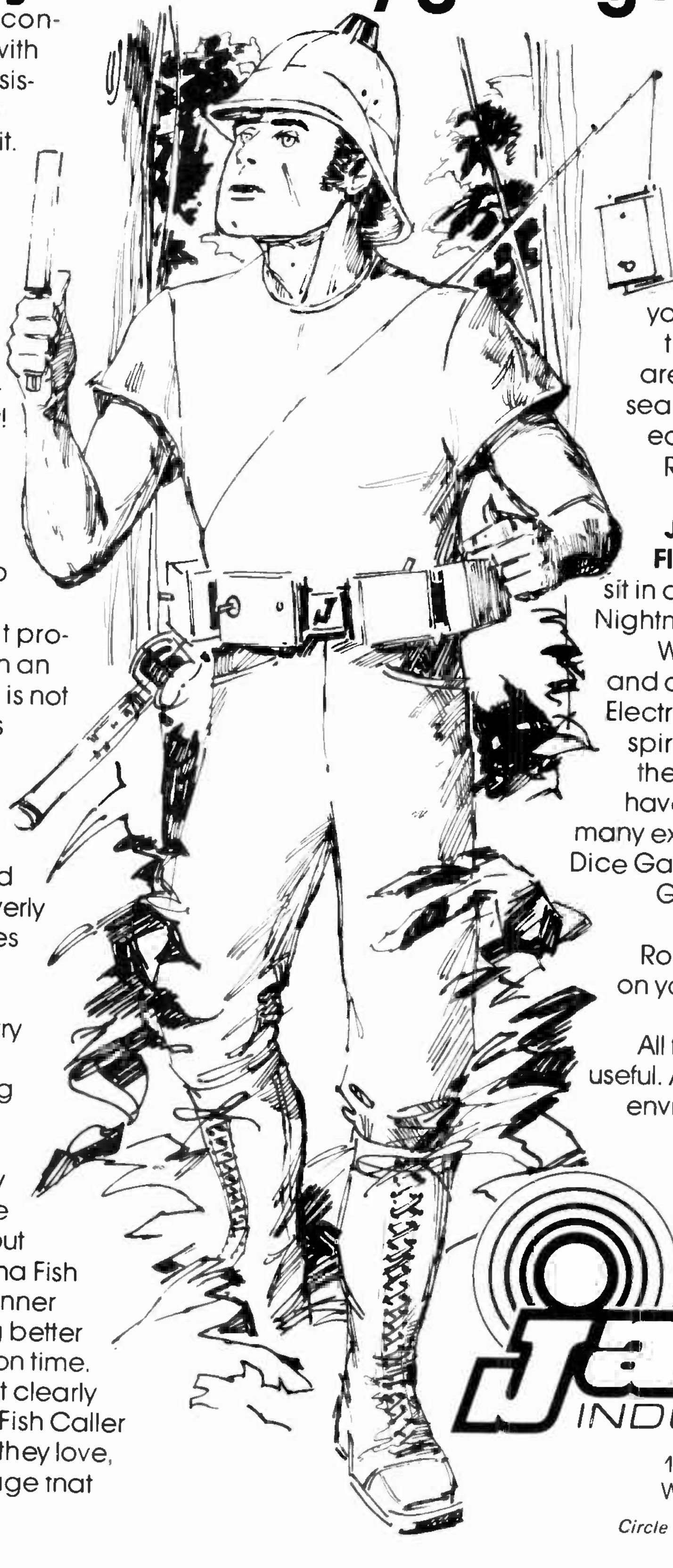

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